1960

Quantitative Analysis of Economic Change

Hyman P. Minsky Ph.D.

TONY

QUANTITATIVE ANALYSIS OF ECONOMIC CHANGE

I. Introduction

1. Research Plan. The research plan described in this proposal consists of several inter-related econometric studies in the general area of economic growth and economic stability. The point of view that underlies the research plan is that further progress in the application of econometric methods requires two changes in the current method of research: first, the principal behavioral relations on which currently available econometric models are based must be disaggregated; secondly, in the specification of an appropriate formal model, much closer attention must be paid to historical and institutional detail than in the past. The research will be carried out by graduate research students under the direct supervision of Professor Roy Radner of the Departments of Economics and Statistics and D. W. Jorgenson of the Department of Economics, with the co-operation of Professor R. A. Gordon, H. P. Minsky, and R. E. Caves of the Department of Economics. The principal projects may be briefly summarized as follows:

(a) Economic Stability. A detailed analysis of the cyclical behavior of the American economy during the inter-war and post-war periods, emphasizing the notion of investment opportunities and changes in such opportunities.

(b) Financial System. A study of corporate, household, and government financial operations, emphasizing the relation between the structure of the financial system and the stability of the economy.

(c) Inter-industry Structure. Construction of an econometric model of U. S. industry based on a detailed industrial breakdown of investment, production, and consumption.

(d) International Trade. A study of the determinants of the long run growth pattern of the economy in relation to the flow of international trade.

These research projects represent a continuation and expansion of previous work by members of the proposed research project. The study of economic stability is an outgrowth of the long-term research effort by Professor R. A. Gordon, reported in a series of publications on cyclical behavior of the U.S. economy during the inter-war period in relation to investment opportunities. At the present time three students are preparing dissertations in this general area under the supervision of Professor Gordon. The subjects of these dissertations are (i) the determinants of commercial building; (ii) the impact of technological change on the composition and volume of private investment; (iii) a study of investment behavior in a particular industry. The research on the financial system is a continuation of work by Professor H. P. Minsky summarized in two recent publications and in a study for the Commission on Money and Credit of the Committee on Economic Development. The work on inter-industry structure is an extension of an inter-industry study of investment during the post-war period by Professor D. W. Jorgenson. This research is to form part of a new econometric model of the United States which will be constructed under the direction of Professor James S. Duesenberry of Harvard University and Professor L. R. Klein of the University of Pennsylvania by a subcommittee of the Committee on Economic Stability of the Social Science Research Council, Professor R. A. Gordon, Chairman. The study of international trade and economic growth is a continuation of research by Professor R. E. Caves on the development of the Canadian economy, reported in a recent monograph.

2. Organization. One of the important subordinate goals of the proposed research project is to assist students in carrying out econometric studies in the area of economic growth and economic stability. Students who choose to work in applied econometrics at any of the major American graduate institutions are confronted by two obstacles to successful research: econometric research is much more expensive, both in money and the time of the investigator, than older and more conventional methods of research. Secondly, almost all graduate students in economics are seriously deficient in mathematical and statistical training upon beginning graduate education. For these reasons closer supervision of both training and research of the individual student than is customary in most of economics is required; further, financial assistance to provide for the costs of additional mathematical and statistical training and for the direct costs of research itself is necessary.

Until greater experience is accumulated in econometric research, it seems unwise to attempt to move immediately to the pattern of experimental research in natural science in which students typically select a problem for research which is part of some project in which the research supervisor is currently engaged. Our intention is to move in this direction by bringing the students into closer contact with faculty research and with each other through close supervision of training and through participation in a research group in applied econometrics. The research group will have space and facilities of its own, period formal discussions of research activity, and daily access to technical advice from faculty members who are themselves engaged in econometric research. The formal discussions will attract and include others besides

those supported under the research program.

II. Detailed Research Plans

The goal of the research program to be described below is to combine a high degree of technical sophistication and a thorough knowledge of economic institutions and economic history in an attack on problems in the general area of economic growth and economic stability. The ultimate aim of the research will be to construct econometric models to be employed for purposes of prediction of economic events, conditional on policy decisions. From a formal point of view such models will not differ from models of the U.S. economy currently available except in the degree of detail of the breakdown of industrial, financial, government, and household activity. However, much more attention will be given to the institutional and historical justification of the a priori specification of the structure of such models. In describing the individual research projects attention will be focused on the way in which historical and institutional material will be brought to bear on the specification of econometric models.

1. Economic Stability. For a number of years Professor Gordon has been studying the boom of the 1920's and the causes of the Great Depression. The emphasis has been on the concept of investment opportunities and on changes in such opportunities between the end of World War I and 1929. Analysis is largely in terms of quantitative economic history. At the present time a number of preliminary findings are available on investment behavior in particular sectors--autos and consumer durables, housing, public utility and local government construction, and the service industries, especially communications, air transport,

and motion pictures. These findings will provide a basis for graduate research students to apply econometric methods for the study of investment behavior in these sectors.

A second phase of the research on economic stability is a detailed analysis of the cyclical behavior of the American economy in the postwar period compared to that for the period before World War II. What has been done by other investigators runs largely in terms of broad generalizations about certain structural changes and the effect of "automatic stabilizers." The National Bureau of Economic Research has recently applied their reference cycle analysis to some 200 time series for varying periods beginning around World War I or earlier and extending up through the 1958 recession. A preliminary analysis of part of this group of series has already been completed. Average reference cycle patterns for the three mild postwar cycles and for two groups of prewar cycles -- the minor cycles of the 1920's and an average of all cycles for the entire interwar period. This analysis will be carried further for all series for which the National Bureau has computed reference cycle patterns through 1958. The results of reference cycle analysis will be employed as a basis for correct specification of the relationships of an aggregative econometric business cycle model.

A third phase of the research is a study of the differential long-term behavior of the prices of capital goods and consumer goods. It has already been determined that capital goods prices have risen faster than those of consumer's goods since 1929 and an attempt is under way to develop better data on the period back to 1900. This research presents an interesting problem for econometric analysis and raises important questions regarding the

properties of dynamic aggregative models cast wholly in "real terms" or models in which price formation and the setting of levels of output are treated separately.

2. Financial System. To date no overall theory of finance exists. Such a theory would treat corporation finance, household finance, financial institutions, and government financial operations as a part of a unified system that affects and is affected by the behavior and performance of the rest of the economy. In the relatively recent past there have been some interesting stirrings pointing toward the establishment of a theory of finance, including the micro-economic studies of H. Markowitz on portfolio selection and the study of cost of capital, corporation finance, and the theory of investment by F. Modigliani and M. H. Miller.

In addition to the ferment on the level of ideas, there has been an accumulation of new types of data which can be exploited to test new ideas through incorporation of these ideas in an econometric model. Among the new data the following can be cited: data from the Federal Reserve-Michigan Survey Research Center on household portfolio choices and household expectations; data from the National Bureau of Economic Research and the Federal Reserve System on the flow of funds, especially quarterly time series on the flow of funds; the Security and Exchange Commission-Department of Commerce data on corporation finance. There is a wealth of older material on monetary and financial matters which can be combined with the new survey information.

The initial research on financial systems will be directed at two specific problems: (a) how financial institutions and usages operate to reduce the uncertainty confronting individual decision-makers; (b) the relation

between the financial system and the other sections of the economy. In the past most econometric studies of economic growth and business cycles have omitted a detailed description of the financial system; much of the analysis of the relation between finance and economic behavior has been carried out in terms of the monetary system alone. The ultimate goal of the research will be to construct an econometric model which includes determinants of analytically significant money flows and provides a means of predicting future money flows. The specification of the behavioral relationships in this model will be based on a macro-economic theory describing the inter-relationships between the financial system and the rest of the economy and a micro-economic theory describing portfolio selection in the framework of existing financial institutions and usages.

3. Inter-industry Structure. Two approaches to econometric research on the U.S. economy may be distinguished: construction of highly aggregated models based on the national accounting system of the Department of Commerce; construction of disaggregated models based on inter-industry transactions accounts. Econometric models have been criticized on the grounds that the relationships of economic theory on which aggregative models are based refer to the behavior of individual firms and consumers but not to the economy as a whole. Inter-industry models have been criticized on the grounds that the input-output model, while permitting a high degree of disaggregation of behavioral relationships, requires the assumption that most variables in the system — inter-industry demands, import demands, all investment, consumption — are strictly proportional to the output of the corresponding sectors.

To construct an econometric model of the U.S. economy based on a detailed

industrial breakdown of all activity, a new approach is indicated. The construction of such a model will be based on a tentative theory of growth that includes as variables to be explained the output of each industry or sector, investment and inter-industry demand by each sector for the output of every other sector, consumer demand for the output of each consumers' goods producing sector, and imports of each commodity into the United States. The explanatory variables include government purchases of goods and services from all sectors, taxes, exports of each commodity from the United States, population growth and technical change. Population growth and technical change should, in principle, be included in the theory of growth. Unfortunately, little research has been done on these problems and it seems best, at present, to measure technical change and population growth accurately and to take these variable as exogenous.

The information required for empirical implementation of the model sketched above includes data on capital stock, output, investment, and consumption for each sector; data on government taxes and expenditures, on population and technical change, and on international transactions. At the beginning of the research reliance will be placed primarily on aggregate times series for each sector available in the U.S. national accounts. A second important source of data is the published and unpublished research of the inter-industry research program of the federal government under the general direction of the Bureau of Labor Statistics before 1953. Finally, data on capital stock and investment will be supplemented by long-term series from the recently completed studies of U.S. capital formation and productivity in U.S. manufacturing carried out at the National Bureau of

Economic Research under the general direction of S. Kuznets and J. Kendrick, respectively.

4. International Trade. There are many different ways in which the volume, structure, and growth rate of international trade might help or hinder the economic development of a particular country or area. Viewed in the broadest terms there are two ways of looking at the relation between international trade and national patterns of development. One is the "time series" approach, formulating and testing hypotheses about the way patterns of trade and patterns of development have been associated in particular regions. An example of this approach is Professor Caves' historical study of the development of the Canadian economy (with R. H. Holton), testing for the determinants of the economy's long-run growth pattern. The second is the "cross-section" approach, formulating and testing hypotheses about the way in which trade and development characteristics interact when viewed over a cross-section of countries or regions at a point of time. An example of this approach is the recent study of H. B. Chenery.

A great deal of information on the historical aspects of trade and development has been accumulated; historical studies like the study of the Canadian economy referred to previously, suggest patterns of development that might be used to generate hypotheses about other regions as well. The expansion of the "European economy" generated by the Industrial Revolution offers case after case of regions that have developed in the presence of significant flows of international trade. However, only a small amount of work has been done in

testing hypotheses derived from historical studies by the use of econometric models. The first step of the research will be to develop a body of hypotheses about the trade-development relation.

In the last two or three decades the amount of statistical information on the flow of international trade has grown enormously under the direction of the United Nations and other international agencies. The second phase of the research will be to utilize this information to construct econometric models capable of predicting and explaining the observed patterns of international trade and economic development, of both "time series" and "cross-sectional" variety.

III. Personnel

The conduct of the research will be directly supervised by the five senior staff members listed in Section I. Professors Radner and Jorgenson will act as chief investigators and will be responsible for the overall conduct of the research. The graduate research students will devote half time to research during the nine months of the academic year and full time for three summer months. Five students will be appointed at the beginning of each year with an appointment to last for two years. The first students will be appointed to begin work on September 1, 1961; five students will participate in the project during the first year and ten students during each of the two succeeding years. Each student will be supervised by a faculty committee consisting of either Jorgenson or Radner, and at least one of the other members of the research project — Minsky, Gordon, or Caves. Three additional members will be appointed to the committee from among the members of the Department of Economics and related departments. The chief supervisor of research will be the Chairman of this committee, who will usually be one of the five members of the research project.

In general the first step in the training of the students will be further study of statistics and mathematics. In the course of preparation for the Ph.D. in economics, all students who participate in the project will be required as a minimum to take an examination in quantitative methods which requires competence in elementary calculus, linear algebra through matrices, introduction to mathematical statistics, applied economic statistics (principally regression analysis), and econometrics. In almost every case students will be encouraged to obtain an

M.A. in Applied Statistics in the Department of Statistics. This program includes in addition to the above two full year courses in applied statistics, focused on analysis of variance, design of experiments, non-parametric methods, sequential analysis, analysis of quantile response data, and analysis of discrete observations. At least one additional course must be chosen from the following: mathematical economics, linear programming and game theory, sampling surveys, dynamic programming. Most students will be encouraged to take an additional course in linear algebra beyond that required for quantitative methods in the Department of Economics. At the present time it appears that many students will take the additional training required for an M.A. in Applied Statistics during the first year of their participation in the research project, devoting half time to research and half time to further training.

The second step in the training of students will be supervised research on a problem of their own choosing if it is agreed by both students and their faculty supervisors that they are ready to begin a dissertation. Otherwise the students will work on a problem suggested by a faculty supervisor, possibly in some area directly related to the supervisor's own current research. At this stage students will be required to report periodically on their research activity to the entire group in seminars to be held once a week. Such seminars will also include reports by faculty members on current research, lectures on advanced topics in econometric methodology or applications not covered in the ordinary curriculum, and discussion of current research by econometricians from other institutions. It should be mentioned in this regard that a considerable amount of econometric research is currently underway at the Giannini Foundation for Agricultural Economics on the Berkeley campus and at the Davis campus of the University of California and at Stanford

University which is near by.

IV. Facilities

The facilities for research will include a seminar room and office space at a central location on the Berkeley campus. Offices will be located near the recently installed IBM 704. Facilities for key punching, collating, and sorting of cards are available at the same location as the computer. Access to two smaller machines is also available: an IBM 650 at the Radiation Laboratory and anIBM 701 in the College of Engineering. Additional computing facilities are available at the Western Data Processing Center, University of California at Los Angeles, where an IBM 709 has recently been installed. The IBM 704 and 701 are under the supervision of the Computer Center of the University of California. The Computer Center provides courses in programming, advice on the use of standard library programs, for example, for routine statistical analysis, or for linear programming, and assistance in the programming of scientific problems.

The standard sources of economic data --publications of government and private statistical agencies -- are available in the main library of the University. In addition unpublished research reports from other centers of work in applied econometrics are available in the library of the Committee on Econometrics and Mathematical Economics. A large collection of mimeographed reports and reprints has been accumulated with a view toward the establishment of a research group in applied econometrics. An additional source of data is the Survey Research Center of the University, which has data-sharing agreements with the major centers of survey research in the United States. This includes the principal private organization involved in survey research in economics in the United States, the Survey Research Center of the University of Michigan. Facilities for card-handling are also available at the Survey Research Center. The

principal needs for additional facilities and equipment are for two desk calculators and an electric typewriter with a technical keyboard for preparation of material for publication.

V. Duration of the Project

The initial request for this project is for support for three (3) years, beginning September 1, 1961. It is anticipated that some or all of the members of the proposed project would have plans for further research in this area at the end of that time since the research proposed is central to the interests of each of the persons involved. A renewal of the project at that time would of course be subject to mutual agreement.

VI. Budget

A. Salaries*

First year:	
Five research students: nine months at half time, three months at full time.	$ 17,175
One secretary-stenographer: twelve months at quarter time.	1,074
Second Year:	
Ten research students: nine months at half time, three months at full time.	34,350
One secretary-stenographer: twelve months at half time.	2,148
Third year:	
Ten research students: nine months at half time, three months at full time.	34,350
One secretary-stenographer: twelve months at half time.	2,148
Subtotal:	91,245

*All salaries are based on current rates of pay at the University of California, Berkeley; if rates of pay are altered during the period of the project, salaries will be revised accordingly. The current rates used in calculating the figures given above are $458 per month for a research student, full time; $358 per month for a secretary-stenographer, full time.

B. Supplies and Expenses

Computer time (IBM 704, Berkeley campus):

First year:

One hundred hours at sixty dollars per hour	$	6,000
plus fifteen per cent for peripheral services.		900
Second Year:		
Two hundred hours at sixty dollars per hour		12,000
plus fifteen per cent for peripheral services		1,800
Third Year:		
Two hundred hours at sixty dollars per hour		12,000
plus fifteen per cent for peripheral services		1,800
Three desk calculators at one thousand dollars each.		3,000
One electric typewriter with technical keyboard.		500
Office supplies, mail, telephone, telegraph		1,500
Retirement (University contribution for secretary-stenographer at half time; 8.18 % of salary.)		350
Subtotal		39,850
Subtotal		131,095
C. Overhead (twenty percent of total budget)		26,219
Total for three years:	$	157,314

ADDENDUM TO PART II.

References:

1. Economic Stability

R. A. Gordon, "Business Cycles in the Interwar Period: The 'Quantitative-Historical' Approach," AER, Papers and Proceedings, May, 1949, pp. 47-63.

_____, "Cyclical Experience in the Interwar Period: The Investment Boom of the 'Twenties,'" Conference on Business Cycles, Universities - NBER Committee, 1951, pp. 163-215.

_____, Business Fluctuations, Harper, New York, 1952.

_____, "Investment opportunities in the United States Before and After World War II," The Business Cycle in the Post-War World, Proceedings of a Conference held by the IEA, ed. E. Lundberg, London, Macmillan, 1955, pp. 283-310.

_____, "Investment Behavior and Business Cycles," Review of Economics and Statistics, February, 1955, pp. 23-34.

_____, "Types of Depressions and Programs to Combat Them," Policies to Combat Depression, Universities - NBER Committee, 1956, pp. 7-21.

_____, "Population Growth, Housing, and the Capital Coefficient," AER, June, 1956, pp. 307-322.

_____, "Stabilization Policy and the Study of Business Cycles," AER, Papers and Proceedings, May, 1957, pp. 115-126.

2. Financial System.

H. Markowitz, Portfolio Selection, New York: Wiley, 1959.

H. P. Minsky, "Monetary Systems and Accelerator Models," American Economic Review, Vol. XLVII, No. 6, December, 1957, pp. 859-83.

_____, "Central Banking and Money Market Changes," Quarterly Journal of Economics, Vol. LXXI, No. 2, May, 1957, pp. 171-187.

F. Modigliani and M. H. Miller, "The Cost of Capital, Corporation Finance and the Theory of Investment," American Economic Review, Vol. XLVIII, No. 3, June, 1958, pp. 261-97.

3. Inter-industry Structure.

D. Creamer, S. Dobrovolsky, and I. Borenstein, Capital in Manufacturing and Mining, (mimeographed) National Bureau of Economic Research, November, 1958.

J. W. Kendrick, "Productivity Trends; Capital and Labor," Occasional Paper No. 53, National Bureau of Economic Research, 1956.

L. R. Klein and A. S. Goldberger, An Econometric Model of the United States, 1929-1952, North-Holland Publishing Company, Amsterdam, 1955.

W. W. Leontief, The Structure of the American Economy, 1919-1939, 2nd edition, revised, Oxford University Press, New York, 1951.

_____, Studies in the Structure of the American Economy, Oxford University Press, New York, 1953.

M. J. Ulmer, Capital in Transportation, Communication, and Public Utilities, Princeton University Press, Princeton, 1960.

4. International Trade.

R. E. Caves and R. H. Holton, The Canadian Economy, Harvard University Press, Cambridge, 1960.

H. B. Chenery, "Patterns of Industrial Growth," American Economic Review, Vol. L, No. 4, September, 1960, pp. 624-54.

H. Neisser and F. Modigliani, Foreign Trade and National Income, University of Illinois Press, Urbana, 1954.