INTERNAL MIGRATION OF THE MALTESE POPULATION : AN APPLICATION OF A MATHEMATICAL MODEL

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Abstract *- This paper is an attempt at statistical modeling, based on the Rogers and Castro migration model. The data used which are derived from the 1995 Census of Population and Housing regarding internal migration provided a basis for analysis of parity of migration, computation of respective gross migraproduction rates as well as compilation of reports on the outcomes of statistical modeling. Seven parameters of the double exponential equation are estimated by means of non-linear regression analysis. The author demonstrates that internal migration needs to be further examined and the research findings need to be applied, since internal migration directly contributes to the processes of : (a) depopulation (the Inner Harbour Region), (b) aging (Gozo and Comino and the Inner Harbour Region) and (c) concentration and population increase (the Northern and the Western Region).*

Introduction

Not so long ago migration used to be referred to as 'a stepchild' of demography. The reasons are mainly of a historic character. For centuries, it was mortality which mainly influenced population size and its structure. A deficiency in migration data still presents the insurmountable problem in the application of various methodologies, which have gone ahead in comparison to the operational possibilities for data collection. Each of the available sources on migration data carries a complex set of pros and cons regarding the quality of data. The most recent improvements in demographic analysis and practice indicate that a synthetic approach in data utilization is imperative. The same applies for greater use of the unpublished data. Arriaga 1996 : 264) stated : "*Migration has, therefore, become the most difficult variable to predict and the most important variable in population growth within countries*". The fact that internal migration is multidimensional makes subnational population projections a very difficult task (Armitage 1986 : 3).

Yet, migration seems to be less analyzed and implemented in the practice of demographic studies than the other two population determinants : mortality and fertility. It is known and frequently stated in demographic literature that the smaller the population of certain area is, the more significant is the effect of the migration component on its future size.

The present state of the Maltese demographic research indicates that the internal migration component for projection purposes has not been implemented. The data collected in the 1985 Population Census were futile as regards the application of the cohort component method of population projections. The data suffered from a common problem of defining the age-time-place coordinates needed for any serious analysis of migration. The 1995 Census of Population represents significant improvement in this respect. It was a practical example of data produced following the theoretic postulates and international recommendations in this field.

This paper aims to reveal the demographic features of the internal migrants in the Maltese Islands using the Rogers and Castro mathematical model (Castro and Rogers 1979a; 1979b; 1983a; 1983b; Rogers and Castro 1981a; 1981b; 1984a; 1988). The aim is to produce the age-gender specific internal migration rates for Maltese population by gender, based on migration data on usual place of residence five years prior to Census and one year prior to Census. The final output of this research are the equations based on the Rogers and Castro migration model for both genders and the total population and for migration five years and one year prior to Census 1995. This would provide the necessary input for multiregional projections following the suggested methodology on sub-national projections (Rogers 1985; UN, 1992).

Table 1: **An overview of mobility, Census 1985 and 1995, in percentage**

	1985*		1995 by region	1995 by locality
Households	Per cent	Population	Per cent	Per cent
No move	76.92	Secondary Onwards	1.63	2.79
Moved once	21.36	Secondary Returned	1.54	1.26
Twice	1.27	Primary	79.76	82.83
Three times and more	0.46	Unknown	17.06	13.11
Total	100.00	Total	100.00	100.00

Source: Census '85 Vol. I Table 40. p.299;

Census 1995

*Data refer to movement of households since 1975

^Data refer to change of usual place of residence one year prior to Census and five years prior to Census

Table 1 gives a comparison between internal migrants by parity of migration in the last two Censuses. It should be noted that full compatibility of two Censuses was not possible owing to different methodologies applied.

It can be observed that secondary onwards migrants (1995 Census data) represent the lowest category in absolute numbers. They are the persons where place of residence was different in all three relevant points in time, namely 26 November 1990, 26 November 1994 and the Census date 26 November 1995. Secondary returned migrants are those migrants who would reside at the same region at any two points in time. Primary migrants are those who made only one change of usual residence as registered by Census questions.

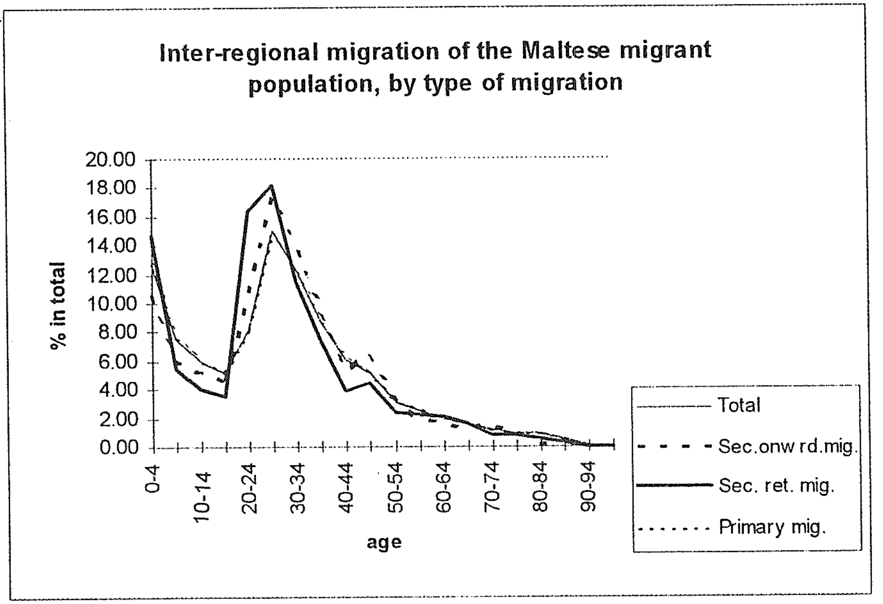


Figure 1.

According to the data collected on the basis of question on place of residence five years prior to Census, the Maltese person makes on average 1.31 inter-regional migration migrations per-lifetime. On the national level, slightly higher values of GMR[1](obs.) were observed for migration one year prior to Census. On average, the Maltese person made 1.45 inter-regional moves per life-time under the socio-economic and other condi-

[1] GMR(obs.) - observed gross migraproduction rate.

tions influencing migration in 1994. Both GMR(obs.) values are relatively low. For the sake of comparison, the Dutch GMR(obs.) on municipality level was around 4 in the 1970's (Castro and Rogers, 1979a) and about 8 in the 1990's.

Table 2 : **A review of GMR(obs.) out-migration five years prior to Census**

	Total	Males	Females
Maltese Islands	1.30806	1.16817	1.37665
Inner Harbour Region	2.22774	1.93954	2.36319
Outer Harbour Region	1.17373	1.10479	1.21885
South Eastern Region	0.78086	0.65981	1.00508
Western Region	1.21210	1.23289	1.20328
Northern Region	0.96956	0.91288	0.98689
Gozo and Comino	0.1548	0.12097	0.17938

Table 3 : **A review of GMR(obs.) out-migration one year prior to Census**

	Total	Males	Females
Maltese Islands	1.45171	1.47387	1.46000
Inner Harbour Region	2.44667	2.20011	2.62404
Outer Harbour Region	1.16391	1.20473	1.16792
South Eastern Region	0.99684	1.09574	1.00172
Western Region	1.89085	2.38480	1.45348
Northern Region	1.30724	1.40429	1.25893
Gozo and Comino	0.2697	0.2085	0.31370

On the regional level population of the Inner Harbour region exhibits the highest inter-regional mobility of 2.2 and 2.4 migrations per life-time, five years and one year prior to Census, respectively. Gozitan population is the least mobile – showing less than 0.2 and 0.3 inter-regional migrations per life-time.

The Rogers and Castro migration model - A theoretical background

One of the models which is based on the analogy with vital events analysis is the Rogers and Castro model migration schedules. The Rogers and

Castro model has the characteristics of a planning model (as defined by Moreland 1990) since the outcome of its simulation can be used for population projections purposes in a short to medium term. The question might be asked as to why this particular model has been adopted in the analysis of Maltese migration data. It has been proved that :

...There is a mathematical formulation that fits all types of observed age-specific gross migration profiles remarkably well. The analytical utility of such mathematical expressions, called model migration schedules, lies in their ability to summarize and codify the fundamental regularity exhibited by age profiles of migration all over the world (Castro 1985 : 1).

The initial idea of the Rogers and Castro model migration schedules, is based on the previous demographic research on marriage frequencies, carried out by Coale in the early seventies (Coale 1974; Coale and McNeil 1972).

The following standard density function was established for marriage event,

$$f_s(x) = \frac{1.2813}{S}\exp\left\{\frac{-1.145}{S}(x - \bar{x} + 8.05S) - \exp\left[\frac{-1.896}{S}(x - \bar{x} + 8.05S)\right]\right\}$$

This type of standard density function has been used further on, in order to describe migration profiles for the labor force. But in reality, it is not only the labor force, which constitutes migration streams of the population. Two other components must be added, namely pre-labor and post-labor component of migration. Therefore, the basic notion of a <u>complete model</u> should be introduced. The complete model of age-gender migration schedules is decomposed into three parts, namely pre-labor force, labor force and post-labour force (Rogers and Castro, 1981a; Castro and Rogers, 1979a) :

$$\begin{aligned} m(x) &= a_1\exp(-\alpha_1 x) \\ &+ a_2\exp\{-\alpha_2(x-\mu_2) - \exp[-\lambda_2(x-m_2)]\} \\ &+ a_3\exp\{-\alpha_3(x-\mu_3) - \exp[-\lambda_3(x-\mu_3)]\} \\ &+ c \end{aligned}$$

$x=1,2,\ldots,z$

where x is age and m(x) is age-specific migration rate.

The following is the interpretation of the parameters as they appear in each segment of model emigration schedules :

- pre-labour force curve is a single negative exponential function with the rate of descent α_1 and level determined by parameter a_1,

- labour force curve is presented by double exponential function describing a unimodal positively skewed curve, with rate of ascent of λ_2 , rate of descent α_1, while the level is defined by the amplitude parameter α_2,

- post-labour force which presents the third part of the m(x) function, which has bell-shape profile, again depicted by double exponential function with rate of ascent λ_3, rate of descent α_3 and level defined by parameter a_3, and

- constant element c which is a measure of level and provides the fit (Rogers and Castro 1981a : 4).

If the third part of age-gender migration schedule, namely post-labor force is presented by a monotonically upwards increasing curve instead of a bell shaped one, then the number of parameters falls from eleven to nine.

The application of the model in this research followed several steps :

1. Transitional data on single age-gender groups were used from the 1995 Population Census. These data reveal transition made by a migrant and recorded at the 26 November 1990 or 1994, and at the end of the five or one year interval, namely on the 26 November 1995 (Rees and Willekens in Rogers and Willekens 1986 : 23). It is important to note that total number of migration movements is not recorded here. In fact, total number of migration movements is higher than obtained by this procedure.

2. The annual migration rates were computed as a ratio between the number of migrants in particular age-gender category and average population exposed to risk of migrating at the mid-period. For data on place of residence five years prior to Census this ratio was further divided by five in order to arrive to an average annual age-gender specific migration rate (Arriaga, 1993 : 247).

3. Annual migration rates were standardized against respective observed gross migraproduction rates, GMR(obs). The standardization was necessary here, since difference between GMR(obs.) of lower spatial areal units present a hindrance regarding comparability, particularly regarding vertical relationships between curves (Castro and Rogers 1979a : 25).

4. Standardized rates were plugged into BMDP AR procedure together with the initial values of parameters.

The result of this four step procedure was the estimate of the Rogers and Castro model parameters. Using the parameters of the model, various useful demographic indicators were derived, and major conclusions about migration characteristics of the Maltese population were formulated.

Based on the complete, eleven parameters equation model migration schedule the following basic measures can be introduced (Castro and Rogers 1979a : 22)

heights : a_1, a_2, a_3, c
locations : μ_2, μ_3
slopes : α_1, α_2, λ_2, α_3, λ_3
and several respective ratios which will be introduced later.

Measures like heights and slopes cannot explain strictly demographic features of migrant population. In the 11 parameters model schedule, four parameters a_1, a_2, a_3, and c refer to migration level. Although two age-gender migration schedules can be of almost identical profile, they can differ significantly in terms of their level i.e. in terms of their position against the y axis. The values of these heights correspond to gross migraproduction rate equal unity. In order to obtain their values for GMR(obs.) levels different from unity, they should be respectively multiplied with the value of GMR(obs.) (Rogers and Castro 1984a).

The summary of parameters also includes locations μ_2 and μ_3, which occur in labour and post-labour force curves and defines the profile rather than the level of the migration schedule. They represent mean age on the age axis around the labour force curve and post-labour force curve, respectively (Hofmeyr, 1988). Parameters μ_2 and μ_3 determine position of labor force and post-labor force curve respectively, on the age axis. Together with rates of ascent and descent they determine the profile of migration curve. An increase of μ_2 signifies that migration in the labor-force age has been postponed. The μ_2 takes position to the right of the x-axis. The value of μ_2 is usually between 17-25 years, or roughly around 20 years. Therefore, Rogers and Castro (in Rogers and Willekens 1986 : 186) distinguish between : (a) population with μ_2 level below 19 years, as an early-peaking migration schedule, (b) population with μ_2 level above 22 years, as late-peaking schedule, and (c) consequently, populations with μ_2 level between 19 and 22 years of age are considered as a moderate-peaking migration schedules.

Figure 2 gives a graphical presentation of age-specific migration rates decomposed into three major parts : pre-labour force, labour force and post-labour force.

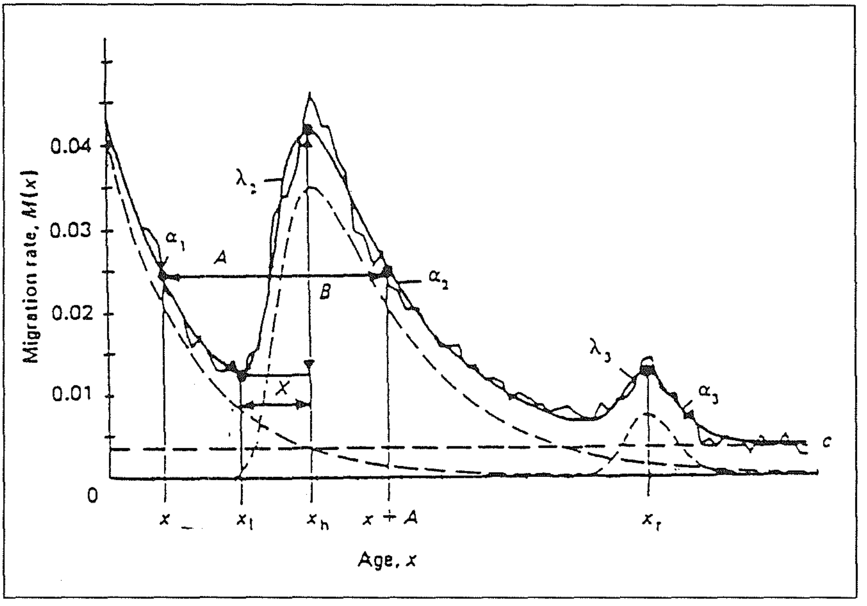


Figure 2.
Source: Castro and Rogers (1979a:15)

The outcomes of the Rogers and Castro migration model application

In this paper the seven parameter equations will be presented for Maltese population, total, males and females, out-migration flows, and migration five years and one year prior to Census. Each equation is followed by the respective graphical presentation, which should facilitate the analysis of a concept of the Rogers and Castro model, as well as prove the goodness-of-fit. The author believes that this is the first attempt to apply the Rogers and Castro model to an island-state, since previously the model was applied in the IIASA[2] project for several, so called medium and small sized countries of which the smallest had population of 4.8 million (Rees and Willekens in Rogers and Willekens 1986).

[2] IIASA – International Institute for Applied Systems Analysis, Luxembourg, Austria

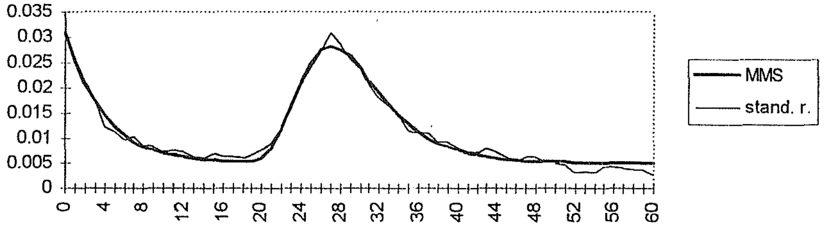
Migration 5 years ago, out-migration, total Maltese population Maltese Islands

$$M(x) = 0.02615e^{-0.251578x}$$

$$+0.063332e^{-0.233573\,(x-26.552095)\,-\,e^{-0.264615\,(x-26.552095)}}$$

$$+0.004966$$

Figure 3. Model migration schedule (MMS) and standardised rates, out-migrants, 1990



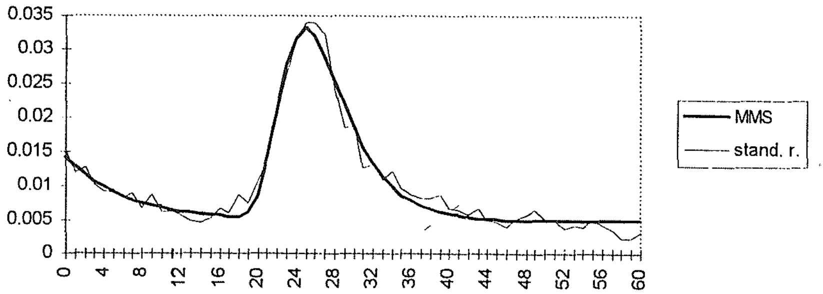
Migration 1 year ago, out-migration, total Maltese population Maltese Islands

$$M(x) = 0.009465e^{-0.155678x}$$

$$+0.075128e^{-0.276042\,(x-24.414493)\,-\,e^{-0.3310499\,(x-24.414493)}}$$

$$+0.004898$$

Figure 4. Model migration schedule and standardised rates, out-migrants, MI, 1994

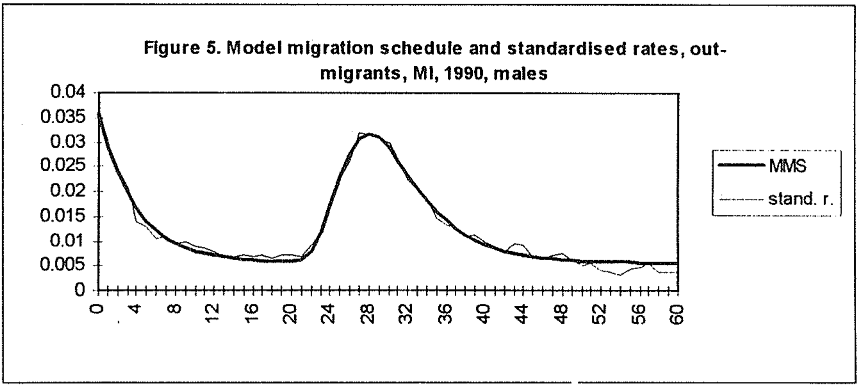


Migration 5 years ago, out-migration, Maltese male population Maltese Islands

$$M(x) = 0.030057e^{-0.251502x}$$

$$+0.068053e^{-0.222429(x-27.053541)-e^{-0.297037(x-27.053541)}}$$

$$+0.00548$$

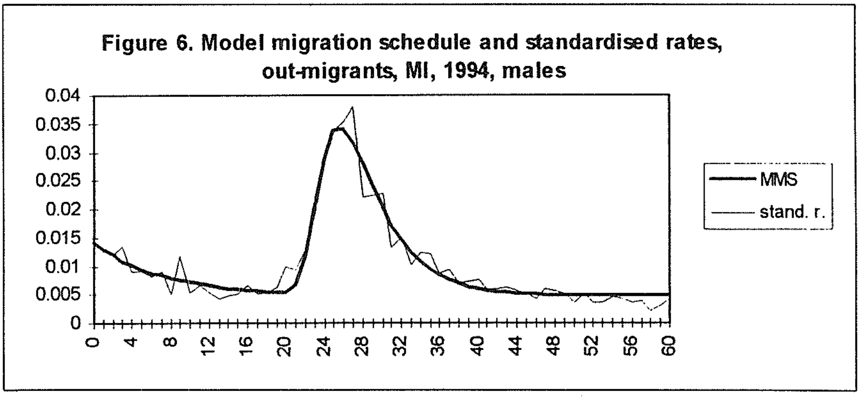


Migration 1 year ago, out-migration, Maltese male population Maltese Islands

$$M(x) = 0.009415e^{-0.137566x}$$

$$+0.070387e^{-0.253317(x-24.287871)-e^{-0.470809(x-24.287871)}}$$

$$+0.004654$$



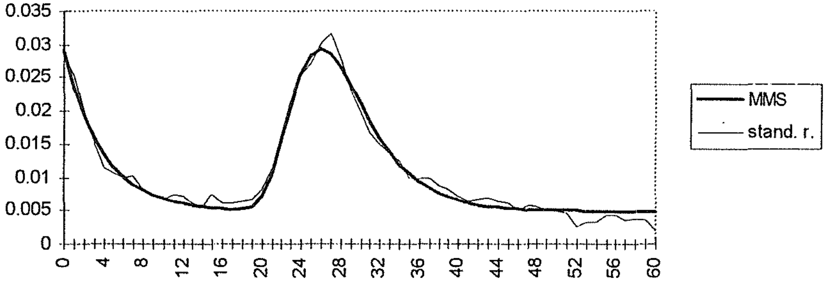
Migration 5 years ago, out-migration, Maltese female population Maltese Islands

$$M(x) = 0.024182e^{-0.255727x}$$

$$+0.066313e^{-0.253961(x-25.616307)-e^{-0.2809958(x-25.616307)}}$$

$$+0.004865$$

Figure 7. Model migration schedule and standardised rates, out-migrants, MI, 1990, females



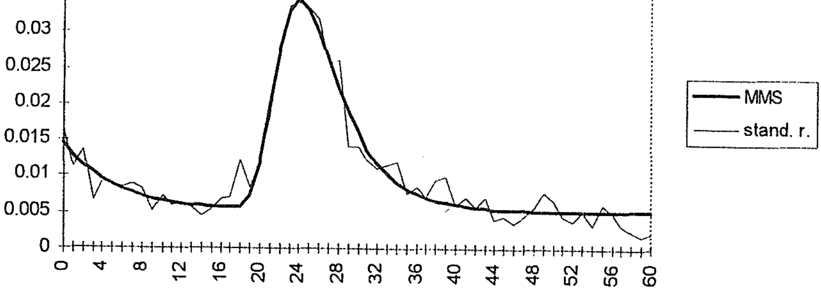
Migration 1 year ago, out-migration, Maltese female population Maltese Islands

$$M(x) = 0.00939e^{-0.189703x}$$

$$+0.07497e^{-0.265541(x-22.967447)-e^{-0.39644(x-22.967447)}}$$

$$+0.005177$$

Figure 8. Model migration schedule and standardised rates, out-migrants, MI, 1994, females



Synthesis of Rogers and Castro model migration schedule

Out-migration

Question on usual place of residence 5 years prior to Census

Maltese Islands

	Total	Males	Females
GMR (mod)	1.0000	1.0000	1.0000
GMR(obs)	1.3081	1.1682	1.3767
a1	0.0262	0.0301	0.0242
stand. error	*0.0009*	*0.0009*	*0.0010*
alfa1	0.2516	0.2515	0.2557
stand. error	*0.0156*	*0.0153*	*0.0203*
a2	0.0633	0.0681	0.0663
stand. error	*0.0018*	*0.0033*	*0.0019*
alfa2	0.2336	0.2224	0.2540
stand. error	*0.0264*	*0.0239*	*0.0328*
lambda2	0.2646	0.2970	0.2810
stand. error	*0.0343*	*0.0382*	*0.0417*
mu2	26.5521	27.0535	25.6163
stand. error	*0.9735*	*0.7708*	*1.0519*
a3	0.0000	0.0000	0.0000
stand. error	*0.0000*	*0.0000*	*0.0000*
alfa3	0.0000	0.0000	0.0000
stand. error	*0.0000*	*0.0000*	*0.0000*
lambda3	0.0000	0.0000	0.0000
stand. error	*0.0000*	*0.0000*	*0.0000*
mu3	0.0000	0.0000	0.0000
stand. error	*0.0000*	*0.0000*	*0.0000*
c	0.0050	0.0055	0.0049
stand. error	*0.0003*	*0.0003*	*0.0003*
n bar (mod.)	25.7308	25.9870	25.4924
% (0-14)	21.0841	21.6058	20.4528
%(15-64)	56.7969	56.2828	57.1641
%(65+)	22.1190	22.1114	22.3831
delta1c	5.2670	5.4849	4.9706
delta12	0.4130	0.4417	0.3647
delta21	2.4213	2.2641	2.7422
delta32	0.0000	0.0000	0.0000
beta12	1.0771	1.1307	1.0070
sigma2	1.1329	1.3354	1.1065
sigma3	0.0000	0.0000	0.0000
xl	18.0000	19.0000	17.0000
xh	27.0000	28.0000	26.0000
xr	n.a.	n.a.	n.a.
X (in years)	9.0000	9.0000	9.0000
A (in years)	31.3300	32.1276	29.5194
B (per 1000)	0.0232	0.0257	0.0242
E value in %	10.1775	0.8323	13.0536

The complete Rogers and Castro migration model

$$m(x) = a_1 \exp(-a_1 x)$$

$$+a_2 \exp\{-a_2 (x-\mu_2) - \exp[-\lambda_2 (x-\mu_2)]\}$$

$$+a_3 \exp\{-a_3)x-\mu_3) - \exp[-\lambda_3 (x-\mu_3)]\}$$

$$+c$$

α_1 =	rate of descent of pre-labor force curve
λ_2 =	rate of ascent of labor force curve
α_2 =	rate of descent of labor force curve
λ_3 =	rate of ascent of post-labor force curve
α_3 =	rate of descent of post-labor force curve
c =	constant
x_l =	the low point
x_h =	the high peak
x_r =	the retirement peak
X=	the labor force shift
A=	the parental shift
B=	the jump

Source: Rogers, Raquillet and Castro (1978)

Synthesis of Rogers and Castro model migration schedule

Out-migration

Question on usual place of residence 1 year prior to Census

Maltese Islands

	Total	Malesa	Females
GMR (mod)	1.0000	1.0000	1.0000
GMR(obs)	1.4517	1.4739	1.4600
a1	0.0095	0.0094	0.0094
stand. error	*0.0010*	*0.0013*	*0.0015*
alfa1	0.1557	0.1376	0.1897
stand. error	*0.0296*	*0.0363*	*0.0548*
a2	0.0751	0.0704	0.0750
stand. error	*0.0036*	*0.0078*	*0.0072*
alfa2	0.2760	0.2533	0.2655
stand. error	*0.0369*	*0.0378*	*0.0434*
lambda2	0.3310	0.4708	0.3964
stand. error	*0.0533*	*0.0931*	*0.0814*
mu2	24.4145	24.2879	22.9674
stand. error	*0.9030*	*0.6172*	*0.8667*
a3	0.0000	0.0000	0.0000
stand. error	*0.0000*	*0.0000*	*0.0000*
alfa3	0.0000	0.0000	0.0000
stand. error	*0.0000*	*0.0000*	*0.0000*
lambda3	0.0000	0.0000	0.0000
stand. error	*0.0000*	*0.0000*	*0.0000*
mu3	0.0000	0.0000	0.0000
stand. error	*0.0000*	*0.0000*	*0.0000*
c	0.0049	0.0047	0.0052
stand. error	*0.0003*	*0.0005*	*0.0004*
n bar (mod.)	26.7567	26.8975	26.7853
% (0-14)	15.8816	16.5407	15.1052
%(15-64)	60.6820	60.4367	60.6160
%(65+)	23.4364	23.0227	24.2788
delta1c	1.9324	2.0230	1.8138
delta12	0.1260	0.1338	0.1253
delta21	7.9375	7.4760	7.9840
delta32	0.0000	0.0000	0.0000
beta12	0.5640	0.5431	0.7144
sigma2	1.1993	1.8586	1.4930
sigma3	0.0000	0.0000	0.0000
xl	17.0000	19.0000	17.0000
xh	25.0000	26.0000	24.0000
xr	n.a.	n.a.	n.a.
X (in years)	8.0000	7.0000	7.0000
A (in years)	27.4100	27.2910	27.5647
B (per 1000)	0.0276	0.0288	0.0291
E value in %	16.4006	19.1319	14.7055

The complete Rogers and Castro migration model

$$m(x) = a_1 \exp(-a_1 x)$$

$$+a_2 \exp\{-a_2(x-\mu_2) - \exp[-\lambda_2(x-\mu_2)]\}$$

$$+a_3 \exp\{-a_3)x-\mu_3) - \exp[-\lambda_3(x-\mu_3)]\}$$

$$+c$$

α_1 =	rate of descent of pre-labor force curve
λ_2 =	rate of ascent of labor force curve
α_2 =	rate of descent of labor force curve
λ_3 =	rate of ascent of post-labor force curve
α_3 =	rate of descent of post-labor force curve
c =	constant
x_l =	the low point
x_h =	the high peak
x_r =	the retirement peak
X=	the labor force shift
A=	the parental shift
B=	the jump

Source: Rogers, Raquillet and Castro (1978)

A suitable demographic interpretation of the parameters in the model migration schedules is of the utmost importance in order to analyze characteristics of migrants, as well as the relationship between migration levels and age-gender patterns. It helps to relate these characteristics with the magnitude of migration and also with the prevailing socio-economic conditions contributing to the occurrence of migration streams. All these presented measures are given for value of gross migraproduction rate equal to unity, i.e. standardized, for reasons of regional comparability and unified graphical presentation.

Derived measures revealing demographic characteristics of the migration model schedule are :
areas : GMR, %(0-14), %(15-64), %(65+)
locations : $\bar{n}$, x_l, x_h, x_r
distances : the labor force shift X, the parental shift A and the labor force jump B.

An important conclusion is that all estimated parameters and derived measures of the Rogers and Castro migration model take values within the range observed world wide. The study indicates an increase in the average age of pre-labour force and labour force for out-migration one year prior to Census being equal to 26.8 years, in comparison to 25.7 years for migration data five years prior to Census. The male migrants were older then the female migrants, but the difference is smaller than the one corresponding to the age difference between spouses at the first marriage.

The Maltese migration schedules' profiles indicate 'late peaking' curves, where the location of the mean age of the labour force component μ_2, takes values higher than 22 years of age, namely 26.5 years for migration five years prior to Census and 24.4 years for migration one year prior to Census (both national level data).

The profile of the model migration schedules described by low points x_l goes in accordance with the Maltese law regarding the minimum age at labour market. Basically, all modeled values of low points were greater than 16 years of age. The high peak x_h occurs at the age of 27 years (five years prior to Census) and at the age of 25 years (one year prior to Census). The high peak of female labour force precedes the one of male labour force in terms of age. The differences are around two years, thus corresponding to the average differences of bride and bridegroom at the first marriage. The time needed for labour force to settle down, i.e. the labour force shift X is around 9 years for migration five years prior to Census and 8 years for migration one year prior to Census. The parental shift A, based on mirroring effect of rates of decrease α_1 and α_2, takes values of 31.3 years for migration five years prior to Census and 27.4 years one year prior to Census. The latter figure can be considered as a proxy for the mean age of childbearing. Specificities of the Maltese society namely the absence of regional labour markets in terms of wage differentials, low participation rates for female labour force, tendency of a young couple to live close to the bride's parents (which ultimately results in a lower inter-regional migrativity of females than in European societies), relatively low level of migrativity of both genders and an earlier 'settling down' process, bring about values of the jump B higher for males than for females. In contrast to European societies, where male labour force migration curve is flatter at the ages characterized by the highest levels of migration rates in the Maltese population there is a high peak resulting in a jump B higher than for the females.

The index of child dependency reveals a 'child dependent' family type of migration, five years prior to Census. However, the difference between five and one year prior to Census data indices, can be attributed to estimated migration for the first five cohorts in the former. For both observed fixed points in the past, the resulting equations returned labor force families of curves symmetrical with values close to unity. This indicates a bell shaped form of labor force component. The index of parental-shift regularity β_{12} confirms similarity between the rates of decrease for pre-labour and labour force components, five years prior to Census. This is just like in the case of the index of child dependency - where family type migration was observed. The values of the index of parental shift regularity for one year prior to the Census indicate that the rate of decline of pre-labour force, α_1 was lower than the labour force one, i.e. α_2, hence values of the index lower than 1.

Finally, the question on overall quality of estimated parameters can be posed. The respective standard errors are given for each estimated parameter of the model (Tables 4 and 5). However, an overall index of goodness-of-fit, E proves to be a better overall measure. In the case of migration five years prior to Census the median value of overall index of goodness-of-fit, E was equal to 12.5% which shows a better result than the similar counterparts in Sweden, the UK and Japan (Hofmeyr 1988 : 26). The analysis shows that Maltese male migration schedules are better approximation of their observed rates than those of females' ones. Modeling based on migration data one year prior to Census shows worse results of estimation due to a higher number of zero values in number of ages and also due to the smaller number of migration events. Higher regional differences were observed in GMR(obs.) five years ago than one year ago, resulting in the respective mean absolute deviation averages (MAD/N%) of 18.2% and 7.8%.

Conclusion

Demography has a distinctive place in the set of social and population related sciences. Social scientists have always highly valued methods and techniques established within demographic research system. Their outcomes usually present inputs for other population related research projects. Because the statistics collected for the purpose of this thesis intends to reveal the underlying processes of migration, it should also help to capture the behavioral patterns connected with local customs, social prescriptions, state of the economy, even the environmental considerations. Although this work is based on methods developed by mathematical demography, it is not isolated from the sociological context of human variable.

There are several reasons why the Rogers and Castro seven-parameter model has been chosen and affirmed useful in this work. The application of the model allows the following :

1. Migration hypothesis for population projections can be based on a modeled, smoothed rates instead of zigzag observed rates. Modeled values of migration rates are based on standardized observed migration rates, which correspond to a gross migraproduction rate equal to unity. This allows comparability between regions.

2. In those cases where only five year age group migration data are available and where there is a need for analysis by single ages, the Rogers and Castro model migration schedules can be used to interpolate single ages between existing five year age groups.

3. The Rogers and Castro model gives the opportunity to create families of model migration schedules. Comparison of migration model schedules families are possible for different spatial units within one country or between different countries. They can be based on : mean labour force

age, μ_2; index of parental shift regularity, β_{12}; index of labor asymmetry, σ_2; index of child dependency, δ_{12}; retirement peak, a_1, a_2, a_3 and c levels, etc. This allows a comparative analysis of the observed schedules and definition of a standard migration schedule representing particular family.

Many developed countries already included internal migration in population projections on the subnational level. If internal migration is considered to be included in population projections procedure locally, then this type of research might be applied using : GMR's on regional level, age-gender specific migration rates, as well as model migration equations based on estimated parameters of the Rogers and Castro migration model.

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