

THE WORLD BANK GROUP ARCHIVES

PUBLIC DISCLOSURE AUTHORIZED

Folder Title: Agarwala, Ramgopal - Articles and Speeches (1972) - 1v

Folder ID: 1649977

Fonds: Records of Office of External Affairs (WB IBRD/IDA EXT)

Digitized: October 24, 2013

To cite materials from this archival folder, please follow the following format:
[Descriptive name of item], [Folder Title], Folder ID [Folder ID], World Bank Group Archives, Washington, D.C., United States.

The records in this folder were created or received by The World Bank in the course of its business.

The records that were created by the staff of The World Bank are subject to the Bank's copyright.

Please refer to <http://www.worldbank.org/terms-of-use-earchives> for full copyright terms of use and disclaimers.



THE WORLD BANK
Washington, D.C.


© 2012 International Bank for Reconstruction and Development / International Development Association or
The World Bank
1818 H Street NW
Washington DC 20433
Telephone: 202-473-1000
Internet: www.worldbank.org

PUBLIC DISCLOSURE AUTHORIZED

AGARWala, RAMGOPAL - ARTICLES and Speeches

Fol

The World Bank Group
Archives



1649977

A1992-007 Other #: 2 212047B

Agarwala, Ramgopal - Articles and Speeches (1972) - 1v

DECLASSIFIED
WBG Archives



INTERNATIONAL BANK FOR RECONSTRUCTION AND DEVELOPMENT
INTERNATIONAL DEVELOPMENT ASSOCIATION

A SURVEY OF THE WORLD BANK'S MACRO MODELS

January 6, 1972



The primary purpose of this paper is to stimulate discussion on the nature and role of econometric models in the Bank's work. We believe that the econometric model-building has come at crossroads, where we need to evaluate our past experience rather carefully and define directions for the future. We think that this task of redefinition of the directions of econometric model-building is possible only if econometricians and economic decision-makers can be involved in a dialogue about the process of problem identification and contribution of econometric analysis to the tackling of these problems. In this paper, we try to identify certain critical problems that may be of interest for the Bank's work on econometric model-building and we also raise some methodological issues relevant for econometric research in the Bank's environment. We shall be very grateful to have the benefit of comments and discussions.

Prepared by: Ramgopal Agarwala
Comparative Analysis and
Projections Division
Economic Program Department

A SURVEY OF THE WORLD BANK'S MACRO MODELS^{1/}

Introduction

1. The future is largely unknown and perhaps largely unknowable. Yet the decisions that have to be taken in the present can be taken only in the light of the expected future. The art of useful forecasting lies in trying to uncover that part of the future the knowledge of which is of maximum use for decision-making in the present. It is necessary to gear the model-building and forecasting exercises to the problems and the situation at hand and try to maximize the utility of the research for the decision-maker while paying due attention to the budget and, even more important, the time constraint for research. The test of a good model is provided not just by some statistical criterion (relating to mean squared error or Theil's inequality coefficient) but by the economic criterion of the marginal product of model in terms of better decisions by the user of the model.^{2/}

2. It is in the light of the above philosophical position that we would like to review the model-building exercises undertaken by the World Bank (henceforth, to be referred to as "the Bank"). Since the Bank is an operational institution, the scientific approach should be to set about designing tools and systems which can meet the Bank's operational needs to

^{1/} I am indebted to Mr. N. G. Carter for initiating this survey and for giving many useful comments and suggestions. He has also kindly allowed me to draw very freely on various internal documents written by him. I have also benefited immensely from discussions with many of my other colleagues in the Bank.

^{2/} For a more detailed discussion of this issue, see Agarwala (2).

the best possible extent. Our objective here is to study the process of development in model-building exercises in the Bank so as to draw lessons for the model-builders in the profession as well as to suggest thoughts for improvements in model-building exercises within the Bank.

3. The arrangement of the paper is as follows. In section I, we make a very brief review of the development in professional thinking on the subject of macro econometric model-building. In section II, we make an analysis of the process by which the Bank's involvement in the model-building exercises has been increasing over time. In section III, we analyze the nature of the Bank's macro models at present. Lastly, in section IV, we make a few brief comments for evaluating the present practice and suggest some thoughts for the future research in this field in the Bank.

I. Evolution of the Professional Thinking on Econometric Model-Building

4. The interest in econometric model-building is relatively new in the profession. Most of the classical economics was concerned with the discussion of economic laws and economic policies where precise quantitative future forecasts were not essential. There were, of course, some attempts at statistical analysis to separate the different components, such as trend, cycle, seasonal and random, from time series data, but these were primarily statisticians' concern. The first serious attempt at macro econometric model-building was undertaken by J. Tinbergen (27). The reception accorded to this study was mixed. In particular, J. M. Keynes wrote a scathing critique (17) of the approach. However, the criticisms and doubts were set aside in the enthusiasm for building models of national economies, which ironically enough Keynesian economics made look feasible. This, combined

with the availability of data and high speed computers, gave a great fillip to model-building industry in the postwar period.

5. A pioneering work was done by L. R. Klein (18) by using the simultaneous equation estimation techniques in his model of the U.S. economy. This was followed by the Klein-Goldberger model (19) and Goldberger's (12) analysis of the impact multipliers and dynamic properties of this model. Some doubts were raised by C. Christ's demonstration (8) in early fifties that econometric models generally perform no better than naive models but Christ's arguments did not have much impact on the profession. Econometric model-building activity increased very rapidly and by the end of the sixties there have been more than a hundred econometric models constructed of different economies in the world.^{1/}

6. With the experience of model-building accumulating rather rapidly in recent years, some of the old doubts raised by Keynes and C. Christ are raising their heads again. The papers presented at the National Bureau Conference at Harvard in November, 1969 (15) demonstrated the limited success achieved by econometric models in predicting turning points in the postwar period in the U.S. Also R. Cooper (9) demonstrated that autoregressive models generally perform as well as the econometric models for purposes of short-term forecasting.

7. Equally sobering were the results from simulations of Brookings Model (11) and their review by Gordon (13). As Gordon argued, many of the surprising results (or discoveries) of the model were due to wrong specification at some vital point or other in the model and not genuine increases

^{1/} A short annotated list covering some 140 models is given in Appendix V of Agarwala and Proulx (3).

in scientific knowledge. Moreover, from the operational point of view, the idea of making model a photographic reproduction of reality ("descriptive realism" in H. G. Johnson's terminology) has led to a process where the models are becoming bigger and bigger and these are often more difficult to understand without always being more useful. This has set in a mood for soul-searching among econometricians. In particular, Leontief (21) has raised some serious and fundamental questions about our whole methodology. On econometric techniques he says:

"In no other field of empirical inquiry has so massive and sophisticated a statistical machinery been used with such indifferent results. Nevertheless, theorists continue to turn out model after model and mathematical statisticians to devise complicated procedures one after another. Most of these are relegated to the stockpile without any practical application or after only a perfunctory demonstration exercise."

He diagnoses the problem as follows:

"In contrast to most physical sciences, we study a system that is not only exceedingly complex, but is also in a state of constant flux. I have in mind not the obvious change in the variables, such as outputs, prices or levels of unemployment, that our equations are supposed to explain, but the basic structural relationships described by the form and the parameters of these equations."

8. However, while the early hopes of forecasting and "fine tuning" with the help of econometric models have not been realized, the models have been found to be useful in a number of ancillary ways. In the first place, the models have provided an excellent means of organizing the relevant data and the discussion of problems in a systematic framework. This has been found to be of great help for communication and discussion among different economists and between economists and policy-makers. For example, in the U.S. the model-building exercises have involved the businessmen, government

officials and academics in the process of national forecasting and policy analysis in a way that was absent before. These exercises have highlighted the need for particular kinds of data and helped the decision-makers to be more articulate about their priorities and constraints. It has also been found that the models have a remarkable advantage of speed and consistency. Once a suitable model is constructed for a particular problem, it becomes relatively easy to work out the implications of different policy alternatives. In many operating environments, this speed can make all the difference between the effectiveness or otherwise of economic advice. The merit of speed becomes all the more important, because one can be sure that the different outcomes of the model are not mutually inconsistent, which is sometimes difficult to ensure in back-of-the-envelope type calculations.

9. In the preceding paragraphs we have concentrated on the performance of macro econometric models in more developed countries (MDC's) because this is where they have been most seriously tried. In less developed countries, the attempts have been rather preliminary. An excellent review of the problems associated with these attempts is given in A. Shourie (26). At the same time, as OECD report (22, p. 5) demonstrates, when used with care, quantitative models can be helpful in a number of ancillary ways in discussing development problems. To quote:

"... the use of quantitative models is not intended to supersede project appraisals or the use of country economic reports containing qualitative as well as quantitative information and analysis, but rather to complement them. In favor of models, it is said that they ensure consistency of reasoning and avoid the dangers of basing conclusions on arguments which are not made explicit. Moreover, their use may provide a useful link between the thought process of those who provide assistance and those who are responsible for drawing up development plans in the less developed countries."

10. An alternative to comprehensive all-purpose model-building approach, is what may be called more truly Keynesian quantitative approach. In this approach, the emphasis is on developing simple quantitative measures on the basis of theoretical reasoning with due attention paid to the particular problem and the particular economy under consideration. Examples of this are provided by Keynes' computation of inflationary gap in How to Pay for the War and of employment multiplier for the depression period in the 1930's. Modern counterparts of this are provided by Okun's computations of "full employment surplus" (25), "gap between actual and potential output" and the well known Okun's law relating the degree of unemployment to the gap between the actual and potential output (23). These kinds of computations are in some ways less "scientific" than the comprehensive model-building approach but in the framework of policy-oriented environment and rapidly changing economic structures, it is difficult to be sure whether they have been less effective than the comprehensive model-building approach. Their main defect is that they cannot adequately take care of feedback effects in the system as a whole.

11. In the light of the above experience, we would like to suggest that it is necessary to examine whether we could combine the strong points of the above two approaches: general equilibrium framework of macro models and the flexibility and pointedness of problem-oriented research. In this connection, a review of the World Bank's experience in model-building may be useful in suggesting both the need for and the limitations of model-building. The former is perhaps illustrated by the process by which the Bank, starting with an interest in project evaluation, was led inexorably to commodity models, country models, and recently global models. The latter is illustrated by the

fact that models that have been found most useful are simple and flexible and not those which were highly "sophisticated". Since the Bank is an operational institution and is also interested in over-all growth prospects of LDCs, problem oriented macro modeling may be particularly relevant. Since the operations of the Bank have produced an impressive documentation on various aspects of project appraisal, sector planning, country performance and global perspectives, its experience may be very helpful in providing the urgently needed fusion between theory and practice of developmental economics.

II. Evolution of the Bank's Approach to Model-Building

12. In the early period of the Bank's operations, the Bank's economic analysis was focused primarily on project evaluation. This approach had some obvious advantages. The technical aspects were studied closely and in many cases, the Bank's study led to improvements in design and planning of the projects. The costs and benefits of the projects were evaluated paying particular attention to the specifics of the situation. As in the case of a private bank lending, so in the case of World Bank's loans, project appraisal was naturally the first critical factor in deciding on the desirability of loans and at this stage, macro economic models as such did not play any important role.

13. In subsequent periods, it began to be realized that "a loan is to a country and not to a project," and the desirability of a project loan cannot be discussed in isolation. The impact of a project on the economy will depend on the over-all conditions of the economy. Similarly, from the point of view of debt servicing capacity, it is important to know not just

whether the project will pay its way but whether the country is in an over-all sound position to repay its debts. In order to consider this aspect the Bank had to develop its analysis of the over-all creditworthiness of the borrowing countries. At the initial stage, these macro economic discussions were largely in financial terms. However, the advantages of computerized modeling were beginning to assert themselves. The Bank was interested in working out the implications of loans at various alternative terms and conditions on the over-all debt servicing requirements of the borrowing countries at some future date. These were difficult to work out intuitively and computerized models were constructed to transform the net foreign capital requirements into gross requirements and to study the effects of alternative terms of loan on future debt servicing burdens. These debt routines were, however, still not properly integrated with the over-all macro variables such as growth rate of GNP, import requirements, etc. and some vagueness was present as to how to insert a plausible net capital requirements series in the debt routine programs.

14. Side by side with the computerization of debt problems, a set of economic models were being developed which tried to integrate the debt problems in an over-all growth model. This integration of growth models into debt models was speeded up with the Bank's increasing involvement in preparing detailed country program papers which articulate the over-all growth perspectives and foreign capital requirements.

15. More recently, the Bank is emerging as an important co-ordinator of world aid programs and in this capacity, it is beginning to take increasing interest in the global demand and supply of foreign capital over the next decade or so. For this purpose, it has been found convenient to put

the calculations of world demand for foreign capital on a set of computerized models. This is important because these exercises have to be done on a number of alternative assumptions about terms of loans, export prospects of LDCs, etc. and the computational costs would be prohibitive except in the framework of computerized models. For tackling this problem, the Bank has constructed a set of models for 30 countries on a uniform pattern for its global assessment of capital needs.

16. The last mentioned activity has brought out some conflicts between the needs of country reports and global assessments. The country reports naturally want to emphasize the specifics of the particular country whereas global models try to put the analysis and data on a comparable basis for all the countries. An extreme example may illustrate the point. In Yugoslavia, the national accounts are prepared along the socialist concept of national output and these are not comparable with the usual concept of national income in the non-communist countries. For purposes of a country report, it is desirable to use the concepts prevalent in the country whereas for global analysis, it may be desirable to redefine the country figures in terms of common international practices. The dilemma that this presents is by no means easy to tackle, but we will return to these problems later on.

17. The above brief historical sketch is intended only to indicate the evolutionary process of the Bank's model-building program. This has been a process of evolution in pragmatic response to the emerging needs of the Bank and this is a very desirable aspect of the process. However, by the nature of the process, certain lopsidedness and crudities have developed in the over-all program and it may be desirable to streamline the operations. This is the subject matter of our final section, but before going to that,

it is necessary to examine the present nature of the Bank's models in some detail. This is attempted in section III.

III. The Present Practice

18. The Bank at present uses many different types of models. There is one group of models which are concerned with commodity analysis. Then there are various models for evaluation of projects. Lastly, there are macro models for analysis of stabilization policies as well as analysis of growth and debt prospects. Our concern here is primarily with the growth/debt models. We do, however, pay some attention to commodity export models to the extent necessary for discussion of growth/debt models.

A General Principle: Need and Comparative Advantage

19. Before coming to details, we may mention one general principle underlying Bank's econometric work. The nature of the Bank's model-building program is naturally influenced by the Bank's needs and the Bank's comparative advantage.^{1/} As regards needs, the Bank's models focus primarily on the role that foreign capital plays in development process and on the questions of debt servicing problems. It is, of course, desirable to know as much as possible of a country. But experience has shown that econometric models oriented towards photographic reproduction of a country's economy are not generally feasible at present and an emphasis on specific problem orientation of models, is generally quite fruitful. Similarly following the good old principle of comparative advantage, the Bank concentrates on those areas of research where it has a comparative advantage vis-a-vis other international

^{1/} Like other principles of maximization in economic behavior, this may or may not have been always applied consciously in deciding the research strategy.

institutions and vis-a-vis the client countries. As compared with the other international agencies, the Bank has the advantage of having people with on-the-spot experience and of being in continuous touch with its client countries on somewhat special terms. As compared with the client countries, the Bank has an advantage in having an international perspective which enables it to judge a country's prospects in the light of experience and prospects elsewhere. For the areas in which the Bank does not specialize in research itself, the general approach is one of obtaining as much knowledge as possible from the research conducted in other international agencies and in client countries.^{1/}

20. Thus, the Bank's model-building program has been in the nature of pragmatic response to the situation. The difference of this pragmatic econometric approach from the usual mechanical econometric model-building should not be overlooked. In the mechanical approach, one starts with a given structure of the economy and tries to fit the data of the particular country to a "Procrustean bed" of a macro model. In this connection, it is surprising how often Keynesian macro models (originally designed for a very different context) are uncritically fitted to some LDCs. In the Bank's flexible approach, on the other hand, the emphasis is on studying the characteristics of each economy and devising macro models suitable for the particular context and particular problems. Apart from the specification stage, there is a

^{1/} This aspect may well be strengthened. Many of the LDCs are now developing useful quantitative models and the Bank may profitably build its research on them and act as a catalytic agent for transmission of this technology to other LDCs. Similarly, the Bank's detailed knowledge of project analysis in different countries could be very profitably used for giving greater realism and depth to the discussions of economic problems such as capital-labor substitution.

subtle but important difference between the Bank's approach and the traditional approach at the estimation stage. The traditional approach assumes that the "population parameters" are stable and the sample period could be utilized to obtain estimates of population parameters. In the Bank's approach, on the other hand, the view is taken that the basic parameters like incremental capital output ratio (ICOR) or marginal saving rate (MSR) are themselves influenced by policy instruments and they are changing over time under the influence of the structural changes going on in a developing economy. In view of the recent emphasis on "shifting parameters", "random coefficients" as well as Leontief's arguments about "the state of flux" of most economic relationships, it is worth considering whether the pragmatic flexible approach is not more "scientific" than the mechanical econometric model-building approach.

The General Outline

21. In terms of the economic content, the basic theoretical underpinning of Bank's models are provided by the analysis of role of foreign assistance in economic development by Chenery and his associates in a number of celebrated papers. Since these papers are well-known, we would not try to enter into any detailed discussion of these. It is important to note, however, that in practice, only a simplified form of Chenery's model is utilized in Bank's work. Very often only one constraint (generally foreign exchange constraint) is regarded as binding over the forecasting horizon, although the plausibility checks of the implied estimates of the non-binding constraints are also made. The discussions of absorptive capacity are mostly

sketchy and subjective.^{1/} On the other hand, the discussion of debt profile is very detailed and many alternative possibilities are explored with the help of computerized models.

22. The broad outlines of the Bank's research on the problems of debt servicing capacities of the LDCs are presented in D. Avramovic, et al (1).

23. The starting point of the study is provided by the argument that "increases of external indebtedness and of debt service liabilities even when large, do not necessarily imply difficulties for borrowers. Increases of services payments have to be measured against the strengthening which has occurred in the borrower's economy." The factors which affect a country's capacity to service debt in the short- and medium-term were classified as follows:

a. Fluctuating Variables

- i. exports
- ii. capital growth
- iii. emergency and inflation induced imports

b. Offsetting Variables

- i. reserves
- ii. compensatory finance

^{1/} This is unfortunate because an investigation of absorptive capacity may have important implications for projections and policy analysis. The problem is the same as that discussed in Keynesian economics under the heading of the distinction between marginal efficiency of capital and marginal efficiency of investment. Even though the marginal productivity of capital is high in many LDCs, marginal productivity of investment in a given period may decline rather fast and thus limit the prospects of fast growth through capital injection. The analysis of ICOR may be improved by consideration of these factors and it can also be useful in discussions of optimum allocation of world capital assistance, among different countries. For a discussion of this important issue, see J. P. Hayes (14).

iii. compressible imports

c. Rigid Variables

1. minimum tolerable imports

ii. debt-service interest

iii. debt-service amortization

24. While it is desirable to take account of all these factors in discussing the debt servicing capacity, in practice, a simplified measure - debt-service ratio (DSR) - is the most frequently used rule of thumb in appraising the creditworthiness of LDCs. This ratio is the proportion of foreign earnings through exports of goods and non-factor income to debt servicing payments in the form of interest and amortization payments. It was demonstrated that on the basis of certain simplifying assumptions about capital output ratio, savings rate, export growth rate and terms of foreign capital inflow, one can construct a simple growth model which gives some interesting insight into the behavior of debt-service ratio in course of growth of an economy. More specifically, an illustrative growth model yielded an interesting debt cycle where the peak of debt-service ratio was more than 50%. It was further pointed out that "the pattern of movement of the ratio depicted by the model variant was not without historical precedent. Canada had a peak investment service ratio of 35% in 1961 and Australia's ratio in the 1920's was 24%. Both these countries successfully effected the transition to low debt-service ratios, as the economy grew and the production base expanded. In 1961-62, Canada's investment service ratio was only 9% and Australia's 11%." It was, of course, recognized that there is nothing inevitable about the DSR declining after a certain time and that there are problems in judging the creditworthiness of a country with reference

to DSR only. However, as emphasized before, a simple concept which is easily understood and which captures some interesting aspect of the problem tends to become rather useful and DSR has tended to be a focus of a considerable amount of attention in the Bank's work on model-building. The estimates of growth prospects of a country as well as the questions of foreign capital requirements for a certain target rate of growth involve considerations of the prospective DSR for a particular country.

25. A computerized model for the growth and debt analysis was suggested by J. P. Hayes and C. Goor as early as 1962. This was a standard computer program for simple macro economic projections, to allow a dynamic treatment of problems of capital requirements and creditworthiness. The model was decomposable into four sections:

- a. The basic growth model: given the growth rate of GDP and ICOR it worked out gross capital formation requirements. Savings were computed by use of marginal savings ratio and the savings gap was derived as the difference between savings and investment thus calculated.
- b. In a variant of the above method, the savings gap was no longer treated as the dependent variable. For some countries, it may be preferable to start from an assumption concerning the development of imports (related, say, to a given growth of product). Given an export projection, the balance on current account would then be obtained as an assumption of the basic growth model and not as its result.
- c. The external capital account projection was made as follows:

- i. The algebraic sum of the balance on current account and all capital account items must be zero, all items being given their correct sign. Thus, when all other items have been either computed or given as data, "New Public Borrowing" can be obtained as a residual.
- ii. Required or permissible "Change of reserves" is treated as datum. So is the net balance of "Private capital transactions and remittances". "Private interest and dividends" may be inserted as data, or alternatively related to GDP or to private external capital transactions.
- iii. Annual figures for "Interest on initial public debt" and "Amortization due on initial public debt" are taken from debt-service data.
- iv. "Interest on subsequent public external borrowing" and "Amortization due on gross public borrowing" are to be derived from the series for "New public borrowing."
- d. Having obtained the debt-servicing cost and exports earnings, the computer program calculated debt-service ratios.

26. In recent years the above model has been made more detailed mainly with the help of the so-called debt subroutine. For this purpose, an exhaustive file of past debts is utilized to give a pattern of payments for interest and amortization. On this profile is imposed a set of hypothetical

new debts with alternative terms of lending. This gives the implications for debt-servicing of past and prospective loans. Since the Bank has access to confidential information on loans from public sources, this debt sub-routine represents a very powerful aspect of the Bank's research. The profile of debt-servicing thus obtained is much more accurate than could have been obtained from even complicated econometric techniques relating debt-servicing payments to loans.

27. The basic nature of the growth/debt models is illustrated by a simplified flow chart. The chart indicates certain broad lines of causation. However, an important aspect of the Bank's approach is that the models are not used in a uni-causal fashion. A number of alternative versions of the models are run to check the plausibility of the results from various angles. Thus, given the available resources, an attempt is made to deduce the plausible rates of growth. Alternatively, the model is run the other way round with target growth rates and foreign capital requirements and the likelihood of these requirements being met is examined. Moreover, the implications of various macro projections are also checked by working out their implications in disaggregative terms. Thus, having obtained an estimate of macro growth rate, it is examined what kind of sectoral growth rates will it imply and whether these are plausible. Thus, the keynote of Bank's approach to model building is pragmatism and flexibility. The objective is to lead up by trial and error to a plausible set of macro forecasts which can be used in the report for the country.

28. This aspect of pragmatism and flexibility is perhaps best illustrated by the method of obtaining export projections. The actual forecasts of export earnings are obtained by quite a complex process involving a

combination of judgments of commodity experts, country analysts and estimates of other international organizations such as UNCTAD and FAO. The use of explicit econometric models has been attempted for only a few commodities but some partial econometric estimates such as price elasticity of consumer demand and supply response to changes in economic variables are quite often used. More important is the role played by the pooling of estimates of exports by country specialists and looking at their global implications. This can often lead to substantial modifications in the initial estimates.

29. For estimating the structural equations relating to growth, savings and imports, various kinds of empirical and judgmental evidence is used, though the actual practice differs from country to country.

30. The above gives the basic line of research for a typical growth/debt model used in the Bank. However, as emphasized repeatedly, flexibility is the keynote in the Bank's econometric work. The basic structure of the model as well as the method of estimating key parameters differ from country to country. For a small country, for example, the prospects of one or two export crops may be the dominant influence. In their case, exports are not treated exogenously, or in any simple fashion but are given careful attention. For larger countries, on the other hand, domestic resource mobilization may be the key and the analysis is varied accordingly.^{1/} Thus, in order to get an idea of Bank's approach, it is necessary to examine particular country models. This is what we attempt below, but instead of trying to give an

^{1/} In fact for a number of very small countries, the movements in many critical variables may be so dependent on some unique events that the statistical models may be even more difficult to construct than they are usually.

exhaustive list, we are only trying to convey the flavor of the approach by giving a few typical examples.

Some Illustrative Models

A. Mexico

31. An early example of the Bank's style was provided by the Bank's projections for Mexico over the period 1966-1970 (Report No. WH-164b). There was no explicit model in the Report but the analysis was organized on an implicit model framework. In this exercise special emphasis was placed on two-year projections only (namely for 1967 and 1968). The long-term prospects (until 1970) were presented in broader and tentative terms. The emphasis was on intensive discussion of various policy alternatives and sectoral prospects based on the official documents, discussions with the high placed officials and the judgment of the members of the Bank mission. Inadequate increase in public savings was identified as an important problem. The estimates of levels of public investment required to maintain the past growth rate of the economy were based on partial sector analysis, on draft plan of the Government and on general economic consideration and when compared with stagnating public savings, these estimates suggested a clear need for additional efforts for mobilization of public savings. A detailed analysis of Mexico's major exports suggested that earnings from commodity exports did not promise to expand as rapidly during the next few years as they did in the past. These combined with estimates of imports requirements and debt-servicing payments obtained from computerized debt programs did suggest some pressures on external account but the magnitude was such that intelligent government policy could be expected to tackle. A special feature of this exercise was the attention paid to financial flows, money supply,

sources of internal credit, changes in velocity of money, etc. in both the sample period and the projection period.

32. More recently, the projection exercise for Mexico has been formalized into a more explicit macro model (Report No. CA-14). Export projections are based on a combination of historical growth rates and judgmental estimates by the Bank. Merchandise imports are, however, determined by an import function derived from input-output analysis and regressions. The elasticity of imports to GDP is 2.3 in the short-run and about .9 in the long-run. Investments are determined by an investment function. In the long-run, 6% growth rate of GDP corresponds to an investment ratio of .181 and 7% growth rate of GDP corresponds to an investment rate of 0.202. The model was used to make projections over the period 1971-85 and to analyze the sensitivity of debt-service ratio to alternative assumptions about growth rates of GDP and the terms on which loans are secured. The Report noted that "although the debt-service ratio has remained so far within a manageable range, there is no doubt that future debt-service levels are one of the most effective potential constraints to rapid economic growth." A sensitivity analysis made with the help of the model demonstrated the alternative paths of DSR under alternative assumptions about growth rates of exports and terms of loans; this analysis was helpful in giving a quantitative feel of the various options open to the Mexican authorities. Another important insight that the model gave was with regard to the impact of private foreign capital inflow on the long-run prospects of the Mexican economy. The Report noted "if . . . foreign-owned firms grow faster on the average than the industrial sector as a whole, some difficult long-term political issues may arise. This is because foreign firms can either reinvest

their earnings or remit them abroad. If they choose to remit a large proportion abroad, the balance of payments is affected adversely in the short-run. If, on the other hand, firms remit a smaller proportion abroad, this implies a higher reinvestment and growth rate. . . . If this [latter] continues foreign-owned capital may make up over 20% of manufacturing in 1980." The extent of the dilemma was not obvious before the model runs were obtained. By emphasizing this problem, the model drew attention to policy measures necessary for tackling it.

B. Uganda

33. For an economy like Uganda's, the Bank's analysis was based on a more simplified model (Report No. AF-58). In Uganda, the availability of statistical data and economic and statistical analysts is very inadequate. In fact, the mission report emphasized that "one of the crucial bottlenecks hampering Uganda's economic development is the serious shortage of qualified and experienced staff in Government agencies and parastatal organizations." The macro model presented in the report was designed to highlight the need for policy changes with regard to saving policy and import in order to close the resources gap that would emerge if the past parameters were allowed to persist. The estimates of GDP, investment and exports were obtained from the detailed sectoral analysis. The macro model was used to estimate the import requirements and savings on the basis of past data, and to calculate the resulting savings gap and trade gap. The model highlighted that "in order to meet the mission target a considerable effort will be required to raise the marginal savings rate from a structural rate of 0.06 to a rate of 0.13. If, however, no improvement were forthcoming on savings, the necessary marginal import rate. . . would have to be 0.20 which would still entail a substantial effort" (being a reduction from a value of .51 in 1965).

C. Kenya

34. For Kenya, where data base is more developed, a fairly detailed model was constructed (Report No. AE-6a). Basically it was a standard two-gap model but a considerable amount of care was devoted to estimation of equations. Most of the critical equations were fitted in alternative forms to see if (a) marginal and average rates are equal and constant ($Y = ax$),^{1/} (b) marginal rate is constant but the average is changing ($Y = a + bx$), and (c) both average and marginal rates are changing but the elasticity is constant ($Y = ax^b$). The ICORs were fitted separately for seven sectors and formulation took account of the question of depreciation and the distinction between net and gross ICORs. The formulation was:

$$k_{gi} = k_{ni} + b r_i$$

where

k_{gi} = gross ICOR for sector i

k_{ni} = net ICOR for sector i

r_i = growth rate for sector i

The R^2 were respectable, though we do not know the plausibility of estimated k_{ni} 's.^{2/} Imports were divided into capital goods, intermediate goods and consumer goods; and sectoral investment rates utilized to estimate the sectoral requirements of imported capital goods. Agricultural exports were projected independently on a commodity-by-commodity basis. However, in simulation exercises, a simple equation relating exports of goods to output

^{1/} However, the statistical problems that this formulation raises regarding the meaning of R^2 , D.W., etc. were not discussed.

^{2/} This is important to test in the light of the results reported by Chenery and Eckstein (7). As Chenery and Eckstein suggested, when the value of the constant term in the above equation is not plausible, a constraint may have to be imposed on it.

originating in agriculture and manufacturing sectors was utilized. Imports and exports of services were made functions of imports and exports of goods in the current year. The debt subroutine was utilized in the usual manner to link net foreign exchange flow to gross flows and to estimate the effects of different terms on debt-service ratio. Subsidiary equations were utilized for estimates of duties on imports of durable and non-durable consumer goods, intermediate goods and capital goods and for other indirect taxes. The reduced form of structural equations was utilized for projections covering the period 1969-1974 and also to work out the consequences of raising value added in a given sector by fl m, of raising the growth rate of a given sector by one percentage point and of raising fixed investment of a sector by fl m.

D. Malaysia

35. A different kind of model was constructed for Malaysia. Malaysia's economy is virtually dependent on exports, particularly of rubber but also of tin. The over-all economic management has been characterized by the importance attached to market forces, although recently, a more active role on the part of the government has come into play. Since exports provide the engine for growth and investment in exports industries are primarily demand determined, the Bank's macro model for Malaysia is primarily of Keynesian kind. In simulations, alternative assumptions are made for exports and government expenditure as well as for estimated coefficients. However, because of the quality of data, the model has not been incorporated in the Bank's Reports for the country, although it does influence their general structure.

E. Jamaica

36. Another excellent example of the flexibility of model structure is provided by the model for Jamaica (4). The model begins by emphasizing the need for specifying "key constraint to development". "In the case of Jamaica, an analysis based solely on information available publicly outside the country appeared to indicate that Jamaica's growth was being hindered by a possible lack of foreign exchange. Once the mission carried out its field work it was apparent that this was not the case and that both foreign exchange and savings were reasonably abundant. . . there were noticeable shortages in infrastructure such as roads, water and power; and these, it was clear, were real constraints to growth." These, in turn, were traced to real shortage of skilled manpower. It is this factor that was critical in determining the probable movements in ICOR and not just past movements in ICORs. The projection of investment, savings, exports, imports, etc. proceeded along the usual lines. The model constructed was subjected to alternative simulations to work out the effects on growth of alternative assumptions with regard to bottlenecks in crucial social overhead investments.

F. Colombia

37. With the advantage of better data and analysis, a more detailed model was constructed for Colombia (Report No. WH-200a). One distinguishing feature of the Colombian economy is its dependence on coffee exports which have substantial influence on public revenue as well as private income. The macro model was basic one-gap (savings gap) type with emphasis on requirements. Of course, the import coefficients as well as availabilities were examined to check the plausibility of the estimates, but so far as the algebraic formulation of the model goes, it was in terms of one-gap requirements analysis

for different rates of growth. One interesting feature was the breakdown of the economy into four sectors: (a) Agriculture, Forestry and Fishing; (b) Modern Manufacturing, Mining, Transport and Energy; (c) Handicraft Manufacturing, Construction, Commerce, and Personal Services; (d) Banking and Other Services. This breakdown is particularly useful in so far as the different sectors differ with respect to ICOR, capital-labor ratio and import content for production and investment. Thus, it gave a scope for analysis of the effects of changes in sectoral composition on such vital parameters as over-all ICOR, import-coefficient, employment-output ratio and saving income ratio.

38. Sector specific ICORs were calculated on the basis of the historical record, work done by ILO employment mission and judgment about the future of the Colombian economy. The marginal saving ratio (MSR) was estimated "so as to maintain average savings at about 22% of the GDP for the next 4-5 years, then raised steadily to nearly 25% by 1985." Government consumption was set to grow at 10% per year and private consumption was computed as a residual. Exports of goods and non-factor services were specified "exogenously" for each year of the projection period; but this was based on intensive research on prospects of coffee. Imports of goods and non-factor services were determined by the model as equal to exports plus the savings investment gap. The savings investment gap together with the figures of debt servicing payments gave the figures of gross foreign capital requirements for different rates of growth. In examining various alternatives, attention was given in a judgmental fashion to such factors as absorptive capacity, movements in debt-service ratio and growth in public revenue. The last mentioned factor was considered because "if government revenue is not adequate to meet the

demands of growing debt-service, current expenses, and the domestic currency portion of new investment projects, external lenders may be unable to commit resources on the desired scale." The model was, thus, run on various assumptions about prospects of foreign assistance, export prospects, etc. and a plausible profile for growth rate, debt-service ratio, etc. was obtained.

G. Indonesia

39. An even more detailed and sophisticated model was constructed for Indonesia (Report No. EAP-22). This simulation model for medium-term projections was predominantly demand determined type. Agricultural growth and exports were the prime movers in the model. The externally determined demand for Indonesia's exports - or as the case may be, supply limitation of export products - generated directly the growth of output in the export oriented agricultural and mining sectors. The non-export agricultural output was determined outside the model. The output of manufactures was dependent mainly on domestic consumption and investment expenditures, including opportunities for import substitution. Output of the transport, power and other service sectors were determined by over-all economic growth.

40. Investment requirements were determined through sectoral ICOR and sectoral growth rates. The savings gap and exchange gap were calculated in the usual fashion. However, the model specified explicitly for import substitution to meet the excess of balance of payments gap over the resource gap and after the point beyond which import substitution was not regarded feasible, the model prescribed currency devaluation as the instrument of last resort for adjusting the balance of payments gap. Another distinguishing feature of the model was the consideration of the effect of population growth. Through its impact on the composition of demand and indirectly on the balance

of payments, its influence on the pattern of growth was assessed as completely as possible. Therefore, the model lent itself to an evaluation of the consequences of a family planning program in economic terms. The model was utilized to make projections on a ten-year period (1970-1980) and also to examine the effects of alternative assumptions about population growth, agricultural growth, and indirect tax rates.

41. The above list of macro models in the Bank is by no means exhaustive. Apart from a number of existing models on countries such as Ghana, Venezuela and Turkey not mentioned above, there are quite a few more under construction at present.^{1/} However, we feel that the models reported above illustrate the over-all style of flexible model-building approach followed in the Bank.

42. It is, of course, difficult to be sure about the exact role that the models play in the Bank's operations. As in the profession at large, so in the Bank, the models have been found chiefly useful not as precise fore-caster or simulator but in various subsidiary ways. Generally, the model-building efforts have been found to be a useful way of being introduced to a country's economy. The models have also provided a useful framework for putting data in perspectives, for giving a quick computational framework and for organizing the discussion of policy issues. As regards the actual input into country reports the results of operations of debt subroutine are the most common feature with some reports incorporating the macro model itself. There have been cases when an analysis of model results revealed dilemmas created by large inflows of private foreign capital. The model brought out

^{1/} In particular, a sophisticated model on Korea has already reached an advanced stage.

the point that at the prevailing rates of private capital inflow, a country in future would have to put up either with high proportion of foreign ownership (which may be politically explosive) or with high outflow of profit with its strains on balance of payments. Similarly, some models in the earlier periods revealed the burden of growing debt that some countries may have to face in future. Some models gave insights into the interrelationships between internal tax revenue collections and balance of payments, about domestic food sufficiency requiring more food production than the amount being dropped from imports. Thus, the models have been chiefly useful in ancillary ways. In a field as complex and ever changing as economic life, it is difficult to construct comprehensive all-purpose models which can become directly usable vehicles of decision-making. There is certainly room for careful refinements in these tools, but uncritical and unimaginative mushrooming of big "sophisticated" models for LDCs (along the pattern of the Brookings model for U.S.A.) does not seem to be the answer. Our over-all view is that both for the importance of organizational continuity and for scientific reasons, the future approach should be one of evolving, adapting and refining the present approach rather than one of sharp break in favor of more "sophisticated" econometric models. This basic theme is elaborated below.

IV. Evaluation and Thoughts for the Future Research

43. As discussed above, the pragmatism and flexibility of the Bank's model-building approach has much to commend itself in the Bank's environment and the temptation of going in the direction of mechanical all-purpose econometric models should be resisted. However, because of the nature of

the evolution of this process, certain crudities have developed in these models and in the light of the extended horizons of the Bank's involvement, it is desirable to undertake a thorough stock-taking of the present practice and discuss outlines of future research in this area.

Objectives of the Bank's Models

44. A careful definition of the objectives of model-building is extremely important for efficient designing of macro models. The idea that one could design a big model of an economy which will be a photographic reproduction of the economy and can be used to discuss any problem that may come up has, in our opinion, proved unsuccessful.^{1/} A more promising line is problem-oriented model-building where one starts with a clear specification of the problems at hand, examines, on a priori, reasoning the salient lines of causation involved for these problems analyses the areas where quantification will be helpful and then designs the econometric models for help in that quantification. One unsatisfactory aspect of the models in the Bank at present is that in the process of evolution the objectives of the model-building exercises have not been discussed and specified as clearly as they could have been. Thus, it seems to us that a discussion of the objectives of the models in the different departments involved may be highly useful. Some initial thoughts that seem relevant as a starting point for discussion are noted below.

45. The Bank, as a joint organization of borrowers and lenders, has to keep in mind the dual (though, of course, related) aspects of loans.

^{1/} All-purpose models quite often turn out to be no-purpose models. They are often found to be too simplistic for the problem under consideration and too detailed for nonessential peripheral aspects.

From the point of view of the lenders, it is interested in knowing whether the loans will be repaid on schedule; and from the point of view of the borrowers, it is interested in knowing up to what point the loans will increase the productive capacity of the economy in the long-run. For the former, the Bank's models should give some index of creditworthiness of the borrowing countries. For the latter, the Bank's models should be of some use in computing the long-run productivity of loans after due adjustment for difference between actual and shadow prices of foreign exchange and such other distortions in the economy. More recently, the Bank has been emerging as the leader of international lending and is thus becoming much more involved with the over-all growth prospects and problems of the LDCs. In order to meet this side of its responsibility, it would be desirable to have the Bank's models focus on some critical problems of development such as unemployment problems, debt problems and possibly trade problems. These three broad objectives are elaborated below.

(a) Creditworthiness Index

46. In the Bank's economic discussions, the debt-service ratio (DSR) plays an important role in considering the creditworthiness of different countries. In spite of its simplicity, DSR has displayed impressive powers of survival and it seems desirable that the macro models should continue generating some such simple summary index of creditworthiness. However, now that we have experience of a number of countries which have had debt-servicing problems, it may be desirable to examine their experience closely to see if we can come up with some more refined definition of DSR which may include a number of other elements of debt mentioned by Avramovic (1, see page 13 above). This, of course, has to be discussed separately from model-

building exercises but once a better definition of DSR is agreed to, the macro models may be designed to yield this kind of DSR.

(b) Productivity of Loans

47. The Bank's research has been rather thin on this aspect, mainly because of its inherent complexities. Evaluation of projects, of course, are made but it is obvious that these measures are incomplete to the extent that they fail to capture the spread effects of the projects and feedbacks of the system. It is obviously important to discuss if the macro models can have built into them some flexibility to consider sectoral composition of output and whether they can yield some guidelines (e.g., shadow prices) for use at project evaluation.

(c) General Development Problems

48. It is becoming increasingly obvious that along the lines of present development paths of most LDCs, the unemployment and debt problems may become really serious by the end of this century. Macro models may be utilized to quantify and specify the magnitude of these problems. Even more important, the models could be vehicles of trying some alternative policy packages (monetary, fiscal and others) which through their influence on critical parameters such as capital-labor ratio, capital-output ratio, marginal saving ratio, marginal import needs, etc. may alleviate the problems of underemployment and debt.

49. A similar problem is the analysis of the global implications of export promotion policies being followed by LDCs. As a curious reminder of cobweb theorem, the LDCs may now be swinging from the extremes of import substitution to the extremes of export promotion. It is possible that some indicative research on global trade needs by the World Bank may be useful

in rescuing the LDCs from dangers of laissez faire of national planning. Global trade models may thus be helpful.

50. Another interesting problem that the World Bank is already discussing in the framework of models is the projection of world needs for foreign aid and their matching with the expected supply.

51. The above lists a number of possible objectives of the Bank's models. As discussed above, the needs for country analysis may sometimes conflict with the needs for global analysis. The cost-benefit analysis of the alternatives is worth discussing. Our preliminary feeling is that with computer technology so developed (and developing so rapidly) the costs of maintaining separate sets of models for separate problems may not be totally prohibitive in the light of the advantages gained.

Specification of the Models

52. The specification of the macro models would naturally have to be modified to include new aspects concerned with employment, redefined DSR, etc. and this can be discussed only after agreement on the objectives mentioned in the preceding paragraphs. However, it may be desirable to discuss some obvious crudities in specification of the present models.

53. First of all, the role of prices, both absolute and relative, should not be neglected to the extent it is neglected at present in the Bank's models. In the first place, the discussion of gaps and debt-servicing requirements is meaningful only in terms of current prices.

Even the definitional equality of two gaps ex post does not sometimes hold at constant prices in some national accounts. Similarly, the current prices framework may be useful for studying the effects of inflation in more developed countries (MDCs) on capital requirements of LDCs. This problem

may be worth analyzing in terms of econometric models because a continuous inflation in MDCs may well be the characteristic of the seventies and because model results may well be different from what one at first expects intuitively. Intuitively, at first thought, one expects that inflation will reduce the burden of debt. However, in the case of LDCs their export prices do not seem to be very sensitive to inflation in MDCs whereas their import costs are. Moreover, inflation increases interest rates in MDCs and thus the Bank's lending rates which in turn will affect the future debt-servicing costs. Thus, a continuing inflation in MDCs in seventies will increase the debt-servicing difficulties of LDCs in seventies and eighties.

54. Even more serious than the neglect of absolute prices, is the neglect of relative prices in the Bank's models. This, of course, is part of the deemphasis on price-mechanism in both MDCs and LDCs in the postwar period. However, in recent years, it is beginning to be realized that price mechanism may have some important bearing on employment prospects, debt prospects, etc. of LDCs. If the models are to be used to give guidance on how to reduce the severity of these problems, the models may have to be reconstructed to capture the effects of fiscal and monetary policies such as interest rate, exchange rate, tariff rates, excise taxes, corporate income tax, investment credits, depreciation allowances, etc. on such vital parameters as capital-output ratio, capital-labor ratio, import content of GNP, export prospects, etc.

55. Another unsatisfactory feature is the inadequate linking among measures of resource gaps. Usually in the Bank's models, the computations of the two gaps are carried out as completely independent exercises.

Factors that affect internal savings are not analyzed for their effects on external resource gap. Similarly, measure for increase in public savings are discussed without working out their effects on private savings or external gap. There are, of course, difficult problems in establishing these links, but it may be worthwhile exploring them and formulating models in such a way that these aspects are not forgotten by model builders.

56. In general, the Bank's models deal too exclusively with national account categories without integrating them properly with balance of payments, budgetary and monetary accounts. Quite often policy suggestions involve changing these monetary flows and it will be desirable to analyze the links between financial and national accounts. Thus, for a proper analysis of whether investment needs are matched by savings, it is important to analyze not just their aggregate magnitudes but also to see whether the channels of financial flows utilized by investors are likely to get funds generated by savers. The whole field of financial flows and its link with national accounts is in an underdeveloped state even in the more developed countries. However, an attempt at introducing these aspects, when feasible, will improve considerably the effectiveness of models for analyzing the problems of capital flows and debt analysis. Apart from its policy implications, the financial flow analysis may be useful in cross-checking the estimates of various national accounts categories, which is an important function in the light of the weak data base of many LDCs.

57. Having pointed out the need for more details in specifications of the Bank's models, we must emphasize that disaggregation as such in model-building has not been particularly successful and more details should be

incorporated only in response to clearly defined needs. As an example, we feel that large scale input-output oriented models may not be particularly helpful to the Bank's work. These models are particularly designed to analyze interindustry flow of resources and these require a considerable amount of time and research. We feel that neither in the light of the Bank's needs nor in the light of the Bank's comparative advantage can a strong case be made for large scale input-output oriented model-building in the Bank for LDCs. The best approach may be to keep in touch with the research in client countries and other international organizations in the field of input-output model and utilize their results when necessary for macro model research. Some excellent examples of how to use the results of input-output analysis in the framework of a macro model are provided in Chenery and Bruno (6).

Statistical Estimation Techniques

58. It is sometimes argued as a criticism that the Bank's econometric model-building work does not make use of the sophisticated techniques such as two-stage least squares, limited information maximum likelihood and such other simultaneous equation techniques. In our opinion, the degree of success achieved by these techniques even for developed countries is only limited in extent and the temptation of going in this direction should be resisted. More specifically, we would summarize our criticisms of simultaneous equation approach for LDCs as follows:

- a. The data available for LDCs are generally of a short duration and poor quality so that the simultaneous equation techniques which eat up degrees of freedom rather voraciously are not particularly suitable.

b. These techniques require precise specifications of exogenous variables for estimation. However, since the Bank's models have to be used in flexible manner where some endogenous variables in one exercise (say, growth rate) become exogenous variables in another, this kind of specification is not possible.

c. Even in the experience of developed countries, it has been found that the simultaneous equations techniques give estimates of parameters which do not appear statistically significantly different from OLS estimates. This was also found to be the case for Jamaica model by N. G. Carter (5).

d. The application of the TSLS and LIML methods lead to an increase in the degree of collinearity in the explanatory variables which complicate the already most serious problem of estimation in econometric model.

59. Thus at present, it is desirable to concentrate on single equation OLS approach for developing the Bank's macro models. However, one should not neglect the use of the usual statistical tests like Durbin-Watson statistic, t-ratios, etc. as may be sometimes tempting to do in the Bank's time constrained research. Similarly, while there is nothing unscientific about treating parameters as shifting over time due to structural changes and policy changes, it should not be used (as there is sometimes a danger of doing) as a license for unconstrained parameter adjustments. While there is no precise mechanical way of predicting these parameters, it is desirable

to discuss some refinements which might increase the element of objectivity in this respect.

(a) Use of Cross-Section Evidence

60. In the first place, it has to be emphasized that the typical time-series data of an LDC are generally so short, so inaccurate and provide such a small range of experience, that analysis of cross-country experience may be essential for projections and as well as policy analysis. Thus, projections of industrial pattern for a country may well benefit from cross-section studies of countries at different levels of growth. Similarly, if one is interested in analyzing the effects of, say, higher interest rate policy on capital-labor ratio or of exchange rate flexibility on trade gap, one may not get much guidance from a time-series where these kinds of policies were not followed. Much more profitable will be analysis of experience of countries which at particular times did follow these kinds of policies. Here again, of course, it is important to emphasize the dangers of mechanical use of cross-section results. The essential point is that one must sift the material carefully in order to gain some confidence that the situations are comparable, that samples come out of the same population. Moreover, one must not expect precise scientific estimates but only some broad guidance from the statistical material to be continually checked against a priori theoretical results.

(b) Refinements in Time-Series Regression

61. Even while using time-series regression, it may be worth considering some refinements specifically geared to our context. One serious problem of estimation in LDCs is that the structure is changing rather fast and it may not always be right to assume an unchanging structure even over a small sample

period of 15-20 years. Thus, our technique should be so designed that it is alert to changing situation and picks up changing structure as soon as possible. One procedure that may be useful for this is that of obtaining time-weighted least squares. Thus, instead of minimizing the simple sum of the squares of the errors ($\sum e_i^2$), we may minimize a weighted sum (namely, $\sum \lambda_i e_i^2$) where weights decline in some predetermined fashion. Thus, we attach greater importance to an error in recent period than to an error in the remote past.

62. A second refinement we would suggest is to consider how far our parameters may be shifting over time because of compositional changes. As is well known, macro parameters are stable only if either the composition of the aggregate remains unchanged or if the micro parameters are the same for all the elements in the aggregate. Agarwala and Proulx (3) applied a technique of obtaining shifting parameters due to compositional changes. The basic logic of the technique is simple. Suppose the ICOR for industry i is β_i and required increase in output is ΔY_i . Then the total investment requirement is:

$$I = \sum I_i = \sum \beta_i \Delta Y_i$$

or

$$I = \Delta Y \beta_1 \sum \frac{\beta_i}{\beta_1} \frac{\Delta Y_i}{\Delta Y}$$

$$= \Delta Y \beta_1 (\text{ADJ})$$

where

$$\text{ADJ} = \sum_i \frac{\beta_i}{\beta_1} \frac{\Delta Y_i}{\Delta Y}$$

The ADJ is a weighted average of the proportion of increase in output in different sectors. The weights are the relative ICORs of different sectors.

Quite often we have some idea of these relative ICORs on the basis of cross-section and such other information. Thus, in running the regression, we would obtain an estimate of β_1 whereas the over-all ICOR which is defined as (β_1 ADJ) may well be shifting over time due to compositional change.

63. Apart from the advantage of better estimation from time-series data, the above approach may introduce greater comparability in parameters across countries. One important reason why the cross-country ICORs may differ is the difference in composition of output. If the above technique nets out the effect of difference in composition, we may be in a better position to judge the plausibility of one country's estimate of ICOR in the light of the experience elsewhere.

(c) Data Refinements

64. The refinements of techniques of statistical estimation can be useful only if the basic data are reliable. Thus, every effort should be made to improve the quality of data not only by greater expenditure on data collection but also by systematic cross-checking. A few decades ago the errors in variables received considerable amount of attention of economists (e.g., Keynes' interesting discussion on various statistical magnitudes in Indian Currency and Finance) but recently the attention has shifted almost exclusively to errors in equations, with some honorable exceptions such as Kuznets' work. At least for LDCs, this degree of shift is premature. Unless efforts in this direction are increased, model builders in LDCs will remain in the situation of a pilot trying to fly an aircraft when he does not know where he is or even where he has been.

65. However, quite often the problem is not just the quality of data but the econometrician's inadequate screening of data and failure to obtain

the figures that the theory behind the equation requires. An example may be helpful. As emphasized by Chenery, the growth process is sometimes constrained by savings and sometimes by foreign exchange. It is not, therefore, entirely satisfactory to use, as is often done in the Bank's models, all the data to estimate both ex ante savings functions and ex ante import functions. Saving function should be estimated by figures in those years where savings was a constraint and similarly for imports function. This may, of course, be quite a difficult thing to do in practice but it seems worth while to consider this problem. In general, it will be useful to consider the process of equalization between two gaps ex post starting from a position of ex ante gap. This may be helpful for the better understanding of the economics of the situation as well as for better statistical estimation.

66. Apart from the specific aspects of specification and estimation discussed above, it seems that Bank's models do not have a continuity that is extremely useful in improving the art of model-building and using. Quite often in the Bank, a model is constructed for a country and used for one particular report and then forgotten. This does not give scope to the process of "learning by doing" which has been found very useful in econometric model-building projects. This is particularly important for the Bank's work because in these models the process of construction and use is somewhat judgmental, and it is not possible to estimate the forecasting errors, or Theil's inequality coefficients in a mechanical manner over the sample period before using the model. In this context a systematic post mortem of the descriptive kind may be feasible and if regularly conducted, it may build up a body of judgmental knowledge that may gradually improve the quality of econometric model-building.

Conclusion

67. The intensive research on econometric model-building in the U.S. (and other developed countries) in the last 20 years has clearly revealed certain points of strength and weakness of comprehensive macro econometric models. Their strength lies in providing an organizational framework for data, for discussion of the issues involved and for quick and consistent computations; their weakness lies in that when faced with a specific problem they are found to be too simplistic for the problem under consideration and too detailed for peripheral aspects. As problem solving operations, the simple quantitative concepts like Keynes' employment multiplier and inflationary gap or Okun's full employment surplus and relation between "gap" and unemployment are perhaps more effective in policy-oriented environment, in spite of their simplicity and partial character. It is perhaps desirable to combine the best of the two approaches and develop problem-oriented macro models which incorporate as much detail and realism as possible for the aspects crucial to the problem under consideration and obtain feedbacks of the system in a simplified framework.^{1/} Being an operational institution, the Bank has naturally developed models intended to be helpful in its assessment and lending programs. The simple and flexible nature of the resulting models is not such a serious defect as it may seem to be the case to a mechanically minded model builder. However, in the process of evolution of Bank's models, certain crudities and lopsidedness have developed, and it is desirable to streamline these operations. Apart from the obvious aspects

^{1/} For a more detailed discussion of how this kind of problem orientation is essential for different stages of model-building - specification, data processing, selection of estimation techniques and testing the performance of the model - see Agarwala and Proulx (3).

of streamlining with regard to preparation of data banks, parameter banks, common notations and computer programs for estimation and solution, we suggest the need for clarification of the objectives of the models, refinements in estimation techniques and need for data improvements. These improvements should, in our opinion, enhance the utility of the models for the Bank's work. However, even with improvements, the models must be treated as approximations to reality suitable for particular contexts and particular problems only. The model builders must be alert to changing situations and be prepared to modify their models as new problems and new insights emerge. If models become substitutes for hard thinking and continuous vigilance to changing economic life, they can be misleading. Econometrics at its best is a humble servant of economic common sense; when it tries to be the master it destroys both (itself and economic common sense). Only with a proper appreciation of the roles of judgment as well as quantitative techniques, can the economic research best serve the management in making decisions which will contribute toward meeting the greatest challenge facing humanity today: eradication of the poverty, disease and malnutrition prevailing in the large parts of the world.

11. D. P. Hayes and P. J. Marzetta, "The Need for Development Assistance: An Interchange," The Economic Journal, June 1971.

12. R. J. Gordon, "The Brookings Model in Action: A Review Article," The Journal of Political Economy, May/June 1970.

13. A. S. Goldberger, Impact Multipliers and Dynamic Properties of the Klein-Goldberger Model, Amsterdam, North Holland Publishing Co., 1958.

14. D. P. Hayes and P. J. Marzetta, Policy Simulations with an Econometric Model, Washington, D.C.: The Brookings Institution, 1968.

References

1. D. Avramovic and Associates. Economic Growth and External Debt, IBRD, The John Hopkins Press, Baltimore, 1964.
2. R. Agarwala. "Tests and Uses of Macro Econometric Models: A Critical Survey", Economics of Planning, Vol. 9, No. 3, 1969.
3. R. Agarwala and G. Proulx. A Study in Econometric Model-Building for Medium-Term Macro Economic Analysis (mimeograph), Economic Council of Canada, 1971.
4. N. G. Carter. Notes on a Macro Economic Model Used to Project the Possible Performance of the Jamaican Economy, 1968-1973, IBRD, Economics Department Working Paper No. 50, 1969.
5. N. G. Carter. A Macro Economic Model of Jamaica, 1959-1966, IBRD, Economics Department Working Paper No. 65, 1970.
6. H. B. Chenery and M. Bruno. "Development Alternatives in an Open Economy: The Case of Israel", The Economic Journal, March 1962.
7. H. B. Chenery and P. Eckstein. "Development Alternatives for Latin America", The Journal of Political Economy, July/August 1970.
8. C. F. Christ. "A Test of an Econometric Model of the United States, 1921-47" in Conference on Business Cycles, New York: National Bureau of Economic Research, 1951.
9. Ronald L. Cooper. "The Predictive Performance of Quarterly Econometric Models of the United States", Paper presented to Conference on Research in Income and Wealth, November 1969.
10. J. S. Duesenberry, G. Fromm, L. R. Klein and E. Kuh (Ed.). The Brookings Econometric Model of the United States, Chicago, Rand McNally 1965.
11. G. Fromm and P. Taubman. Policy Simulations with an Econometric Model, Washington, D.C.: The Brookings Institution 1968.
12. A. S. Goldberger. Impact Multipliers and Dynamic Properties of the Klein-Goldberger Model, Amsterdam, North Holland Publishing Co., 1959.
13. R. J. Gordon. "The Brookings Model in Action: A Review Article", The Journal of Political Economy, May/June 1970.
14. J. P. Hayes and R. L. Marris. "The Need for Development Assistance: An Interchange", The Economic Journal, June 1971.

15. B. Hickman (ed.). "Econometric Models of Cyclical Behavior",
Proceedings of Conference on Research in Income and Wealth
held at Harvard in November 1969, (to be published by NBER).
16. H. G. Johnson. "The Keynesian Revolution and the Monetarist Counter-
Revolution", The American Economic Review, May 1971.
17. J. M. Keynes. "On a Method of Statistical Business Cycle Research",
The Economic Journal, 1939.
18. L. R. Klein. Economic Fluctuations in the United States, 1921-41,
New York, John Wiley & Sons, 1950.
19. L. R. Klein and A. S. Goldberger. An Econometric Model of United
States, 1929-52, Amsterdam, North Holland, 1954.
20. Axel Leijonhufvud. On Keynesian Economics and the Economics of Keynes:
A Study in Monetary Theory, New York, Oxford University Press,
1968.
21. W. Leontief. "Theoretical Assumptions and Non-Observed Facts", The
American Economic Review, March 1971.
22. O.E.C.D. Quantitative Models as an Aid to Development Assistance
Policy, Paris, 1967.
23. A. M. Okun. "Potential GNP: Its Measurement and Significance", in
Proceedings of Business and Economics and Statistical Sections
of the American Statistical Association, 1962.
24. A. M. Okun. The Political Economy of Prosperity, Washington, D.C.:
The Brookings Institution, 1970.
25. A. M. Okun and Nancy H. Teeters. "The Full Employment Surplus
Revisited", The Brookings Papers on Economic Activity, No. 1,
1970.
26. Arun Shourie. The Relevance of Econometric Models for Medium- and
Longer-Term Forecasts and Policy Prescription, IBRD, Economics
Department Working Paper No. 75, 1970.
27. J. Tinbergen. Statistical Testing of Business Cycle Theories,
Vol. I, League of Nations, Geneva, 1939.
28. UNCTAD. Trade Prospects and Capital Needs of Developing Countries,
United Nations, New York, 1968.

15. B. Hickman (ed.). "Economic Models of Cyclical Behavior".
Proceedings of Conference on Research in Income and Wealth
held at Harvard in November 1969, (to be published by NBER).
16. H. G. Johnson. "The Keynesian Revolution and the Monetarist Counter-
Revolution", The American Economic Review, May 1971.
17. J. M. Keynes. "On a Method of Statistical Business Cycle Research",
The Economic Journal, 1939.
18. J. R. Klein. Economic Fluctuations in the United States, 1921-11,
New York, John Wiley & Sons, 1950.
19. J. R. Klein and A. S. Goldberger. An Econometric Model of United
States, 1929-52, Amsterdam, North Holland, 1951.
20. Axel Leijonhufvud. On Keynesian Economics and the Economics of Keynes:
A Study in Monetary Theory, New York, Oxford University Press,
1968.
21. W. Leontief. "Theoretical Assumptions and Non-Observed Facts", The
American Economic Review, March 1971.
22. O.E.C.D. Quantitative Models as an Aid to Development Assistance
Policy, Paris, 1967.
23. A. M. Okun. "Potential GNP: Its Measurement and Significance", in
Proceedings of Business and Economics and Statistical Sections
of the American Statistical Association, 1962.
24. A. M. Okun. The Political Economy of Prosperity, Washington, D.C.:
The Brookings Institution, 1970.
25. A. M. Okun and Nancy H. Teeters. "The Full Employment Surplus
Revisited", The Brookings Papers on Economic Activity, No. 1,
1970.
26. Aron Sroufe. The Relevance of Econometric Models for Medium- and
Longer-Term Forecasts and Policy Prescription, IPRD, Economics
Department Working Paper No. 15, 1970.
27. J. Tinbergen. Statistical Testing of Business Cycle Theories
Vol. I, League of Nations, Geneva, 1939.
28. UNCTAD. Trade Prospects and Capital Needs of Developing Countries,
United Nations, New York, 1968.