

HISTORICAL BACKGROUND OF GLOBAL MODELING

Akira ŌNISHI

1. Birth and Background of Global Modeling.
2. The "Limits to Growth" Global Model.
3. The Mesarović-Pestel Global Model.
4. Klein's "Project LINK"
5. The challenge of Making New Model.

1. Birth and Background of Global Modeling.

In this paper we should like to trace the genealogy, so to speak, of the global models which have been developed for purposes of analyzing current economic situations and doing research on how we can help shape the future in desirable directions as we move toward the 21st century in search of a New International Economic Order.

Behind the intensified interest in global models which has among research organizations in all countries increased markedly since the beginning of the 1970s, we should mention not only the recognition that the development of each country's economy depends on globally interdependent relationships, but also the fact that individuals in all countries, when thinking about the future of human society, have a stronger-than-ever desire to be able to grasp, in terms that are as quantifiable as possible, the ways in which human life will be affected by limitations on available resources and energy and by other restraints posed by environment.

Heretofore the "traditional economics" has been studied with the economy of one or another single nation as its primary focus of attention. With respect to individual countries, major problems set before the science of economics have been questions of, for example, how to eliminate business stagnation and unemployment; what can be done to raise the population's material standards of living; or what sorts of resource distribution are desirable for purposes of getting maximum efficiency at minimum cost. However, in today's world

* Department of Economics, Soka University.

of intensified transnational interdependence, we often bump into cases where what is by many considered to be a rational policy for one's own country becomes an inconvenience for other countries. Thus we may say that interest in researching world economic models has increased, first and foremost, because of the necessity to make adjustments among the economic policies of different countries.

For an example of how economic interdependence can give rise to frictions let us here look at the sorts of trade frictions between the United States and Japan which attracted attention in recent years. While Japan's exports to the United States were during these years at a relatively high level, Japan's imports from the United States were inevitably at low level because of Japan's sluggish domestic demand situations. At the same time, because of Japan's technological innovation, higher labour productivity increase in the export industries, sales in the overseas market or such items as automobiles and electronic products were increased with the great success that these products came to be exported to overseas markets in greater—especially to the United States.

In this way, then, frictions inevitably occurred in the trade between the US and Japan. In cases where importing business conditions are relatively good in the US market but relatively bad in the Japanese market, the US cannot export to Japan the hoped-for volume of manufactured goods, foodstuffs and raw materials, with result that the US trade balance with respect to Japan worsens.

Let us take as a further illustration of reasons for the Japan-US trade friction the typical automobile produced in Japan and exported to the US. Because this vehicle was fitted with equipment to minimize air pollution and was at the same time economical in its consumption of fuel, it is not surprising that in the US, where strict controls on automotive exhaust gases had been instituted, and where citizens were living under the restraints of high prices for petroleum energy and thus were becoming more interested in energy-saving, should show a strong interest in the Japanese cars which consumed relatively little fuel.

In relation to the Japan-US trade imbalance dilemma in 1980 that was brought about largely by increased Japanese automobile to the US, there was also an exchange rate dilemma in which the yen became weaker in a Japan where domestic prices and interest rates were relatively stable and the dollar became stronger in a US where domestic prices and interest rates were rising at a fast tempo.

These sorts of problems are ones which by their very nature cannot be solved except by mutual adjustments in the economic policies of Japan and the US. A solution cannot come simply from economic policies adopted by Japan alone. The above is indeed a good

illustration of the fact that in today's international economic order many important problems can no longer be solved just within the framework of the economy of any single country.

Characteristic of our times and having done much to attract interest to research on global models are current problems having to do with resources and energy. As we move toward the 21st century it is not impossible that in our global society—we might call it a society now in transition from petroleum energy to such substitutes as nuclear and solar energy—problems concerned with energy could become a sort of “time-bomb” that might eventually precipitate violent global conflict.

As long as the present economic growth patterns of the industrially developed countries continue, energy consumption will continue to increase enormously and it follows that energy supplies to support this growth would have to be available. Without assured energy supplies, the world's economy could fall into serious disorder.

As evidenced in the energy question, from now into the 21st century global society will embrace a large number of serious problems in regard to which the whole of humankind is being pressed to find solutions. But we are living in a time when people around the world indeed begun to search in earnest for ways to transform for the better the present “human society on the brink of crisis.”

In order to solve these problems on a global level, traditional models dealing with the economies of single countries are incapable of performing the necessary analysis, while “global models” which make the whole world the object of their attention are, needless to say, a necessity. It is through a historical process of responding to realities that global models have come to be researched and developed.

2. The “Limits to Growth” Global Model.

At present, three types of approaches are used in building global models, one of which is the “World System Dynamics Model” developed by Jay W. Forrester Massachusetts Institute of Technology in the United States.¹⁾

This model, which considers the whole world as a single system, makes use of composite statistics on world production, population, resources, environment, food supplies, etc., and then applies the methods of systems analysis to make analyses of how these variables are interdependently related to one another and how these relationships have changed from past to present and can be expected to change in the future.

1) Jay W. Forrester, *World Dynamics*, Wright-Allen Press, Cambridge, Massachusetts, 1971.

This World System Dynamics Model was the basic model used in preparing the Club of Rome's first report, entitled *The Limits to Growth*.²⁾ The report itself, written under the direction of Forrester's younger colleague Dennis and Donella H. Meadows, made forecasts about the world's future and points out that if present growth patterns in the industrially advanced countries continue, before long further economic growth would necessarily have to be limited because of exhausted resources and environmental pollution. Similarly, it warned that if the world's population kept increasing in line with present patterns, one day famine would stalk forth because of the limits to the world's food supplies and humankind would be in a grave crisis.

The Limits to Growth is significant and of scientific interest not just because of the vision expressed in its forecasts of alternative futures, but also because of the fact that it used methods based on the achievements of the science of system dynamics—including computation by computer and the exposition of forecasts in quantifiable terms.

The techniques by which factual economic data may be expressed in a computer model and then, in the form of a system made up of linear and/or non-linear equations, may be subjected to computer analysis, belong to the field of "systems science" which made rapid progress after the Second World War. The research team led by Meadows undeniably made a very large and pioneering achievement in applying with dexterity advanced "software" technology at that time, with the help of a large-scale computer, to forecast future circumstances in global society. This achievement shows that future circumstances which we draw in our heads only vaguely and indistinctly can, by such "scenario analysis," be drawn more scientifically and more quantitatively, responding to questions about when, and in what way human society may be expected to experience them.

When *The Limits to Growth* was consulted and read throughout the world, it collided in a rather extraordinary way with many people's preconceptions because, in offering prescriptions for the crucial questions of how, after all, each country could overcome future problems concerning resources and energy, urgent recommendations are made for a radical revolution in the growth patterns that have heretofore supported the industrially developed countries, and even changes in people's sense of values away from those values which center around, or put greatest emphasis on, material things.

So with the publication of *The Limits to Growth* giving part of the impetus, in the early 1970s a new slogan was born: "small is beautiful." Before, not only was the phrase "big is beautiful" widely encountered, but it was widely thought to be necessarily up-to-date and in best style to applaud ever larger production and ever material standards of living.

2) D. H. Meadows, et al., *The Limits to Growth*, Potomac Associates, Washington, 1972.

—even the gaining of “world superpower” status (especially in the case of one’s own country)—through economic growth and the accumulation of wealth. Small enterprises thought it smart to grow, if possible, into big enterprises and in time to expand worldwide in the form of giant multinational enterprises. But we may say that today there have arisen doubts in regard to massive, limitless growth; also we may say that an era has begun in which we aim at conserving energy and resources and are groping for new patterns of growth which will allow this to be realized.

The future world (or future social system) which Forrester envisioned was a world in a sort of stable equilibrium. Population, for example, would not further increase beyond limits which the global society could bear. And it should be expected that people’s material wants would be kept under control accordingly. Present-day growth patterns which dissipate massive amounts of resources and energy would be changed and, after a reasonable and globally equitable standard of living had been achieved, growth rates pared down as much as possible—if possible, to “zero growth” equilibrium. In such a concept, equilibrium is considered to be achieved under conditions of both zero economic growth and zero population growth. Such was Forrester’s vision of future society.

A very interesting point in this connection is that the above concept coincides with the final destination of economic growth, namely the “stationary state” written about by such classical economists as Adam Smith, David Ricardo, and John Stuart Mill. In at least one respect, it is a modern edition of Thomas Malthus’s theories about population.

Malthus, in his famous work entitled *An Essay on the Principle of Population*, developed the concept that since population should not be allowed to continue to increase without limit because of the unpalatable restrictions which would eventually be imposed by limited food supply, population would have to be controlled through human intelligence. The reader has probably already noted that this concept has very much in common with the image of future society presented in *The Limits to Growth*.

If Malthus seems, however, to have been pessimistic—or at least prematurely so—it was partly because his thinking about the problem of population and food supply was confined, so to speak, to a small bowl of soup. In the years after Malthus’s death the population/food ratio did not, on the whole, develop in the dismal way that that this economist, who had underestimated potential food resources and had relatively little faith in human intelligence *en masse*, had predicted. In the United States, Canada, Australia and elsewhere the growth of food supplies took place much more rapidly than the growth of population, and these areas are today able to provide food for other parts of the world. Thus, over the past century and more, among industrially advanced societies—even in those with food

deficits in domestic production like Japan or the UK—have not in peacetime experienced restrictions on population due to a shortage of available food. Rather, living standards have risen, people's wants have proliferated, and the speed of population growth has come to be kept down, more or less in proportion to the progress of urbanization, by the increasing burdens on family budgets of providing material assistance for the wants and needs (including education) of their children. This process of restraining population follows a different route from Malthus's original idea since these restraints have come to take place as a function of mankind's entering a society characterized by high educational levels. And at the same time, the area of the planet's cultivated land has expanded far more, and it has been possible to raise agricultural productivity through large-scale use of fertilizers to a far higher level, than had been envisioned by Malthus.

Industrially developed countries like Japan which have a deficit of food resources within their own borders have been able to cover their food needs by relying on nutritional resources in other countries—for example, by supplementing their own resources with imports from the US and Canada. To import food from another country is so to speak, the same as producing food on land borrowed or rented from another country. For Japan, it is because this sort of possibility is available that there has in recent years been no direct encounter with a food crisis. There *would* be a crisis if Japan had available to it only that food and animal feed produced within the confines of its own territory and territorial waters, but in circumstances where food can be imported from the rest of the world Japan will not fall into such a crisis and can survive through the export of manufactured products. It must be remembered, of course, that the above remarks are made from observations at the single country level.

Forrester's representations of possible future societies show, however, that if population increases too much on a global level, expanding beyond the capacity of global food supplies, some of all countries would face a crisis of food shortages and would in no way be able to get the food supplies to sustain further population increases. In such circumstances population would inevitably be curtailed through increased death rates from and starvation. This possibility as presented by Forrester is in its ultimate outcome quite the same as the possibility so feared by Malthus.

As for attaining the static equilibrium—i. e., a state of equipoise which would continue in the global society limitlessly into the future with no increases or decreases in either population or total production—which *The Limits to Growth* proposes in its conclusions, much could happen to frustrate its realization.

So long as global society is fractured into "national" entities or groupings in which

influential subgroups insist on always assigning prime importance to the maintenance of what are considered to be sovereign "national" interests, there is a possibility that international disputes, engendered perhaps by disagreements over rights to use dwindling natural resources, could become violent; and so long as possible "enemy" nations nervously target one another with nuclear weapons of frightful destructive potential, we cannot say that the likelihood of violent conflict involving these nuclear weapons is nil. Indeed we cannot ignore what should be a very real fear that humankind might thereby terminate its very existence at an earlier date than the time it could be expected to take for the hypothesized kind of "equilibrium society" to be achieved.

For humankind to respond to this crisis, a change in people's sense of values is surely necessary. This is to say that until there is a good deal of further progress the path of a "human" or "humanist" revolution bringing us to a higher dimension of awareness and altruistic spirit and responsiveness, there would seem to be very little chance of bringing about an "equilibrium society" (in a good sense), to say nothing of the possibility that we could eventually lose the means to extricate ourselves from developments leading to war and economic ruin.

The Club of Rome's report *The Limits to Growth* is, as we have seen, a pioneering effort in using a global model for research in forecasting future circumstances. The model used for this study nevertheless has various "problematic," the most important being its tendency to oversimplify the real world.

The world is at present made up of approximately 150 countries (nearly all of them participants in the United Nations Organization), each of which, in the name of "national interests" or "national rights," pursues what it considers to be its own national advantage and works to meet the welfare needs of its citizens. And while giving due recognition to the relationships of interdependence, it is at the same time important to remember not only the fact that the various countries do not adopt uniform policies affecting economic growth, but also the fact that nature has not uniformly distributed the world's natural resources. There is no nicely balanced scheme by which countries that use great amounts of natural resources necessarily have great amounts of them on their territories, while countries that use little have little. There is likewise no neatly ordered distribution of population. If most of the world's population were concentrated in the world's richest countries, with only small populations in the poorer countries, a somewhat better balance might perhaps be had; but reality is not necessarily this way. The world's wealthiest countries tend to have relatively small populations, or at least relatively small rates of population growth, in contrast to the dilemma of so many other countries where, the

poorer the country, the greater the rate of population increase tends to be. According to one calculation, approximately 18% of the world's present population live in that group of "wealthiest countries" which consume 60% of the world's total production of raw materials and manufactured goods.

If a great starvation-causing food crisis should occur, it is thought that it would not hit all regions of the world simultaneously with uniform severity. For example, crisis conditions might prevail in certain areas like India and Bangladesh without occurring in the United States and Canada. We see, then, that the first type of approach, i. e., using a model which describes the whole world only as a single and undifferentiated unit, falls into a dilemma.

3. The Mesarović-Pestel Global Model.

A second type of approach now made its debut. It is well represented by the world system model that originated from the research of a group led by Mesarović and Pestel.³⁾ Yugoslavia-born Mesarović is director of the Systems Research Center at Case Western Reserve University (Cleveland, Ohio) in the United States, and is considered to be an expert in the field of systems analysis. Pestel was director of the Economic Research Institute at Hannover University in West Germany at that time.

The global model here under consideration was thus developed under the leadership of an expert on systems engineering and an expert in the field of economics. It being foreseen that large financial resources would be needed for the development of this model, the Volkswagen Foundation in West Germany provided generous assistance.

An important feature of this model is that, unlike the World System Dynamics Model of the Forrester and Meadows groups, it divides the world into ten "regions." The Mesarović-Pestel model, which is a sort of composite of ten regional sub-models, can thus reflect regional characteristics, and also the possibility that in regard to such questions as food and energy some regions might encounter much more severe circumstances than others.

The various regions are in interdependent relationship to one another, linked through the exchange of products and services, and also by flows (however inadequate), of capital resources to the "developing countries" from the "develop countries" in the form of "official development assistance" or in other private channels.

Various groups in the developed countries invest directly in enterprises within the

3) M. Mesarovic and E. Pestel, *Multilevel Computer Model of World Development Systems*, Vols. I-VI, IIASA, Schloss Laxenbrug, Austria, 1974.

territories of other developed countries, as seen, for example, in the fact that while US-based companies like IBM and Coca-Cola have set up and invested in branch companies in Japan, a number of Japan-based companies are making direct investments in enterprises in the United States. This is an important way in which the economies of the developed countries interpenetrate one another. Various groups in the developed countries furthermore make investments in "developing" areas. Some of these are investments in resource development ; some are investments in manufacturing enterprises ; some are investments in banking and financial institutions.

Thus the various regions of the world, which rely on one another through trade, development assistance, foreign investment, etc., together constitute a sort of "organic world order" or "organic world system" which is not static but is rather in dynamic notion.

Mesarović and Pestel, with assistance from their colleagues, have used their world model to carry out studies on what in the future are likely to be significant problem areas for humankind in such a world system. They have directed especially careful attention to questions of energy and food.

With respect to energy, while Mesarović and Pestel recognize that at present the world is in a period of change away from "fossil energy" sources centered around petroleum, and toward other types of sources such as solar and nuclear energy, they have taken a very critical stand in regard to the generation of electricity through energy from nuclear fission reactions. For although present-day energy research is making rapid progress toward the goal of harnessing for peaceful use a safe form of sustained nuclear fusion energy, the development of fission energy using plutonium in the nuclear fuel cycle is, so to speak, a double-bladed sword that can be directed to either peaceful or war-related aims. Therefore, Mesarović and Pestel take the basic standpoint that, given the threat of mass death and destruction from nuclear war, there is necessarily the fear that the development of plutonium production around the world would lead to more widespread production and ownership of nuclear bombs. Consequently, they propose that the development of types of energy with such dangerous potential be abandoned. They propose solar energy as a safer type of energy that ought to be the object of large-scale development efforts, since it is primarily useful for peaceful purposes, with little potential for military use that could lead humankind into an abyss of destruction.

However, we must consider the likelihood that it will not be until after the beginning of the 21st century that the development of solar energy will reach a point of large-scale practical utilization, and we must also consider the outlook that until then the problem of limits to the production of petroleum energy is likely to continue.

According to studies made by Mesarović and Pestel, in the case of a hypothetical "scenario" in which oil prices were frozen at present levels, the industrially advanced countries would be so wasteful in their consumption of petroleum that they might suddenly find themselves in a crisis of dried-up oil supplies. What, then, would happen if oil prices were raised to an unreasonable degree? In other words, what could be expected to happen if the OPEC (Organization of Petroleum Exporting Countries) member states carried out a united policy of raising oil prices beyond a certain limit?

The model's forecast results are, as might be expected, that in this case the world would be afflicted with "stagflation" (i. e., inflation combined with very low or stagnant economic growth). It is clear that if economic conditions in the industrially advanced countries suffered excessively, in a sense part of the bill to be paid would revert back to the oil-exporting countries, which could in extreme cases begin to receive falling incomes due to cut-off demand for unaffordable oil.

The modelers of the world model, therefore, stress the importance of mutual dialogue and cooperation between the industrially advanced countries and the OPEC countries, two groups of countries which are, as the model shows so well, in an interdependent relationship. For such cooperation to be successfully carried out it is necessary that we go beyond the types of economic activities, still characteristic of the present, which are narrowly centered around the concept of "national interest" and instead change to behavior that is grounded in a type of perspective that is focused on human society as a whole. The modelers of the global model described above believe that feuds between national entities over one or another dwindling resource cannot otherwise be avoided.

Thus, a still-remaining task for our "human society on the brink of crisis" is now, in our attitudes and thinking, to reduce the concept of "national right" or "national interest" to a subordinate position within a larger framework of economic and political insight.

4. Klein's "Project LINK"

A third type of global model approach is seen in an econometric modeling system called "Project LINK," produced by a group headed by Lawrence Klein of the University of Pennsylvania in the United States.⁴⁾

This global model may be said to focus on the developed countries, which are mutually linked to each other and form the model's core. Developing regions surround this core in a

4) R. J. Ball, *The International Linkage of National Economic Models*, North Holland/American Elsevier, 1973; and J. L. Waelbroeck, ed., *The Models of Project LINK*, North-Holland, 1976.

schematization, we might say, of the present-day "international economic order." Basically, each country's economy is schematized as having analytically separable lines of linkage to the economy of every other country. In other words, the links are at a "national" rather than a "regional" level. On the basis of economic forecasts, especially with respect to the developed countries, desirable forms of international policy adjustments can to a certain degree be specified.

The system employed in "Project LINK" has as one of its major aims the making of short-term forecasts for the world economy, allowing a researcher to know, for example, what sorts of influence on other countries could be expected if the US economy should take a turn for the better, or what sorts of influence on the US would result if a recovery of good economic conditions in Japan or Western European countries were slower than anticipated.

It is likely that world econometric models designed along the lines of "Project LINK" will undergo further development so that, in parallel with improvements in the world's information networks over the coming decades, data from all over the world will come to be collected through the use of communications satellites and analyzed with the help of computers and very large-scale econometric models. The results of this analysis could then be "fed back" around the world (likewise via communications satellites) and used as basic information for national and transnational policy-making.

All this suggests the possibility that with respect to the future world economy a situation might actually develop whereby "those who control information control the world." Could not, for example, information on the world economy become concentrated in one or another country and then could not that country (or countries), by having at its (or their) fingertips detailed information on economic conditions in various or all other countries, and by furthermore developing a "global model" specifically designed to suggest ways of trying to fit the world economy into its (or their) own self-centered schemes, in fact succeed in changing and then maintaining the world economic order in ways to suit itself (or themselves)? Such behavior is not beyond the reach of imagination, especially in the case of one or another "superpower."

However, any such egotistic behavior by a superpower would surely be subjected to a torrent of severe criticism, especially from the "Third World." From countries in economically developing regions known as the Third World there is a good deal of criticism directed at the fact that the present-day world economic order is subjected, so to speak to a "superpower system" centering around the United States. People from the developing countries believe that their countries must have equal rights in deciding how to establish a new world economic order, and they are strengthening their resolve to participate in building such a

system. Certainly there is no reason they should be left out of the world economic system, and it should not be forgotten that, politically speaking, each developing country has a national right to one vote in the deliberations of the United Nations General Assembly.

This having been said, it should be seen that there will indeed be a need for equitably controlled global models which will link, as nation-level units, all the approximately 150 members of the United Nations, which make up the world economy. To construct such a giant-scale global models is by no means impossible. Forthcoming super computers will have superlative computation capabilities and be able to handle huge volumes of information with much faster speed than could be imagined right now. Great progress is also being made in such "software" aspects as techniques for handling large volumes of data, model building technologies, and "scenario" analysis techniques for making forecasts of future circumstances.

Thus, it can be said that the conditions are such that we can overcome former limitations and rise to the challenge of developing still newer and better global models.

5. The challenge of Making New Model.

Up to now we have discussed three global models, developed through three different approaches. But in addition to these, there are a number of other global models. Some of the best known are the "Latin American World Model"⁵⁾ developed by a group of Latin American researchers known as the "Bariloche group," taking the name of the resort town in the Argentine Andes where they met; the "World Food and Agriculture Model" developed by Hans Linnemann of the Netherlands;⁶⁾ and, still more recently, the "United Nations World Model" constructed under contract with the United Nations by a group under Wassily Leontief.⁷⁾

The last-mentioned model, i. e., the United Nations World Model of the "Leontief group," was built in connection with the work of setting economic growth targets for developing regions during the UN's "Third Development Decade," in 1981—1990. Although this model was originally developed as a so-called "environment model," it is also being used

5) Amilcan O. Herrera, et al., *Catastrofe o Nueva Sociedad?* (The creation of a new society world models as seen from Latin America) Defense, Buenos Aires, 1976.

6) "MOIRA: Food and Agriculture Model," Proceedings of the Third IIASA Symposium on Global Modelling (September 22—25, 1975), CP-77-1, February 1977.

7) Wassily Leontief, et al., *The Future of the World Economy* (A United Nations Study), Oxford University Press, 1977; Japanese translation by Akira Ōnishi under the title *Seichō no jōken—hokusai haihatsu senryaku no tame no shinario* (The conditions for growth—scenarios for international development strategy), Daiyamondo-sha, Tokyo, 1977.

at the United Nations in experimental analyses of both the ways in which economic growth takes place and the alternative future results to be expected from a variety of possible growth patterns.

For example, the model shows that if present-day patterns of economic growth in the developed and the developing countries are extended into the future, the per capita income gap between "North" and "South" will widen. In order to minimize or avoid this, it is strongly recommended that the developed countries should make still greater efforts to provide development assistance, while people in developing areas must at the same time make self-reliant efforts to raise economic growth rates and especially to expand the production of manufactured goods and the ratio of self-sufficiency in food.

To add some explanation about the "Bariloche model," it may be said to be the first model constructed as a conscious challenge from the Third world to the global model developed by the Forrester-Meadows group. This element of challenge may also be recognized in its clearly "socialistic" coloration. Another very interesting point about the model is that it takes the form of an "optimization model." Posing the question of what sort of growth patterns are needed to maximize people's average life expectancy at birth, recommendations are produced for various world regions. It is very interesting to see this as a good true-to-life expression of an import and outlook held by Latin Americans toward life itself—namely, the wish to be long-lived!

Unlike the developed countries (among which the citizens of Japan and Sweden are at present the longest-lived), in many of the developing countries high rates of infant mortality contribute to a lowering of the average length of life expectancy at birth. The Bariloche model, which features the introduction of people's desire for long life as a goal to be given optimum conditions for realization, shows that in order to maximize life expectancy at birth there must be a stop to the spread of environmental pollution, a wider dissemination of practices of public hygiene, and better education reaching the entire population.

While the Bariloche model is characterized by its very appropriate focus on human concerns, it includes rather many technical deficiencies, and it is the latter which account for its not having been officially adopted for use in preparing a report to the Club of Rome. It would be going rather too far to think that the Club of Rome did not adopt the model for fear of its "socialist" nature; and it is important to note in this regard the "humanistic socialism" is advocated in the report entitled *Reshaping the International Order* which was submitted to the Club of Rome under the editorship of Tinbergen from the Netherlands.⁸⁾

8) Jan Tinbergen, *Reshaping the International Order: A Report to the Club of Rome*, E. P. Dutton, New York, 1976.

This should serve as evidence that it was not because of any dislike of the word "socialism" that the Club of Rome did not adopt the Bariloche model.

Most of the global models which we have mentioned have been discussed in detail in symposiums held by the IIASA (International Institute of Applied Systems Analysis). This organization, located in the suburbs of Vienna, Austria, has hosted annual global modeling symposiums since 1972.

The IIASA is most unusual as an international research organization in that it was established as an "East-West" cooperative effort, for which funding is jointly provided by the USSR, Eastern European countries, the United States, Canada, Japan, West Germany, France, the UK, Australia, and other industrially advanced countries. The purpose of the Institute's founding is to work toward achieving benefits for all humankind through deepening international scientific exchanges among scholars and researchers in the fastevolving field of systems studies.

These types of exchange are a significant effort among scholars, at a people-to-people level transcending "East-West" rivalries, toward the relaxation of international tensions, and as such can be expected to make a large contribution to a "New International Order." It is of course hoped that funding for the IIASA from the various governments will continue to increase.

At the 5th Global Modelig Symposium held at the IIASA during three days in September 1977, reports were made on the United Nations World Model of the Leontief group and also on a global model built by a team from Japan.

The Japanese team's global model, called the "Project FUGI" the acronym standing for "Future of Global Interdependence" was the result of research on possible future configurations of global interdependence.⁹⁾

Work on this Japanese global model was begun as a joint project by a group under Yoichi Kaya of the Engineering Faculty of the University of Tokyo and a group directed by this writer of the Institute of Applied Economic Research at Soka University. The project also received additional cooperation from a group led by Yutaka Suzuki of the Faculty of Engineering of the University of Osaka. This project, representing three universities, has received international attention in part due to its interdisciplinary character, with cooperation by persons in different fields of the natural and social sciences.

An important characteristic of the FUGI model system is its "hybrid" joining together of

9) Y. Kaya and A. Onishi, FUGI- Future of Global Interdependence, *Input-Output Approaches in Global Modeling*, proceedings of the Fifth IIASA Symposium on Global Modeling, Gerhart Bruckmann, Editor, IIASA Proceedings Series 9 Pergamon Press, 1980 pp. 91-357.

three constituent models as follows: (1) a global macroeconomic model (GMEM), (i. e. a macro-model of international linkage in the world economy) on which work was done by Onishi group; (2) a global input-output model (GIOM), (i. e., a model of industrial linkages in the world economy developed by the Kaya group; and. (3) a global resources model (GRM) developed by the group under Suzuki.

If information from the GMEM model on such future estimates as gross domestic product, consumption, investment, and trade etc in various world regions are given to the GIOM model, forecasts can be made about how the world's industrial structure might be expected to change under given constraints on resources, labor force, technology and food supplies. At the same time the GIOM model can be used as an "optimization model" in the quest to learn how the world's resources might be optimally distributed. And by using this hybrid system model, the Japanese team has been accumulating specific knowledge on the types of influence that could be expected on various countries' economies from various types and degrees of resource limitations. The first resource which was studied using the GRM model was copper, which forecasts were produced indicating what uses of copper may be expected to be made in various world regions, and what sorts of impacts this will have on world supplies.

Upon the request by UN ESCAP, Development Planning Division in 1978, Onishi and Kaya reconstructed GMEM and GIOM respectively so that the future of ESCAP member countries might be envisaged. Its interim report was presented at ESCAP seminar in February 1979 and also at 4th World Conference of Input-Output Techniques in April 1979. The final report was presented in March, 1980 to the ESCAP, Development planning Division where reproduced it entitled "Long-term Projections of the Economies of ESCAP Countries" in March 1980.

The current purpose of the FUGI global modeling project is to provide alternative long-term projections of the world economy under different scenarios regarding national and international policies designed to promote the North-South dialogue and cooperation. The model is expected to play as a major instrument in projecting the current and long-term trends of the world economic activities as well as in assessing the feasibility of the goals and investigating alternative world development strategies and policies relevant to a New International Economic Order and the United Nations' International Development Strategies for the 1980s.

From above examples, it may be seen that a major aim of global modeling is to make forecasts regarding ways in which society may change, and to suggest desirable directions for this society's future economic development.

A fundamental tenet of our research should be this: In order to adjust, at the global level, efforts toward desirable growth and development in the various countries and regions of our present-day global society, we must go forward in communication with one another and with a sense of united purpose in working for optimal benefits for the whole of humankind.

We say this because there seems to be sufficient reason to believe that in the future each country will not try to grow only according to its own fancies, but rather countries will be able to work together in setting growth patterns and working out new patterns and systems of international trade and financial flows through reasoned mutual understandings and consensuses.

There is consequently the necessity of having objective data and reference materials on which such reasoned understandings may be based. In this connection we believe that a vital task of global modeling is precisely that of providing accurate information and suggesting how humankind can best respond to new circumstances.