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DEMOGRAPHY AND ITS RELATION TO OTHER DISCIPLINES

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Congratulations to the Department of Demography and Geodemography on the anniversary of 100 years of teaching Demography. Some of the early and major contributions to the field of demography occurred in Europe during the 19th century, and it is comforting to see that Demography has had a continuous tradition in many European institutions, and especially at such a historic and prestigious university as Charles University. The Department of Demography and Geodemography is particular noteworthy because its achievements have not only been manifested in many publications, but also because the department is devoted to teaching and education in Demography. Besides a full curriculum in Demography during the regular semester, the department also offers an internationally oriented summer school. Some time ago we looked at the programme and were impressed by both its scope and the prominent persons involved in the lectures.

The celebration of 100 years of teaching Demography at Charles University is an appropriate occasion to reflect on the field of Demography as a discipline, and in particular, the relation of Demography to several other disciplines.

The populations of most of the world's countries are growing older. This shift is creating a new demography, a demography of low fertility and long lives. The rapidly growing populations of the elderly are putting unprecedented stresses on societies, because new systems of financial support, social support, and health care have to be developed and implemented. In this talk today we will briefly touch on some of the health, social, and economic issues arising from the transformation of the demographic landscape across Europe and the world, and we will address the question of how demographic knowledge can affect public policies to accommodate or possibly influence this transformation. We cannot even start, however, to do justice to all the interesting research demographers have done on the problems and opportunities associated with population aging, fertility change and family behaviour in the last decades. So we would like to focus our talk on a particular research thrust, namely those areas of demographic research that are related to the current activities at the Max Planck Institute for Demographic Research (MPIDR) in Rostock.

The challenge to address questions like *What is demography?* and *How is demography related to other disciplines?* is particularly relevant at an institution like the Max Planck Institute for Demographic Research. The research agenda for demography at the MPIDR is not confined by disciplinary boundaries – in contrast to many university centres that are often located within a department of sociology, geography, or a similar field. While these centres frequently focus on demographic research in these particular disciplines, researchers at the Max Planck Institute for Demographic Research enjoy the advantage that they need not restrict themselves to *only* eco-

nomic, sociological or biomedical research. We can transcend these boundaries. This freedom is clearly advantageous in many respects, but it also poses considerable challenges. In particular, we, more than anybody else, need to ask ourselves about the specific strengths and advantages of our discipline as compared to other fields, and we need to establish demography as a field that is distinct from other areas of research but also closely integrated in a wide network of multidisciplinary researchers.

Our vision of demography and its relation to other disciplines is represented in Figure 1. We demographers like numbers, especially censuses and official statistics, and we like calculations and formulas. We like to count and it is our ability to count that gives us insights and influence. We have influence because demography is of great interest to the public and of considerable importance to policymakers. So demography rests on the bedrock of mathematics and statistics but its research findings float upward into the windy heights of politics and policymaking.

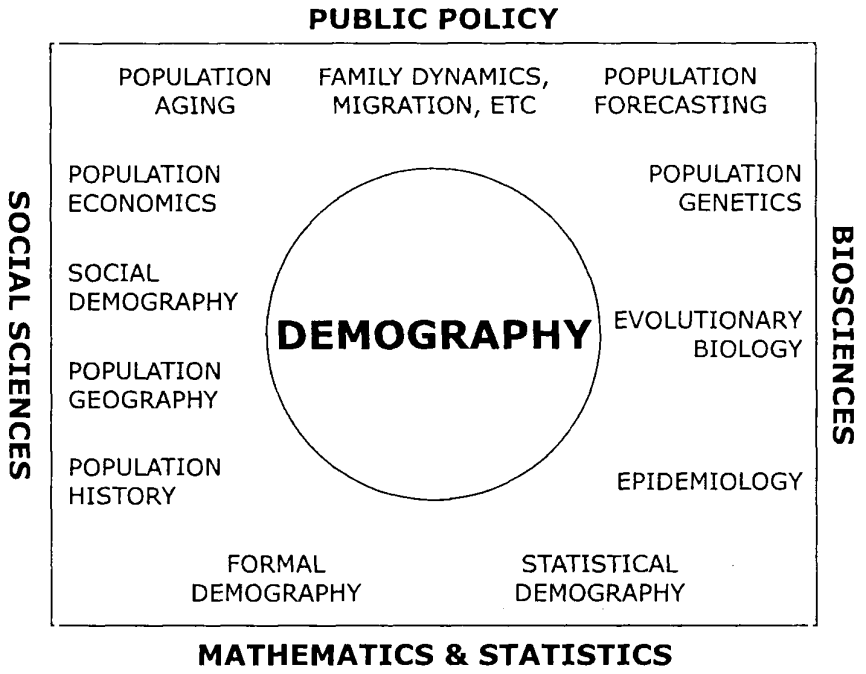

Figure 1: Demography in relation to other disciplines

The models and methods of demography shed light on the structure and dynamics of populations. Most of us are mainly interested in human populations, but Alfred Lotka, Raymond Pearl, and many other distinguished demographers have also had a deep interest in animal populations. Furthermore, the two things we study most – namely fertility and mortality – are quite biological. Hence, as shown in Figure 1, we see demography as lying at the meeting ground between the social sciences on the one hand, including sociology, economics, geography, history, and cultural anthropology, and the biological sciences on the other hand, including epidemiology, ecology, genetics, and biological anthropology.

As indicated earlier, the central questions of demographic research are of immediate relevance for policy makers. For instance, let us turn to the impact of mortality reductions on the growth of the elderly population, specifically the population of centenarians. In the countries with reliable data on centenarians, the number of centenarians is increasing at an exceptionally rapid rate, about 8% per year on average. Demographers are used to population growth rates of around 1% per year or so; an 8% growth rate seems more like an inflation rate. In England & Wales, an average of 74 persons per year reached age 100 between 1911 and 1920; by 1990 the number of people celebrating their 100th birthday had increased to almost 2000 and in 1997 the number was around 3000. The population of centenarians is growing, in part, because of the increase in births a century ago, the sharp decline in infant and childhood mortality, and the substantial decline in mortality at ages from childhood up to age 80. Demographic analysis demonstrates, however, that by far the most important factor in the explosion of the centenarian population – two or three times more important than all the other factors combined – has been the decline in mortality after age 80 (Vaupel and Jeune 1995).

Centenarians are still unusual, but these findings do illustrate the fact that mortality reduction can have major impacts on population growth at older ages and on extending the frontier of survival. The growth of the population of female octogenarians in England & Wales provides another telling example. The remaining life expectancy of 80-year-old females in England & Wales around 1950 was approximately 6 years. Currently the corresponding figure is about 9 years, some 50% higher. As a result, the population of female octogenarians in England & Wales is roughly half as big again as it would have been if mortality after age 80 had remained at 1950 levels. Putting this in terms of population counts, more than a half million females aged 80+ are alive today in England & Wales who would have been dead if mortality after age 80 had not been reduced.

Current family and fertility dynamics are equally striking for many observers. Several European countries are presently experiencing unprecedented low, or *lowest-low*, fertility levels. Countries like Italy and Spain, which are commonly associated with highly family-related and traditional values, are approaching a total fertility rate of one, while many forerunners of the second demographic transition have considerably higher fertility rates. Rather extraordinary changes in fertility and family behaviours have also occurred in the formerly socialist countries. For instance, since 1989 eastern Germany has experienced one of the most dramatic falls in birth rates ever to be observed during peace time in a country. Between 1989 and 1994 the annual number of births in eastern Germany dropped by 60% from 200,000 to 79,000; the number of marriages declined in equal magnitude from 131,000 to 52,000. The mean age of mothers at first birth has increased from 23.6 to over 26 years, and the socio-economic characteristics of parents have changed. If these trends continue in the future, the inevitable results in the so-called New Länder will be a substantial reduction in population size, a rapid ageing of the population, and a substantial shift in the composition of households.

The implications of such a different demographic landscape, independent of whether it is due to substantial improvements of mortality or lowest-low fertility levels, are innumerable: they range from the planning of public services for the young and old, the long-term viability of pay-as-you-go pension systems, the availability and supply of labour and human capital, the level

of national savings, to the demand for housing and other goods and services. Moreover, the question of whether migration can possibly provide an amelioration for these trends is of pressing importance. State-of-the-art demographic knowledge is necessary in order to assess and evaluate these changes in the size and structure of a population, and this knowledge is an important aspect in the respective public policy measures implemented to either influence or accommodate these demographic changes.

Many of these policy measures need to anticipate future changes in the size, structure and composition of the population. Population forecasting therefore is an important tool through which demographic knowledge affects public policy. For instance, Ronald Lee (2000) in a recent analysis of the US social security system argues that the long-term financial outlook for the system is worse than previously thought. This long-run funding imbalance of system is mostly due to the addition of an extra four years to the currently projected increase in life expectancy by 2075. Moreover, Lee argues that industrial countries have a history of under-predicting the growth of their elderly population, and it is expected that large mortality adjustments may also be needed in the projections for public pension programs in industrial countries other than the United States. Appropriate forecasts of population aging can avoid such *surprises* in the future structure of the population, and many policymakers are well-advised to rely on these or similar forecasts in their planning of public and social policies.

In view of this relevance of Demography for the sphere of public policy, it is comforting to look at the opposite side of the diagram in Figure 1: Demography rests on a solid foundation built on two pillars. Firstly, the discipline has theoretical roots in mathematics and statistics, which manifest themselves in the sophisticated areas of *formal and statistical demography*. Secondly, demography has *firm empirical roots* in registration and survey data. Fortunately, both pillars of demography experience rapid innovations which increase the scope and quality of demographic analyses.

Let us first consider data. While we have known survey data for a long time, the availability of large amounts of register-based individual level data is a relatively recent development. Nordic countries have been the leaders in this area, and many of these countries allow complex linkages of individual level information from different registers in order to provide a comprehensive longitudinal picture of individual-level demographic events and their determinants. Although less well-known, similar capacity exists in some countries in Central and Eastern Europe, where, for instance linkages between census and registration data allow for unprecedented opportunities to investigate the recent decline in fertility and life-expectancy. Moreover, the availability of such registration data in the Nordic and some CEE countries considerably enhances the power and scope of demographic analysis in studying rare events, like oldest old mortality, or the demography of small subpopulations. As all of you know, these investigations are usually problematic because small populations or rare demographic events are not sufficiently represented in survey data. Individual level registration data, however, may bring about major breakthroughs in these analyses.

The empirical basis of our research, however, is also expanding in another dimension. Demographers are currently starting to utilize data sources that several years ago were either unknown

or not frequently used. These data come primarily from the biological or medical sciences and are related to the tremendous progress in the ability to collect, store and analyse biomedical information. In the near future these new data will provide demographers with genetic information for substantial samples of the population, results from biological experiments with nonhuman species, or information on special populations like twins.

This availability of new and more comprehensive data is accompanied by advances in demographic and statistical methods to analyse them. To a large extent these methodological advances are related to the rapidly increasing computational power of computers. Anybody following statistical advances must be fascinated by new techniques ranging from non- & semi-parametric statistics, advances in event history models, ability to control for unobserved heterogeneity (with special sample designs, such as twin data or experimental data), but also advances in more traditional demographic methods, like the adjusted total fertility rate that was suggested to augment the standard TFR in low fertility settings.

New mathematical methods for studying population dynamics and the interactions of populations with economic or environmental or social systems also transform demographic analyses and open new areas of investigation in formal demographic analyses. This progress in analysing the interaction of populations with various social and economic spheres is related to improvements in the study of non-linear systems. In order to make such progress available for demographers, the Max Planck Institute for Demographic Research for instance organizes a workshop series on non-linear demography that brings together scholars from formal demography, mathematics and related fields. Nevertheless, despite the progress in non-linear systems, we sometimes encounter situations where the *math breaks down*, i.e., where formal questions are no longer analytically tractable. Fortunately, methods of simulation become more and more commonplace, and we are convinced that simulation will be an increasingly important tool of demographic analysis in the future. The study of social interactions, or the investigation of non-linear interaction in demo-economic systems are just two examples where computer-based demographic modelling is likely to yield substantial progress in the coming years.

It is apparent from the above discussion that Demography rests on a solid foundation of data and methods. Due to the recent progress in these foundations, our discipline therefore is better equipped than ever before to face new challenges. The first challenge, already discussed earlier, is the use of demographic knowledge in the important aspect of public policy. The second challenge of contemporary demography, in our opinion, is the utilization of the opportunities that arise from the unique position of our discipline at the interface of the social and biological sciences. While the social and biological spheres have been quite separate within demography for many years, and most demographers were active either in the social sciences or in the biological sciences, the merging of social and biological perspectives in the study of demographic processes affects some of the greatest opportunities for progress in modern Demography.

Let us first elaborate the more familiar relations of demography to some of the social sciences.

Social demography: This is probably the most familiar aspect of demography to all of us, and we will be quite brief on this topic. In our opinion, one of the most innovative aspects in this area is

the study of interacting populations. Whereas early demographic theory followed structuralistic approaches or modernization theories, like the demographic transition theory, Gary Becker's approach *individualized* much of demographic behavioural theory. While to a large extent we are in favour of this economic perspective, it clearly has major disadvantages. This is not the place to elaborate this in detail, but the breakthrough of an individual perspective is now turning into its disadvantage: in particular, the individual perspective implies that the important influence of social interactions is lost. While there is a substantial amount on data on households and individuals, there is still limited information on data that describes relations between individuals, as for instance through intergenerational transfers or social networks. For instance, is it relevant for our demographic behaviour that we have different social environments/networks, and if yes, how relevant is it? Topics in this are for instance questions of social influence, that is, questions of how our preferences regarding children or marriage or such are affected by *others*, and whether the presence of social interaction has any impact for our interpretation of fertility dynamics.

Population economics: Again, this is a vast field, to which we can hardly pay justice within a few minutes. Nevertheless, let us point out two aspects where population economics is facing new challenges. On the one hand, microeconomics has considerably broadened its scope in recent years, and game theory, behavioural economics (i.e., the boundary of economics and psychology), bounded rationality, had a substantial impact on how economists think about the individual determinants of behaviour. To some extent, however, the microeconomic approaches to demographic behaviour – usually associated with Gary Becker – still need to catch up with these developments. On the other hand, macroeconomics also is facing important new challenges. Two prominent examples are population ageing and the associated problems of transfer systems and health economics, and secondly, the interaction of population, the economy and the environment.

After this brief discussion of important aspects of demographic research in the social sciences, let us now turn to aspects that may be less familiar to you: the relation of demography to the biological sciences.

In mortality, the relations between demography and the biological sciences are very obvious. Nevertheless, it was only relatively recently that these questions received systematic attention from demographers. A central question in the contemporary research on mortality is *Why do some people die at 60, others at 80, and a few at 100?* It might be expected that the answers to these questions – and the determinants of longevity more generally – are well understood. A recent review, however, of the determinants of longevity (Christensen and Vaupel 1996) concludes that surprisingly little is known. The chance of reaching age 80 (or 90 or 100) is better for (a) women than men, (b) people born in this century rather than earlier, (c) people born in developed countries, and (d) people who have some favourable genes, such as the ApoE 2 gene (Schächter et al. 1994).

Studies of twins and other kinds of related individuals suggest that about 25 percent of the variation in adult life spans appears to be attributable to genetic variation among individuals (McGue et al. 1993, Herskind et al. 1996). Moreover, recent research at the MPIDR suggests that an additional 25 percent may be attributable to non-genetic characteristics that are more or less fixed

by the time a person is 30 or so, characteristics such as educational achievement, socio-economic status, etc.

While the above findings are quite interesting in themselves, they mark only the beginning of a research agenda: in the near future we will have data from DNA sequencing on a sufficiently large sample population to actually study the impact on specific genes on mortality. In addition, the intersection between demography and the biological sciences is considerably wider. For instance, much research has been done on life-history analysis in nonhuman species and some of this research attempts to address the issue of why there are large intra-species and inter-species differences in life spans. In addition, some genes have been found, notably for nematode worms, that substantially increase longevity.

While in mortality the link of demography to the biological sciences is more obvious, the study of fertility behaviour – which has traditionally been the topic of social demography – can also benefit from looking towards biology. For instance, we have recently looked at whether fertility is subject to genetic influences, looking at data on Danish twins (Kohler, Rodgers and Christensen 2000). On one hand, one might speculate that the investigation of genetic influences on fertility is a dead end. Since *a trait for zero children cannot be heritable*, the fundamental theorem of natural selection would argue that fertility should have relatively little genetically determined variation. Correct; but at the same time, our environment today is distinctly different from our evolutionary environment, and what might have been true in the past, may no longer hold. And surprisingly, this turned out to be the case: cohorts who make conscious choices of their fertility levels, and cohorts who seem to have the freedom to make such choices, exhibit the strongest genetic influences, for instance, cohorts facilitating the demographic transition, and recent cohorts who have most choice in their fertility decisions. This study therefore suggests that the *heritability of fertility behaviour* is not constant. On the contrary, it changes systematically with the socio-economic and demographic context of cohorts. Therefore, understanding the genetic influences on fertility behaviour requires a deep understanding of the socio-economic and demographic context. Thus, it confirms the picture presented here of the discipline of demography being situated between the social and biological sciences.

At the end of this partial and personal overview of how demography is related to other disciplines, we hope that we have convinced you that demographers can contribute a great deal to public policy and other disciplines. Demography is sometimes defined in a narrow way. The concepts, methods, and materials of demography are so powerful and so useful that it seems to us that it would be better for demography to be defined in a much broader, much more inclusive way. Demography lies at the core of the population sciences and demographers can contribute important research findings to many fields. We understand how to study the structure and dynamics of populations. Our knowledge can help us shed new light on the mechanisms driving population structures and dynamics as well as on the consequences of population structures and dynamics. In particular, it seems to us that demographic research will certainly provide new insights and perhaps the crucial insights into the mechanisms that drive the processes of ageing and survival, and similarly, the processes related to fertility, family formation and the human life-course.

Demography, in our view, is based on a solid foundation of data and methods and explores the intersection of the social and biological sciences. Demographic knowledge in the coming years is likely to become increasingly important and influential. Based on these conclusions, we do not see any problems in filling another 100 years of successful teaching and Charles University with an exciting agenda and curriculum. We have no doubt that you will actually do so. Our congratulations once again on your great achievements at Charles University.

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