

## NATIONLAB 1999: Creating a Vision for the Economic and Social Reconstruction of Bolivia

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### INTRODUCTION

How can a nation best begin the process of economic and social reconstruction, when it is hampered by chronic poverty, illiteracy, systemic corruption, and an illegal but extremely profitable narcotics industry? Because these problems are mutually reinforcing, any adequate answer to this question must involve a simultaneous attack on all fronts. To succeed, this attack must be politically supported by an aroused citizenry and financially supported by friendly international agencies and countries. Finally, the attack must be based on a shared vision of how to proceed. This shared vision is perhaps the key to the entire process, because political and financial support tend to accrue to those policies that come to be seen, through public discussion and intense scrutiny, as feasible and most likely to be effective.

This article addresses the creation of a shared vision for the pathway to reconstruction, based primarily on the example of an ongoing effort undertaken by Bolivia. The process by which a national vision is created and developed is fundamentally political, in the best sense of the word. Policy ideas come from everywhere and anywhere, but they are woven together into a coherent fabric by the processes of public debate, private study, academic analysis, and media attention. To advance this process, the Bolivian School for Higher National Studies (acronym EAEN, for Escuela de Altos Estudios Nacionales) recently embarked upon an innovative program of annual exercises that are designed to test national policies that might be deployed in battle against poverty, corruption, and the cocaine industry. Students of the EAEN are typically on part-time leave from responsible positions in government, the military, the national police, and the legal and medical professions. In these exercises they play the roles of all key policy-making figures in the national government. In addition, there

are several “opposition” roles, e.g. for the leadership of the cocaine cartels. During the 5- to 25-year span of a typical exercise, these role-players attempt to guide the country through the next stages national reconstruction, while coping with an array of difficult and sometimes unexpected crises that come from all directions.

In response to these crises and policy initiatives, the evolving social and economic condition of the country is computed by a simulation program that models the dynamics of poverty, education, civil service corruption, public health, the formal, informal, and agricultural sectors of the economy, and the cocaine industry. This simulation program, known as NATIONLAB, was constructed specifically to support national exercises and policy studies within Bolivia. The goal of NATIONLAB is to foster the development of a shared vision for the pathway to reconstruction, by providing an experimental testbed within which policy ideas can be played out in a unique environment comprised of highly trained and talented people and a sophisticated mathematical model of the social and economic dynamics of Bolivia.

To summarize, the thesis put forward here is that the political process of mobilizing public and international support for a comprehensive program of national reconstruction can be advanced by means of a series of national policy exercises, undertaken by talented individuals who are training for leadership positions, that subject any and all potential policies to detailed and quantitative computer-assisted scrutiny. It is hoped that these exercises will contribute substantially to the ongoing vigorous public debate over ways and means for achieving national goals.

## RECENT HISTORY

Although the average income of a citizen of Bolivia is low, it would be a serious mistake to imagine that Bolivia is mired in perpetual poverty, unable to begin the process of national reconstruction. In fact the current efforts at structural reform are an integral part of a long and difficult history of social change that extends back to 1952. Before the great Bolivian National Revolution of 1952, the large indigenous population of Bolivia lived in appalling conditions of servitude and slavery, unable to vote, bear arms, or own land. The coalition of peasants, tin miners, and labor unions that came to power under Víctor Paz Estenssoro began one of the most far-reaching land-reform decrees ever enacted in the Western Hemisphere. The native Aymara- and Quechua-speaking people of Bolivia were freed from centuries of servile labor obligations and, for the first time in 400 years, received arms, land, and the right to vote.

While the politics of Bolivia since 1952 have been extraordinarily turbulent, the turmoil can be seen and understood as an unfolding of the promises made in the Revolution. Like most Latin American countries, Bolivia has suffered from extreme political polarization between left and right. At one time in the early 1970s the radical military government of General Torres replaced the Congress of Bolivia with a soviet-style Popular Assembly. The next year a young colonel named Hugo Banzer seized control, suppressed labor unions, ended civil liberties, occupied the tin mines with troops, and prohibited peasant syndicates. Despite its autocratic beginnings, the Banzer regime managed to complete many of the basic changes in social and economic infrastructure that had begun in the Revolution of 1952, and ultimately became the longest ever in Bolivian republican history (1971-78).

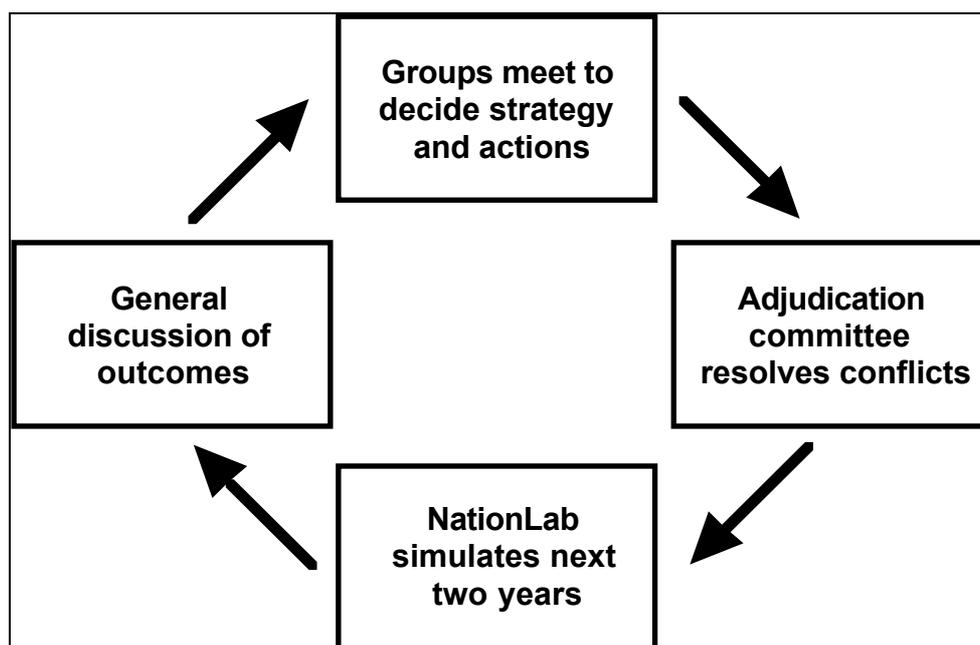
Bolivia in the early 1980s suffered under a “narco-dictatorship,” a corrupt military government heavily influenced by the illegal cocaine industry. This unfortunate episode devastated the Bolivian economy and nearly destroyed the central government itself. In the 1990s a fragile civilian government emerged which succeeded in taming an episode of spectacular hyperinflation. A period of national stability began with the second presidency of Hugo Banzer, this time after free elections. The Banzer “Dignity Plan” for the elimination of the illegal cocaine industry has achieved much greater success than predicted, and foreign investment is now flowing into a rejuvenated economy.

At the beginning of this period the Banzer government identified three primary threats to the national security of Bolivia: poverty, corruption, and narcotrafficking. The key to national reconstruction, it was believed, lay in breaking the self-perpetuating vicious cycle between these aspects of Bolivian society, economy, and government. In 1997 the EAEN approached US Southern Command in Miami, Florida, with a request for assistance in creating a simulation model of this vicious cycle. The resulting model, known as NATIONLAB, has now been used in three annual policy exercises at the EAEN.

### **NATIONAL SECURITY EXERCISES**

The time span of the 1999 exercise was eight years, to be played during four exercise days. The first three years of this eight-year span were played under optimistic conditions, while the following five years were played under a difficult set of pessimistic conditions.

Starting with the current national situation, each day of the exercise began with a presentation of the results of the previous day’s actions, with supplementary graphs and charts from the NATIONLAB simulation software. After each morning brief the EAEN scenario designers presented the overall national situation for the next time period. Each team then prepared its proposed course of action for the next time period. These proposed courses of action were briefed to the student and faculty body as a whole, with ample time for questions and clarifications.



*Figure 1: The daily cycle of a NATIONLAB exercise.*

At the end of every iteration of the exercise, the adjudication committee has the task of determining the outcomes of the conflicting plans and actions of the opposing teams. Many adjudication decisions require qualitative human judgements and are not appropriate for computer simulation; examples of such decisions include whether a policy is constitutional, or whether an action is humanly possible given the time and resources available. On the other hand, there are many quantitative adjudication decisions that are far more appropriate for computer simulation than human judgement; examples include the level of per capita income, the total tonnage of coca leaf processed into cocaine, and the percentage of adults who have at least a secondary education. The NATIONLAB simulation model was used to remove from the exercise adjudication process as much of the need for quantitative “guesstimates” of the social and economic outcomes of policy decisions as possible.

Perhaps not surprisingly, the degree of success achieved by a national policy exercise of this nature turns on three factors:

- the depth of advance preparations by the participants;
- the creativity of the “opposition” role players; and
- the fairness and accuracy of the adjudication committee.

The adjudication committee necessarily works until extreme time pressure. It must consider every facet of every course of action, weigh them for feasibility, legality, and cost, make judgements as to the extent to which each course of action will actually be undertaken, and reconcile the outcomes of conflicting actions. To do this properly, a representative of each role-playing group (e.g. the national security council, and the ministries of finance, education, health, labor, etc.) must be present in the adjudication committee to clarify and justify their actions whenever needed. In addition, the committee must be able to draw upon members with expertise and experience in the politics, economics, and social dynamics of the country and its international context. Finally, the committee must be able to come rapidly to agreement on appropriate inputs for the quantitative computer simulation model. It is in the discussions of the adjudication committee that the core policy issues become clear for all to see.

## **NATIONLAB**

The 1999 edition of NATIONLAB consists of seven tightly integrated dynamic models, created with a commercial modeling tool known as STELLA. The individual models deal with the cocaine processing and exporting industry, the peasant coca farmers, corruption of the civil service, the education and public health systems, poverty, and the informal and formal economic systems. The sector model dealing with the processing of coca leaf into cocaine is depicted in Figure 2, below.

Much of the modeling for NATIONLAB is based on current Bolivian data. However, a dynamic model like NATIONLAB is substantially different from a standard computer database.

The starting condition of the model is, of course, as close to reality as its designers can achieve. From the moment the simulation begins, its quantitative state diverges from the initial conditions. Children are born, students graduate from school, coca fields are planted and harvested, inflation and unemployment fluctuate, and people in search of jobs migrate from rural areas to urban centers, and so on across the entire range of simulated human activity. Within a few simulated months, none of the variables in the model have their initial values any longer. At any given moment the variables in the model constitute a database, but the significance of the simulation model derives from the way these variables affect each other over time, not from their momentary values. Thus the cause-and-effect relations between the variables of the model are of paramount importance. As a tool for assisting national policy exercises, the simulation model stands or falls on its ability to behave with the same cause-and-effect dynamics as the actual society under study.

In some of the sectors of the NATIONLAB model, the cause-and-effect dynamics are based on straightforward flows of people or material through a system. The coca processing model depicted in Figure 2 is such a flow model, and the NATIONLAB model of the educational system of Bolivia is another. Such models are relatively easy to quantify, as long as data exist for the quantities flowing through the system at each important stage.

In some socio-economic sectors the nature of the cause-and-effect relations between variables are more subtle than a flow process. For example, modern economic models of growth and development use many variables for which a flow is very hard to define. Unemployment is such a variable: it is not enough simply to measure how many workers do not have jobs. There are degrees of underemployment, and even among completely unemployed workers there are degrees of discouragement. How then can a model be constructed which accurately and verifiably reflects the cause-and-effect relationships found in society itself?

To summarize very briefly, the answer lies in a different form of mathematical representation, a form which requires careful statistical analysis of multiple time series of data. The key lies in an equation which describes an "effect" as a rate of change in a quantitative state variable, and its "causes" as a linear (or sometimes nonlinear) function of all variables that have a direct influence on the state variable. This specification allows the use of regression analysis (2SLS) to estimate the linear coefficients of the relationship. All that is needed is good data over a sufficiently long span of time so that the regression methods can generate estimates with a reasonable degree of accuracy.

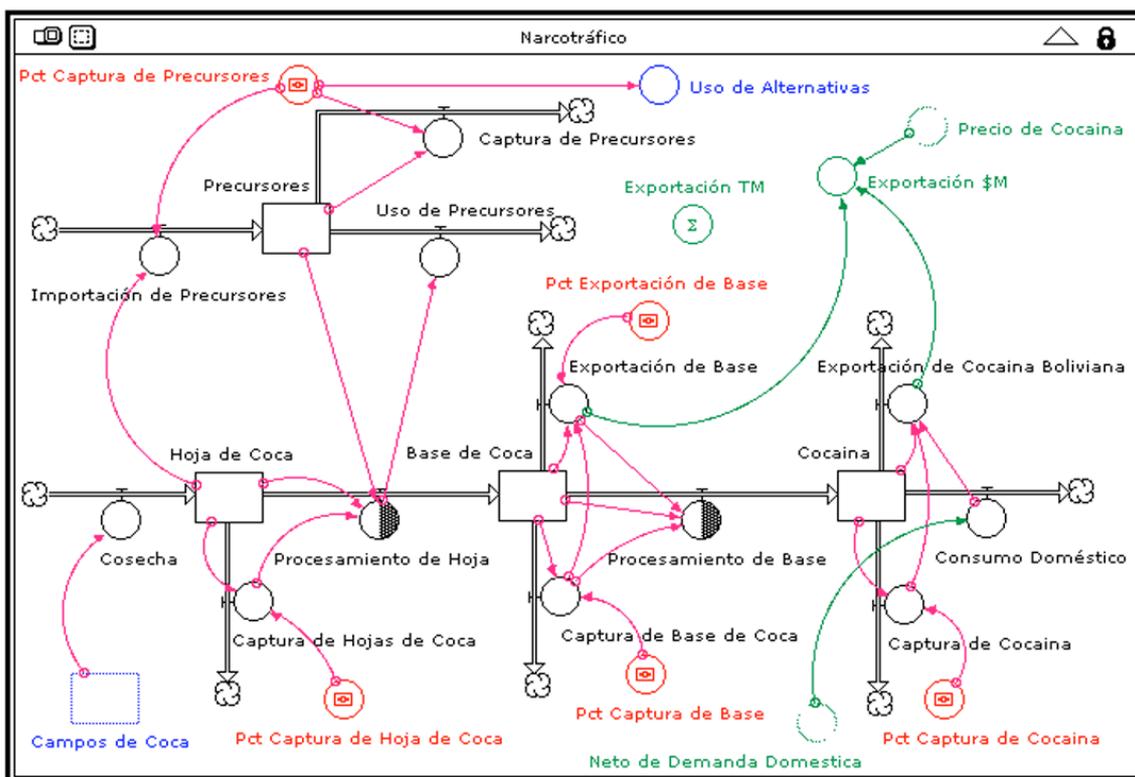


Figure 2: The “wiring diagram” for the narcotrafficking sector of NationLab 99. Each symbol in this diagram has a precise mathematical meaning, and each circle contains an equation that exactly specifies the nature of the diagrammed relationship.

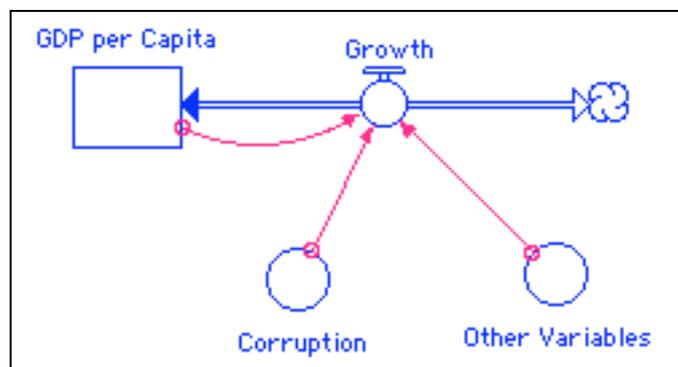
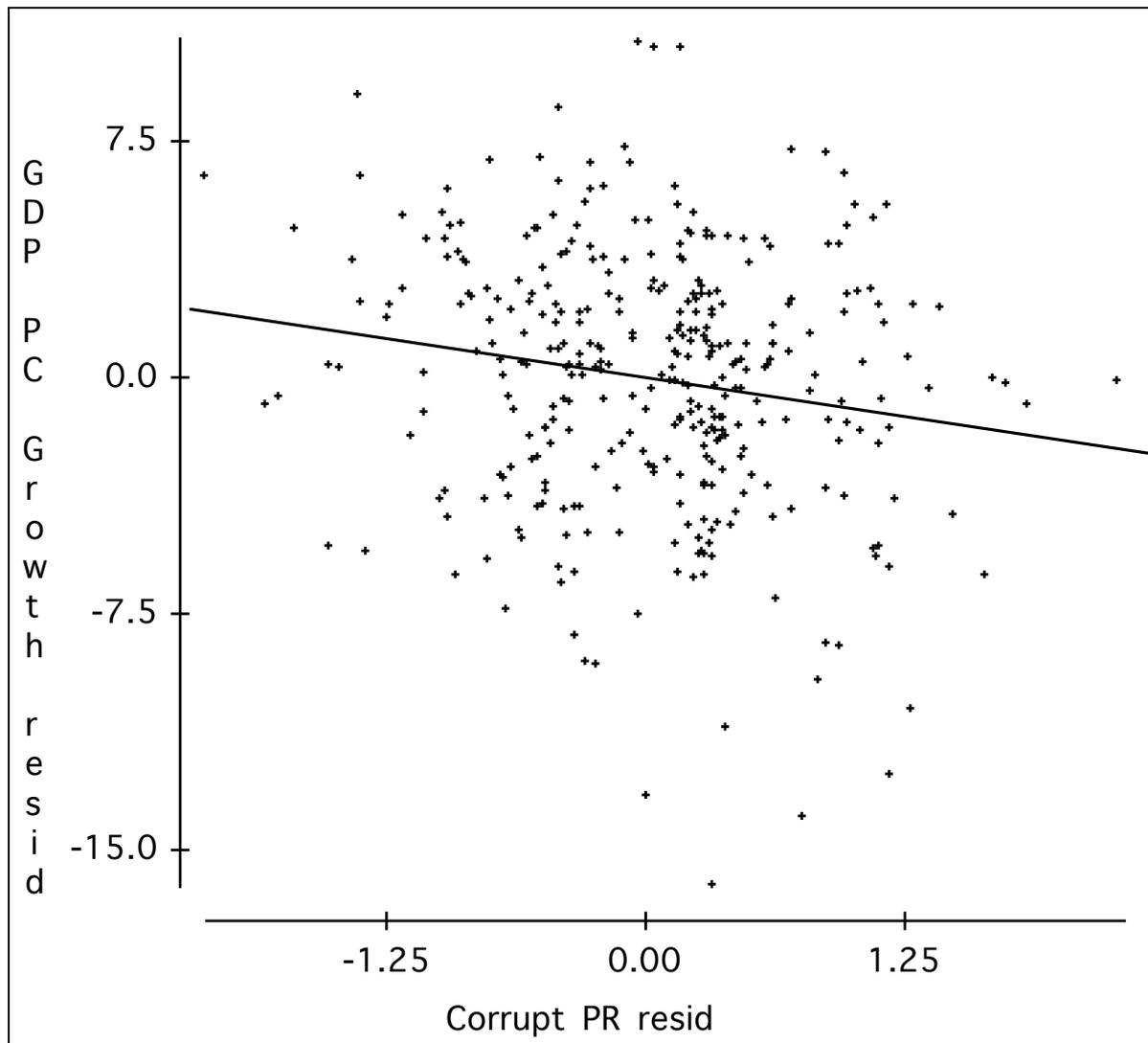


Figure 3: The STELLA representation of a cause-and-effect relationship between governmental corruption and economic growth.

For example, consider the relationship between corruption and economic growth. If we suppose, as many do, that corruption has a direct effect on growth, then the STELLA model for this effect will look like Figure 3. The actual coefficient for the influence of corruption on economic growth is estimated from a regression analysis in which growth is the dependent variable, and corruption and all other plausible direct influences on growth are independent variables. The causal effect is assumed to be real if the coefficient is statistically different from zero. The implied causal effect of corruption on growth can be seen visually in a “partial regression” scatterplot, as illustrated in Figure 4. Note that as corruption increases the average annual per capita economic growth rate decreases rather sharply. The effect is both

substantial and statistically significant, despite the rather large amount of random noise observed.



*Figure 4:* The strength of the cause-and-effect relationship between governmental corruption and economic growth is visible in this partial regression scatterplot. Data are from 15 years of annual measurements for 67 countries around the world. The data on corruption are from the Political Risk Group, Inc. The economic growth measure is the annual increase in per capita Gross Domestic Product, adjusted for Purchasing Power Parity.

## DATA SOURCES

It would be difficult and perhaps impossible to overstate the importance of good data for the construction of accurate models of societal dynamics. Since the time of history's first quantitative sociologist, Karl Marx, debates of enormous national importance have turned on poorly quantified economic and social variables. The 20<sup>th</sup> Century's long Cold War divided the nations of the world on the basis of several very poorly tested economic and social

theories. The ideological fervor with which people espoused these theories seemed at the time to be inversely proportional to the extent of quantitative testing of the competing theories. It is scarcely a coincidence that these ideological conflicts have steadily decreased in recent years as worldwide data on social and economic conditions have improved and theories that once were held as articles of faith come under systematic scientific scrutiny.

The last several years have seen a remarkable blossoming of worldwide and regional comparative data for a very broad range of quantitative social and economic variables. The quality of these data are at a level that was only dreamed of just 20 years ago. In addition, new variables have emerged. One such is the influential Human Development Index (HDI), created by the late Mahbub ul Haq of the United Nations Development Program. Based on a complex formula that uses four common social indicators (real GDP per capita, life expectancy at birth, adult literacy rate, and combined gross school enrollment rate), the HDI was designed to provide a better index of quality of life than monetary income alone. Almost from the very year it first appeared in 1990, the HDI has been enthusiastically accepted as a means for measuring the socio-economic health of nations.

As a result of these developments, sufficient worldwide comparative data now exist to open up huge new domains for socio-economic analysis and modeling. The NATIONLAB effort of the EAEN/Bolivia and US Southern Command is merely one such project, a single part of a massive international effort to at last come to grips with the essential dynamics of social and economic development.

## CONCLUSION

This article began with the question, "How can a nation best begin the process of economic and social reconstruction, when it is hampered by chronic poverty, illiteracy, systemic corruption, and an illegal but extremely profitable narcotics industry?" The answer, uncovered in stages, is a multi-front attack whose exact details are worked out in national public debate, supported by detailed simulation-assisted policy exercises which subject potential strategic courses of action to intense scrutiny. This inherently political process will, it is hoped, attract the necessary internal popular support and external financial support for the chosen courses of action, which will under any circumstances be difficult and painful to carry out.

## REFERENCE MATERIALS

- Aghion, Phillippe. 1998. *Growth, Inequality and Globalization: Theory, History and Policy*. Cambridge, UK: Cambridge University Press.
- Barro, Robert J., 1997. *Determinants of Economic Growth: A Cross-Country Empirical Study*. Cambridge, MA: MIT Press.
- Cobb, Loren, Gonzalez, Miguel, and Hannan, Robert L., 2000. *National Security Exercises in Latin America: Bolivia 1999. Adelante*.
- Cobb, Loren. *Stochastic Differential Equations for the Social Sciences*. 1981, In *Mathematical Frontiers of the Social and Policy Sciences*. Edited by Loren Cobb and Robert M. Thrall. Boulder, Colorado: Westview

Press.

- De Mesa, José, Gisbert, Teresa, and Gisbert, Carlos., 1999. *Historía de Bolivia, 3<sup>rd</sup> Edición*. La Paz, Bolivia: Editorial Gisbert.
- Edwards, Sebastian., 1995. *Crisis and Reform in Latin America: From Despair to Hope*. New York: Oxford University Press.
- Hudson, Rex, and Hanratty, Dennis M., 1989. *Bolivia: A Country Study, 3<sup>rd</sup> Edition*. Washington, DC: Federal Research Division, US Library of Congress.
- Jain, Arvind K. (ed.), 1998. *Economics of Corruption*. Boston, MA: Klewer.
- Jenkins, Jerry (ed.), 1988. *Beyond the Informal Sector: Including the Excluded in Developing Countries*. San Francisco, CA: Institute for Contemporary Studies.
- Jolly, Richard, (ed.), 1999. *UNDP Human Development Report 1999*. New York: Oxford University Press.
- Léons, Madeline B, and Sanabria, Henry, (eds.), 1997. *Coca, Cocaine, and the Bolivian Reality*. Albany, NY: State University of New York Press.
- Ray, Debraj., 1998. *Development Economics*. Princeton, NJ: Princeton University Press.
- Robinson, Mark (ed.), 1998. *Corruption and Development*. Portland, OR: Frank Cass Publishers.
- Rydell, C. Peter, and Everingham, Susan S., 1994. *Controlling Cocaine: Supply Versus Demand Programs*. Santa Monica, CA: RAND Corporation.
- Soligen, James N, and Hannan, Robert L., 1999. *Second Annual US-Bolivian National Security Wargame: "Bolivia Towards the 21<sup>st</sup> Century."* Unclassified Final Report. Miami, FL: US Southern Command Headquarters.
- Stapenhurst, Rick, and Kpundeh, Sahr J. (eds.), 1999. *Curbing Corruption: Toward a Model for Building National Integrity*. Washington, DC: The World Bank.
- Turnovsky, Stephen J., 1995. *Methods of Macroeconomic Dynamics*. Cambridge, MA: MIT Press.