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FOREWORD

The evolution of human populations over time and space has been a central concern of many scholars in the Human Settlements and Services Area at IIASA during the past several years. From 1975 through 1978 some of this interest was manifested in the work of the Migration and Settlement Task, which was formally concluded in November 1978. Since then, attention has turned to disseminating the Task's results, to concluding its comparative study, and to exploring possible future activities that might apply the mathematical methodology to other research topics.

This paper is part of the Task's dissemination effort. It is a draft of a chapter that is to appear in a volume entitled *Migration and Settlement: A Comparative Study*. Other selected publications summarizing the work of the Migration and Settlement Task are listed at the back.

Andrei Rogers
former Chairman
of the Human Settlements
and Services Area

CONTENTS

REGIONAL MIGRATION DIFFERENTIALS IN IIASA NATIONS

1. INTRODUCTION

Declining fertility levels and generally stable mortality patterns in the more developed industrialized nations have elevated the relative importance of migration as a contributor to regional population change. Migration affects not only the size of an area's population, but it also alters the composition of that population by selectively adding and subtracting people with distinctive characteristics. Because of its growth and compositional impacts, few governments are indifferent to the patterns of migration that evolve within and across their borders.

The label "migration" has in the past been applied to two related, but different, indicators of mobility: a population of *moves* and a population of *individuals* who have moved. The first concept views migration as an *event* much like birth and death; the second treats migration as a *transition*—a transfer of status analogous to a change in marital or employment status. Thus one of the central problems in migration measurement arises as a consequence of the different sources of migration data.

1.1 Migration Data

Most information regarding migration is obtained from population censuses or population registers that report migration data, for a given time interval, in terms of counts of migrants or of moves, respectively. Migration data produced by censuses are usually in the form of transitions; population registers treat migration as an event and generate data on moves. Yet another source of migration data is the sample survey, which may be designed to provide information both about migrants and about moves.

A mover is an individual who has made a move at least once during a given interval. A migrant on the other hand, is an individual who at the end of a given interval no longer inhabits the same community of residence as at the start of the interval. Thus paradoxically a multiple mover can be a nonmigrant, if after moving several times he returns to his initial place of residence before the end of the unit time interval.

Migration data collected by population censuses usually come from responses to four typical questions that ask about: place of birth, duration of residence, place of last residence, and place of residence at a fixed prior data (United Nations 1970). From the answers to these questions it is possible to establish the count of surviving migrants living in a region at the time of the census, disaggregated by different retrospective time intervals. The longer the time interval, the less accurate becomes the migration measure.

Because population registers focus on moves and not on transitions, differences will arise between data obtained from registers and from population censuses. This inconsistency is examined in the annex to the UN *Manual on Methods of Measuring Internal Migration* (United Nations 1970), where it is stated:

> Since at least some migrants, by census definition, will have been involved, by registration definition, in more than one migratory event, counts from registers should normally exceed those from censuses ... Only with Japanese data has it so far been possible to test the correspondence between migrations, as registered during a one-year period and migrants enumerated in the census in terms of fixed-period change in residence. (United Nations 1970:50)

Table 1, taken from the UN analysis, illustrates how the ratio of register-to-census migration data is in general greater than unity, increasing with decreasing distance, as for example, in the case of intra- versus interprefectural migration in Japan. In general, the ratio of register-to-census migration data should tend to unity as longer distances are involved. It should be greater than unity when short distances are considered, because the probability of moving across long distances several times is expected to be less than the probability of moving the same number of times between short distances.

Finally, migration occurs both over time and across space; therefore, studies of its patterns must trace its occurrence with respect to a time interval, as well as over a system of geographical areas. In general, the longer the time interval, the larger the number of return movers and nonsurviving migrants; hence, the more the count of *migrants* will understate the number of interarea *movers* (and moves). Philip Rees, for example, after examining the ratios of one-year to five-year migrants between the Standard Regions of Great Britain, found that

> ... the number of migrants recorded over five years in an interregional flow varies from four times to two times the number of migrants recorded over one year. (Rees 1977:247)

A fundamental aspect of migration is its change over time. As Ryder (1964) pointed out for the case of fertility, period and cohort reproduction rates will differ whenever the age distribution of childbearing varies from one cohort to another. The usefulness of a cohort approach in migration, as in fertility analysis, lies in the importance of historical experience as an explanation of current behavior. Morrison (1970) indicates that migration is induced by transitions from one stage of the life cycle to another, and "chronic" migrants may artificially inflate the migration rates of origin areas that are heavily populated with migration-prone individuals. Both influences on period migration are readily assessed by a cohort analysis.

Table 1. Comparison of migration by sex and type based on the population register and the census for the one-year period between October 1959 and October 1960, Japan.

Sex and type of migration	Register data	Census data	Ratio x 100
BOTH SEXES			
Intra-prefectural	2,966,621	1,998,171	148.47
Interprefectural	2,625,135	2,590,751	101.33
MALES			
Intra-prefectural	1,488,935	1,001,745	148.63
Interprefectural	1,450,817	1,466,898	98.90
FEMALES			
Intra-prefectural	1,477,686	996,426	148.30
Interprefectural	1,174,318	1,123,853	104.49

SOURCE: United Nations (1970, Table 42:50).

It is the migration of a period, however, and not that of a cohort, that determines the sudden redistribution of a national population in response to economic fluctuations, and its is information on period migration that is needed to calculate spatial population projections.

1.2 Migration Rates and Migration Schedules

The simplest and most common measure of migration is the crude outmigration rate: the ratio of the *number of migrants*, leaving a particular population located in space and time, to the average *number of persons* (more exactly, person-years) exposed to the risk of becoming migrants. Data on nonsurviving migrants are generally unavailable, therefore the numerator in this ratio generally excludes them.

Because migration is highly age selective, with a large fraction of migrants being young, our understanding of migration patterns and dynamics is aided by computing migration rates for each single year of age. Summing these rates over all ages of life gives the *gross migraproduction rate* (GMR), the migration analog of fertility's gross reproduction rate. This rate reflects the level at which migration occurs out of a given region.

The age-specific migration schedules of multiregional populations exhibit remarkably persistent regularities. For example, when comparing the age-specific annual rates of residential migration among whites and blacks in the United States during 1966-1971, one finds a common profile (Figure 1). Migration rates among infants and young children mirrored the relatively high rates of their parents, young adults in their late twenties. The mobility of adolescents was lower but exceeded that of young teens, with the latter showing a local low point around age 15. Thereafter migration rates increased, attaining a high peak at about age 22, and then declined monotonically until the ages of retirement. The migration *levels* of both whites and blacks were roughly similar, with whites showing a GMR of about 14 and blacks one of approximately 15.

Although it has frequently been asserted that migration is strongly sex selective, with males being more mobile than females, recent research indicates that sex selectivity is much less pronounced than age selectivity and is less uniform across time and space. Nevertheless, because most models and studies of population dynamics distinguish between the sexes, most migration measures do also.

Figure 2 illustrates the age profiles of male and female migration schedules in four different countries at about the same point in time between roughly comparable areal units: communes in the Netherlands and Sweden, voivodships in Poland, and counties in the United States. The migration levels for all but Poland are similar, varying between 3.5 and 5.3 migrations per lifetime; and the levels for males and females are roughly the same. The age profiles, however, show a distinct, and consistent, difference. The high peak of the female schedule precedes that of the male schedule by an amount that appears to approximate the difference between the average ages at marriage of the two sexes.

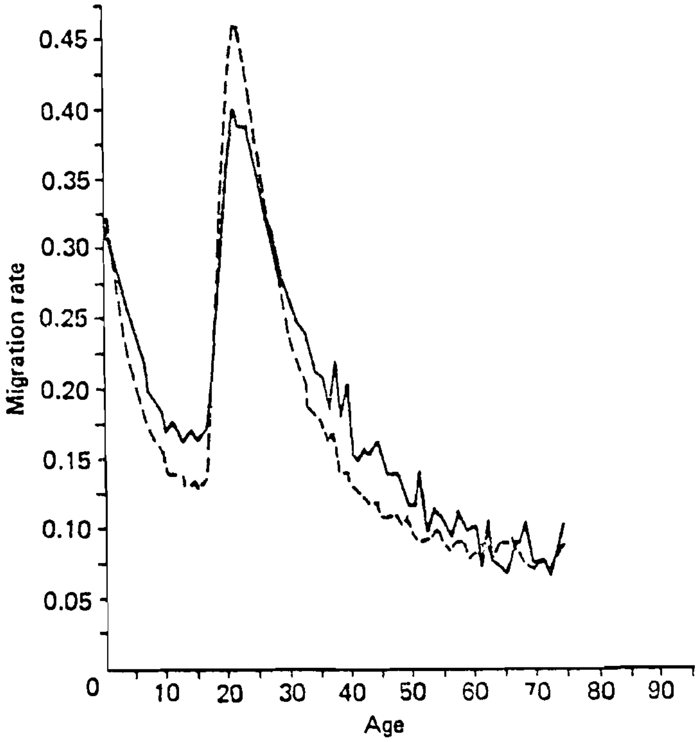

Figure 1. Observed annual migration rates by color (--- white, —— black) and single years of age: the United States, 1966-1971.

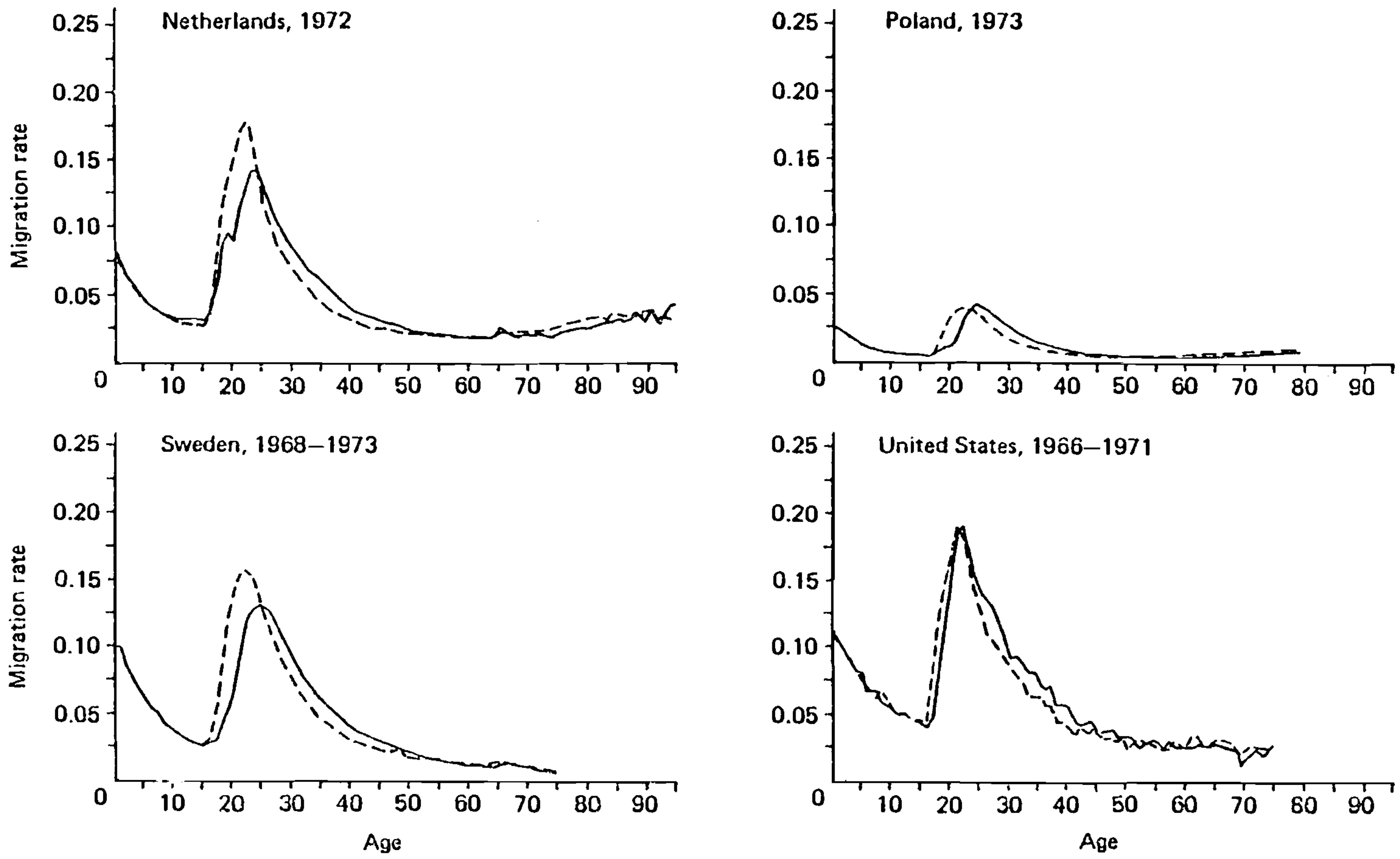

Figure 2. Observed annual migration rates by sex (--- females, —— males) and single years of age: the Netherlands (intercommunal), Poland (intervoivodship), Sweden (intercommunal), and the United States (intercounty), around 1970.

Under normal statistical conditions, point-to-point movements are aggregated into streams between one civil division and another; consequently, the level of interregional migration depends on the size of the areal unit selected. Thus a minor civil division, such as a county or commune, would have a greater proportion of residential relocation included as migration than would a major civil division, such as a state or province.

Figure 3 presents the age profiles of female migration schedules as measured by different sizes of areal units: (1) all migrations from one residence to another, (2) changes of residence within county boundaries, (3) migration between counties, and (4) migration between states. The respective four GMRs are 14.3, 9.3, 5.0, and 2.5. The four age profiles appear to be remarkably similar, indicating that the regularity in age pattern persists across areal delineations of different sizes.

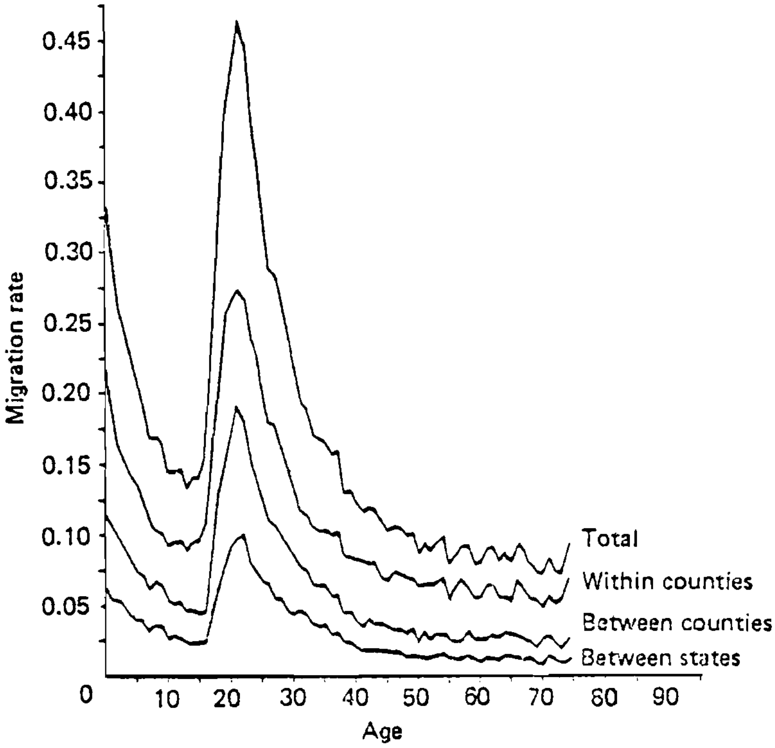

Figure 3. Observed average annual migration rates of females by levels of areal aggregation and single years of age: the United States, 1966-1971.

2. REGIONAL COMPARATIVE ANALYSIS OF MIGRATION: LEVELS

Despite the growing availability of statistics on migration among various administrative areas within the more developed nations, the unresolved problem of how to standardize areal units to reflect different sizes and shapes has hampered international comparisons of geographical mobility levels. To avoid this problem, a few studies have resorted to comparisons of counts of all changes of residence during a specified interval of time (e.g., Long and Boertlein 1976). Table 2 sets out such a comparison by way of illustration.

According to Column 2 of Table 2, about 18.6 percent of the US population moved from one residence to another within the country during a 12-month period around 1980, compared with about 11.1 percent in Great Britain and 12.0 percent in Japan. These data lend support to the hypothesis that rates of geographical mobility are relatively high in the United States.

Table 2. The residentially mobile population in seven countries: around 1970.

Country	Percent moving in one year[a]	
	Including movers from abroad	Excluding movers from abroad
Australia	(NA)	15.7
Canada	(NA)	(NA)
Great Britain	11.8	11.1
Ireland	5.1	4.3
Japan	12.0	12.0
Taiwan	(NA)	9.1
United States	19.2	18.6

NA: not available

[a] Persons one year old and over.

SOURCE: Long and Boertlein (1976:3)

The migration data collected for the Comparative Migration and Settlement Study have a number of crippling deficiencies that make them totally unsuitable for international comparisons of this sort. Not only do they describe flows of people between areas of different sizes and shapes, but also they do so for different moments in time, using time intervals of different widths, and relying on data collected in different ways. Therefore, in this paper, we shall focus only on comparisons of differences *within* (and not *between*) countries. In this way we hope to reduce, as much as possible, the unknown impacts of these deficiencies in the data and to carry out some guarded and rough assessments of *intra*national differentials in migration patterns.

The shape, or *profile*, of an age-specific schedule of migration rates is a feature that may be usefully studied independently of its intensity, or *level*. This is because there is considerable empirical evidence that although the latter tends to vary significantly from place to place, the former is remarkably similar in various communities. Regional differentials in migration levels are examined in this section; a comparison of regional differentials in migration age profiles are studied in the next section. We begin with an examination of differentials among total populations and then go on to consider disaggregations by sex and age.

2.1 Differentials Among Regional Populations

To examine regional differentials in outmigration levels, we must first adopt an aggregate measure of such levels. A convenient indicator is the gross migraproduction rate (GMR): the sum of all age-specific outmigration rates from a region multiplied by the number of years in the age interval (five in our case). It is evident from this definition that a region's gross migraproduction rate is calculated in a way analogous to its gross death rate and its gross reproduction rate. By giving equal weight to each age-specific outmigration rate, this measure avoids the dependence on a particular population's age composition that is exhibited by alternative indicators such as the crude outmigration rate, for example.

The 17 countries of IIASA's Comparative Migration and Settlement Study were divided into a total of 139 regions. Gross migraproduction rates for each country and for each region may be found in the Appendix to this paper. Since the main purpose of this section is to analyze national patterns of regional differentials, we shall focus only on a summary indicator of regional variation within each country. Following the example set by the earlier study of regional differentials in mortality (Termote 1982), we adopt the "mean absolute deviation" (MAD) as our principal indicator, i.e., the sum of the differences between each regional value and the national figure, divided by the number of regions. To control for differences in aggregate levels among nations, we express the mean absolute deviation as a percentage of the national value.

Table 3 sets out the lowest and highest regional gross migraproduction rates for each of IIASA's 17 countries, including in each case the corresponding national figure. In Austria, for example, the national rate in 1971 was 0.35. Among the nine regions into which the country was divided, the lowest rate was 0.22, the highest rate was 0.51, and 0.51 - 0.35 = 0.16 was the "highest absolute deviation". Adding to this figure the other eight absolute deviations and then dividing by nine gives 0.09, the entry at the top of the fourth column of numbers. Expressing this as a percentage of the national gross migraproduction rate yields the 27.0% found at the top of the last column of numbers.

An examination of the last column in Table 3 reveals that considerable regional differentials in levels of outmigration exist in a number of IIASA's countries. Foremost are the high differential countries of Canada (74.2%) and the Federal Republic of Germany (56.8%), with Japan not far behind (41.3%). At the

Table 3. Regional differentials in gross migraproduction rates.

Country (reference year: number of regions)	National (N)	Lowest	Highest	MAD	MAD/N%
Austria (1971:9)	0.35	0.22	0.51	0.09	27.0
Bulgaria (1975:7)	0.31	0.23	0.46	0.07	23.5
Canada (1971:10)	0.77	0.48	2.14	0.57	74.2
Czechoslovakia (1975:10)	0.52	0.31	0.87	0.15	29.6
Fed. Rep. of Germany (1974:11)	1.19	0.74	3.30	0.68	56.8
Finland (1974:12)	1.62	0.85	2.47	0.35	21.9
France (1975:8)	0.84	0.64	1.35	0.19	22.2
German Dem. Rep.(1975:5)	0.44	0.37	0.53	0.07	15.5
Hungary (1974:6)	2.36	1.77	3.19	0.48	20.4
Italy (1978:5)	0.43	0.26	0.54	0.11	25.1
Japan (1970:8)	1.35	0.76	2.37	0.56	41.3
Netherlands (1974:5)	1.10	0.82	1.62	0.22	19.6
Poland (1977:13)	0.66	0.44	1.05	0.12	18.2
Soviet Union (1974:8)	2.20	1.06	3.53	0.70	31.8
Sweden (1974:8)	1.20	0.82	1.47	0.22	18.3
United Kingdom (1970:10)	1.20	0.87	1.84	0.25	20.5
United States (1970:4)	1.31	1.12	1.45	0.10	7.6
Additional Aggregation					
Austria (1971:4)	0.16	0.11	0.23	0.04	25.0
Italy (1978:20)	0.54	0.32	0.10	0.16	30.1

other extreme are the low differential countries of the German Democratic Republic (15.5%), Poland (18.2%), and Sweden (18.3%).* The remaining ten countries exhibit a range of MAD/N % values lying between 20% and 40%.

The particular regional disaggregation adopted for each country has an obvious influence on migration levels and on the degree of regional differences that are observed. In two cases, we have an indication of the impact of regional delineation: Austria and Italy. In the Austrian case study a four-region disaggregation was also studied, and the Italian case study also considered spatial population dynamics in a system of twenty regions. The last two rows of Table 3 indicate that, for these two countries, an increase in the number of regions led to an increase in the degree of spatial differentials in regional migration levels, which is to be expected. What is somewhat surprising is that the amount of the increase was relatively small: from 25.0% to 27.0% in the Austrian case and from 25.1% to 30.1% in the Italian case.

Several city regions are included in the case studies of the Federal Republic of Germany and Poland. If outmigration from such geographically small regions is higher than the average, then of course, the degree of a country's regional differentials is inflated relative to that of nations without city regions. The data on the sample of city regions presented in Table 4, however, suggest that no such simple pattern is evident. In the Federal Republic of Germany outmigration from city regions was about twice as high as the national figure, whereas in Poland it was about the same, with four out of five city regions showing a *lower* than national value. No regularities are evident in the other countries either, except for an apparent association between the level of a city region's gross migraproduction rate and its crude net inmigration rate. All city

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*The United States, with its four very large regions, naturally exhibits an unusually low degree of regional disparity (7.6%); however, the coarseness of the regional disaggregation makes its inclusion unsuitable for our comparative study. Consequently we do not include it in our analysis.

Table 4. Regional differentials in gross migraproduction rates: city regions.

Country (City: reference year)	National (N)	Urban (U)	Difference (U-N)	Net migration rate (per 1000)
Austria (1971)	0.35			
Vienna		0.43	0.08	1.89
Bulgaria (1975)	0.31			
Sofia		0.30	-0.01	5.64
Fed. Rep. of Germany (1974)	1.19			
Hamburg		2.87	1.68	-5.90
Bremen		3.30	2.11	-4.80
Finland (1974)	1.62			
Uusimaa-Helsinki		1.46	-0.16	6.21
France (1975)	0.84			
Paris		1.35	0.51	-2.91
German Dem. Rep. (1975)	0.44			
Berlin		0.50	0.06	11.13
Hungary (1974)	2.36			
Central-Budapest		2.77	0.41	3.66
Japan (1970)	1.35			
Kanto-Tokyo		0.76	-0.59	15.36
Poland (1977)	0.66			
Warsaw		0.50	-0.16	7.78
Lodz		0.59	-0.07	3.23
Gdansk		0.71	0.05	4.57
Katowice		0.44	-0.22	6.84
Cracow		0.63	-0.03	3.09
Sweden (1974)	1.20			
Stockholm		1.45	0.25	-2.99
United Kingdom (1970)	1.20			
South East-London		1.06	-0.14	-0.85
Additional Aggregation				
Czechoslovakia (1975)	0.62			
Prague		0.83	0.21	5.26
Bratislava		0.78	0.16	12.24
Italy (1978)	0.35			
Lazio-Rome		0.52	0.17	1.48
Netherlands (1974)	1.66			
North Holland-Amsterdam		1.75	0.09	-5.82

regions with low GMRs ($\leq 3/4$) gained population through net migration; those with high GMRs ($\geq 1\frac{1}{2}$) lost, with two exceptions: Helsinki and Budapest. The latter, however, is a member of a class of city regions exhibiting positive net inmigration: all East European cities.

To summarize, regional differentials in outmigration levels are roughly twice as strong in some IIASA countries as in others. Apparently these differences are not simply a consequence of different regionalizations. (Austria and Italy stayed in the 20%-40% category despite significantly different degrees of disaggregation.) Nor do they simply reflect the presence or absence of city regions.

Among city regions few generalizations are apparent. Those with low outmigration levels gained from migration exchanges with the rest of the country, whereas those with high GMRs generally lost. City regions in Eastern Europe gained from net migration, whereas those in Western Europe gained or lost, depending on their level of outmigration.

2.2 Differentials Among Sex- and Age-Specific Regional Populations

A study of regional differentials among populations without regard to sex- and age-specific details may hide patterns that are identifiable only at finer levels of resolution. Male and female migration patterns may vary, and infants may exhibit migration rates that differ from those of the elderly.

Table 5 repeats the calculations set out in Table 3 for the seven IIASA countries for which a disaggregation by sex could be made. These figures indicate that regional differentials in migration levels among females are slightly higher than among males in high differential countries, with Japan being the only country in which males show more regional differentials than females. Regional differentials for the two sexes in low differential countries are about the same.

Do females migrate more than males? According to Table 5 they do not. Differences in national levels of the GMR between the sexes are small; nevertheless it does seem that males migrate more than females in high differential countries.

Table 5. Regional differentials in gross migraproduction rates: males and females.

Country (reference year: number of regions)	National (N)	Lowest	Highest	MAD	MAD/N%
Male					
Canada (1971:10)	0.77	0.49	2.12	0.56	72.7
Fed. Rep. of Germany (1974:11)	1.36	0.87	3.68	0.74	54.7
Finland (1974:12)	1.60	0.75	2.33	0.34	21.0
France (1975:8)	0.83	0.62	1.36	0.18	22.1
Japan (1970:8)	1.58	0.88	2.79	0.66	42.0
Sweden (1974:8)	1.18	0.81	1.47	0.22	18.3
United Kingdom (1970:10)	1.23	0.93	1.90	0.25	20.2
Female					
Canada (1971:10)	0.74	0.46	2.13	0.58	78.4
Fed. Rep. of Germany (1974:11)	1.02	0.61	2.89	0.60	58.7
Finland (1974:12)	1.64	0.96	2.63	0.39	23.7
France (1975:8)	0.84	0.65	1.33	0.19	22.2
Japan (1970:8)	1.17	0.63	2.01	0.46	39.6
Sweden (1974:8)	1.21	0.82	1.48	0.23	18.8
United Kingdom (1970:10)	1.17	0.81	1.80	0.24	20.7

Tables 6, 7, and 8 present data on regional migration differentials for three distinct age groups: infants (0-4 years), young adults (15-29 years), and the elderly (65 years and over). Recalling the age profiles of migration set out earlier in this paper, one might reasonably expect these groups to capture the range of diverse patterns of migration behavior. Migration levels should be relatively high among young adults, low among the elderly, and somewhere in between these two extremes among infants.

Of the three high differential countries identified in Table 3, Canada and the Federal Republic of Germany show high regional differentials in all three age groups, with MAD/N % values exceeding 50% in all cases. Japan, on the other hand, shows high regional differentials only in the young adult age group (58.3%). Thus the high differential status of Japan is largely a consequence of the diverse migration behavior of its young adults.

Among the three low differential countries in Table 3, the German Democratic Republic and Sweden exhibit relatively low differentials in all three age groups, with MAD/N % values not exceeding 25% in all cases. But Poland, which in Table 3 had a MAD/N % value under 20%, now shows a slightly higher figure for infants and significantly higher values for young adults and the elderly (31.2% and 35.6%).

Within each of the three age groups considered, no distinct patterns of country differentials are evident. France and the Soviet Union show high regional differentials among the elderly, but exhibit low and moderate differentials, respectively, in the other two age groups. Seven countries have MAD/N % values under 20% for infant migration and four countries have scores this low for the elderly. Yet no pattern emerges. It appears that a more profitable search for regularities might flow from a focus on the entire age profile and its disassociation from migration levels.

Table 6. Regional differentials in gross migraproduction rates: infants (0-4 years).

Country (reference year: number of regions)	National (N)	Lowest	Highest	MAD	MAD/N%
Austria (1971:9)	0.022	0.012	0.041	0.008	36.4
Bulgaria (1975:7)	0.021	0.014	0.034	0.006	30.6
Canada (1971:10)	0.085	0.048	0.228	0.059	69.1
Czechoslovakia (1975:10)	0.056	0.038	0.096	0.016	29.3
Fed. Rep. of Germany (1974:11)	0.083	0.053	0.287	0.058	69.6
Finland (1974:12)	0.202	0.099	0.276	0.036	17.8
France (1975:8)	0.088	0.069	0.126	0.014	16.1
German Dem. Rep. (1975:5)	0.055	0.045	0.076	0.010	18.5
Hungary (1974:6)	0.110	0.086	0.135	0.017	15.3
Italy (1978:5)	0.027	0.017	0.037	0.006	20.7
Japan (1970:8)	0.077	0.062	0.099	0.015	19.2
Netherlands (1974:5)	0.077	0.049	0.105	0.015	19.7
Poland (1977:13)	0.060	0.033	0.086	0.013	21.9
Soviet Union (1974:8)	0.070	0.029	0.099	0.019	26.4
Sweden (1974:8)	0.134	0.093	0.180	0.025	18.6
United Kingdom (1970:10)	0.104	0.082	0.191	0.027	26.2
United States (1970:4)	0.123	0.091	0.148	0.019	15.7
Additional Aggregation					
Austria (1971:4)	0.010	0.008	0.013	0.002	15.0
Italy (1978:20)	0.033	0.018	0.062	0.011	32.1

Table 7. Regional differentials in gross migraproduction rates: young adults (15-29 years).

Country (reference year: number of regions)	National (N)	Lowest	Highest	MAD	MAD/N%
Austria (1971:9)	0.165	0.109	0.246	0.040	24.1
Bulgaria (1975:7)	0.164	0.107	0.284	0.054	33.0
Canada (1971:10)	0.216	0.119	0.756	0.218	101.1
Czechoslovakia (1975:10)	0.202	0.137	0.289	0.048	24.0
Fed. Rep. of Germany (1974:11)	0.521	0.343	1.390	0.281	53.9
Finland (1974:12)	0.772	0.426	1.270	0.204	26.4
France (1975:8)	0.251	0.200	0.287	0.028	11.3
German Dem. Rep. (1975:5)	0.206	0.179	0.246	0.024	11.7
Hungary (1974:6)	1.239	0.866	1.797	0.292	23.5
Italy (1978:5)	0.169	0.086	0.245	0.058	34.6
Japan (1970:8)	0.679	0.269	1.385	0.396	58.3
Netherlands (1974:5)	0.417	0.341	0.698	0.124	29.8
Poland (1977:13)	0.240	0.104	0.402	0.075	31.2
Soviet Union (1974:8)	1.357	0.607	2.443	0.486	35.8
Sweden (1974:8)	0.517	0.341	0.724	0.120	23.3
United Kingdom (1970:10)	0.463	0.360	0.749	0.108	23.4
United States (1970:4)	0.506	0.398	0.568	0.057	11.2
Additional Aggregation					
Austria (1971:4)	0.084	0.054	0.125	0.021	25.0
Italy (1978:20)	0.201	0.099	0.489	0.077	38.4

Table 8. Regional differentials in gross migraproduction rates: elderly (65 years and over).

Country (reference year: number of regions)	National (N)	Lowest	Highest	MAD	MAD/N %
Austria (1971:9)	0.030	0.017	0.041	0.008	28.1
Bulgaria (1975:7)	0.018	0.015	0.025	0.004	20.6
Canada (1971:10)	0.107	0.063	0.253	0.056	52.2
Czechoslovakia (1975:10)	0.090	0.051	0.161	0.027	30.4
Fed.Rep.of Germany (1974:11)	0.139	0.064	0.368	0.077	55.2
Finland (1974:12)	0.060	0.024	0.093	0.015	25.6
France (1975:8)	0.104	0.055	0.283	0.055	52.8
German Dem. Rep. (1975:5)	0.020	0.016	0.028	0.005	25.0
Hungary (1974:6)	0.274	0.214	0.306	0.022	8.2
Italy (1978:5)	0.047	0.037	0.055	0.005	10.6
Japan (1970:8)	0.110	0.085	0.221	0.026	23.9
Netherlands (1974:5)	0.196	0.144	0.253	0.035	17.8
Poland (1977:13)	0.151	0.104	0.317	0.054	35.6
Soviet Union (1974:8)	0.191	0.132	0.471	0.090	47.2
Sweden (1974:8)	0.063	0.039	0.112	0.016	25.0
United Kingdom (1970:10)	0.136	0.061	0.185	0.027	19.9
United States (1970:4)	0.106	0.102	0.113	0.003	3.1
Additional Aggregation					
Austria (1971:4)	0.012	0.009	0.015	0.003	22.9
Italy (1978:20)	0.066	0.042	0.154	0.021	32.3

3. REGIONAL COMPARATIVE ANALYSIS OF MIGRATION: AGE PROFILES

Most human populations experience rates of age-specific fertility and mortality that exhibit remarkably persistent regularities. Consequently, demographers have found it possible to summarize and codify such regularities by means of mathematical expressions called model schedules. Although the development of model fertility and mortality schedules have received considerable attention in demographic studies, the construction of model migration schedules has not, even though the techniques that have been successfully applied to treat the former can be readily extended to deal with the latter.

We began this paper with an examination of regularities in age profile exhibited by empirical schedules of migration rates; we now adopt the notion of model migration schedules to express these regularities in mathematical form. We then use model schedules to examine patterns of variation present in a large number of such schedules. Drawing on this comparative analysis of "observed" model schedules, we develop several "families" of schedules and define a "standard" migration schedule. We then go on to disaggregate age profiles by cause and by family status in an effort to account for their apparent universality.

3.1 Model Migration Schedules

The most prominent regularity found in empirical schedules of age-specific migration rates is the selectivity of migration with respect to age. Young adults in their early twenties generally show the highest migration rates and young teenagers the lowest. The migration rates of children mirror those of their parents; hence the migration rates of infants exceed those of adolescents. Finally, migration streams directed toward regions with warmer climates and into or out of large cities with relatively high levels of social services and cultural amenities often exhibit a "retirement peak" at ages in the mid-sixties or beyond.

Figure 4 illustrates a typical *observed* age-specific migration schedule (the jagged outline) and its graduation by a *model schedule* (the superimposed smooth outline) defined as the sum of four components:

1. A single negative exponential curve of the *pre-labor force ages*, with its rate of descent α_1
2. A left-skewed unimodal curve of the *labor force* ages positioned at mean age μ_2 on the age axis and exhibiting rates of ascent λ_2 and descent α_2
3. An almost bell-shaped curve of the *post-labor force* ages positioned at μ_3 on the age axis and exhibiting rates of ascent λ_3 and descent α_3
4. A constant curve c, the inclusion of which improves the fit of the mathematical expression to the observed schedule

The decomposition described above suggests the following simple sum of four curves (Rogers et al. 1978):

$$\left.\begin{aligned} M(x) &= a_1 \exp(-\alpha_1 x) \\ &+ a_2 \exp\{-\alpha_2(x-\mu_2) - \exp[-\lambda_2(x-\mu_2)]\} \\ &+ a_3 \exp\{-\alpha_3(x-\mu_3) - \exp[-\lambda_3(x-\mu_3)]\} \\ &+ c \end{aligned}\right\} \quad x = 0,1,2,\ldots,z \qquad (1)$$

The labor force and the post-labor force components in equation (1) adopt the "double exponential" curve formulated by Coale and McNeil (1972) for their studies of nuptiality patterns.

The "full" model schedule in equation (1) has 11 parameters: a_1, α_1, a_2, μ_2, α_2, λ_2, a_3, μ_3, α_3, λ_3, and c. The *profile* of the full model schedule is defined by 7 of the 11 parameters: α_1, μ_2, α_2, λ_2, μ_3, α_3, and λ_3. Its *level* is determined by the

α_1 = rate of descent of pre-labor force component
λ_2 = rate of ascent of labor force component
α_2 = rate of descent of labor force component
λ_3 = rate of ascent of post-labor force component
α_3 = rate of descent of post-labor force component
c = constant

x_ℓ = low point
x_h = high peak
x_r = retirement peak
X = labor force shift
A = parental shift
B = jump

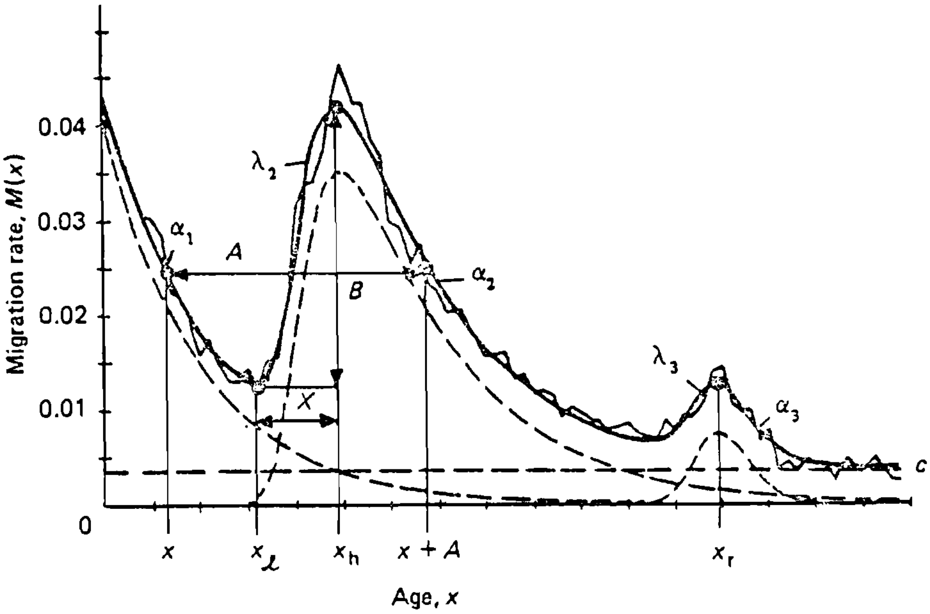

Figure 4. Observed and model migration schedules: males, Stockholm, 1974.

Source: Rogers and Castro (1981b).

remaining 4 parameters: a_1, a_2, a_3, and c. A change in the value of the GMR of a particular model schedule alters proportionally the values of the latter but does not affect the former. As we shall see later in this paper, however, certain aspects of the profile also depend on the allocation of the schedule's level among the pre-labor, labor, and post-labor force age components and on the share of the total level accounted for by the constant term c. Finally, migration schedules without a retirement peak may be represented by a "reduced" model with seven parameters, because in such instances the third component of equation (1) is omitted.

Table 9 sets out estimated values for the basic and derived measures of the model schedule presented in Figure 4. The method chosen for fitting the model schedule to the data is a functional-minimization procedure known as the modified Levenberg-Marquardt algorithm (Appendix A of Rogers and Castro 1981b, Brown and Dennis 1972, Levenberg 1944, Marquardt 1963). Minimum chi-square estimators are used to give more weight to age groups with smaller rates of migration.

To assess the goodness-of-fit that the model schedule provides when it is applied to observed data, we may calculate E, the mean of the absolute differences between estimated and observed values expressed as a percentage of the observed mean:

$$E = \frac{(1/n) \sum_x \left| \hat{M}(x) - M(x) \right|}{(1/n) \sum_x M(x)} 100 \qquad (2)$$

This measure indicates that the fit of the model to the Stockholm data is reasonably good, the index of goodness-of-fit E being 6.87.

Model migration schedules of the form specified in equation (1) may be classified into *families* according to the ranges of values taken on by their principal parameters. For example, we may order schedules according to their migration levels as defined by the values of four level parameters in equation (1), i.e., a_1, a_2, a_3, and c (or by their associated GMRs). Alternatively, we may distinguish schedules with a retirement peak from those without one, or we may refer to schedules with relatively low or high values for the rate of ascent of the labor force curve λ_2 or the mean age $\bar{n}$. In many applications, it is also meaningful to characterize migration schedules in terms of several of the fundamental measures illustrated in Figure 4, such as the low point x_ℓ, the high peak x_h, and the retirement peak x_r. Associated with the first pair of points is the labor force shift X, which is defined to be the difference in years between the ages of the high peak and the low point, i.e., $X = x_h - x_\ell$. The increase in the migration rate of individuals aged x_h over those aged x_ℓ will be called the jump B.

Table 9. Parameters and variables defining observed model migration schedules: outmigration of males from the Stockholm region, 1974 observed data by single years of age.

Parameter or variable	Value	Parameter or variable	Value
GMR[a]	1.45	$\bar{n}$	31.02
a_1	0.033	%(0-14)	25.61
α_1	0.097	%(15-64)	64.49
a_2	0.059	%(65+)	9.90
μ_2	20.80	δ_{1c}	13.56
α_2	0.077	δ_{12}	0.716
λ_2	0.374	δ_{32}	0.003
a_3	0.000	β_{12}	1.26
μ_3	76.55	σ_2	4.86
α_3	0.776	σ_3	0.187
λ_3	0.145	x_ℓ	16.39
c	0.003	x_h	24.68
		x_r	64.80
		X	8.29
		A	27.87
		B	0.029

[a] The GMR, its percentage distribution across the three major age categories (i.e., 0-14, 15-64, 65+), and the mean age $\bar{n}$ are all calculated with a model schedule spanning an age range of 95 years.

The close correspondence between the migration rates of children and those of their parents suggests another important shift in observed migration schedules. If, for each point x on the post-high-peak part of the migration curve, we obtain by interpolation the age (where it exists), $x - A_x$ say, with the identical rate of migration on the pre-low-point part of the migration curve, then the average of the values of A_x, calculated incrementally for the number of years between zero and the low point x_ℓ, will be defined as the observed parental shift A.

An observed (or a graduated) age-specific migration schedule may be described in a number of useful ways. For example, references may be made to the heights at particular ages, to locations of important peaks or troughs, to slopes along the schedule's age profile, to ratios between particular heights or slopes, to areas under parts of the curve, and to both horizontal and vertical distances between important heights and locations. The various descriptive measures characterizing an age-specific model migration schedule may be conveniently grouped into the following categories and subcategories:

1. Basic measures (the 11 fundamental parameters and their ratios)

   heights: a_1, a_2, a_3, c

   locations: μ_2, μ_3

   slopes: $\alpha_1, \alpha_2, \lambda_2, \alpha_3, \lambda_3$

   ratios: $\delta_{1c} = a_1/c,\ \delta_{12} = a_1/a_2,\ \delta_{32} = a_3/a_2,$
   $\beta_{12} = \alpha_1/\alpha_2,\ \sigma_2 = \lambda_2/\alpha_2,\ \sigma_3 = \lambda_3/\alpha_3$

2. Derived measures (properties of the model schedule)

   areas: GMR, %(0-14), %(15-64), %(65+)

   locations: $\bar{n}, x_\ell, x_h, x_r$

   distances: X, A, B

A convenient approach for characterizing an observed model migration schedule (i.e., an empirical schedule graduated by equation (1)) is to begin with the central labor force curve and then to "add on" the pre-labor force, post-labor force, and constant components. This approach is represented graphically in Figure 5.

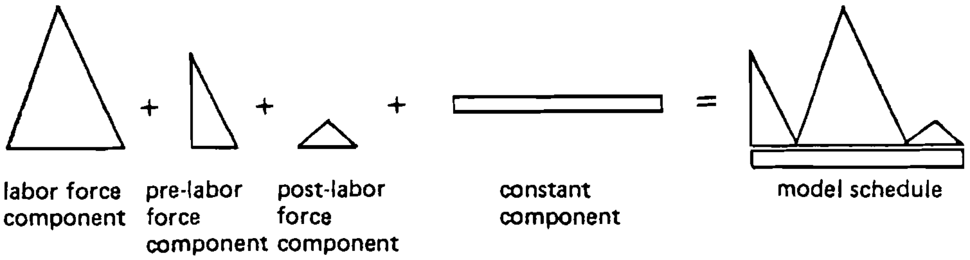

Figure 5. A schematic diagram of the fundamental components of the full model migration schedule.

One can imagine describing a decomposition of the model migration schedule along the vertical and horizontal dimensions; e.g., allocating a fraction of its level to the constant component and then dividing the remainder among the other three (or two) components. The ratio $\delta_{1c} = a_1/c$ measures the former allocation, and $\delta_{12} = a_1/a_2$ and $\delta_{32} = a_3/a_2$ reflect the latter division.

The heights of the labor force and pre-labor force components are reflected in the parameters a_2 and a_1, respectively; therefore the ratio a_2/a_1 indicates the degree of "labor dominance", and its reciprocal, $\delta_{12} = a_1/a_2$, the index of child dependency, measures the pace at which children migrate with their parents. Thus the lower the value of δ_{12}, the lower the degree of child dependency exhibited by a migration schedule and, correspondingly, the greater its labor dominance. This suggests a dichotomous classification of migration schedules into *child dependent* and *labor dominant* categories.

An analogous argument applies to the post-labor force curve, and $\delta_{32} = a_3/a_2$ suggests itself as the appropriate index. It will be sufficient for our purposes, however, to rely simply on the value taken on by the parameter α_3, with positive values pointing out the presence of a retirement peak and a zero value indicating its absence.

Labor dominance reflects the relative migration levels of those in the working ages relative to those of children and pensioners. *Labor asymmetry* refers to the shape of the left-skewed unimodal curve describing the age profile of labor force migration. A convenient indicator of the degree of asymmetry of the curve is the ratio $\sigma_2 = \lambda_2/\alpha_2$.

Again, an analogous argument applies to the post-labor force curve, and $\sigma_3 = \lambda_3/\alpha_3$ may be defined as the index of retirement asymmetry.

When "adding on" a pre-labor force curve of a given *level* to the labor force component, it is also important to indicate something of its *shape*. For example, if the migration rates of children mirror those of their parents, then α_1 should be approximately equal to α_2, and $\beta_{12} = \alpha_1/\alpha_2$, the index of parental-shift regularity, should be close to unity.

Large differences in GMRs give rise to slopes and vertical relationships among schedules that are noncomparable when examined visually. Recourse then must be made to a standardization of the areas under the migration curves, for example, a general rescaling to a GMR of unity. Recall that the principal slope and location parameters and ratios used to characterize model migration schedules are not affected by changes in levels. Only heights, areas, and vertical distances, such as the jump, are level-dependent measures.

3.2 A Comparative Analysis

Section 3.1 demonstrated that age-specific rates of migration exhibit a fundamental age profile, which can be expressed in mathematical form as a model migration schedule defined by a total of 11 parameters. In this section we seek to establish the ranges of values typically assumed by each of these parameters and their associated derived variables. This exercise is made possible by the availability of the relatively large data base on migration flows collected by the Comparative Migration and Settlement Study. The migration data for each of the 17 countries included in this study are set out in individual case study reports, which are listed at the end of this paper.

The age-specific migration rates that were used to demonstrate the fit of the model migration schedule in the last section were single-year rates. Such data are scarce at the regional level and, in our comparative analysis, were available only for Sweden. All other region-specific migration data were reported for five-year age groups only and, therefore, must be interpolated to provide the necessary input data by single years of age. In all such instances the region-specific migration schedules were first scaled to a GMR of unity (GMR = 1) before being subjected to a cubic-spline interpolation (McNeil et al. 1977). Starting with a migration schedule with a GMR of unity and rates by single years of age, the nonlinear parameter estimation algorithm ultimately yields a set of estimates for the model schedule's parameters.

Table 9 referred to results for rates of male migration from the Stockholm region to the rest of Sweden, that is, to the aggregate of the other seven regions that were defined in the Swedish case study. If these rates were to be disaggregated by region of destination, then $8^2 = 64$ interregional schedules would need to be examined for each sex, which would complicate comparisons with other nations. To resolve this difficulty we shall associate a "typical" schedule with each collection of national rates by calculating the mean of each parameter and derived variable.

To avoid the influence of unrepresentative "outlier" observations in the computation of averages defining a typical national schedule, it was decided to delete approximately 10 percent of the "extreme" schedules. Specifically, the parameters and derived variables were ordered from low value to high value; the lowest 5 percent and the highest 5 percent were defined to be extreme values. Schedules with the largest number of low and high extreme values were discarded, in sequence, until only about 90 percent of the original number of schedules remained. This reduced set then served as the population of schedules for the calculation of various summary statistics. Table 10 illustrates the average parameter values obtained with the Swedish data. (The median, mode, standard deviation-to-mean ratio, and lower and upper bounds are also of interest and are included as part of the more detailed computer outputs reproduced in Appendix B of Rogers and Castro 1981b.)

The availability of one-year and five-year age intervals for the same Swedish data allowed us to test whether the interpolation procedure gives satisfactory results. To investigate this, the results of Table 10 were replicated using an aggregation with five-year age intervals. The results, set out in Table 11, indicate that although the interpolation procedure is adequate, the parameter λ_2 is consistently under-estimated with five-year data. This tendency should be noted and kept in mind.

It is also important to note the erratic behavior of the retirement peak, apparently a result of its extreme sensitivity to the loss of information arising from the aggregation. Thus, although we shall continue to present results relating to the post-labor force ages, they will not be a part of our search for families of schedules.

Tables 10 and 11 summarize average parameter values for 57 male and 57 female Swedish model migration schedules. We now shall expand our analysis to include a much larger data base, adding to the 114 Swedish model schedules another 164 schedules from the United Kingdom (Table 12), 114 from Japan, 20 from the Netherlands (Table 13), 58 from the Soviet Union, 8 from the United States, and 32 from Hungary (Table 14). Summary statistics for these 510 schedules are set out in Appendix B of Rogers and

Table 10. Mean values of parameters defining the reduced set of observed model migration schedules: Sweden, 8 regions, 1974 observed data by single years of age until 84 years and over.[a]

	Male		Female	
Parameter	Without retirement peak (48 schedules)	With retirement peak (9 schedules)	Without retirement peak (54 schedules)	With retirement peak (3 schedules)
a_1	0.029	0.026	0.026	0.024
α_1	0.124	0.085	0.108	0.093
a_2	0.067	0.051	0.076	0.055
μ_2	20.50	21.25	19.09	18.87
α_2	0.104	0.093	0.127	0.106
λ_2	0.448	0.416	0.537	0.424
c	0.003	0.002	0.003	0.003
a_3		0.0006		0.0001
μ_3		76.71		74.78
α_3		0.847		0.938
λ_3		0.158		0.170

[a] Region 1 (Stockholm) is a single-commune region; hence there exists no intraregional schedule for it, leaving $8^2 - 1 = 63$ schedules, of which 6 were deleted.

Table 11. Mean values of parameters defining the reduced set of observed model migration schedules: Sweden, 8 regions, 1974 observed data by five years of age until 80 years and over.[a]

Parameter	Male Without retirement peak (49 schedules)	 With retirement peak (8 schedules)	Female Without retirement peak (54 schedules)	 With retirement peak (3 schedules)
a_1	0.028	0.026	0.026	0.026
α_1	0.115	0.088	0.108	0.077
a_2	0.068	0.052	0.080	0.044
μ_2	20.61	20.26	19.52	19.18
α_2	0.105	0.084	0.133	0.089
λ_2	0.396	0.390	0.374	0.341
c	0.002	0.001	0.002	0.002
a_3		0.0017		0.0036
μ_3		77.47		77.72
α_3		0.603		0.375
λ_3		0.148		0.134

[a] Region 1 (Stockholm) is a single-commune region; hence there exists no intraregional schedule for it, leaving $8^2 - 1 = 63$ schedules, of which 6 were deleted.

Table 12. Mean values of parameters defining the reduced set of observed model migration schedules: the United Kingdom, 10 regions, 1970.[a]

Parameter	Male		Female	
	Without retirement peak (59 schedules)	With retirement peak (23 schedules)	Without retirement peak (61 schedules)	With retirement peak (21 schedules)
a_1	0.021	0.016	0.021	0.018
α_1	0.099	0.080	0.097	0.089
a_2	0.059	0.053	0.063	0.048
μ_2	22.00	20.42	21.35	21.56
α_2	0.127	0.120	0.151	0.153
λ_2	0.259	0.301	0.327	0.333
c	0.003	0.004	0.003	0.004
a_3		0.007		0.002
μ_3		71.11		71.84
α_3		0.692		0.583
λ_3		0.309		0.403

[a] No intraregional migration data were included in the United Kingdom data; hence $10^2 - 10 = 90$ schedules were analyzed, of which 8 were deleted.

Table 13. Mean values of parameters defining the reduced set of observed model migration schedules: Japan, 8 regions, 1970; the Netherlands, 12 regions, 1974.[a]

	Japan		Netherlands	
	Male	Female	Male	Female
Parameter	Without retirement peak (57 schedules)	Without retirement peak (57 schedules)	With retirement slope (10 schedules)	With retirement slope (10 schedules)
a_1	0.014	0.021	0.013	0.012
α_1	0.095	0.117	0.080	0.098
a_2	0.075	0.085	0.063	0.084
μ_2	17.63	21.32	20.86	20.10
α_2	0.102	0.152	0.130	0.174
λ_2	0.480	0.350	0.287	0.307
c	0.002	0.004	0.003	0.004
a_3			0.00001	0.00004
α_3			0.077	0.071

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[a] Region 1 in Japan (Hokkaido) is a single-prefecture region; hence there exists no intraregional schedule for it, leaving $8^2 - 1 = 63$ schedules, of which 6 were deleted. The only migration schedules available for the Netherlands were the migration rates out of each region without regard to destination; hence only 12 schedules were used, of which 2 were deleted.

Table 14. Mean values of parameters defining the reduced set of observed total (males plus females) model migration schedules: the Soviet Union, 8 regions, 1974; the United States, 4 regions, 1970-1971; Hungary, 6 regions, 1974.[a]

	Soviet Union	United States	Hungary	
Parameter	Without retirement peak (58 schedules)	With retirement peak (8 schedules)	Without retirement slope (7 schedules)	With retirement slope (25 schedules)
a_1	0.005	0.021	0.010	0.015
α_1	0.302	0.075	0.245	0.193
a_2	0.126	0.060	0.090	0.099
μ_2	19.14	20.14	17.22	18.74
α_2	0.176	0.118	0.130	0.159
λ_2	0.310	0.569	0.415	0.274
c	0.004	0.002	0.004	0.003
a_3		0.002		0.00032
μ_3		81.80		
α_3		0.430		0.033
λ_3		0.119		

[a] Intraregional migration was included in the Soviet Union and Hungarian data but not in the United States data; hence there were $8^2 = 64$ schedules for the Soviet Union, of which 6 were deleted, $6^2 = 36$ schedules for Hungary, of which 4 were deleted, and $4^2 - 4 = 12$ schedules for the United States, of which 2 were deleted because they lacked a retirement peak and another 2 were deleted because of their extreme values.

Castro 1981b; 206 are male schedules, 206 are female schedules, and 98 are for the combination of both sexes (males plus females).*

A significant number of schedules exhibited a pattern of migration in the post-labor force ages that differed from that of the 11-parameter model migration schedule defined in equation (1). Instead of a retirement peak, the age profile took on the form of an "upward slope". In such instances the following 9-parameter modification of the basic model migration schedule was introduced

$$\left.\begin{aligned} M(x) = {} & a_1 \exp(-\alpha_1 x) \\ & + a_2 \exp\{-\alpha_2(x-\mu_2) - \exp[-\lambda_2(x-\mu_2)]\} \\ & + a_3 \exp(\alpha_3 x) \\ & + c \end{aligned}\right\} \quad x = 0,1,2,\ldots,z \qquad (3)$$

The right-hand side of Table 13, for example, sets out the mean parameter estimates of this modified form of the model migration schedule for the Netherlands.

Tables 10 through 14 present a wealth of information about national patterns of migration by age. The parameters, given in columns, define a wide range of model migration schedules. Four refer only to migration level: a_1, a_2, a_3, and c. Their values are for a GMR of unity; to obtain corresponding values for other levels of migration, these four numbers need to be multiplied by the desired level of GMR. For example, the observed GMR for female migration out of the Stockholm region in 1974 was 1.43. Multiplying $a_1 = 0.029$ by 1.43 gives 0.041, the appropriate value of a_1 with which to generate the migration schedule having a GMR of 1.43.

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*This total does not include the 56 schedules excluded as "extreme". During the process of fitting the model schedule to these more than 500 interregional migration schedules, a frequently encountered problem was the occurrence of a negative value for the constant c. In all such instances the initial value of c was set equal to the lowest observed migration rate, and the nonlinear estimation procedure was started once again.

The remaining model schedule parameters refer to migration age profile: α_1, μ_2, α_2, λ_2, μ_3, α_3, and λ_3. Their values remain constant for all levels of the GMR. Taken together, they define the age profile of migration from one region to another. Schedules without a retirement peak yield only the four profile parameters: α_1, μ_2, α_2, and λ_2, and schedules with a retirement slope have an additional profile parameter α_3.

A detailed analysis of the parameters defining the various classes of schedules is beyond the scope of this study. Nevertheless a few basic contrasts among national average age profiles may be usefully highlighted.

Let us begin with an examination of the labor force component defined by the four parameters a_2 (level), μ_2 (mean age), α_2 (rate of descent), and λ_2 (rate of ascent). The national average values for these parameters generally lie within the following ranges:

$$0.05 < a_2 < 0.10$$

$$17 < \mu_2 < 22$$

$$0.10 < \alpha_2 < 0.20$$

$$0.25 < \lambda_2 < 0.60$$

In all but two instances, the female values for a_2, α_2, and λ_2 are larger than those for males. The reverse is the case for μ_2, with two exceptions, the most important of which is exhibited by Japan's females, who consistently show an older mean age of migration during the labor force years than do males. This apparently is a consequence of the tradition in Japan that girls leave the family home at a later age than boys.

The two parameters defining the pre-labor force component, a_1 and α_1, generally lie within the ranges 0.01-0.03 and 0.08-0.12, respectively. The exceptions are the Soviet Union and Hungary, which exhibit unusually high values for α_1. Unlike the case of the labor force component, consistent sex differentials are difficult to identify.

Average national migration age profiles, like most aggregations, hide more than they reveal. Some insight into the ranges of variations that are averaged out may be found by consulting the lower and upper bounds and standard-deviation-to-mean ratios for each set of national schedules listed in Appendix B of Rogers and Castro (1981b). Table 15 illustrates how parameters vary in several *unaveraged* national schedules, by way of example. The model schedules presented there describe migration flows out of and into the capital regions of each of six countries: Helsinki, Finland; Budapest, Hungary; Tokyo, Japan; Amsterdam, the Netherlands; Stockholm, Sweden; and London, the United Kingdom. All are illustrated in Figure 6.

The most apparent difference between the age profiles of the outflow and inflow migration schedules of the six national capitals is the dominance of young labor force migrants in the inflow; that is, proportionately more migrants in the young labor force ages appear in the inflow schedules. The larger values of the product $a_2\lambda_2$ in the inflow schedules and of the ratio $\delta_{12} = a_1/a_2$ in the outflow schedules indicate this labor dominance.

A second profile attribute is the degree of asymmetry in the labor force component of the migration schedule, i.e., the ratio of the rate of ascent λ_2 to the rate of descent α_2 defined as σ_2. In all but the Japanese case, the labor force curves of the capital-region outmigration profiles are more asymmetric than those of the corresponding inmigration profiles. We refer to this characteristic as labor asymmetry.

Examining the observed rates of descent of the labor (α_2) and pre-labor force (α_1) curves, we find, for example, that they are close to being equal in the outflow schedules of Helsinki and Stockholm and are highly unequal in the cases of Budapest, Tokyo, and Amsterdam. In four of the six capital-region inflow profiles $\alpha_2 > \alpha_1$. Profiles with significantly different values for α_2 and α_1 are said to be irregular.

Table 15. Parameters defining observed total (males plus females) model migration schedules for flows from and to capital cities: Finland,, 1974; Hungary, 1974; Japan, 1970; the Netherlands, 1974; Sweden, 1974; the United Kingdom, 1970.

	Finland		Hungary		Japan	
Parameter	From Helsinki	To Helsinki	From Budapest	To Budapest	From Tokyo	To Tokyo
a_1	0.037	0.024	0.015	0.008	0.019	0.008
α_1	0.127	0.170	0.239	0.262	0.157	0.149
a_2	0.081	0.130	0.082	0.094	0.064	0.096
μ_2	21.42	22.13	17.10	17.69	20.70	15.74
α_2	0.124	0.198	0.130	0.152	0.111	0.134
λ_2	0.231	0.231	0.355	0.305	0.204	0.577
c	0.000	0.003	0.003	0.003	0.003	0.002
a_3	0.00027		0.00001	0.00005	0.00002	0.00131
μ_3	99.32					
α_3	0.204		0.072	0.059	0.061	0.000
λ_3	0.042					

Table 15. Continued.

Parameter	Netherlands		Sweden		United Kingdom	
	From Amsterdam	To Amsterdam	From Stockholm	To Stockholm	From London	To London
a_1	0.015	0.012	0.028	0.018	0.015	0.014
α_1	0.085	0.108	0.098	0.102	0.090	0.072
a_2	0.050	0.093	0.046	0.093	0.048	0.067
μ_2	21.62	19.66	20.48	19.20	19.65	18.81
α_2	0.141	0.150	0.095	0.134	0.111	0.123
λ_2	0.284	0.288	0.322	0.323	0.327	0.320
c	0.002	0.003	0.003	0.002	0.005	0.004
a_3	0.00229	0.00002	0.00004	0.00003	0.00003	
μ_3			80.32	73.19	81.13	
α_3	0.012	0.066	0.616	1.359	0.676	
λ_3			0.105	0.255	0.112	

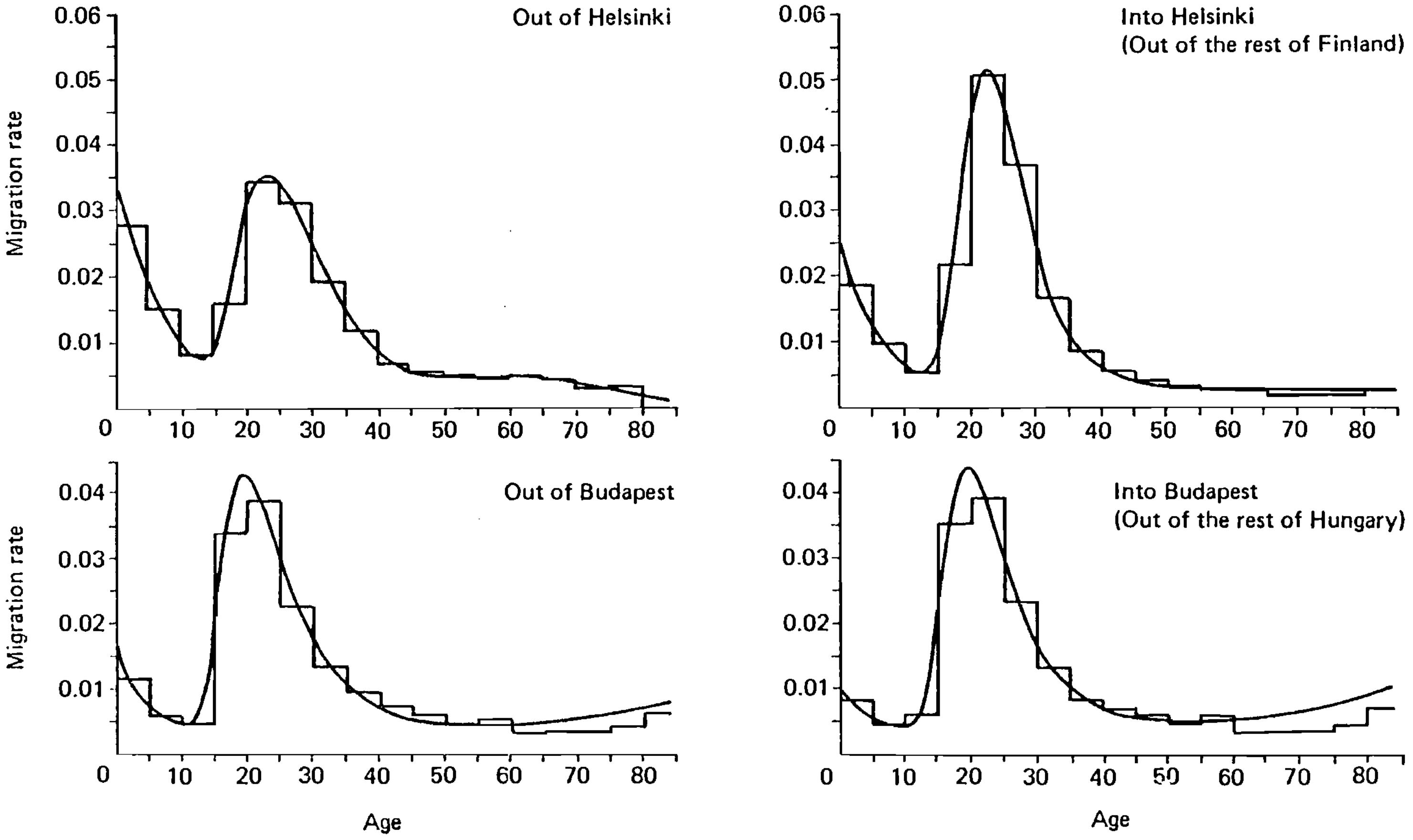

Figure 6. Migration age profiles of outflows from and inflows to capital cities: Helsinki, Budapest, Tokyo, Amsterdam, Stockholm, and London.

Source: Rogers and Castro (1981b).

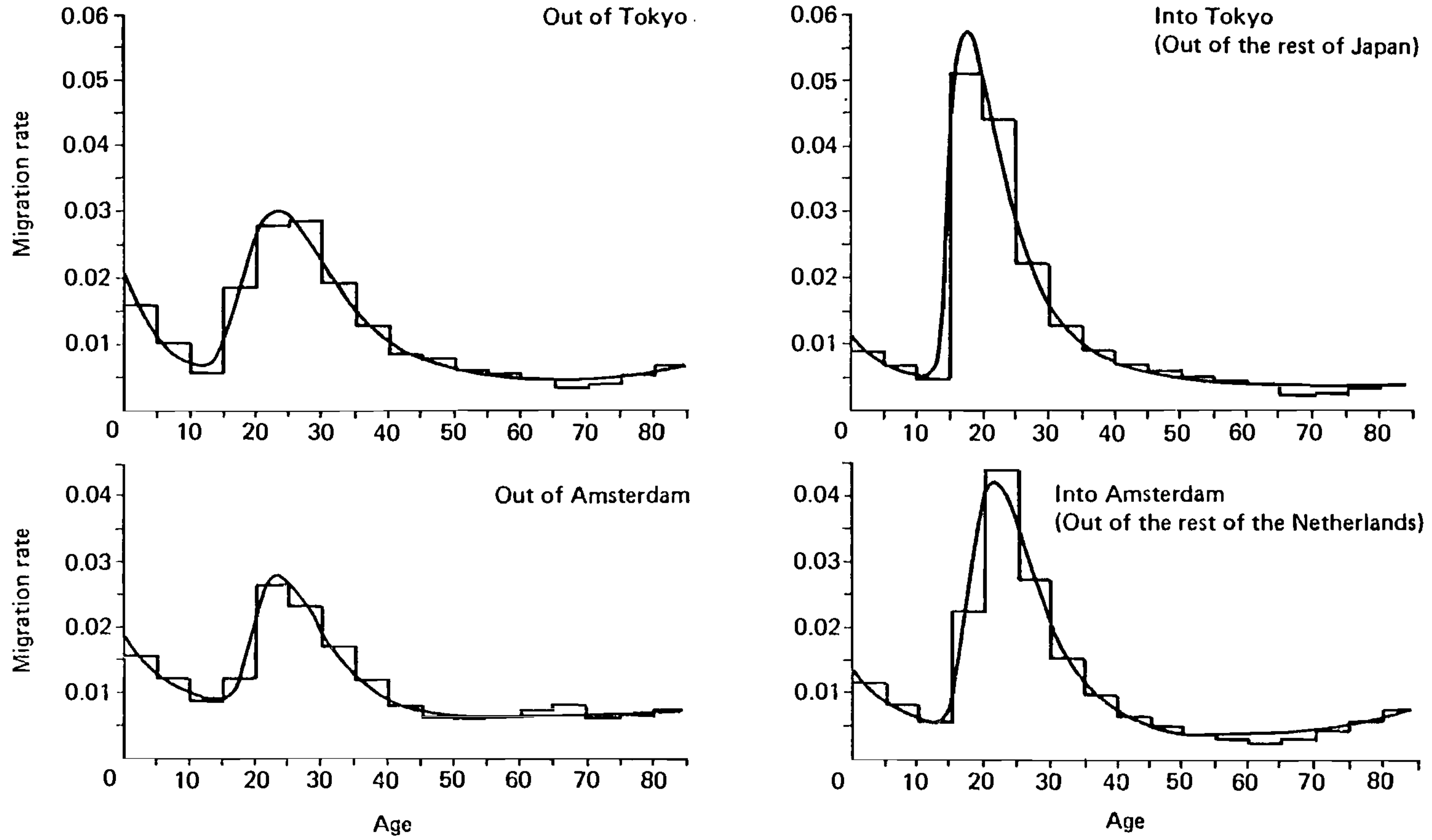

Figure 6. Continued.

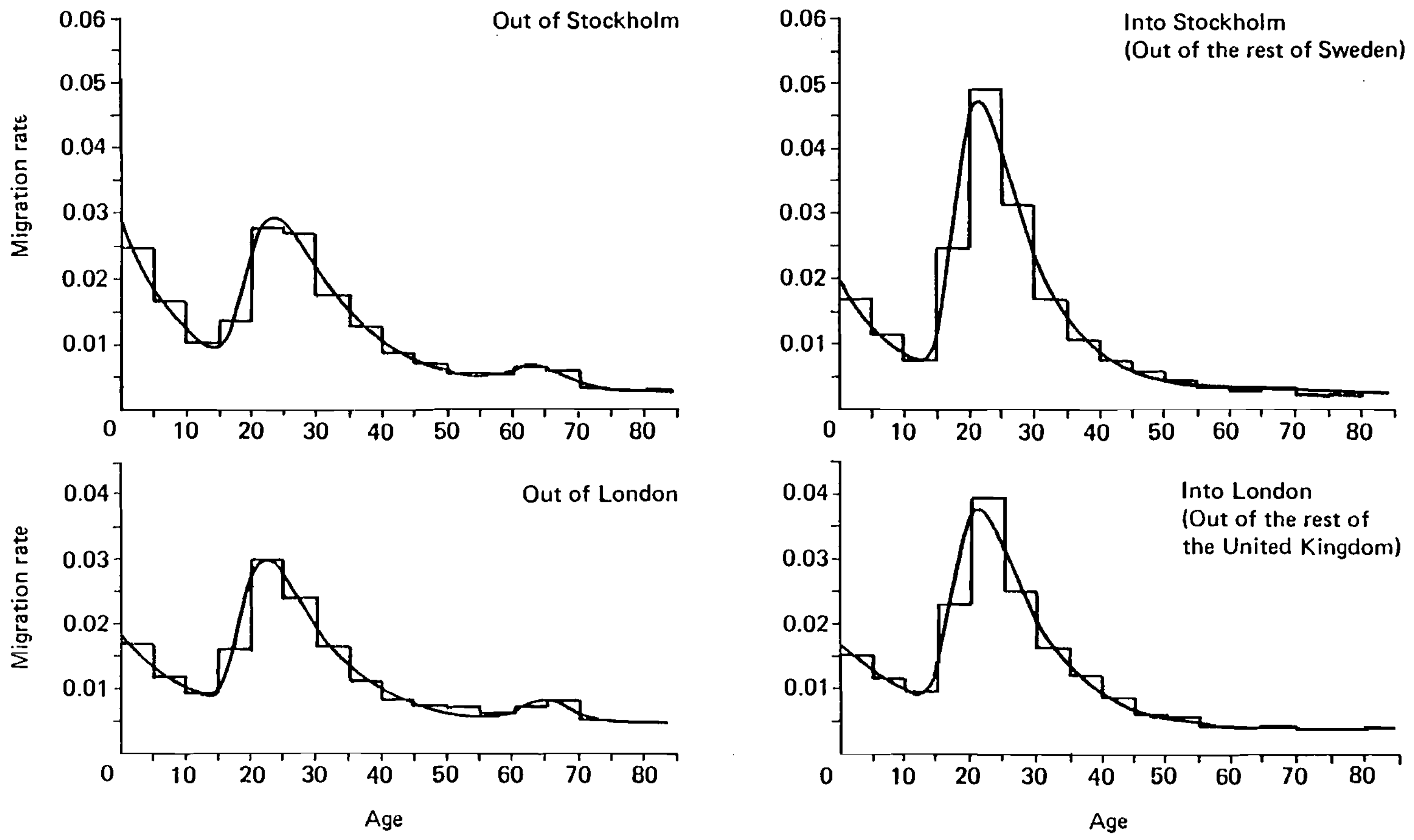

Figure 6. Continued.

In conclusion, the empirical migration data of six industrialized nations suggest the following hypothesis. *The age profile of a typical capital-region inmigration schedule is, in general, more labor dominant and more labor symmetric than the age profile of the corresponding capital-region outmigration schedule.* No comparable hypothesis can be made regarding its anticipated degree of irregularity.

3.3 Families of Schedules and a Basic Standard Schedule

Three sets of model migration schedules have been defined in this paper: the 11-parameter schedule with a retirement peak, the alternative 9-parameter schedule with a retirement slope, and the simple 7-parameter schedule with neither a peak nor a slope. Thus we have at least three broad families of schedules.

Additional dimensions for classifying schedules into families are suggested by the above comparative analysis of national migration age profiles and the basic measures and derived variables defined in section 3.1. These dimensions reflect different locations on the horizontal and vertical axes of the schedule, as well as different ratios of slopes and heights.

Of the 524 model migration schedules studied in this section, 412 are sex-specific and, of these, only 336 exhibit neither a retirement peak nor a retirement slope. Because the parameter estimates describing the age profile of post-labor force migration behave erratically, we shall restrict our search for families of schedules to these 164 male and 172 female model schedules, summary statistics for which are set out in Tables 16 and 17.

An examination of the parametric values exhibited by the 336 migration schedules summarized in Tables 16 and 17 suggests that a large fraction of the variation shown by these schedules is a consequence of changes in the values of the following four parameters and derived variables: μ_2, δ_{12}, σ_2, and β_{12}.

Table 16. Estimated summary statistics of parameters and variables associated with reduced sets of observed model migration schedules for Sweden, the United Kingdom, and Japan: males, 164 schedules.

Parameter or variable	Summary statistics						
	Lowest value	Highest value	Mean value	Median	Mode	Standard deviation	Standard deviation/ mean
GMR (observed)	0.00539	1.81309	0.22642	0.13176	0.09578	0.27380	1.20928
GMR (model)	1.00000	1.00000	1.00000	1.00000	1.00000	0.00000	0.00000
E	4.75751	62.98674	16.22228	13.10527	13.49189	9.95789	0.61384
a_1	0.00173	0.04891	0.02084	0.01992	0.01824	0.00879	0.42204
α_1	0.00009	0.40526	0.10491	0.10390	0.10138	0.05358	0.51077
a_2	0.01559	0.22707	0.06716	0.06471	0.06846	0.02578	0.38391
μ_2	14.68744	43.96579	20.04227	19.67385	19.07919	3.95015	0.19709
α_2	0.03471	0.29735	0.11164	0.10618	0.10037	0.04389	0.39316
λ_2	0.06951	1.76712	0.39110	0.37244	0.31650	0.21146	0.54068
c	0.00003	0.00704	0.00266	0.00263	0.00248	0.00130	0.48947
$\bar{n}$	24.71596	40.53283	30.71751	30.41339	30.25187	2.72144	0.08860
%(0-14)	4.92484	29.69068	18.93871	19.02262	18.54605	4.91304	0.25942
%(15-64)	60.27293	86.29065	72.08085	71.29800	66.77736	5.10213	0.07078
%(65+)	1.35294	17.31658	8.98045	8.71650	8.53658	3.49047	0.38867
δ_{1c}	0.37762	712.88135	14.36314	6.79034	36.00280	56.75620	3.95152
δ_{12}	0.02274	1.53679	0.35774	0.33571	0.24985	0.20221	0.56523
β_{12}	0.00092	7.47530	1.11318	1.02442	1.12208	0.81866	0.73542
σ_2	0.30349	24.23831	4.27564	3.42123	3.89371	3.26113	0.76272
x_ℓ	6.91004	18.26030	13.72508	13.34019	12.01766	2.14485	0.15627
x_h	17.11028	28.14053	22.50278	22.95041	23.17692	2.14731	0.09542
X	2.90007	16.93039	8.77770	8.38019	7.81068	2.28557	0.26038
A	22.33532	102.41312	32.97422	31.54365	34.34699	7.58660	0.23008
B	0.01107	0.07343	0.02994	0.02775	0.02666	0.01036	0.34609

Table 17. Estimated summary statistics of parameters and variables associated with reduced sets of observed model migration schedules for Sweden, the United Kingdom, and Japan: females, 172 schedules.

Parameter or variable	Summary statistics						
	Lowest value	Highest value	Mean value	Median	Mode	Standard deviation	Standard deviation/ mean
GMR (observed)	0.00388	1.59564	0.19909	0.11590	0.08347	0.24085	1.20973
GMR (model)	1.00000	1.00000	1.00000	1.00000	1.00000	0.00000	0.00000
E	4.17964	60.83579	15.42092	12.26192	7.01245	9.85544	0.63910
a_1	0.00526	0.04496	0.02259	0.02209	0.01916	0.00851	0.37664
α_1	0.01585	0.41038	0.10698	0.10883	0.11448	0.05091	0.47587
a_2	0.02207	0.18944	0.07426	0.06935	0.06391	0.02693	0.36263
μ_2	15.06610	37.76019	20.63237	19.88280	18.47021	3.50346	0.16980
α_2	0.05467	0.33556	0.14355	0.13434	0.12489	0.04993	0.34784
λ_2	0.08367	1.49869	0.40032	0.37870	0.29592	0.19248	0.48081
c	0.00012	0.00685	0.00347	0.00350	0.00315	0.00139	0.39940
$\bar{n}$	24.51402	37.86541	30.65265	30.53835	29.18701	2.69720	0.08799
%(0-14)	9.37675	31.87480	20.93872	20.68939	19.50087	4.26504	0.20369
%(15-64)	60.55278	81.17286	68.65491	68.07751	67.76981	4.34828	0.06334
%(65+)	1.46164	19.56255	10.40638	10.32867	9.60705	3.40400	0.32711
δ_{1c}	0.89359	192.60318	9.39987	5.95881	10.47907	16.22411	1.72602
δ_{12}	0.02828	0.90435	0.34847	0.32367	0.33490	0.17420	0.49989
β_{12}	0.09121	2.48385	0.81472	0.84944	0.92863	0.37720	0.46298
σ_2	0.38917	12.23371	3.26434	2.89784	2.16585	2.12718	0.65164
x_ℓ	10.32012	21.79038	14.51330	14.75022	14.33471	1.95309	0.13457
x_h	17.03028	30.92059	22.49959	22.46040	21.89189	2.14262	0.09523
X	2.89007	15.09035	7.98629	7.61017	7.16017	2.11207	0.26446
A	23.73040	37.24700	28.50972	28.17807	27.10955	2.47098	0.08667
B	0.00831	0.09111	0.03118	0.02970	0.02901	0.01149	0.36845

Migration schedules may be early or late peaking, depending on the location of μ_2 on the horizontal (age) axis. Although this parameter generally takes on a value close to 20, roughly three out of four observations fall within the range 17-25. We shall call those below age 19 early peaking schedules and those above 22 late peaking schedules.

The ratio of the two basic vertical parameters, a_1 and a_2, is a measure of the relative importance of the migration of children in a model migration schedule. The index of child dependency, $\delta_{12} = a_1/a_2$, tends to exhibit a mean value of about one-third with 80 percent of the values falling between one-fifth and four-fifths. Schedules with an index of one-fifth or less will be said to be labor dominant; those above two-fifths will be called child dependent.

Migration schedules with labor force components that take the form of a relatively symmetrical bell shape will be said to be *labor symmetrical*. These schedules will tend to exhibit an index of labor asymmetry ($\sigma_2 = \lambda_2/\alpha_2$) that is less than 2. Labor asymmetric schedules, on the other hand, will usually assume values for σ_2 of 5 or more. The average migration schedule will tend to show a σ_2 value of about 4, with approximately five out of six schedules exhibiting a σ_2 within the range 1-8.

Finally, the index of parental-shift regularity in many schedules is close to unity, with approximately 70 percent of the values lying between one-third and four-thirds. Values of $\beta_{12} = \alpha_1/\alpha_2$ that are lower than four-fifths or higher than six-fifths will be called irregular.

We may imagine a 3 × 4 cross-classification of migration schedules that defines a dozen "average families" (Table 18). Introducing a low and a high value for each parameter gives rise to 16 additional families for each of the three classes of schedules. Thus we may conceive of a minimum set of 60 families, equally divided among schedules with a retirement peak, schedules with a retirement slope, and schedules with neither a retirement peak nor a retirement slope (a reduced form).

Table 18. A cross-classification of migration schedules.

Schedule	Measure (average value) Peaking ($\mu_2 = 20$)	Dominance ($\delta_{12} = 1/3$)	Asymmetry ($\sigma_2 = 4$)	Regularity ($\beta_{12} = 1$)
Retirement peak	+	+	+	+
Retirement slope	+	+	+	+
Reduced form	+	+	+	+

The comparative analysis of national and interregional migration patterns carried out in section 3.2 identified at least three distinct families of age profiles. First, there was the 11-parameter *basic model migration schedule* with a retirement peak that adequately described a number of interregional flows, for example, the age profiles of outmigrants leaving capital regions such as Stockholm and London. The elimination of the retirement peak gave rise to the 7-parameter *reduced form* of this basic schedule, a form that was used to describe a large number of labor dominant profiles and the age pattern of migration schedules with a single open-ended age interval for the post-labor force population, for example, Japan's migration schedules. Finally, the existence of a monotonically rising tail in migration schedules such as those exhibited by the Dutch data led to the definition of a third profile: the 9-parameter *model migration schedule with an upward slope*.

Within each family of schedules, a number of key parameters or variables may be put forward in order to further classify different categories of migration profiles. For example, in section 3.2 we noted the special importance of the following aspects of shape and location along the age axis:

1. Peaking: early peaking versus late peaking (μ_2)
2. Dominance: child dependency versus labor dominance (δ_{12})

3. Asymmetry: labor symmetry versus labor asymmetry (σ_2)
4. Regularity: parental-shift regularity versus parental-shift irregularity (β_{12})

These fundamental families and four key parameters give rise to a large variety of standard schedules. For example, even if the four key parameters are restricted to only dichotomous values, one already needs $2^4 = 16$ standard schedules. If, in addition, the sexes are to be differentiated, then 32 standard schedules are a minimum. A large number of such schedules would make the notion of a standard curve somewhat unworkable. Hence we propose only a single standard for both sexes and assume that the shape of the post-labor force part of the schedule may be determined exogenously.

The similarity of the male and female median parameter values set out in Tables 16 and 17 (for Sweden, the United Kingdom, and Japan), suggests that one could use the average of the values for the two sexes to define a unisexual standard. A rough rounding of these averages would simplify matters even more. Table 19 presents the simplified basic standard parameters obtained in this way. The values of a_1, a_2, and c are initial values only and need to be scaled proportionately to ensure a unit GMR. Figure 7 illustrates the age profile of this simplified basic standard migration schedule.

Table 19. The simplified basic (Rogers-Castro) standard migration schedule.

Fundamental parameter	Fundamental ratio
$a_1 = 0.02$	$\delta_{12} = 1/3$
$\alpha_1 = 0.10$	$\sigma_2 = 4$
$a_2 = 0.06$	$\beta_{12} = 1$
$\mu_2 = 20$	$\delta_{1c} = 6$
$\alpha_2 = 0.10$	
$\lambda_2 = 0.40$	
$c = 0.003$	

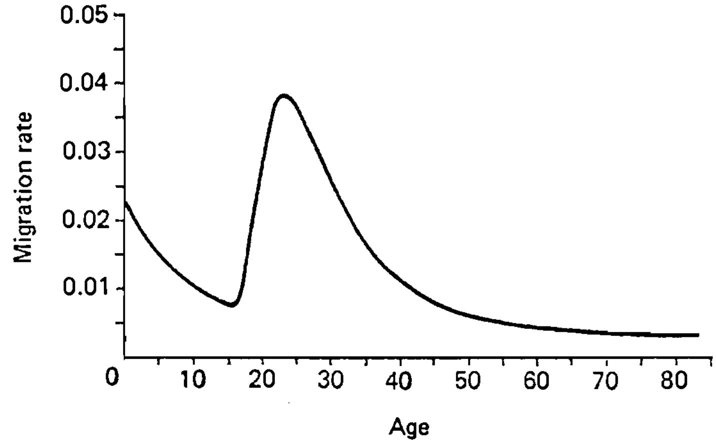

Figure 7. The basic (Rogers-Castro) standard migration schedule.

Source: Rogers and Castro 1981b.

3.4 Accounting for the Age Profile: Migration by Cause

Studies have shown that the age pattern of deaths varies systematically with the level of mortality. For example, as the expectation of life at birth increases, the largest absolute declines in mortality generally occur at ages below 5 and above 65. This is a consequence of the dramatic reduction in the contribution to overall deaths made by infectious diseases, which have a U-shaped age profile of mortality. Are there analogous systematic variations in age patterns of migration? Does the age pattern of migration vary with the level of migration? For example, if divorce is a reason for migration, and if the level of migration and the number of divorces per capita both increase with economic development, should one then expect a particular shift in the age profile of aggregate migration?

Why people move is a question that needs to be considered with respect to (1) those characteristics of potential migrants that condition receptivity to migration and (2) those environmental factors that stimulate migration from one community to another. Nevertheless, some insight into motivations for migration may be obtained simply by asking people why they moved. This approach has been adopted, for example, in nationwide surveys conducted by the US Bureau of the Census (Long and

Hansen 1979) and in national migration registers maintained in such countries as Czechoslovakia (Kühnl 1978).

Studies of reported causes for migration within a given country are subject to a number of serious limitations. First, usually only the "main" cause is tabulated and examined, yet multiple interdependent causes underlie migration behavior. Second, the number of alternative causes listed in migration questionnaires are typically broad aggregations of a much wider range of causes and therefore may inadequately reflect the true importance of motivations connected with migration. Finally, problems arise when the causes are not separately classified for the initiators of migration (e.g., household heads) and for their dependents (e.g., children). In short, reported causes of migration are often mutually interdependent, usually insufficient in number, and generally not linked directly to the true decision maker. However, analogous limitations also appear in studies of mortality disaggregated by cause, without presenting insuperable obstacles. As noted by Preston (1976, p. 2):

> Causes are undoubtedly recorded with considerable inaccuracy and inter-population incomparability, and these problems have discouraged the exploitation of cause-of-death statistics. But demographic data are never perfectly accurate, and the choice is between neglecting them altogether and producing qualified statements about the tendencies they suggest.

Part A of Table 20 gives the percentage of household heads moving for each of five causes in the US and in Hungary. These data confirm that it is a great oversimplification to explain migration solely in terms of economic motivations, i.e., employment. Although approximately half of the migrating household heads cited employment as the main reason for moving, a combination of education, marriage, housing, and other reasons provided the motivation for the other half to migrate. Moreover, Hungarian data indicate that employment as a cause of migration has been declining in relative importance over time.

Table 20. Migration data disaggregated by cause: United States[a], Hungary[b], Czechoslovakia[c], various dates.

Region	Date	Percentage of migrants citing the cause				
		Employment	Education	Marriage	Housing	Other
A. HOUSEHOLD HEADS ONLY						
United States	1974-1976	56.6	5.4	1.6	8.1	28.3
Hungary	1958	49.7	2.5	15.4	12.0	20.4
Hungary	1968	43.8	1.7	21.5	14.1	18.9
B. ALL MIGRANTS						
United States	1974-1976	59.8	3.9	1.4	8.0	26.9
Czechoslovakia	1973	28.1	1.0	17.0	41.8	12.1

[a] USA data are taken from Long and Hansen (1979) and refer to interstate migration.

[b] Hungarian data are taken from Compton (1971) and refer to all intercommunity migration.

[c] Czechoslovakian data are taken from Kühnl (1978) and refer to all intercommunity migration; the Czech Republic and the Slovak Republic together comprise the nation of Czechoslovakia.

Part B of Table 20 presents comparable data for all migrants, including the household head. Only 36% of all migrants were found to be household heads in the USA survey; in Hungary the corresponding proportion ranged from 55% in 1958 to 63% in 1968. The data for Czechoslovakia do not distinguish between household heads and their accompanying dependents.

Housing reasons accounted for over 40% of all migration between communities (communes) in Czechoslovakia in 1973; this total is about five times as high as the figure for the USA. Data for the USA, however, refer to *interstate* migration, and one would expect housing reasons to decline in importance relative to employment reasons when considering migrations over such relatively greater distances.

Less than 30% of migration within Czechoslovakia was caused by changes in employment. This relatively low share of the total is somewhat surprising and apparently reflects a leveling of regional economic differences (Kühnl 1978).

Causes of migration are related to a person's age and sex. For example, migration motivated by health reasons is a phenomenon characteristic of old persons, whereas education-related migration is predominantly associated with young people. Wives tend to be younger than their husbands; therefore the age profile of female migration peaks at an earlier age than the corresponding profile for males. Thus, in order to understand better why people move, it is important to disaggregate cause-specific migration data by age and sex.

If the age pattern of migration is influenced by its cause-specific structure, then it should be possible to attribute differences in age patterns of migration in two or more populations, at least partially, to differences in their cause-specific structures. Unfortunately, detailed age-specific migration data that are disaggregated by cause are exceedingly scarce, and we have been able to find only one source for this study: the Czechoslovakian migration register.*

Figure 8 displays histograms and their associated model migration schedules for age-specific male and female migration rates in Czechoslovakia. Figure 9 presents the age-specific cause-of-migration structures that underlie these rates. For ease of visual comparison all age profiles have been scaled so that the area under the curve is unity.

The model schedule defined in equation (1) may be used to fit all of the cause-specific profiles illustrated in Figure 9. The two profiles concerned with change of employment and moving closer to place of work and the profiles of migration associated with marriage and with divorce may be described by the reduced, 7-parameter model. Education-motivated migration profiles follow the model schedule with both the first and the third components omitted ($a_1 = a_3 = 0$). The age pattern of health-related migration can be described by the model schedule with both the first and the second components omitted ($a_1 = a_2 = 0$). Finally, migration caused by housing reasons and by the remaining "all other causes" (including divorce) takes on the profile of the full, 11-parameter model, as does the aggregate schedule. More detailed numerical outputs are described in Rogers and Castro (1981a).

The age profiles reveal that the causes of migration have quite different age patterns. Of the eight causes illustrated, the age profile of *housing* reasons is most similar to that of the aggregate migration schedule, exhibiting roughly the same four peaks: during infancy, during the early years of labor force participation, at retirement, and in the oldest age group.

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*Identification of causes of migration has been a part of the regular internal migration register of Czechoslovakia since 1966. The data are based on responses given by migrants at the time that they notify local authorities of their change of address. Dependents are not distinguished from household heads in these data.

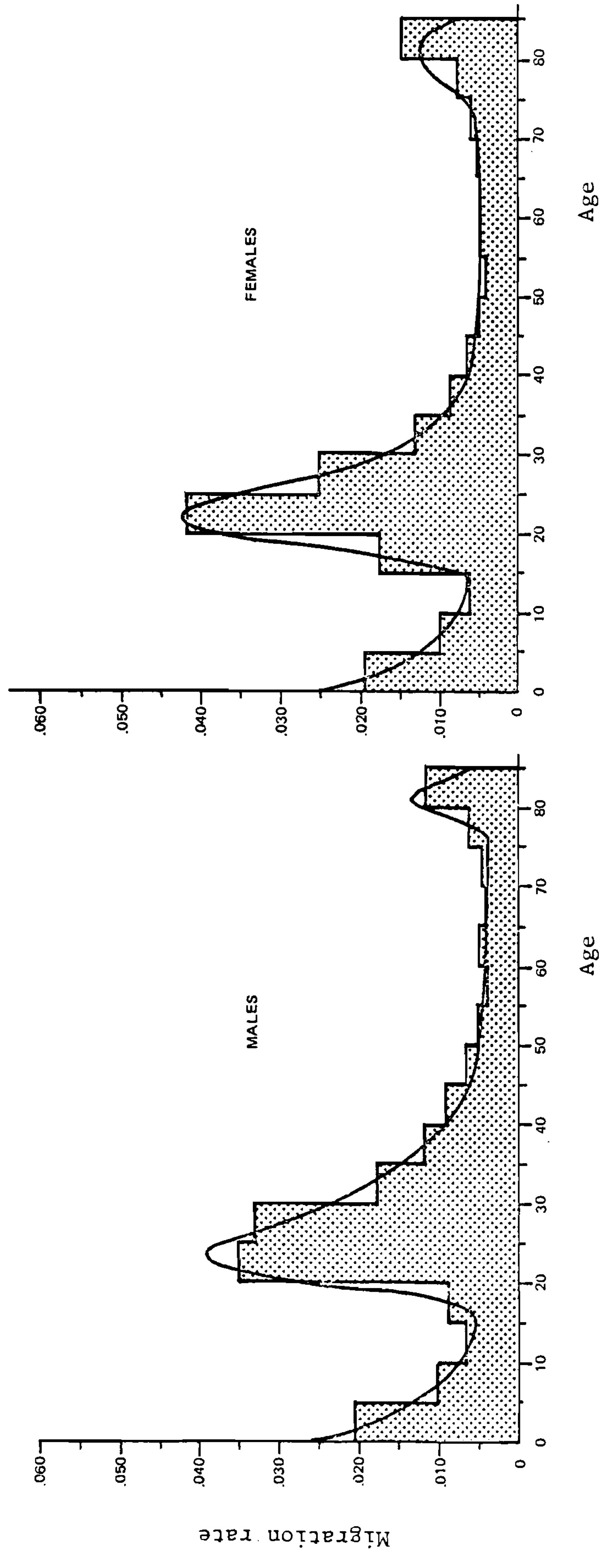
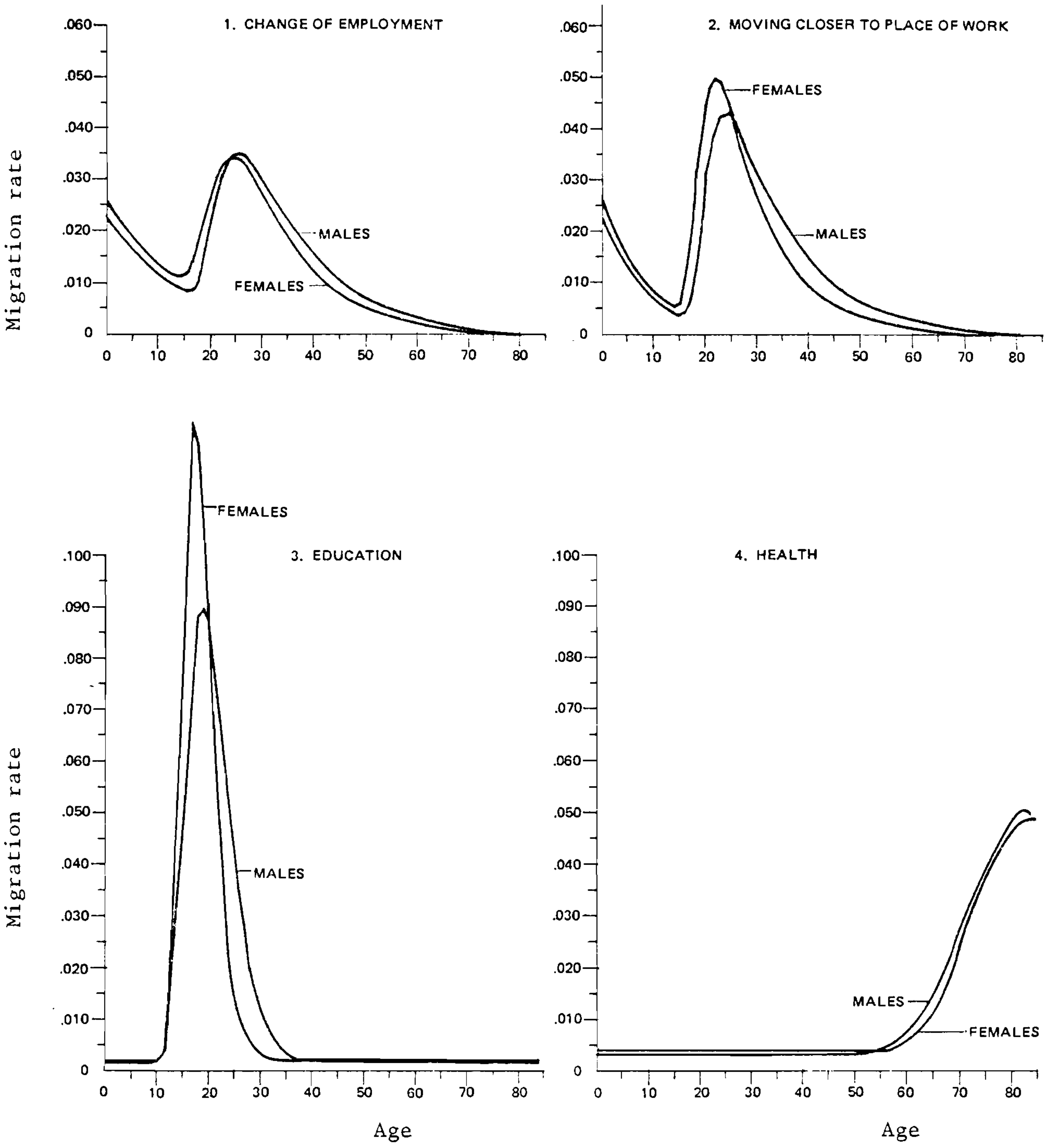


Figure 8. Model schedules of observed migration rates for all causes combined: Czechoslovakia, males and females, 1973.



1. CHANGE OF EMPLOYMENT

2. MOVING CLOSER TO PLACE OF WORK

3. EDUCATION

4. HEALTH

Figure 9. Model schedules of observed cause-specific migration rates: Czechoslovakia, males and females, 1973.

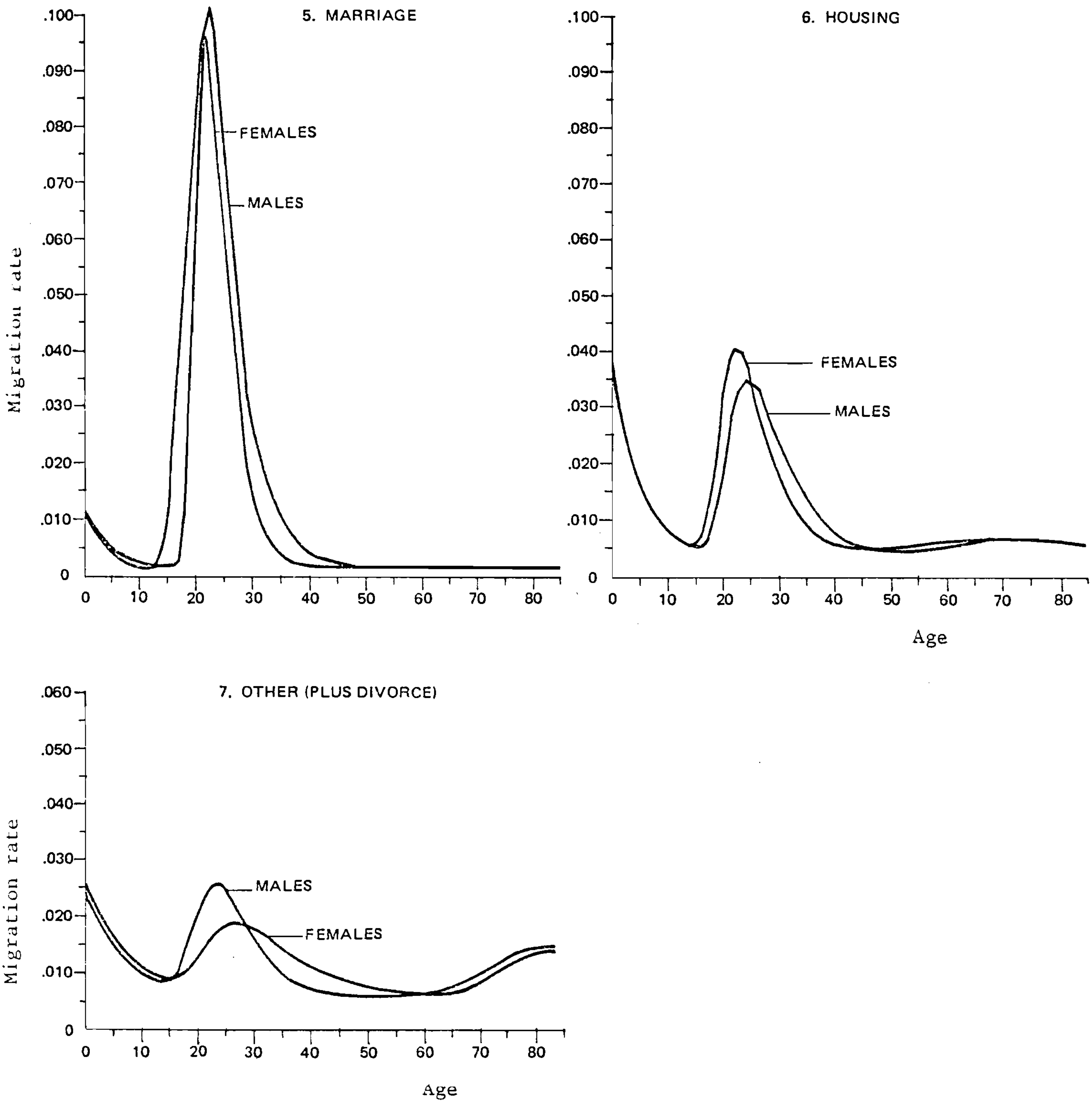


Figure 9. Continued.

Migrations due to *marriage* and *education*, on the other hand, are concentrated between the ages of 10 and 30 and are essentially unimodal in age profile. Migrations caused by *divorce*, *change of employment*, and *moving closer to the place of work* have profiles that are bimodal, with local peaks during infancy and during the early years of labor-force participation. Finally, *health* is apparently an important cause of migration only for the elderly. (The residual category "all other reasons" is aggregated with divorce in Figure 9 in order to give it a profile that is more amenable for our analysis.)

The different cause-specific age patterns may be interpreted within a life-cycle framework in which individuals pass through different states of existence. Starting with birth and then entry into the educational system at the elementary level, the "passage" may also include entry into military service or university, marriage, multiple entries into and withdrawals from the labor force, perhaps divorce and remarriage, retirement, death of spouse, and moves to enter sanatoria or to rejoin relatives.

Associated with this individual life-cycle perspective is a family life cycle which begins with marriage, passes on to procreation and child rearing (possibly interrupted by divorce or death), continues with child "launching", retirement, and ultimately ends with the death of both spouses. Such a perspective suggests an alternative means of accounting for the migration age profile: family status. We take up this idea next.

3.5 Accounting for the Age Profile: Migration by Family Status

A population pyramid graphically displays the age composition of a population—a composition that reflects the past history of fertility and mortality to which the population has been exposed. For example, high rates of natural increase give rise to age pyramids that taper more rapidly with age, and zero growth rates ultimately produce age pyramids that are nearly rectangular until ages 50 and 60 and that decline rapidly thereafter as death rates increase among the aged. Thus one may conclude that the age composition of a population tells us something about past patterns of fertility and mortality. What does the age composition of migrants tell us?

The age profile of a schedule of migration rates reflects the influences of two age distributions: the age composition of migrants and that of the population of which they were a part (Rogers 1976). This can be easily demonstrated by decomposing the numerator and denominator of the fraction that defines an age-specific migration rate.

If O(x) denotes the number of outmigrants of age x, leaving a region with a population of K(x) at that age, then

$$M(x) = \frac{O(x)}{K(x)} = \frac{O\ N(x)}{K\ C(x)} = o\ \frac{N(x)}{C(x)} \qquad (4)$$

where

$M(x)$ = migration rate for individuals aged x years at the time of migration

O = total number of outmigrants

$N(x)$ = proportion of migrants aged x years at the time of migration

K = total population

$C(x)$ = proportion of total population aged x years at mid-year

o = crude outmigration rate

We define the collection of N(x) values to be the *migration proportion schedule* and the set of M(x) values to be the *migration rate schedule.*

We have shown that observed age-specific migration rate schedules exhibit a common shape. The same shape also characterizes the shape of migration proportion schedules. That is, the migration proportion schedule may be divided into young-dependent, adult, and elderly components. We shall confine our attention in this chapter to only the first two; but our argument is equally valid for profiles showing a retirement peak or an upward retirement slope.

The observed age distribution of migrants, $N(x)$, may be described by a function of the form:

$$N(x) = N_1(x) + N_2(x) + c \tag{5}$$

where

$$N_1(x) = a_1 e^{-\alpha_1 x}$$

for the young-dependent component,

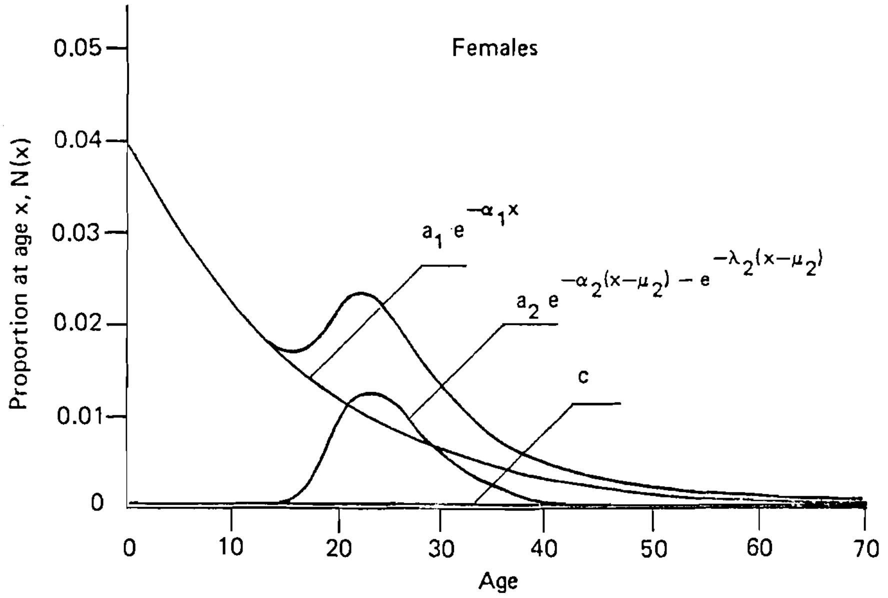
$$N_2(x) = a_2 e^{-\alpha_2(x-\mu_2) - e^{-\lambda_2(x-\mu_2)}}$$

for the adult (independent) component, and c is the constant term that improves the fit when migration distributions at older ages are relatively high. Figure 10 illustrates the female model migration proportion schedules of the observed data for Mexico and Sweden, which by definition show an area of unity under each curve.

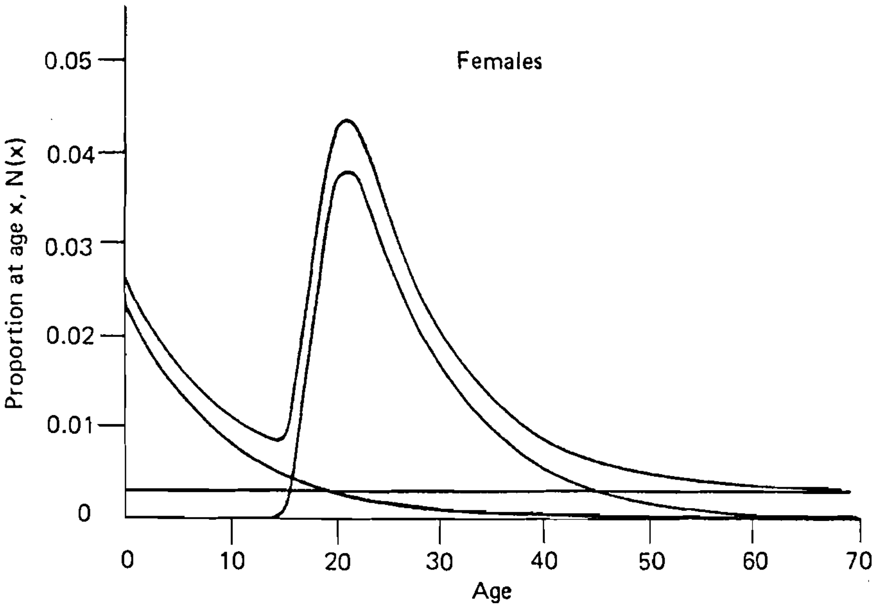
An alternative way of expressing (5) is as a weighted linear combination of the density functions representing the above three components (Castro and Rogers 1983):

$$N(x) = \phi_1 f_1(x) + \phi_2 f_2(x) + \phi_c (1/w) \tag{6}$$

where w is the last age included in the schedule, ϕ_1 and ϕ_2 are the relative shares of the child and adult components, ϕ_c is the share of the constant term, $f_1(x)$ and $f_2(x)$ are respectively, the single and double exponential density functions



a. Interstate migration, Mexico 1970.



b. Interregional migration, Sweden 1974.

Figure 10. Components of the model migration proportion schedule.

$$f_1(x) = \alpha_1 e^{-\alpha_1 x} \tag{7}$$

$$f_2(x) = \frac{\lambda_2}{\Gamma(\alpha_2/\lambda_2)} e^{-\alpha_2(x-\mu_2) - e^{-\lambda_2(x-\mu_2)}} \tag{8}$$

and $\Gamma(\alpha_2/\lambda_2)$ represents the gamma function value of α_2/λ_2. Note that $\phi_1 + \phi_2 + \phi_c = 1$ by definition.

Equations (6) through (8) imply that

$$a_1 = \phi_1 \alpha_1 \tag{9}$$

$$a_2 = \phi_2 \frac{\lambda_2}{\Gamma(\alpha_2/\lambda_2)} \tag{10}$$

and

$$c = \frac{\phi_c}{w} \tag{11}$$

The six parameters a_1, α_1, a_2, α_2, λ_2, and μ_2 do not seem to have demographic interpretations. (Both a_1 and a_2 reflect the heights of their respective parts of the profile; α_1 and α_2 refer to the descending slopes; λ_2 reflects the ascending slope; and μ_2 positions the adult component on the age axis.) Taken as a group, these parameters suggest a number of useful and robust measures for describing an observed migration proportion schedule. For example, the ratio $D_o = \phi_1/\phi_2$, the dependency migration ratio, is one of several important ratios that may be used to interpret particular patterns of dependency among migrants. It assumes a central role as an indicator of family dependency structure by defining the number of dependents per adult migrant (Castro and Rogers 1983).

It is widely recognized that a large fraction of total migration is accounted for by individuals whose moves are dependent on those of others. Indeed family migration is such a well-established phenomenon that Ryder (1978) has even suggested its use as a criterion for identifying family membership: a family comprises those individuals who would migrate together.

To understand the influences that family and dependency relationships have on migration age compositions, it is useful to examine how such profiles respond to fundamental changes in dependency patterns. To illustrate this, consider a single-sex population that is divided into two groups: dependents and heads, where dependents are simply individuals who have not left home to become heads. (Included as heads are independent single individuals who may be viewed as one-person families.) Thus the age distribution of the female population C(x) may be composed by weighting the density functions of dependents and heads:

$$C(x) = \phi_{1c} f_{1c}(x) + \phi_{2c} f_{2c}(x)$$

where ϕ_{1c} and ϕ_{2c} are the proportions of dependents and heads in the total female population and, $f_{1c}(x)$ and $f_{2c}(x)$ are their corresponding age distributions, respectively.

To investigate analytically some of the underlying patterns of "head formation" requires some mathematical theorizing. Let y_o denote the age at which an appreciable number of females first leave home to establish their own household. Since marriage is an important reason for leaving the family home, it is likely that the probability density function describing the pattern of head formation by age is similar to the one found in studies of nuptiality—the double exponential function defined in equation (8). If g(y) is such a function then

$$G(x) = \int_{y_o}^{x} g(y)dy$$

defines the proportion of females who have ever left home by age x, that is, who are heads according to our definition.

Since $f_{2c}(x)$ defines the proportion of the population of heads that are of age x, and G(x) defines the proportion of the population who are heads by age x, it is evident that in a stable population growing at an intrinsic rate of growth r,

$$f_{2c}(x) = \frac{e^{-rx} \ \ell(x) \ G(x)}{\int_0^\infty e^{-ry} \ \ell(y) \ G(y) dy}$$

where $\ell(x)$ denotes the probability of surviving from birth to age x. For similar reasons

$$f_{1c}(x) = \frac{e^{-rx} \ \ell(x) \ [1 - G(x)]}{\int_0^\infty e^{-ry} \ \ell(y) \ [1 - G(y)] \ dy}$$

Figure 11 illustrates the above argument with hypothetical data. It presents the survivorship curve, $\ell(x)$, which is that of the Brass standard with $\alpha = -0.80$ and $\beta = 1.75$ with an expectation of life at birth of approximately 69 years (Brass 1971); and the head formation curve G(x) is the Coale-McNeil double exponential (Coale and McNeil 1972) expressed by the Rodriguez and Trussell (1980) standard with mean (22 years) and variance (5 years) of age of becoming a head. Figure 12 shows the resulting dependent, head, and population (dependents plus heads) distributions of stable populations growing at intrinsic rates $r = 0$ and $r = 0.03$, respectively.

To derive the corresponding age compositions of migrants we introduce the probabilities $p_1(x)$ and $p_2(x)$ that a dependent and a head, respectively, migrate at age x in an interval of time. The age distribution of migrants is defined as before:

$$N(x) = \phi_1 \ f_1(x) + \phi_2 \ f_2(x)$$

where

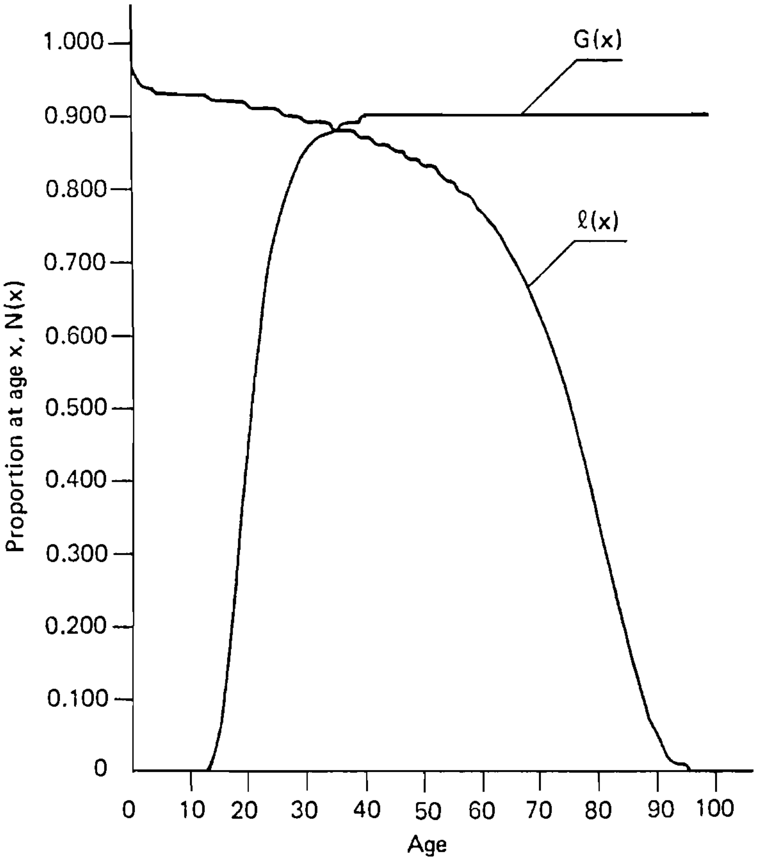


Figure 11. Proportion surviving to age x, $\ell(x)$, and proportion of individuals who have ever left home by age x, G(x).

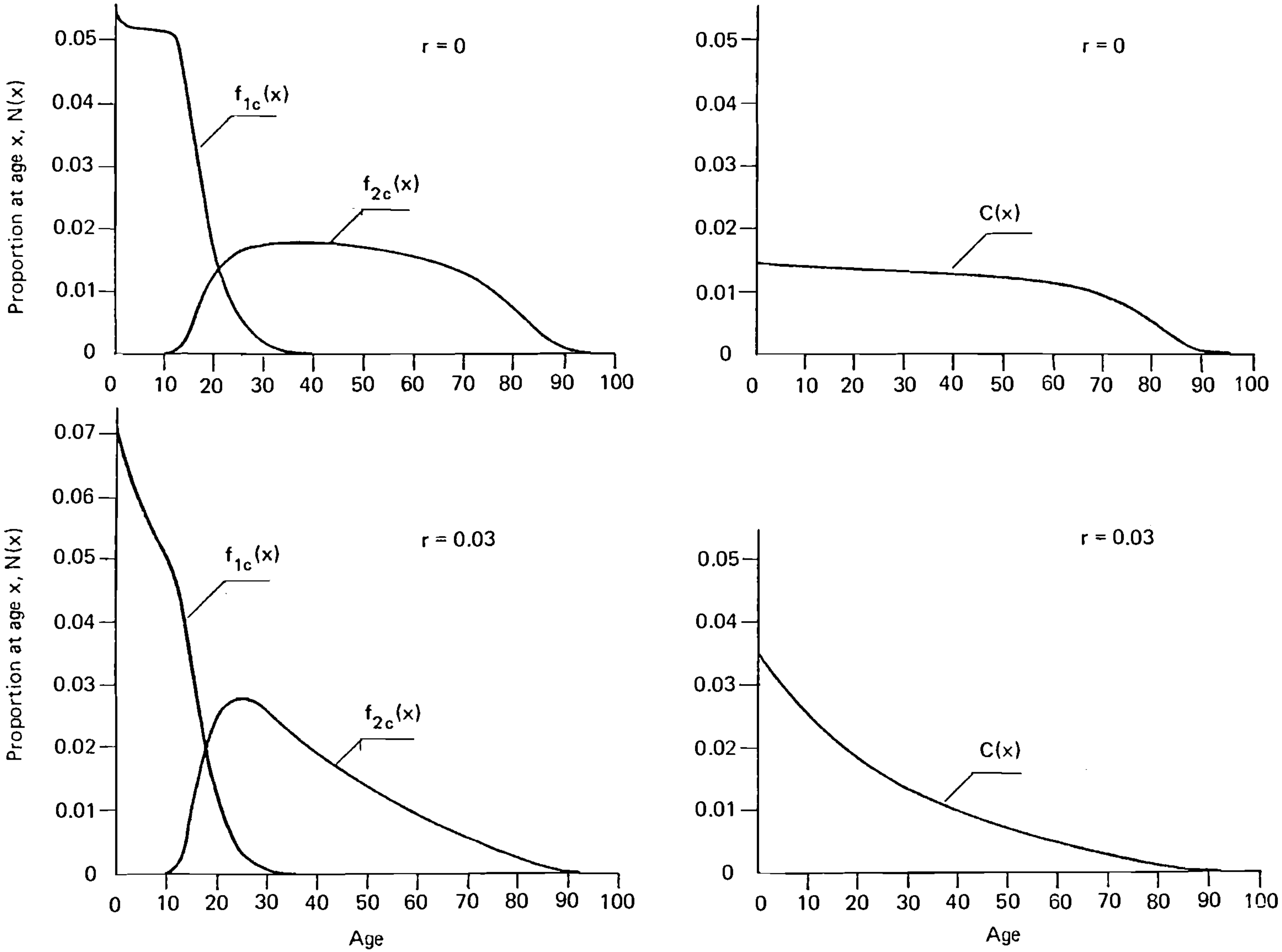


Figure 12. Proportion of dependents at age x, $f_{1c}(x)$, proportion of heads at age x, $f_{2c}(x)$, and the resulting population age composition, C(x), for intrinsic rates of growth r of zero and 0.03, respectively.

$$f_1(x) = \frac{e^{-rx} \ell(x)[1 - G(x)] p_1(x)}{\int_0^\infty e^{-ry} \ell(y)[1 - G(y)] p_1(y) dy}$$

and

$$f_2(x) = \frac{e^{-rx} \ell(x) G(x) p_2(x)}{\int_0^\infty e^{-ry} \ell(y) G(y) p_2(y) dy}$$

To specify correctly the probabilities $p_1(x)$ and $p_2(x)$ from different sources of migration data, it is necessary to identify first the number of moves a person undertakes during a unit interval. However, for our purposes we may assume that both dependents and heads follow a negative exponential propensity to migrate with respect to age, with the function's parameter reflecting the average rate of moving per unit of time. Formally, we have then

$$p_1(x) = o_1 e^{-o_1 x}$$

and

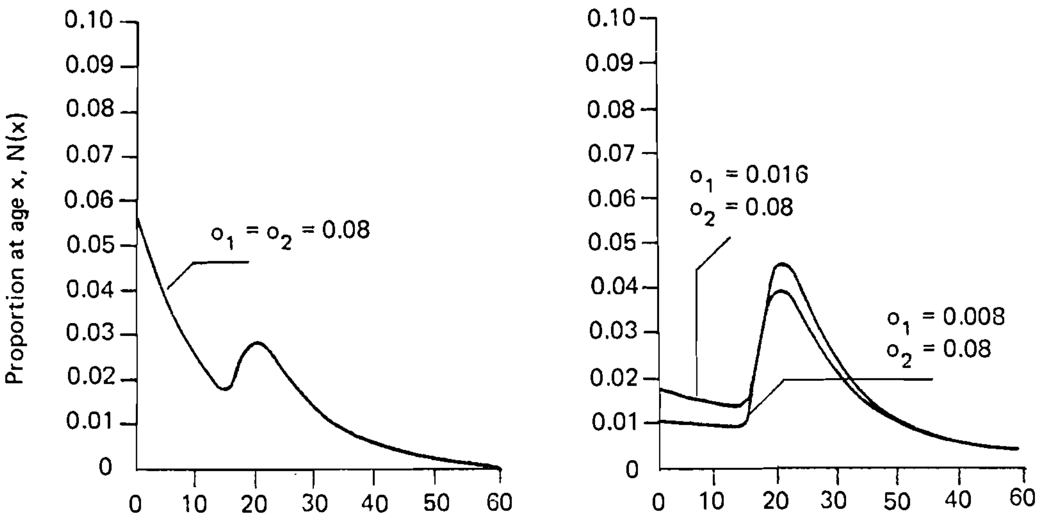
$$p_2(x - y_o) = o_2 e^{-o_2(x - y_o)}$$

where y_o denotes, as before, the age at which an appreciable number of females first leave home to establish their own household, and o_1 and o_2 denote the average rates of moving per unit of time of dependents and heads, respectively. One might expect that the average rate of moving per unit of time for dependents, o_1, should not exceed o_2, the corresponding rate for heads.

The parameters defining the mobility conditions may be used to set out a typology of migration profiles that helps to identify how a particular family migration pattern may be reflected in a migration age composition and how important the migration propensities among heads and dependents are in structuring that age composition. Figures 13 and 14 present a set of profiles classified according to two distinctly different rates of natural increase. For each of the hypothetical populations we show three alternative combinations of propensities to migrate among heads and dependents. First, Figure 13 sets out, for low head migration propensities ($o_2 = 0.08$), profiles showing a significant degree of family migration ($o_1 = o_2$) and also of low family dependency ($o_1 = 0.10o_2$ and $o_1 = 0.20o_2$). In a similar format, Figure 14 presents the corresponding profiles for high head migration propensities ($o_2 = 0.16$). With the aid of these two figures we can see that patterns such as those of Sweden in Figure 10 indicate a relatively low family migration dependency with high head migration propensities and low population growth rates, whereas profiles such as those of Mexico present characteristics that correspond to high family migration dependency and relatively high dependent and head migration propensities.

In conclusion, it appears that the regularities that occur among migration age compositions can be summarized in a useful manner and that they may be telling us something about patterns of natural increase, family relationships, and mobility levels among migrants.

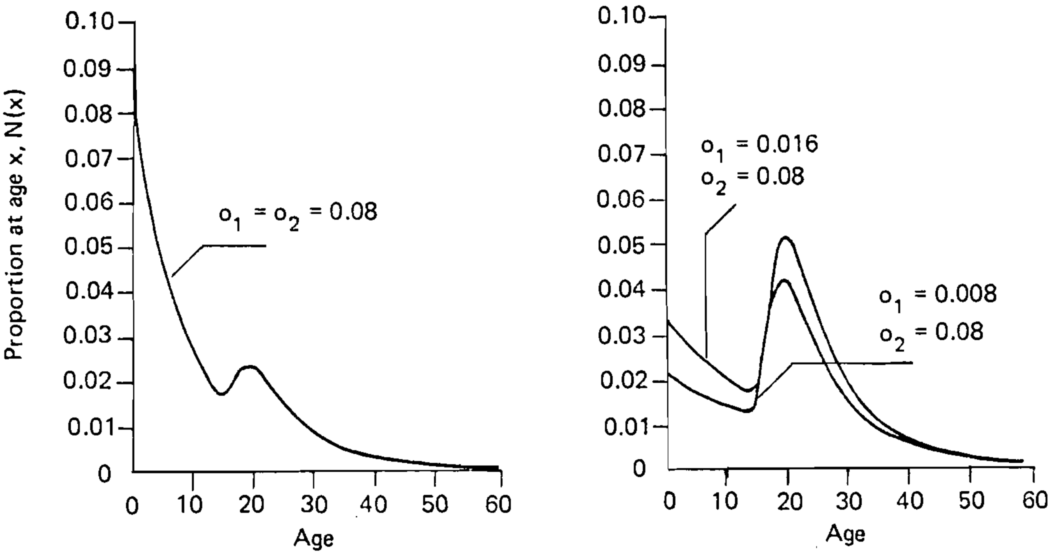
A disaggregation of migrants into dependent and independent categories, and the adoption of model migration proportion schedules, illuminates the ways in which the age profile of migration is sensitive to relative changes in dependency levels and in rates of natural increase and mobility. Viewing the migration process within a framework of dependent and independent movements allows one to observe that if the independent component is mainly comprised of single persons, then the associated dependent migration may be insignificant in terms of its relative share of the total migration. On the other hand, if migration tends to consist principally of family migration, then the share of dependent children may become an important part of total migration.



Low Population Growth, r = 0
Low Head Migration Propensity,
$o_2 = 0.08$; $o_1 = 0.08$, 0.016, and 0.008

a. Family migration

b. Low family dependency



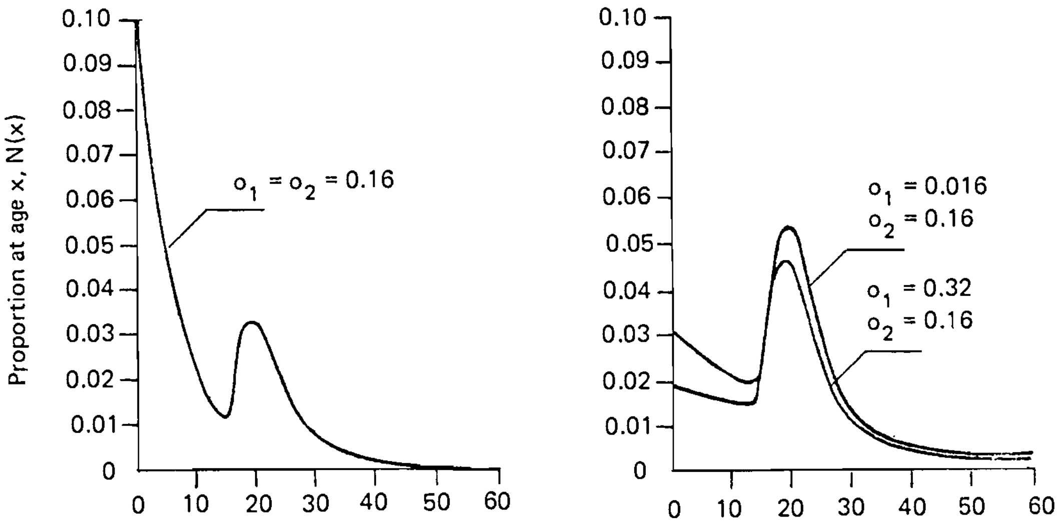
High Population Growth, r = 0.03
Low Head Migration Propensity,
$o_2 = 0.08$; $o_1 = 0.08$, 0.016, and 0.008

c. Family migration

d. Low family dependency

Figure 13. A typology of age migration distributions for low and high population growth, family migration dependencies, and low head migration propensities.

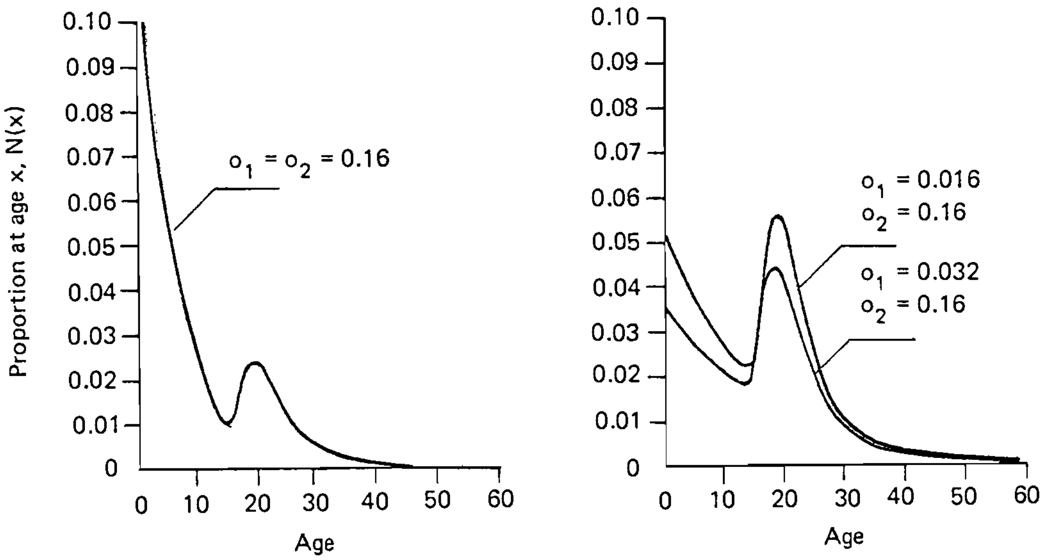
Low Population Growth, r = 0
High Head Migration Propensity,
$o_2 = 0.16; o_1 = 0.16, 0.032,$ and 0.016



a. Family migration

b. Low family dependency

High Population Growth, r = 0.03
High Head Migration Propensity,
$o_2 = 0.16; o_1 = 0.16, 0.032,$ and 0.016



c. Family migration

d. Low family dependency

Figure 14. A typology of age migration distributions for different population growth, family migration dependencies and high head migration propensities.

The degree of propensity to migrate among independent migrants is also evident from observed age profiles. Strongly skewed distributions in the adult ages, corresponding to high λ_2 and α_2 parameter values, indicate relatively higher migration propensities for the independent component. Profiles with high dependency levels show much more weakly skewed adult migration compositions due to lower propensities for individual moves among heads.

Just as population age compositions reflect particular characteristics of fertility and mortality regimes, so do observed migration age compositions reflect key aspects of family structure and migration patterns. Although, many of the relationships set out in this section are still conjectural, a modest start has been made. A framework for assessing the impacts of natural increase, family dependencies, and differing migration propensities has been outlined.

4. CONCLUSION

The two principal conclusions that arise as a consequence of the findings presented in this paper are that significant spatial differences in migration levels exist in a number of IIASA member nations and that remarkably stable age profiles characterize the patterns of internal migration flows in all IIASA countries. Because differences in levels are so directly associated with differences in the areal delineations that are adopted, we emphasized the analysis of differentials in age profiles over differentials in levels. It appears that the former exhibit surprisingly stable regularities across areal delineations of substantially different scale.

Among the data examined in this study, Canada and the Federal Republic of Germany showed the highest degrees of regional variation in migration levels; the German Democratic Republic and Sweden exhibited the lowest. City regions in Eastern Europe gained from net migration, whereas those in Western Europe gained only if their outmigration levels were relatively low. Differentials by sex were generally insignificant, but differentials by age were important. In some countries, such as Japan, a narrow age bracket (young adults) accounted for much of the aggregate regional differentials; in other countries, such as the German Democratic Republic and Sweden, generally the same pattern of regional differences was reflected by all age groups.

The data analyzed in this study confirmed the observation that although migration levels vary substantially from region to region, the shape of an age-specific schedule of migration rates seems to be quite similar across a wide range of communities. Young adults in their early twenties generally exhibit the highest regional outmigration rates and young teenagers show the lowest. Because children migrate with their parents, infant migration rates are higher than those of adolescents. And retirement migration may give rise to a bell-shaped protrusion in the migration age profile around the ages of retirement.

Model migration schedules may be used to capture the regularities in age pattern exhibited by observed age-specific rates of migration. The particular mathematical form used in this study successfully represented over 600 such schedules and suggested a disaggregation of observed schedules into families and the designation of a standard schedule. Efforts to account for this age profile led to a decomposition of migration flows by cause and then to a disaggregation of migrants by family status. Although exploratory in nature, these efforts indicate that considerable insight is afforded by such techniques borrowed from mortality and fertility analysis.

APPENDIX: THE GROSS MIGRAPRODUCTION RATES AND THE MEAN AGE OF THE MIGRATION SCHEDULE FOR EACH REGION IN THE COMPARATIVE MIGRATION AND SETTLEMENT STUDY

Migration

Country (reference year) and region	Population (1)	GMR (2)	mean age of migr.sched. (3)	GMR(0-4) (4)	GMR(15-29) (5)	GMR(65+) (6)	GMR(70-74) (7)
Austria (1971)							
Burgenland	272119.	0.51	26.32	0.029	0.246	0.028	0.007
Carinthia	525728.	0.33	27.02	0.016	0.184	0.021	0.005
Lower Austria	1414161.	0.49	29.05	0.030	0.243	0.037	0.009
Upper Austria	1223444.	0.22	30.23	0.012	0.109	0.020	0.005
Salzburg	401766.	0.35	30.25	0.022	0.172	0.030	0.007
Styria	1192100.	0.26	27.89	0.016	0.136	0.018	0.004
Tyrol	540771.	0.22	30.45	0.013	0.110	0.017	0.004
Vorarlberg	271473.	0.25	29.24	0.015	0.137	0.018	0.005
Vienna	1614841.	0.43	31.83	0.041	0.160	0.041	0.010
Austria	7456403.	0.35	30.14	0.022	0.165	0.030	0.007
Bulgaria (1975)							
North West	1042803.	0.46	21.91	0.032	0.284	0.015	0.003
North	1400117.	0.30	23.35	0.020	0.157	0.018	0.002
North East	1486719.	0.25	23.62	0.014	0.138	0.016	0.003
South West	696466.	0.39	23.90	0.020	0.213	0.025	0.004
South	2164076.	0.23	25.06	0.014	0.122	0.016	0.003
South East	866834.	0.43	23.59	0.026	0.242	0.025	0.004
Sofia	1069975.	0.30	28.44	0.034	0.107	0.023	0.004
Bulgaria	8726990.	0.31	24.13	0.021	0.164	0.018	0.003
Canada (1971)							
Newfoundland	507750.	1.03	31.01	0.100	0.424	0.080	0.013
Prince Edward Island	110085.	1.61	29.00	0.178	0.628	0.103	0.019
Nova Scotia	772500.	1.28	29.26	0.151	0.449	0.090	0.016
New Brunswick	625674.	1.33	30.76	0.154	0.470	0.118	0.021
Quebec	5904307.	0.49	37.31	0.048	0.119	0.086	0.013
Ontario	7331987.	0.48	33.20	0.059	0.131	0.063	0.011
Manitoba	975655.	1.70	34.03	0.176	0.460	0.225	0.041
Saskatchewan	940790.	2.14	32.45	0.228	0.756	0.251	0.049
Alberta	1545537.	1.33	38.31	0.125	0.302	0.253	0.046
British Columbia	2029147.	0.66	32.30	0.078	0.191	0.080	0.015
Canada	20743436.	0.77	34.14	0.085	0.216	0.107	0.019
Czechoslovakia (1975)							
Central Bohemia	2300705.	0.53	35.61	0.061	0.204	0.106	0.011
Southern Bohemia	667998.	0.70	31.63	0.079	0.282	0.092	0.015
Western Bohemia	872796.	0.87	33.72	0.096	0.289	0.139	0.014
Northern Bohemia	1135800.	0.84	36.50	0.081	0.282	0.161	0.018
Eastern Bohemia	1224599.	0.66	34.02	0.072	0.271	0.109	0.011
Southern Moravia	1985174.	0.44	33.88	0.048	0.186	0.075	0.009
Northern Moravia	1875294.	0.44	33.78	0.046	0.162	0.070	0.009
Western Slovakia	1966889.	0.31	33.04	0.038	0.137	0.051	0.007
Central Slovakia	1455491.	0.49	33.90	0.055	0.204	0.080	0.011
Eastern Slovakia	1316921.	0.38	33.71	0.038	0.159	0.057	0.006
Czechoslovakia	14801667.	0.52	34.46	0.056	0.202	0.090	0.010

Migration

Country (reference year) and region	Population (1)	GMR (2)	mean age of migr.sched. (3)	GMR(0-4) (4)	GMR(15-29) (5)	GMR(65+) (6)	GMR(70-74) (7)
Fed.Rep.of Germany(1974)							
Schleswig-Holstein	2584343.	1.84	31.23	0.127	0.897	0.165	0.026
Hamburg	1733802.	2.87	33.51	0.265	1.043	0.364	0.050
Lower Saxony	7265539.	1.35	32.42	0.088	0.647	0.149	0.025
Bremen	723990.	3.30	32.05	0.287	1.390	0.368	0.051
N. Rhine-Westphalia	17218626.	0.83	34.58	0.060	0.347	0.112	0.019
Hessen	5576082.	1.38	33.45	0.101	0.561	0.157	0.026
Rhineland-Palatinate	3687561.	1.77	32.12	0.115	0.852	0.187	0.031
Baden-Wuerttemberg	9226239.	1.05	32.30	0.070	0.479	0.099	0.018
Bavaria	10849123.	0.74	31.64	0.053	0.343	0.064	0.012
Saarland	1103325.	1.49	30.58	0.090	0.797	0.129	0.019
West Berlin	2034366.	2.00	35.43	0.160	0.676	0.275	0.052
Fed.Rep. of Germany	62002996.	1.19	33.33	0.083	0.521	0.139	0.023
Finland (1974)							
Uusimaa	1073485.	1.46	26.59	0.205	0.599	0.070	0.022
Turku and Pori	691672.	1.25	25.40	0.162	0.596	0.043	0.015
Ahvenanmaa	22009.	0.85	24.19	0.099	0.426	0.024	0.
Hame	657049.	1.75	25.80	0.225	0.817	0.064	0.019
Kymi	345985.	1.56	25.76	0.200	0.727	0.052	0.017
Mikkeli	212200.	2.47	26.05	0.276	1.270	0.093	0.029
Pohjois-Karjala	177870.	2.18	25.73	0.235	1.170	0.074	0.024
Kuopio	251320.	2.03	25.78	0.244	1.033	0.078	0.026
Keski-Suomi	238814.	2.00	25.33	0.245	1.009	0.061	0.022
Vaasa	423043.	1.29	24.95	0.159	0.682	0.036	0.011
Oulu	400853.	1.63	26.26	0.183	0.822	0.055	0.017
Lappi	196232.	1.84	27.22	0.208	0.897	0.074	0.024
Finland	4690532.	1.62	25.89	0.202	0.772	0.060	0.019
France (1975)							
Paris Region	9876665.	1.35	39.62	0.126	0.261	0.283	0.065
Paris Basin	9647540.	0.89	31.58	0.092	0.287	0.092	0.018
North	3913250.	0.65	31.49	0.071	0.212	0.064	0.012
East	4905810.	0.68	30.94	0.072	0.204	0.058	0.010
West	6889705.	0.64	29.32	0.072	0.254	0.055	0.011
Southwest	5553655.	0.73	29.05	0.087	0.278	0.061	0.012
Middle East	6129105.	0.65	31.81	0.069	0.200	0.068	0.014
Mediterranean	5464635.	0.76	29.76	0.090	0.264	0.070	0.014
France	52380364.	0.84	33.06	0.088	0.251	0.104	0.022
German Dem.Rep.(1975)							
North	2085383.	0.53	25.59	0.076	0.246	0.028	0.007
Berlin	1098174.	0.50	26.15	0.062	0.199	0.024	0.007
Southwest	2529805.	0.39	25.29	0.045	0.192	0.017	0.005
South	7134846.	0.37	24.87	0.047	0.179	0.016	0.005
Middle	3972041.	0.51	25.53	0.060	0.239	0.026	0.008
German Dem.Rep.	16820250.	0.44	25.20	0.055	0.206	0.020	0.006

Migration

Country (reference year) and region	Population (1)	GMR (2)	mean age of migr.sched. (3)	GMR(0-4) (4)	GMR(15-29) (5)	GMR(65+) (6)	GMR(70-74) (7)
Hungary (1974)							
Central	2968109.	2.77	32.54	0.135	1.451	0.306	0.056
North Hungary	1357973.	2.27	31.60	0.096	1.232	0.214	0.044
North Plain	1543604.	3.19	30.93	0.128	1.797	0.288	0.054
South Plain	1451260.	1.91	33.08	0.105	0.954	0.260	0.045
North Trans-Danubia	1823844.	1.77	34.70	0.086	0.866	0.270	0.045
South Trans-Danubia	1303694.	1.84	33.65	0.095	0.924	0.263	0.045
Hungary	10448484.	2.36	32.57	0.110	1.239	0.274	0.049
Italy (1978)							
North West	15424582.	0.48	33.34	0.037	0.155	0.050	0.010
North East	10394756.	0.26	35.67	0.017	0.086	0.037	0.006
Center	10790837.	0.32	35.04	0.021	0.113	0.043	0.008
South	13471822.	0.54	32.58	0.026	0.245	0.055	0.011
Islands	6518288.	0.53	31.59	0.028	0.232	0.047	0.009
Italy	56600292.	0.43	33.17	0.027	0.169	0.047	0.009
Japan (1970)							
Hokkaido	5184287.	1.86	32.71	0.099	0.820	0.221	0.034
Tohoku	11392179.	1.98	29.45	0.070	1.209	0.112	0.020
Kanto	30257930.	0.76	33.65	0.062	0.269	0.089	0.015
Chubu	17401128.	1.08	29.53	0.063	0.581	0.085	0.015
Kinki	16511391.	1.09	32.10	0.094	0.424	0.119	0.019
Chugoku	6996961.	1.70	27.79	0.089	1.021	0.103	0.019
Shikoku	3904014.	2.18	27.96	0.086	1.385	0.120	0.022
Kyushu	13017290.	2.37	29.04	0.099	1.364	0.135	0.023
Japan	104665176.	1.35	30.50	0.077	0.679	0.110	0.019
Netherlands (1974)							
North	1473611.	1.08	34.14	0.075	0.464	0.169	0.025
East	2592786.	1.36	35.01	0.085	0.589	0.225	0.034
West	6150477.	1.10	37.00	0.087	0.341	0.205	0.035
South-West	322891.	1.62	33.76	0.105	0.698	0.253	0.044
South	2948600.	0.82	35.39	0.049	0.371	0.144	0.021
Netherlands	13488365.	1.10	36.03	0.077	0.417	0.196	0.032
Poland (1977)							
Warsaw	2207161.	0.50	50.19	0.033	0.104	0.195	0.040
Lodz	1099132.	0.59	46.35	0.050	0.154	0.208	0.034
Gdansk	1287689.	0.71	49.69	0.049	0.175	0.287	0.043
Katowice	3557261.	0.44	42.90	0.035	0.128	0.125	0.022
Cracow	1143864.	0.63	41.96	0.061	0.196	0.180	0.035
East-Central	2930837.	0.90	33.23	0.086	0.402	0.137	0.025
Northeast	2398497.	0.74	33.43	0.067	0.333	0.118	0.021
Northwest	2106814.	1.05	42.11	0.086	0.311	0.317	0.052
South	2505722.	0.71	37.84	0.072	0.256	0.151	0.023
Southeast	4208485.	0.62	34.79	0.053	0.291	0.104	0.019
East	2479828.	0.68	33.77	0.063	0.321	0.111	0.017
West-Central	4712562.	0.53	36.69	0.051	0.196	0.106	0.018
West	4059724.	0.74	40.64	0.067	0.229	0.212	0.031
Poland	34697580.	0.66	38.29	0.060	0.240	0.151	0.026

Migration

Country (reference year) and region	Population (1)	GMR (2)	mean age of migr.sched. (3)	GMR(0-4) (4)	GMR(15-29) (5)	GMR(65+) (6)	GMR(70-74) (7)
Soviet Union (1974)							
Urban areas of the:							
RSFSR	88230272.	1.38	31.61	0.060	0.788	0.146	0.029
Ukrainian+Mold.SSRs	29527222.	1.76	31.41	0.066	1.023	0.176	0.035
Byelorussian SSR	4549020.	2.33	35.17	0.084	1.178	0.343	0.067
Central Asian Rep.s	8681624.	2.13	35.54	0.045	1.141	0.296	0.058
Kazakh SSR	7348350.	3.23	35.44	0.099	1.688	0.471	0.094
Caucasian Republics	6918171.	1.06	33.88	0.029	0.607	0.132	0.026
Baltic Republics	4334008.	1.57	30.73	0.055	0.931	0.143	0.027
Rural areas of USSR	101280288.	3.53	29.17	0.080	2.443	0.208	0.041
Soviet Union	250868944.	2.20	30.92	0.070	1.357	0.191	0.037
Sweden (1974)							
Stockholm	1486821.	1.45	29.26	0.180	0.495	0.112	0.024
East Middle	1397129.	1.47	27.34	0.164	0.627	0.072	0.017
South Middle	763793.	1.38	26.83	0.143	0.654	0.064	0.016
South	1157556.	0.86	26.87	0.098	0.383	0.040	0.009
West	1603323.	0.82	27.12	0.093	0.341	0.039	0.009
North Middle	853655.	1.28	26.61	0.131	0.622	0.058	0.014
Lower North	400292.	1.40	26.26	0.138	0.724	0.057	0.016
Upper North	494569.	1.14	27.31	0.104	0.588	0.054	0.011
Sweden	8157138.	1.20	27.42	0.134	0.517	0.063	0.015
United Kingdom (1970)							
North	3359700.	1.21	31.69	0.106	0.504	0.140	0.019
Yorkshire + Humbers.	4811900.	1.34	30.82	0.119	0.539	0.139	0.028
North West	6788700.	1.06	32.92	0.082	0.411	0.131	0.026
East Midlands	3362800.	1.57	30.63	0.146	0.611	0.162	0.034
West Midlands	5178000.	1.16	30.89	0.091	0.448	0.093	0.015
East Anglia	1673500.	1.84	30.47	0.191	0.690	0.185	0.047
South East	17315502.	1.06	33.98	0.089	0.373	0.144	0.028
South West	3763700.	1.84	30.91	0.161	0.749	0.185	0.035
Wales	2733900.	1.21	31.82	0.105	0.508	0.145	0.029
Scotland	5199100.	0.87	28.56	0.085	0.360	0.061	0.010
United Kingdom	54186800.	1.20	31.96	0.104	0.463	0.136	0.026
United States (1970)							
Northeast	49040708.	1.12	31.02	0.091	0.398	0.105	0.027
North Central	56571668.	1.31	29.99	0.117	0.494	0.113	0.032
South	62795372.	1.38	28.37	0.137	0.568	0.105	0.033
West	34804200.	1.45	29.08	0.148	0.550	0.102	0.030
United States	203211920.	1.31	29.46	0.123	0.506	0.106	0.030

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