

POP 502 / ECO 572 / Soc 532
Research Methods in Demography

Spring 2017

Germán Rodríguez grodri@princeton.edu

Yo-Yo Chen sc37@princeton.edu

<http://data.princeton.edu/eco572>

This course deals with classical demographic techniques used in the study of population, including general methods such as standardization and smoothing; techniques designed specifically for the analysis of mortality, nuptiality, and fertility; deterministic and stochastic approaches to population projections, and the stationary and stable population models. We pay attention to the quality of data from vital registration, censuses and surveys. While the coverage focuses on traditional demographic approaches, we also provide an introduction to relevant modern statistical methods. *Prerequisite:* Pop 501 and a statistics course at the level of wws507c.

List of Topics

In the list that follows each topic corresponds roughly to a week.

1. Introduction, Rates and Standardization

The subject of demography. The balancing equation. The Lexis diagram. Age, period, and cohort. Rates and probabilities. Rates of growth. Doubling time. Age-specific rates. Direct and indirect standardization. The standardized mortality ratio. Decomposition of differences in rates.

2. Interpolation and Graduation

Age heaping. The Myers index. Scatterplot smoothers. Running means and running lines. Regression and smoothing splines. Spline interpolation. Application to fertility rates. The human fertility database.

3. Mortality

Continuous-time life tables. The hazard and survival functions. Expectation of life. Period life tables. Common approximations. The human mortality database. Cohort survival and the Kaplan-Meier estimator.

4. Survival Models

Parametric models: exponential, Weibull, Gompertz. Model life tables: The Brass relational system. The Coale-Demeny families. Life tables with regression and Cox's proportional hazards model.

5. Unobserved Heterogeneity

Unobserved heterogeneity of frailty. The gamma and inverse Gaussian distributions. Non-parametric frailty. Identification issues in single-spell models. Multivariate survival.

6. Competing Risks

Modeling competing risks and the identification problem. Multiple decrement life tables. The associated single-decrement table. Applications to contraceptive effectiveness.

7. Nuptiality

Age at marriage and proportions married. Singulate mean age at marriage. Current-status life tables. The Coale-McNeil model. The Hernes model. Multi-state models. Increment-decrement tables.

8. Fertility Rates

Fertility rates. Age patterns of fertility. Henry's natural fertility model. The Coale-Trussell models of marital and general fertility by age. The Page model of marital fertility by age and duration. Models with covariates.

9. Birth Intervals

The components of a birth interval. The analysis of birth intervals using life tables. The quantum and tempo of fertility. Parity-specific rates or birth intervals? The proximate determinants of fertility.

10. Tempo Effects

Period versus cohort quantum and tempo. Ryder's demographic translation. The Bongaarts-Feeney adjustment. Applications to mortality. Competing measures of longevity: mean age at death, cohort average life, life expectancy, and the Bongaarts-Feeney adjusted life expectancy.

11. Population Projections

The cohort component method. The Leslie matrix. Stochastic projections. The Lee-Carter model of mortality. Extensions to fertility.

12. The Stable Population Model

Stable populations in discrete and continuous time. Lotka's renewal equation. Population Momentum.

Bibliography

Our main textbook is Preston et al., which we plan to follow closely, but you may find discussions in the other three books useful at times.

Keyfitz, N. and Caswell, H. (2005). *Applied Mathematical Demography*. Third Edition. Springer.

Preston, S. H., Heuveline, P. and Guillot, M. (2001). *Demography: Measuring and Modeling Population Processes*. Blackwell Publishing.

Siegel, J. S. and Swanson, D. A., editors (2004). *The Methods and Materials of Demography*, 2nd Edition, Elsevier Academic Press.

Watcher, K.W. (2014). *Essential Demographic Methods*. Harvard University Press.

Book Website

The following book, a compendium of useful techniques updating the famous United Nations *Manual X*, is available as a website at <http://DemographicEstimation.iussp.org>, as well as in pdf form.

Moultrie, T.A., Hill, A. G., Hill, K., Timaeus, I. M. and Zaba, B., editors (2013) *Tools for Demographic Estimation. Paris: International Union for the Scientific Study of Population*.

Articles

The following articles expand on some of the issues discussed in the text, venture into related areas, or have become classics. I also include some of my own writings.

Alho, J. M (1992). Modeling and Forecasting U.S. Mortality: Comment. *Journal of the American Statistical Association*, 87(419):673-674.

Arthur, W. B. (1981). Why a Population Converges to Stability. *The American Mathematical Monthly*, 88:557-563.

Bongaarts, J. (1978). A Framework for Analyzing the Proximate Determinants of Fertility. *Population and Development Review*, 4:105-132.

Bongaarts, J. (2015). Modeling the Fertility Impact of the Proximate Determinants: Time for a Tune-up. *Demographic Research*, 33:535-560.

Bongaarts, J. and Feeney, G. (1998). On the Quantum and Tempo of Fertility. *Population and Development Review*, 24(2):271-291. See also Reply on 26(3):560-564.

Coale, A. J. and McNeil, D. R. (1972). The Distribution by Age of the Frequency of First Marriage in a Female Cohort. *Journal of the American Statistical Association*, 67:743-749.

Coale, A. J. and Trussell, J. (1974). Model Fertility Schedules: Variations in the Age Structure of Childbearing in Human Populations. *Population Index* 40, pp. 185-201.

Cox, D. R. (1972). Regression Models and Life-Tables (with discussion). *Journal of the Royal Statistical Society, Series B (Methodological)* 34(2):187-220.

Kim Y. J. and Schoen, R. (2000). On the Quantum and Tempo of Fertility: Limits to the Bongaarts-Feeney Adjustment. *Population and Development Review* 26(3):554-559.

Hernes, G. (1972). The Process of Entry into First Marriage. *American Sociological Review* 37(2):173-182.

Kalbfleisch, J. D. and Prentice, R. L. (2002). *The Statistical Analysis of Failure Time Data*, 2nd Edition. John Wiley & Sons. (Chapter 8. Competing Risks and Multistate Models).

Kitagawa, E. M. (1955). Components of a Difference between Two Rates. *Journal of the American Statistical Association*, 50(272):1168-1194.

Lee R. L. and Carter, L.R. (1992). Modeling and Forecasting U.S. Mortality. *Journal of the American Statistical Association*, 87(419): 659-671. See also Rejoinder in 87(419):674-675.

Leslie, P. H. (1945). On the Use of Matrices in Certain Population Mathematics. *Biometrika*, 33(3):183-212.

Lesthaege, R. J. and Page, H. J. (1980). The Post-Partum Non-Susceptible Period: Development and Application of Model Schedules. *Population Studies*, 34:143-169.

McNeil, D. R., Trussell, J. and Turner, J. (1977). Spline Interpolation of Demographic Data. *Demography*, 14:245-253.

McNown, R. (1992). Modeling and Forecasting U.S. Mortality: Comment. *Journal of the American Statistical Association*, 87(419): 671-672.

Murray, C. J.; Ferguson, B.D.; Lopez, A. D; Guillot, M; Salomon, J. and Ahmad, O. (2003). Modified logit life table system: principles, empirical validation, and application. *Population Studies*, **57** (2) 165-182.

National Research Council (2000). *Beyond Six Billion: Forecasting the World's Population*.

Pullum, T. W. (1978). Standardization. *WFS Technical Bulletins*, 3. World Fertility Survey.

Rodríguez, G. (2006). Tempo Effects in Demography: An Accelerated Failure Time Perspective. *Demographic Research*, 14-6.

Rodríguez, G. and Cleland, J. C. (1989). Modelling Marital Fertility by Age and Duration: An Empirical Appraisal of the Page Model. *Population Studies*, 42:241-257.

Rodríguez, G. and Hobcraft, J. (1980). Life Table Analysis of Birth Intervals: Illustrative Analysis. *WFS Scientific Reports*, 16. World Fertility Survey.

Rodríguez, G. and Trussell, J. (1980). Maximum Likelihood Estimation of the Parameters of Coale's Model Nuptiality Schedule from Survey Data. *WFS Technical Bulletins*, 7. World Fertility Survey.

Ryder, N. (1964). The Process of Demographic Translation. *Demography*, 1(1):74-82.

Smith, P. (1979). Splines as a Useful and Convenient Statistical Tool. *The American Statistician*, 33:57-62.

Vaupel, J. W. (1986). How Change in Age-Specific Mortality Affects Life Expectancy. *Population Studies*, 40(1):146-157.

van Imhoff, E. and Keilman, N. (2000). On the Quantum and Tempo of Fertility: Comment. *Population and Development Review*, 26(3): 549-553.

Vaupel, J. and Yashin, A. (1985). Heterogeneity's Ruses: Some Surprising Effects of Selection on Population Dynamics. *American Statistician*, 39:176-185.

Vaupel, J.W., Manton, K. G., and Stallard, E. (1979). The Impact of Heterogeneity in Individual Frailty on the Dynamics of Mortality. *Demography*, 16:439-454.

Wilmoth, J. R; Zureick, S., Canudas-Romo, V.; Inoue, M, and Sawyer, C. (2012). A flexible two-dimensional mortality model for use in indirect estimation. *Population Studies*, **66** (1):1-28.