Journal of Economic Perspectives—Volume 5, Number 1—Winter 1991—Pages 171–179

Distinguished Fellow
An Appreciation of Guy Orcutt

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Guy Henderson Orcutt was born and grew up in Michigan, near Detroit, and had established a lifelong curiosity about how things work before he entered high school. His earliest efforts involved electrical devices and experiments, sometimes with explosive effects, but with continuing support and encouragement from his parents. His later efforts, as he progressed from engineering through physics to economics and econometrics, have given several generations of economists new ways to think about economic phenomena and new and better tools for investigating them. Guy has now moved to a new phase of his career and we can confidently expect further insights and inspiration from this distinctive and Distinguished Fellow of our Association.

Most of Guy's career has been at four universities: Michigan, where he earned all three degrees, Harvard, Wisconsin, and Yale. In between, he spent periods at MIT, Cambridge University in England, the International Monetary Fund, the World Bank, and The Urban Institute. To me, Guy is several persons rolled into one: inventor, visionary, empiricist, mentor and friend.

Inventor

Guy's colleagues will recognize his inventiveness as embodied in the microsimulation models he has developed. But many will not be acquainted with the hardware side of his early experience. His aspirations were in

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engineering as he began undergraduate study in 1936, when he had already built several devices for carrying out electrical experiments at home. He had also developed a glass device for delivering precise amounts of a liquid from a bottle to make his life easier in a post-high school job in a testing laboratory.

As he became more exposed to laboratory science in college and in summer jobs, Guy shifted his focus toward physics, mathematics, and logic. This shift reflected a growing interest in basic research. Despite these changes he completed his undergraduate studies in three years with a B.S. in physics. He began graduate work in economics in 1939. The shift into economics was motivated by the nation's economic hardship at the time, as he observed it in Michigan and in a summer work camp in the West Virginia coal fields. By this time, with some influence from his wife-to-be Geil Duffendack, who shared his scientific interests and had a vigorous sense of social justice, he had infused his scientific curiosity with serious social purpose.

The shift to graduate economics with no previous economics education required some catch-up and Guy devoured five undergraduate economics courses in his first semester of graduate study. With Arthur Smithies as mentor, and James Duesenberry and Daniel Suits as roommates, he made rapid progress. During the second year of graduate study Guy designed and built two "analogue electrical-mechanical" devices that could produce, given values for parameters and initial conditions, solutions to complex duopoly and spatial location problems. This was his first, and probably one of *the* first, uses of simulation methods and electrical machinery to generate specific solutions of economic models.

Turning to his dissertation research, after building (hands on) low-cost housing to accommodate himself and his bride, Guy became convinced of the urgent need for a stronger empirical basis for economic models. His 1944 doctoral dissertation, "Statistical Methods and Tools for Finding Natural Laws in the Field of Economics," was devoted to ways of discovering and testing relationships that might provide a credible basis for broader theoretical structures and deductions. The first part of that dissertation considered the complementarity of deduction and induction in economic science, problems in making inference from nonexperimental data, and tests of significance or serially correlated time series (which would be elaborated later). The second part contained the design of a new machine called a regression analyzer capable of computing the correlations and regression coefficients among several variables.

A prototype of the regression analyzer was finally constructed after Guy had accepted an appointment at MIT in 1944. That machine could handle up to three time series with up to 30 observations in each. Data were entered by punchcard and could be displayed in series or scatter diagram form on a cathode ray tube. The machine was sufficiently portable to be taken to Cleveland and demonstrated at the annual economics meeting in 1945. The device, as well as Guy's interest in autocorrelated time series, attracted the attention of Richard Stone, who invited him to visit Cambridge University, where a new Department of Applied Economics was just getting under way.

Guy Henderson Orcutt

The analyzer accompanied the young Orcutt family to England where, under the sponsorship of Stone, it was modified and became the subject, with photographs and circuit diagrams, of Guy's first scholarly publication (Orcutt, 1948). It was also used extensively in the Monte Carlo studies reported in Orcutt and James (1948). That work led in turn to the papers with Donald Cochrane (Cochrane and Orcutt, 1949; Orcutt and Cochrane, 1949) and the Cochrane-Orcutt estimation procedure for dealing with autocorrelated errors that is now, and will forever be, a part of every working econometrician's vocabulary.

But Guy's most important and influential invention lies in the conceptualization and implementation of microsimulation models in large-scale digital computers. He became convinced around 1950 that data aggregated to the national accounts level simply could not provide sufficient information for discovering the elusive secrets of the economy with enough reliability to be useful for policy guidance. Guy believed that a solid understanding of the behavior of microeconomic units—people, households, firms, school districts, and so on—had to be the foundation on which better models could be built. But more than a foundation was needed. In particular, consequences of policies toward individuals and firms may depend on how the impact of those policies is distributed among non-homogeneous groups. Aggregative time series typically do not capture these crucial distinctions. Even if robust behavioral relationships could be established at the microunit level, there remained the problem of aggregating those relationships and finding dynamic solutions that could lead to understanding the macroeconomic consequences of policies or other exogenous influences. The dynamic microsimulation model was Guy's answer to that problem.

The system Guy envisioned represented a convergence of ideas he had nurtured for some time with developments in data collection and computing that were emerging in the mid-1950s. The first was Monte Carlo simulation, which Guy had already used to explore the consequences of autocorrelation on regression estimates, but in the context of electrical analogue models rather than mathematical models to be simulated in a high speed digital computer. The second was his neoclassical economics training, which had inculcated an appreciation of market mechanisms for representing the interactions of many economic actors. The third, attributable to his early study of physics, was that the world is essentially recursive: response follows stimulus, however short the lag. Using recursive behavior as a starting point made possible the modeling and estimation of a system without the complication of simultaneity that is inescapable when working with annual series of highly aggregated economic data.

These ideas combined with two further developments that shaped Guy's research agenda (and that of many others) for many years. First, electronic digital computers had begun to reduce the cost of manipulating and analyzing large data files, and were becoming increasingly accessible to university researchers. Second, large data files containing data on households were being collected by the Survey Research Center at the University of Michigan, and these were also available to researchers. These developments enabled Guy to envision the possibility of using large samples of microunits to estimate behavioral relations and the use of the same or similar samples to represent entire populations in simulations—both aspects making heavy use of the new computing machinery. Estimated recursive behavioral equations would be used to simulate the period-by-period evolution of individual microunits and the resulting outcomes would be aggregated and interacted in simulated markets with the outcomes of other units, whether units of the same type (say other households) or other types (say other firms). Prices and other signals generated in the market process would then be fed back for their possible influence on the next round of simulation.

This structure was first described in Orcutt (1957) and a first implementation was begun around that time. The effort involved three doctoral students—Martin Greenberger, John Korbel, and Alice Rivlin—and several programmers including an undergraduate named Steven Goldfeld. This initial model was programmed before the appearance of FORTRAN. In each simulation run, it simulated the month-by-month progress of a sample of 10,358 persons through a ten-year period. The main focus of this model was on demographic processes (birth, death, marriage, divorce, and aging), labor supply, and education demand. The first results of microanalytic modeling are available in Orcutt et al. (1961).

As this basic idea has been elaborated over the years, Guy's inventiveness has found steady employment. He pioneered the use of models to analyze distributional impacts of policies. Those models have been refined by researchers in and out of government and are in steady use by policy analysts today. For Guy's part, the scientific curiosity which begets his inventiveness still runs strong as he continues to seek better ways of getting answers to questions about economic and social systems.

Visionary

As he was working through the first implementation of microanalytic simulation in the late 1950s, Guy realized that his vision could only come to full fruition within a research institute (perhaps more than one) dedicated primarily to building and perfecting microanalytic simulation models. Such an institute could bring together the computer hardware and software, the statistical and economic expertise, and the massive data sets that were becoming available. In such a context, and with adequate support assured for enough time to do a very large job, Guy was convinced that he could develop an empirically based micromodel, with both consumption and production sectors and with features that enabled analysts to simulate the consequences of a wide range of economic policies. Such a model would directly compute the macroeconomic implications of microeconomic behavioral relations.

During 1958 he had a chance to start building such an institute. He received an offer from the University of Wisconsin in Madison to join the Economics Department and was also offered both encouragement and seed money to develop the kind of institute needed to carry forward the development of microanalytic models. In the fall of 1959 the Social Systems Research Institute (SSRI) was launched. Over the next several years, it would substantially change the face and facilities of Wisconsin's social science departments. More than a dozen appointments were made in economics alone, a statistics department was established, and the computer center and computer science departments were strengthened. An eight-floor addition to the Social Science building was added in the early 1960s to accommodate the SSRI, three social science departments, and the Wisconsin Survey Research Laboratory.

Guy's vision was extraordinarily successful in building an institution. By 1965 the SSRI could claim a score of books, an equal number of doctoral dissertations, and more than 100 reprints written under its sponsorship. Six research centers organized the research, and centralized service facilities provided secretarial, library, programming and computer operation services. Such an extensive operation required substantial resources, however, and the vision did not suffice to provide adequate and secure forward funding. In addition, it proved difficult to unify and coordinate the efforts of a large number of independent teacher-scholars to the extent necessary for developing an operational microanalytic model of the U.S. economy. Seeing the achievement of that vision as beyond his reach at Wisconsin, Guy left after seven extremely active and influential years.

Following a year at Harvard and another at the World Bank, Guy joined the Urban Institute and started a new effort to realize his vision. This time he was more successful. DYNASIM, the Urban Institute Dynamic Simulation of Income Model, resulted. This is a fully operational microanalytic model for the U.S. household sector. A highly flexible computer simulation system, MASH, was developed by George Sadowsky to operate DYNASIM. DYNASIM's demographic operators simulate birth, death, immigration, family formation and dissolution, education and geographic mobility. On the income side, simulation processes generate labor force, wage rates, earnings, unemployment, disability, transfer income, property income, taxes, saving and wealth. This model, along with selected applications, is described in Orcutt et al. (1976).

In 1970, after a year as visiting professor, Guy was appointed A. Whitney Griswold Professor of Urban Studies at Yale University. The return to academia brought Guy once again into contact with doctoral and post-doctoral students and a new group of collaborators. Work on DYNASIM continued both at the Urban Institute, with the help of Harold Guthrie as project coordinator, and at Yale. Guy was concerned that the costs of operating a large model such as DYNASIM would severely impede development of such methods and models at universities. In working with several doctoral students at Yale, he developed a new simulation system, MASS, that succeeded in achieving a substantial saving in computer costs.

Both the vision and the applications of microeconomic modeling given to us by Guy have, without question, had lasting effects on the science and practice of economics. Haveman and Hollenbeck (1980) provide a selection of applications to policy problems. A report on an international conference on microsimulation models held in Sweden is provided in the volume edited by Bergmann, Eliasson and Orcutt (1980). A more recent volume, edited by Orcutt, Merz, and Quinke (1986), contains papers and discussion from a symposium on applications of microanalytic models to issues in social and financial policy in West Germany. While none of these efforts has realized the full range of Guy's vision, they amply demonstrate its vitality.

At the present time any federal policy initiative involving taxes or transfer payments that affect households will be simulated on one or more of the microanalytic models that are direct descendants of Guy's approach. The names of the various systems are acronyms that are well recognized by analysts and congressional staff: TRIM, MATH, KGB, TRIM2, and a relatively new one from Canada, SPSD/M, which can be implemented on a high speed personal computer. Simulations have become an obligatory part of any competent policy analysis during the development of such policies and form an important part of the supporting (and adversary) testimony in the legislative process. The main reasons are that simulations provide the capacity to measure the distributional impacts of alternative policies and afford more accurate estimates of the cost implications of programs as they interact with other programs and with work and other behavior of the affected persons.

Empiricist

Coming into economics from physics with a strong sense of social purpose, Guy lost confidence at an early stage in the ability of deductive theory to provide even reasonably precise answers to pressing policy questions. His engineering background made it impossible for him to be satisfied with knowing only the direction of effect from some measured or measurable policy change. Moreover, the state of art at the time he was exploring the biases inherent in estimates from autocorrelated time series left even the empirical verification of direction of effect in some doubt. It is not hard to understand why much of Guy's attention has been directed toward improving methods of measurement.

After several years of work on improving tools for analyzing aggregative time series, as mentioned above, Guy came to believe that there was not enough information in the time series data to enable even the best methods to obtain reliable tests or estimates of models to be used for serious policy analysis. But the alternative—use of data on individual microunits, and if possible data from repeated measurements on the same microunits—required a major change in the collection and dissemination of economic data (Orcutt, 1968).

Over the past 40 years, governmental, university and private sources have provided increasing amounts of microdata, mainly because scholars like Guy have actively campaigned to improve the micro-database and have joined committees, boards, and commissions that have guided and developed standards for public-use data files. Because of his special and persistent concern for the improvement of microanalytic studies, Guy has been a steadfast and prominent supporter of all efforts to improve and broaden the micro-database.

During the late 1960s, interest developed in experimental studies to determine the effect of policies on individual behavior—specifically on the effect of negative tax subsidies on labor supply. This issue was important at that time because of welfare reform and income maintenance initiatives that were part of the War on Poverty. Again, and surely in part as a continuation of his early interest in experiments, Guy was highly supportive of the effort and contributed substantially to the concurrent discussion of design issues (Orcutt and Orcutt, 1968).

However, recognizing that deliberate and fully controlled experiments are expensive in both resources and in the time it takes between initial design and mature interpretation, Guy has more recently begun to focus his empirical energies on the potential of "natural experiments." These are the opportunities to analyze cross-national or other semi-aggregated jurisdictional data which possess substantial amounts of measured variation in policy treatment, along with microdata that can be matched to it in terms of time and place. This spontaneous variation can then be used to explore a wide range of possible responses depending on the richness of the database—an approach described in Orcutt (1984) and exemplified in Orcutt *et al.* (1977) and Mendelsohn and Orcutt (1979).

Mentor and Friend

A sure measure of a scientist's contribution to his discipline is the number and vitality of his students and collaborators, and here is another large deposit of Guy's influence. If it were possible for a mentor to receive a new payment every time his or her generously transmitted wisdom is tapped, the way a television actor receives residuals every time an old film is reshown, Guy would be wealthy indeed. One of Guy's favorite activities is the guidance and nurture of young scholars. At each stage in his career he has successfully attracted able doctoral and post-doctoral scholars, worked closely with them in joint undertakings, and generously shared the credit for the results. The beneficiaries of these attentions have not become disciples who try to evangelize around narrow and dated versions of Guy's methodological vision. Rather, they have gained a broader appreciation of the importance of empirical discovery and verification and been inspired by exposure to an original and creatively skeptical intelligence.

An article introducing the basic ideas of microsimulation in the Winter 1990 issue of this journal by Barbara Bergmann, who was one of Guy's earliest students, testifies to the continuing vitality of the inspiration she received. Other examples of his influence on students will be found in a special "Orcutt Festschrift" issue of the *Journal of Economic Behavior and Organization* (Vol. 14:1, September 1990).

Those of us who can claim Guy as a mentor also value his friendship. We know the always youthful smile and gentle good humor that are a dependable part of any encounter, social or professional. We know the hospitality and warmth of his home which we have shared—some of us many times. It is an always renewable pleasure to be with Guy, to share his latest interests and triumphs and, with his wife Geil, catch up on the family which is a continuing source of pride and fulfillment.

But even those economists and social scientists who have not had the privilege of close association with Guy have benefitted from his contributions to statistical methods, simulation modelling, and microdata dissemination. We can all take pride in recognizing our debt to this unique and inspiring scholar.

■ *I have drawn upon, and am very grateful for, Guy Orcutt's own autobiographical reflections prepared at the time of his retirement and published in the* Journal of Economic Behavior and Organization, *September 1990, 14, pp. 5–27.*

I am also grateful for helpful comments received from Glen Cain, Alice Rivlin and the editors of this journal.

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