

**MULTIREGIONAL DEMOGRAPHIC PROJECTIONS:
POLISH EXPERIENCES**

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1. Introduction

Polish geographers and demographers have practised multiregional projections for more than a decade. Judging by the number of publications, the methodology, particularly popular in the eighties, seemed to be losing its appeal recently. It may be therefore appropriate to assess how it has been used and what was the value added by Polish researchers.

2. Multiregional population projections: A Polish perspective

There is a real monoculture in Poland in the domain of multiregional demographic projections. Namely, the only model that has been widely used until now is the one presented in the books by A. Rogers (1975): "Introduction to Multiregional Mathematical Demography", and Willekens and Rogers (1978): "Spatial Population Analysis: Methods and Computer Programs". In the course of this paper, whenever multiregional population projection is referred to, it means the multiregional Rogers model and its modifications. It is significant that almost no attention has been paid in Poland to demographic accounting modelling.

Chronologically, the first multiregional projection of Polish population was presented in the publications by Dziewoński and Korcelli (Dziewoński and Korcelli 1978, and Korcelli 1978). These publications were of an introductory nature.

Since that time research based on multiregional and occasionally multistate projection models has been going in Poland in eight following directions¹: 1. Development of the theory of multistate demographic projections; 2. Generation of projections and analysis of their results as the source of knowledge on the current demographic situation in its spatial dimension; 3. Application of different parameters of projected population for better understanding and measurement of the dynamics of multiregional population²; 4. Simulations; 5. Comparisons of a series of projections for one time point, but using various types of data concerning spatial mobility of population; 6. Analysis and comparison of a series of projections for the constant spatial setting and for one type of data, but using data for various years; 7. Generation of multistate projections; 8. Assessment of the exactness of multistate population projections. Developments in each of the categories enumerated above will be discussed in brief.

¹ An earlier assessment of the achievements of Polish multistate demography may be found in Paradysz (1985a, 1987) and Kupiszewski (1987a).

² The approaches presented in points 2 and 3 are similar from a substantial point of view, but from a methodological point of view they differ. This is why they were separated.

2.1. Development of the theory of multistate demographic projections

Jóźwiak (1988) defined the fundamental matrix of the multistate population projection model. This concept is similar to the one introduced by Kemeny and Snell (1960) with respect to Markov chains and is new in multistate demography. The author proposes two possible applications of the concept: "Properties of the fundamental matrix may be utilized, first of all, to assess the mean level and dispersion of time spent by individuals of the system in specified states. Another possibility for application of the fundamental matrix is related to evaluating the multistate population structures." (Jóźwiak 1988 p.7). Comparison of the structures of multiregional female population of Poland observed in 1977 and 1982 was the basis for testing the concept.

The question of the method of data aggregation in the spatial cross-section and according to age has been solved by Jóźwiak (1983, 1985). She has proposed the aggregation method and presented the necessary and sufficient condition for perfect aggregation. A number of earlier papers dealt with the problem (Rogers 1975, 1976, Gibberd 1981). As Paradysz (1987) noted, the solution proposed by Jóźwiak is an advance in comparison to the results of Rogers (1975) because it is independent of time. What's more, Jóźwiak (1983, 1985) has demonstrated that the matrix of weights allocated to aggregated elements of the system should obey very general conditions. This solution is different from what Gibberd (1981) has proposed because his method of

aggregation did not hold the condition for perfect aggregation. Józwiak (1983, 1985), without doubt, has brought an important methodological achievement, making a connection with the theoretical studies conducted elsewhere in the world. Alas, the Polish literature in this subject lacks the empirical approach to determining the magnitude of errors arising as the result of various forms of spatial aggregation.

2.2. Projections results as the source of knowledge on the current demographic situation.

Virtually all publications describing the use of the Rogers model present the results of analysis concerning changes in population dynamics within an adopted regional system, related to directions and intensities of flows and to the regional processes of natural growth. However some of them are solely devoted to this sort of analysis rather than to methodological problems. To this category belongs the publications by Dziewoński and Korcelli (1978, 1981), Korcelli (1978, 1985, 1986, 1987, 1990), Kupiszewski (1990, 1991a) and Korcelli and Kupiszewski (1990, 1992). A particular place on this list is occupied by the work reported by Kędelski (1985), because of the novel, in Poland, application of projection to the assessment of dynamics of changes in the professional structure of rural population (see 2.7).

2.3. Application of different parameters of projected population for better understanding and measurement of dynamics of multiregional population

The basic idea behind this category of applications is to use various indices characterising projected population(s) to learn more about observed population(s). Three examples can be enumerated here: Kędelski's (1986) analysis of the evolution of the mean age of multiregional population, Kupiszewski's (1989) comparison of the changes in age structures of the multiregional population of Poland, and Kupiszewski's (1991a) assessment of fertility changes over time in multi-regional population based on intrinsic single- and multi-regional birth rates. This direction of research seems to be very promising because it allows for a more precise description and analysis of various features of population.

2.4. Simulations

Usually, projections of multiregional population are carried out based on the assumption of constant age dependent birth, death and mobility rates, equal to the ones observed at the initial time point. It is possible, however, either to take into account mathematically or statistically forecasted changes of fertility, mortality and/or mobility, as Rogers suggests, or to assume some trajectories of changes based on scholar's knowledge, experience and intuition. In both cases the procedure is usually highly

arbitrary. However this procedure allows us to study various alternative paths of the development of the population system and answering "what-if" questions. Such an approach was applied by Dziewoński and Korcelli (1981). They run two simulations: in the first one they reduced by half the population flows among all the regions with exception of the South-Eastern macroregion, while in the second one the authors "intended to study the effects of implementing major economic-investment programs" (1981 p. 64) in the Eastern macroregion, encompassing the Lublin Coal Basin then being created. It was assumed that outflows from this region shall be neutralized by the inflows. The authors of the simulation would evaluate their experiment in the following way: "Further tests of this kind would seem useful especially if they incorporate more comprehensive scenarios, including simultaneous or stepwise alterations of more than one demographic component at a time" (1981 p. 66). An effort aiming at realization of the latter postulate has been undertaken, on the basis of experiences gained by Scherbov and Usbeck (1983), by Kupiszewski (1990), who modified the Rogers model in such a way that the changes of age-dependent births, deaths and migrations rates could be possible at every step of projection. This requires, of course, generation of the growth matrix at each step of projection. The thus modified model served to simulate the changes in depopulation processes of Polish rural areas.

Recently multistate models with an option allowing for altering parameters of projected multiregional population are almost

standard³, however in the early 1980's approach proposed by Dziewoński and Korcelli was quite innovative.

2.5. Comparisons of series of projections using various types of data concerning spatial mobility of population

An evaluation of the consequences of introduction of various types of migrational data into the Rogers model was presented in publications by Kupiszewski (1987b, 1988a). The author ran two series of computations, introducing two types of migrational data to the Rogers model. The first type of data concerned the numbers of migrations acquired from the current registration, while the second concerned the numbers of migrants over the period of one year and were acquired from the National Census of 1978⁴. It has been stated that various types of the data considered generate in the projections a specific spatial population distribution and structure patterns, which results not only from the different concepts of measuring population mobility, but also from the fact that these sets of data concern different categories of the migrating population (during the National Census the criterion of the de facto residence was used, while in current registration it was the formally-legal criterion). Analysis of the phenomenon

³ Compare, for example, Scherbov's DIALOG or Willekens' MUDEA models.

⁴ The questions asked during the Census were about the place of last residence and about the date of move. The data obtained are therefore not transitional data, where we compare the place of inhabitation at two fixed points in time.

was made difficult by the incoherent treatment of the migrating population by the Polish statistics⁵.

2.6. Analysis and comparison of series of projections for data for various years

Korcelli and Kupiszewski (Korcelli 1986, 1987, 1990; Korcelli and Kupiszewski 1990, 1992; and Kupiszewski 1988b) have performed a series of projections on the basis of data for various years and compared trajectories of projected growth of these populations. Korcelli and Kupiszewski (1990, 1992) adopted the 13-regional setting used already in the earlier works (see Dziewoński and Korcelli, 1981) and ran projections for the data of the years 1977, 1978, 1981 and 1983. In other publications Korcelli (1986, 1987) used five-regions system (Warsaw, other towns of the Warsaw voivodships, rural areas of the Warsaw voivodship, other towns of Poland, other rural areas of Poland) and two series of the input data: for 1978 and for 1983. In that way multistate projections were applied for analysis of urban change in a meso-scale. In the paper by Kupiszewski (1988b) the biregional schema was used, distinguishing urban and rural areas, and two series of the input data - for 1978 and for 1983.

The purpose of such studies can be expressed as follows:
"Comparison of the time series of input data with the

⁵ More detailed analysis of the Polish sources of data on population mobility may be found in Kupiszewski (1992).

corresponding series of projections, generated on their basis, should allow an assessment of the sensitivity displayed by the Rogers model with regard to small, but observable differentiation of the output structures of the population. In case when the time series of data observed present certain temporal trends it is an interesting question to follow the representation of these trends in particular stages of projections. (...). A parallel, more practically oriented goal of analysis was recognition of the implications of changes observed in the years 1978-1983 for the future population transformations of Poland in the interregional setting" (Korcelli, 1985 p. 4). Studies quoted above proved that the multipoint approach was very useful for comparative and measurement purposes.

2.7. Generation of multistate projections

The fact that application of the Rogers model is not limited to the multiregional cases, but can be made for the multistate settings (Essays in Multistate..., 1980, Multidimensional Mathematical..., 1982), found its reflection in the studies conducted in Poland, both in the theoretical and in the empirical sphere. The analytical form of the multistate model was presented by Józwiak (1985). The multistate projection of the rural and urban population by age, and with respect to rural population by occupational structure was prepared by Kędelski (1985). This author has distinguished as states the following states: "population of large cities", "population of medium and small

towns", "agricultural population of the rural areas", and "non-agricultural population of the rural areas". The two latter states express the occupational structure of rural population splitting it up into two groups: living in rural areas and working in agriculture and living in rural area and working outside agriculture. The study considered made it possible to analyze the hypothetical changes of spatial-occupational redistribution of the rural population, which reflects the urbanization processes. It is a well known phenomenon that changes from rural to urban style of life could either start or be enhanced with the change from agricultural to non-agricultural occupation. It should be mentioned that a similar analysis, in which the set of rural communes, the set of communes having the character of small towns, the set of township communes, and finally the set of large cities were distinguished, was carried out for the former German Democratic Republic by Usbeck (1985), however he did not recognize a non-spatial dimension.

2.8. Assessment of the exactness of multistate population projections

Two papers have tried to analyse the exactness of population projections. The first has set up a theoretical framework (Jóźwiak 1987). The other (Kupiszewski, 1988c) used some measure of structure similarity/dissimilarity to assess the exactness of various multiregional and single-regional population projections and forecasts. Despite the fact that there are a large number of papers on the accuracy of projections it is unusual that they deal with the idea of multidimensionality in demography. In that sense these papers were additions to the literature.

3. Conclusions

Studies on the applications of multiregional projection models and wider multistate demography are conducted in Poland in three centres: in the Academy of Economics in Poznań, in the Central Trade School (the former Central School of Planning and Statistics) in Warsaw and in the Institute of Geography and Spatial Organization of the Polish Academy of Sciences in Warsaw. In the first two centres the research is conducted by the demographers, while in the third one - by geographers. This has an obvious influence on the way that questions of multiregional analysis are approached. Demographers concentrated mainly on the model theory (Jóźwiak 1985), fertility questions (see numerous publications of Paradysz, 1980, 1982a,b, 1984, 1985b, who

combined the multistate and longitudinal approaches) and on the problems related to construction and computation of multiregional (Englert and Paradysz 1978, Kędelski 1981) and multistate (Kędelski and Gołata 1986, Gołata 1987) life tables. Geographers are primarily interested in the spatial problems and especially in the generation of multiregional projections. Research carried out by the demographers concentrated on generalizing the multiregional analysis to encompass the multistate case. Kędelski states that "further progress in this domain will be connected not so much with the geographical approach and spatial delimitation of the populations, but with the demometric decomposition of more homogeneous subpopulations, distinguished mainly from the point of view of factors shaping demographic processes" (1981 p. 63). Ten years later it is clear that Kędelski was wrong, as much of the research effort over the last decade has been invested in handling more complicated spatial divisions, as for example small areas (Rees 1991) or very large areas (Rees, Stillwell and Convey 1992) where multilevel multiregional models were indispensable. Still, because acquisition of data for the multistate analysis, especially with regard to the interstate flows is extremely difficult, all the studies performed by Polish demographers to date use the standard division into the urban and rural population. This cross-section is very significant but, it does not reflect regional differentiations. There is also a lack of multistate cross-sections, except for the unique study by Kędelski (1985). It should be emphasized that the studies to date display very limited sets of potential states and apparently do not implement,

at least in the empirical sphere, the research postulates forwarded by Kędelski.

Until now, geographers were not - with detriment to the studies conducted by them - interested in the introduction of multiple states to their analyses. The regional breakdowns they used, on the other hand, are far more sophisticated. They have also conducted a number of experiments concerning three factors of the model: time, the manner of data acquisition, and space. Further essential progress in these studies can be achieved mainly through integration of the "demographic" approach, tending to encompass possibly many states in the analysis, with the "geographic" approach, characterized by the emphasis on spatial aspects of the analyses.

Polish research was predominantly 'blue sky' research, without attempting to apply multistate methodology to solve any practical problems. This is mainly because there was no real market in Poland for that advanced demographic research technology. It was probably one of the fundamental weaknesses of Polish research - the lack of incentives from the real world. This may change in the late 1990's provided that the economy will take off and the profits of mathematical modelling of social processes understood by governmental and commercial organizations. Nevertheless it seems that the input of Polish researchers into multistate demography has brought a number of innovative concepts, both theoretical and empirical.

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