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SIMULATION MODELS IN SUPPORT OF DEVELOPMENT PLANNING

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This presentation outlines the structure of a simulation model of the Bolivian economy. It was designed to assist policy-makers in estimating the costs of alternate strategies for improving the performance of an economy in a deep crisis. The data requirements of the model are relatively modest as it relies on national accounts and readily obtainable information. Likewise, the model's structure is quite simple - its equations are generally identities rather than more complex behavioral relationships. The model proved useful in influencing high level government officials as they sought to identify medium term policies for economic growth and development.

The purpose of this presentation is not only to discuss the characteristics of the Bolivian model, but also to suggest that relatively elementary models - in particular, simulation models - may have a variety of uses for AID economists. By providing a framework for estimating the costs of alternate strategies for economic development, they can serve as a useful instrument for comparing some of the effects of competing policies for promoting growth and development. Simple macroeconomic models can provide a useful framework within which the impacts of foreign assistance can be assessed. They can also estimate some of the costs of attaining various macroeconomic objectives - in particular of speeding up economic growth.

An Overview of the Bolivian Model

The simulation model of the Bolivian economy was prepared in 1983 and 1984 as part of a United Nations project with the purpose of assisting the nation's economic authorities cope with a severely deteriorated economy. While the model, in itself, did not purport to offer answers concerning which among several major policy options would be the best for the nation, the

scenarios generated by the simulation model served to discredit some of the more unrealistic policy packages.

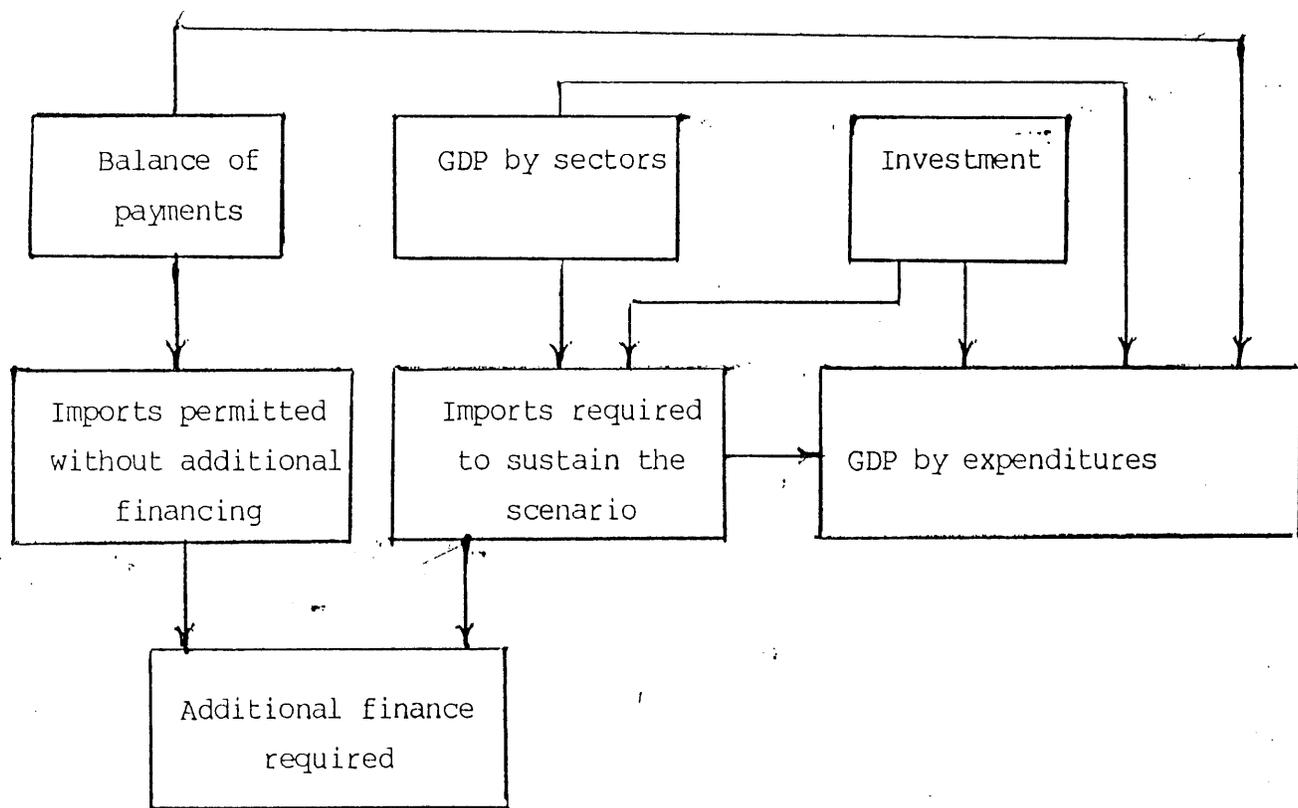
The simulations of the Bolivian economy examined alternate paths of basic macroeconomic and financial variables through the year 1995. Variations in the paths of some of these variables could be traced in time by altering basic assumptions regarding the values of exogenous variables (such as the prices of exported minerals). It also served to simulate the effects of major investments (such as the construction of a gas pipeline to Brazil) upon the balance of payments and the debt burden.

It should be emphasized that the model is not intended for economic forecasting. It purports to do no more than provide a structure enabling policy-makers to analyze some of the possible effects of implementing alternate policies for promoting economic growth and development.

The flow diagram on the following page affords a quick overview of the model's basic design. At the top of the diagram, the values of the variables in the three boxes (balance of payments, GDP by sectors and investment) are determined outside the simulation model. The balance of payments data (which initially exclude imports) project debt service (interest, principal payments and the payment or accumulation of arrears), exports (these were estimated by projecting the volumes and prices of principal exports and by considering the impact of investments upon the production of exportable goods and services), international reserves, direct investment from abroad and other items in the capital and current accounts. As a residual, the balance of payments calculation determines the amount of imports permitted by the balance of payments without obliging the nation to seek additional international finance.

GDP by sectors (ten productive sectors are considered in the model) is projected by consultation with planning officials. They are free to simply choose the figures believed most appropriate for insertion in their plans; due to the political attractiveness of presenting optimistic projections, it is

BASIC FLOWS IN THE BOLIVIAN SIMULATION MODEL



not surprising that these figures tend to be rather high on initial simulations. Similarly, investment figures (for both public and private investment) are determined in consultation with the planning authorities. It should be mentioned that some - but not all - public investment is directly linked to future levels of production and exports.

Once the above three boxes are specified, the model then estimates the value of imports needed to sustain the scenario. The estimation is performed for the three principal components of imports: consumer items, intermediate inputs and capital. After having dropped dramatically in the early 1980s, the importation of consumer items is assumed to grow by 3 percent annually from 1985 to 1995. The importation of intermediate inputs is tied to the output of each of the ten productive sectors, using the proportions of imported inputs to value-added from the input-output matrix of 1978. Thus, assuming that the forgoing proportions are fixed, any increase in output must necessarily be accompanied by a proportional increase in the amount of imported intermediate inputs. The third component of imports, capital goods, is made equal to gross investment less the gross value of construction. According to Central Bank figures, the value of capital equipment produced domestically is negligible.

Upon estimating the level of imports required of the scenario, only a few additional assumptions are needed to complete the estimation of GDP by expenditures. These include a correction of imports and exports for contraband, projections of public consumption and a projection of inventory changes. The estimation of private consumption is left as a residual.

Upon subtracting the estimation of imports required to sustain the scenario from the amount of imports permitted by the basic balance of payments projections without additional financing, it is possible to estimate the amount of additional financing required to sustain the scenario. It should be mentioned that the scenario then proceeds to reestimate the balance of payments figures on the assumption that the additional financing is, in fact, obtained. This implies securing additional loans (the scenario assumes they can be found) which, in turn, the scenario proceeds to service as interest and

principal payments come due. If there is no financing gap - that is if the amount of imports permitted by the basic balance of payments projections exceeds the estimation of imports required to sustain the scenario - then the simulation model adds the excess funds to international reserves. Large and persistent financing gaps prove very troublesome to the scenario because the simulation model automatically finds credits to cover any gap, but at the same time this means the gap will widen in the future as the burden of servicing the new loans further weighs on the nation's financial solvency.

According to Ministry of Planning officials, Bolivia could historically find international credit for approximately 65 percent of investments (public and private) above a relatively small threshold requiring solely internal finance. It was assumed that this relation would continue in the future. Thus the financing gap was divided into a part needed to support investment projects and another part called "balance of payments support." It was generally believed that the first component could be financed rather easily. However, large requirements for balance of payments support were taken as a sign of a non-viable scenario.

Once the forgoing calculations are completed, the model provides a series of additional indicators of the viability and acceptability of the scenario under consideration. These include:

- An index of per capita consumption,
- External and internal savings necessary to sustain the scenario,
- Debt service, divided into interest and principal payments, as a proportion of exports, and
- Debt service as a proportion of GDP.

Per capita consumption was considered as an especially important variable to the nation's planning authorities. This was because it was estimated to have fallen by about 33 percent in real terms during the economic turmoil (consisting of a deteriorating balance of payments and severe economic mismanagement exacerbated by droughts in the highlands and floods in the

lowlands) during the early 1980s. The levels of external and internal savings necessary to support the scenario are considered important in gauging whether the projected GDP and investment figures are commensurate with the nation's ability to generate savings. The relations of debt service and total debt to exports and GDP were used to ascertain if an acceptable scenario could be found to alleviate the problem of insolvency. It should be mentioned that, at the time the scenarios were constructed, Bolivia was already generally considered insolvent.

How the Simulation Model was Used

During 1983 and 1984, hundreds of alternative macroeconomic scenarios were run for the Bolivian economy on an Apple III computer. During the same two years, the Government was in the process of drawing up its 1984 to 1987 Plan. The scenarios assisted the nation's economic authorities in scaling down grandiose aspirations for sharp increases in the public investment budget and exaggerated targets for GDP growth. In fact, the planned investment program turned out to be relatively modest - some public sector investments of highly questionable economic merits were left out. The scenarios demonstrated that the pressures on the nation's balance of payments simply could not support rapid growth without subjecting a virtually bankrupt nation to unattainable levels of international credit.

The scenarios also served to confirm that, short of an economic miracle, the nation would probably not be able to avoid defaulting on some of its debt. The simulation depicted the especially severe consequences of the probable end of natural gas sales to Argentina at the end of 1991. The only way these further difficulties could be mitigated would require the identification and implementation of credit-worthy investments having exceptionally high returns over very short gestation periods. Unfortunately the arduous search for such investments did not come up with many exciting prospects. At the time the scenarios were run, the only possibility that could be identified for relieving Bolivia of severe balance of payments

pressure was the rapid construction of a gas pipeline to Brazil and the consequent sale of natural gas (at favorable prices) to that country.

The model demonstrated that other investment possibilities being considered at the time - even if they were realized under exceptionally favorable circumstances - could not save the nation from slipping deeper into insolvency. These included projects to increase mineral production, stimulate tourism and to construct a petrochemical complex.

How Simulation Models May be Useful to AID Economists

Unlike econometric models, which tend to be more demanding in their information requirements and more difficult to estimate and understand, macroeconomic simulation models can often be constructed using easily obtainable data. In designing a simulation model, missing data or parameters can often be estimated by "educated guesses" without disastrous repercussions. Of course, simplicity has its price - and one of the prices of using simple models is the failure to measure economic relations between variables which economists frequently feel should be specified in their models. For instance, we often feel uncomfortable if we avoid an attempt to quantify the relation between factor inputs and output. The Bolivia model does not, for instance, have a well-specified production function. As mentioned previously, investments in the Bolivia model are not always closely linked to future production. There is reason to believe, however, that even more sophisticated models likewise fail to specify these relationships well.

Although there are certainly circumstances which may justify the construction of highly complex econometric models, in general I believe few such circumstances exist in the nations where we are assigned. It is often said that the Third World is the graveyard of econometric models.

I believe that most of us who are assigned to overseas missions have a need to assess the likely impacts of donor assistance, external events and/or domestic policies on the macroeconomic performance of our host countries. As

in the Bolivia case, simple models also serve to determine if a nation with troubled finances is, in fact, insolvent or likely fall into insolvency. The utilization of basic quantitative techniques could greatly improve our ability to assess which policies are among the most effective for promoting economic growth and development. While quick calculations with a pencil and paper may serve to estimate the impacts of several major events, I believe that we could do much better if we maintain a basic quantitative model, projecting - at a minimum - basic balance of payments and production data and attempting to take advantage of the model to estimate in concrete terms what the impacts of developmental programs may be on the future economic performance of our host countries. In particular, I believe that the macroeconomic impacts of program assistance should be assessed in the context of the overall direction of the economy in question.

Whether or not it is appropriate, at this time, to recommend the utilization of generic models, it is likely that the construction and utilization of even very basic models permitting the simulation of the impacts of alternate policies and external events could be extremely useful to many Missions who do not already take advantage of these techniques. We can, of course, make ample use of World Bank and IMF projections without building our own models. This may be a second best solution if special circumstances impede the construction of a USAID model. In order to fully understand the structure of the model we are using, I believe it necessary for us to attempt to either construct our own model or subject those built by others to a careful evaluation before using them.