MIGRATION AGE PATTERNS: II. CAUSE-SPECIFIC PROFILES

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FOREWORD

Declining rates of national population growth, continuing differential rates of regional economic activity, and shifts in the migration patterns of people and jobs are characteristic empirical aspects of many developed countries. In several instances, they have combined to bring about a relative (and in some cases absolute) population decline of highly urbanized areas, e.g., New York, Tokyo, and Stockholm. In other cases, they have brought about rapid metropolitan growth, e.g., Houston, Miami, and Moscow.

The objective of the Urban Change Task in IIASA's Human Settlements and Services Area is to bring together and synthesize available empirical and theoretical information on the principal determinants and consequences of such urban growth and decline.

This paper is the second of five to focus on migration age patterns in national populations. It draws its data from a large data bank on migration patterns assembled at IIASA as part of the earlier Migration and Settlement Task, which was formally concluded in 1978. The first paper in this series dealt with the mathematical description of observed migration schedules, the analysis of their age profiles and the study of how those profiles are influenced by the age composition of the population in the region of origin. This paper continues the earlier analysis by examining the contributions of different cause-specific migration age profiles to variations in aggregate age-specific migration rates. Subsequent papers will deal with a comparative analysis of the large data bank on migration schedules, a study of status-specific migration age profiles, and an investigation of alternative methods for developing model schedules for inferring migration flows on the basis of inaccurate or inadequate data.

A list of related publications in the Urban Change Series appears at the end of this paper.

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ACKNOWLEDGMENTS

The data used in this paper were collected as part of a comparative migration and settlement study conducted at the International Institute for Applied Systems Analysis (IIASA). The authors gratefully acknowledge the generous provision of detailed Czechoslovakian data by Karel Kühnl of the Department of Geography at Charles University in Prague. We are also grateful for the opportunity to discuss the subject of this paper with Nathan Keyfitz who contributed a valuable suggestion.

ABSTRACT

This paper seeks to illuminate the role played by various reasons for migration in accounting for observed variations of age-specific migration rates. The focus is on the levels and age profiles of different cause-specific migration schedules and on their contribution to aggregate migration age curves that change over time and space.

CONTENTS

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INTRODUCTION

Mortality studies have shown that the age pattern of deaths varies systematically with level. For example, as the expectation of life at birth increases, the largest absolute declines 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. Are there analogous systematic variations in migration age patterns? Does the age pattern of migration vary with level? 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 aggregate migration age profile?

Sam Preston (1976, p. 109) points out that "...roughly half of the variance in age-curves of mortality at a particular mortality level can be accounted for by variance in relative importance of 6-7 cause of death categories among populations at that level...it suggests that causes of death have substantial value in accounting for disparities in age patterns in mortality." Can the same be said of disparities in age patterns of migration?

This paper seeks to illuminate the role played by various reasons for migration in accounting for observed variations of age-specific migration rates. The focus is on the levels and age profiles of different reason-specific migration schedules and on their contribution to aggregate migration age curves and their changes over time and space. Because we follow the "mortality" approach in decomposing aggregate migration schedules, we refer to reasons as causes. In a forthcoming paper, however, we shall focus instead on the "fertility" approach of analyzing such schedules, adopting a decomposition by status instead of by cause.

MIGRATION BY CAUSE

Why people move is a question that needs to be considered within the context of (1) those differentiating characteristics of potential migrants that condition receptivity to migration, and (2) those differentiating environmental factors that stimulate migration from one community to another. Nevertheless, insights into motivations for migration can be developed simply by asking people why they moved. This approach has been adopted, for example, in nationwide surveys conducted by the U.S. Census Bureau (Long and Hansen, 1979) and by national migration registers maintained in such countries as Czechoslovakia (Kühnl, 1978).

Studies of reported causes for internal migration 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 typically are 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 often are mutually interdependent, usually insufficient in number, and generally not linked directly to the true decisionmaker. However,

analogous limitations also appear in studies of mortality by cause, without presenting insuperable obstacles for the generation of insights in that area of demographic research:

> "Causes are undoubtedly recorded with considerable inaccuracy and interpopulation 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." (Preston, 1976, p. 2)

Table 1.A gives the percent of household heads moving for each of five causes in the U.S. and in Hungary. These data confirm that it is a great oversimplification to explain migration solely in terms of economic motivations. Although employment reasons account for about a half of the recorded reasons for moving by household heads, education, marriage, housing and other reasons account for the other half. Moreover, the data indicate that in Hungary economic motivations have been declining in relative importance over time.

Table 1.B presents comparable data for total persons migrating, including the household head. Only 36 percent of total migrants were household heads in the U.S. survey; in Hungary the corresponding percentage ranged from 37 percent in 1958 to 45 percent in 1968. The data for Czechoslovakia do not distinguish between household heads and their accompanying dependents.

Housing reasons accounted for over 40 percent of all migration between communities (communes) in Czechoslovakia in 1973; this total is about three times as high as Hungary's and five times as high as the U.S. figure. Data for the U.S., however, refer to <u>interstate</u> migration, and one would expect housing reasons to decline in importance relative to economic reasons in migrations over such distances.

Less than 30 percent of total internal migration in Czechoslovakia was attributed to economic causes. This relatively low share of the total is somewhat surprising and apparently reflects a leveling of regional economic differences:

Table 1. Migration by cause

1.A Household Heads

	Employment	Education	Marriage	Housing	Other	Total
USA (1974-76)	56.6	5.4	1.6	8.1	28.3	100.0
Hungary (1958)	49.7	2.5	15.4	12.0	20.4	100.0
Hungary (1968)	43.8	1.7	21.5	14.1	18.9	100.0

1.B Total Migrants

	Employment	Education	Marriage	Housing	Other	Total
USA (1974-76)	59.8	3.9	1.4	8.0	26.9	100.0
Czechoslovakia (1973)	28.1	1.0	17.0	41.8	12.1	100.0
Czech Republic (1973)	20.9	0.7	17.1	47.8	13.5	100.0

Sources: Long and Hansen (1979), Compton (1971), and Kühnl (1978). The U.S. data are for interstate migration; the Hungarian and Czechoslovakian data refer to all inter-communal migration. The Czech Republic and the Slovak Republic together comprise the nation of Czechoslovakia.

> "...for the major part, it is the outcome of specific Czechoslovak conditions: In recent years, development in the whole Czechoslovak Socialist Republic, but particularly in the Czech Socialist Republic, was characterized by a relatively balanced territorial development of productive forces, accompanied by a levelling-out of regional differences in economic and income structure and in the training requirements of available jobs." (Kühnl, 1978, p. 4)

Table 2 shows that the cause structure of migration varies with migration distance. For example, the two principal causes of migration in the Czech Republic, employment and housing, exhibit opposite associations with migration distance.* They mirror the similar inverse relationship shown in the U.S. and Hungarian data set out earlier in Table 1.A, which reflect the commonly observed tendency of short-distance migration to be primarily motivated by housing reasons and long-distance migration by employment reasons. For as Hoover (1971) points out in a study of U.S. data:

> "...those men who only moved within the same county were predominantly influenced by housing considerations. Since all of a county is generally regarded as being in a single labor market or commuting range, job changes are related only to a minor extent with intracounty moves: most such movers are not changing jobs.
>
> For those who moved to a different county...the picture is quite different, with employment changes (including entry to or exit from military service) emerging as the major reasons for migrating. This reflects the fact that an intercounty migration generally involves shifting to a different labor market beyond the commuting range for the former job." (Hoover, 1971, p. 169)

Migration causes 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 migration 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.

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*There are a dozen administrative regions in Czechoslovakia: eight in the Czech Republic and four in the Slovak Republic. The nation is comprised of about 100 districts and approximately 10,000 communities (communes).

Table 2. Migration by cause and distance: Czech Republic, 1966-1973

Distance	Year	Causes									
		1	2	3	4	5	6	7	8	9	Total
Migration between regions	1967	30,6	6,3	0,9	5,2	13,5	2,0	36,0	4,3	1,2	100,0
	1969	28,4	5,6	1,5	5,0	15,3	3,0	37,0	4,1	0,1	100,0
	1971	26,4	6,0	1,3	5,2	13,6	2,9	39,1	5,4	0,1	100,0
	1973	24,4	5,7	1,4	5,6	15,5	3,4	38,3	5,7	0,0	100,0
Migration between districts within regions	1967	23,3	8,1	0,6	4,4	13,0	2,1	43,6	4,0	0,9	100,0
	1969	21,2	7,4	0,6	4,0	16,0	3,1	43,9	3,8	0,0	100,0
	1971	19,1	7,1	0,6	4,2	15,2	3,0	45,2	5,5	0,1	100,0
	1973	16,8	6,6	0,6	4,4	17,5	3,3	45,4	5,4	0,0	100,0
Migration between communities within districts	1967	12,2	7,9	0,2	4,5	13,1	1,7	55,8	3,9	0,7	100,0
	1969	9,5	6,8	0,2	4,8	18,4	2,7	54,3	3,7	0,1	100,0
	1971	8,7	6,1	0,2	3,8	16,6	2,6	56,5	5,3	0,2	100,0
	1973	7,6	5,9	0,2	4,5	17,9	2,8	55,4	5,7	0,0	100,0

Reasons:
1 - change of employment
2 - moving closer to place of work
3 - education
4 - health
5 - marriage
6 - divorce
7 - housing
8 - other
9 - unknown

Source: Kühnl (1978), p. 7.

Table 3 illustrates typical age and sex differentials in migration-by-cause data. Except for housing reasons in Hungary, most moves attributable to each cause occur before the age of 40. Only health- and housing-related migrations occur in significant percentages at older ages. Finally, age concentration is most pronounced in migration associated with marriage (60 to 80 percent between the ages of 20 and 30) and education (94 to 97 percent between the ages of 16 and 30).

DESCRIPTION: CAUSE-SPECIFIC AGE PROFILES

If the age pattern of migration is influenced by its cause-of-migration 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 structures. Unfortunately, detailed age-specific data on migration by cause are exceedingly scarce, and we have been able to find only one source for this study: the Czechoslovakian migration register.*

Figure 1 displays histograms and their associated cubic spline interpolations (McNeil, Trussell, and Turner, 1977) for age-specific male and female migration rates in Czechoslovakia. Figure 2 presents the age-specific migration cause structures that underlie these rates. For ease of visual comparison all age profiles are scaled to sum to a unit area under the curve (i.e., to exhibit a gross migraproduction rate, GMR, of unity).

The age profiles reveal that the causes of migration vary substantially in age pattern. Of the eight causes illustrated, the age profile of housing reasons mirrors most closely that of the aggregate migration schedule, exhibiting roughly the same

*Identification of migration causes 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.

Table 3. Age and Sex Differentials in Migration-by-Cause Patterns: Hungary, 1958 and Czechoslovakia, 1973

3.A Males

Cause \ Age		16-19	20-29	30-39	40-49	50-59	60+	Total
Change of employment	Hu	9,8	41,7	26,8	11,8	7,1	2,8	100,0
	Cz	7,9	48,2	23,1	15,1	4,7	1,0	100,0
Closer to place of work	Hu	5,7	47,0	28,2	10,4	6,3	2,4	100,0
	Cz	7,0	58,3	18,2	11,1	4,2	1,2	100,0
Education	Hu	68,8	28,0	2,4	0,5	0,3	-	100,0
	Cz	40,9	53,6	4,1	1,0	0,2	0,2	100,0
Health	Hu	2,5	15,0	17,2	18,4	18,6	33,7	100,0
	Cz	5,3	13,2	9,1	8,4	9,1	54,9	100,0
Marriage	Hu	3,9	73,0	14,0	4,6	2,8	1,7	100,0
	Cz	3,8	81,8	8,9	3,2	1,4	0,9	100,0
Housing	Hu	6,0	27,1	23,4	12,7	12,4	18,4	100,0
	Cz	7,1	53,0	17,5	8,5	4,4	9,5	100,0

3.B Females

Cause \ Age		16-19	20-29	30-39	40-49	50-59	60+	Total
Change of employment	Hu	20,8	44,8	18,7	8,8	4,8	2,1	100,0
	Cz	12,5	48,8	22,0	12,2	3,2	1,3	100,0
Closer to place of work	Hu	15,0	52,9	19,4	7,2	4,0	1,5	100,0
	Cz	12,9	61,2	14,8	7,4	2,8	0,9	100,0
Education	Hu	70,1	26,8	2,5	0,3	0,2	0,1	100,0
	Cz	62,8	34,6	1,2	0,8	0,6	0,0	100,0
Health	Hu	4,2	15,5	15,2	9,4	17,6	38,2	100,0
	Cz	2,9	11,9	5,3	4,5	8,1	67,3	100,0
Marriage	Hu	24,8	59,5	9,6	3,3	2,0	0,8	100,0
	Cz	22,3	69,1	4,7	2,3	1,0	0,6	100,0
Housing	Hu	6,6	27,8	18,6	11,0	12,0	24,0	100,0
	Cz	10,8	52,6	12,3	7,1	5,6	11,6	100,0

Sources: Compton (1971) pp. 90-91 and Czechoslavakian Federal Statistical Office (1974). The migration of those less than 16 years of age is here assumed to be dependent migration.

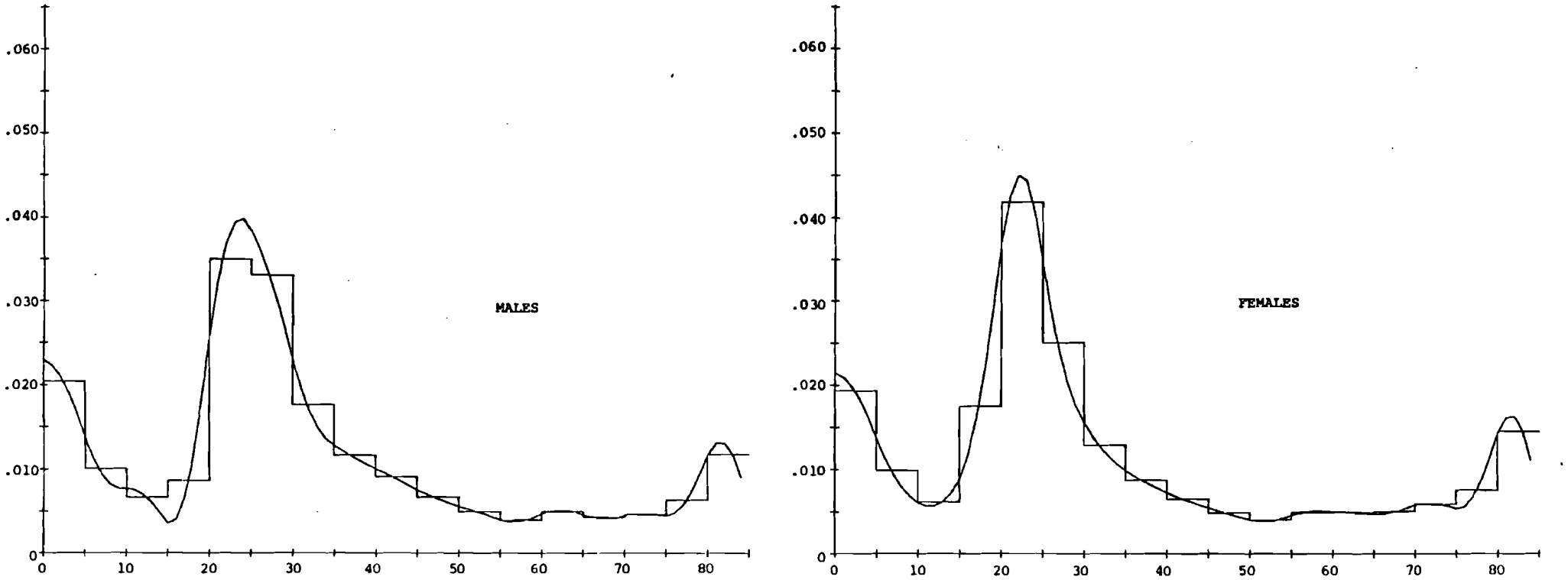
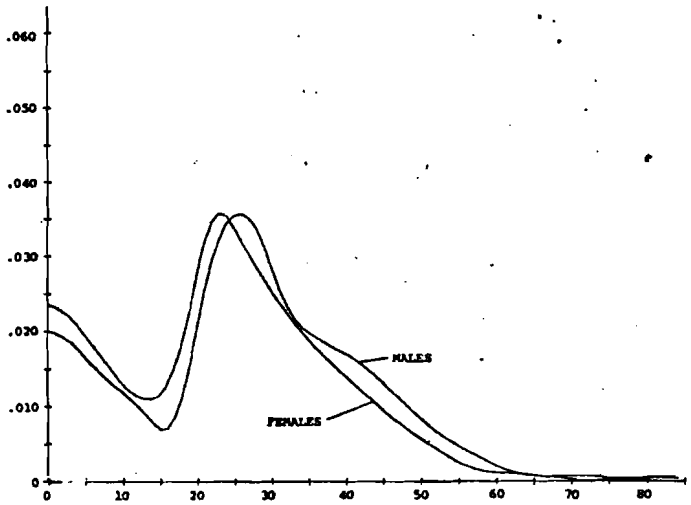
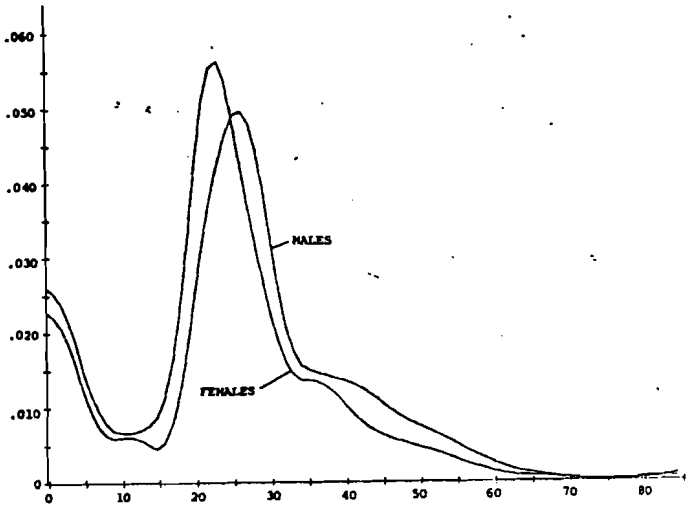


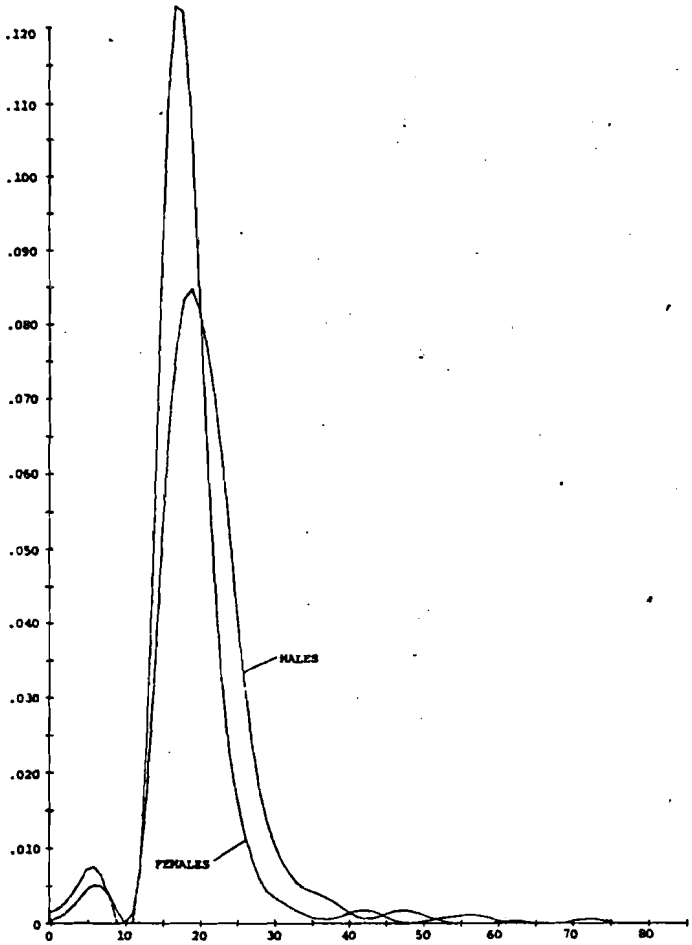
Figure 1. Observed annual migation rates: Czechoslovakia, males and females, 1973.



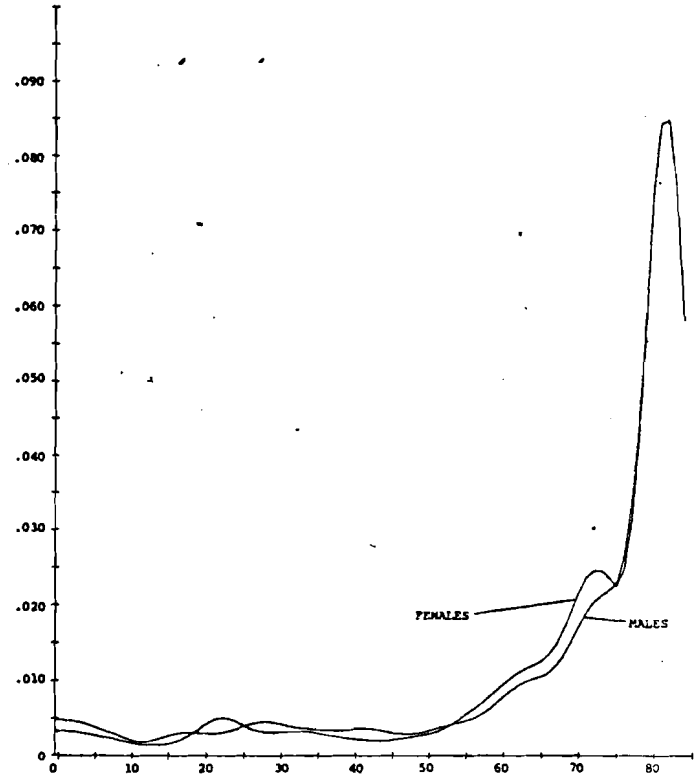
1. Change of employment.



2. Moving closer to place of work.

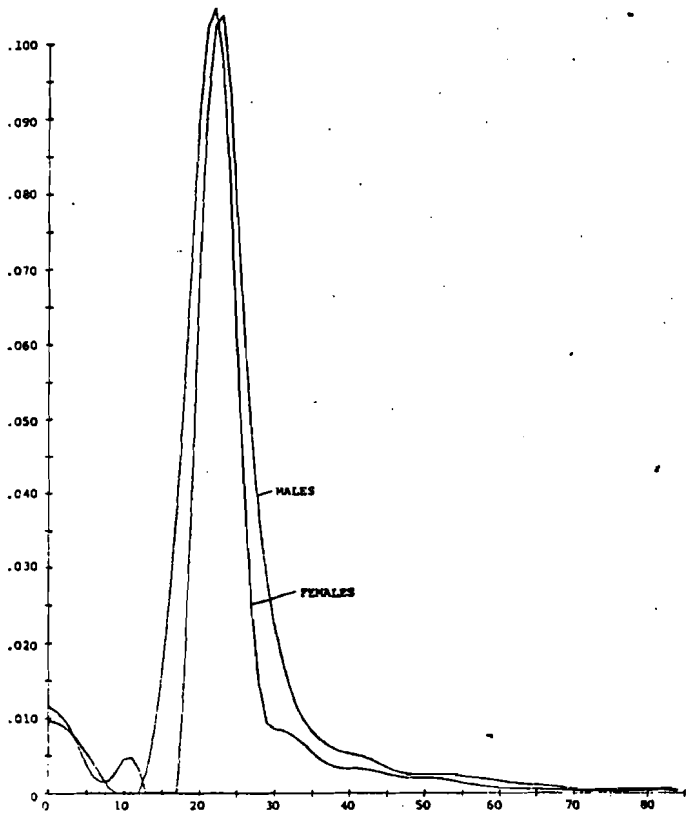


3. Education

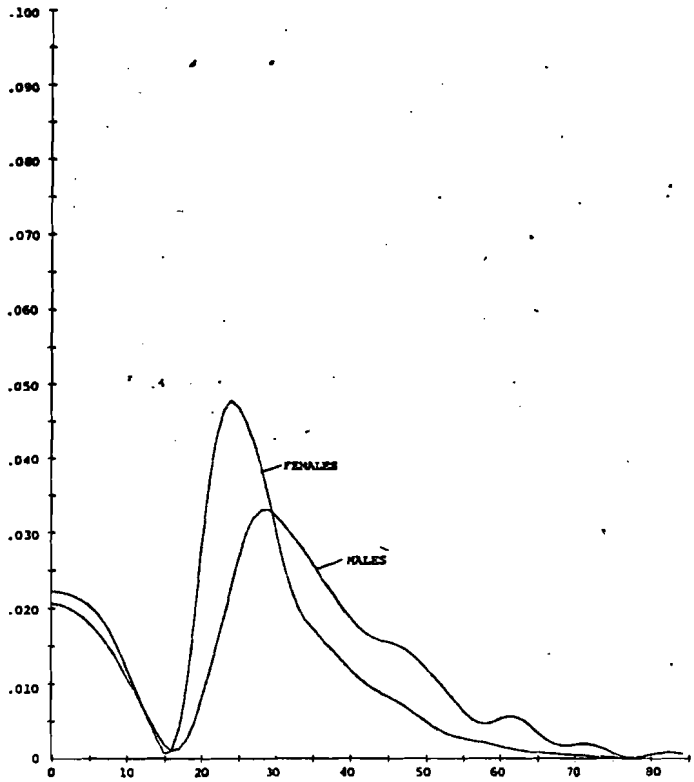


4. Health

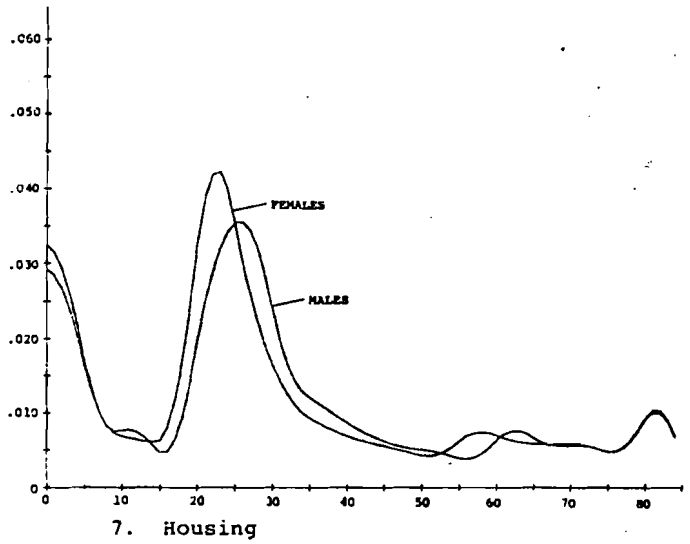
Figure 2. Observed cause-specific migration rates: Czechoslovakia, males and females, 1973.



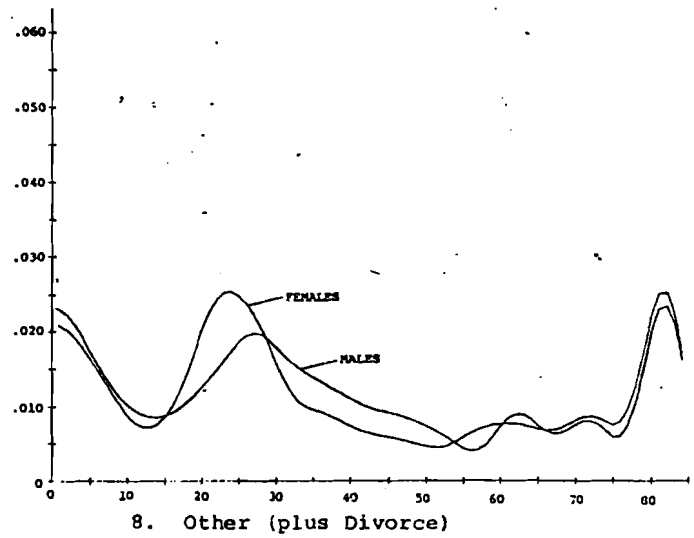
5. Marriage



6. Divorce



7. Housing



8. Other (plus Divorce)

Figure 2. Observed cause-specific migration rates: Czechoslovakia, males and females, 1973, continued.

four peaks: at infancy, during the early labor force participation years, at retirement, and during the oldest age interval. Marriage and education reasons, on the other hand, are concentrated between the ages of 10 and 30 and are essentially unimodal in age profile. Divorce, change of employment, and moving closer to the place of work have profiles that are bi-modal, with local peaks at infancy and at the early labor force participation ages. Finally, health reasons apparently are an important cause of migration only for the elderly. (The residual category, "all other reasons" is consolidated together with divorce in Figure 2 in order to give it a profile that is more amenable for our subsequent analytical manipulations.)

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 an entry into the educational system at the elementary level, the "passage" may also include entry into the military or the university, marriage, multiple entries into and withdrawals from the labor force, perhaps divorce and remarriage, retirement, widowhood, and moves to enter sanatoria or to rejoin relatives.

Associated with this individual life cycle perspective is a family life cycle orientiation which begins with marriage, passes on to procreation, child rearing (possibly interrupted by divorce or death), continues on to child "launching", retirement, and ultimately ends with the death of both spouses:

> "The main stages through which a family passes during its lifetime are the initial childless stage, usually lasting one or two years, the childbearing stage, defined by the interval between the first and last birth, usually extending over approximately eight years, and the intermediate stage occurring between the birth of the last child and the first child leaving home, extending for about 16 years and representing the only period during which all members of the family are living in the household. This is followed by what is often referred to as the 'launching' stage, occurring between the events of the first and last child leaving home, usually of comparable length to the childbearing stage. Beyond the launching stage, when the parents are again alone in the household is the post-parental stage ending when one of the spouses dies. Then follows a period of widowhood until the death of the other parent. Obviously, the sequence and timing of the stages of the life cycle differ from this for families prematurely broken by death or divorce of the parents." (Young, 1975, p. 61)

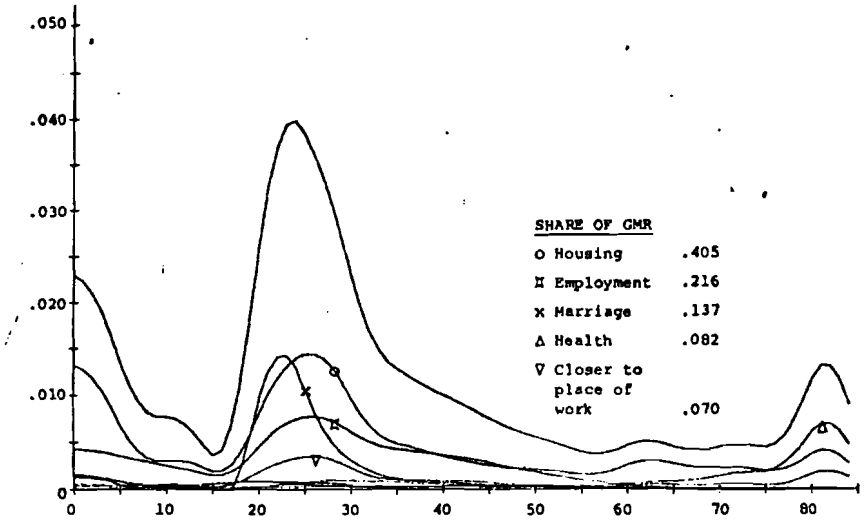
Figure 2 presented cause-specific age profiles scaled to a unit GMR for ease of comparison. Their relative levels in the observed migration schedule are illustrated in Figure 3, which also includes comparable data for another year, 1970, to permit an examination of changes over time. The aggregate migration profile, however, is still scaled to sum to a unit area under the curve.

Figure 3 shows that both the levels and the age profiles of the 1970 and 1973 migration cause structures are roughly similar. Housing reasons account for approximately 40 percent of the total gross migraproduction rate, economic reasons for an additional 25 to 30 percent, marriage for 12 to 15 percent, health for 8 to 11 percent, and all other reasons for the remaining 5 to 15 percent. The major difference in age profiles occurs in the post-retirement ages, with the 1973 schedules exhibiting a much more pronounced old-age-peak.

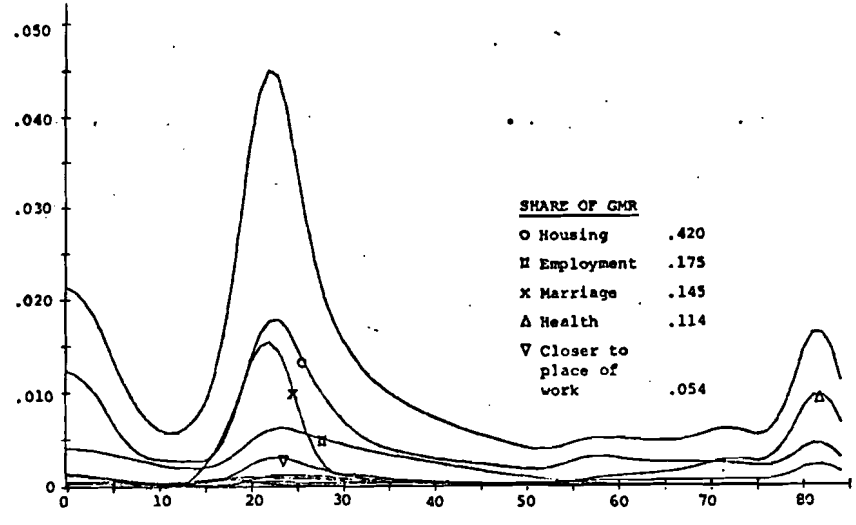
Figure 4 contrasts the levels and age profiles of male intra-republic moves with those of male inter-republic moves in an effort to identify the possible effects of distance on the migration cause structure. Here the findings are not as clear cut. Although intra-republic migration levels by cause seem to be similar in both the Czech and the Slovak republics, they diverge in the corresponding inter-republic migration data. Housing reasons, for example, contribute 45 percent of the total GMR in the flow from the Czech to the Slovak republic, but account for only 33 percent of the flow in the reverse direction. The age profiles also seem to differ, but a more accurate assessment requires a scaling to a unit GMR, such as appears in Figure 5.

Figure 5 enlarges the age profiles of the following three causes to a unit GMR:

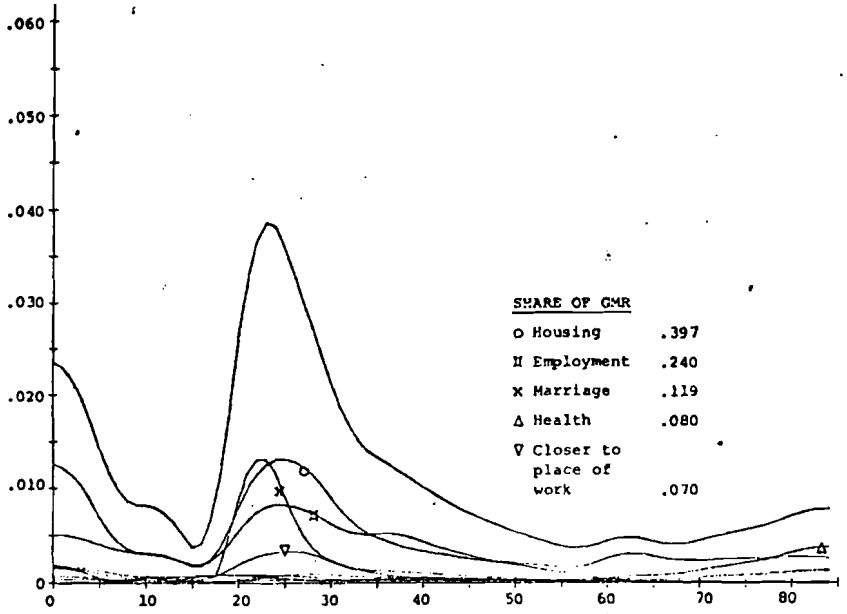
1. change of employment,
2. moving closer to place of work, and
3. housing.



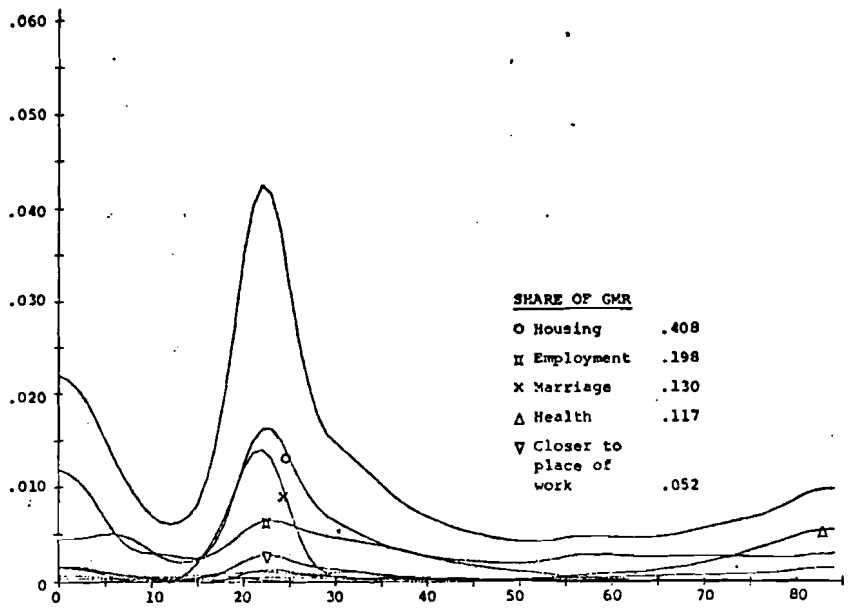
1. Males, 1973.



2. Females, 1973.

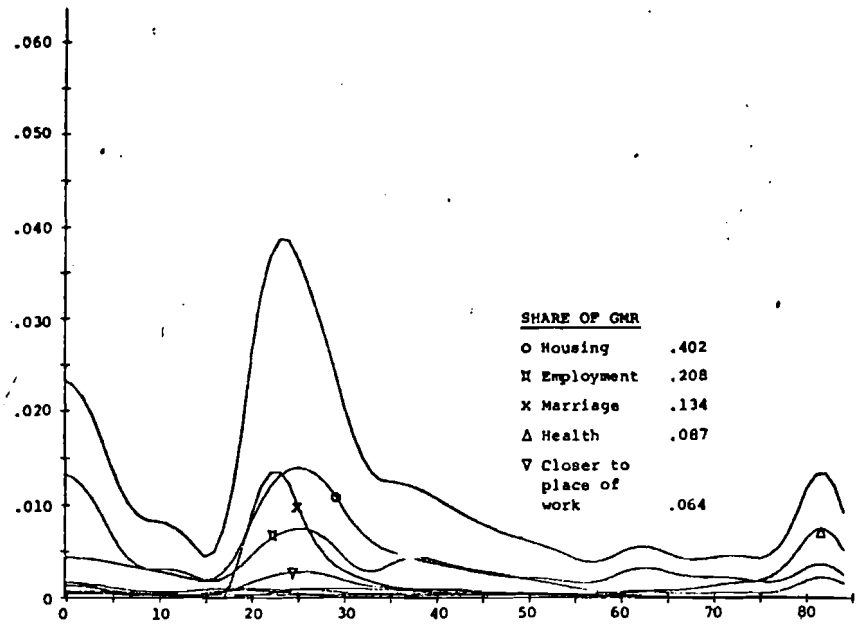


3. Males, 1970.

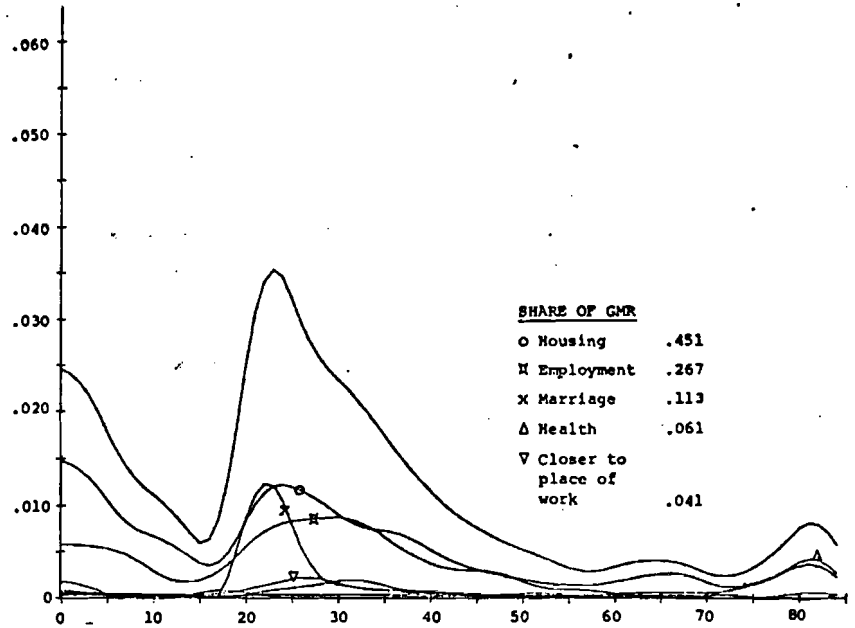


4. Females, 1970.

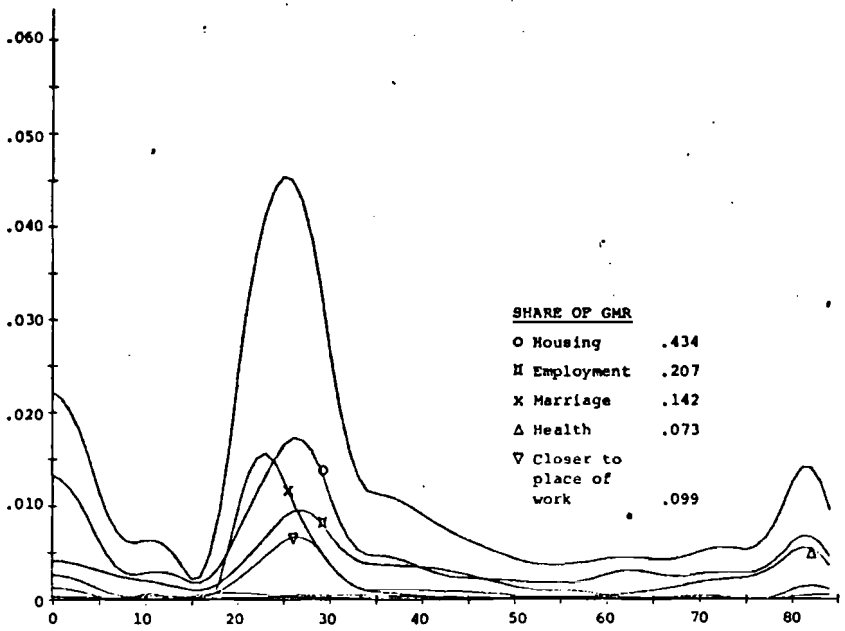
Figure 3. Observed cause-specific migration rates: Czechoslovakia, males and females, 1973 and 1970.



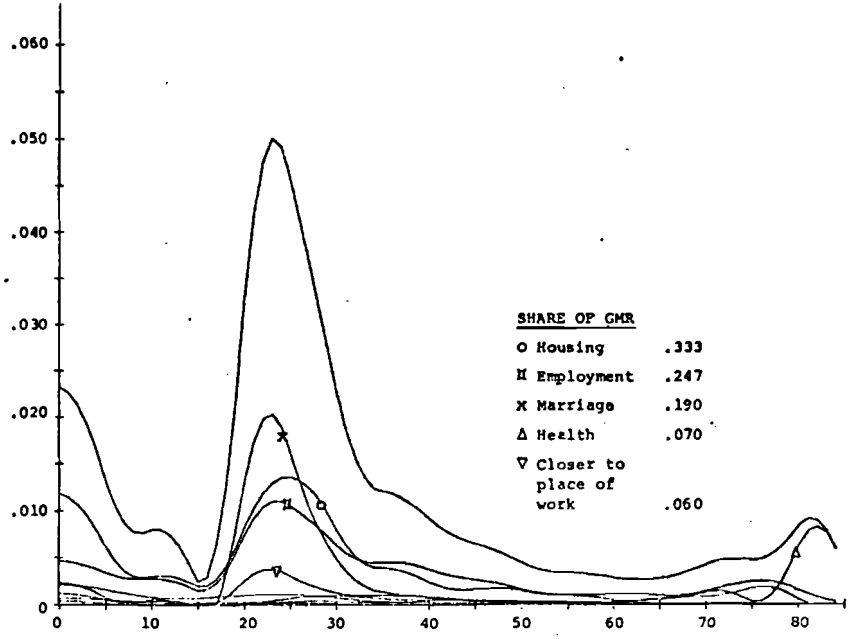
1. Intra-(Czech) republic migrations.



2. Inter-(Czech-to-Slovakia) republic migrations.



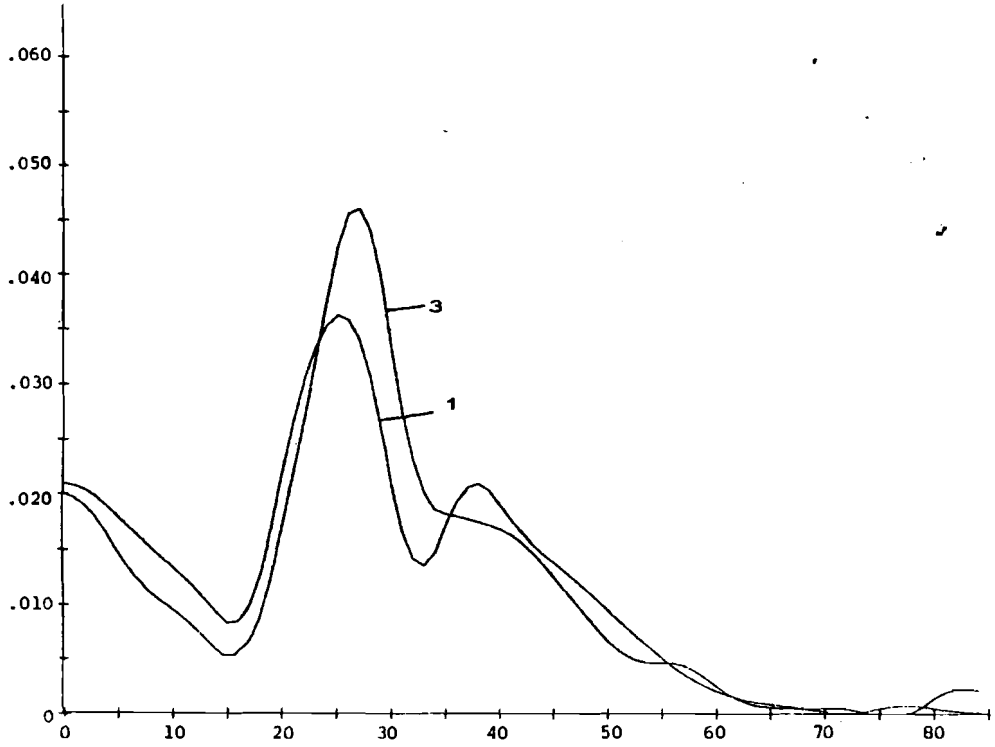
3. Intra-(Slovakia) republic migrations.



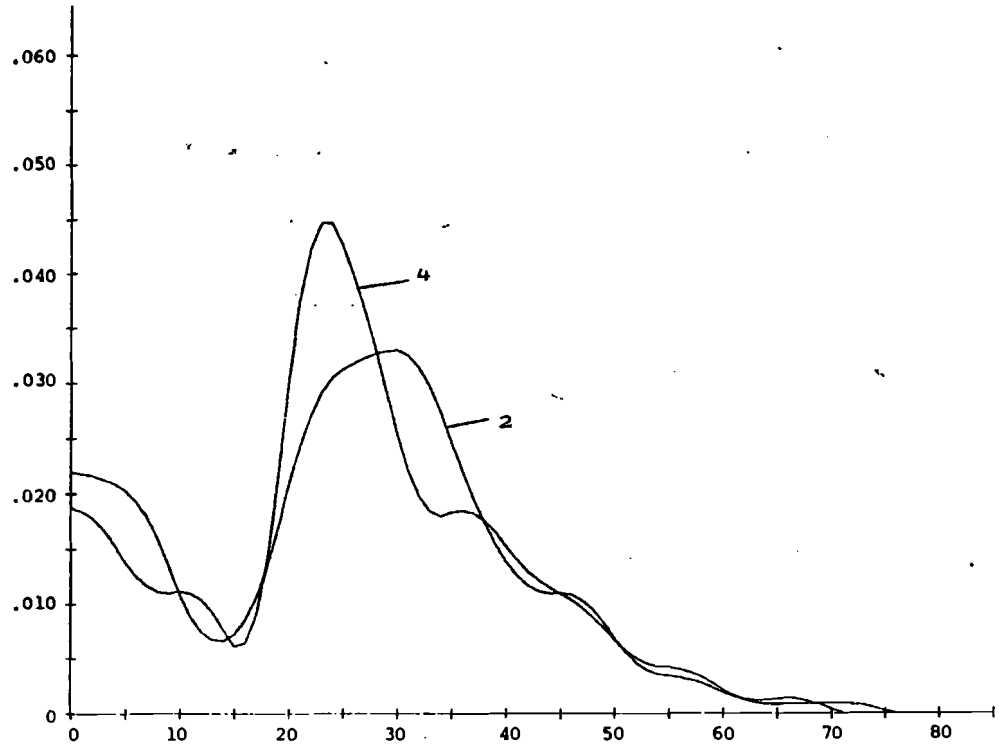
4. Inter-(Slovakia-to-Czech) republic migrations.

Figure 4. Observed cause-specific migration rates: Intra- and inter-republic migrations in Czechoslovakia, males, 1973.

Legend: 1 = Intra-(Czech) republic migration
2 = Inter-(Czech-to-Slovakia) republic migration
3 = Intra-(Slovakia) republic migration
4 = Inter-(Slovakia-to-Czech) republic migration



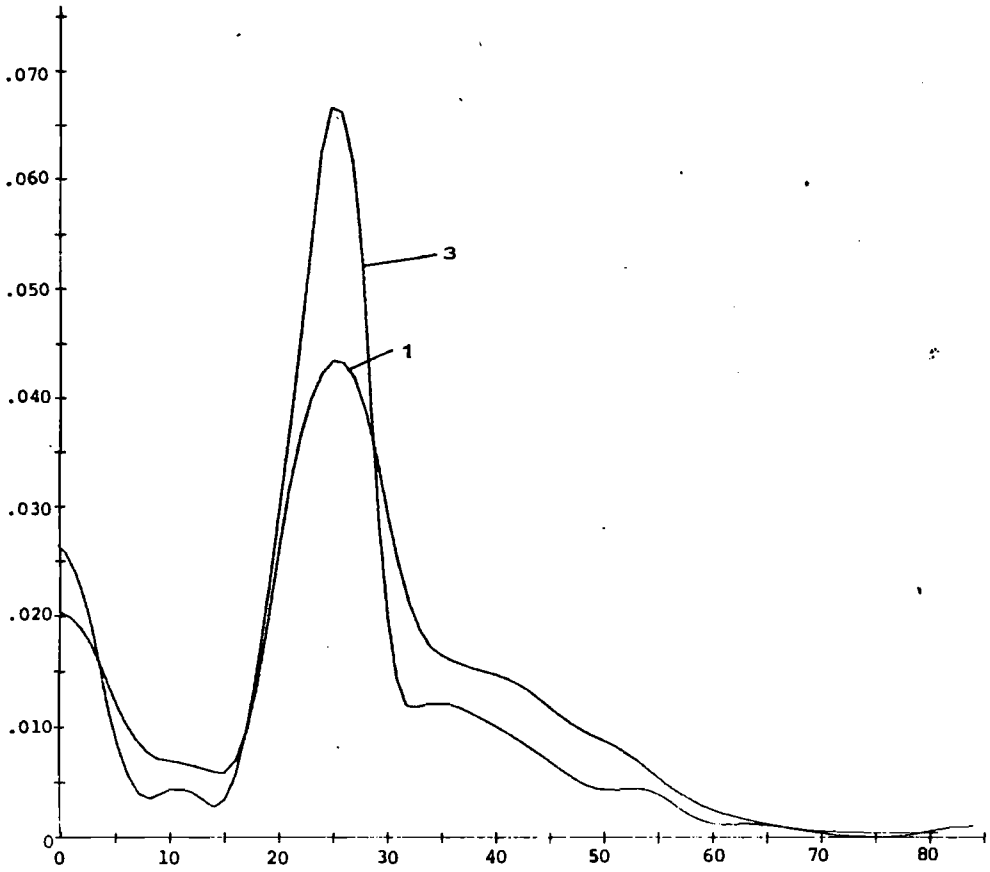
1. Intra-republic migration: Change of employment.



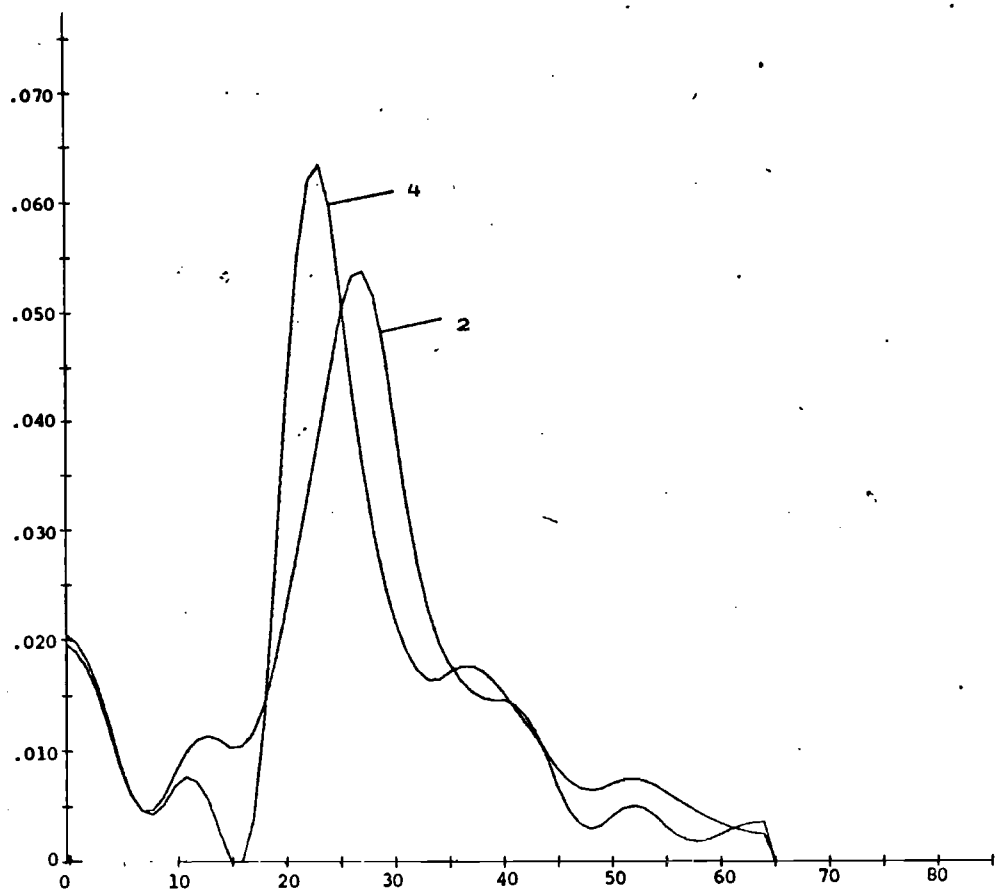
2. Inter-republic migration: Change of employment.

Figure 5. Observed cause-specific migration rates: Intra- and inter-republic migrations in Czechoslovakia, males, 1973, for specific causes.

Legend: 1 = Intra-(Czech) republic migration
2 = Inter-(Czech-to-Slovakia) republic migration
3 = Intra-(Slovakia) republic migration
4 = Inter-(Slovakia-to-Czech) republic migration



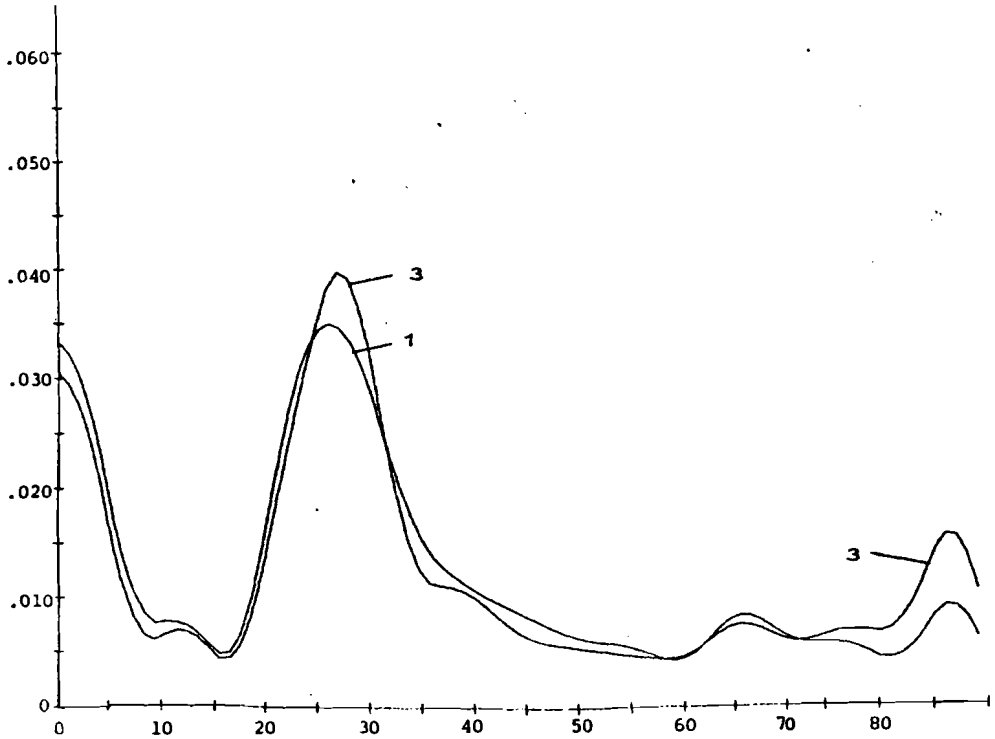
3. Intra-republic migration:
Moving closer to place of work.



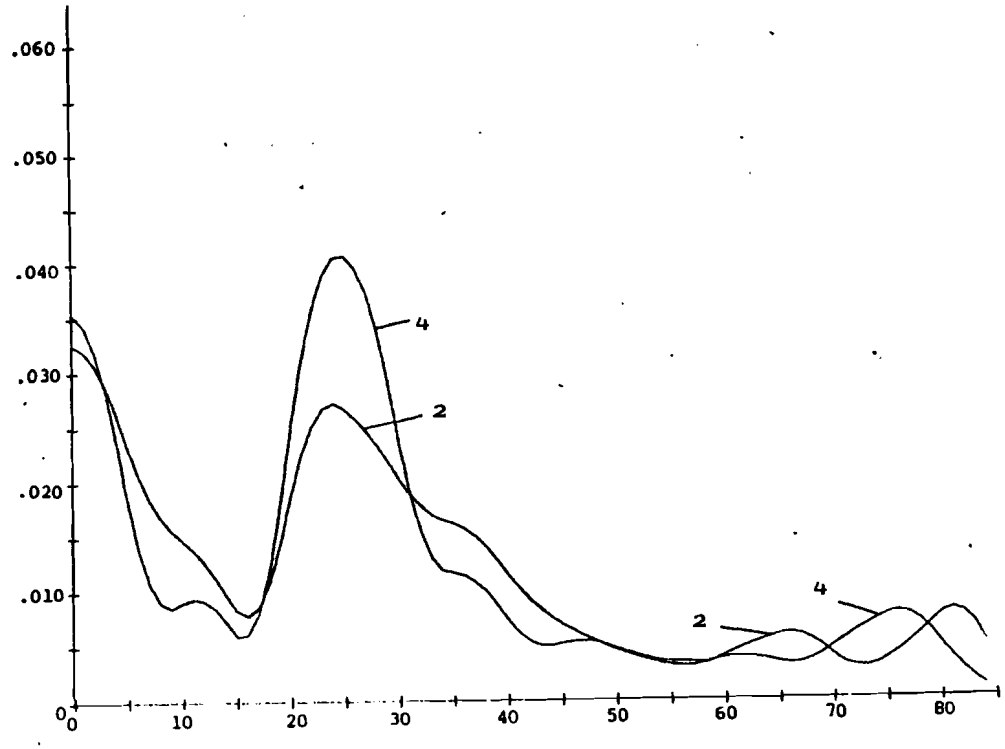
4. Inter-republic migration:
Moving closer to place of work.

Figure 5. Observed cause-specific migration rates: Intra- and inter-republic migrations in Czechoslovakia, males, 1973, for specific causes, continued.

Legend: 1 = Intra-(Czech) republic migration
2 = Inter-(Czech-to-Slovakia) republic migration
3 = Intra-(Slovakia) republic migration
4 = Inter-(Slovakia-to-Czech) republic migration



5. Intra-republic migration: Housing.



6. Inter-republic migration Housing.

Figure 5. Observed cause-specific migration rates: Intra- and inter-republic migrations in Czechoslovakia, males, 1973, for specific causes, continued.

Differences in age profiles associated with differences in the distances migrated are hard to identify. Indeed more significant profile differences seem to be associated with the republic of origin than with the category of flow (i.e., intra vs. inter). For example, the age profiles of migration originating in Slovakia are more labor dominant, i.e., a higher proportion of the total GMR is to be found in the prime young labor force ages. A labor dominant curve, consequently, is characterized by a relatively thinner and higher peak between the ages of 20 and 30.

We conclude, therefore, that although the migration levels associated with various causes vary with distance, the cause-specific age profiles may in fact by quite similar. Only more data of the sort illustrated above can clarify this matter. At the moment the above conclusion is merely a conjecture.

ANALYSIS: MODEL SCHEDULES

Figure 6 illustrates both the observed age-specific migration schedules (scaled to unit GMR) for Czechoslovakian males and females in 1973 and their graduation by a model schedule (the superimposed smooth outlines) 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 unimodal curve of the labor force ages with its rates of ascent and descent, λ_2 and α_2, respectively;
3. another unimodal curve of the post-labor force ages with its rates of ascent and descent, λ_3 and α_3, respectively, and
4. a constant curve c, the inclusion of which improves the quality of fit provided by the mathematical expression of the schedule.

The decomposition described above suggests the following

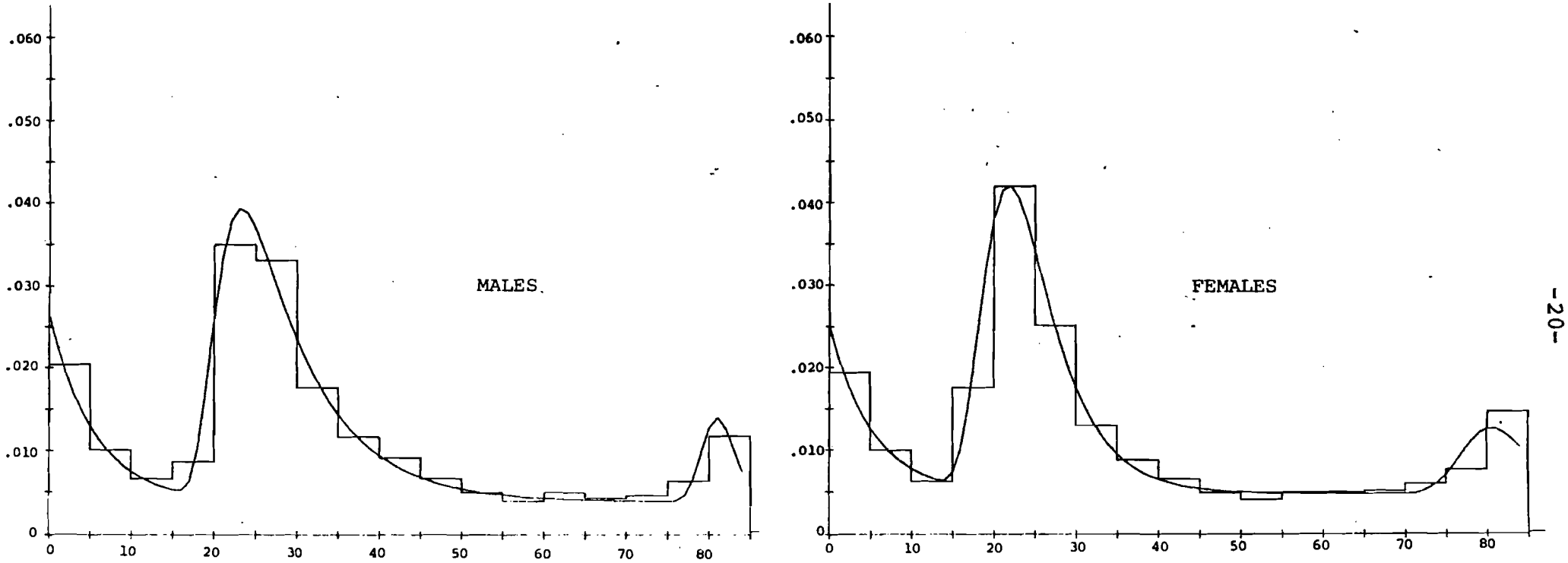


Figure 6. Model schedules of observed migration rates for all causes combined: Czechoslovakia, males and females, 1973.

simple sum of four curves (Rogers, Raquillet, and Castro, 1978)*:

$$M(x) = a_1 e^{-\alpha_1 x} + a_2 e^{-\alpha_2 (x-\mu_2) - e^{-\lambda_2 (x-\mu_2)}} + a_3 e^{-\alpha_3 (x-\mu_3) - e^{-\lambda_3 (x-\mu_3)}} + c \quad , x = 0,1,2,\ldots,z \qquad (1)$$

The "full" model schedule in equation (1) has eleven 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 seven of the eleven parameters: α_1, μ_2, α_2, λ_2, μ_3, α_3, and λ_3. Its level is determined by the remaining four parameters: a_1, a_2, a_3, and c. A change in the value of the gross migraproduction rate of a particular model schedule alters proportionally the values of the latter but does not affect the former. Finally, migration schedules without a retirement or old age peak may be represented by a "reduced" model with seven parameters, because in such instances the third component of equation (1) is omitted.

The model schedule defined in equation (1) may be used to fit all of the cause-specific profiles illustrated in Figures 2 and 5. The two employment-related profiles and the profiles of migration associated with marriage and with divorce may be described by the reduced seven-parameter model. Education-motivated migration profiles follow the model schedule with both the first and the third components omitted (i.e., $a_1 = a_3 = 0$). The age pattern of health-related migration can be described by the model schedule with both the first and the second components omitted (i.e., $a_1 = a_2 = 0$). Finally, migration caused by housing reasons and by the remaining "all other causes" (including divorce) takes on the profile of the full eleven parameter

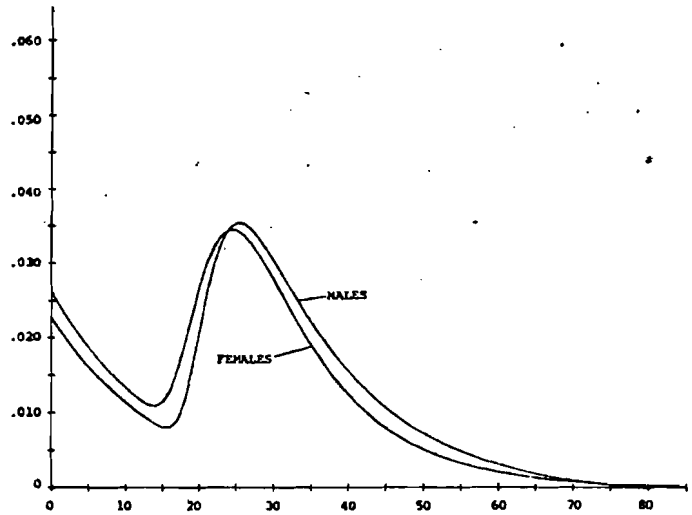
*Both the labor force and the post-labor force components in equation (1) are described by the "double exponential" curve formulated by Coale and McNeil (1972) for their studies of nuptiality and fertility.

model, as does the aggregate schedule. Figures 7 and 8 display the results of such fits, and Appendix Tables A, B, C, and D set out the numerical estimates of the various parameters and variables that define these model migration schedules. (Their interpretation and methods of derivation are described in Castro and Rogers, 1979).

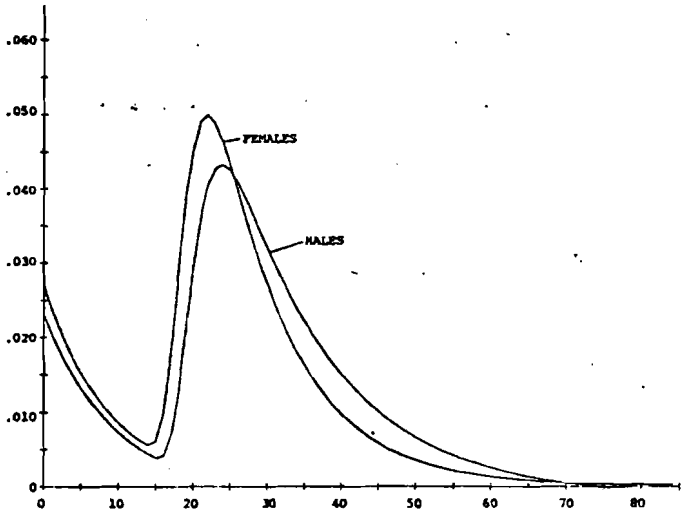
The model schedule profiles displayed in Figures 6,7, and 8 repeat the patterns exhibited by the cubic-spline interpolations of the same data in Figures 1, 2, and 5. The principal advantage of the model schedule representation is that the mathematical description is particularly well-suited for analytical studies of the properties of each cause-specific curve and of the impacts of changes in each curve's relative importance on the aggregate migration age pattern.

The Czechoslovakian age patterns of internal migration by cause may be characterized in a number of different ways with the measures presented in the Appendices. We begin by observing that among the seven causes examined, only health, housing, and other reasons exhibit a retirement (indeed a post-retirement) peak, with the one for housing being located more than a dozen years ahead of the peak for health. We also note that the low point and the high peak, x_ℓ and x_h, respectively, occur earlier in female profiles than in male profiles, in all cases for which these measures have been calculated. This undoubtedly is a reflection of the differences in ages at marriage.

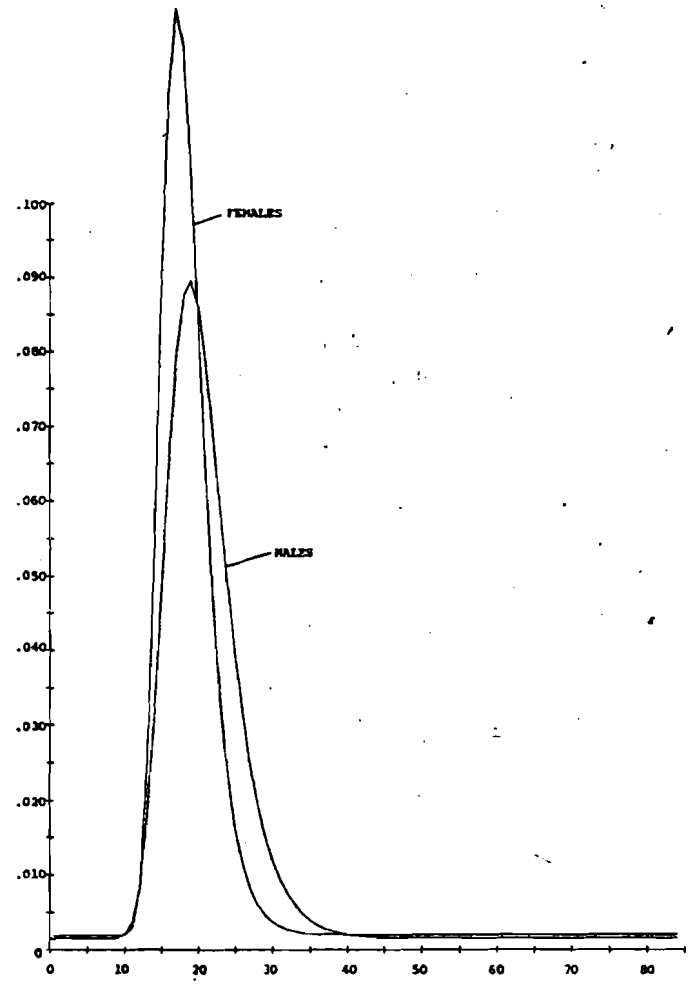
The age profiles of reduced-form model migration schedules (i.e., no retirement peak and only seven parameters) are determined by the four parameters α_1, μ_2, α_2, λ_2, and the ratio $\delta_{12} = a_1/a_2$. The first and third define the rates of descent against age of the migration rates of children and their parents, respectively. The second locates the labor force curve on the age axis. The fourth defines the rate of ascent of the migration rates of those young adults leaving the family home for primarily marriage, education, and economic reasons. And the last relates the height of the pre-labor force curve to that of the labor force component.



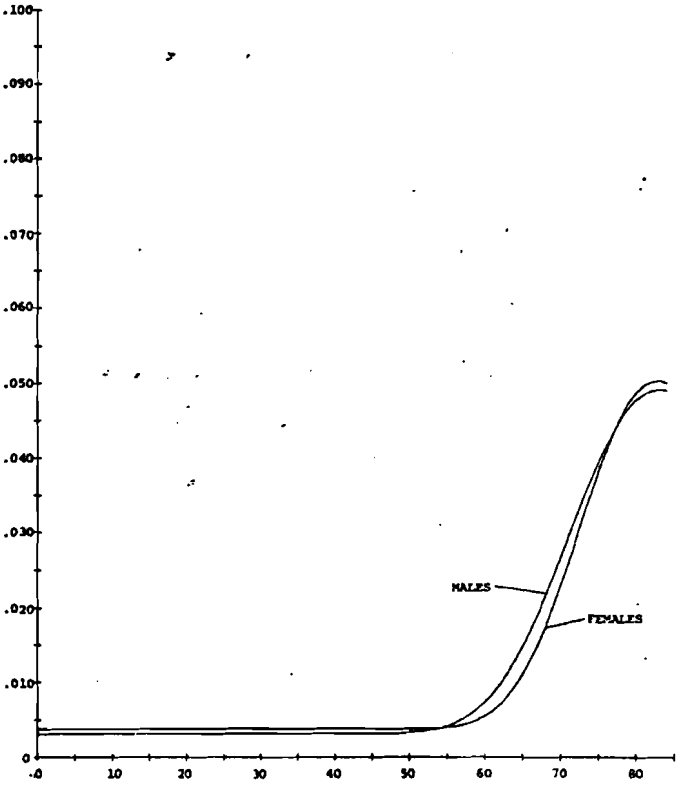
1. Change of employment.



2. Moving closer to place of work.

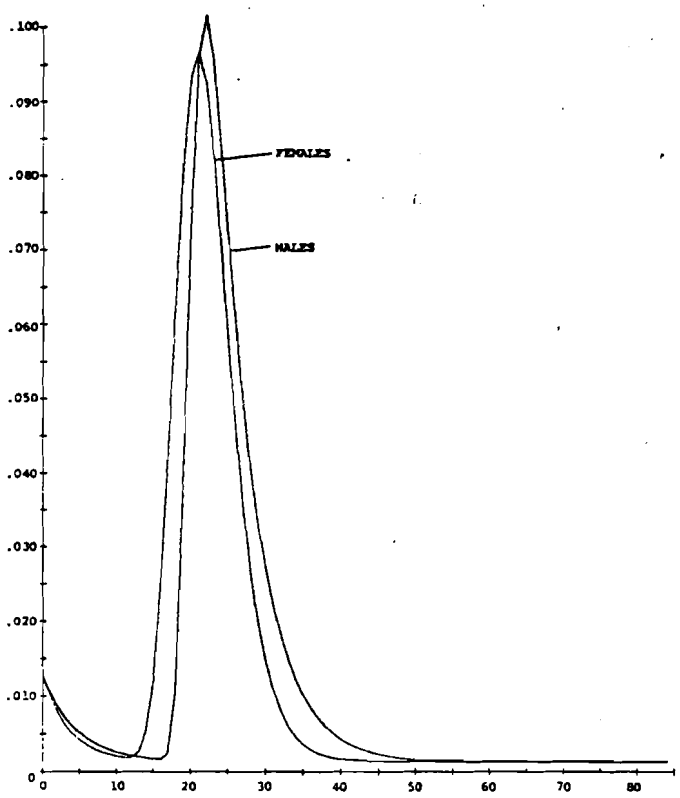


3. Education.

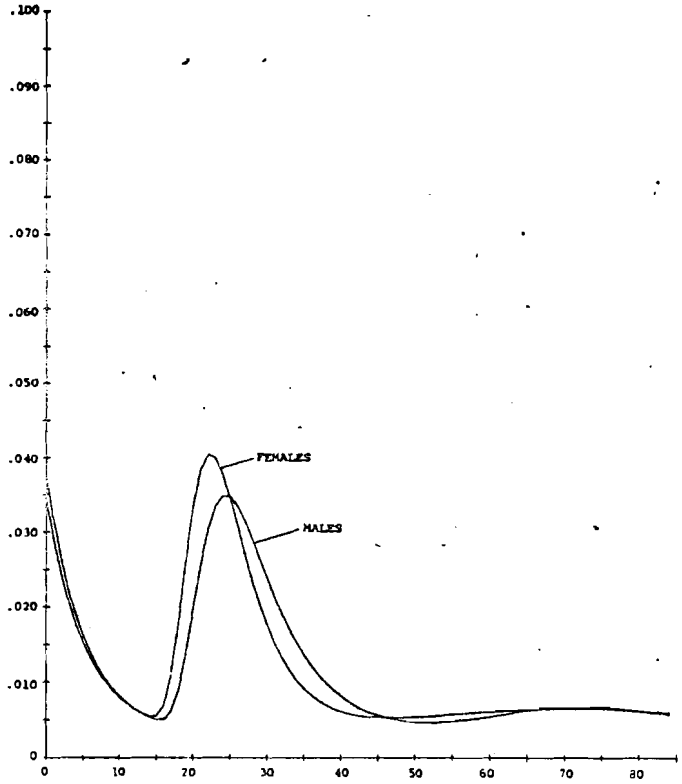


4. Health.

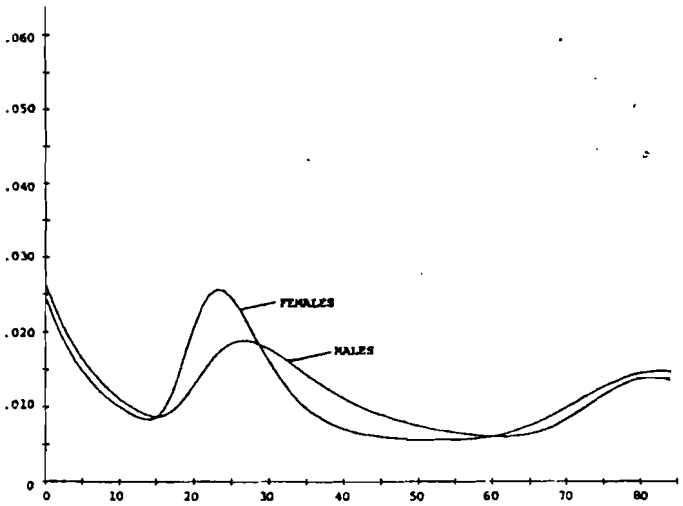
Figure 7. Model schedules of observed cause-specific migration rates: Czechoslovakia, males and females, 1973.



5. Marriage.



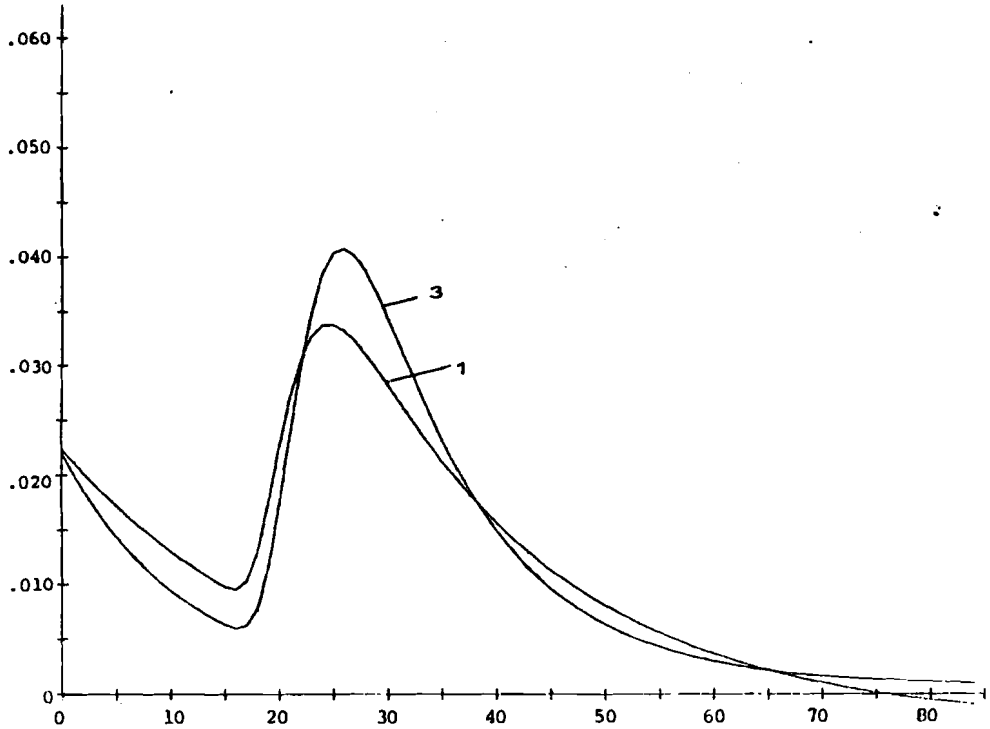
6. Housing.



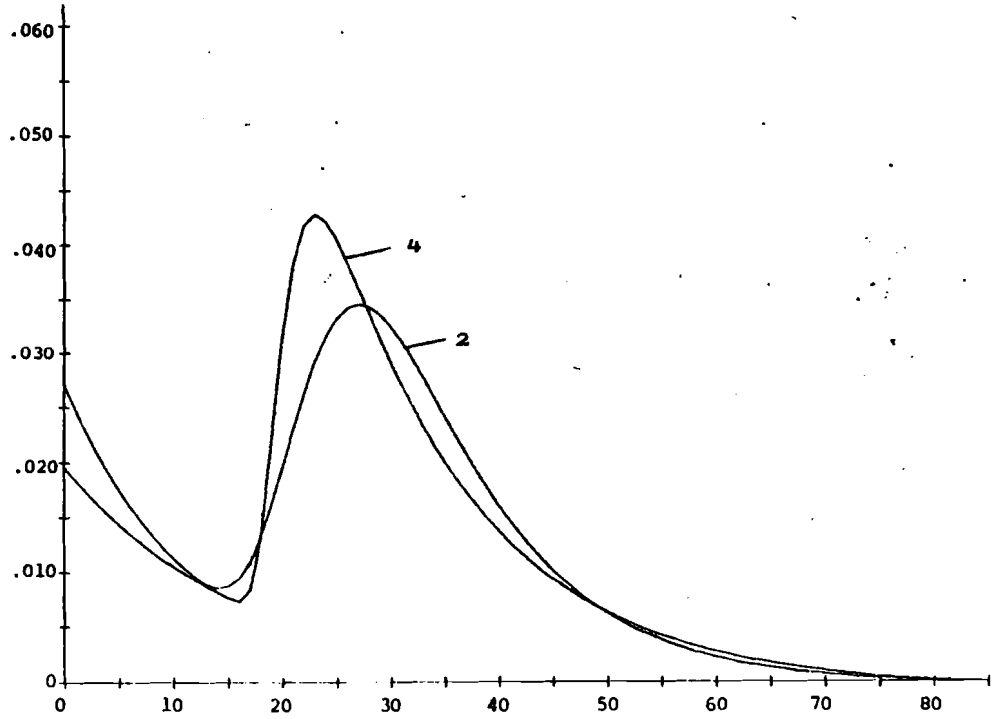
7. Other (plus Divorce)

Figure 7. Model schedules of observed cause-specific migration rates: Czechoslovakia, males and females, 1973, continued.

Legend: 1 = Intra-(Czech) republic migration
2 = Inter-(Czech-to-Slovakia) republic migration
3 = Intra-(Slovakia) republic migration
4 = Inter-(Slovakia-to-Czech) republic migration



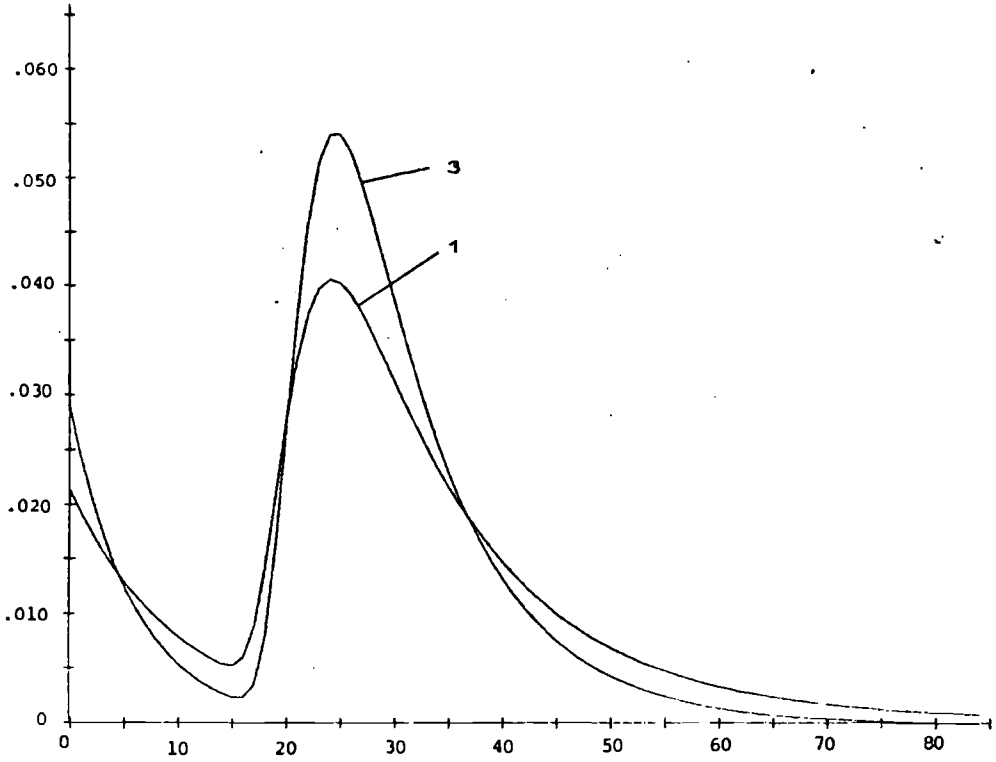
1. Intra-republic migration: Change of employment.



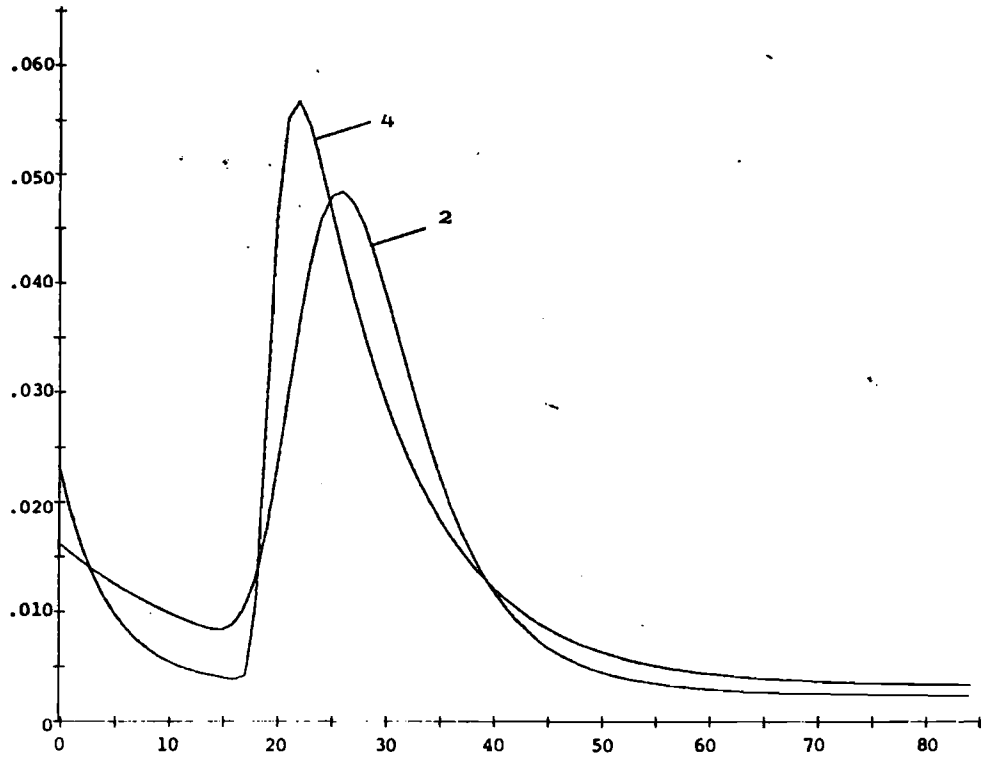
2. Inter-republic migration: Change of employment.

Figure 8. Model schedules of observed cause-specific migration rates: Intra- and inter-republic migrations in Czechoslovakia, males, 1973, for specific causes.

Legend: 1 = Intra-(Czech) republic migration
2 = Inter-(Czech-to-Slovakia) republic migration
3 = Intra-(Slovakia) republic migration
4 = Inter-(Slovakia-to-Czech) republic migration



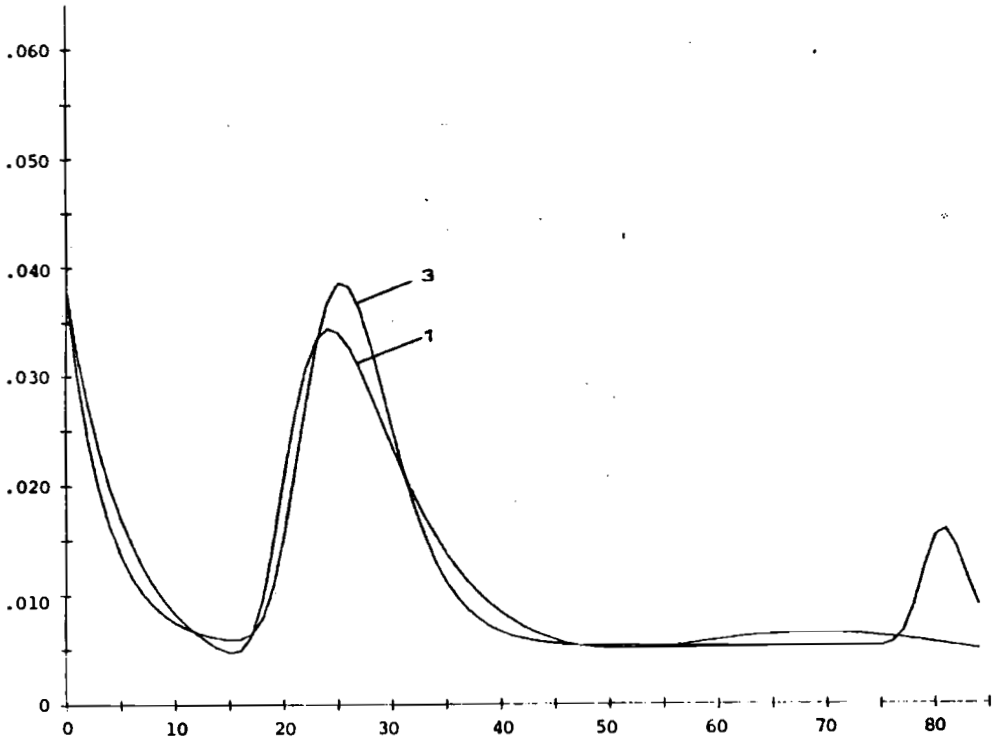
3. Intra-republic migration:
Moving closer to place of work.



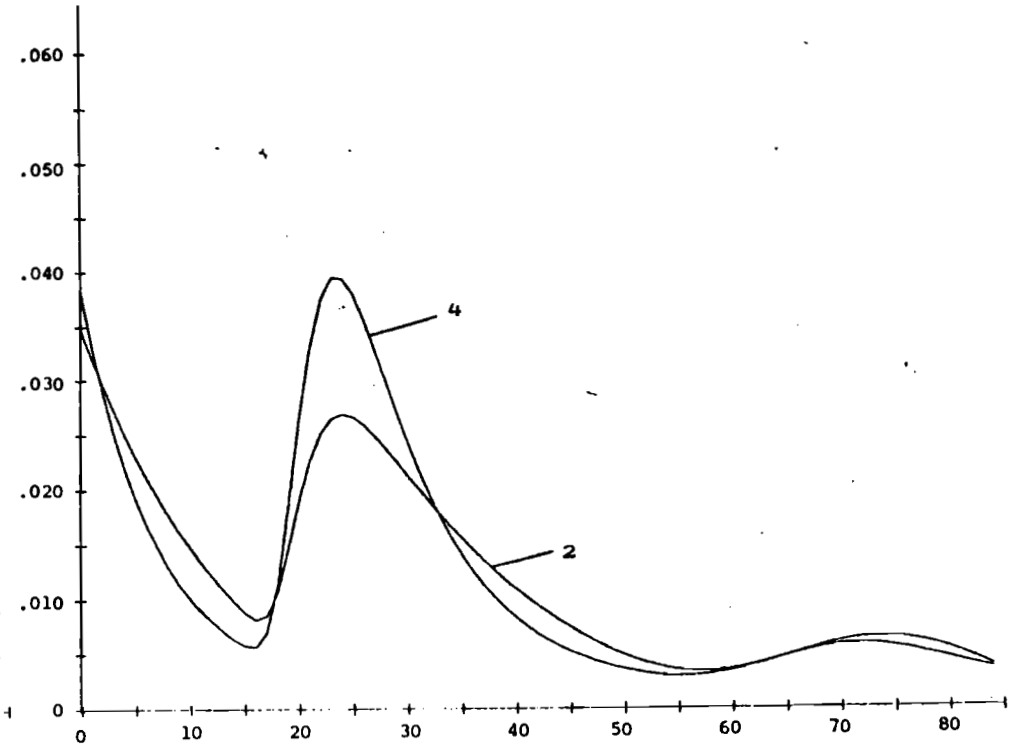
4. Inter-republic migration:
Moving closer to place of work.

Figure 8. Model schedules of observed cause-specific migration rates: Intra- and inter-republic migrations in Czechoslovakia, males, 1973, for specific causes, continued.

Legend: 1 = Intra-(Czech) republic migration
2 = Inter-(Czech-to-Slovakia) republic migration
3 = Intra-(Slovakia) republic migration
4 = Inter-(Slovakia-to-Czech) republic migration



5. Intra-republic migration: Housing.



6. Inter-republic migration: Housing.

Figure 8. Model schedules of observed cause-specific migration rates: Intra- and inter-republic migrations in Czechoslovakia, males, 1973, for specific causes, continued.

The model schedules illustrated in Figures 6, 7, and 8 exhibit a wide range of values for these parameters of interest. The tallest, those for education and marriage, may be characterized by their relatively low values for $\delta_{12} = a_1/a_2$, values that are about one-fifth as large as those of the other profiles. Age patterns with much higher values of δ_{12} tend to also show relatively higher migration rates for children. Thus these latter profiles may be said to be child dependent, in contrast to the former, which may be called labor dominant profiles.

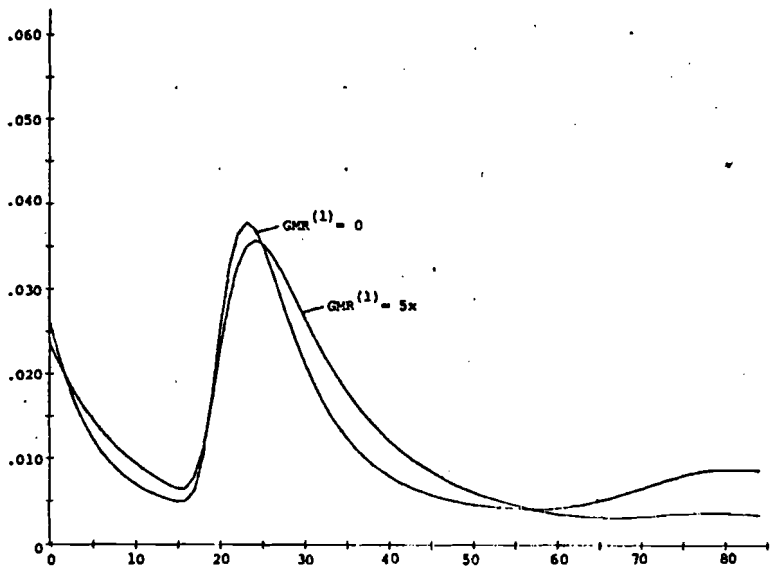
Labor dominance reflects the relative migration levels of those in the working ages relative to those of children and pensioners. Labor asymmetry refers to the shape of the central bell-shaped curve and is measured by the ratio $\sigma_2 = \lambda_2/\alpha_2$. The numerical values for σ_2 in the Appendices indicate that the national moving-closer-to-place-of-work profile exhibits the most asymmetrical pattern of all causes.

SYNTHESIS: SENSITIVITY EXPERIMENTS

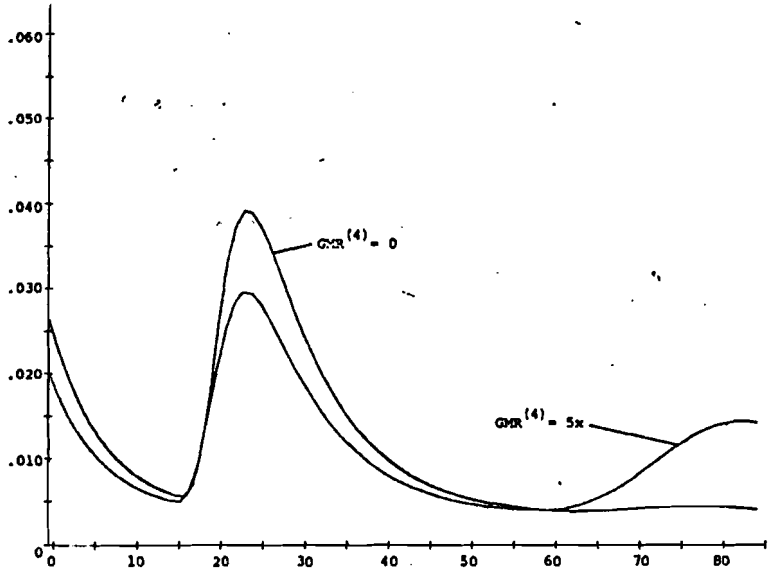
The preceding two sections have been devoted to a description and an analysis of cause-specific migration age profiles. We now turn to an examination of cause-deleted age profiles, focusing in particular on the impact that the deletion of a particular cause has on the remaining aggregate migration age pattern.

Figure 9 illustrates four of the seven aggregate model schedule age profiles that are numerically defined in Appendix E.* In each case, the aggregate age profile with a single cause deleted is contrasted with one in which that single cause's share is increased to five times its observed level. The resulting contrasts clearly identify the contribution of each cause to the aggregate age profile.

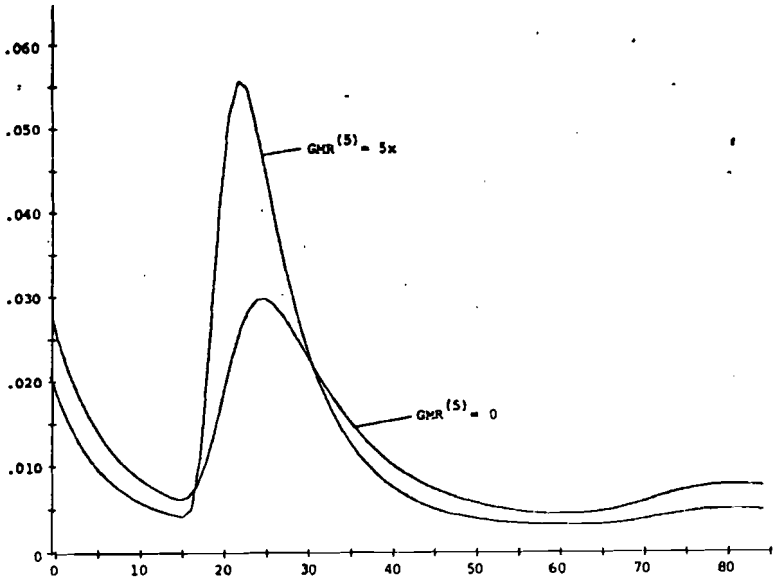
*The area under each curve is once again scaled to equal unity in each case, i.e., GMR = 1.



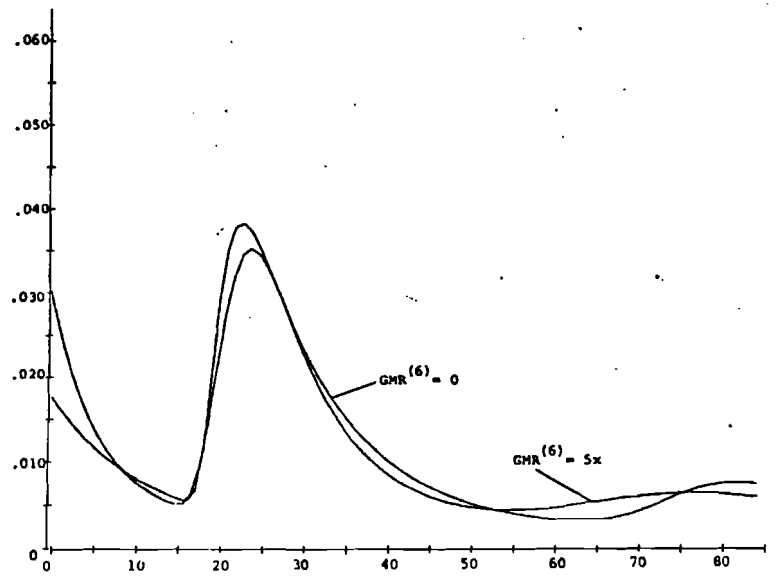
1. Change of employment.



2. Health.



3. Marriage.



4. Housing.

Figure 9. Model schedules of cause-deleted and cause-exaggerated aggregate migration rates.

Deleting change-of-employment reasons for migrating from the aggregate of all causes results in a shift of the mean age toward an older age because of the then increased relative importance of migration in the post-labor force ages. Increasing the relative importance of change-of-employment reasons five-fold lowers the rates of descent of the migration rates of young adults, α_2, and of their children, α_1.

Health reasons for migrating become important only in the post-retirement ages. Thus deleting them removes the peak in those ages; increasing their importance five-fold simply increases the height of that peak. The slope parameters α_1, α_2, and λ_2, and the location parameter μ_2, remain unchanged.

Increasing the relative importance of marriage, as a cause for migration, dramatically increases the height of the high peak. The rate of ascent, λ_2, increases, but the rates of descent α_1 and α_2 are only slightly affected. The curve becomes a member of the labor dominant family analyzed in Castro and Rogers (1979).

Finally, housing reasons influence the aggregate profile at the very young and the retirement ages. Deleting them lowers the rate of descent of pre-labor force migration, α_1, and raises the importance of old age migration. The mean age remains virtually unchanged.

Figure 9 shows that changes in the relative importance of different causes of migration produce predictable changes in the aggregate migration age profile. Employment reasons influence the rates of descent α_1 and α_2. Health reasons affect only the post-retirement profile, influencing λ_3 and the age of the post-retirement peak, x_r. Marriage reasons dramatically affect the rate of ascent λ_2, but leave α_1 and α_2 relatively unaffected. Housing reasons, on the other hand influence the latter, especially α_1.

CONCLUSION

This paper was motivated by the conjecture that regularities in the migration age patterns of different national populations are likely to be stronger and more evident in cause-specific schedules than in aggregate schedules. The implications of this for model migration schedules are the same as for model mortality schedules, in the context of which Preston (1976) observed:

> "Model mortality patterns are typically required for demographic estimation only if death registration is incomplete. But if the degree of incompleteness is largely invariant with respect to cause of death, then the *cause-structure* of mortality can be reliably estimated. In such a case the *age pattern* of mortality should be largely recoverable without reference to any external models. The *level* of mortality can then be estimated through conventional stable population or census survival techniques." (Preston, 1976, p. 118, italics added.)

Substituting in the word "migration" for "mortality" and "death" in the above quotation yields the observation that the age pattern (i.e., profile) of migration may be estimated by weighting each cause-specific profile by the migration structure (i.e., the fraction of the total GMR that is attributable to each of k causes):

$$\bar{M}(x) = \sum_{i=1}^{k} G\bar{M}R^{(i)} \; \bar{M}^{(i)}(x) \quad , \tag{2}$$

where $\sum_{x}^{z} \bar{M}(x) = 1$, $\sum_{i}^{k} G\bar{M}R^{(i)} = 1$, and $\sum_{i}^{k} \bar{M}^{(i)}(x) = 1$, $x = 0,1,2,\ldots,z$.

Equation (2) also may be expressed in the form of migration proportions

$$N(x) = \sum_{i=1}^{k} N^{(i)} \; N^{(i)}(x) \quad , \tag{3}$$

where $N^{(i)}(x)$ denotes the fraction of migrants at age x among those citing cause i, and $N^{(i)}$ is the fraction of total migrants citing cause i.

The estimation problem also can be "turned on its head" as Preston observes:

> "Just as the cause-structure of mortality can be used to predict the age pattern, the age pattern implies a special cause of death structure." (Preston, 1976, p. 116)

In the context of migration, this suggests that given, for example, the Hungarian aggregate migration age pattern and the Czechoslovakian cause-specific migration age patterns (profiles) one could use equations (2) or (3) to develop estimates of the implied Hungarian cause of migration structure and compare it with the one described in Section 2 of this paper.*

*We are indebted to Nathan Keyfitz for calling our attention to this "inverse" use of the mortality cause-structure relationship by Sam Preston.

REFERENCES

Castro, L.J. and A. Rogers (1979) *Migration Age Patterns: I. Measurement and Analysis.* WP-79-16. Laxenburg, Austria: International Institute for Applied Systems Analysis.

Coale, A.J. and D.R. McNeil (1972) The distribution by age of the frequency of first marriage in a female cohort. *Journal of the American Statistical Association,* 67: 743-749.

Compton, P.A. (1971) *Some Aspects of the Internal Migration of Population in Hungary Since 1957.* Budapest, Hungary: Central Statistical Office, Demographic Research Institute.

Czechoslovakian Federal Statistical Office (1974) *Demographic Trends in Czechoslovakia.* Prague, Czechoslovakia.

Hoover, E.M. (1971) *An Introduction to Regional Economics.* New York: A.A. Knopf.

Kühnl, K. (1978) Selected aspects of migration motivation in the Czech Socialist Republic. *Acta Universitatis Carolinae, Geographica,* 13(1): 3-11.

Long, L.H. and K.A. Hansen (1979) *Reasons for Interstate Migration: Jobs, Retirement, Climate, and Other Influences.* Current Population Reports, Series P-23, No. 81, Washington, D.C.: Bureau of the Census, U.S. Department of Commerce.

McNeil, D.R., T.J. Trussell, and J.C. Turner (1977) Spline interpolation of demographic data. *Demography,* 14: 245-252.

Preston, S. (1976) *Mortality Patterns in National Populations.* New York: Academic Press.

Rogers, A., R. Raquillet, and L.J. Castro (1978) Model migration schedules and their applications. *Environment and Planning A,* 10(5): 475-502.

Young, C.M. (1975) Factors associated with the timing and duration of the leaving-home stage of the family life cycle. *Population Studies,* 29(1): 61-73.

APPENDICES

Legend

Cause 1 = Change of employment
2 = Moving closer to place of work
3 = Education
4 = Health
5 = Marriage
6 = Housing
7 = Other
8 = All causes

Table A.1 Parameters and variables defining observed model cause-specific migration schedules: Czechoslovakia, males, 1973.

	1	2	3	4	5	6	7	8
GMR (OBS)	0.22832	0.07414	0.00973	0.08687	0.14475	0.42813	0.08501	1.05694
GMR (MMS)	0.99706	0.99759	1.05827	1.36446	1.05302	1.04005	1.10948	1.02932
MAE%M	8.28649	16.13420	12.62849	46.06667	13.52592	12.37815	16.78544	8.57164
A1	0.02461	0.02570	0.00000	0.00000	0.01258	0.03812	0.02265	0.02489
ALFA1	0.06397	0.10403	0.00000	0.00000	0.21349	0.19165	0.12484	0.18486
A2	0.05519	0.06871	0.21037	0.00000	0.21069	0.07477	0.03021	0.06803
MU2	21.35782	20.22688	21.50009	0.00000	20.65884	22.66046	23.78325	20.88616
ALFA2	0.06853	0.07191	0.31682	0.00000	0.21405	0.15098	0.09431	0.12812
LAMBDA2	0.32095	0.41243	0.20419	0.00000	0.57113	0.29236	0.19419	0.42862
A3	0.00000	0.00000	0.00000	0.00038	0.00000	0.00031	0.00024	0.00005
MU3	0.00000	0.00000	0.00000	129.25330	0.00000	116.40599	116.25908	90.44624
ALFA3	0.00000	0.00000	0.00000	0.23520	0.00000	0.16319	0.26248	1.28572
LAMBDA3	0.00000	0.00000	0.00000	0.03902	0.00000	0.03521	0.04909	0.20373
C	-0.00131	-0.00143	0.00143	0.00366	0.00133	0.00311	0.00490	0.00394
MEAN AGE	26.92261	26.69720	24.64404	72.80155	26.81527	34.46154	42.99207	35.15611
%(0-14)	21.92932	17.50977	7.34002	4.10135	7.14720	22.40590	20.56418	17.88818
%(15-64)	77.76012	83.16303	88.41094	15.26308	89.27063	60.47754	50.00044	65.75255
%(65+)	0.31055	-0.67281	4.24904	80.63557	3.58218	17.11657	29.43537	16.35927
DELTA1C	-18.72077	-17.98383	0.00000	0.00000	9.49213	12.24543	4.62645	6.31150
DELTA12	0.44587	0.37401	0.00000	0.00000	0.05972	0.50985	0.74968	0.36582
DELTA32	0.00000	0.00000	0.00000	0.00000	0.00000	0.00419	0.00780	0.00073
BETA12	0.93339	1.44665	0.00000	0.00000	0.99737	1.26936	1.32373	1.44285
SIGMA2	4.68306	5.73504	0.64452	0.00000	2.66813	1.93644	2.05913	3.34538
SIGMA3	0.00000	0.00000	0.00000	0.16588	0.00000	0.21577	0.18703	0.15845
X LOW	16.07025	15.85025	5.34001	0.00000	16.55026	15.99025	15.57024	16.23026
X HIGH	25.77048	24.31044	19.36033	0.00000	22.39040	24.89046	27.13051	23.68043
X RET.	0.00000	0.00000	0.00000	83.20175	0.00000	72.57948	82.01150	81.41137
X SHIFT	9.70022	8.46019	14.02032	0.00000	5.84013	8.90020	11.56026	7.45017
A	34.33701	37.80360	0.00000	0.00000	33.88362	29.07706	29.08875	32.32034
B	0.02759	0.03944	0.00813	0.04653	0.09999	0.03007	0.01012	0.03416

Table A.2 Parameters and variables defining observed model cause-specific migration schedules: Czechoslovakia, females, 1973.

	1	2	3	4	5	6	7	8
GMR (OBS)	0.18916	0.05818	0.00679	0.12306	0.15853	0.45577	0.09250	1.08399
GMR (MMS)	0.99914	1.00747	1.09491	1.39222	1.05011	1.04442	1.12564	1.05941
MAE%M	7.07582	12.64702	14.05034	47.88653	20.66070	11.48562	18.16703	12.67905
A1	0.02719	0.02848	0.00000	0.00000	0.01301	0.03388	0.02054	0.02230
ALFA1	0.06730	0.11599	0.00000	0.00000	0.27833	0.19080	0.14362	0.18986
A2	0.06362	0.08654	0.28366	0.00000	0.17396	0.09271	0.05328	0.09538
MU2	21.37095	19.17327	19.43375	0.00000	24.90277	21.39939	24.12472	21.03097
ALFA2	0.09251	0.10477	0.46279	0.00000	0.40363	0.20259	0.21418	0.20711
LAMBDA2	0.23451	0.41851	0.28093	0.00000	0.20020	0.31701	0.20494	0.30105
A3	0.00000	0.00000	0.00000	0.00061	0.00000	0.00030	0.00028	0.00012
MU3	0.00000	0.00000	0.00000	134.39360	0.00000	137.68983	127.29836	97.25676
ALFA3	0.00000	0.00000	0.00000	0.19788	0.00000	0.10295	0.19910	0.60703
LAMBDA3	0.00000	0.00000	0.00000	0.03436	0.00000	0.02262	0.03773	0.10699
C	-0.00007	0.00022	0.00189	0.00305	0.00142	0.00342	0.00533	0.00463
MEAN AGE	25.03554	24.46350	23.72281	73.78278	24.92222	34.53135	44.09703	36.56535
%(0-14)	25.58745	20.30622	10.04876	3.35996	6.76956	20.82524	18.45527	17.11870
%(15-64)	73.26627	78.60558	84.57401	14.60548	89.36448	61.69809	48.62447	62.20044
%(65+)	1.14629	1.08820	5.37724	82.03456	3.86596	17.47667	32.92026	20.68086
DELTA1C	-366.79382	132.11542	0.00000	0.00000	9.13307	9.90647	3.85487	4.81541
DELTA12	0.42738	0.32904	0.00000	0.00000	0.07476	0.36545	0.38556	0.23385
DELTA32	0.00000	0.00000	0.00000	0.00000	0.00000	0.00328	0.00529	0.00126
BETA12	0.72750	1.10717	0.00000	0.00000	0.68956	0.94179	0.67055	0.91672
SIGMA2	2.53505	3.99467	0.60704	0.00000	0.49599	1.56478	0.95686	1.45353
SIGMA3	0.00000	0.00000	0.00000	0.17365	0.00000	0.21969	0.18952	0.17625
X LOW	14.26021	14.75022	7.70006	0.00000	12.01016	15.00023	14.44022	14.13021
X HIGH	24.84045	22.38040	17.67029	0.00000	21.41038	22.79041	23.81043	22.26040
X RET.	0.00000	0.00000	0.00000	83.43180	0.00000	70.53905	83.22176	81.04129
X SHIFT	10.58024	7.63017	9.97023	0.00000	9.40022	7.79018	9.37021	8.13019
A	29.73326	30.90177	0.00000	0.00000	28.99369	26.51705	25.22472	27.32467
B	0.02371	0.04437	0.12430	0.04594	0.09476	0.03514	0.01741	0.03573

Table B.1 Parameters and variables defining observed model cause-specific migration schedules: Czechoslovakia, males, 1970.

	1	2	3	4	5	6	7	8
GMR (OBS)	0.29635	0.08633	0.01197	0.09902	0.14644	0.48970	0.10358	1.23339
GMR (MMS)	1.01490	1.00524	1.05739	1.26116	1.06026	1.02457	1.08862	1.03365
MAE%M	9.11786	18.20402	13.44149	7.42840	13.83925	6.26912	6.84090	5.31996
A1	0.02481	0.02661	0.00000	0.00000	0.01596	0.03760	0.03054	0.02554
ALFA1	0.06229	0.09435	0.00000	0.00000	0.26587	0.16101	0.11857	0.16790
A2	0.05466	0.05322	0.23743	0.00000	0.23200	0.07236	0.02462	0.06010
MU2	21.41127	19.24976	19.25745	0.00000	20.70897	22.34701	21.45374	20.44023
ALFA2	0.06993	0.05193	0.26361	0.00000	0.23683	0.14367	0.06815	0.11497
LAMBDA2	0.29810	0.50858	0.25130	0.00000	0.57681	0.29268	0.24080	0.48173
A3	0.00000	0.00000	0.00000	0.00700	0.00000	0.00113	0.00032	0.00099
MU3	0.00000	0.00000	0.00000	144.75052	0.00000	140.82730	149.12640	120.73910
ALFA3	0.00000	0.00000	0.00000	0.12361	0.00000	0.08521	0.15639	0.16812
LAMBDA3	0.00000	0.00000	0.00000	0.02880	0.00000	0.02133	0.02890	0.04242
C	-0.00101	-0.00250	0.00151	0.00312	0.00146	0.00129	0.00234	0.00345
MEAN AGE	27.13773	27.90430	24.65069	75.00883	26.61332	35.16151	44.05198	36.21602
%(0-14)	22.44630	17.61143	7.14535	3.63024	7.50273	22.52970	22.99731	18.41443
%(15-64)	76.53215	82.10146	88.75771	14.63406	88.57130	59.43447	44.00539	63.24842
%(65+)	1.02155	0.28712	4.09695	81.73570	3.92598	18.03583	32.99730	18.33715
DELTA1C	-24.67950	-10.64596	0.00000	0.00000	10.95189	29.11929	13.06424	7.41177
DELTA12	0.45389	0.50000	0.00000	0.00000	0.06880	0.51960	1.24073	0.42503
DELTA32	0.00000	0.00000	0.00000	0.00000	0.00000	0.01568	0.01300	0.01646
BETA12	0.89072	1.81687	0.00000	0.00000	1.12262	1.12067	1.73971	1.46036
SIGMA2	4.26284	9.79323	0.95333	0.00000	2.43556	2.03720	3.53323	4.19007
SIGMA3	0.00000	0.00000	0.00000	0.23295	0.00000	0.25031	0.18478	0.25233
X LOW	15.78025	15.81025	6.37003	0.00000	16.53026	15.93025	15.63024	16.40026
X HIGH	25.83048	23.49042	19.08032	0.00000	22.26040	24.72045	25.99048	23.38042
X RET.	0.00000	0.00000	0.00000	94.15409	0.00000	75.33007	90.43330	88.20282
X SHIFT	10.05023	7.68018	12.71029	0.00000	5.73013	8.79020	10.36024	6.98016
A	33.67702	39.66355	0.00000	0.00000	33.03363	32.36700	26.43486	31.65367
B	0.02000	0.03475	0.08745	0.04977	0.10661	0.02890	0.00891	0.03242

Table B.2 Parameters and variables defining observed model cause-specific migration schedules: Czechoslovakia, females, 1970.

	1	2	3	4	5	6	7	8
GMR (UBS)	0.25620	0.06765	0.00713	0.15162	0.16827	0.52903	0.11641	1.29630
GMR (MMS)	1.00283	1.02095	1.10634	1.26649	1.05566	1.03134	1.08222	1.04361
MAE%M	10.68861	16.82710	21.40944	10.51390	21.67021	6.72738	5.22975	7.05139
A1	0.03050	0.03101	0.00000	0.00000	0.01747	0.03401	0.02742	0.02269
ALFA1	0.06115	0.09488	0.00000	0.00000	0.31199	0.17930	0.15458	0.16517
A2	0.05225	0.05554	0.28905	0.00000	0.17416	0.08398	0.04628	0.08209
MU2	21.05717	18.17378	18.36008	0.00000	24.94529	21.12695	21.00349	20.36508
ALFA2	0.08771	0.06215	0.41998	0.00000	0.41376	0.20297	0.17692	0.18910
LAMBDA2	0.26106	0.65986	0.31031	0.00000	0.20119	0.34715	0.33487	0.35138
A3	0.00000	0.00000	0.00000	0.00113	0.00000	0.00397	0.00179	0.00278
MU3	0.00000	0.00000	0.00000	158.81168	0.00000	191.60085	167.78363	111.57628
ALFA3	0.00000	0.00000	0.00000	0.13826	0.00000	0.03228	0.09642	0.16549
LAMBDA3	0.00000	0.00000	0.00000	0.02553	0.00000	0.01086	0.02210	0.05004
C	-0.00019	-0.00165	0.00298	0.00267	0.00125	0.00178	0.00447	0.00449
MEAN AGE	24.15170	24.70141	25.91103	75.21085	24.28372	35.83890	44.50188	37.45120
%(0-14)	29.50291	21.96146	11.71107	3.25016	7.36534	20.98272	20.85575	18.41419
%(15-64)	69.33871	78.60107	80.39476	14.49330	89.27168	59.54916	44.74255	59.26760
%(65+)	1.15858	-0.56254	7.89417	82.25653	3.36298	19.46813	34.40170	22.31821
DELTA1C	-156.61819	-18.73866	0.00000	0.00000	13.93153	19.10191	6.13840	5.04880
DELTA12	0.58370	0.55832	0.00000	0.00000	0.10033	0.40496	0.59235	0.27645
DELTA32	0.00000	0.00000	0.00000	0.00000	0.00000	0.04729	0.03867	0.03388
BETA12	0.69719	1.52680	0.00000	0.00000	0.75404	0.88339	0.87374	0.87344
SIGMA2	2.97637	10.61806	0.73887	0.00000	0.48626	1.71036	1.89281	1.85813
SIGMA3	0.00000	0.00000	0.00000	0.18469	0.00000	0.33657	0.22921	0.30239
X LOW	14.92023	15.49024	7.86007	0.00000	12.06016	15.30024	15.45024	14.65022
X HIGH	24.60045	21.55038	17.39028	0.00000	21.37037	22.67040	22.81041	22.10039
X RET.	0.00000	0.00000	0.00000	92.66377	0.00000	91.22346	101.12558	87.68271
X SHIFT	9.68022	6.06014	9.53022	0.00000	9.31021	7.37017	7.36017	7.45017
A	26.90043	32.57695	0.00000	0.00000	28.56203	32.77700	22.64613	26.22182
B	0.01966	0.03712	0.11248	0.04722	0.09768	0.03288	0.01756	0.03276

Table C. Parameters and variables defining observed model migration schedules for all causes combined: Intra- and inter-republic migrations, males and females, 1973.

	MALES				FEMALES			
	Czech	Cz-to-Sl	Slov.	Sl-to-Cz	Czech	Cz-to-Sl	Slov.	Sl-to-Cz
GMR (OBS)	1.06572	0.05709	0.73390	0.17034	1.10164	0.05953	0.78280	0.15640
GMR (MMS)	1.03048	1.03137	1.05426	1.04091	1.07818	1.04177	1.06862	1.05027
MAE%M	9.48874	7.96563	13.52898	10.75592	14.87849	12.40684	13.83922	12.56975
A1	0.02483	0.02907	0.02555	0.02554	0.02212	0.02495	0.02326	0.02497
ALFA1	0.16826	0.08508	0.22924	0.16215	0.16917	0.13308	0.25278	0.17908
A2	0.05853	0.04596	0.10160	0.08370	0.08810	0.08439	0.11259	0.10044
MU2	20.34470	19.78886	22.81952	20.45475	20.61113	25.48699	21.34600	20.54708
ALFA2	0.11435	0.06630	0.18349	0.13365	0.19014	0.22120	0.22853	0.19281
LAMBDA2	0.48799	0.50284	0.31787	0.49900	0.29350	0.16164	0.35523	0.28488
A3	0.00006	0.00044	0.00010	0.00018	0.00010	0.00007	0.00036	0.00008
MU3	90.35128	114.17873	98.24731	97.95280	113.92844	92.32352	98.79751	104.74212
ALFA3	1.27319	0.20703	0.56599	0.43251	0.30132	0.76019	0.44808	0.33119
LAMBDA3	0.20525	0.04439	0.09893	0.08466	0.05409	0.13727	0.08807	0.06166
C	0.00392	-0.00095	0.00389	0.00266	0.00446	0.00374	0.00438	0.00396
MEAN AGE	35.18716	31.77822	36.14500	32.68065	37.12376	31.64652	38.04327	33.56535
%(0-14)	18.75984	22.59763	15.85206	17.71621	17.52818	21.44716	14.64727	18.24899
%(15-64)	64.71851	65.26329	65.91956	68.59452	60.56496	64.88058	62.48698	64.88286
%(65+)	16.52164	12.13908	18.22838	13.68927	21.90686	13.67226	22.86575	16.86815
DELTA1C	6.33062	-30.66192	6.56393	9.61540	4.96434	6.67088	5.30565	6.30737
DELTA12	0.42413	0.63242	0.25153	0.30511	0.25109	0.29569	0.20658	0.24862
DELTA32	0.00106	0.00950	0.00095	0.00213	0.00116	0.00082	0.00320	0.00084
BETA12	1.47141	1.28339	1.24934	1.21321	0.88968	0.60163	1.10609	0.92877
SIGMA2	4.26739	7.58478	1.73235	3.73361	1.54359	0.73073	1.55440	1.47746
SIGMA3	0.16121	0.21440	0.17479	0.19575	0.17951	0.18057	0.19655	0.18617
X LOW	16.35026	16.39026	16.01025	16.43026	13.76020	12.80018	15.07023	13.45019
X HIGH	23.28042	23.53042	24.55045	23.07041	22.05039	23.43042	22.59040	21.89039
X RET.	81.47138	78.18068	80.63120	78.67078	82.18153	79.86104	80.34114	77.48053
X SHIFT	6.93016	7.14016	8.54020	6.64015	8.29019	10.63024	7.52017	8.44019
A	31.69367	30.21036	32.31035	31.13034	27.05038	27.23875	29.07702	27.16730
B	0.03178	0.02729	0.04092	0.04374	0.03298	0.02896	0.04407	0.03724

Table D.1 Parameters and variables defining observed model cause-specific migration schedules: Intra-(Czech) republic migrations, males, 1973.

	1	2	3	4	5	6	7	8
GMR (OBS)	0.22134	0,06770	0.01089	0,09261	0,14281	0,42866	0,10171	1,06572
GMR (MMS)	1,00940	1,02531	1,04628	1,39446	1,05507	1,03354	1,10734	1,03048
MAE%M	15,03584	12,88149	10,60690	47,70626	16,30471	11,50634	16,96381	9,48879
A1	0,02573	0,02201	0,00000	0,00000	0,01344	0,03909	0,02480	0,02482
ALFA1	0,04660	0,10191	0,00000	0,00000	0,21557	0,17233	0,10652	0,16826
A2	0,04347	0,06775	0,20907	0,00000	0,18683	0,07015	0,02316	0,05853
MU2	20,65276	20,55301	21,23007	0,00000	20,34097	21,95762	20,99136	20,34467
ALFA2	0,05524	0,07916	0,29589	0,00000	0,19492	0,13073	0,05904	0,11435
LAMBDA2	0,39349	0,34563	0,20087	0,00000	0,63374	0,30831	0,22053	0,48799
A3	0,00000	0,00000	0,00000	0,00133	0,00000	0,00038	0,00018	0,00006
MU3	0,00000	0,00000	0,00000	125,87879	0,00000	119,26225	117,76509	90,35147
ALFA3	0,00000	0,00000	0,00000	0,21359	0,00000	0,14460	0,26947	1,27319
LAMBDA3	0,00000	0,00000	0,00000	0,04013	0,00000	0,03129	0,04863	0,20524
C	-0,00281	0,00027	0,00124	0,00387	0,00148	0,00197	0,00352	0,00392
MEAN AGE	26,26701	29,09851	24,30675	72,86125	27,24080	33,56468	42,20306	35,18717
%(0-14)	23,43978	16,98633	7,92492	4,23789	7,66777	23,02964	21,69858	18,75988
%(15-64)	77,25292	79,75479	88,31863	15,50708	88,31594	61,52133	49,85508	64,71846
%(65+)	-0,69270	3,25888	3,75645	80,25504	4,01630	15,44903	28,44634	16,52167
DELTA1C	-9,16820	82,45650	0,00000	0,00000	9,09606	19,82555	7,04470	6,33058
DELTA12	0,59186	0,32483	0,00000	0,00000	0,07196	0,55726	1,07078	0,42413
DELTA32	0,00000	0,00000	0,00000	0,00000	0,00000	0,00540	0,00791	0,00106
BETA12	0,84352	1,28740	0,00000	0,00000	1,10590	1,31816	1,80416	1,47139
SIGMA2	7,12323	4,36632	0,67887	0,00000	3,25124	2,35831	3,73520	4,26748
SIGMA3	0,00000	0,00000	0,00000	0,18788	0,00000	0,21640	0,18046	0,16120
X LOW	16,43026	15,34024	5,08000	0,00000	16,67027	15,89025	14,84023	16,35026
X HIGH	25,11046	24,66045	19,31033	0,00000	22,21039	24,68045	26,06048	23,28042
X RET.	0,00000	0,00000	0,00000	84,22197	0,00000	69,39880	82,27155	81,47138
X SHIFT	8,68020	9,32021	14,23033	0,00000	5,54013	8,79020	11,22026	6,93016
A	33,27034	37,35361	0,00000	0,00000	34,73693	32,12320	27,94930	31,69367
B	0,02432	0,03537	0,08479	0,04738	0,09531	0,02970	0,00814	0,03178

Table D.2 Parameters and variables defining observed model cause-specific migration schedules: Inter-(Czech-to-Slovakia) republic migrations, males, 1973.

	1	2	3	4	5	6	7	8
GMR (OBS)	0.01522	0.00234	0.00033	0.00351	0.00644	0.02573	0.00318	0.05709
GMR (MMS)	1.01229	1.08694	1.06976	1.22643	1.09476	1.02252	1.04448	1.03137
MAE%M	8.58534	15.45625	9.08502	36.15261	22.26922	8.19593	16.99869	7.96563
A1	0.02858	0.01438	0.00000	0.00000	0.02217	0.04231	0.01675	0.02907
ALFA1	0.08677	0.05927	0.00000	0.00000	0.43857	0.06739	0.07641	0.08508
A2	0.07819	0.11667	0.00875	0.00000	0.25234	0.03494	0.07296	0.04596
MU2	24.71216	25.78951	27.22010	0.00000	20.93860	20.18018	25.72021	19.78886
ALFA2	0.09884	0.17662	0.82155	0.00000	0.29141	0.04431	0.10465	0.06630
LAMBDA2	0.17317	0.19823	0.16872	0.00000	0.53221	0.43674	0.23546	0.50284
A3	0.00000	0.00000	0.00000	0.00022	0.00000	0.00028	0.00000	0.00044
MU3	0.00000	0.00000	0.00000	110.63741	0.00000	123.24733	0.00000	114.17873
ALFA3	0.00000	0.00000	0.00000	0.38648	0.00000	0.18911	0.00000	0.20703
LAMBDA3	0.00000	0.00000	0.00000	0.06197	0.00000	0.03581	0.00000	0.04439
C	-0.00029	0.00230	0.00055	0.00632	0.00297	-0.00616	0.00227	-0.00095
MEAN AGE	26.52830	30.23652	19.70169	64.80225	29.06568	29.82519	33.05912	31.77822
%(0-14)	23.44665	16.22780	9.89727	7.81039	8.54257	30.11555	17.46655	22.59763
%(15-64)	75.71056	77.16001	88.75983	26.08353	83.52267	57.85184	75.05268	65.26329
%(65+)	0.84280	6.61219	1.34290	66.10609	7.93476	12.03261	7.48077	12.13908
DELTA1C	-99.05306	6.24379	0.00000	0.00000	7.47563	-6.87042	7.39576	-30.66192
DELTA12	0.36554	0.12321	0.00000	0.00000	0.08788	1.21086	0.22963	0.63242
DELTA32	0.00000	0.00000	0.00000	0.00000	0.00000	0.00793	0.00000	0.00950
BETA12	0.87784	0.33557	0.00000	0.00000	1.50500	1.52104	0.73018	1.28339
SIGMA2	1.75200	1.12233	0.20536	0.00000	1.82633	9.85705	2.24994	7.58478
SIGMA3	0.00000	0.00000	0.00000	0.16035	0.00000	0.18936	0.00000	0.21440
X LOW	14.80022	15.29024	5.68002	0.00000	16.04025	16.79027	17.71029	16.39026
X HIGH	27.56052	26.26049	17.85029	0.00000	22.08039	24.50045	29.00055	23.53042
X RET.	0.00000	0.00000	0.00000	52.75954	0.00000	74.28985	0.00000	78.18068
X SHIFT	12.76029	10.97025	12.17028	0.00000	6.04014	7.71018	11.29026	7.14016
A	33.81753	32.94038	0.00000	0.00000	33.37362	25.21708	38.10035	30.21036
B	0.02594	0.04015	0.14955	0.03936	0.10492	0.01876	0.02988	0.02729

Table D.3 Parameters and variables defining observed model cause-specific migration schedules: Intra-(Slovakia) republic migrations, males, 1973.

	1	2	3	4	5	6	7	8
GMR (OBS)	0.15218	0.07293	0.00617	0.05347	0.10395	0.31881	0.02639	0.73390
GMR (MMS)	1.01743	1.03265	1.12476	1.25450	1.00476	1.04493	1.19703	1.05428
MAE%M	13.65972	23.22148	22.68097	37.57237	3.82813	13.43434	27.11550	13.53080
A1	0.02236	0.03165	0.00000	0.00000	0.01294	0.03696	0.01552	0.02555
ALFA1	0.08998	0.16661	0.00000	0.00000	0.31901	0.26723	0.14107	0.22921
A2	0.07375	0.10682	0.08587	0.00000	0.27789	0.06833	0.04286	0.10158
MU2	22.67849	21.78282	25.94279	0.00000	21.86274	29.15339	29.62001	22.81852
ALFA2	0.09438	0.11166	0.46893	0.00000	0.27422	0.33384	0.17258	0.18345
LAMBDA2	0.31098	0.34866	0.16516	0.00000	0.52430	0.18151	0.15882	0.31791
A3	0.00000	0.00000	0.00000	0.00030	0.00000	0.00005	0.00036	0.00010
MU3	0.00000	0.00000	0.00000	119.66566	0.00000	90.92983	119.02089	98.17974
ALFA3	0.00000	0.00000	0.00000	0.27717	0.00000	1.21942	0.26104	0.56456
LAMBDA3	0.00000	0.00000	0.00000	0.04508	0.00000	0.19069	0.04761	0.09908
C	0.00082	-0.00006	0.00228	0.00309	0.00076	0.00529	0.00516	0.00389
MEAN AGE	29.16799	26.32052	26.07045	71.93900	25.94263	36.76037	50.25954	36.14482
%(0-14)	19.14968	16.66988	6.96239	3.77566	5.01226	20.44844	14.62898	15.85217
%(15-64)	77.25692	82.99930	86.75901	14.80056	92.93345	59.15599	44.65869	65.92010
%(65+)	3.59340	0.33082	6.27859	81.42378	2.05430	20.39558	40.71233	18.22773
DELTA1C	27.32711	-509.20111	0.00000	0.00000	17.05395	6.98987	3.01082	6.56391
DELTA12	0.30319	0.29626	0.00000	0.00000	0.04655	0.54095	0.36216	0.25155
DELTA32	0.00000	0.00000	0.00000	0.00000	0.00000	0.00066	0.00851	0.00099
BETA12	0.95338	1.49215	0.00000	0.00000	1.16332	0.80049	0.81743	1.24942
SIGMA2	3.29492	3.12250	0.35221	0.00000	1.91195	0.54370	0.92028	1.73290
SIGMA3	0.00000	0.00000	0.00000	0.16264	0.00000	0.15637	0.18240	0.17549
X LOW	16.78027	16.13025	5.34001	0.00000	17.01027	15.89025	16.87027	16.01025
X HIGH	26.36049	25.02046	19.63033	0.00000	23.11041	25.80048	29.02055	24.55045
X RET.	0.00000	0.00000	0.00000	79.37093	0.00000	72.78953	83.27177	80.62120
X SHIFT	9.58022	8.89020	14.29033	0.00000	6.10014	9.91023	12.15028	8.54020
A	35.41367	36.67363	0.00000	0.00000	34.39696	28.32709	32.92043	32.31035
B	0.03480	0.05203	0.09716	0.04552	0.11730	0.03273	0.01445	0.04092

Table D.4 Parameters and variables defining observed model cause-specific migration schedules: Inter-(Slovakia-to-Czech) republic migrations, males, 1973.

	1	2	3	4	5	6	7	8
GMR (OBS)	0.04204	0.01026	0.00068	0.01199	0.03235	0.05678	0.01624	0.17034
GMR (MMS)	1.01038	1.11938	1.06015	1.87947	1.01286	1.03727	1.04013	1.04091
MAE%M	8.35239	15.52731	25.93324	76.79087	6.77758	13.97594	15.62685	10.75592
A1	0.02074	0.02207	0.00000	0.00000	0.02239	0.03926	0.04358	0.02554
ALFA1	0.05977	0.21966	0.00000	0.00000	0.40777	0.14591	0.06922	0.16215
A2	0.05840	0.08099	0.01408	0.00000	0.22927	0.07395	0.03065	0.08370
MU2	20.00769	19.71714	36.31760	0.00000	20.98363	21.09735	20.60582	20.45475
ALFA2	0.07553	0.10648	0.33989	0.00000	0.22652	0.12490	0.02943	0.13365
LAMBDA2	0.52819	0.76119	0.08416	0.00000	0.61129	0.37570	0.22337	0.49900
A3	0.00000	0.00000	0.00000	0.01006	0.00000	0.00018	0.00033	0.00018
MU3	0.00000	0.00000	0.00000	165.91145	0.00000	104.30516	109.67673	97.95280
ALFA3	0.00000	0.00000	0.00000	0.11078	0.00000	0.25675	0.26356	0.43251
LAMBDA3	0.00000	0.00000	0.00000	0.02414	0.00000	0.05083	0.04795	0.08466
C	-0.00066	0.00330	-0.00001	0.00324	0.00068	0.00152	-0.00851	0.00266
MEAN AGE	26.99272	32.24638	21.40929	78.25678	25.57002	30.02316	35.96915	32.68065
%(0-14)	19.45409	12.95629	15.40655	2.63990	6.27967	25.31213	27.03136	17.71621
%(15-64)	79.41010	77.85696	84.41621	10.92032	91.89914	62.58442	50.74323	68.59452
%(65+)	1.13582	9.18675	0.17725	86.43979	1.82119	12.10345	22.22541	13.68927
DELTA1C	-31.51206	6.68160	0.00000	0.00000	32.72689	25.87339	-5.12186	9.61540
DELTA12	0.35511	0.27248	0.00000	0.00000	0.09765	0.53092	1.42174	0.30511
DELTA32	0.00000	0.00000	0.00000	0.00000	0.00000	0.00241	0.01089	0.00213
BETA12	0.79134	2.06294	0.00000	0.00000	1.80019	1.16823	2.35186	1.21321
SIGMA2	6.99263	7.14881	0.24760	0.00000	2.69866	3.00807	7.58917	3.73361
SIGMA3	0.00000	0.00000	0.00000	0.21788	0.00000	0.19798	0.18191	0.19575
X LOW	16.54026	16.88027	5.02000	0.00000	16.79027	16.19026	15.49024	16.43026
X HIGH	23.51042	22.30040	19.74034	0.00000	22.62040	23.94043	27.09051	23.07041
X RET.	0.00000	0.00000	0.00000	102.74593	0.00000	72.14939	73.10960	78.67078
X SHIFT	6.97016	5.42012	14.72034	0.00000	5.83013	7.75018	11.60027	6.64015
A	33.97031	40.48018	0.00000	0.00000	37.72023	27.54039	28.20291	31.13034
B	0.03552	0.05309	0.06916	0.11139	0.10954	0.03402	0.01024	0.04374

Table E.1 Parameters and variables defining observed model cause-deleted migration schedules ($GMR^{(i)}$=0): Czechoslovakia, males, 1973.

	1	2	3	4	5	6	7	8
GMR (OBS)	0,99571	0,99635	0,99656	0,99635	0,99689	0,99455	1,00000	0,99659
GMR (MMS)	1,02410	1,01920	1,01744	1,00823	1,01956	1,01593	1,01702	1,01707
MAEXM	1,18119	1,08561	0,87149	1,05459	0,73274	1,70263	0,98136	0,98383
A1	0,02474	0,02343	0,02397	0,02516	0,02537	0,01633	0,02401	0,02346
ALFA1	0,18689	0,15809	0,15667	0,15527	0,15431	0,09887	0,16143	0,15582
A2	0,06920	0,06370	0,06197	0,06800	0,05564	0,05695	0,07176	0,06355
MU2	20,99706	20,97582	20,85157	20,88403	22,09190	20,87667	20,89230	20,89419
ALFA2	0,14308	0,12667	0,11747	0,12055	0,11734	0,09902	0,12622	0,12097
LAMBDA2	0,41164	0,40169	0,42515	0,40606	0,28688	0,52506	0,41360	0,40523
A3	0,00060	0,00151	0,00182	0,00013	0,00069	0,00434	0,00110	0,00083
MU3	115,74378	105,09891	103,69529	101,80935	109,57520	98,82841	104,41233	107,49193
ALFA3	0,19163	0,18746	0,17873	0,26932	0,20832	0,18743	0,18479	0,20276
LAMBDA3	0,04335	0,05270	0,05330	0,06037	0,04991	0,06452	0,05219	0,05155
C	0,00365	0,00359	0,00330	0,00341	0,00371	0,00235	0,00318	0,00342
MEAN AGE	37,85199	36,27081	35,73534	32,59140	36,89940	36,23365	34,32169	35,62924
%(0-14)	17,36247	18,35161	18,35305	19,46551	19,87547	15,92885	17,89872	18,29871
%(15-64)	60,71494	62,82971	63,97753	68,17837	60,58633	66,45901	66,70763	64,18069
%(65+)	21,92259	18,81868	17,66942	12,35612	19,53819	17,61214	15,39365	17,52061
DELTA1C	6,78097	6,52640	7,26036	7,36660	6,84042	6,93850	7,55120	6,86453
DELTA12	0,35745	0,36784	0,38683	0,36993	0,45608	0,28666	0,33464	0,36924
DELTA32	0,00874	0,02369	0,02944	0,00186	0,01232	0,07624	0,01532	0,01308
BETA12	1,30622	1,24809	1,33375	1,28794	1,31508	0,99849	1,27893	1,28810
SIGMA2	2,87705	3,17122	3,61933	3,36829	2,44479	5,30256	3,27679	3,34978
SIGMA3	0,22619	0,28112	0,29821	0,22416	0,23960	0,34424	0,28244	0,25422
X LOW	16,11025	16,14025	16,31026	16,13025	15,65024	16,44026	16,14025	16,13025
X HIGH	23,55042	23,81043	23,83043	23,83043	25,12046	23,17042	23,73043	23,83043
X RET.	81,42137	80,91126	80,82124	76,52032	80,80124	82,11152	80,01107	80,77123
X SHIFT	7,44017	7,67018	7,52017	7,70018	9,47022	6,73015	7,59017	7,70018
A	30,68368	30,92369	31,69034	31,50368	31,20037	33,13698	31,86367	31,50368
B	0,03286	0,03090	0,03155	0,03368	0,02369	0,03277	0,03546	0,03142

Table E.2 Parameters and variables defining observed model cause-exaggerated migration schedules ($GMR^{(i)}$ = 5 times): Czechoslovakia, males, 1973.

	1	2	3	4	5	6	7	8
GMR (OBS)	0,99813	0,99731	0,99671	0,99732	0,99775	0,99864	0,98932	0,99659
GMR (MMS)	1,00498	1,01114	1,01692	1,04492	1,01114	1,01750	1,01712	1,01707
MAExM	0,95816	0,81639	2,06948	0,83626	0,92867	0,79031	0,97720	0,98303
A1	0,02279	0,02363	0,02184	0,01850	0,01932	0,03169	0,02241	0,02346
ALFA1	0,10488	0,14728	0,15183	0,15580	0,17159	0,18329	0,14276	0,15582
A2	0,05740	0,06369	0,07006	0,04999	0,09929	0,06883	0,04700	0,06355
MU2	20,89734	20,69442	21,11075	20,88598	20,45528	21,84672	20,97179	20,89419
ALFA2	0,09016	0,10662	0,13343	0,12074	0,15397	0,13802	0,10724	0,12897
LAMBDA2	0,37535	0,41176	0,33345	0,40633	0,54837	0,33259	0,37169	0,40523
A3	0,00075	0,00085	0,00159	0,00079	0,00085	0,00078	0,00173	0,00083
MU3	98,40837	103,34177	100,56111	117,79493	101,61893	111,99707	105,07902	107,49193
ALFA3	0,22140	0,20951	0,20297	0,20979	0,21154	0,15035	0,20477	0,20276
LAMBDA3	0,06591	0,05709	0,06081	0,04424	0,06014	0,03868	0,05860	0,05155
C	0,00197	0,00278	0,00368	0,00335	0,00297	0,00337	0,00383	0,00342
MEAN AGE	31,67168	33,74206	35,26817	44,35493	32,67358	34,96843	38,41679	35,62924
%(0-14)	19,96464	18,13621	18,00892	14,96259	14,57160	20,74212	19,14831	18,29871
%(15-64)	70,30359	68,16843	64,94262	52,69080	72,60479	61,90141	58,79522	64,18069
%(65+)	9,73177	13,69537	17,04845	32,34661	12,82362	17,35648	22,05647	17,52061
DELTA1C	11,57242	8,48579	5,93547	5,51917	6,50589	9,41830	5,85265	6,86453
DELTA12	0,39703	0,37095	0,31178	0,37001	0,19455	0,46045	0,47676	0,36924
DELTA32	0,01312	0,01330	0,02272	0,01590	0,00857	0,01130	0,03675	0,01308
BETA12	1,16331	1,38139	1,13793	1,29039	1,11446	1,32803	1,33120	1,28810
SIGMA2	4,16329	3,86205	2,49909	3,36529	3,56151	2,40976	3,46596	3,34978
SIGMA3	0,29768	0,27251	0,29961	0,21087	0,28430	0,25724	0,27154	0,25422
X LOW	16,10025	16,07025	15,32024	16,13025	16,60027	16,01025	16,02025	16,13025
X HIGH	24,54045	23,92043	23,81043	23,83043	22,77041	24,46045	24,22044	23,83043
X RET.	78,78081	80,18111	80,67121	82,58162	80,65121	76,62035	81,52139	80,77123
X SHIFT	8,44019	7,85018	8,49019	7,70018	6,17014	8,45019	8,20019	7,70018
A	32,84034	33,14699	30,98369	31,51701	32,08366	30,04704	30,62037	31,50368
B	0,02936	0,03300	0,03084	0,02476	0,05171	0,03008	0,02288	0,03142

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