Chapter 13
On Teaching Demography: Some Non-traditional Guidelines

13.1 Introduction

I am grateful to Frank Trovato for the opportunity to discuss some of my recent writings on scientific methodology – on the relations among theory, models, and data – and on their implications for the teaching of demography. I am particularly pleased to get the reactions of such distinguished panelists. I am confident that by the end of the session, my thinking will have been clarified and, where necessary, corrected, and that I shall go away with new insights. These are difficult issues on which there seldom is consensus. Only occasionally do I have a sense that I have got it just right.

I have always felt that demography needed more and better theory. Until just a few years ago, I attributed the status of theory to simple neglect and to lack of sufficient interest – an opportunity cost, one might say, of demography's heavy emphasis on data, techniques, and empirical description (Burch 1996). I now believe that the problem goes deeper, and is due to the influence of a misleading philosophy of science that has dominated twentieth century empirical social science in general and demography in particular. This view is the logical empiricism of Ernest Nagel and Carl Hempel, combined with the ideas of Karl Popper on falsification, and with deeper roots among scientists of the nineteenth (for example, Ernst Mach) and early twentieth centuries (for example, Karl Pearson).

13.2 Logical Empiricism

The central difficulty lies in logical empiricism's view of the nature of theory and its relations to empirical data. In the logical empiricist program, it is empirical generalizations or 'laws' that provide the foundation for theoretical propositions, arrived at by a process of induction – from particular cases to more general theory.

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The process can go through several levels, from empirical generalizations to so-called 'middle-range' theory, up to the most general and abstract theory. The relations between empirical data on the one hand and theoretical propositions on the other are purely logical. A valid proposition is one that is consistent with the data.

In this system, explanation of a phenomenon is achieved by subsuming it under some general law – thus the term the 'covering law' approach to explanation.

In many versions of logical empiricism and frequently in research practice, an empirical generalization or a theoretical proposition will be rejected ('falsified') by the discovery of empirical data that do not support the generalization – exceptions, 'counter-examples,' negative findings, etc. A classic case in demography is the frequent rejection of demographic transition theory due to exceptions discovered in detailed historical research.

A central feature of the logical empiricist approach is that theory is a superstructure derived from and therefore limited by empirical findings. In demography, this feature finds expression in the heavy reliance on statistical models, which have no place for unmeasured (directly or indirectly) variables.

Among the many difficulties with this approach identified by scientists and by philosophers of science, two stand out:

1. There are few broad empirical generalizations (without exceptions) and hardly any universal generalization in social science, so that the foundations on which to build theory in this way are sparse and weak.
2. The acceptance or rejection of a theoretical idea is unrelated to the specific purpose or purposes for which it is to be used. A theory is or is not logically consistent with the data; such logical consistency is the sole criterion for acceptance.

Some social scientists have come to see logical empiricism as a frustrating and self-defeating approach. Not a few philosophers of science have argued, and some physical scientists have testified on their own behalf, that logical empiricism does not describe how they actually work. Roger Newton, writing about Isaac Newton's laws, comments '...Newton's laws of motion are not simply inductive consequences of observations but are products of a very fertile imagination' (Newton 1997, p.15).

13.3 An Alternative to Logical Empiricism

An alternative view is found in many quarters but is not the mainstream view in contemporary demography. Theoretical economics provides a partial departure from the above characterization of logical empiricism. Its central theory is derived from axioms, but its development and range have been cramped by rigid adherence to a limited axiom set. The political scientist Eugene Meehan outlined an alternative approach as early as 1968 (*Explanation in Social Science: A System Paradigm*). Nathan Keyfitz did much the same in his 1975 paper 'How do we know the facts of demography?' Hedstrom and Swedberg (1998) have advocated a return to ‘middle-range’ analytic theory, again in an approach that departs sharply from logical empiricism.

An influential school of contemporary philosophy of science (the ‘semantic’ school) has elaborated ideas similar to those of the authors just mentioned. An accessible and authoritative work is by Ronald Giere (1999). Giere call this alternative view a ‘model-based’ view of science. For Giere, the prototype of scientific knowledge is not the scientific law, but the theoretical model plus a list of cases to which it applies. In this approach, a theory or theoretical model – the distinction is seen largely as one of scope – is constructed in such a way that it is formally true, in Giere’s words ‘true in the same way that a definition is true.’ The model consists of clear concepts with well-specified relations among them, forming a logically consistent and coherent system. It is this clarity and coherence that yields a model’s analytic power. The empirical question, then, is not whether a model is true or false, valid or invalid – it is true by definition. The relevant empirical question is whether it fits some empirical phenomenon, some well-described part of the real world (a) closely enough (b) in certain respects (c) to be useful for some well-defined purpose – prediction, explanation, intervention and control, and – especially relevant to today’s topic – teaching. If a model does not meet all three of these criteria, then it is not used, but it also is not rejected as a theoretical model that may well prove useful for other purposes in other contexts. If it fits well enough, then it is considered acceptable for the purpose at hand.

Theory is viewed not as Truth, but as an analytical tool. Taken as a whole it constitutes a toolbox of many theoretical models, some simple, some complex, some useful for one purpose, another for other purposes. It is these tools, so long as they are fashioned with clarity, rigor and logical consistency, that give theory its analytical, predictive, and explanatory power.

Where do data and empirical research fit in? Empirical work is needed first of all the to give an accurate description of some phenomenon or some portion of the real world. Secondly, it is needed to test how well one or more of the seemingly relevant theoretical models fits that portion of reality – goodness of fit, but in a much broader sense than in statistical modelling. Finally, if empirical generalizations on the topic at hand exist, there is nothing to prevent their incorporation into the model itself.

In this model-based approach, theory is a response to empirical data, but is not derived from and therefore limited by data. The construction of theoretical models is an act of creative imagination.

In this view, demographic transition theory, especially if it were stated more rigorously, would be seen as a perfectly good and useful theoretical model, even though it does not fit some cases (e.g., France) very well, in respect to the relative timing of fertility and mortality decline. But it fits a large number of historical cases well enough for us to assert with confidence, for example, that any highly developed human society (by the conventional definitions of development) will have low fertility.

13.4 Questioning the Formal/Behavioral Distinction

This view of scientific theory has many implications for how we view and teach demography. One of the most important is that it erases the traditional sharp distinction between formal demography and population studies, based on the distinction between necessary and contingent relationships. With respect to theory, in the model-based view, all theoretical models and theories are formal, that is, true by definition.

It is customary in demography to consider formal demographic models as expressions of necessary relationships, for example, the fundamental demographic equation, or the stable model. Behavioral models such as transition theory or microeconomic models of demographic behavior are seen as involving contingent relationships, which must therefore be tested against data.

In the model-based view, however, a behavioral model can and must be stated in such a way that it is formally and necessarily true. The logistic model of population growth, for example, assumes linear relationships between population density and both mortality and fertility. The classic transition model assumes strong relationships between development and both mortality and fertility. These relationships can be precisely specified, even if they seldom are. Are the relations between density and birth and death rates, or between development and birth and death rates necessary or contingent? The answer is that they are contingent in the real world, but necessary in the model – assumed, given, defined – true in the way that definitions are true.

Thus, the exponential equation $P[t] = P[0]e^{rt}$ is a theoretical model, a formal representation of the inherent nature of the growth of a biological population. No one would question the validity of this functional definition. Empirically it may or may not provide an accurate account of real world populations; over some specified period, some populations may grow approximately exponentially. But for many populations the model will not be even close. By this same reasoning, the life-table or the cohort-component projection models can be seen as theoretical models of population dynamics, as well as a measure of mortality and a forecasting tool respectively.

On the other hand, a simplified version of the Easterlin economic model of fertility and fertility control can be stated in such a way that it is true by definition:

Definitions:

-> Motivation = expected minus desired surviving children
-> Costs = money, time, effort, and ‘psychic’ costs

Propositions:

{-> IF motivation > costs of control, THEN fertility control will occur}
{-> IF motivation < costs of control, THEN fertility control will not occur}

The brackets suggest that this is a definition of a function, although not yet a mathematical function (although it could be developed into one). The model is true by definition and therefore completely general. Whether it applies to any particular real-world system is an empirical question.

By this same reasoning, many other behavioral models in demography can be stated in such a way that they are formally true – transition theory, Lee's model of migration, Hernes' model of first marriage, and Coale- and Hoover's model of population and development, to give only a few familiar examples.

One of the advantages of this perspective is that many older, simpler models – often discarded or neglected – are retained as useful tools.

13.5 Concluding Comment

There is a paradox in all of this. Many of our demographic techniques are elevated to the status of theory, while theory is downgraded to an analytic tool, a thinking technique. But the model-based approach may offer a better way to advance demography as a science. To be faithful to the spirit of the model-based view, of course, we must not advance it as the only useful model of how science works or should work. There may be scientific laws (universal or nearly universal empirical generalizations) even in the social and behavioral sciences, so that there may be topics for which the logical-positivist approach to theory and explanation will work. But for demography now, I suggest that a model-based view will provide a liberating and more fruitful approach to theory, modelling, and demographic explanation. It also has many implications for the teaching of demography, some of them at odds with current practice. I have discussed these at length elsewhere (Burch 2001a, b and Chaps. 11 and 12 above), and shall only summarize them here by appending a statement of ten principles for teaching basic demography. These principles or guidelines are suggested by the approach to scientific methodology sketched above. They also are consistent with pedagogical practice in well- developed physical sciences, notably physics. Several of them correspond closely to the characteristics of teaching in the physical sciences outlined by Stephan and Massey (1982) in their thought-provoking paper on teaching undergraduate sociology.

13.6 Ten Principles for Teaching Basic Demography

1. Put more emphasis on theory, that is, abstract models of population dynamics and demographic behavior. Teach demography as a body of theoretical knowledge, as well as a body of data, techniques, and descriptive findings.
2. Retain and develop older and simpler – even 'oversimplified' – models insofar as they contain valuable insights that can help students begin to understand how populations work.

3. Put more emphasis on student activity – getting them to use the theoretical models that have been learned to solve real-world (or at least realistic) problems and exercises. The goal is the development of the student's ability to reason demographically, to explain, predict, or suggest policy interventions.
4. Set problems and exercises that lead students to face the limitations of available models, and to try to construct better ones. Allow students – even encourage them – to be theorists.
5. Require students to have or to learn the tools needed for rigorous reasoning in the use of analytic models. The classic tool is mathematics. A more flexible and accessible tool for many demography students (notably in sociology departments) is some form of computer modelling, notably systems dynamics.
6. Integrate 'formal demography' or 'techniques' with 'substantive' or 'behavioral demography' in the same course, rather than in distinct courses.
7. The basic principles of demography (technical and behavioral) must be taught or assumed in every demography course. Otherwise, it is not a demography course.
8. For efficiency and understanding, teach the most basic and general principles first. For example, subsume many of the standard demographic measures under the concepts of weighted sums or averages. For another example, present e_0, TFR and the singulate mean age at marriage as measures of the area under some curve, not as three totally disparate measures.
9. For beginning students, put less emphasis on data collection, errors in data, and the most precise techniques. This is not a counsel of sloppiness. It is not sound pedagogy to immerse students in data-collection techniques and discouraging claims about errors, at the expense of substantive ideas.
10. Since many demographic models lend themselves to visual representation, use more diagrams in texts and lectures. Use visual representation for ideas, not just for graphing data.

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