

Statistics and the Explanation of Fertility and Family Behaviour: Ideas from the Recent Past

*La Statistica e la Spiegazione dei Comportamenti
Riproduttivi e Familiari: Idee dal Recente Passato*

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Riassunto: si discute dei legami tra statistica e demografia, ponendo una particolare attenzione alla spiegazione dei comportamenti familiari e procreativi. In particolare, si effettua una rassegna critica e un’analisi delle fonti utilizzate per lo studio dei comportamenti demografici, dello sviluppo di un’impostazione teorica prevalente, l’approccio del corso di vita, e del rinnovato legame tra la statistica e la “nuova” micro-demografia a scopo esplicativo. Alcune prospettive per il futuro sono fornite, con specifico riguardo ai legami tra statistica e demografia nel contesto italiano.

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1. Introduction

When making references to their historical origin, it is not at easy to distinguish the one of statistics from the one of demography. This is nevertheless not the only reason for which, in the Italian academic and scientific tradition (similarly to other, but not to all, traditions), demography has been considered as part of the general family of statistical sciences. Italian demographers thus actively contribute to the work of the Italian Statistical Societies. In order to discuss about the strength of the ties between statistics and demography, I will focus on two keywords: *sources* and *methods*.

The creative use of existing *sources* has been fundamental at the birth of demography (and statistics), with John Graunt (or, according to some historians, William Petty), and the life table. The discussion on sources, with specific attention to official and other administrative sources, still occupies the first chapter of all introductory textbooks in demography. The solid and in-depth analysis of the quality of data sources is still a main concern in population studies (in what follows, we shall use “population studies” as a synonym of “demography”). The largest demographic research institution in the world, the French National Institute of Demographic Studies (INED), encourages some of its best researchers to spend

a period of about three years at the French National Statistical Office (INSEE) in order. This follows from the idea that getting one's hands "dirty" with the production of real data is a key part in the trajectory of a top-level demographer. We can only but agree with INED's spirit, although also the advantages for INSEE in terms of innovativeness have to be acknowledged. Whereas introductory textbooks can see sources as exogenously given to demographers, this attitude would be a serious flaw if taken literally by researchers. As researchers, we should always challenge existing sources, and, as I shall say in the remainder of this text, this is particularly true if we want to explain demographic behaviour.

For what concerns *methods*, during the last decades we observed what Courgeau and Lelièvre (1996) termed "a paradigm shift in demography". Together with the (sometimes complex) description and monitoring of macro-level trends in population dynamics, with a special emphasis on the quality of existing data, micro-demography has grown up rapidly. Micro-demography, or paraphrasing economics, micro-founded demography, has occupied an increasingly larger territory within population studies. Together with the development of new data sources of primary interest (sample surveys with a dynamic reconstruction of event histories, either retrospective or prospective), and the use of new statistical techniques, micro-demography has added to description and monitoring a strong push towards the explanation of demographic behaviour. New micro-level statistical techniques are sometimes analogous to those used for the macro level (i.e., life tables built starting from micro-level data and not from aggregate-level statistics). With the push towards explanation, the link with neighbouring disciplines - in particular economics and sociology but also policy analysis, epidemiology - has become crucial. The link with the interdisciplinary approach to the study of human behaviour known as the *life course approach*. It is not by chance that 80% of the papers presented in the 2005 bi-annual gathering of Italian demographers (the "Giornate di Studio sulla Popolazione" organised by GCD-SIS in Padua), were based on micro-level data (Dalla Zuanna, personal communication).

In this paper I would like to reflect on the implications of the trend towards explanatory micro-demography by starting from a critical review of what has happened during the last decades, with a specific emphasis on the role of statistics. I will focus my attention on fertility and family behaviour, leaving out the study of mortality, biodemography of reproduction, migration. More specifically, in Section 2 I will describe and discuss the developments concerning data sources for the study of demographic behaviour. In Section 3 I will discuss of the theoretical basis for the development of micro-demography. In Section 4 I will touch the renewed strong link between statistics and demography. Section 5 includes a summary and some considerations on future directions for demography and demographers.

2. Once we used official ones: the data sources

Official sources of administrative data, on both stocks and flows of population, are the traditional ones in the study of human population. This is especially clear when we have a look at introductory textbooks. The population census is one of the sources “by default”, even if scientific publications on top demographic journals based on census data (especially on aggregate-level census data) are increasingly more infrequent. For what concerns Italy, the delayed availability of census data, and in particular of micro-level census data, may explain the scarce use of this traditional source for scientific publications; this goes hand in hand with the speed of change in a population shaped by a significant inflow of in-migrants. The availability, and above all the easy and decentralised accessibility, of census data is a crucial issue. The IPUMS project (Minnesota Population Center, s.d.) puts on the internet samples of micro-level census data for free; for this reason the website of the IPUMS projects cites more than 1,800 publications using the U.S. version. Considering flow data, a significant amount of research has been produced using population registers linked to various sources, particularly in Nordic countries. The Nordic school has put a specific emphasis on the longitudinal micro-level reconstruction of demographic behaviour and on its explanation based on linking other registers, using a personal identification number that is similar to the “fiscal code” used in Italy. The results obtained in explaining the contribution of economic factors to demographic choices have been, for example, remarkable (see, e.g., Hoem, 2000). In Italy, the only similar source is the Turin Longitudinal Study, with a record linkage between population census and register in a single municipality (Turin). Besides some monitoring results on fertility (Billari et al., 1999), this study has allowed to build an explanatory approach to the interaction between fertility and short-range migration (Michielin, 2004). The Turin Longitudinal Study is, however, a rather isolated case in the Italian context.

We may say that, given the new chances offered by new statistical techniques of analysis (see below) and by computing power, traditional statistical sources of population stocks and flows have not proved to be adequate for two new, strictly interrelated, needs coming from population sciences: explaining demographic behaviour on the one side, and evaluating the impact (past and potential) of socio-economic and policy change on demographic behaviour. Having said this, traditional sources are still rather underexploited as the origin of demographic monitoring. A recent and welcome development in Italy is the quick and easily accessible (in two languages) demographic monitoring system developed by ISTAT (<http://www.demo.istat.it/>).

Let us however go back to the new needs. Why did such needs emerge within the demographic community? Possibly, a competition issue has been of central importance: scholars of neighbouring disciplines, and in particular economists and sociologists, have started to try and explain fertility and family behaviour. We shall go back to this point later, but the push from Becker and the now wide field of “Population Economics” and the one from the interdisciplinary life course approach have been crucial. Demographers today, I shall say fortunately, cannot

avoid trying and explaining, from a scientific perspective, demographic behaviour. For this reason, in demographic research, and even more so when fertility and family behaviours are concerned, sample surveys have started being the most important sources. I am not the first one to notice this: twenty years ago, Paolo De Sandre (1986) discussed the central role of theory-based sample surveys in the explanation of fertility choices. Before this paradigm shift, sample surveys were considered as a way to obtain estimates of indicators when the universe was not reachable or too costly to reach. Today, theory-based sample surveys are the main source for the explanation of demographic behaviour. The development of retrospective and prospective surveys has gone hand in hand with the development of a theoretical perspective (leading to the creation of micro-demography) and the development of appropriate statistical techniques. We shall get back to these points in the following sections. We now focus on sources, and emphasise also in this case the importance of exogenous pressure on demography, and especially on Italian demography. Large-scale comparative demographic surveys have been pushing competition in research and setting standards of best practice.

During the '70s and the '80s of the last century, the World Fertility Survey project pushed towards the systematic collection of retrospective event histories. Italy participated to the project with the First National Fertility Survey (INF-1). The next wave of internationally comparative surveys, i.e. Fertility and Family Surveys (FFS), has developed from a strict link to the life course approach and has pushed the systematic collection of retrospective event histories not only concerning demographic choices. In Italy, FFS was implemented with the Second National Fertility Survey (INF-2), in 1995-96. The full implementation of the survey and the strong links with statistics have put Italian demographers at a competitive edge within the international research community, at least for what concerns methodological issues.

At the end of the FFS project, some demographers who had been in frequent contacts with neighbouring disciplines expressed some dissatisfaction with the way FFS implied that event histories had to be explained by other event histories only. John Hobcraft and Ron Lesthaeghe, at the final "Flagship" conference of the project, advocated for demographic surveys also containing explanatory variables concerning economic and ideational factors. Hobcraft, in particular, asked to "move beyond elaborate description" towards understanding choices, opportunities and constraints (Hobcraft, 2002). For this reason, also making use of experiences at the national level, the new series of demographic surveys comes under a specific program, and it is labelled *Generations and Gender Surveys* (GGS) (see, e.g., United Nations, 2005): a survey mixing retrospective reconstruction and prospective (panel) approach, together with a multilevel framework with the construction of a contextual database. More specifically, "The Generations and Gender Programme (GGP) is a system of national Generations and Gender Surveys (GGS) and contextual databases, which aims at improving the knowledge base for policy-making in UNECE countries. The GGS is a panel survey of a nationally representative sample of 18-79 year-old resident population in each participating country with at least three panel waves and an interval of three years

between each wave. The contextual databases are designed to complement the micro-level survey data in multi-level analyses” (from the GGP Programme Summary). It is unfortunate that Italy has not yet been in the position to implement a full-fledged GGS, even if ISTAT has made big efforts in making the standard household survey as close as possible to the GGS. Without fully taking part in the GGP, Italian demography risks losing the opportunity to continue being competitive at the international level.

3. Once we were describing trends: the development of micro-demography oriented towards explanation

The success of “micro-demography” can be strictly linked to three main factors: the development of data collection efforts (see above), the development of appropriate statistical tools (see below), and the emergence of *life course approach* as an interdisciplinary program of study in the social and behavioral sciences (see e.g. Dykstra and van Wissen, 1999). The life course approach has been under development since the mid-1970s (Mayer and Tuma, 1990). In their end-of-millennium review, Giele and Elder (1998) identify four chief elements as fundamentally shaping individual biographies; the first three are individual development (human agency), history and culture (location in time and place), social relations (linked lives). The intersection of such elements constitutes the fourth chief element: the timing of lives. The key elements outlined by Giele and Elder are naturally linked to notions used to define the coordinates of populations in demography. The human agency concept lies behind the use of *age* as a privileged time axis. Location in time and, to an extent, the idea of linked lives suggests *cohorts* or groups of cohorts as basic descriptive units for comparison. History and culture emphasize the importance of *period* and *location* in space. As events lie at the very heart of the tradition of demography, it is not a surprise that the life course approach has been particularly influential in demographic research both from a substantive point of view (Dykstra and van Wissen, 1999) and from a methodological point of view, with a field of *life course analysis* emerging as an important part of research in population (Billari, 2003). Nevertheless, and differently from the conceptual frameworks developed in rational choice sociology or in economics, the life course approach does not explicitly provide a model for the micro-to-macro link, i.e. a scheme including a transformational mechanism. For this reason, the diffusion of the life course approach has so far probably contributed to widen the gap between scholars focusing on macro-level issues and those focusing on micro-level issues.

An important discussion of the tensions between what we may call “macro-demography” and “micro-demography” is made by Ronald Lee (2001). Lee mentions that “Demography is changing in profound ways, in its methods and topics of research, and in its training. There is less aggregate level (macro) analysis and more individual level (micro) analysis. There is less emphasis on process and dynamics, and more emphasis on individual decisions about demographic behavior.

There is less formal demography, and more data analysis. There is much less funding of aggregate demography and formal demography, and much more funding of micro level empirical studies. Formal demography is not the same thing as aggregate or macro demography. There is also micro level formal demography, and much formal demography integrates micro and macro approaches. But for the most part, when I refer to formal demography, I will have in mind either macro level or integrative formal demography.” (Lee, 2001, p. 1). Lee connects the rise of “micro-demography” to some factors, of which some are important for our argumentation here. First, the increasing availability of survey data, contrary to the past—when data were mostly arising from aggregate-level population statistics. Second, the importance of the links with economics, and in particular the development of the New Home Economics approach centered on the work of Gary Becker. Third, the links with other disciplines have pushed demographers to try to communicate as much as possible with colleagues from neighboring disciplines, and as we have seen before micro-foundations have become important in neighboring disciplines. The conclusion by Lee is that demography is abandoning its core, mostly macro and mostly formal, and that this is a danger, as “key issues are macro demographic” (Lee, 2001, p. 3).

To sum up, the development of micro-demography may be lacking the links to macro-level population dynamics: how to bridge micro- and macro-demography? Due to space limitations, the reader can only be referred to Billari (2006a), from which this section is drawn, for possible answers.

4. Once we were “the same thing”: the renewed relationship between statistics and demography

Macro-level demography has faced, also during the recent years, some important developments also thanks to its links with statistics. Age-period-cohort models have been used to analyse macro-level demographic data by decomposing the effect of the main traditional “explanatory factors” of demographic change (see, e.g., Wilmoth, 1990). In the field of demographic forecasting, the area of stochastic, or probabilistic, population forecasts has been rapidly developing during the last decade; recent reviews on this area can be found in Lutz and Goldstein (2004), as well as in Alho and Spencer (2005). We now turn to the specific links between demography and statistics along with the developments of micro-demography.

The approach developed for the analysis of demographic rates was specifically aimed at the analysis of homogeneous groups in a population (Henry, 1972), though Louis Henry took heterogeneity into account in his analysis of the components of fertility. The importance of heterogeneity beyond traditional variables such as age, sex, cohort, and period was recognized by actuaries as early as the 1930s (Perks, 1932). The work of Vaupel and his colleagues (see, e.g., Vaupel et al., 1979) has shown that ignoring changes in the composition of a cohort leads to wrong inference about the dependence on age of the force of

mortality. Since then, the importance of micro-level variation in frailty (also known as unobserved heterogeneity) has become primary in the interpretation of changes in demographic rates; as we shall see, this has been a key issue since the late 1970s also for the statistical analysis of micro-demographic data

The success of micro-demography is even more linked to what we could define as the new statistical approach to demographic data: *event history analysis*. Although event history analysis clearly shares common origins with formal demography and in particular with life tables—see e.g. the title of the widely cited paper by David Cox (1972), “Regression models and life-tables”, its development in the 1970s has been very much independent on progress in formal demography, with some exceptions. Early links between event history analysis and formal demography from the probabilistic and statistical point of view have been present in the work of Jan Hoem (see e.g. Hoem, 1987; Borgan and Hoem, 1988). The general idea of Hoem’s approach was to show that macro-level quantities actually used in formal demography could be embedded in a probabilistic setting, and thus be naturally linked to regression models. These regression models could be linked to indirect standardization techniques, focusing on counts, or to micro-level event history models. In their 1989 manual “Event history analysis in demography”, Daniel Courgeau and Éva Lelièvre linked event history analysis to formal demography, explicitly saying that the move from longitudinal analysis in formal demography to event history analysis marked a paradigm shift in demographic research. Since then event history analysis had an important impact on demographic research, an impact that is likely to have triggered reactions like the one documented in Section 1 by Ron Lee, given a possibly excessive focus on the micro side. Also relevant is the fact that some methodological contributions of Italian scholars on event history analysis (Billari, 2001; Rosina, 2006), on heterogeneity (Barbi et al., 2003), and on algorithmic methods for life course analysis (De Rose and Pallara, 1997; Billari and Piccarreta, 2005) have been published in top-level international demographic journals. In some cases, this has been the outcome of collaboration between a demographer and a statistician.

The diffusion of event history analysis as the main technique for micro-demography has taken advantage from the theoretical basis of the life course approach, including the explicit reference to age, period, and cohort as key dimensions of that approach. The link was evident especially among scholars on the border between sociology and demography. Mayer and Huinink (1990) for instance, discussed the use of event history analysis to estimate age, period and cohort effects—seeing event history analysis as a “farewell to Lexis”, implying that in the era of micro-level data age-period-cohort analysis would have overcome its classical problems deriving from the use of macro-level data.

Fortunately, although the focus of studies using event history analysis has mainly been on the micro-level, some more recent studies have included macro-level determinants in a multilevel setting. Earlier papers have included macro-level covariates in micro-level event history models. Blossfeld and Huinink (1991) included a measure of the business cycle in an event history model of the timing of first marriage and of first birth. Later on, event history models have been

generalized for the inclusion of unobserved heterogeneity at the aggregate level, creating fully multilevel event history models (Courgeau, 2003). These models have recently been systematized in their discrete-time version (see e.g. Barber et al., 2000) and in their continuous-time version, with a generalization to multilevel and multiprocess event history models (Lillard, 1993; Lillard and Panis, 2004).

An important impact triggered by the development of multilevel event history analysis has been on data collection. More advanced demographic data collection efforts that are based on micro-level data, e.g. getting information via individual- or household-level interviews, are more and more oriented towards the collection of macro-level data, including time-varying macro-level data. Axinn et al. (1997), with their “Neighborhood History Calendar”, design an instrument that is aimed at collecting neighborhood- or community-level histories to be used as inputs in multilevel event history models. This instrument could provide useful retrospective reports of a community history. The need to complement micro-level histories with macro-level time-varying data has been influencing the idea of the GGP to complement the GGS survey with a contextual database.

The “multilevel and multiprocess” event history modelling proposed by Lillard and Panis has been particularly influential as a way to assess causality within the life course, by evaluation of the impact of changing covariates (including those related to other life course trajectories) on the hazard of experiencing an event, by controlling for possible common, time-constant, factors that influence a set of hazard rates. Coppola (2004) has used this approach to model the relationship between education and union formation.

Unravelling causal links controlling for observed and unobserved spurious factors is the primary focus of another approach, which originates from the – mostly econometric – literature focusing on program evaluation from observational data. In program evaluation, the main task is to estimate the impact of participating in a certain policy program, the treatment, on a specific outcome. This estimate is used as a support for policy decisions. Two key issues arise. First, to illuminate policies, one wants to isolate the causal impact of a certain program from other effects that link the program with the outcome. Second, because for cost-benefit evaluation the size of the causal impact, and not only its direction or statistical significance, matters, the emphasis on minimizing estimation bias is usually stronger than in traditional life course analysis.

The characteristic problem in program evaluation is that participation into a program is voluntary and can be due to factors that are themselves correlated with outcomes. Thus, we face a similar situation when we want to evaluate the impact on some outcome measure of life course events. Life course events are subject to choice, and factors leading to choices may be influencing the outcome as well. Although in some situations experimental designs are also feasible, we here focus only on observational, non-experimental studies. The basic “evaluation problem” or the “fundamental problem of causal inference” (Holland, 1986) is that to truly know the effect of a certain event (e.g., the participation into a program), we must compare the observed outcome of an individual who has experienced the event of interest with the outcome that would have resulted had that person not

experienced the event. Equivalently, we must compare the observed outcome of an individual who has not experienced the event of interest with the outcome that would have resulted had that person experienced the event. This “counterfactual” outcome cannot be observed, and all approaches developed in the program evaluation literature aim at providing an estimate of the counterfactual and at using this in order to identify the causal effect of an event. In addition, the impact of an event can be different across different groups of a population.

To estimate treatment effects controlling for from observational studies, there are three approaches in the literature. First, one can use data on highly related individuals, usually twins, and exploiting the variation between them; twin data however are not widely collected and the results are not always easy to generalize. Second, one can use an instrumental variables (IV) approach, looking for variables that are good predictors of the event of interest but are not related to the outcome measure. This approach is hardly feasible when dealing with life courses, and the most promising avenue uses instrumental variables to estimate bounds of causal effects. The third approach is the most promising for life course research, propensity scores matching, originally proposed by Rosenbaum and Rubin (1983), with the matching of treated and untreated individuals according to observed covariates summarized in a “propensity score”. The use of matching on propensity score permits to reduce the bias due to observed variables influencing both the probability of experiencing the event of interest, and the outcome (Rosenbaum and Rubin, 1983). To control for fixed unobserved characteristics influencing both the potential “cause” and the outcome, it is necessary to use other techniques usually relying on longitudinal data. For instance, instead of the difference in outcomes between treated and untreated one can estimate the difference-in-differences between treated and untreated. Aassve et al. (2005) use difference-in-differences estimators combined with propensity score matching techniques to find that hat independently of how well-being is defined, childbearing events never have a positive impact on individuals’ material well-being. The negative impact might however be buffered by welfare.

5. Summary and discussion

We have outlined the development of micro-demography, focusing on the study of fertility and family behaviour. We have mentioned three key factors favouring the emergence of micro-demography to being the main approach nowadays used in research concerning human population. First, the increasing availability, and accessibility, of sample surveys, some of which are longitudinal and/or internationally comparable. Second, the competitive pressure from neighbouring disciplines, which has forced demography to adopt a theoretical approach to the explanation of demographic choices, namely, the interdisciplinary life course approach. Third, the diffusion of new statistical techniques that help in explaining demographic choices and in evaluating the causal impact of such choices and/or or interventions possibly affecting such choices.

We now end with a short reflection on the future of demography, focusing again on fertility and family and on the Italian setting. First of all, the future of demography is indissolubly linked with the continuous development of theory-based surveys; this direction had been signalled already twenty years ago by Paolo De Sandre (1986). These surveys have to be easily and quickly accessible to the research community, with a transparent development of the main instruments; a fully-implemented large-scale panel survey (such as the GGS) for Italy will contribute significantly to the explanation of demographic behaviour. We face the risk of not being able to cope with the international-level competition in research, which constitutes, hopefully, a positive factor pushing our ambitions upwards. Second, demographers will need to continue interacting with researchers from other behavioural disciplines, and in particular economics and sociology. However, the life course approach with its interdisciplinarity is already a “mainstream” in demography, and this should shape the training of new researchers. Third, and last, for what concerns the links between demography and statistics, a robust preparation in statistics for demographers (including some issues that are more frequently dealt with by econometricians) as well as a mutual contact between demographers and statisticians should be continued. The situation, from this point of view, gives some competitive advantage to the Italian school within the international arena. For this reason, I may conclude with an optimistic view towards the future.

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