APPLICATION OF QUANTITATIVE METHODS FOR ENERGY-ECONOMIC PLANNING IN SEMISOCIALIZED ECONOMIES

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A final special recognition should be delivered to former Senator Leland Stanford who indirectly helped us to carry out this work. He stated many years ago a few words that have inspired our investigation: "I attach great importance to general literature for the enlargement of the mind and for giving business capacity. I think I have noticed that technically educated boys do not make the most successful businessmen. The imagination needs to be cultivated and developed to assure success in life. A man will never construct anything he cannot conceive."

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PREFACE

To be fully useful for policy makers as well as energy specialists, quantitative energy-economy models must be applicable to any economic system. The major models to date have focused almost entirely on free market economies in industrialized countries. This volume describes how such models might be adapted to other economic environments, particularly those we shall characterize as semisocialized.

Semisocialized economies are those in which many important economic sectors are owned and/or operated by the State and where overt and hidden subsidies are omnipresent, distorting the price system. We also include countries that purport to be based on a free market price system but in reality contain a strong government that imposes a large degree of control through subsidies, regulations, incentives, and other methods. Justifications for such actions are often associated with economic development objectives.

This volume neither analyzes nor criticizes the essence of free-market and semisocialized economies. It simply tries to introduce the reader to those general problems that have hampered attempts to apply quantitative methods developed in industrialized nations to problems in semisocialized nations.

The volume is particularly relevant to Argentina, in which a model based on the Decision Focus Incorporated (DFI) Generalized Equilibrium Modeling System (GEMS) has been in use over the past several years. In fact, Argentina serves as a case study with which to motivate some of the concepts we introduce.

Our findings contradict the rather widely held notion that the sole contributor to economic inefficiency in developing countries is price subsidies to consumers. The commonly held notion is that one need only eliminate price subsidies on consumer commodities to solve developing countries' investment problems. Our findings in Argentina suggest that this is far from true. Indeed, *hidden* subsidies emanate at the point furthest upsteam in the economic system (primary resource production) and proliferate downstream throughout the entire economic system. The effects of such subsidies are to overproduce domestic resources, to drive domestic prices away from world prices, to commit too much investment capital to energy and economic sectors, and therefore to deny investment to so-called *social sectors*.

This volume should not be viewed as a finished research product. Indeed, it is but an initial step down a very difficult road. We hope our ideas motivate further research regarding planning in semisocialized economies. We are confident that if this occurs, our work will have contributed to a a broader sense of cooperation and understanding among the nations of the world.

INTRODUCTION

This volume investigates quantitative modeling techniques as applied to economies other than textbook free market economies. Most existing quantitative modeling approaches are descended from textbook supply-demand balancing ideas, which frankly do not apply in most economies of the world. Indeed, most economies of the world are not comprised solely of private producers and private consumers; the government is a large and important player in most economic systems. And the government does not necessarily pursue the textbook objectives of profit maximization or utility maximization upon which quantitative models are founded. We shall term economies with a large and important government sector *semisocialized* economies, and we shall investigate the fundamental nature of such economies, the adaptations in economic modeling approaches needed to characterize such economies, and how such adaptations can be used to support public policy analysis.

It is not our intent to pass judgment on whether a semisocialized economy is better or worse than a free market economy. Indeed, we take as given the fact that there are and will continue to be many semisocialized economies in the world. Rather, our goal is to suggest analytic methods that apply specifically to the case of semisocialized economies, i.e., that help planners in semisocialized economies do a better job of planning and managing their economies. In short, our intent is to suggest tools to support semisocialized countries given the environment in those countries rather than to presumptuously and unrealistically suggest fundamental changes in the environment itself.

One of our most difficult tasks is to define what a semisocialized economy is. Probably the most effective way is to observe the nature of socioeconomic change that has occurred in many economies during the twentieth century. For those economies that have evolved away from a free market form, it is uniformly true that the state as represented by the central government has gained an increasing share of *ownership* of the productive capacity of the country. In effect, the state has acquired an increasing share of the *common equity* of the country. As this has occurred, the state has acquired an increasing degree of *control* over the economy. Obviously, state control over totally or partially state-owned industries is almost absolute. However, and perhaps more subtle, direct and implicit state control of industries that have remained private has increased. In contrast with the textbook economic supply-demand theory, the state is a large often monolithic player in such economies. Price competition does not occur. Profit maximization does not apply as a relevant behavioral model for the largest player in the system, meaning that textbook monopoly, oligopoly, or competitive models do not necessarily apply. The government is not an invisible or a neutral player in the system. In short, textbook models have become increasingly unrealistic for such economies the larger the role of the state has become.

The idea of a semisocialized economy arises from the observation that most governments stop far short of nationalizing all productive activities. In most economies of the world, there still exists a privately owned sector together with a large government sector. Therefore, it is equally inappropriate to assume that such countries are totally owned and controlled by their governments, and it is therefore inappropriate to model such countries as monolithic. The truth of the matter is that they are only partially socialized, or as we use the term, semisocialized. Some of the productive activities are in government hands and some are in private hands. It is the interplay between government and private agents that makes modeling of such economies so challenging, yet so necessary.

Because real-world economies are semisocialized and therefore neither free market nor totally socialized, the degree of transparency of the economic system is very low. The price system operates only partially and under significant government control. Production and consumption decisions are affected partially by individual autonomous control and partially by government action. The net result is that the operation of the economic system, in general, is not well understood either by the players within it nor by external analysts.

In a **socialized** system, changes in government-owned production do not necessarily lead to changes in prices. Indeed, prices for government-produced goods are invariably set by public sector bodies based on social needs criteria. The net result is that prices are not equal to marginal production cost, and consumer response to changes in production or productive capacity is small. In effect, the response is quite **inelastic.**

In a **free market** economy, changes in production imply changes in the supply curve. Assuming competitive markets and upward sloping supply, changes in the supply curve have a direct effect on prices and thereby a direct effect on consumption decisions. In contrast to socialized economies, the response to production changes is **elastic.** Furthermore, prices will be equal to marginal production costs. Economic theory tells us that the competitive supply-demand equilibrium point is economically efficient.

Semisocialized economies are hybrids, since they contain a large government sector as well as a privately owned sector. In general, the privately owned sector can be expected to behave as private companies would in a free market economy, and the government sector might be expected to behave as governments would in socialized economies. However, because private companies have to compete with the government in a number of areas, private decisions are dramatically affected by the pricing decisions of the government. In particular, if the government decides to set prices low to subsidize consumption, private companies will be forced to cut back, be driven out of business, or be forced to sell out to the government. In all cases, the market is very nontransparent to the players in the system.

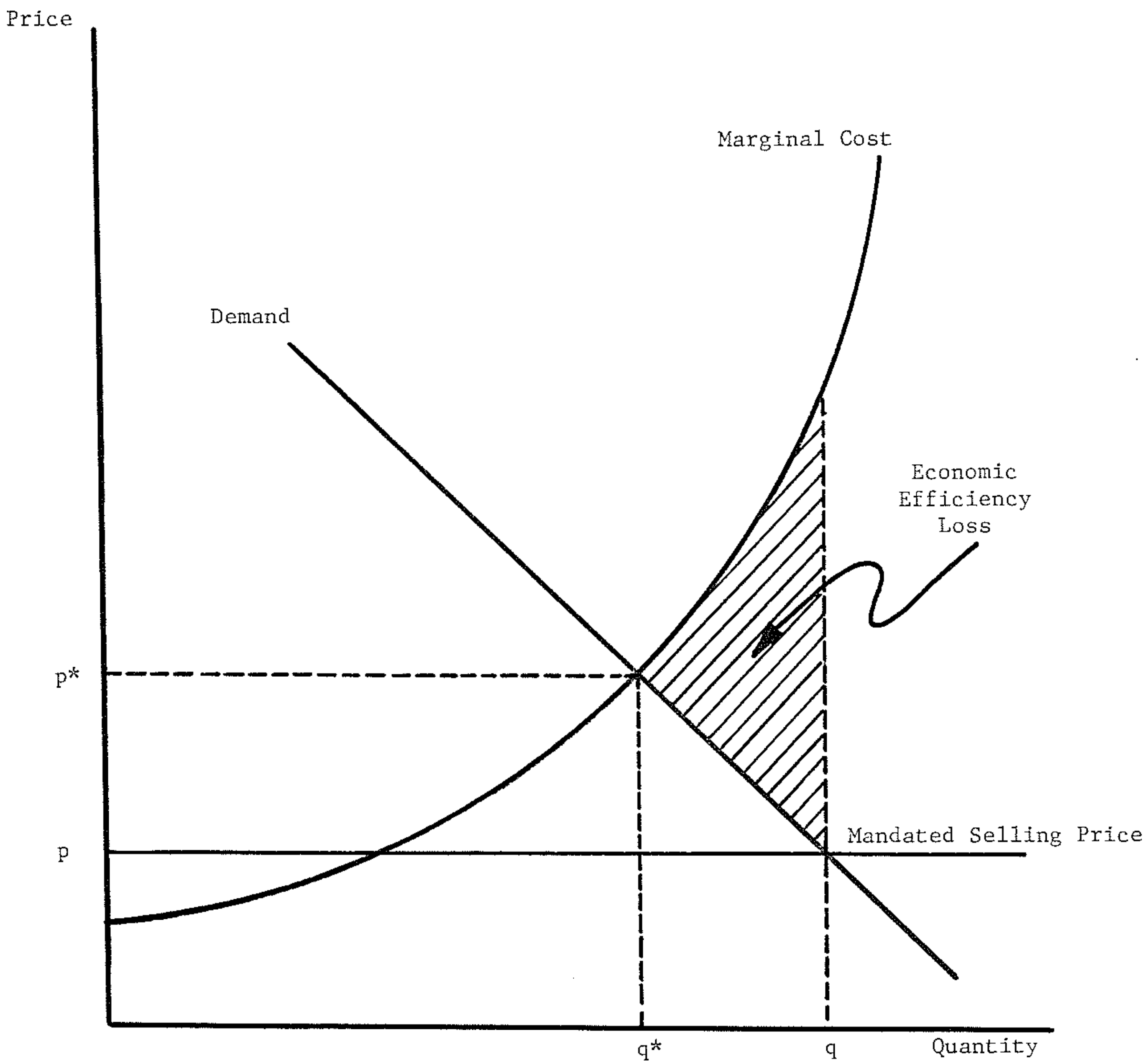
Following up on the idea that the semisocialized system is a hybrid of the free market and totally socialized systems, we have drawn in Figure I-1 the case of a semi-socialized economic system. The marginal cost curve represents the aggregate ability to produce, the demand curve represents the aggregate preferences for consumption, and the horizontal line represents a government-mandated price for the resource being supplied. By subsidizing prices, the price is decreased from its free market level p^* to the level p, and the quantity is increased from its free market level q^* to q. The corresponding loss in economic efficiency (which is the dollar cost of the subsidy) is equivalent to the shaded area in the figure. Conceptually, it corresponds to the dollar value of the resource that consumers would not be able to afford and therefore would not buy without the price subsidy. In effect, the government is buying this resource for them through the price subsidy.

The key question, given that price subsidies induce dead weight economic efficiency losses, is: Why would the government want to implement them? The usual answer is for distributional reasons, i.e., to ensure that basic commodities are available to people of all income classes. Furthermore, even though such distributional goals come at the expense of economic efficiency, capital formation, etc., they are viewed as worth the cost, particularly in countries where low income people might not be able to afford basic commodities. We will use the terminology that public policy goals seek to transfer funds from the economic sector to the social sector, even if such transfer requires costs to be borne.

It should of course be noted that the government does not want to pay an inordinately high cost, i.e., the government wants to effect the transfer in the most cost-effective manner possible. The penalty for cost-inefficient transfer includes the inability to acquire and service capital, the need for external assistance, austerity and

Figure I-1

LOW GOVERNMENT-MANDATED PRICES



sacrifice, and future instability. Thus, in summary, the key problem facing the government in a semisocialized economy is to minimize the size of the shaded area in Figure I-1 while at the same time meeting realistic social and distributional objectives. A delicate balancing act indeed is required. One might interpret the size of the shaded area in the figure as the degree of socialization of the economy.

To make these ideas more concrete, consider the following example. Consider a hypothetical country in which there are three oil fields within the same geological structure. Assume further that fixed development costs are the same for all three fields but that production is not, implying that marginal costs differ. One field produces 100 cubic meters per day, the second 50, and the last only 10. At the present world oil prices level only the first one will be profitable, the second will be on the verge of profit, and the third one will assume losses if produced.

If these three fields were located in a country with a free market economy, only the 100 cubic meter per day field would go into production; the other two would wait for better world oil prices or more advanced technologies to lower marginal costs. By contrast, if those fields were located in a semisocialized economy whose stated policy was to achieve energy independence, all three fields would be developed simultaneously, even the two noneconomic fields. This would be accomplished by either government development of the fields or subsidization of domestic producers to develop the fields. In either case, the government would be spending more than the world oil price on a unit basis to develop the latter two fields. And the government would be paying for consumers to utilize domestic oil that cannot compete with world oil on a price basis.

A key goal of public policy analysis in the semisocialized environment is to calculate the cost of the subsidy necessary to develop the uneconomic fields, which is required by the announced public policy. If the magnitude of subsidy is judged to be appropriate relative to the distributional and other objectives of the government, then the subsidy is appropriate. On the other hand, if the magnitude of subsidy is judged to be too large, then the government has the fundamental information to modify public policy accordingly.

To conclude, we offer the following preliminary characterization of a semisocialized economy: an economy in which the government, whether or not it actually owns productive activities, chooses to interfere with the operation of the market through such mechanisms as regulations, incentives, restrictions, quotas, etc., thus distorting the operation of the price system.

When an overall energy-economy assessment was commissioned in Argentina in 1980, it was immediately obvious that public statements, which perhaps were not even regarded beforehand as public policies, had profound effects on markets in the country. The authors found that to obtain useful and credible results, modeling methods and supporting data had to be developed to reflect the particular set of government policies in the country. It was not sufficient to simply adopt techniques designed to analyze free market economies; rather, it was necessary to customize tools to our particular situation. In particular, if tools developed to analyze the free market situation are not adapted to semisocialized environments, their level of application in most of the countries of the world will be quite restricted.

Recognizing the need to start with a free market tool and thereafter adapt it to our particular situation, we initially sought the best available free market tool with the greatest possibilities for such adaptation. Easily the best tool available was the Generalized Equilibrium Modeling System (GEMS) built by Decision Focus Incorporated (DFI), which we obtained and have subsequently adapted. This document focuses on the nature of adaptations required, the nature of adaptations accomplished to date, and the future adaptations that could profitably be made.

Because most energy-economy modeling tools are free market by nature, many opportunities have been lost to apply formal methods in semisocialized economies. By suggesting adaptations on what we consider to be the best available quantitative modeling tool, we hope to motivate the use of the tool in a broad range of semisocialized economies. The benefits from such application include improved understanding and relations between free market economies such as the United States and semisocialized economies as well as fundamentally better planning by semisocialized nations.

Chapter 1

ENERGY AND ECONOMIC PLANNING IN A SEMISOCIALIZED ECONOMY

This paper characterizes the fundamental nature of the energy-economy system in what we will term a semisocialized sociopolitical environment. As an aid to such characterization, we will highlight the differences between semisocialized economies and free market economies. Our purpose is to investigate the relationships between the formulation of public policies and their implications for the overall socioeconomic system. We also define what we mean when we use the terms public policies, alternatives, scenarios, and uncertainties. We view this as necessary to avoid confusion with other implicit definitions people might have for these terms.

This paper finally evaluates the applicability of a particular quantitative modeling methodology--Generalized Equilibrium Modeling--to help decision makers in semisocialized countries anticipate in the intermediate and long run the overall socioeconomic impacts that will result from public policies they might apply.

Because we are most intimately familiar with the situation in Argentina, we will frequently use Argentina as an example. While we will not argue that the situation in Argentina can be directly extrapolated to all other countries, there are nonetheless similarities (particularly in South and Central America) that lead us to believe in the validity of such extrapolations.

1.1 SEMISOCIALIZED COUNTRY

1.1.1 The Approach

What is a semisocialized country? What are the common characteristics of such economies? What is the role of public and private sectors in such economies? To what extent does energy policy pervade such economies?

The objective of this paper is to suggest answers to these questions. We emphasize that the vast majority of countries in the world are semisocialized (according to the definition we will introduce here). The number of such countries bespeaks the importance of developing a method for analyzing such economies rather than relying on textbook methods that focus on the idealized (and rare) case of the so-called free market economy. In fact, we would go so far as to state that the United States is the only economy in the world that is close to being a textbook free market economy, and even the United States is socialized when it comes to environmental regulations and other government restrictions.

Recognizing the large number of semisocialized economies in the world, if any progress is to be made in those economies, a new planning approach customized to their particular structure must be developed. Specifically, if such countries are to avail themselves of (1) technical assistance for development planning, (2) better tools for official decision-makers, (3) provincial/regional energy-economy assessments for local GDP optimization, (4) sectoral/industrial/agricultural/educational analyses, or (5) government-to-government support by means of bilateral agreements, new tools and a new language of communication will have to be developed to explicitly recognize the semisocialized nature of such economies. It is simply indisputable that such countries have distinctive characteristics originating from a fundamentally different political and philosophical system than free market economies.

Should one dare to argue that the socioeconomic systems in such countries should be changed and adapted to the free market paradigm, he is unlikely to make *any* contribution to public policy analysis. It is indeed naive to think that one can change the result of processes that have evolved over many years, i.e., that one can change quickly public opinion, culture, and lifestyle. At best, such economies will only desocialize extremely slowly and only if the government elects to pursue an evolutionary policy with such an end in mind. It is our conjecture that desocialization, if it occurs at all, will generally stop far short of transforming currently semisocialized economies into free market economies. It is our feeling that such economies will always retain some significant degree of socialization.

We should emphasize that the private sector in such economies tends to be so intertwined with the public sector that disengagement of the two is a formidable task indeed. Only through a slow and persistent strategy can one hope to decouple and "privatize" industries that are currently publicly owned and controlled.

1.1.2 How a Country Might Lose its Free Market Status

Some countries that are currently semisocialized countries were many years ago free market economies. In fact, many countries started their independent existences under a free market system. To illustrate a typical evolution from a free market system to a semisocialized system, we will use Argentina as an example. Table 1-1 shows a small portion of the economic history of the country from 1945 through 1977. In 1945,

Table 1-1

CHANGES IN THE ARGENTINE GOVERNMENT PARTICIPATION IN ECONOMIC ACTIVITIES

		%Participation			
		Until 1945		May 1977	
		Private	State-owned	Private	State-owned
1.	Railroads	90	10	0	100
2.	Electric Services	100	-	0	100
3.	Telephone Companies	100	-	2	98
4.	Subways	100	-	0	100
5.	Urban Transportation	100	-	100	0
6.	Domestic Shipping	100	-	10	90
7.	International Shipping	100	-	20	80
8.	Oil Companies	60	40	20	80
9.	Steel Companies	100	-	30	70
10.	Heavy Chemical Industries	100	-	50	50
11.	Gas Companies	100	-	0	100

Note: The preceding table is an estimation, but the numbers are correct and have a fairly sound basis. This work does not include the 700 government-owned companies.

the Argentine economy was almost completely a free market economy, the main economic sectors being owned and controlled by private companies. The only significant exception was the oil and gas sector in which the government was approximately a 40 percent owner.

As illustrated in the table, by May of 1977, the State owned between 50 and 100 percent of most of the industries in the table, having transformed them into public utilities. These public entities included almost the whole transportation sector, electricity, oil, gas, etc. and most of the heavy industrial concerns. Although not depicted in the table, the socialization of smaller industries (e.g., hotels, casinos, and even night clubs) was equally pervasive.

The portion of the Argentine economy that remained in 1977 under private ownership and control was quite small--primarily light industries, agriculture, cattle-breeding, urban transportation by bus, a limited part of the banking and financial system, cement, food industries, and so forth. It was estimated that by 1977, the government owned and controlled between 60 and 70 percent of the entire productive sector of the Argentine economy, this socialization having occurred over a 35 year period.

The implication of this degree of socialization for Argentina is evident--public policies have grown in importance relative to private decision making. That is, government behavior has become increasingly important to the socioeconomic system. In general, the more an economy is socialized, the greater the impact of public policies on the socioeconomic system. Therefore, if something were to be done to reverse the socialization process and its implications, it must begin with public policies with this objective firmly in mind.

It is also true that in an economy with the degree of socialization shown in Table 1-1, government tends to regulate those industries that it does not own more than a government in a free market system might. In short, the government not only runs the sector of the economy it owns directly, but it interferes quite liberally in that portion of the economy it does not own. Such interference occurs in the form of regulations, decrees, taxes, incentives, and so forth.

In a private economy, the government is just one more player in the economic system and not necessarily the most important player. As such, governments in private economies tend not to impose regulations that stifle the economy because such regulations are not in the government's interests--the government gains when the private sector gains.

By contrast, however, in semisocialized economies such as that in Argentina, the government must *compete* both politically and economically with the private sector. The government is not at all a disinterested player but is aspiring for credibility relative to the private sector. This often introduces a "zero sum" element into the economy in which success of the private sector is perceived by the government as detrimental to the interests of the government. Conversely, success by the government is perceived by the private sector as detrimental to its interests. In such a situation, it is politically difficult if not impossible for the government not to intervene in the operation of the private sector, and the objective of such intervention is not necessarily benevolent or neutral. The net effect of the government attempting to stifle its private sector is a loss in economic efficiency.

The effect of the socialization of the economy depends therefore on the size of the government's share of the economy (relative to the private sector), the magnitude, severity, and enforceability of regulations and restrictions imposed on the private sector, the consequences of such regulations and restrictions, and their transparency to the populace. In the case of Argentina (and many other Latin American countries), the government sector is quite large, and its effect is very pervasive throughout the economic system. Planning methods derived from free market economic models are obviously not appropriate.

1.2 A RUDIMENTARY APPROACH TO PLANNING IN SEMISOCIALIZED ECONOMIES

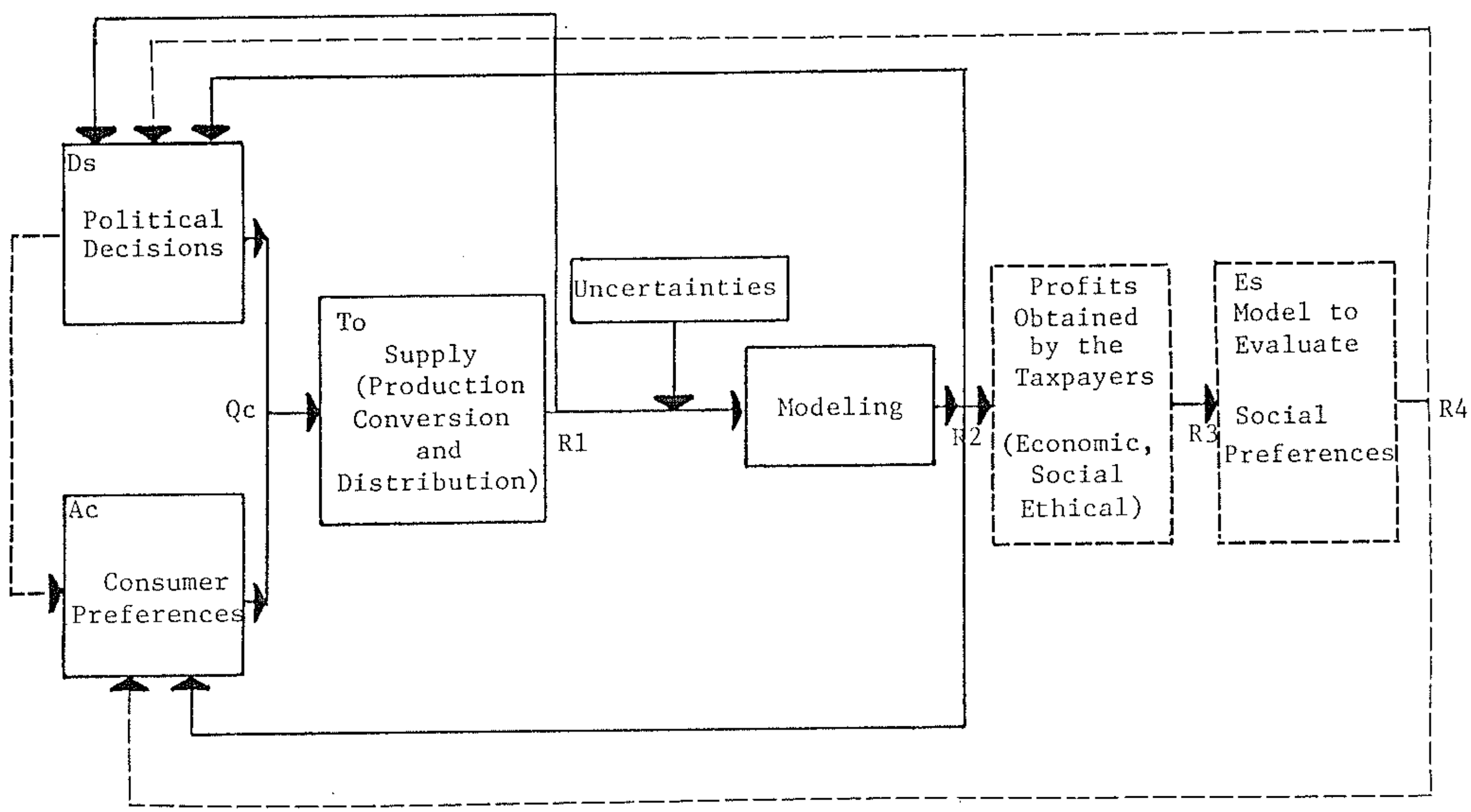
This section sketches our formulation of the general problem of planning in a semisocialized economy. The discussion here is abstract, the intent being to characterize a few of the most fundamental considerations for public policy making in semisocialized economies. Later sections will expand on the simple abstract model presented here.

Figure 1-1 illustrates in schematic form the structure of a semisocialized economy. It will serve as a basic framework for our discussions. In the figure, the box denoted Ds represents political decisions made by the government. The box denoted Ac represents consumer preferences for technologies and commodities of all types. The box designated To represents the supply subsector of the economy, including production, conversion, and distribution of all goods desired by consumers subject to the political decisions (Ds) made by the government. For example, if supply decision makers choose to produce electricity by burning fuels instead of using hydro, the supply sector will be comprised of wells or mines, conversion will be comprised of refining plants, and distribution will consist of high-voltage power lines. Clearly the configuration of the supply system (broadly defined) will depend on political decisions and supply decisions made in that environment. Consumer preferences will affect the supply system only to the extent that they are felt by producers through the price system.

In the figure, the point R1 represents the energy balance for the economy. In particular, the point R1 is the point at which enough supply must be delivered to meet projected demand, or where shortfalls must be measured. Clearly the government strives to ensure against shortfalls and to satisfy consumer preferences as best it can. Perhaps based on projections from a quantitative energy balance tool, the government can devise production and political decisions to ensure a better supply-demand balance. And using extrapolations of population, economic growth rates, and other information, the government can generate projected energy balances.

Figure 1-1

PROCESS ANALYSIS FOR THE DETERMINATION OF PUBLIC POLICIES
IN THE ENERGY SECTOR



The problem facing the government at the point R1 is: What is the *optimal* set of political decisions Ds and production decisions To? What particular set of decisions is best for the populace as a whole? To determine the answer to this question, a tool is needed that generates much more than merely an energy balance at the point R1. The notion of an optimal public policy explicitly considers such attributes as maximum GDP, lowest energy consumption rate, and lowest required investment levels, maximum possible rate of employment, and so on. Therefore, the supply-demand balancing tool used to project the supply-demand balance at the point R1 in the figure must be able to generate these other attributes in addition to the supply-demand balance itself. Only then can policy makers determine which public policies are better and in fact which public policies are optimal.

1.3 EQUILIBRIUM AND STABILITY

If at any given point in time, supply and demand are in balance (i.e., there are no excesses or shortfalls in supply relative to demand), we say that the system is in equilibrium. The output of the supply system at R1 will provide the quantity Qc at the mandated (and free) prices in the system. However, any variation from this supply-demand equilibrium will cause either a shortage or a surplus of production relative to consumption for some commodity. If this occurs, we observe that the entire system will become unstable; changes in the economic system will begin to occur. In practice, such changes will be initiated by the party or parties bearing the brunt of the cost of the shortage or surplus. The figure indicates that the ramifications of disequilibrium will be passed back to the government along the arrow running from the box labeled To to the box labeled Ds. In concept, the government will be motivated to modify its political decisions Ds in response to this stimulus.

Unlike the purely free market in which the disequilibrium production signal from R1 will feed back only to the consumer, the government in a semisocialized economy is an integral, indeed major, player. How the government should set its decisions Ds in the essence of public policy analysis.

In practice, economies are subject to a large number of endogenous and exogenous stimuli that serve to displace the system from equilibrium, e.g., changes in public policies, variations in economic development, introduction of new technologies, problems in the energy sector itself such as depletion of wells and mines, or changes in prices for imported energy and energy-related products. Therefore, the problem faced by the government is fundamentally dynamic; it must update its policies Ds to respond to such stimuli and to maintain optimality (which we shall define shortly).

Because the government sector usually lacks a comprehensive tool to predict either the consequences of its own decisions or unexpected changes in the economy (i.e., to predict the effect of its policies on producers, consumers, and the equilibrium indicated at R1), the problem of adapting public policy to achieve and maintain equilibrium is hit-or-miss at best. Misses tend to impose social costs on the economy as a whole. In the figure, these changes in the economic environment are collectively termed *uncertainties*, and the government's job is to behave optimally in the face of these uncertainties. One of the main reasons for adopting an explicit quantitative tool is to limit as much as possible the cost on the economic system if uncertainties are not anticipated and dealt with in advance.

1.4 PUBLIC POLICIES, ALTERNATIVES, AND SCENARIOS

Before proceeding further, we will digress to present explicit definitions of terms we have until now used somewhat loosely. While these terms are common in the jargon of energy-economic planners, we want to minimize the possibility that they are understood in ways we do not intend. In other words, it is our intent to make explicit definitions even though some of these definitions might differ in subtle ways from the common understanding of these terms.

> Public Policies. Public policies are general statements that orient the solution to energy-economic problems, either at the overall level or the sectoral level. These statements are intended to provide strategic guidance. They do not contain specific policy directives or instructions for execution; they are usually statements of philosophy. They might also be termed *propositions for government action* that include new directions aimed at improving a particular situation.
>
> When the policy problem being analyzed requires the government to implement more than one policy statement, a necessary condition to guarantee a viable solution is that the set of policy statements be coherent and self-consistent. That is, the policy statements must be complementary or harmonious. To use a mathematical analogy, the set of all public policies defines a *feasible set* within which the public and private agents in the economy must operate. (See example in Appendix 1).
>
> Alternatives. Alternatives are specific decisions that are available to public and private agents within the feasible set defined by public policy. In general, the state of the economy depends on the particular combination of public and private alternatives. That is, each combination drives the economy to a particular state, i.e., induces different socioeconomic consequences. Therefore, each combination of alternatives results in a specific GNP, employment rate, regional development, external debt, energy consumption, price stability, and so on. We will use the term combination and alternative synonymously. The problem facing policy makers is to set public policy so that the combination of public and private alternatives drives the economy to the best or optimal state.

Scenarios. A scenario is the final overall state of the economy, i.e., socio-economic consequences brought about by implementing a certain alternative. Obviously a scenario is a complex function of the particular set of public and private alternatives pursued by the various agents. The function of energy-economic modeling is to begin with the general public policy in force and thereafter to predict the best set of public and private alternatives, and in so doing, to predict the optimal scenario. A valid scenario is one that is deemed to be reasonable given the underlying policy environment and the predicted actions of public and private decision makers.

In terms of Figure 1-1, public policy occurs in the box labeled Ds. Specific alternatives occur in the box labeled To (production sector) and in the box labeled Ds, where they affect consumers directly as indicated by the broken arrow downward from the box labeled Ds to the box labeled Ac. Finally, the scenario occurs at the point R2.

1.5 SOUND OBJECTIVES OF GOOD GOVERNMENT PUBLIC POLICY ANALYSIS

We advance the proposition that the legitimate function of government is to advance the aggregate interests (welfare) of the citizens of the country. That is, a "good" government is one that seeks to obtain an adequate and rational distribution of the existing economic, physical, and human resources thus avoiding social tensions generated by development lags, excessive internal and external financing commitments, low employment rates, and so on. To achieve such ends, a government should focus its attention on determining an appropriate set of public policies. This requires an exhaustive analysis of the possible policies and a sound methodological approach for selecting one particular public policy from the set. We advance as a model for doing so the diagram in Figure 1-1.

By *public policy analysis* we mean a formal and ongoing effort aimed at systematizing all the information related to public problems and identifying the best policy and its likely consequences. The concept of best must be based on social, moral, and ethical values as well as on purely economic values.

1.6 THE INTRODUCTION OF UNCERTAINTIES

The public sector is always concerned about the level and nature of the many uncertainties that might hamper its development plans. The implications and political connotations of these uncertainties pervade the whole social body.

It is useful to classify uncertainties facing public policy analysis as follows:

- Endogenous, when they are the result of well-known decisions (such as changes or alterations proposed in government planning), but imply collateral effects of unknown proportions. Summarizing, the temper of this uncertainty is known, the orientation and probable timing is foreseeable, but its collateral effects can neither be predicted, nor computed beforehand. To resolve such uncertainties is the principal aim of public policy analysis.

- Exogenous, when they are the result of actions by decision makers outside the economic system; uncertainties are in an important sense outside the control of public policy makers. Examples of exogenous uncertainties include changes in world oil prices, wars, probable existence of a new source of energy, a nuclear failure, and so on. To anticipate and hedge against such uncertainties is a key aim of public policy analysis.

Figure 1-1 shows how such uncertainties might be considered by our analytical approach. They are inserted just prior to the modeling block, indicating that they must be represented probabilistically and thereafter analyzed using an explicit quantitative model. This implies the need for a modeling method that can correctly process probabilistic as well as deterministic information, representing the complete range of future outcomes (i.e., the complete range of scenarios) that can occur given each public policy alternative under consideration.

1.7 INSERTION OF UNCERTAINTIES INTO A GENERALIZED EQUILIBRIUM ENERGY-ECONOMY MODEL

We now move to the modeling box in Figure 1-1. The model represents the fuels, technologies, sectors, resources, and end-uses that comprise the energy system. Conceptually, it is a network comprised of all possible existing and potential future chains of technologies from resources in the ground; through conversion, transportation, and distribution processes; and finally to end-use conversion. We emphasize that the collection of chains represented in the model must be exhaustive for the economic system (or portion of the economic system) being analyzed. If any potentially competitive chains are omitted from consideration, the answer generated by the model will be incomplete, indeed wrong. Equilibrium occurs when the particular chains of technologies in the ground from resource production to end-use are the lowest cost chains consistent with the institutions, constraints, and government actions in the energy system.

Of course, calculation of equilibrium for a single set of input assumptions characterizing each chain does not solve the public policy problem. Indeed, each solution represents a single scenario. The essence of public policy analysis is to choose the public policy that gives the best scenario.

Since the model is an aggregated representation of reality showing the consequences of the chosen policies over the medium and long term, the main required results will include:

- Energy supply and demand projections for each set of public policies adopted (alternatives).
- A thorough knowledge of many economic and social consequences of those energy demand projections.
- Quantification of all the requirements imposed by each scenario including financial, industrial, human, and educational resources.
- A guide for promoting changes in those institutional aspects that may restrict the adoption or hamper the success of the proposed alternatives.
- A direct cost-to-benefit evaluation between different sets of policies (alternatives) through an adequate cross-check of the resultant scenarios.
- A correct determination of the type, location, temper, and relative importance of the uncertainties included in the chosen alternative. This is accomplished by running different scenarios with and without the alternative under study.
- The likelihood that the chosen alternative will cause undesirable outcomes (i.e., the risk implicit in the chosen alternative). This is not provided by deterministic models such as GEMS. Rather, a separate but coordinated uncertainty analysis is required.

1.8 THE NEED FOR A GENERALIZED EQUILIBRIUM MODEL

All the different scenarios are collected at the point in Figure 1-1 labeled R2. This collection of scenarios represents for each policy alternative the range of possible outcomes, and it is sufficient under certain assumptions to generate a probability distribution over outcomes for each policy alternative. These scenarios (or probability distributions) are, as the diagram shows, then fed back to the public sector decision makers and the consumers, who may or may not revise their decisions as a result.

It is obvious that if a broad enough array of outcomes (attributes) of a particular public policy alternative are to be considered, the modeling system must:

1. Include most of the existing government policies and private objectives related to energy decisions and energy-economy decisions.
2. Represent the large number of technological and fuel options using an easily-constructed and implemented network representation.

3. Include both currently existing and future technologies.

4. Determine an energy supply-demand balance consistent with the government policies and private objectives that exist in the country.

5. Include as much detail as possible regarding the financial requirements necessary to sustain a given energy-economic scenario. These financial results must be generated in detail for each element of the network and then aggregated across the entire economy because the financial impacts of a particular scenario depend on economy-wide financial requirements. That is, the ability to acquire and service debt and the interest rate paid will depend on the whole-economy level of borrowing.

6. Calculate results over a long planning horizon for each scenario generated. Long planning horizons are essential because of the need to weigh investment, debt acquisition, energy import, and technology import decisions, whose impacts unfold over a very long future time horizon.

In our judgment, GEMS meets all these needs better than any other quantitative modeling approach. Therefore, we chose to use GEMS to support our modeling needs indicated in the box in Figure 1-1.

Returning to Figure 1-1, once the results of the model are fed back to the various government and private decision makers, they will modify their decisions as appropriate. Thus an iterative cycle will begin, which will end when (1) all decision makers simultaneously agree that the system is optimally configured or (2) the cycle ends prematurely because of time or budget constraints. In the former case, an optimal public policy has been identified. In the latter case, although an optimal public policy might not have been identified, each cycle has resulted in a strictly better set of public policies. Thus, decision makers can be confident that whether or not the cycle stops prematurely, they will have identified a better set of public policies than they began with; they will have made improvements.

1.9 THE NEED FOR COMPLEMENTARY MODELS

In our experience, no single approach could possibly meet the full range of policy needs of a government no matter what kind of economy exists. Thus, a set of complementary models, each focused on a different issue in a different level of detail, is appropriate. In particular, to measure benefits to particular players in the economic system, two specific benefits models are needed.

These benefits models are motivated by the following questions facing the public sector:

1. Are the goals set by our development plan the best goals?

2. Are these goals consistent with the motivations, preferences, and expectations of the citizens of the country?

These questions require the two models indicated Bs and Es in Figure 1-1, which will be explained in more detail.

The box denoted Bs represents a model that measures the benefits that accrue to consumers *as perceived by the government policy makers.* Such models are the subject of welfare economics, and authors such as Harsanyi (1955) have advanced sophisticated and general models of social welfare as perceived by representatives in general and government representatives as a special case. Typically, government policy makers evaluate consumer welfare based on economic, social, and ethical parameters. As indicated in the figure, the welfare measure computed by the policy makers' preference model is fed back to government decision makers, who may choose to revise public policy if they perceive it not to be in the social interest.

By contrast, the box denoted Es represents the benefits that accrue to consumers *as perceived by the consumers themselves.* The Es box represents the opinions of the populace themselves, not policy makers or other representatives of the populace. Harsanyi's theory specifies a theoretically rigorous form for such a consumer welfare model. As shown in the figure, the output of the consumer welfare model is fed back to the government box in the form of public opinion, where public decision makers might change public policy in response. In evaluating public policy, government decision makers should know the answers to the following questions.

- What functions do the general populace want the government to perform?
- Is the current mix of public policies in line with those desires? If not, is there a mix that is more consistent with the desires of the populace?
- How much difference is there between what the government thinks the people want and what the people themselves think the people want?
- If there is a gap between what the government thinks and what the people think, what can be done to ease the inevitable tensions and increase the prestige of the government in the eyes of the populace?

1.10 TYPE OF DATA REQUIRED BY THE DIFFERENT MODELS

In this section, we emphasize that two types of data are required to analyze public policy with a quantitative model such as the GEMS: descriptive data and normative data.

Descriptive data refers to the question: "What is?" Descriptive data includes for example resource cost data, technical parameters, cost parameters for various technologies, interest rates, imported oil prices, and population. Although difficult, it is possible to project descriptive data into the future.

By contrast, normative data refers to the question: "What should be? What do we want?" Normative data includes for example educational, political, ethical and moral attitudes. Normative data is often strongly influenced by laws, rules, and even prejudices. It is sometimes difficult to project normative data into the future because of the possibility that attitudes and mores might change over time. It is clear that the welfare models indicated in Figure 1-1 are normative, while the supply-demand models are to a large extent descriptive.

Obviously, for public policy analysis, normative models are the most interesting. An ambitious challenge for modeler and policy maker alike, normative models cannot be built by unskilled technicians or by people without intimate knowledge of the economic system being analyzed. Broad training and experience are indispensable.

1.11 CONCLUSIONS

Two main themes underlie any energy-economy planning work in a semisocialized economic system: (1) cheap and abundant energy will boost social and economic development and (2) political risks will always arise when the country depends on imported energy sources. The typical implication of these policy directives is that energy self-sufficiency becomes a national goal.

In semisocialized economies, one very seldom finds such free market notions as "energy should be conserved," "domestic prices should be allowed to equilibrate with world prices," "unconventional sources should be developed to replace depletable fossil sources," or "to justify projects, one must show that economic benefits will flow from those projects."

Because of the fundamental differences between semisocialized economies and free market economies as described previously and in later chapters of this paper, we often see the following differences in the operation of such economies. In semisocialized economies, we see:

- Extremely fast depletion of nonrenewable resources and slow growth of unconventional sources.
- Unnecessarily high investments in the energy sector.

- Excessive dependence on foreign loans and credit.
- Persistent lagging behind announced development plans.
- Increasing transfer of government funds.
- Increasing transfer of private sector funds to state-controlled activities.

which lead to:

- Higher government participation in the economy with the whole social system becoming even more socialized.
- Larger transfer of private funds to other more economically stable countries (i.e., emigration of capital).
- Lower valuation of local currencies on world markets.
- Generalized social unrest pervading the country, often at a level that threatens government stability.

By contrast, in free market economies, we generally see the antithetical situation. However, the degree of difference depends on the degree of control the government in such economies chooses to exercise in the economy and on the availability of domestic and foreign investment capital.

Based on our experience in Argentina, the application of formal quantitative procedures based on GEMS helps the government anticipate and quantify the consequences of different public policies *before* they are actually officially imposed. The less the degree of government intervention, the better GEMS in its present form will apply. However, even for economies with significant government participation such as in Argentina, GEMS can provide significant help. In particular, regardless of the nature of the economy under analysis, GEMS models will interrelate technological, economic, and other factors to project future scenarios on a consistent basis. They will ensure that the Btus add up, the dollars add up, the technologies and resources are completely represented, and so forth.

Perhaps more importantly, models such as GEMS provide a catalyst for people from a broad range of organizations, backgrounds, and disciplines to participate in and evaluate public policy analysis. They will share a common technical language, a common understanding of assumptions, and a common understanding of the implications of those assumptions for policy results. This in effect depoliticizes an otherwise totally political decision-making process, which, we contend, will do much to improve the accuracy and effectiveness of public policy making.

Chapter 2

ANALYTICAL APPROACH

This chapter investigates the main behavioral components of a semisocialized economy and proposes the skeleton of an appropriate analytical framework. The proposal is based on the observation that many semisocialized economies in the world today are relatively low-efficiency economies, consuming a large amount of capital to support energy sector investments, and as a result, encountering severe financial problems. Our intent here is to outline a basic analytical approach whose long run objective is to develop a proper set of public policies for semisocialized economies that can perhaps alleviate the present problems in such economies.

2.1 ENERGY-ECONOMIC PLANNING IN SEMISOCIALIZED ECONOMIES

2.1.1 Ownership and Control of Production Facilities in Mixed Economies

Two of the most significant economic planning issues within any country are:

- Who owns the various industries (or more generally the processes) that comprise the economy--the government or private parties?
- Who controls the various processes that constitute the economy--the government or private parties?

In this volume, we will not consider the extremely difficult philosophical and practical problem that the composition of public and private ownership of production processes in an economy is in fact a *decision* that must be made by the government and the citizenry. Rather, the primary focus will be on making investment, operation, retirement, and regulatory (i.e., government control) decisions given a particular ownership institution already in place within a country. Such problems are difficult enough in their own right--to solve them one must explicitly consider the fact that every economic activity is characterized by its own specific set of ownership and control parameters, i.e., every individual economic activity falls into one of the four boxes in Figure 2-1. Furthermore, every real-world economy has processes that fall into more than one of these boxes, i.e., no economy falls entirely within a single box.

Lest we be tempted to argue that so-called free economies such as the United States are confined entirely within one of the boxes, we can give examples of distinct economic activities in the United States economy that fall into each of the four boxes:

- Oil companies are privately owned and controlled.
- Electric utilities are privately owned but publicly controlled (i.e., subject to rate-of-return regulation).
- National laboratories are publicly owned but privately controlled (e.g., Martin-Marietta Corporation manages Oak Ridge National Laboratory under contract to the United States government).
- The Tennessee Valley Authority is publicly owned and controlled.

At the other extreme, lest we be tempted to argue that centrally planned economies such as the Peoples' Republic of China fall entirely within a single box, we note that in China

- Publicly owned and privately controlled agricultural plots exist and are in fact highly productive.
- The products from these private plots are themselves privately owned and controlled, being traded in private markets.
- Heavy industry is publicly owned and controlled.

If the United States and China, generally regarded as falling at the opposite ends of the capitalism/socialism spectrum, are not confined to a single box in Figure 2-1, what of the majority of economies in the world that lie between the two extremes? It is our observation that *all* countries in the world have *mixed* economies in the sense that they are comprised of processes that fall into two or more of the boxes in Figure 2-1. That is, no real-world economies can be confined to only one of the boxes in Figure 2-1.

2.1.2 <u>The Semisocialized Economy--a Special Form of Mixed Economy</u>

The vast majority of countries in the world, particularly developing and industrializing countries, are what we have termed semisocialized. In particular, the productive processes (i.e., the industrial sector) of such economies are characterized by a high degree of government ownership and control--government bodies (rather than private companies) make investment, new technology, financing, regulatory, and other decisions broadly throughout the production subsector. In terms of Figure 2-1, most if not all of the industrial activities fall within the lower right box. We caution that even in such economies, many activities, particularly private consumption activities, have a high degree of private control whether or not they are publicly owned.

Perhaps the best simple characterization of semisocialized economies is that there is an imaginary line in the economic system upstream from which all activities are

Figure 2-1

OWNERSHIP AND CONTROL

OWNERSHIP \ CONTROL	PRIVATE	GOVERNMENT
PRIVATE	UNREGULATED PRIVATE INDUSTRY	REGULATED PRIVATE INDUSTRY
GOVERNMENT	PUBLICALLY OWNED, PRIVATELY OPERATED	PUBLICALLY OWNED AND OPERATED INDUSTRY

privately controlled (whether publicly or privately owned) and downstream from which most activities are publicly owned and controlled. We shall return to this fundamental theme of a monolithic upstream sector and a diverse downstream sector interacting in such an economy.

2.1.3 Difficulties in Planning within a Semisocialized Economy

From a pragmatic point of view (not necessarily a philosophical point of view), it is extremely difficult to plan a semisocialized economy such as most Latin American economies for two reasons:

1. *There are no prices to guide investment decisions in the productive sector.* For example, in the energy sector in Argentina, which is almost completely owned and controlled by the government, there are no markets for indigenous investment capital (i.e., no interest rates). Capital is allocated among alternative energy investments without regard to an interest rate or a rate-of-return criterion to govern that allocation. The prices of products are set by the government without prior knowledge of whether supply and demand will balance at those prices. The prices that do exist in the economy are a poor guide to public investment decisions. By contrast, in an economy with broad private ownership, observable prices exist for transactions between producing entities, and these observable prices govern investment decision making to a large degree.

2. *There is no explicit yardstick to measure economic performance.* How can the government measure how well it is doing? There is no apparent measure of economic welfare upon which government decision makers can base their energy investment decisions. It is impossible using known techniques to predict the impact of a particular government policy on GNP, which is often advocated as a proxy measure of social welfare. The connection between energy investment decisions and GNP in semi-socialized economies is not at all understood. The general level of delivered energy prices is also a poor measure--implicit or explicit government subsidies can set these prices almost at will. (We hasten to point out, however, that the consumption levels, shortages, etc., that result from such prices cannot be set by the government--they result directly from the prices that are imposed.) Indeed, in reality, in economies with a higher degree of government ownership, GNP growth issues are often in practice secondary to distributional issues. Prices are often heavily subsidized at great penalty to GNP to ensure that lower income people can purchase particular commodities. By contrast, in an economy with broad private ownership, the yardstick to each party in the economy is simple--profit. This yardstick is well understood by all the players in such economies (including the government), and it allows each party to measure its performance. The profit yardstick may be difficult to apply in a semi-socialized economy or may not even be appropriate. Profit is an indicator of economic efficiency, not equity, and the latter may be the government's chief concern.

Because there are no prices to decompose economic decisions and because there is no a priori measure of economic performance, there is no immediately available set of signals to tell policy makers how well they are doing or what they should do in order to allocate resources more efficiently. This makes the job of a planner in a semi-socialized economy such as Argentina extremely difficult.

The difficulty of managing semi-socialized economies has become painfully obvious in the economic turmoil of the past several years. In many countries with a high degree of government ownership in the energy sector, Argentina among them, balance-of-trade deficits have more than doubled, the portion of national income spent for energy has increased dramatically, currencies have weakened against those of industrialized countries, and the ability to service external debt has become compromised. In such economies it is often the case that economic danger signals occur after the dimension of the problem has become extremely large. Also, one of the most important danger signals, i.e., a decline in the private employment rate, is often masked by the creation of more government employment through public works.

By contrast, in economies with a large private sector, danger signals occur at the level of individual firms in the economy. Corporate bankruptcies occur, plants shut down, capital investment slows, or unemployment increases. In such economies, much of the debt that could not be serviced in the future will in fact never be acquired, and the problem will be mitigated from the outset. While the danger signals in largely private economies are politically traumatic in their own right, they represent in part the important economic phenomenon Lester Thurow (1981) has termed *disinvestment*, and in part, the equally important economic phenomenon of reallocating capital resources in a more efficient manner. There are no such safety valves in semi-socialized economies--planners must make correct decisions in the first place.

Difficulties with Conventional Quantitative Planning Approaches. The interactions between the monolithic publicly owned upstream sector and the privately controlled downstream sector are absolutely fundamental to effective planning in semisocialized economies. Yet, the problem with standard quantitative methods as applied to semi-socialized economies is that they make one of two extreme assumptions--that *all* economic activities fall within the lower right box (Walras-Arrow-Debreu general equilibrium theory) or within the upper left box (maximization of a specified social welfare function.)[1] For a semisocialized economy, neither extreme is even remotely correct--we need a fundamentally different approach to understand the interactions between the monolithic government sector and the downstream private activities. We offer such an approach later in this paper.

Examples from Argentina. Over the past ten years or more, the government-owned energy sector in Argentina has consumed a large and increasing portion of the investment resources of the country.[2] This increase is due in large part to the perception by decision makers that economic and social development in Argentina requires as a necessary precursor significant growth in indigenous energy production. Therefore, it seemed clear to government decision makers that Argentina should finance aggressive indigenous energy growth, the financing coming largely from external sources. Even the high capital intensity and the long lead times of such indigenous energy investment did not moderate this perception. It also seemed clear to Argentine decision makers that Argentina should strive to achieve energy independence, investing in domestic productive capacity to eliminate imports to the maximum extent possible.

Were these public policy decisions in the national interest? Or did they merely contribute to (or cause) Argentina's current economic problems? We will offer two potential answers, both emanating from the problems we have mentioned with regard to planning semisocialized economies such as Argentina. The first potential answer comes from the original policy decision that Argentina should be self-sufficient in energy. Given this policy decision, the logical consequence is that the government should make massive investments in indigenous energy projects--nuclear, hydro, natural gas, coal, and oil--regardless of cost to eliminate energy imports. This represents a capital-for-energy displacement, and its real economic cost to the nation (ignoring the long lead times involved in capital investment) is equal to the difference between the cost of the capital and the cost of the energy imports displaced. While Argentina was making these massive investments, in fact the cost of capital and the cost of energy were going the wrong way. The cost of capital was increasing and the cost of energy was decreasing. Yet, because Argentina was a semisocialized economy, it was not possible to reflect these unfavorable prices in indigenous markets, and therefore, it was not possible for individuals (including the downstream, privately controlled sector) to change their behavior; the signals simply were not there. The extreme difficulty of managing investments without a pricing system, therefore, encouraged continuation of the policy of energy self-sufficiency past the point at which it was known to be problematic.

The second argument involves economic efficiency: in the absence of indigenous price signals, expenditures in the Argentina economy were not economically efficient.

That is, given that planners had no explicit guidance, capital investments in the country were directed into projects whose benefits did not exceed the costs. This argument is independent of the oil self-sufficiency argument. Stated simply, it argues that investment capital in Argentina was wasted, i.e., there were other ways to allocate capital that would make everyone in Argentina simultaneously better off.[3] In our view, the possibility of economically inefficient investments in economies without price signals is the most fundamental risk of a semisocialized economy--inefficiency is virtually guaranteed in a nonmarket system.

Economic theory offers a method to compute the loss in GNP implied by an economically inefficient allocation relative to an efficient one. If the economy were moved from the inefficient to the efficient configuration, the amount of money thus calculated would be freed up from alternative uses and could be reemployed in socially useful ways. We shall in this paper illustrate how losses in economic efficiency implicit in a particular allocation can be quantitatively measured.

Interactions Between the Upstream and Downstream Agents in a Semisocialized Economy. We should point out before leaving this discussion that even though the government does not completely control the downstream activities in the economy, it typically makes major, political decisions that affect decisions by downstream decision makers. For example, governments might ban new heavy oil-fired boilers. Or governments might tax gasoline. Or they might restrict imports of particular commodities (e.g., crude oil, raw materials). It is usually true that governments that own a larger proportion of the productive sectors also impose more stringent regulations on the downstream portion of the economy. Therefore, in such countries, the influence of the government will be far more encompassing. However, even in countries in which the government owns or controls a relatively smaller proportion of the producing sector, government usually regulates to some degree the downstream sector of the economy.

2.1.4 Difficulties with Technological Change within Semisocialized Economies

For most developing and industrializing economies, the path to development and growth lies in technological change. Perhaps the best way to illustrate the difficulties with such technological change is to contrast semisocialized and free economies with regard to the incentives for such change.

Beginning with free market economies, the past fifty years has seen remarkable development and penetration of new technologies into free market economies such as the

United States. Incentives for such technological changes are not totally understood, but they include distributional incentives arising from market agents pursuing profits, patents, the potential for monopoly or oligopoly, speculation, resale of information, and the arms race motivation, that each individual company faces the prospect that its competitors will beat it to the punch if it does not engage to some degree in technological innovation. In addition, government and quasi-public institutions have infused free market economies with research and development dollars, but a good deal of the actual R&D is conducted by private individuals and institutions. In short, the existence of a price system is thought to produce strong incentives for private R&D.

However, in free market economies, some of the products of R&D are immediately appropriable not just by the innovating firm but also by all its competitors. That is, R&D can in some cases produce a public good. It is known that public goods decrease incentives for private individuals to pursue R&D.

To summarize, the price system has a significant effect on the process of innovation by individual entrepreneurs in free market economies. In particular situations where such R&D is not pursued because of lack of appropriability of benefits by the innovating firm, such economies typically have established government and quasi-public institutions to ensure that the necessary R&D gets done. In short, free market economies have become exporters of technology to other countries.

In semisocialized economies, we have not seen the proliferation of innovation that we have seen in free market economies. Perhaps the largest impediment to such R&D is the absence of a critical mass of trained people. The so-called brain drain from developing and industrializing countries to developed countries is indicative of the strong personal incentives facing appropriately trained individuals to perform R&D in developed countries. It is only in developed countries that they can reap personal reward from successful R&D. To follow this idea further, the absence of a price system in semisocialized countries precludes technological innovators from obtaining personal rewards from such innovation, and it also precludes sponsors of such innovation from achieving increased profits. Much more extremely so than in developed countries, the benefits of innovation in semisocialized countries are inappropriable by innovators.

In view of the lack of appropriability of the benefits of technological innovation, developing and industrializing semisocialized economies are technology importers--they are quite dependent on other countries for technologies. Thus they are in a difficult situation--they must either import finished products or they must import the technology to manufacture those finished products themselves. Both have turned out to be extremely expensive, exacerbating balance of payments and debt problems for such countries.

Given that finished products and the technologies needed to produce them indigenously are expensive to import, planners in semisocialized economies need careful and accurate methods to predict which technologies and products are the most economically efficient for their country. Only by identifying the most efficient technologies and products can they be certain they are paying the minimum possible cost for the expensive new technologies they dearly need. Even with a price system, technology planning is extremely difficult. Without it, such planning is almost prohibitive.

2.2 THE IMPORTANCE OF THE ENERGY SUBSECTORS

Table 2-1 illustrates the importance of government ownership of all sectors. This section focuses on the importance of the energy subsectors relative to the economy as a whole. The main reason we focus on the energy sector in more detail is twofold:

- The influence of energy can be felt at every level of the economy.
- If there is any degree of socialization at all, it most likely occurs in the energy sector.

Thus we discuss energy not only as an important economic planning issue in its own right, but also as a case study of the effect of socialization in an economy.

2.2.1 The Service Sector

Returning to the particular situation in Argentina, Table 2-1 decomposes total investment in Argentina between the service sector and the economic sector (i.e., the productive sector), and thereafter, decomposes investment in the economic sector between energy and nonenergy industries. During the period 1970 to 1984, investment in the economic sector ranged from 78 to 83 percent of total investment in Argentina. That is, nearly five-sixths of all investment was in the economic sector outside the service sector. During the same period, energy accounted for 49 to 62 percent of total investment in Argentina, comprising the lion's share of investment in the economic sector. In short, unlike the United States, energy projects took more than half of all the money invested in Argentina. The "elephant-rabbit" analogy (the elephant being the economic sector and the rabbit being the energy sector) used to describe the United States definitely does not apply in Argentina. In fact, the roles of the elephant and rabbit are reversed.

Table 2-1

YEARS	TOTAL PUBLIC INVESTMENTS (1)		ECONOMIC SECTORS INVESTMENTS (2)		ENERGY SECTOR INVESTMENTS (3)		
	10^6 Argentine Current Pesos	%	10^6 Argentine Current Pesos	%/1	10^6 Argentine Current Pesos	%/1	%/2
1970	4,878.8	100	3,844.3	78.8	1,897.2	38.8	49.3
1971	7,550.6	100	6,067.2	80.3	2,572.6	34.0	42.4
1972	13,459.7	100	11,041.5	82.0	4,730.0	35.1	42.8
1973	20,382.5	100	16,683.4	81.8	7,306.9	35.8	43.8
1974	27,039.5	100	21,359.8	78.9	12,200.1	45.1	57.1
1975	86,398.8	100	63,201.5	73.1	40,076.7	46.3	63.4
1976	670,689.9	100	524,226.4	78.1	307,079.7	45.7	58.5
1977	1,767,702.5	100	1,335,171.3	75.5	778,980.5	44.0	58.3
1978	4,231,019.8	100	3,163,280.5	74.7	1,947,493.8	46.0	61.5
1979	9,310,624.3	100	6,921,974.8	74.3	3,910,302.5	41.9	56.5
1980	16,154,863.0	100	12,671,708.0	78.4	7,328,305.2	45.3	57.8
1981	30,008,271.5	100	22,792,377.2	75.9	14,301,100.0	47.6	62.7
1982	87,278,653.0	100	72,095,900.0	82.6	48,213,800.0	47.6	66.8
1983*	374,098,683.0	100	311,564,900.0	83.3	194,983,200.0	55.2	62.5

* estimated

One might argue that the energy sector itself is a service sector with regard to the rest of the economy, energy being required to fuel economic growth and living standards in the country. Viewed simply, a service sector does not contribute directly to economic growth or living standards; its contributions are indirect. Continuing the simple view, one could argue that the role of a service sector is to supplement other more important economic activities in the economy--to be as economically efficient, reliable, and small as possible. It should not divert a large proportion of investment capital from other more productive uses. It should not be perceived as a large employer for social and/or political reasons. Nor should it be subsidized by the other sectors either though high energy prices, high taxes on the other sectors, or diversion of investment capital at subsidized rates. Rather, in an ideal economic system, the productive and social sectors would work jointly to produce the highest possible GDP accompanied by the highest possible welfare and would adopt the smallest possible service sector to achieve those objectives.

Table 2-1 clearly indicates that the energy service sector is consuming the major portion of investment capital in Argentina: the "servant" is making more money than the "boss."

2.2.2 The Consuming Sector

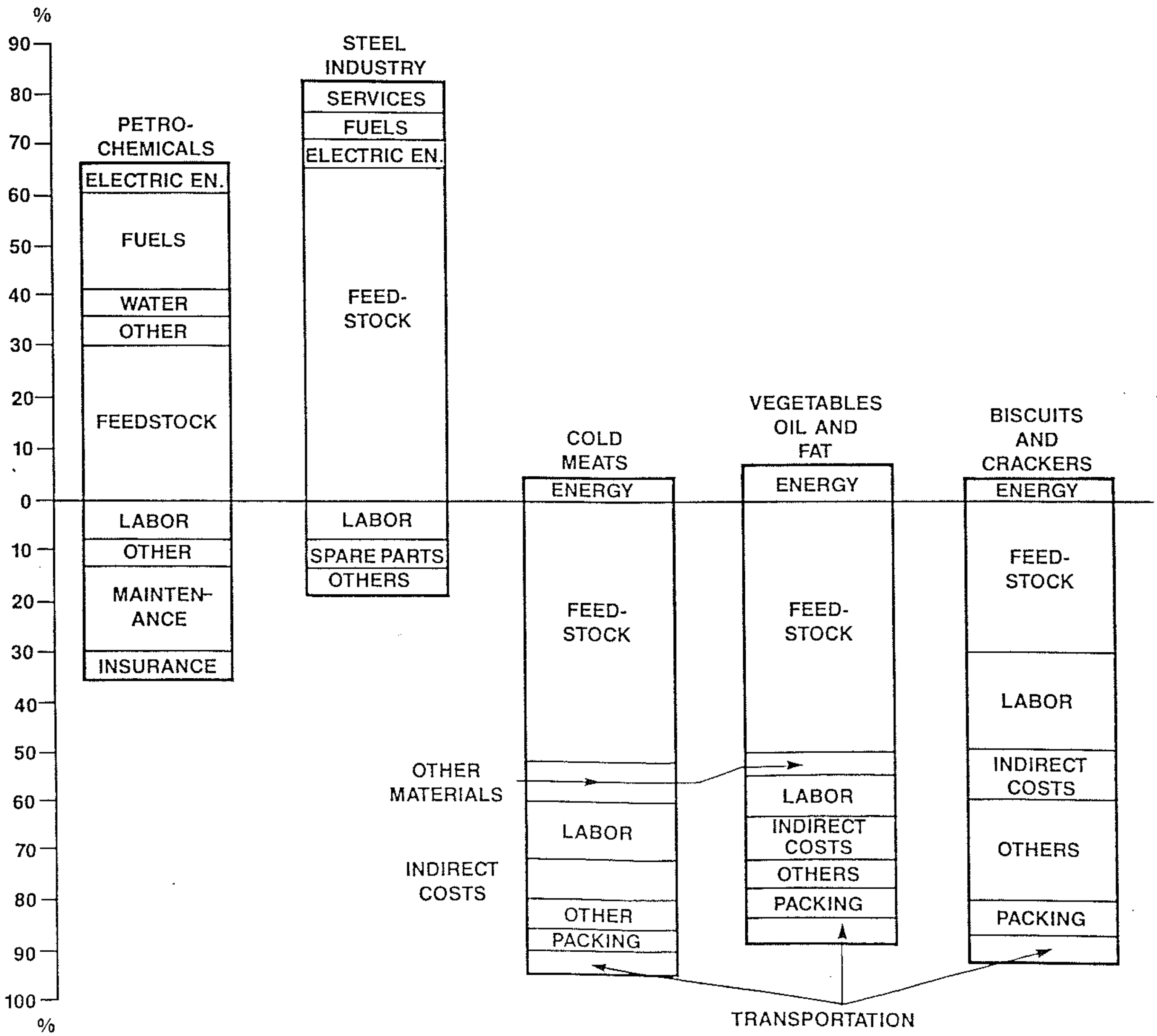
Energy is delivered to the consuming sector either directly in the form of fuels or indirectly in terms of the hidden energy content of manufactured or agricultural products. Figure 2-2 shows for the case of Argentina the composition of demand. Note that 65 to 85 percent of the final cost of petrochemical and refined products is energy cost. By contrast, only of one to three percent of the final cost of cold meats, edible oil, fats and margarines, biscuits and crackers, and other industries in the country are comprised of energy. If Argentina is to reduce the size of its energy service sector, the composition of the consuming sector must be altered. Clearly, energy-intensive industries such as petrochemicals and refined products might have to give way to less energy-intensive industries.

2.2.3 Financing and Lead Times in Capital Investment

Not only does energy consume a significant portion of the investment capital of a semisocialized country such as Argentina, energy investments have particularly long lead times because of their capital intensity. This means that the benefits of energy investments do not begin to accrue until long after they are made. Furthermore, the investment costs themselves (e.g., interest payments, principal repayments, return on

Figure 2-2

PRODUCTION COSTS OF DIFFERENT INDUSTRIES



equity) must be paid immediately when the investments are made whether or not the benefits have begun to accrue.

In this regard, Argentina is no different than a large electric company in the United States that decided to build a nuclear plant in 1974. Even though the plant had not begun operation by 1984, the electric company had spent several billion to construct the plant and another several billion dollars to pay interest on the debt acquired to build the plant. And yet by 1984, the plant had not returned one dollar in revenue (benefit) to the electric company. And it will not return one dollar in benefits until the plant is completed and begins operation. Because of the size of the project relative to the utility's capitalization, its bonds were derated at least twice during the ten years and the company has faced increasing problems in acquiring new debt to finance the rest of its operation.

If the government of a semisocialized economy decided to make massive investments in energy projects, it would face exactly the same problems as the electric company. It might have a debt problem, or a cash flow problem. Its energy situation might not improve because of the long lead times. And the entire economy might suffer because of the degraded financial situation. All these effects might happen even if the energy projects were economically efficient (i.e., economically justified). To compound the problem, however, in semisocialized economies, these energy investments may not even be economically efficient.

In contrast to the energy sector, investments in other industries might begin to pay benefits fairly early on. The country (or private decision makers in the country) must be careful to time-stage the investments so that benefits from some investments happen early, in time to pay for the investment costs of the long lead time projects.

To illustrate the importance of these long lead times and their potential effect on the economy, Table 2-2 depicts the situation in the electric sector between 1970 and 1979 in Argentina.

The time lag problem in the Argentine electric system is not a trivial problem to solve. Construction of new generation projects (with their own very long lead times) creates the need for additional investment in infrastructure, which itself must be planned under very long lead times. Thus, to fully integrate a new hydro generation facility into an increasingly complex electric grid requires a time-staged investment schedule over many years. And the more complex the grid becomes, the more lead time may be required in subsequent investments. In short, the lead time problem in the Argentine

Table 2-2

PUBLIC INVESTMENT IN ELECTRIC GENERATION AND CORRESPONDING PRODUCTION*

Year	Construction Investments in Electric Public Utilities (10^6 $ 1960)	Difference in Investments With the Previous Year (%)	Increase in Electrical Production (GWH)	Difference When Compared With Previous Year (%)
1970			1570	10.0
1971		27.3	1842	10.9
1972	93.5	4.4	1751	9.4
1973	119.0	-2.0	1204	5.9
1974	124.3	38.5	1432	6.6
1975	121.9	9.2	1526	6.6
1976	168.8	35.3	650	2.6
1977	184.3	30.7	1969	7.8
1978	249.3		1729	
1979	325.9			

*Total energy production in a certain year is compared with the investments made two years before, due to the logical delay between works and production. Four and six year delay comparison have also been carried out rendering similar results.

electric system is not likely to alleviate quickly as long as demand grows at the projected (and historical) eight percent per year. That is, if the Argentine electric system grows at eight percent per year, it can be expected to cause a cash drain on the country for many years. In view of the critical nature of this investment schedule, it is imperative that it be accomplished in the most economically efficient fashion.

2.2.4 The Productive Sectors

It is often argued that all sectors--industry, transportation, agriculture, residential-commercial, nonenergy products--should strive to consume the most abundant and lowest priced type of energy available for the purpose in minimum amounts. This conservation ethic has become quite important in energy planning in semisocialized economies that do not necessarily have an operational price system so that individuals can tell which is the lowest-cost source. In the absence of a pricing system, the emphasis in semisocialized countries has been on reducing investments to a bare minimum and thereby diminishing the adverse financial impacts of long-lead-time, capital-intensive energy projects.

To illustrate the typical approach to planning, let us draw from the Argentine industrial sector as an example. Figure 2-3 shows that the majority of industrial energy consumed is used for direct heat, indirect heat, and chemical feedstocks--the three accounting for almost 80 percent of total industrial demand. At present, Argentine industry is fueled almost entirely by oil and natural gas products. Their extensive and continued use has implications for the existing depletable resource base and the necessary infrastructure required to develop and produce them. Changes in the pattern of demand will have profound changes on these investments.

To explore the range of potential effects of an industrial conservation program in Argentina, consider Figures 2-4 to 2-6. Figures 2-4 to 2-6 were generated assuming that the industrial sector grows from its present 36 percent of Argentine GDP at 3.5 per year. Figure 2-4 represents industrial energy consumption in a low conservation or business-as-usual scenario between 1980 and 2010. Under this scenario, it is assumed that no significant conservation measures are taken. Figure 2-5 is identical with the low conservation scenario in Figure 2-4 in all regards except that a medium conservation set of assumptions is imposed on the industrial sector processes. These medium conservation assumptions are that roughly 60 or 70 percent of the maximum feasible conservation targets are achieved. That is, 60 to 70 percent of the maximum possible conservation effect is achieved in the industrial sector. Finally, Figure 2-6 is an aggressive conservation scenario, which adds to Figure 2-5 the assumption that oil and coal facilities are converted to natural gas at an ambitious but realistic rate. (Argentina has large natural gas reserves.)

The difference between the high- and medium-conservation case, in the overall level of investments, would be approximately 15 billion dollars. Furthermore, medium conservation is always more beneficial to the country than none. It is interesting in these three cases that the increased capital cost of conservation is more than offset by the decreased cost of expensive hydrocarbon fuel.

In summary, the dollar savings from higher conservation will accrue to the economy as an increase in GDP--an increase in funds available for the best alternative use in the economy. By implementing the higher conservation strategy, the government could provide to the citizens the welfare benefits that the billions of dollars in savings can buy.

It is interesting to note that some economies have both high economic growth and low energy investment. To achieve such an end in Argentina would require a massive industrialization policy--a major change in public policy. If such a policy succeeded, however, the country would be inevitably tied to energy-intensive growth and capital-intensive industry, which might not be ideally suited to the Argentine resource or social situation. By contrast, a more agriculturally oriented economy (an economy for which Argentina is ideally suited in terms of natural resources) could be supported with much less energy (and perhaps capital). Which of these two strategies to pursue is a matter of extreme public policy importance. What would a free market economy do? What would the foreign trade balance be? What would Argentine welfare be?

This example illustrates the close interrelationship between energy conservation and economic development planning. Whichever economic development strategy is pursued, however, energy planning must be accomplished in the most economically efficient way. If this involves ambitions energy conservation investments (which it is likely to do), then they should be undertaken.

2.3 REGIONAL CONSIDERATIONS

Transportation and distribution of energy are important because they are potentially costly activities. Furthermore, a particular energy-economic development strategy must be supportable by a particular transmission and distribution system, and this system is a potentially expensive part of the development strategy.

Due to the particular geographic configuration of Argentina, transportation accounts for 43 percent of total energy investment. This magnitude of required investment might of course be altered under a different growth scenario or a different set of public policies regarding the energy system. However, public policy alternatives have significant regional implications and they must be closely coupled with regional energy-economic development plans.

The present pattern of energy flows between the eight aggregate regions into which we have subdivided the Argentine energy system is illustrated in Figure 2-7. The figure depicts where energy is produced and where it is sent. We have indicated intraregional flows by an arrow that emanates and ends in the same region.

2.4 RESEARCH AND DEVELOPMENT

The energy-economic situation could be improved (in aggregate) if new and better technologies were applied within the economy. New technologies tend to improve the overall socioproductive structure through such mechanisms as improved average efficiency, increased GDP, or a combination of both.

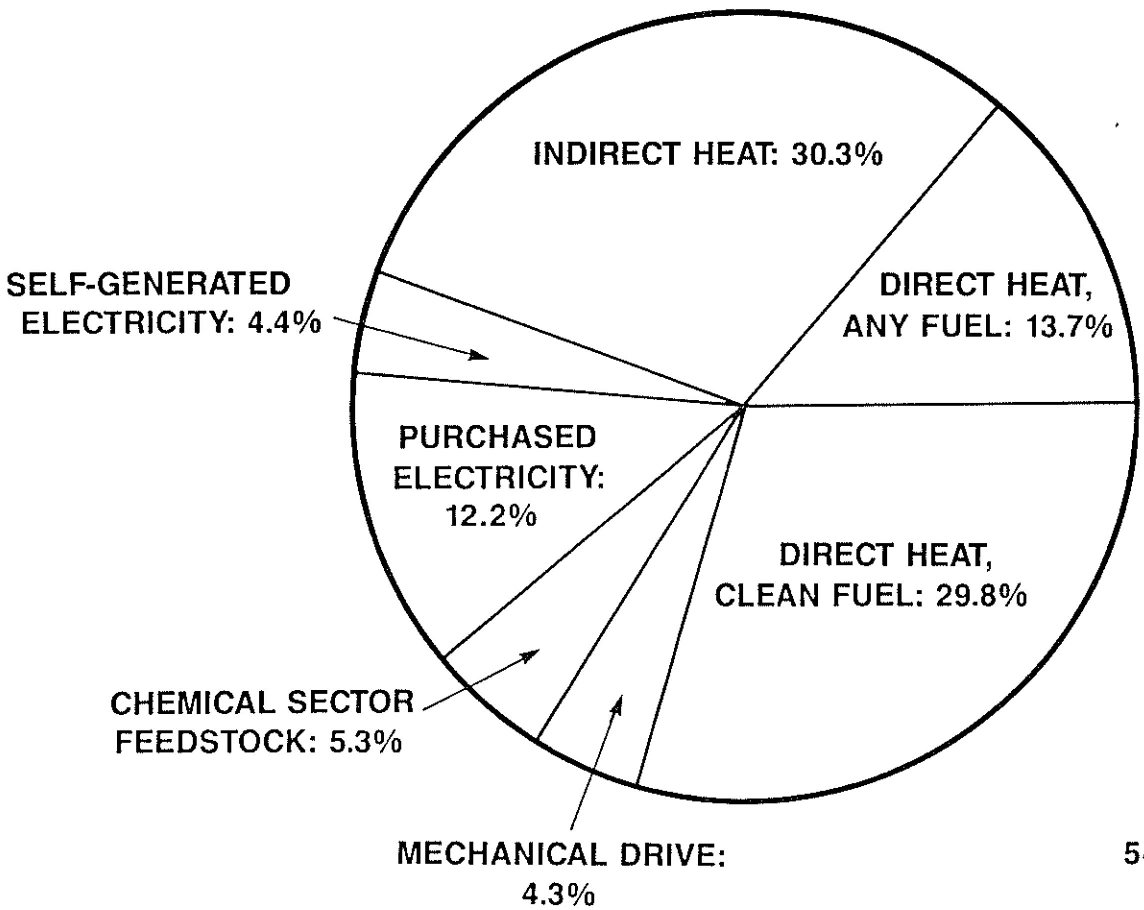
To facilitate the penetration of new technologies into the economy, the public sector must encourage policies favorable to R&D. To do so requires that the public sector understand the implications such new technologies will have on the economic system under their control. For example, what would be the implications of new unconventional hydrocarbon production technologies? What will be the degree of benefit to fossil fuel reserves? Required external investment capital? Industrial growth? GDP and its distribution?

As a specific example, Figure 2-8 depicts the potential importance of new unconventional resource technologies in Argentina. (Implicit here is the benefit of a public policy designed to encourage R&D on such technologies.) In the figure, a reference case might be compared to two high R&D cases defined as follows. A medium-R&D case that assumes a 25 percent capital cost reduction relative to the reference case, all else equal, might be compared to the reference case. Similarly, a high-R&D case that assumes a 50 percent capital cost reduction might also be compared. Figure 2-8 shows the results of two such runs for Argentina and illustrates their significance--solar and ethanol technologies penetrate the Argentine energy system to a substantial degree during the next 25 years in the medium- and high-R&D cases.

However, in spite of the large penetrations evident in Figure 2-8, it is not expected that the private sector will pursue the necessary R&D--conventional hydrocarbon sources are much less expensive and much more profitable to pursue. Recognizing the benefits

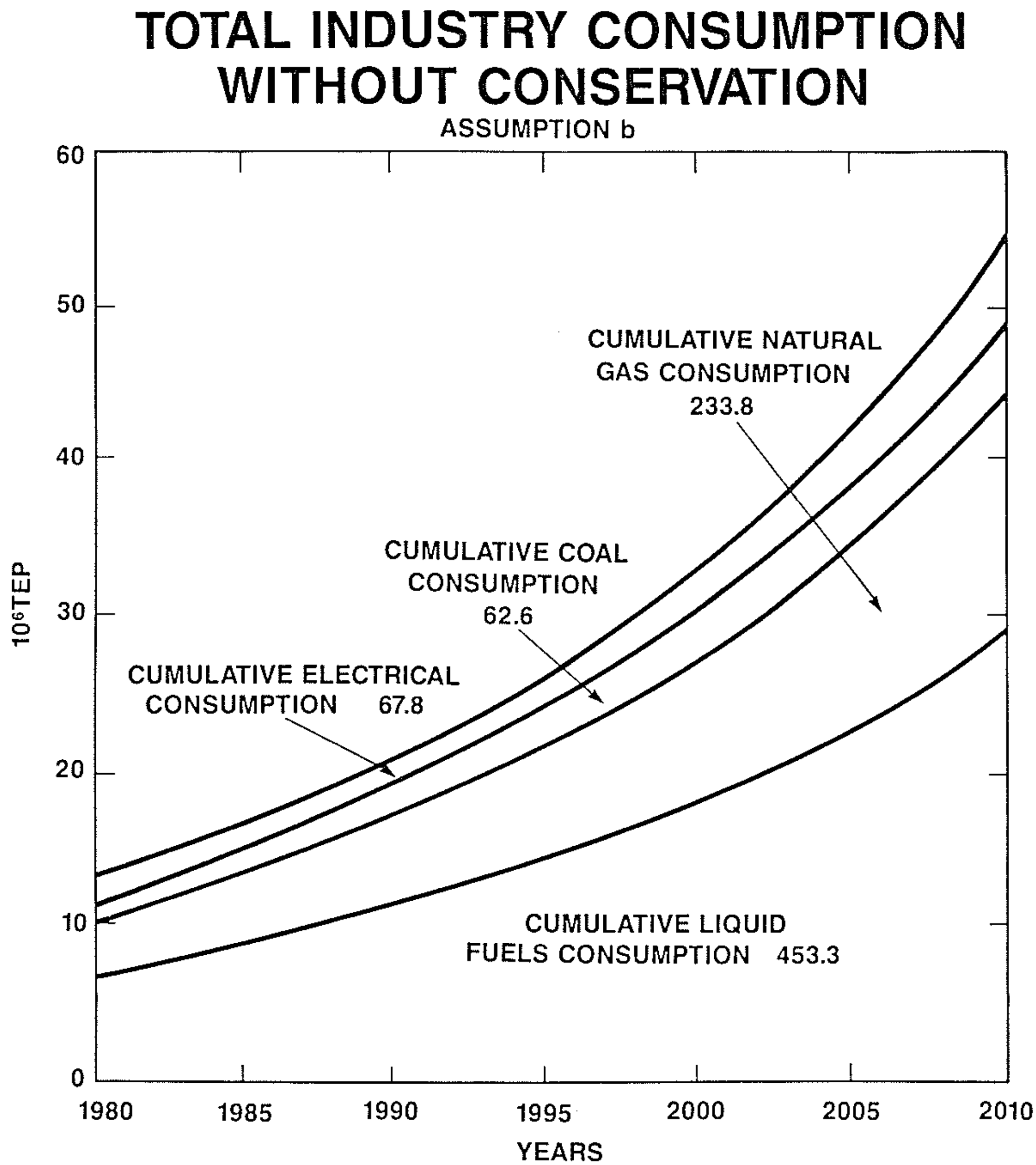
Figure 2-3

INDUSTRIAL SECTOR USEFUL ENERGY DEMAND



5472×10^3 T.O.E.

Figure 2-4



TOTAL INDUSTRY CONSUMPTION
WITHOUT CONSERVATION
ASSUMPTION b
CUMULATIVE NATURAL GAS CONSUMPTION 233.8
CUMULATIVE COAL CONSUMPTION 62.6
CUMULATIVE ELECTRICAL CONSUMPTION 67.8
CUMULATIVE LIQUID FUELS CONSUMPTION 453.3
10⁶TEP
0
10
20
30
40
50
60
1980
1985
1990
1995
2000
2005
2010
YEARS

Figure 2-5

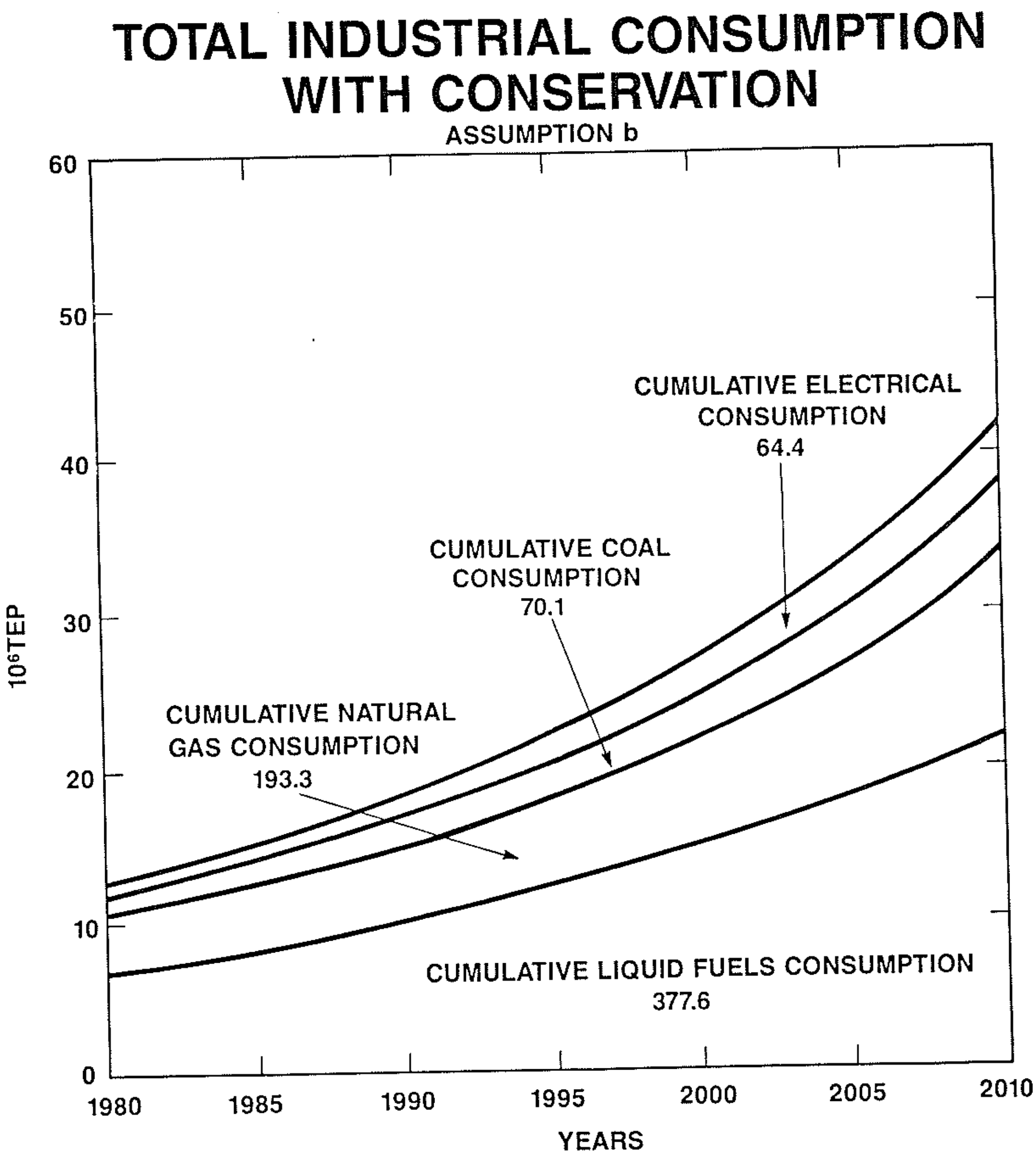

TOTAL INDUSTRIAL CONSUMPTION
WITH CONSERVATION
ASSUMPTION b
60
50
40
30
20
10
0
10^6TEP
CUMULATIVE ELECTRICAL
CONSUMPTION
64.4
CUMULATIVE COAL
CONSUMPTION
70.1
CUMULATIVE NATURAL
GAS CONSUMPTION
193.3
CUMULATIVE LIQUID FUELS CONSUMPTION
377.6
1980
1985
1990
1995
2000
2005
2010
YEARS

Figure 2-6

TOTAL INDUSTRY CONSUMPTION WITH CONSERVATION AND LIQUID FUELS AND COAL PRODUCTS SUBSTITUTION FOR NATURAL GAS

ASSUMPTION b

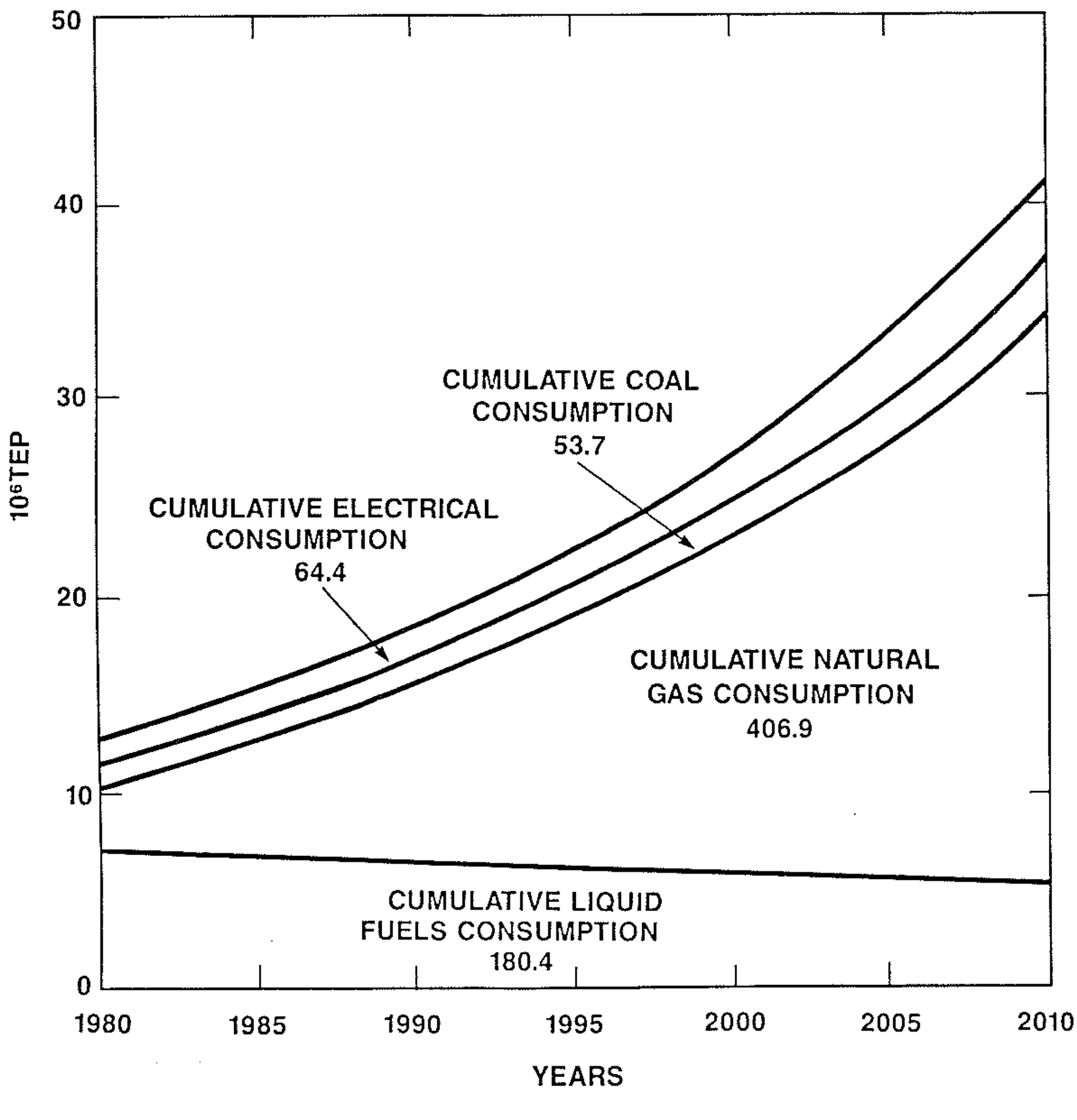


Figure 2-7

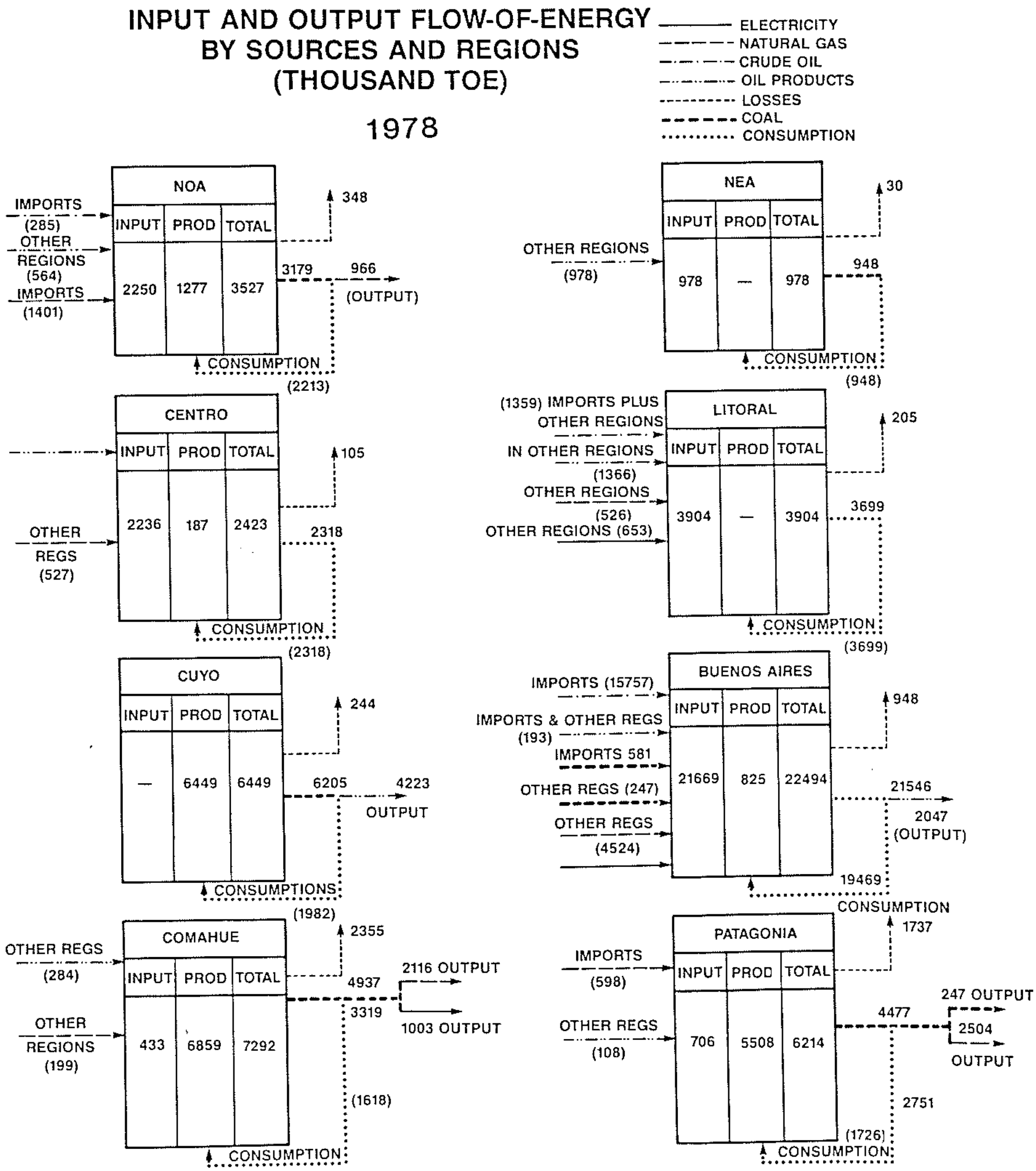
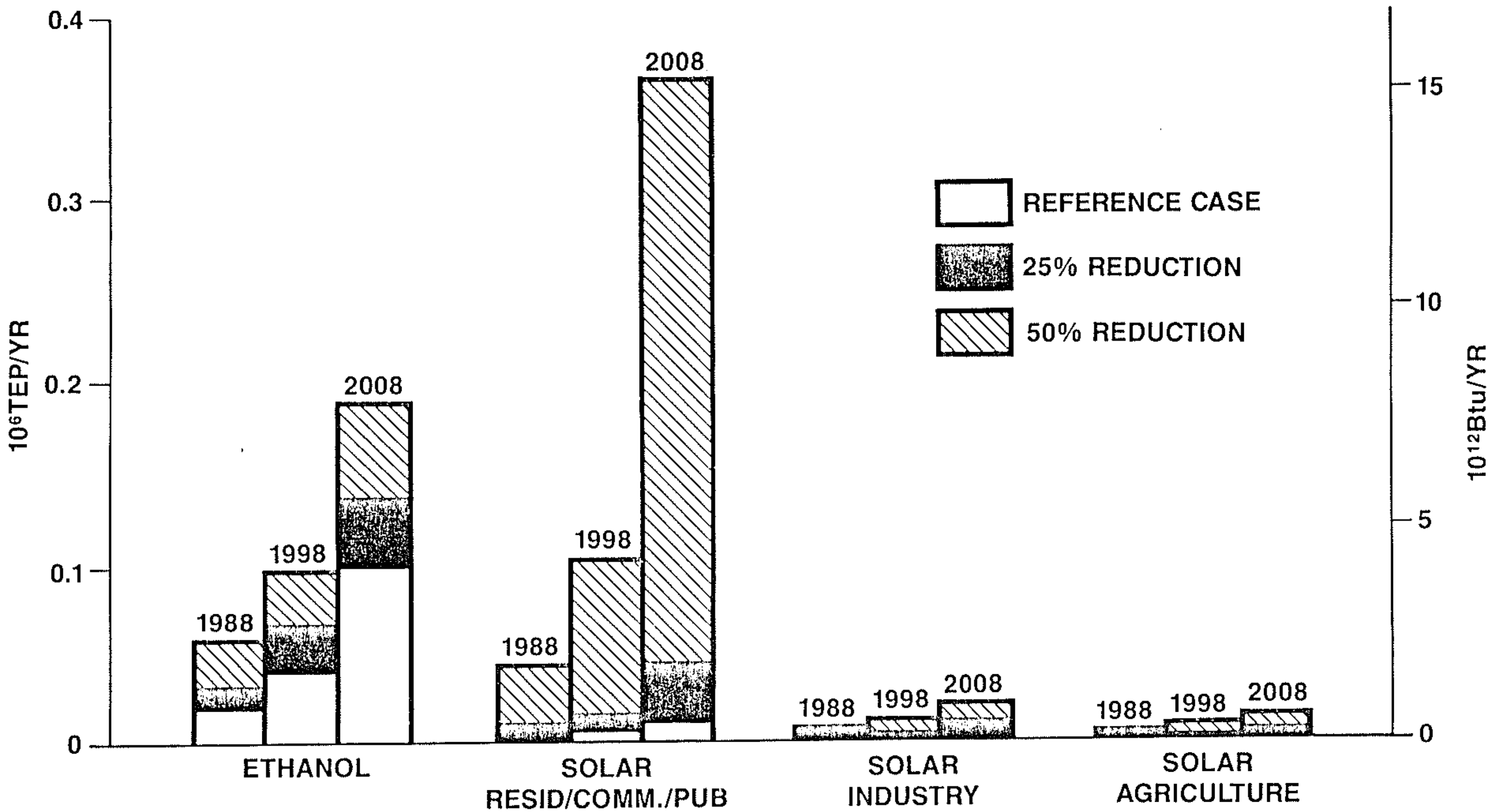

INPUT AND OUTPUT FLOW-OF-ENERGY
BY SOURCES AND REGIONS
(THOUSAND TOE)
1978
ELECTRICITY
NATURAL GAS
CRUDE OIL
OIL PRODUCTS
LOSSES
COAL
CONSUMPTION
NOA
INPUT PROD TOTAL
2250 1277 3527
IMPORTS (285)
OTHER REGIONS (564)
IMPORTS (1401)
348
3179
966
(OUTPUT)
CONSUMPTION (2213)
NEA
INPUT PROD TOTAL
978 — 978
OTHER REGIONS (978)
30
948
CONSUMPTION (948)
CENTRO
INPUT PROD TOTAL
2236 187 2423
OTHER REGS (527)
105
2318
CONSUMPTION (2318)
LITORAL
INPUT PROD TOTAL
3904 — 3904
(1359) IMPORTS PLUS OTHER REGIONS
IN OTHER REGIONS (1366)
OTHER REGIONS (526)
OTHER REGIONS (653)
205
3699
CONSUMPTION (3699)
CUYO
INPUT PROD TOTAL
— 6449 6449
244
6205
4223
OUTPUT
CONSUMPTIONS (1982)
BUENOS AIRES
INPUT PROD TOTAL
21669 825 22494
IMPORTS (15757)
IMPORTS & OTHER REGS (193)
IMPORTS 581
OTHER REGS (247)
OTHER REGS (4524)
948
21546
2047 (OUTPUT)
19469
CONSUMPTION
COMAHUE
INPUT PROD TOTAL
433 6859 7292
OTHER REGS (284)
OTHER REGIONS (199)
2355
4937
2116 OUTPUT
3319
1003 OUTPUT
(1618)
CONSUMPTION
PATAGONIA
INPUT PROD TOTAL
706 5508 6214
IMPORTS (598)
OTHER REGS (108)
1737
4477
247 OUTPUT
2504
OUTPUT
2751
(1726)
CONSUMPTION

Figure 2-8

EFFECTS OF REDUCTIONS IN CAPITAL COSTS ON RENEWABLE RESOURCE TECHNOLOGY PENETRATION



of solar and ethanol technology and recognizing that the private sector might not be motivated to pursue these benefits, the government might intervene through a set of public policies designed to encourage private sector R&D in these areas. Such intervention would typically take the form of government-paid R&D, price guarantees, tax incentives, or subsidies. Whether or not the government should enter into such incentive programs depend on whether the benefits in the market will outweigh the costs in the market plus the direct R&D costs.

2.5 CONCLUSIONS

It is our observation that most countries of the world share semisocialized economic systems. For those countries, the array of public policies--when properly oriented--could reduce the overall burden of their energy investments and related financial problems.

It is also obvious that those same countries are in a much better position than free market economies to obtain immediate benefits from an adequate set of public policies because their application is straightforward and almost ineluctable since the government is the dominant decision maker.

Therefore, it is imperative to count on a modern and adaptable energy-economy computational tool to devise the most promising scenario gaining high overall productive efficiency that will surely lead to a more equitable distribution of a larger quantity of resources.

FOOTNOTES

1. Under certain assumptions, maximization of an economy-wide objective function is equivalent to the Walras-Arrow-Debreu model. Whether the two are equivalent is irrelevant for our present purposes, however. The fact of the matter is that real-world economies have processes that fall into at least three of the four boxes.

2. Later in the paper, we shall discuss specific figures for Argentina to justify this assertion. Increased investment in the energy sector at the expense of the other sectors has been true over the past ten years for a broad range of developing and industrializing countries. See DOE (1981a, 1981b, 1981c).

3. Economic efficiency means Pareto efficiency. See Varian (1984).

Chapter 3

EFFECTS OF EXISTING ENERGY-ECONOMY PUBLIC POLICIES ON SECTORAL GDP AND ENERGY INVESTMENTS

In the recent past, many semi-socialized economies have experienced low GDP growth together with high energy growth. The apparent contradiction is easily explained by analyzing structural economic changes rather than focusing purely on energy supply-demand problems. This chapter focuses on such structural changes and their relationship to energy supply and demand, implicitly listing a set of economic phenomena that should be considered in quantitative approaches to energy and economic planning.

Argentina since 1950 experienced a change in the composition of GDP. In particular, the importance of traditional activities such as agriculture, cattle-breeding, and textiles diminished, while the importance of new activities such as petrochemical, mechanical, and metallurgical manufacturing increased. These changes were driven in large part by public policies, and they induced fundamental changes in the demand patterns for energy and the traditional energy-to-GDP ratio.

This chapter focuses on the role of the government in this structural change, attempting to shed light on the role of the government in a semi-socialized economy. In particular, we will examine how government activities might have led to the accelerating pace of energy investments and how internal energy prices were set.

3.1 THE ENERGY-ECONOMY PUZZLE

One of the most perplexing questions regarding the Argentine economic situation is: Why has overall energy consumption grown steeply since 1950 while average GDP has remained stagnant or declined in spite of increasing population? Table 3-1 depicts energy consumption, GDP and population growth from 1954 through 1980.

It is not easy to answer these questions through purely quantitative analysis. On the contrary, this section presents a largely qualitative analysis to explain the phenomena in Table 3-1 and to infer the future. This qualitative analysis will serve as background for later discussions of needed quantitative modeling methods to analyze the Argentina economy.

Table 3-1

Year	Mid-Year Population (10^6)	Annual Growth Rate (%)	GDP Growth Rate (%)	Per Capita GDP Growth Rate (%)	Total energy requirements Quads 10^{15} BTU
1955	18.53	1.60	15.8	NA[a]	
1956	18.80	1.46	-5.3	-6.6	
1957	19.10	1.60	-3.3	-4.8	
1958	19.38	1.47	8.0	6.5	
1959	19.66	1.45	0.0	-1.4	
1960	19.92	1.32	7.4	6.0	
1961	20.24	1.61	6.9	5.2	
1962	20.54	1.48	-0.9	-2.4	
1963	20.85	1.51	-3.7	-5.2	
1964	21.17	1.54	-2.4	-3.9	
1965	22.18	4.77	11.7	6.6	
1966	22.49	1.40	10.1	8.5	
1967	22.80	1.38	0.8	-0.6	
1968	23.11	1.36	3.4	2.0	
1969	23.43	1.39	NA	NA	
1970	23.75	1.37	NA	NA	1.05
1971	24.07	1.35	3.6	2.2	1.12
1972	24.39	1.33	1.6	0.3	1.15
1973	24.72	1.35	3.4	2.0	1.23
1974	25.05	1.34	7.7	6.3	1.22
1975	25.38	1.32	-2.1	-3.4	1.20
1976	25.72	1.34	-3.2	-4.5	1.23
1977	26.06	1.32	5.0	3.7	1.28
1978	26.39	1.27	-3.7	-4.9	1.28
1979	26.73	1.29	11.0	9.6	1.40
1980	27.06	1.23	1.1	-0.2	

3.2 THE INDUSTRIAL GDP STRUCTURE

Industrial extraction and manufacturing activities (in the aggregate) accounted in 1978 for about 30 percent the total Argentine energy consumption. Residential-commercial-public consumption accounted for 22 percent, transportation for 32 percent, agriculture for 5 percent, and feedstock fuels for 10 percent. If we count feedstocks as part of the industrial sector, industry accounted for almost 40 percent. Furthermore, industrial consumption has been increasing relative to that in the other sectors during the entire 1954-1980 period.

In spite of the continuing and accelerating growth of the industrial sector, there was a significant change in sectoral GDP shares within the industrial sector. For purposes of examining the composition of GDP, the industrial sector will be subdivided as follows:

- primary (agriculture, forestry, hunting and fishing),
- primary, non-agricultural (quarries and mines),
- manufacturing (all types),
- construction (all types), and,
- tertiary (utility services, financing, insurance, real estate, etc.).

During the past 25 years, except for primary and manufacturing, all the other industrial sectors have contributed a declining share of total industrial GDP. We must dig deeper into the manufacturing sector to understand why.

Table 3-2 disaggregates the manufacturing sectors. Note that some grew quite rapidly while some were quite stagnant. For example, significant growth occurred in chemicals and metallics. Table 3-3 categorizes the industries in Table 3-2 into three aggregate categories--stagnant, semi-stagnant, and dynamic. In the dynamic category are the steel and chemical industries, which grew sharply from 37 to 60 percent average share. It is clear from Table 3-3 that the growth in the manufacturing sector is due entirely to growth in a few key industries (i.e., dynamic industries). Furthermore, these key industries are among the most energy intensive. The shift in composition of industrial GDP, which entailed increased energy consumption, was not accompanied by a corresponding shift in GDP. The reason is that losses in less energy-intensive industries offset to a significant degree gains in more energy-intensive industries. Thus, in summary, Argentina experienced a shift toward more energy-intensive industries (which contributed increasingly to GDP) but endured losses in its less energy-intensive industries (which detracted increasingly from GDP). The net effect was a modest gain in GDP but a significant increase in industrial energy consumption.

Table 3-2

MANUFACTURING SECTORS PARTICIPATION IN INDUSTRIAL GDP (%)

Period	Food Industry	Textiles, Garment	Lumber	Paper Cardboard	Non-Metallic Mines and Quarries	Chemicals and Petrochemicals	Primary Metal	Metallic, Machinery, Vehicles
1952/58	23.3	21.4	2.7	4.9	4.9	13.7	3.1	19.7
1959/61	20.3	17.3	2.0	4.7	4.0	15.0	4.3	27.0
1963/74	18.1	12.6	1.9	4.1	4.3	17.9	5.6	31.2
1975/79	15.2	11.6	1.0	4.4	4.0	20.4	5.8	33.6

Table 3-3

DYNAMIC INDUSTRIAL GDP STRUCTURE (%) AS A PART OF THE OVERALL MANUFACTURING SECTOR

Period	Manufacturing Sector in General	Stagnant	Semi-Stagnant	Dynamic Industries
1952/58	29.3	44.7	12.4	36.6
1959/61	31.0	37.7	10.7	46.2
1963/74	34.8	30.7	10.3	54.7
1975/79	36.2	26.8	9.4	59.8

STAGNANT: Food, beverage, tobacco, textile, garment, leather, etc.

SEMI-STAGNANT: Lumber, paper, non-metallic mines, excluded oil and coal, etc.

DYNAMIC: Chemicals, steel, etc.

3.3 GOVERNMENT VERSUS PRIVATE EXPENDITURES

The overall gross domestic product can be distinguished by type of expenditure as shown in Table 3-4. Note that the share of final consumption accounted for by the private sector has decreased since 1960, and the government's share has remained stable. (Stocks were not increased during this period). The figure reinforces the observation that the influence of the public sector in the Argentine economy has grown significantly, particularly in the energy and related sectors and in what we have termed dynamic enterprises.

The (energy-intensive) dynamic enterprises have been selected and actively promoted by the government. This is a very significant event because it implicitly if not explicitly restricts activity by the private sector in those particular industries. What private company would choose to compete with the much larger resources of the government? Government choices as to the industries in which it will participate lies at the very heart of the economic changes observed, even though these choices were to a significant degree political decisions.

3.4 LABOR ISSUES

Table 3-5 depicts the size of the labor force during the period 1947-1980. The figure indicates that the total size of the labor force has decreased in spite of increased employment of women in Argentina. It is obvious that the lack of growth of the labor force has been borne disproportionately by low paid people and by women.

The most likely explanations of the smaller size of the labor force are: (1) the growing trend toward self-employment, (2) the increasing approval of early retirement benefits, and (3) an increase in enrollment in higher education in the country. (See Table 3-5.) The first two explanations are directly affected by the increased degree of government influence in the economy.

3.5 INTERNATIONAL TRADE AND BALANCE OF PAYMENTS

Table 3-6 shows the Merchandise Balance and the Overall Balance of Payments between 1955 and 1980. Despite maintaining a positive Merchandise Balance (i.e., commercial balance) during the entire period from 1955 to 1980, the overall balance of payments was only very slightly positive and, in recent years, very negative. The reason is that Argentina has acquired a very large external debt, in excess of $40 billion

Table 3-4

PRIVATE AND GOVERNMENT FINAL CONSUMPTION AS A PERCENTAGE OF GDP

Year	Final Consumption: Private	Final Consumption: Government	Increase in Stocks	Gross Fixed-Capital Formation	Exports	Imports
1960	70.0	10.0	0.0	20.0	10.0	10.0
1961	75.0	8.3	-8.3	25.0	8.3	8.3
1962	66.7	13.3	0.0	20.0	13.3	13.3
1963	68.4	10.5	0.0	15.8	10.5	10.5
1964	73.1	7.7	3.8	15.4	7.7	7.7
1965	72.2	8.3	2.8	16.7	8.3	5.6
1966	71.1	11.1	0.0	17.8	8.9	6.7
1967	70.0	10.0	0.0	18.3	10.0	6.7
1968	71.0	10.1	0.0	18.8	8.7	7.2
1969	70.4	9.9	0.0	21.0	8.6	8.6
1970	69.5	9.5	0.0	20.0	8.4	8.4
1971	70.7	9.8	0.8	19.5	8.3	9.0
1972	69.5	9.1	0.9	20.0	9.1	8.6
1973	66.3	10.1	1.1	19.5	9.6	6.6
1974	64.7	10.2	0.2	24.1	8.9	7.9
1975	67.7	9.1	0.3	24.5	7.0	8.6
1976	66.2	9.5	0.1	22.2	8.9	6.8
1977	62.8	9.9	-0.1	23.4	14.6	10.7
1978	62.7	12.7	-0.4	20.7	11.9	7.6

Table 3-5

LABOR FORCE AND LABOR-FORCE PARTICIPATION RATES

Year	Labor Force (10^6) Men	Labor Force (10^6) Women	Labor Force (10^6) Total	Labor-Force Participation Rates (%) Men	Labor-Force Participation Rates (%) Women	Labor-Force Participation Rates (%) Total
1947	5.3	1.3	6.6	–	–	41.5
1960[a]	6.5	1.7	8.2	61.9	16.8	39.8
1970	7.0	2.3	9.3	58.8	19.5	39.2
1980[a]	7.4	3.0	10.4	54.8	22.1	38.5

	Higher-Education Enrollment (% of population aged 20-24) 1960	1977
Argentina	11	29
Middle income countries	4	11
Brazil	2	12
Taiwan	4	12
Costa Rica	5	18
Mexico	3	10
Industrialized countries	17	36
Japan	10	29
United States	32	56

Table 3-6

ARGENTINE MERCHANDISE BALANCE AND BALANCE OF PAYMENTS

Year	Merchandise Balance (Exports-Imports)	Overall Balance of Payments	Exports as % of GDP	Imports as % of GDP	Crude Petroleum Imports million $
1955	-109	NA			85
1956	-54	NA			
1957	-186	NA			
1958	-97	NA			
1959	130	NA			
1960	-27	150.4	10.0	10.0	70
1961	-328	-157.3	8.3	8.3	
1962	16	-321.9	13.3	13.3	
1963	497	161.5	10.5	10.5	
1964	457	24.4	7.7	7.7	
1965	431	53.5	8.3	5.6	55
1966	1,112	23.7	8.9	6.7	
1967	494	415.8	10.0	6.7	
1968	333	159.5	8.7	7.2	
1969	217	-111.2	8.6	8.6	
1970	274	259.9	8.4	8.4	45
1971	87	-560.4	8.3	9.0	
1972	256	-284.7	9.1	8.6	
1973	1,288	730.8	9.6	6.6	
1974	714	94.7	8.9	7.9	
1975	-549	-1,094.5	7.0	8.6	240
1976	1,150	124.7	8.9	6.8	
1977	1,855	2,479.0	14.6	10.7	
1978	2,913	3,199.8	11.9	7.6	
1979	1,784	4,378.1			
1980	-1,359	-2,514.5			375

including financial services. Payments to service this debt have offset and recently totally swamped the positive commercial balance.

Table 3-6 characterizes the level of exports and imports as a percentage of GDP. Note that these levels have been quite constant except during relatively brief periods.

Finally, Table 3-6 depicts the level of oil imports. It is particularly significant that oil imports have increased sharply since 1973.

3.6 CONCLUSIONS

Recalling from Table 2-1 that energy investments have increased continuously during the past 15 years and that the overall GDP rate has not increased, the analysis of this section suggests the following conclusions:

- The role of the public sector has grown dramatically in Argentina, and this growth has resulted in limited participation by the private sector in the economy,
- Conversely, the perceived low level of private participation has fueled public sector growth.
- The low level of private participation was caused by a number of factors, not the least of which was the existence of a growing set of public policies that hindered its participation.
- Limited private sector participation, long lead times, and other factors induced the government sector to import more energy and capital goods since 1973 in spite of their much increased prices.
- The government sector did not allow internal prices to reflect the high cost of energy and capital on world markets. That is, indigenous decision makers were sheltered by government action from feeling the true world prices of energy and capital.

As a consequence,

- The public sector was obliged to seek an extremely high level of external debt in order to cover its internal energy financing commitments. Debt attributed to energy sector investments today accounts for more than 50 percent of all external debt in Argentina.
- It is not clear that the allocation of investment capital between the energy and nonenergy sectors or within the energy sector itself in Argentina was economically efficient. To the extent such allocation was inefficient, Argentina has suffered *deadweight* economic losses on some of the money it has borrowed. It must repay this money knowing that benefits will never cover the costs, i.e., less than a dollar's worth of GDP was purchased for each dollar that will be paid to service external debt.

- Local currency weakened against those of more advanced countries, exacerbating all the problems described above.

Chapter 4

QUANTITATIVE PLANNING METHODS FOR SEMISOCIALIZED ECONOMIES--THE GENERALIZED EQUILIBRIUM APPROACH

This section describes the recently completed quantitative energy-economy assessment in Argentina with the cooperation of the United States government. The analytical tools used in that assessment are described, and the rationale--both theoretical and practical--for the particular tools used are given. We will focus to the maximum extent possible on the adaptation of those tools to deal with the specific problems of the semisocialized nature of the Argentine economy.

We also describe the network representation of the Argentine economy upon which the assessment was based, the important planning assumptions, and the types of macroeconomic scenarios and energy alternatives selected.

The section concludes with a brief discussion of the important findings of the assessment and their implication for public policy in Argentina. These findings have influenced the direction of public policy in the country since the assessment.

4.1 THE NEED FOR A QUANTITATIVE APPROACH

The previous three chapters have characterized the fundamental nature of a semisocialized economy, the interactions between energy and the other productive sectors in such an economy, the effects of existing public policies, and some of the difficulties faced by the labor force and the financial sector. In those sections, Argentina was used as a specific example to illustrate key points. The present chapter attempts to become more concrete, applying the ideas developed earlier to assess the energy-economic situation in Argentina. We reiterate that even though Argentina continues to be our specific example, many of the ideas and techniques we conjecture can be directly extrapolated to other semisocialized economies in Latin America or elsewhere.

Mindful of how difficult it would ultimately be, the Argentine government decided in mid 1980 to carry out an energy-economy assessment with the cooperation of the United States. Two official teams were established--the team from the United States was comprised of government technicians and consultants and the Argentine team of members from different public and private sector organizations. The assessment is described in more detail in DOE (1981).

The quantitative tool chosen to support the assessment was the Generalized Equilibrium Modeling System (GEMS) built and owned by Decision Focus Incorporated (DFI). The GEMS allowed the Argentine/United States team to, in a comprehensive manner, accomplish the following:

1. determine the balance between energy production and consumption decisions, considering simultaneously every portion of the energy system and recognizing that many of the production decisions are made by the government and not by private industry;

2. represent important economic and technological parameters as well as some normative parameters;

3. design and compute a broad range of energy-economy scenarios over a relatively long time horizon;

4. represent the potential future role of new technologies relative to existing technologies and resources;

5. incorporate as many tax- and financial-related issues as possible; and

6. quantify the cash flow implications for the Argentine economy under each energy scenario to determine whether that cash flow will be positive or negative over what future periods.

The GEMS was found to be particularly successful (relative to previously attempted approaches) because:

1. It is not an econometric model. Thus, it requires neither historical time series (sometimes difficult or impossible to obtain in Argentina) nor statistical correlation-regression methods of any type.

2. It is unnecessary to write computer code to use the model. GEMS contains a library of process models from which we could choose.

3. The basic input to the model is a *picture* of the energy-economy system under consideration, represented by a network diagram customized to the specific needs of the planner. Such network diagrams serve as valuable communication tools in their own right.

4. It could be used on an independent and ongoing basis by Argentine personnel. It does not require a DFI specialist to run it.

5. It allowed Argentine staff to coordinate the work of many subteams comprised of technicians from many different public and private sector organizations.

The GEMS has allowed Argentine personnel working independently to perform sensitivity analyses, formulate development scenarios, analyze changes in the composition of the GDP, represent conservation impacts and fuel switching, compute relative prices, obtain many economic results, feed those results into other models, carry out many independent sectoral models, and train an ample host of in-country modeling technicians. But, perhaps most importantly, the GEMS has allowed Argentine decision makers to examine in detail the ramifications of the variety of policy options under consideration and to determine in a sensible fashion which policies are better.

Much of what follows in this volume relates to a significant degree to the GEMS approach. While the reader need not be intimately familiar with the GEMS, close understanding of the technical issues and language used here will be facilitated by reviewing the massive existing documentation of the GEMS. Rather than reproduce any of that documentation, we instead refer the reader to Nesbitt (1984), DFI (1983), Adler, et. al. (1979), Phillips (1983), and DFI (1983).

4.2 THE ARGENTINE ENERGY-ECONOMIC NETWORK

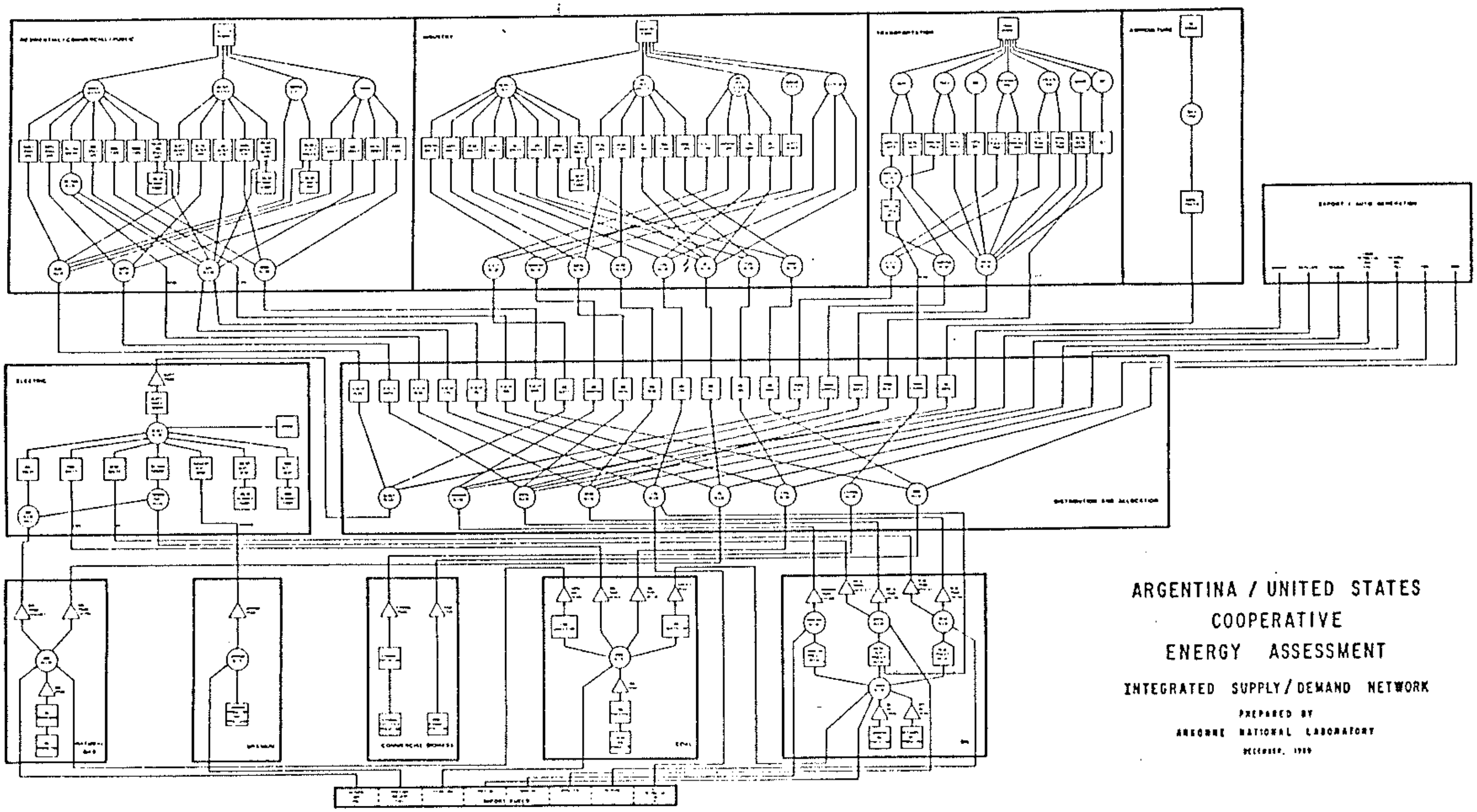
4.2.1 Diagram

Figure 4-1 contains a representation of the energy-economic network for Argentina. This diagram represents at a fundamental level the resources, technologies, and options available to public policy makers in Argentina. We will leave aside in this paper the specific rationale underlying structure of the network. However, we emphasize that the network diagram was considered to be representative of the energy-economy sector as of 1978.

To ensure that the energy network, the underlying numerical data, and the resulting analyses remain manageable, aggregation of certain economic activities was deemed necessary. In particular, some technologies were aggregated, some fuel categories were aggregated, and some geographic regions were aggregated. We emphasize that the degree of aggregation is made explicit in the network. For example, the specific fuel switching alternatives considered and the degree of detail in which they are considered are implicit in the network structure.

The GEMS was used to compute the prices that balance supply and demand throughout the entire network shown in Figure 4-1 over the time interval 1978-2008.

Figure 4-1



ARGENTINA / UNITED STATES
COOPERATIVE
ENERGY ASSESSMENT

INTEGRATED SUPPLY/DEMAND NETWORK

PREPARED BY
ARGONNE NATIONAL LABORATORY
DECEMBER, 1979

4.2.2 Input Assumptions

The assumptions required to drive the GEMS can be categorized as follows:

- assumptions related to economic growth,
- assumptions related to engineering cost, performance, and financial parameters for every technology in the supply system,
- assumptions concerning market and consumer behavior such as sensitivity of fuel switching decisions to relative prices, and
- assumptions regarding government regulations, incentives, and incentives.

We will now describe those assumptions in somewhat more detail. Our purpose in doing so is to show how the GEMS in its present form can represent a broad range of issues for semisocialized economies but equally importantly to show where expansions in the GEMS were required to handle Argentina's specific situation (and in fact the general situation in semisocialized economies) in a more realistic fashion.

4.2.2.1 Demand Assumptions

Industry

- Moderate conservation. Efficiency improvements for end-use conversion devices in the range of 5 to 27 percent are assumed to occur. Solar boiler technology is assumed to be available at relatively competitive economics. However, this is the only industrial conversion technology not in place in 1978 that is considered for the future.
- Two different growth scenarios. Annual GDP growth rates of 4.5 percent and 1 percent are assumed.

Agriculture

- Moderate conservation. Efficiency improvements occur at approximately historical rates. New solar crop dryers are available at relatively competitive economics.
- Same growth scenarios as industrial sector.

Residential/Commercial/Public

- Moderate conservation. New equipment available includes solar/gas space heater, solar/gas water heater, and solar/electrical cooking process. Technological improvements foreseen include solid-state TV circuitry, refrigeration door seals and compressors, and electric or pilotless ignition for gas stoves and water heaters.
- Same growth scenarios as previous sectors.

Transportation

- Moderate conservation. Major fuel switching is assumed possible among automotive technologies including gasoline, diesel, and alcohol blends. Technological improvements foreseen include air deflectors or spoilers on trucks, reduced rolling resistance, and reduced drivetrain losses. The potential consequences include the following:

  - gasoline-fueled automobile engines will have 37 percent greater energy intensity than comparable diesel automobiles,

  - gasoline-fueled trucks will have 50 percent greater energy intensity than diesel trucks,

- Same growth scenarios as previous sectors.

Non-Substitutable Fuel Demand

- Moderate conservation. Only increases in end-use conversion efficiency are foreseen; no new processes are assumed to penetrate nor is any fuel switching assumed to occur.

- Same growth scenarios as previous sectors.

4.2.2.2 Supply Sectors

Oil Sector

- Imported crude oil price is assumed to grow at a compound annual real rate of 2.7 percent.

- Petroleum product prices are assumed to grow at the same rate as world crude oil.

Coal Sector

- Potential future new conversion processes include gasification and liquefaction of coal.

- Coal gasification technologies available in Argentina include a second generation technology for gasifying high-sulfur, low Btu coal (namely the IGT HYGAS process coupled with steam oxygen hydrogen production).

- The coal market is assumed to become fairly competitive, with prices increasing at a rate slightly slower than that of oil.

Natural Gas Sector

- Methanol production is considered a candidate.

- International prices are assumed to increase according to the Canadian price.

Uranium Sector

- The world market price for uranium is assumed to grow at a fairly vigorous rate, the resulting real price increases being about 3 percent per year.

Biomass

- Wood production rates are assumed to remain constant.
- The use of waste wood in paper pulp and forest product industries is assumed to grow gradually and smoothly.
- Ethanol production from high-starch crops and crop residues is assumed to increase.

Electric Sector

- The introduction of non-conventional solar, wind, and hydro facilities is strongly emphasized.
- Self-generated electricity by the industrial sector will decrease.

4.3 MACROECONOMIC DEVELOPMENT SCENARIOS

4.3.1 The Reference Case

Based on the historical rate of growth of GDP from 1955 to 1980, a future growth rate of 3.5 percent annually would seem to be reasonably representative. To be sure that we have scenarios that bracket this reasonable range, two scenarios were defined: a high growth scenario (4.5 percent) and a low growth scenario (1 percent). The high-growth scenario was considered a reference case for comparison with the low growth scenario. (We emphasize that which of the two cases was dubbed the reference case is immaterial. What we were really interested in was *differences* across cases representing the effects of specific policy variables.)

4.3.2 High-Growth Scenario

The performance of the Argentine economy immediately prior to 1980 gave credence to the rather optimistic 4.5 GDP growth rate. Furthermore, this growth rate of 4.5 percent was between two other economic growth projections presented in the National Electrical Plan--5.3 percent and 3.4 percent. Adopting this 4.5 percent mid-point provided a convenient point of calibration with previous electric sector planning analysis, which had included use by the Secretariat of Energy of three quantitative models: USM (Utility Selection Model), Load Forecast System Model, and a Probabilistic

Reserve Model. Also applied was an Aggregated Hydrological Model. Thus, use of the 4.5 percent assumption was quite expedient.

Although optimistic, the high growth scenario was judged to be sustainable over the 30 year study horizon if both world and local economic conditions remained relatively stable over the entire period. The results of the reference case therefore implicitly make that assumption.

4.3.3 Low-Growth Scenario

The low growth scenario, a more pessimistic outlook, was based on extrapolation of the difficulties that had beset the Argentine economy between 1972 and 1980. In particular, during that period, the Argentine economy had experienced triple-digit inflation. (See the consumer price index tabulation in Table 4-1) Through this very difficult ten year period, real per capita GDP was exactly the same in 1980 as it had been in 1974.

If the economy remained this weak over a long period of time, continuing to be afflicted by hyperinflation over the long run, it was deemed conceivable that long run real annual GDP growth of 1 percent would be likely. This 1 percent rate was achieved during the difficult periods from 1956-1964 and 1968-1978. The low growth scenario also might reflect significant international instability, the effects of which would be detrimental to the Argentine economy.

4.3.4 Conservation Alternatives

Several alternative degrees of conservation were assumed, and combinations of these conservation scenarios with economic growth scenarios were considered. This section defines the particular conservation alternatives.

Moderate Conservation

This scenario represents a number of technologies not presently in place in Argentina. Thus in a very real way, it anticipates the future existence of such technologies. Such anticipation is the very essence of national economic planning. To illustrate, the moderate conservation scenario contains potential future technologies such as coal liquefaction, methanol production, solar boilers, etc. in many different applications in both the supply and demand sectors. When energy prices rise to a certain level, these new technologies will begin to penetrate the energy picture.

Table 4-1

ANNUAL INFLATION INDICES

Year	Consumer Price Index[a] (CPI)	Change in CPI (%)
1955	0.20	-
1956	0.30	50.0
1957	0.40	33.3
1958	0.50	25.0
1959	1.00	100.0
1960	1.20	20.0
1961	1.40	16.7
1962	1.80	28.6
1963	2.20	22.2
1964	2.70	22.7
1965	3.40	25.9
1966	4.60	35.3
1967	5.90	28.3
1968	6.80	15.3
1969	7.40	8.8
1970	8.30	12.2
1971	11.20	34.9
1972	17.80	58.9
1973	28.70	61.2
1974	35.40	23.3
1975	100.00	182.5
1976	543.20	443.2
1977	1,499.60	176.1
1978	4,131.40	175.5
1979	10,721.40	159.5
1980	21,524.40	100.8

Efficiency levels are assumed to remain constant for well-known existing and near-commercial technologies. (Examples are fossil fuel thermal power plants, gas space heaters, and electric furnaces.) In the longer term, efficiency levels for Argentine technologies are assumed to increase to levels that would be typical of industrialized foreign countries.

High Conservation

The high conservation scenario differs from the moderate conservation scenario only in the attained levels of end use conversion efficiency. The high conservation scenario assumes that end use conversion R&D is successful, and that the fruits of such R&D are available for implementation in the Argentine energy system.

4.4 ENERGY SERVICE DEMAND GROWTH

Using the initial year (1978) distribution of useful energy demand and the economic-growth scenarios, projected future useful energy demand was estimated.

4.4.1 Methodology

Initial Year

The initial year (i.e., base year) selected for this study was 1978. This choice was not based on criteria that the year was *good* or *bad* from an economic standpoint. Rather, 1978 was considered to be a *credible* year both because of the large quantity and high quality of available data and because of the absence of physical or economic calamities that would render 1978 an unrepresentative initial year.

As it turned out, the years 1979 and 1980 had larger GDPs and higher employment rates than did 1978, but these latter two years were perceived to be above average years and were therefore considered nonrepresentative. GDP is expressed in constant 1976 dollars (June 30).

4.4.2 Quantity Projections, Demand Sector

Industry

Useful energy demand was projected using only GDP data for each of the two economic growth scenarios. End-use categories considered included indirect heat, direct heat (any fuel), direct heat (clean fuel), non-substitutable electricity and feedstock.

Agriculture

Demand growth was projected using GDP only. The categories of useful energy demand included direct heat (any fuel), electromechanical and lighting and mechanical drive.

Residential/Commercial/Public

Growth projections were tied to GDP growth rates. End use categories considered included space heating, water heating, cooking and non-substitutable electricity.

Transportation

Demand was projected based on GDP growth but adjusted for efficiency improvements.

Non-Substitutable Fuel Demand

This sector consists of fuel and feedstock consumption for which interfuel substitution is considered impossible. Changes in efficiency of use were considered insignificant or inappropriate (as for lubricants) and no end-use device efficiencies were assigned.

Self-Generation of Electricity

Fuels for self-generation were specified exogenously. Projections were made based on the GDP growth rate and subjective considerations. An electricity generation efficiency of 25 percent was assigned for computing the future year shift from self-generated electricity to purchased electricity. This shift away from self-generated electricity reflected both existing government policy mandates (which seek to minimize inefficient self-generation in favor of more efficient central generation) and basic economics (which imply that self-generation will become uneconomic as Argentina's vast hydroelectric resource is developed.)

4.4.3 Price Projections, Supply Sector

Domestic Non-renewable Resources

Primary resource supply curves were constructed in accordance with the specifications of the GEMS depletable resource modeling logic. [See Adler, et. al. (1979) for a comprehensive description of the GEMS logic.] These resource supply curves include the fixed and variable cost of exploration, development, and production of domestic resources but exclude what economists have termed *economic rent.* Economic rent is computed directly in the depletable resource module. However, special modifications to the resource module had to be made because depletable primary resources in Argentina (and we suspect other semisocialized countries) are not owned by private companies but instead are owned and produced by the government. Furthermore, the government tends to set prices well below the point at which such economic rent is recovered in those prices, i.e., the government insulates domestic energy producers and consumers from world energy prices. In general, the behavior of the government with regard to depletable primary resources determines how much if any economic rent will be contained in resource prices.

Imported Energy

Price data for fuel imports to Argentina between 1978 and 1980 have been used as base prices from which projections were made. Prices for petroleum products reflect the value added to crude oil by the refining process.

The projected price of natural gas was assumed to be higher than that of crude oil because of the current and prospective pricing policies of many gas-producing countries.

Coal prices were assumed to be lower than crude prices: Demand is significantly lower and the costs of transporting and burning coal mean that the minemouth price must be lower in order for coal to be competitive with crude or products.

Price projections for uranium were based on the assumption that the world market price for uranium grows at the rather vigorous rate of 3 percent per year in real terms.

4.5 SUMMARY OF ASSESSMENT RESULTS

This section summarizes the results of the Argentine/U.S. assessment. More complete descriptions can be found in Argonne, et. al. (1984) and Ussher, et. al. (1985).

4.5.1 Total Energy System Results

Energy consumption in the demand sectors is projected to grow by more than a factor of three from its current level of 26 million tons of oil equivalent (MTOE) per year in 1978 to 87 MTOE in 2008. The sectoral shares of consumption are projected to remain constant over that period.

According to the results of the assessment, domestic energy resources will satisfy the bulk of Argentine energy demand as follows:

Oil. Crude oil feedstocks for Argentine refineries will in 2008 come from the following sources: 65.5 percent onshore Argentine production, 17.4 percent Argentine off-shore, 8.8 percent crude imports, and 8.3 percent synthetic crude. These market shares reflect which sources of oil will be the most economically competitive at that time. However, because of ongoing depletion, the market shares of Argentine onshore and offshore oil will be declining gradually, being replaced by a combination of imports and synthetics. The reserves/production ratio will decline to low-levels toward the end of the planning period.

Natural Gas. Gas utilization, as a share of total primary energy utilization, will grow to 45.6 percent by 2008, becoming the dominant energy resource.

Coal and Renewable Resources. These resources show no significant growth. Furthermore, coal will not even be economically competitive for use in electricity generation. The reason is that Argentina is generously endowed with hydro sites, which promise to be much more economical than thermal technologies.

Electric Generation. By 2008 hydroelectricity is projected to account for 65 percent, nuclear for 10 percent and oil/gas for 27 percent of electric generation. Large-scale hydroelectricity will satisfy the bulk of generation requirements, and there will be even by the year 2008 a large excess of hydroelectric capacity available.

4.5.1.1 Effects of Conservation and Economic Growth Rate. Assuming that Argentine GDP grows at the (high growth) rate of 4.5 percent, the difference between the high conservation and moderate conservation scenarios implies a decrease in total consumption of 13 percent in 1988, 15 percent in 1998, and 16 percent in 2008. Similar calculations made using the low-growth scenario imply that final consumption will be reduced by 26 percent in 1988, 45 percent in 1998 and 59 percent in 2008. An interesting sidelight is that virtually all growth in the Argentine energy system can be met with domestic natural gas.

4.5.2 Total Facility Requirements

To meet the ambitious requirements of the high growth scenario, a significant number of new energy facilities will be required between now and 2008. Because of the extreme importance of the infrastructural requirements for this growth, an extensive analysis was conducted using the Energy Supply Planning Model (ESPM) built by the Bechtel Corporation. ESPM details material, equipment, capital and labor resources necessary to construct and operate the facilities required by a given energy supply/ demand balance. The analysis determined that the new facilities called for in the GEMS model runs will cost from 130 billion dollars (high growth, high conservation) to 170 billion dollars (high growth, moderate conservation). For comparison, only 96 billion dollars worth of facilities will be required if low growth and moderate conservation occur.

4.5.3 Total Energy Bill and Total Cost of Delivered Fuels

The cost of imported fuels is estimated to increase by over 800 percent, due in part to the increasing prices of imported fuels and in part to their increasing market share. However, the cost of fuel imports will not change substantially relative to GDP until the turn of the century, remaining near current levels of 1.2 percent through 1998 but thereafter rising to 3.0 percent by 2008.

4.6 CONCLUSIONS

We reiterate that it is not the purpose of this paper to investigate in detail the results obtained by the energy-economy assessment. Rather we wish to give a flavor of the types of results obtained. To do so, we will outline a few salient conclusions relevant to public policy making in semisocialized economies, of which Argentina is representative.

1. As anticipated in 1980, a substantial number of new energy facilities will have to be built in Argentina over the next 30 years. The cumulative cost of these facilities over the 30 year period will range between 170 billion dollars (moderate conservation) to 130 billion dollars (high conservation) under the assumptions applied for the high-growth scenario, and to 96 billion dollars with moderate conservation under the low-growth scenario.

   The bill for imported fuels will be quite large, as will the bill for delivered fuels in Argentina. The bill for imported fuels will rise (as a percentage of GDP) from its current value of 1 percent to 3.5 percent by 2008. The total cost of delivered fuels will rise from its current value of 10 percent of GDP to 13 percent by 2008. Expressed in dollar terms, the total cost of delivered fuels will grow more than tenfold (in the Reference Case) over the next 30 years from its level of $580 million in 1978 to $6000 million dollars in 2008. Oil accounts for 70 percent of this final total.

   In view of the fact that Argentina can count on a favorable commercial trade balance of no more than $3000-4000 per year, oil import bills of this magnitude are of significant concern. They point to the need for policies to limit imports of oil.

2. At present, capital investment in the energy sector accounts for about 53 percent of total investment in the Argentine economy. Under a broad range of scenarios studied, it is unlikely that energy investment will decline relative to total investment in the economy. In fact, the energy sector might require a larger fraction of total investment than has occurred in the recent past. This observation points to the need for public policies that ensure that the necessary debt to support these development plans is effectively serviced; otherwise, it will not be available. In particular, it points to careful consideration that each project generate sufficient revenues to be self-supporting given the debt required to build it.

3. The 14 currently proposed hydroelectric plants can fully satisfy Argentina's projected electric power requirements between 1978 and 2008. Nuclear and other thermal generation methods can be justified only from the standpoint of wanting to develop indigenous high-technology capability and know-how, defense considerations, or hedging against delays in hydro projects or *dry years*. Thermal capacity cannot be justified from the standpoint that it is needed to meet growing electric demand. Keep in mind that Argentine is endowed with perhaps the best hydroelectric sites in the world, particularly when viewed on a per capita basis.

4. By the year 1993 (a representative *mid-term* year), total energy requirements are expected to double relative to 1978. If that occurs, total annual costs of energy (including capital, operating and fuel import costs) will be $20 billion dollars (about 23 percent of expected GDP). In that year, capital requirements are expected to constitute 90 percent of the $20 to $22 billion total cost of energy.

5. Required construction labor is expected to grow from 32,200 person/years in 1979 to 79,100 in 2008--a 146 percent increase. This implies huge infrastructural requirements that must be planned for now.

6. With the exception of natural gas and uranium, all other fuels will be imported in increasing quantities by the turn of the century.

In summary, given the ambitious economic growth and development strategy planned by the government, the energy sector will have to grow substantially to provide the necessary support. And this energy sector growth will have to occur first. This *out front* growth of the very capital-intensive energy sector implies that the credit needs of Argentina are not likely to abate if the country is to meet its growth targets. Therefore, it is imperative that the country develop specific procedures to minimize its debt.

Chapter 5

APPLICATION OF THE GEMS TO PLANNING IN SEMISOCIALIZED ECONOMIES: PROBLEMS IDENTIFIED AND THEIR POTENTIAL CONSEQUENCES

This chapter details the operating and theoretical problems found during the Argentine energy-economy assessment. Among the many problems encountered by the Argentine team, several were simply the result of a lack of experience. Such problems were easily solved with help from the American team. However, many problems encountered were due to the specific nature of the Argentine economy and the need for customized modeling capability to represent it. That is, they were due inherently to the nature of the semisocialized economic system in Argentina. Most of these problems resulted from the fact that the more socialized an economy is, the less it tends to respond to price incentives. Therefore, model capabilities related to free markets had to be adapted (or abandoned completely) in favor of logic that applied specifically to Argentina.

As this section discusses, many of the requisite changes required simple modifications in the network representation of the Argentine economy. Still others required assembly of heretofore unavailable data. And still others required fundamental changes in model structure and logic.

This section surveys a range of problems encountered, what was done to *fix* them, and what remains to be done in the future to ensure that the GEMS capability transferred to Argentina remains a vigorous ongoing capability.

5.1 THE NEED FOR A SYSTEMATIC QUANTITATIVE ANALYSIS

Perhaps the primary benefit of a model-based analysis such as the assessment outlined previously is to call the attention of both analysts and policy makers to aggregate results and to detailed assumptions and results that underlie those results. When these results appear counterintuitive, the analyst is obliged to undertake a more detailed investigation of:

- The structure of the model upon which the results are based. Does it reflect the decision makers and institutions of the country?
- The scope of the network representing the economy. Has anything been left out?

- The numerical data characterizing the resources, technologies, end-uses, and sectors of the economy. Is the data realistic?

The primary benefits of a formal, quantitative procedure lies in this process of investigation, revision, investigation, revision, etc.

This section describes what we learned as a result of this iterative process in the context of the Argentine energy assessment using the GEMS. One of the most important things we learned was that model structure, network structure, and data are to a significant degree intertwined and that the answers to the above questions are interrelated. But perhaps the main thing we learned was to be better quantitative public policy analysts.

We should emphasize that when we state that a particular model requires improvement to represent a particular phenomenon, we are not leveling criticism at that model. Indeed, it is our opinion that almost any quantitative model is better than unaided human judgment. Rather, our criticisms are intended to serve as a guide to refine a tool that is already *much* better than unaided human intuition but which we perceive can be made even better, more accurate, and more useful.

Tables 5-1 through 5-3 will serve as a guide to our discussion of the difficulties encountered as we continually reviewed and revised our model and results.

5.2 USABLE ENERGY DEMAND BY SECTOR

It proved to be difficult to make projections of usable energy demand for each end-use in each sector of the Argentine economy during the planning horizon. This section details the difficulties and what was done to overcome them. We show that the difficulties do not lie in the model structure but rather in the paucity of relevant data and the difficulty of making a direct link from an overall projection of GDP to detailed projections by end use category.

5.2.1 Industrial Demand

As mentioned previously, industrial demand was projected based on the assumed growth rate in GDP--either 4.5 percent or 1 percent in the high and low cases respectively. This estimation procedure was based in part on other work (particularly that contained in the Argentine National Electric Plan) and in part on subjective judgments made by technical experts and policymakers in the country. These projections were not based on a detailed macro model of the Argentine economy--we had no such model.

Table 5-1

PROBLEMS IDENTIFIED WITH APPLYING GEMS: OVERALL DEMAND

PLACE IN THE NETWORK 1	OPERATION OR CALCULATION 2	AS A FUNCTION OF 3	SECTOR 4	WHAT WAS DONE IN IN THE ASSESSMENT 5	PROBLEMS FOUND WHEN APPLIED TO A SEMI-SOCIALIZED ECONOMY 6
Top (aggregated final demand)	Overall demand by sectors	quantities as a function of prices	Industry, R/C/P, Transportation, Agriculture, non-substitutable fuels	not applied	-In economies like these there is not a transparent market sensitive to prices. -Short, mid and long-term price elasticities were not properly known for the overall economy and each individual economic sector. - Lack of data on final and end-use demand.
		Quantities as a function of population growth.	Industry, Agriculture, transportation	not applied.	-Lack of individual sectoral $\Delta E/\Delta pop.$ relationships
			R/C/P	Not applied	-idem - Lack of accurate data to separate residential, commercial and public.
		Quantities as a function of GDP	Industry, agricultúre, transportation, R/C/P	4,5 and 1% growth-rates used,	-Lack of sectoral E/GDP rates
			Non-sustitutable fuels.(feedstocks, lubricants, exports and self-generated electricity)	Fixed demands per period used(dummy)	- lack of sectoral E/GDP rates - exports are fixed quotas. - self generated electricity is restricted in accordance to public policies.
TOP (separate final demands)	Overall demands by sectors	prices population GDP	All sectors	Not applied;each final demand had a fixed percentage on the aggregated demand.	- Lack of sectoral elasticities relating quantities on separate final demands with GDP, population or prices. - Industry sector can not be studied by temperature range

DUE TO : 7			DIRECT CONSEQUENCES ON 8				SOLUTION GIVEN 9		
HOW IT WAS FACED 7.1	LACK OF DATA 7.2	DIFF. WITH THE LOGICS 7.3	PRO-CESSES 8.1	ALLO-CATIONS 8.2	DEPLETABLE RESOURCES 8.3	FINAL DEMAND 8.4	WHAT DID WE DO LATER? 9.1	WHAT SHOULD BE DONE? 9.2	DO WE HAVE THE WAYS TO DO IT; WHICH ONES? 9.3
-	yes	-	-	-	-	lack of exactness	nothing	analyes and investigations to determine price elasticities. Comparisons between present studies and those based on prices.	no, because the market doesn't respond to prices.
-	yes	-	-	-	-	idem	We applied some studies made by Shell on transportation based on population growth.	Investigate differences with E/GDP results.	yes, but it requires better data.
-	yes	-	-	-	-	idem	idem	Relate the residential energy growth to population and welfare.	idem
-	yes	-	-	-	-	idem		The state-owned and operated sector and the private one should be investigated separately per economic activity.	idem
yes	yes	-	-	-	-	lack of exactness and a different network.		Separate this sector by individual subsectors, specially petrochemical feedstocks and self-generated electricity.	idem
yes	yes	-	-	-	-	idem	nothing	-analyses and investigations to determine different elasticities. -draw networks applying criterias such as public and private, temperature ranges, irrigation, residential disaggregation, etc.	idem

Table 5-2

PROBLEMS IDENTIFIED WITH APPLYING GEMS: END-USE DEMAND BY SECTORS

PLACE IN THE NETWORK	OPERATION OR CALCULATION	AS A FUNCTION OF	SECTOR	WHAT WAS DONE IN THE ASSESMENT	PROBLEMS FOUND WHEN APPLIED TO A SEMI-SOCIALIZED ECONOMY
1	2	3	4	5	6
Top of the end-use demand sectors	Conversion of fuels into useful energy for final demands.	-	All those aggregated in the final demand.	Only the most important ones were considered here and future ones have not been included.	- Lack of specific data to aggregate them by temperature ranges that would have helped substitutions. - Lack of data on future devices.
Bottom of the end-use demand sector Unconventional resources	Quantities of unconventional resources.	-	idem	Many possible sources were not included.	- Because an improper fuel substitution is made there are no ecónomic incentives for highly developed technologies.
Bottom of the electric sector	Calculation of hydro resources	-	Electric energy conversion	Fixed amounts of hydroelectric production included per period. Prices were not calculated.	- It is not possible to choose hydroelectric projects by price, thus failing to visualize degree of competitiveness and an adequate selection of individual projects.
Middle of the supply sector	Resource conversion	-	Oil, natural gas, coal	In accordance to model requirements.	Public criterion on the "optimization function" is based on "overall benefit" for the economy.
Botton of the supply sector	depletable resource price	-	all sectors	in accordance to the logics requirement	Semi-socialized economies very seldom include "economic rents" in their pricing policies. Optimization function based on "maximum overall benefit" rather than minimum cost. Non-economic resources are produced and world oil prices not observed. -
Bottom of the network	price and quantity of oil related products.	-	importation	It was considered as a "dummy". Prices assumed for the period	No benefits were computed.

DUE TO: 7			DIRECT CONSEQUENCES ON 8				SOLUTION GIVEN 9		
HOW IT WAS FACED	LACK OF DATA	DIFF. WITH THE LOGICS	PROCESSES	ALLOCATIONS	DEPLETABLE RESOURCES	FINAL DEMAND	WHAT DID WE DO LATER?	WHAT SHOULD BE DONE?	DO WE HAVE THE WAYS TO DO IT;WHICH ONES?
7.1	7.2	7.3	8.1	8.2	8.3	8.4	9.1	9.2	9.3
yes	yes	-	-	lack of exactness	increased demand of conventional sources.	errors	nothing	a broader disaggregation of end-use devices and a search for more specific data should be performed.	Yes, surveys and investigations backed by different institutions.
yes	yes	-	-	conventional allocations with vary	idem	errors	Sectoral models including highly sophisticated technologies were developed. Sensitivity analyses made lowering SSC in 25 and 50% for each tech. already inc.	investigations an unconventional resources should be intensified. A survey on foreign developments made.	idem
-	-	yes	-	allocations vary and future investments too.	demand for fuels oriented to electric energy production.	errors	nothing	A specific computing module for semisocialized economics should be developed	no, we don't. It should be done by model developers.
-	-	yes	different prices will be found	allocations vary and future investments too.	higher demand of depletable products	errors, less substitution	two runs were made one under restrictions and another without them. Differences in investments and quantities were computed by hand.	it should be determined an optimization function based on minimum investments and, if possible, with positive cash-flow.	idem
-	-	yes	-	wrong allocation	prices offset increased oil demand. Depletion times shorter	errors	several runs made using different "scarcity rents"	a new optimization function should be determined based on maximum benefit, minimum investments and the lowest possible cash-flow.	no, it should be made by model-makers
yes	-	-	prices offset	idem	lack of exactness in oil prices	errors	nothing	Import process modules should be modified to provide an alternative when domestic prices are higher and rest. on imp.	idem

Table 5-3

PROBLEMS IDENTIFIED WITH APPLYING GEMS: DATA PARAMETERS

PARAMETER (Specific process) 3	PARAMETER (Generic process) 3	PROBLEMS FOUND WHEN APPLIED TO A SEMI-SOCIALIZED ECONOMY 4	DUE TO: 5 How it was faced 5.1	Lack of data 5.2	Differ. with the logics 5.3	DIRECT CONSEQUENCES ON: 6 Price 6.1	Quantities 6.2	Capacity additions 6.3
CONVERSION Specific Capital Cost, SCC (5)	Labor fraction of SCC, CLFR (6)	Difficulties in determining a representative capacity. Problems due to very old plants exceeding their scheduled life-time,	yes	yes	-	yes	-	-
Variable operating cost, VOC (7)	Labor fraction of VOC, OLFR (8)	idem	yes	yes	-	yes	-	-
Efficiency, EFF (9)		Efficiencies were measured based on the largest and most modern plants due to a lack of data on smaller ones and obsolete units still operating.	yes	yes	-	yes	yes	yes
Planning lead time IPLTIM (10)		Invariably long in semi-socialized economies, but not in private works.	yes	-	-	yes	yes	yes
Year of availability, IYRAVL (12)	Early availability penalty, EARLY (13)	Domestic technological developments are scarce and hard to predict when available. Foreign technologies adopted using a five year lag term.	-	yes	-	yes	-	-
Technological limit on capital, CLIM (14)	Technological rate on SCC, CRATE (15)	idem	-	yes	-	yes	-	-
Technological limit on efficiency EFLIM (19)		idem	-	yes	-	yes	yes	yes
Characteristic life, CLIFE (22)	Aging parameter, VOAGRT (23)	Plants operate beyond more than two times their operating cost having negative cash-flow This is not shown in the model.	yes	yes	-	yes	-	-
Tax life, ITXLIF (24)		Extremely short times for returns on capital in the private sector, therefore taxes were added too fast.	yes	-	-	yes	-	-

EGREE OF SENSITIVITY ON FINAL RESULTS 7 HIGH 7.1	AVERAGE 7.2	LOW 7.3	RANGE 8 MINIMUM 8.1	MAXIMUM 8.2	SOLUTION GIVEN 9 WHAT WAS DONE? 9.1	WHAT SHOULD BE DONE ? 9.2
ifference of 1% on) varies prices about .14%.	-	-	(5) ≥ 0 (6) 0	any 1	In the industrial sector values were obtained from large and modern plants.	Represent medium and small size plants. Obtain better data.
ifference of 1% on) varies price about 11%	-	-	(7) ≥0 (8) 0	any 1	idem	idem
x	-	-	positive larger than zero	1	Values were obtained only from large and modern plants.	Include smaller and obsolete plants still operating.
-	x	-	positive	t doesn't have to exceed the model horizon.	Values obtained from private companies and foreign works.	Separate into two different modules: government and private.
-	-	x	(12) 1900 (13) positive	(12) 2100 (13) positive	Foreign values used with a five year lag term.	Obtain more accurate data on domestic developments.
-	-	x	(14) positive (15) 0	(14) - (15) 1	idem	idem
ee Chapter II, igures 6, 7, 8	-	-	0	positive	High and low efficiency scenarios based on international values were run. No scale factors were registered.	same
-	x	-	(22) positive (23) 0.01	(22) positive (23) 40	Following the logics was assumed that new plants will be added when always surpass the two-times operating cost level.	Include the real world: negative cash-flows.
-	x	-	positive	no larger than the model period	It was decided to work with longer periods but this is not real,	Work the private sector through a separate module.

Table 5-3 (continued)

PARAMETER (Specific process) 3	PARAMETER (Generic process) 3	PROBLEMS FOUND WHEN APPLIED TO A SEMI-SOCIALIZED ECONOMY 4	DUE TO : 5			DIRECT CONSEQUENCES ON: 6			.GREE OF SENSITIVITY ON FINAL RESULTS 7			RANGE 8		SOLUTION GIVEN 9	
			How it was faced 5,1	Lack of data 5,2	Dif. with the logics 5,3	Price 6.1	Quantities 6.2	Capacity additions 6.3	HIGH 7.1	AVERAGE 7.2	LOW 7,3	MINIMUM 8.1	MAXIMUM 8,2	WHAT WAS DONE? 9.1	WHAT SHOULD BE DONE ? 9.2
Debt life, IDLIFE (25)		idem	yes	-	-	yes	-	-	-	a difference of-10 years changes pr.+0.8% and +10 -0.5%.	-	0	positive	idem	idem
Equity fraction, EQFR (29)		State-owned enterprises work with a reduced equity fraction borrowing most of the capital required.	yes	-	-	yes	-	-	-	a difference of; -25%ch.pr. -1.6% +12.5% " +0.7% -37.5% " -2.4%	-	0	1	idem	idem
Availability, AVAIL (20)		--	-	-	-	-	yes	-	-	x	-	0	1	-	-
Initial capacity change rate, RATIN (31)	New capacity flexibility, NEWFLEX (32)	It was difficult to obtain accurate data, especially from government owned companies.	-	yes	-	yes	yes	yes	-	x	-	(31) 0 (32) positive but not zero	1 positive	We used historic data. In semi-socialized economies these values are lower because positive cash-flows are not observed.	Obtain better and more updated data.
-	Spending lead time fraction, CFLDR(11)	idem	-	yes	-	yes	-	-	-	-	x	0 or positive	positive	idem	idem
	Technological rate on VOC,VOCRAT (18) Technological limit opening,PRELIM(16) Technological limit production POSTLM (17)	Data like this can not be obtained because domestic technologies are very seldom developed.	-	yes	-	yes	-	-	-	-	x	(18) 0 (16) positive (17) 0.01	(18) 1 (16) positive (17) 1	We used foreign data,	Use domestic data for those capacities that might come on line.
	VOC multiplier in capacity factor, CFMULT (36). Capacity factor sensitivity,CFSEMS (37)	Parameters to be used should correspond to smaller plants. Equation $\delta = 2\ \ln(9)/\ln W$ differs with the size of existing plants.	-	yes	yes	yes	yes	yes	x	-	-	(36) positive (37) 1	(36) positive (37) 80	We used foreign data.	Eq. $\delta = 2\ \ln(9)/\ln W$ should be adapted to smaller capacities or plants.

Table 5-3 (continued)

PARAMETER (Specific Process) 3	PROBLEMS FOUND WHEN APPLIED TO A SEMI-SOCIALIZED ECONOMIES 4	DUE TO: 5 How it was faced 5.1	Lack of data 5.2	Dif. with the logics 5.3	DIRECT CONSEQUENCES ON: 6 Price 6.1	Quanti-ties 6.2	Capaci-ty ad-ditions 6.3
RESOURCE Initial resource cost, INRCST (40) Capital charge fraction, CCCF (44)	Scarcity rent is very seldom included and a "maximum overall benefit" is followed, thus making impossible positive cash-flows.	yes	-	yes	yes	yes	yes
Base price, BASEPR (41) New resource capital cost fraction, NCCF (46)	idem	yes	yes	yes	yes	yes	yes
Undiscovered reserve base, UNRCRS (47)	There is a lack of accurate information on commitments especially for the state-owned sector. Scarcity rents not included in government calculations. It's hard to distinguish the true "expected future resource discoveries" from sheer optimistic expectations.	yes	yes	yes	yes	yes	yes
Undiscovered reserves, 2x Base (43)	idem	yes	yes	yes	yes	yes	yes
Deposit decline rate, DCLNO (47) Half depletion VOC multiplier HDCMLT (49) Full-depletion cost multiplier, FDCMLT (50)	Very difficult to determine	-	yes	-	yes	-	-
Final to initial cost TRMULT, (53)	Lack of accurate data because price estimations in long-term periods are very seldom carried out by government companies.	-	yes	-	-	-	yes
Owner's discount rate, ROWN (48)	None	yes	-	-	yes	yes	yes
ALLOCATION Share sensitivity parameter,SHSENS(1) Behavioral lag BELAG (2)	This is possibly the toughest problem because there is not a transparent market sensitive to price changes.Furthermore many substitutions are not possible due to non-existing or restricted commodities.	-	yes	yes	yes	yes	yes

PARAMETER (Specific Process) 3	DEGREE OF SENSITIVITY ON FINAL RESULTS 7 HIGH 7.1	AVERAGE 7.2	LOW 7.3	RANGE 8 MINIMUM 8.1	MAXIMUM 8.2	SOLUTION GIVEN 9 WHAT WAS DONE? 9.1	WHAT SHOULD BE DONE? 9.2
RESOURCE Initial resource cost, INRCST (40) Capital charge fraction, CCCF (44)	x	-	-	(40) 0 (44) 0	(40) positive (44) 1	Several alternatives to the reference Case we constructed based on different "economic rents" for each depletable resource.	Adapt the logics to the"maximum benefit" case.Rework definitions and parameters.Consider non-economic facilities going into prod.
Base price, BASEPR (41) New resource capital cost fraction, NCCF (46)	x	-	-	(41) INRCST < BASEPR (46) 0	positive 1	In accordance to the logics. Private sources were consulted.	Idem, but based on better data when referred to uncommitted production.
Undiscovered reserve base, UNRCRS (47)	x	-	-	0	positive	A thorough screening was performed to distinguish "expected future resources" from sheer expectations Private sources were consulted.	Have better data mainly geologically-based one.
Undiscovered reserves, 2x Base (43)	x	-	-	0	Max. UNRCRS	idem	idem
Deposit decline rate, DCLNO (47) Half depletion VOC multiplier HDCMLT (49) Full-depletion cost multiplier, FDCMLT (50)	-	-	x	1 HDCMLT	HDCMLT FDCMLT	No data available when working with state-owned companies. Foreign and private data used.	Search for better data.
Final to initial cost TRMULT, (53)	-	x	-	1	positive	Private and foreign estimations were used.	Search for better data
Owner's discount rate, ROWN (48)	-	x	-	0	positive	Private&governmentestimations differ sharply because the latter is based on overal benf/ criteria and	Induce state-owned companies reaching positive cash-flows.Induce the gov. to treat its own comp.1/2
ALLOCATION Share sensitivity parameter,SHSENS(1) Behavioral lag BELAG (2)	or γ = 7.5 12 iterations - γ = 12.5 18 iter. under these cond, alloc. prices vary from -0.5 to 2% -resour. pr. -0.3% to13%- Quan. of imp. oil the end of the hor, +1.2% and oil res. the rst ten years +3.7%being less with time. or γ=5 11 iterations- Alloc pr. +6.6 to 2.3% il res. pr. 0.6 to 11.8% Quan. higher.			(1) n-1/n (2) 0	80 xn-1/n positive	Values from free- market economies were used.	γ should vary as a function of GDP and real salaries.Otherwise it should be inelastic because the consumer can not choose.

1.- stated-owned concerns are not considered resource producers that buy leases.
2.- .. "[illegible]" concerns that should maximize profits.

Table 5-3 (continued)

OTHER DATA 1	NUMBER 2	PARAMETER 3 OTHER	PROBLEMS FOUND WHEN APPLIED TO A SEMI-SOCIALIZED ECONOMIES 4	DUE TO: 5			DIRECT CONSEQUENCES ON: 6		
				How it was faced 5.1	Lack of data 5.2	Dif. with the lo- 5.3	Price 6.1	Quantities 6.2	Capacity additions 6.3
DATA BY GLOBAL REGIONS	d.1	Inflat, INFLAT (38)	It would be convenient to work with true inflation figures but very often they exceed 200%	-	-	yes	yes	yes	yes
INPUT DATA	e.1	Regulatory policy, REGTST (51) Ceiling price, REGPR (52)	Regulations are real subsidies applied always on prices, not quantities, devoted to meet social welfare programs. They last many years affecting the mid and long-term energy balances	-	-	yes	-	yes	-

DEGREE OF SENSITIVITY ON FINAL RESULTS 7			RANGE 8		SOLUTION GIVEN 9	
HIGH 7.1	AVERAGE 7.2	LOW 7.3	MINIMUM 8.1	MAXIMUM 8.2	WHAT WAS DONE? 9.1	WHAT SHOULD BE DONE? 9.2
-	x	-	1	200 %	Constant dollar prices were used because more than 200% doesn't allow to reach convergence.	It would be convenient to compare final results when using constant dollars and true inflation figures. Logics will have to be adapted.
x	-	-	(51) TRUE (52) 0	False positive	Regulations have not been applied because present logics limit them to one period and are based on quantity restrictions.	The ceiling pr. intended to change should adequate investment alloc. reducing overall expenditure. But on SEE pr. subsidies induce to consume and invest more. A new logic should be developed to reflect this case.

The judgmental procedure, admittedly approximate, was the best possible avenue at the time. To ensure against egregious errors, projected demands were compared with historical 1950-1980 time series. These comparisons lent at least a minimum level of credibility to the projections.

However, one of the key findings of the early subjective analyses was that some industries had remained relatively stagnant while others (particularly those promoted heavily by the government) were growing significantly. This motivated us in later studies to divide the industrial sectors into key industries, distinguishing stagnant from growing industries. These more disaggregated analyses showed that the most dynamic industries tended to be very capital- and energy-intensive and were usually state-owned. By contrast, the stagnant industries tended to be largely privately owned and less energy- and capital-intensive.

We therefore concluded that it was necessary to project industrial energy service demand at the level of key industries. Such projections were made using the following types of approaches:

a. estimating the rate of GDP growth of separate industrial groups in relations to the assumed overall industrial GDP growth (See Figure 5-1.)

b. distinguishing the whole *package* of state-owned concerns, because they were in general the most energy- and capital-intensive industries (See Figure 5-2).

c. distinguishing by fuel type and temperature range (See Figure 5-3).

We found that there existed enough data to effectively utilize all three approaches, which gave us more confidence in our industrial end-use projections.

To facilitate analysis of interfuel competition, we also classified industrial use into generic categories such as steam heat, direct heat, metallurgical coal, petrochemical feedstocks, etc. Such disaggregation of course requires additional detail and complexity; however, it increases one's knowledge of interfuel and intertechnology competition in the sector.

5.2.2 Residential/Commercial/Public

Demand information was more difficult for these three sectors than for the industrial sector simply due to the lack of historical analysis of these sectors. The projections made for these sectors (which were based on assumed energy/GDP ratios and population projections) were therefore more subjective and probably less exact.

Figure 5-1

INDUSTRIAL SECTOR

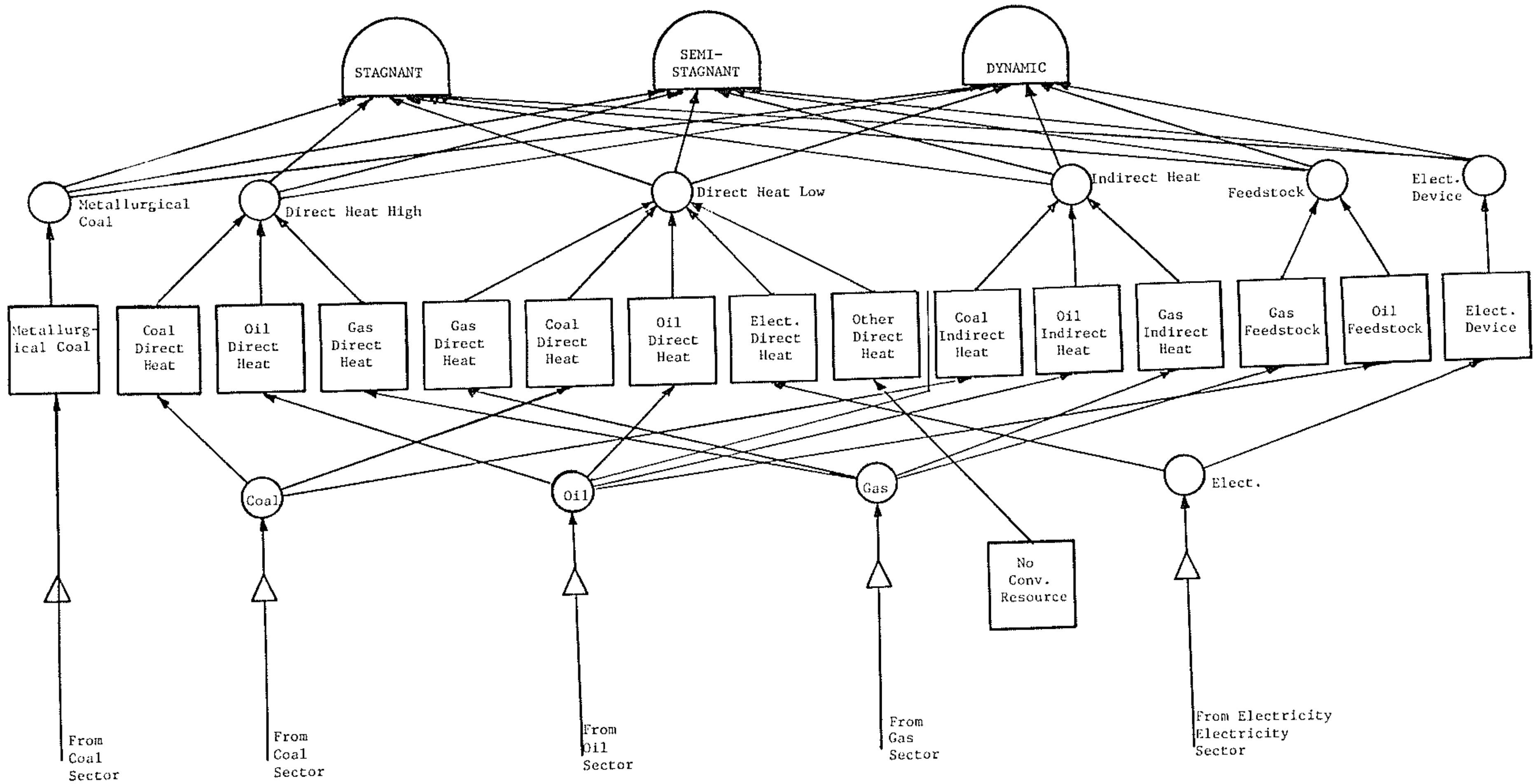


Figure 5-2

INDUSTRIAL SECTOR

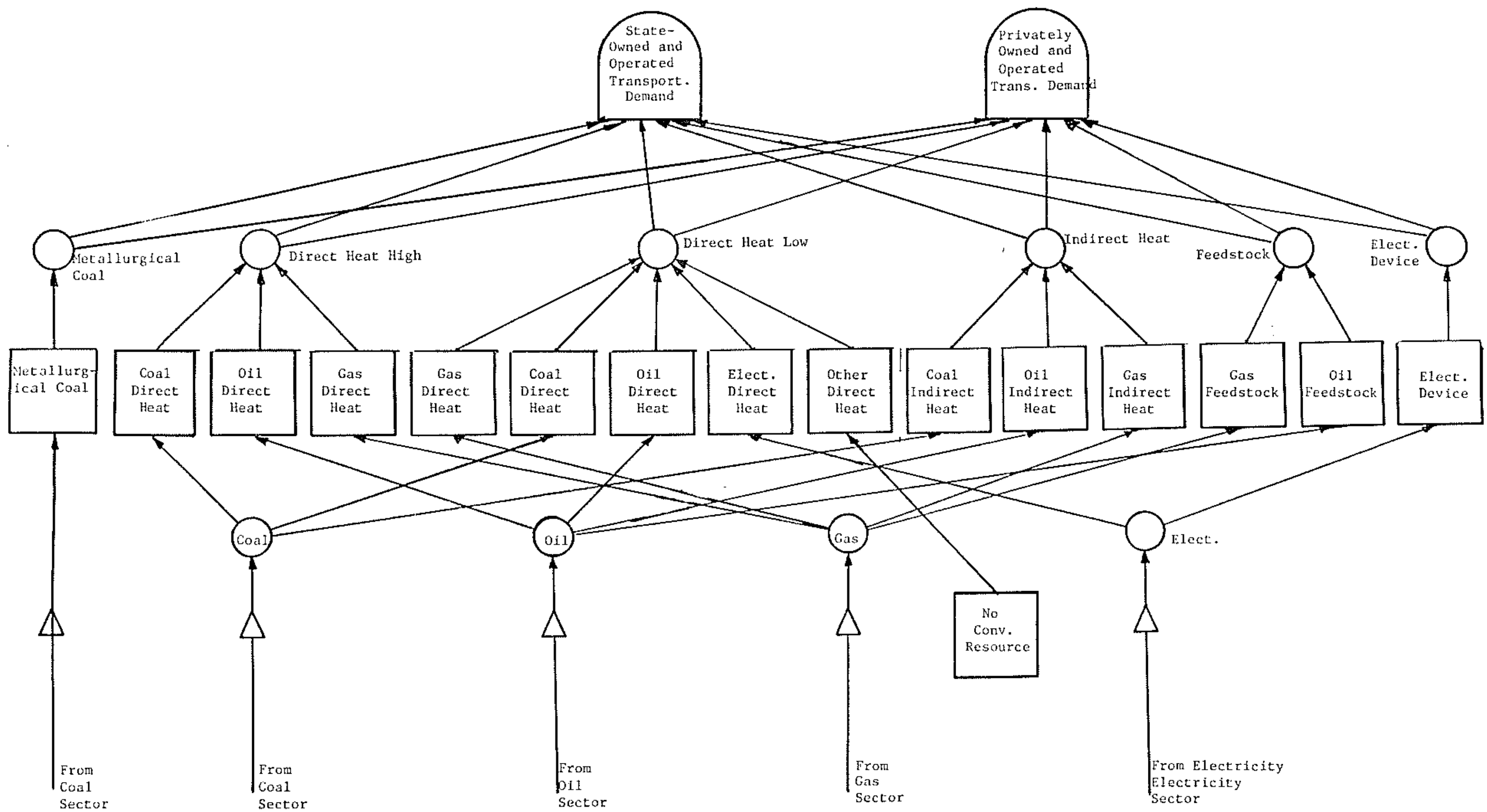
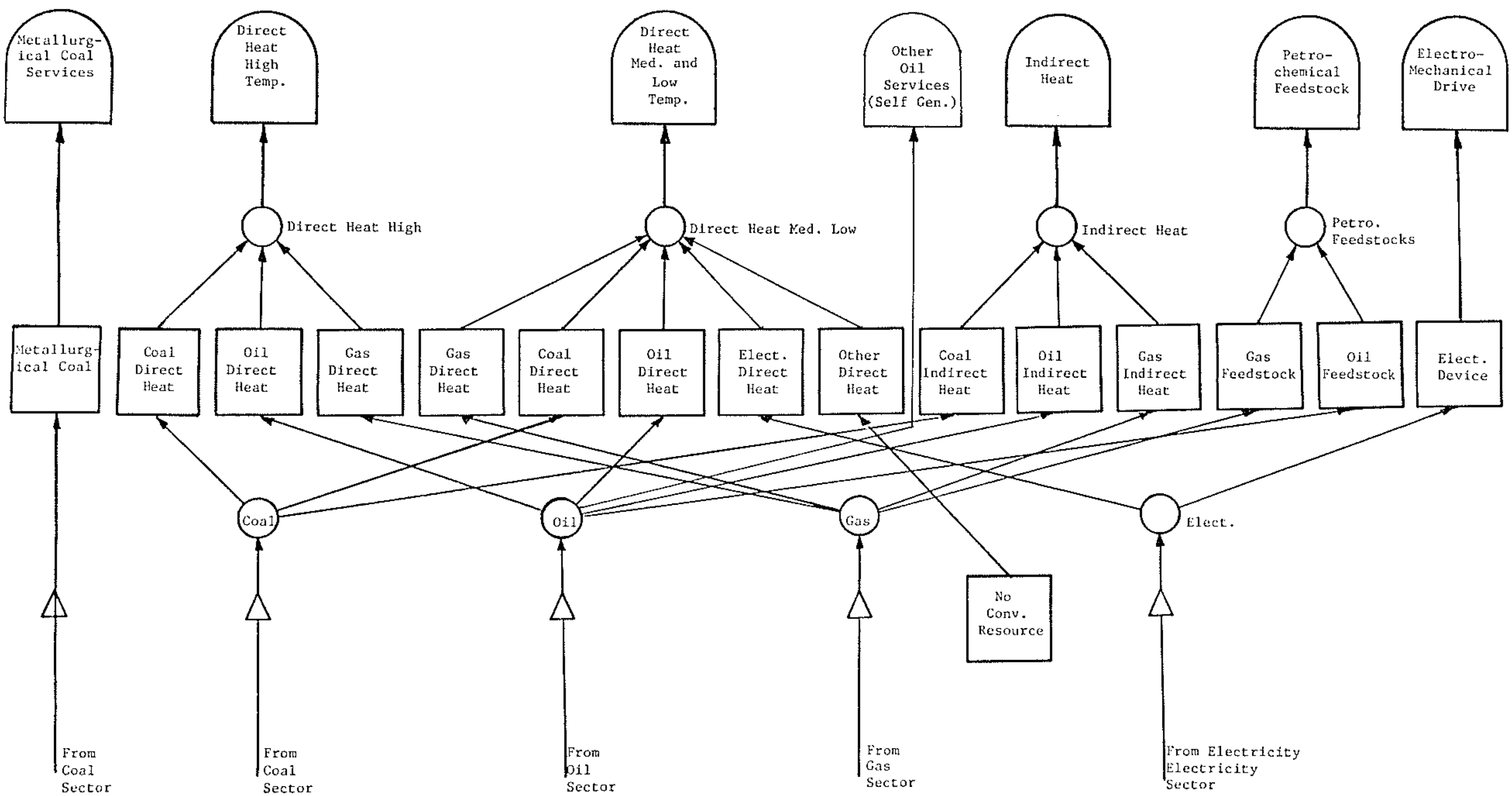


Figure 5-3

INDUSTRIAL SECTOR (STATE-OWNED AND PRIVATE)



The specific procedures followed are summarized in this section. During the assessment, consensus emerged as to the need for distinct growth projections in the three sectors:

- **Residential.** Huge collective public housing programs have a major impact on residential construction. Just as privately funded housing projects do, these public housing programs depend both on population growth and assumed welfare. For example, if population is growing but economic means are scarce (low welfare), it is likely that appeals for government-sponsored intervention in the construction market will be frequent and vocal. However, if economic means are scarce, the housing stocks thus constructed can be expected to be more basic (i.e., less deluxe). Conversely, if economic means are not scarce, government housing programs might not be conducted or, if they are, the resulting housing stocks will be more deluxe. Clearly, the particular type of government housing program initiated and the economic environment will have a profound influence on housing stocks, resulting energy demand, and the economy as a whole.

  But housing stocks are only half of the story. Welfare considerations must be considered in combination with housing stocks to determine residential demand. In general, we expect that higher welfare (higher economic growth) means more energy-intensity in the residential sector, i.e., more kilowatts consumed per inhabited square foot. As a matter of fact, energy consumption per unit of inhabited surface might be affected indirectly by population growth and directly by overall welfare.

  In summary, residential useful energy consumption is a complex function of many factors: salaries and wages, savings, inhabited square feet, average temperatures, etc. The assessment convinced us that better models focused specifically on these issues were needed to support suitably deep policy analysis in the residential sector. Our agenda includes supplementing the GEMS with such models.

- **Commercial.** Tied directly to outcomes in the entire economy, one could argue that commercial demand is closer to industrial than to residential demand--it should therefore follow the GDP path. This assumption was in fact made during our work to date. However, we recognize that population and other factors affect the mix of commercial establishments in place, and more complex representations may have to be built.

- **Public.** This sector is related directly to the level of government activity including medical, educational, and other services in addition to the armed forces (which requires for example reserves of oil for security reasons). Unlike free market economies, in semisocialized economies the government is a major player, and its level of activity is probably closely related to GDP. Thus it was assumed that the public sector grows at the GDP rate.

5.2.3 Transportation

Transportation demand was projected by estimating the energy to GDP ratio for this sector. However, it was later found that accurate estimations of the energy to GDP ratio for transportation are difficult to obtain for the following reasons:

- This sector is partly government-owned (railroads, subways, airlines, sea and inland water freight) and the rest privately-owned (buses, freight trucks, taxis). Passenger fares are set by the public sector consistent with real salary levels, prices of fuels, inflation, etc. Therefore GDP growth rates are different for those sub-sectors under government control than those that are privately controlled.
- In general the transportation sector is strongly affected by established conservation and fuel substitution policies as well as restrictions as to which technologies, foreign and domestic, can be implemented. Consequently its relationship with GDP is not clear.

Work in Argentina subsequent to the Argentine/U.S. assessment demonstrated the advantage of disaggregating this sector into those sub-areas that are subject to government control and those that are not. Figures 5-4a and 5-4b illustrate. Sufficient data were available to disaggregate to this degree, but such disaggregation introduced new challenges in estimating transportation sector growth.

5.2.4 Agriculture

The agricultural sector is owned and operated by private producers. Within the agricultural sector, we have also chosen to include the forestry, fishing, cattle breeding, and other agrarian industries. Initial surveys within the agricultural sector were conducted to estimate the growth rate in usable energy demand.

After the initial surveys, a more careful examination indicated that it would be necessary to disaggregate the sector into artificially irrigated lands and non-irrigated ones. The former would correspond to arid and semiarid regions, which would be brought into agricultural production or cattle production by explicit land reclamation policies. Assessments were made as to the relative intensity of fertilizer application in both irrigated and non-irrigated lands.

Sufficient data were available within Argentina to make this level of disaggregation for most areas. However, regional estimates of yields on arid and semiarid acreage had to be estimated subjectively. Figures 5-5a and 5-5b summarize the agricultural sector.

5.2.5. Non-Substitutables

The procedure used to estimate non-substitutable energy demand was less satisfactory than in the other sectors due primarily to the heterogeneity of non-substitutable

Figure 5-4a

TRANSPORTATION SECTOR

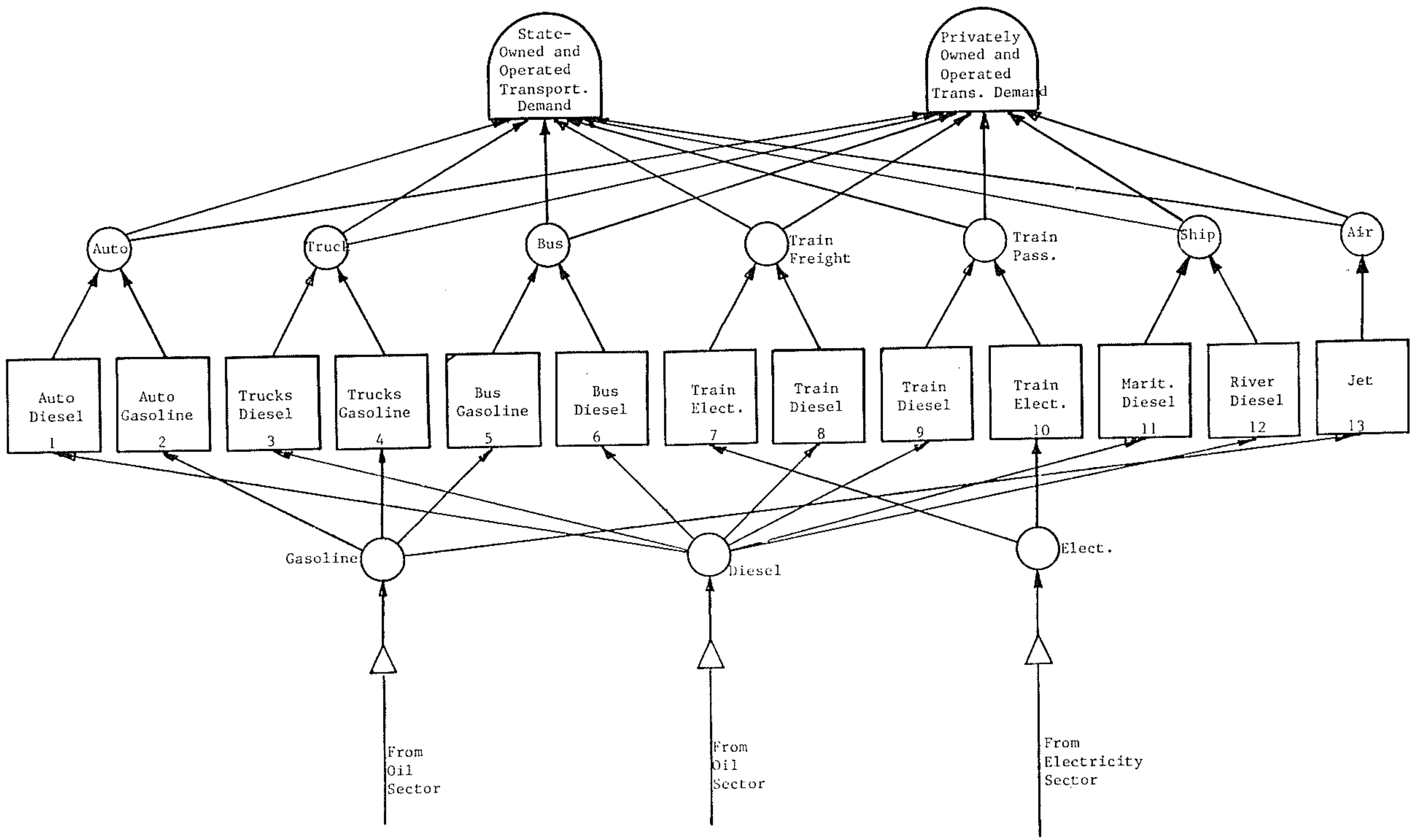


Figure 5-4b

TRANSPORTATION SECTOR (ONLY PRIVATELY OWNED AND OPERATED)

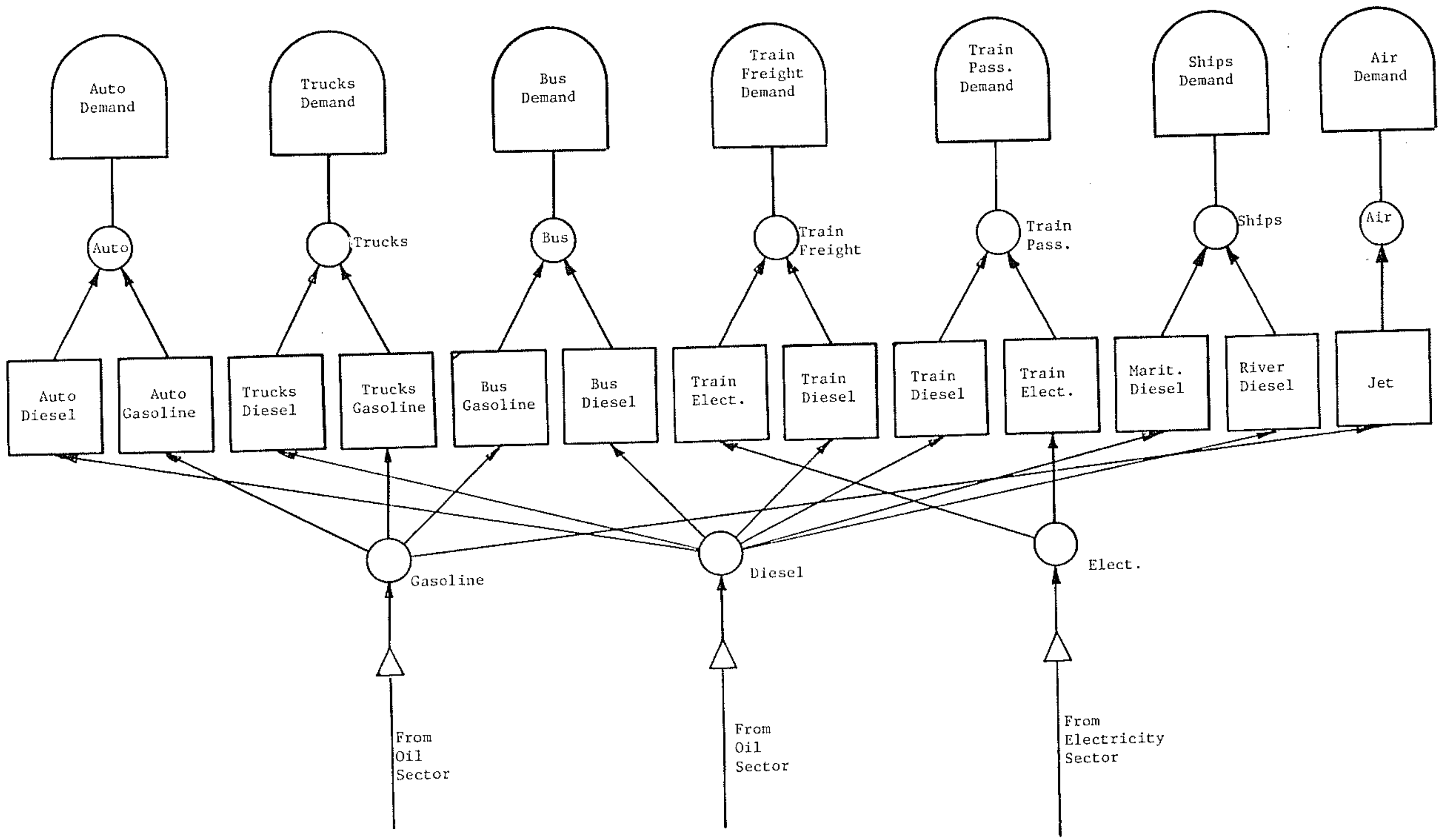


Figure 5-5a

AGRICULTURE SECTOR

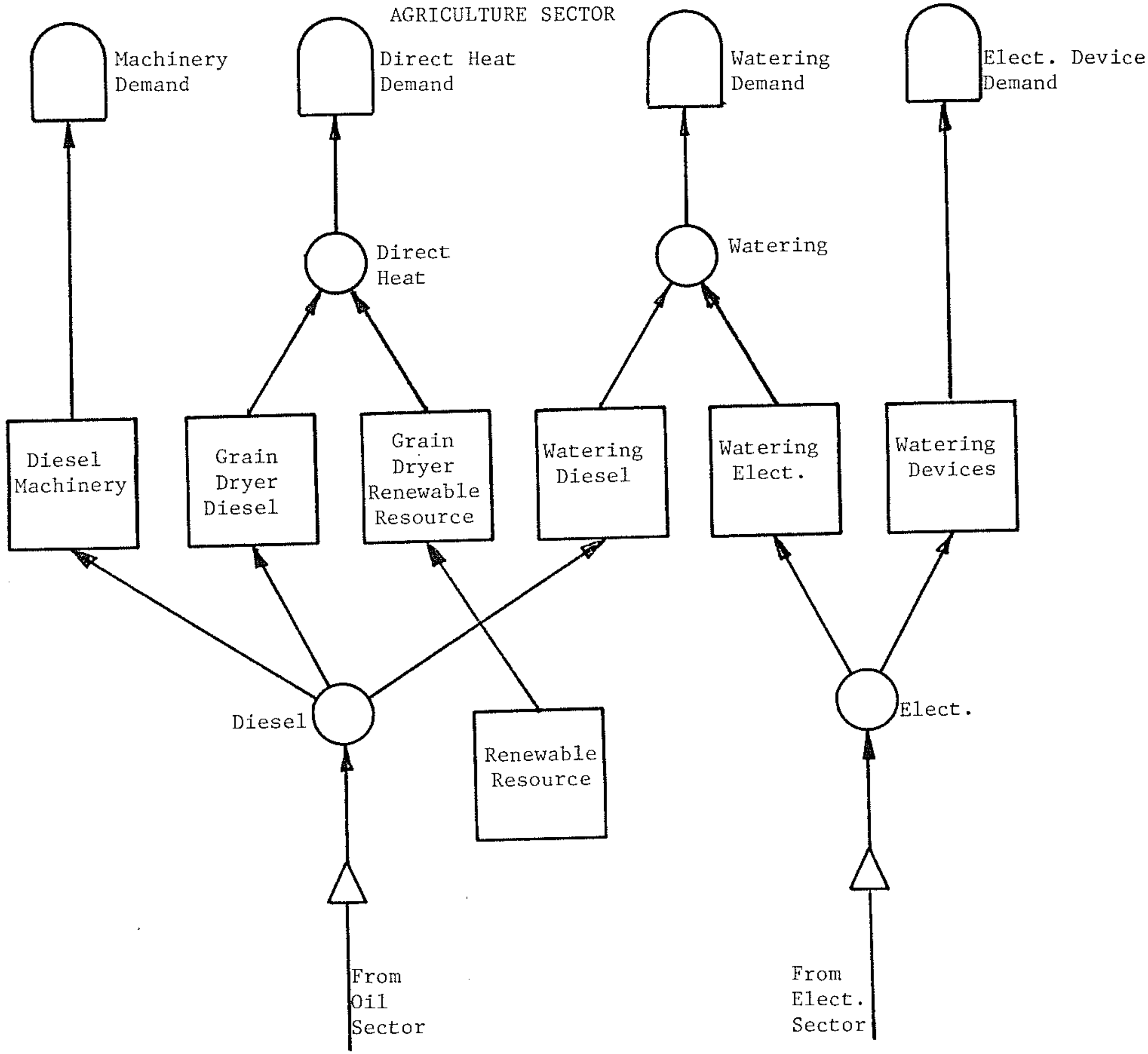
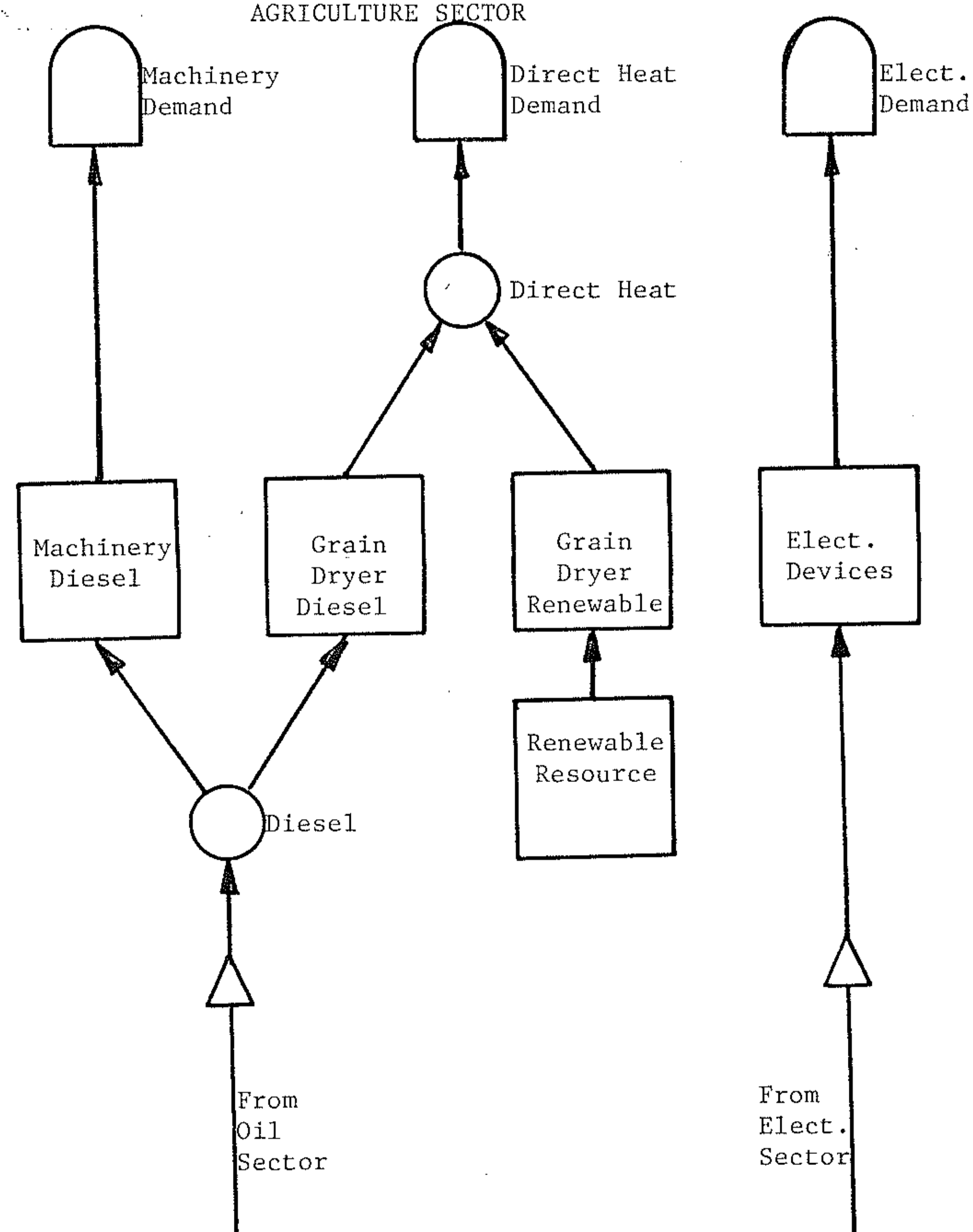


Figure 5-5b

AGRICULTURE SECTOR



demand. For example, self-generated electricity, lubricants, petrochemical feedstocks, and exports are quite different; yet, they were grouped together for this analysis. In spite of the relative crudeness of the approximation, the projections (made subjectively by category and then added) were sufficiently good to conduct the analysis. However, future efforts will require distinctions between the major non-substitutables: feedstocks and self-generated electricity.

Imports and exports are modeled as non-substitutables. In addition, maximum levels of each are estimated to simulate policy decisions on the part of the government and/or infrastructural limitations. Such estimates, while difficult, are deemed relatively easy to make.

5.3 END-USE DEMAND BY SECTORS

Within each end-use sector, there exists a relatively complex network that represents the competing technologies for each end-use. Competition among these technologies depends on the particular end-use being served. For example, if different temperature ranges must be distinguished, then explicitly different end uses (one for each temperature range) must be incorporated into the network. As represented in the network, there was no distinction by temperature range. The technology penetration results are subject to the approximation implicit in this lack of distinction among temperature ranges. We should point out that to distinguish among temperature ranges requires cost and performance estimates for each competing technology in each temperature range. Such data was not sufficiently available to warrant such disaggregation.

A second area of concern was the price sensitivity of technology selection among competing technologies. The GEMS allows the user to input parameters to reflect a range of price sensitivities; however, such parameters have to be estimated either econometrically or subjectively. Lacking time to do either, we accepted values extrapolated from United States and other experience.

In summary, the Argentine experience indicated the following directions for further work in the end use sectors:

- more detailed disaggregation of end-use markets and devices, and
- more detailed examination of the sensitivity of end-use technology selection to relative prices.

The bottom row depicts some renewable sources determined to be non-competitive during the analysis (e.g., solar, biomass) and a few energy conversion conversion systems based on those sources (e.g., industrial feedwater heat boilers, agricultural crop dryers, small-scale hydroelectric turbines).

In reality, the economic attractiveness of these types of sources tends to be highly region- and site-specific. However, the analysis was fairly aggregate; indeed, it was a country-level analysis. Even though these region- and site-specific fuels and technologies might not be economic on a national aggregate basis, it is likely that they are competitive in particular regions for particular applications. To determine such competitiveness would require a detailed regional model, which was not possible to build during the assessment. The results are, therefore, a result of the approximate nature in which region- and site-specific technologies were represented.

Notwithstanding these approximations, solar and biomass technologies did not penetrate for economic reasons:

- subsidized natural gas and electricity prices all over the country render solar and biomass technologies noncompetitive, and
- solar and biomass technologies require imports of modern technologies from abroad.

Both subsidies and imports are matters of significant public policy concern.

To investigate the degree of error implicit in the solar and biomass approximations, two sensitivity analyses were run to examine cases significantly different from the reference case. The first case assumed a 25 percent capital cost subsidy for all advanced technologies with unlimited restriction to implement these technologies (if economic) within Argentina. The second case, more extreme than the first, assumed a 50 percent capital cost subsidy for all advanced technologies with unlimited import restrictions. To different degrees, both sensitivity cases resulted in increased penetration of solar and biomass technologies. Particularly the latter case would induce profound changes in the overall energy-economy structure.

After examining the penetrations in the 25 and 50 percent subsidy cases, we examined in more detail whether these cases could indeed occur given the particular set of institutions within Argentine. The answer was probably no. We discovered that there is a reluctance on the part of the government to subsidize non-conventional resources because such resources (e.g., ethanol from sugar cane, wind-mills, solar devices) tend to be owned and operated by private entrepreneurs, in contrast to conventional fossil fuels, which are owned by the government. In practice, the government would prefer to subsidize its own activities rather than those of the private sector. Furthermore, the degree of subsidy necessary to achieve the indicated level of penetration would be prohibitively expensive.

5.3.1 Hydroelectric Generation

In practice, hydroelectric facilities are somewhat different from other electric generation facilities--they are 100 percent capital cost and virtually 0 percent variable cost. Furthermore, the number of sites where such facilities can be built is known, making it easy to forecast the maximum possible hydro potential. However, once built, hydro facilities have the lowest operating cost of all generation facilities in the country and therefore should be run to the maximum possible extent before any other facilities are dispatched. Therefore, it was appropriate to assume (as we did) that

- hydro sites are limited and currently known
- hydro facilities will never be shut down as a result of price changes, and they will operate over their entire lifetime.

Knowing the planned expansion strategy in the NEP (National Electric Plan), it was easy to project the quantity of hydroelectricity that will be generated over the model horizon, particularly in the near to intermediate term. This projection was imposed as a constraint on the model solution, and different levels of constraint were analyzed to reflect different feasible hydroelectric development plans.

In view of the extreme importance of hydroelectricity in the Argentine energy system, this approximate method is in need of improvement: Argentine policy makers want to know the optimal allocation of resources among hydro, fossil fuel, and other electric generation facilities. To accomplish this end, the electric sector of the model should be improved to:

- explicitly represent each existing and potential future hydroelectric site, complete with its economic, construction, and financing characteristics. This should replace the aggregate representation of total hydro capacity over time.
- explicitly account for every hydroelectric facility either currently in operation or currently under construction, where under construction means that significant capital expenditures have already been made. This sets the minimum committed level of hydroelectricity. The difference between this amount of generation and total electric demand must, in principle, be split among current and future fossil plants and future hydro plants.

- calculate for each generation alternative the true, cost-based price of generation from that alternative. This will serve as a reference price to determine if any implicit or explicit subsidy is being paid to any generation technology.

  - If the cost-based price of a particular hydro project is lower than competing generation alternatives, that hydro project should be pursued.

  - If the cost-based price of a particular hydro project is higher than competing generation alternatives, that hydro project should be deferred or cancelled in favor of a lower cost competing project.

To make the necessary hydro calculations requires a significant quantity of new data but minimal changes in model logic.

We should point out that hydroelectric facilities are very region- and site-specific. Thus the enhanced hydro module and data should ultimately be applied at the regional level, comparing generation alternatives for that region. These comparisons must of course reflect regional economic considerations as well as the national and international environment in terms of fuel prices and technologies available.

5.4 DEPLETABLE RESOURCES

This section attempts to reconcile the standard economic theory of depletable resources (which is based on producer profit maximization or government utility maximization) with the situation as we see it in Argentina (which we conjecture is representative of a broad range of semisocialized countries). In particular, the standard economic theory tells us that the utility-maximizing (i.e., welfare-maximizing) resource exploitation schedule is such that the resources should be sold within the economy at a price higher than production cost. If fact, they should be sold within the economy at world prices. Yet, in Argentina (and we suspect in most semisocialized economies), domestic resource prices are set well below world prices to *insulate* consumers from such prices. It is our general observation that domestic resources are sold at (or sometimes below) production cost. This observation suggests that governments in semisocialized economies do not behave according to the traditional economic model and they therefore do not maximize economic welfare. We will suggest that a more accurate representation of observed behavior is that such governments sell the resource at cost and thereby over-consume domestic resources relative to imports.

At the beginning of the assessment, it was assumed for convenience that the traditional economic model of depletable resource production applied directly in Argentina. Having observed the resulting resource prices, which were equal to world prices and which were much higher than would be expected under anticipated government pricing policy, we were obliged to reinvestigate the question of depletable resource production and pricing.

Fortunately, to simulate the situation in which the government produces and sells depletable primary resources at cost, a trivial change was required in the depletable resource module. The traditional theory computes an *intertemporal opportunity cost* of primary resource production based on a discount rate, which represents the cost of capital in the economy. If one simply sets this discount rate to infinity, the resource module will simply price the resource at cost--there is no intertemporal opportunity cost. Rather than running two cases--one with and one without intertemporal opportunity cost (i.e., economic rent)--we instead ran a range of cases. That is, we ran a range of discount rates to simulate a range of intertemporal opportunity costs. Our reasons for running multiple cases were two: (1) to stimulate rethinking among policy makers regarding socially optimal resource prices and (2) to investigate the sensitivity of resource prices and production rates to the social discount rate assumed. It is our observation that the social discount rate used should be at least as large as the interest rate on external debt; otherwise, there is the danger that debt for resource projects might not be serviced.

When discount rates are low and the full opportunity cost is included in the price, the domestic resource is produced much more slowly. That is, domestic resources are *conserved* in favor of imports if full intertemporal opportunity costs are included in domestic prices. Keeping in mind that this is the economically optimal solution, we notice that it is in direct conflict with social policy that imported oil should be minimized or eliminated.

Given the chronic situation in industrializing semisocialized economies that external debt is large, we now ask what the pricing policy of selling primary resources at cost (without economic rent) will imply for aggregate domestic investment. The answer is that it will *increase* domestic investment (because more domestic resources will be sold) and correspondingly *decrease* imports. That is, domestic investment will be higher than it would otherwise be.

Consider, however, the socially optimal pricing policy that includes economic rent in domestic resource prices. In this case, domestic resources (and therefore domestic investment) are slowed and imports are accelerated. However, more significantly, domestic prices are higher and total oil consumption is reduced. That is, price-induced conservation is imposed on the economy.

The tradeoff, therefore, is between external debt and oil imports. Which is preferred is a matter of public policy. As the reader is no doubt aware, such issues are matters of great debate in semisocialized countries.

We will offer a brief comment on conversion processes such as refineries, gas separators, coal washing, etc. Our empirical observation is that when government owns and operates such facilities, if acts so as to minimize capital investment subject to the constraint of meeting the prices mandated by fiat for the economy. (This is quite different than the standard, free market, microeconomic assumption of a profit maximizing producer.) It also gives attention to maintaining positive cash flow. It is straightforward to implement such a behavioral rule in GEMS (rather than pure profit maximization), but it has not as yet been accomplished.

5.5 IMPORTS

The supply of imports to the Argentine economy has been represented as elastic at an exogenously given price. Having computed equilibrium in the Argentine economy under this assumption, we have then calculated the *import bill,* which is the price times the quantity of imports. Differences in the import bill across scenarios quantifies the *economic drag* on the economy caused by the need to pay for imported energy. Comparisons across scenarios indicate the cost borne in terms of increases (or decreases) in imported energy bill as a result of a particular public policy.

5.6 CHARACTERIZATION OF CONVERSION PROCESSES IN THE ECONOMY

In the GEMS system, conversion processes are characterized by their cost and performance characteristics including

- representative plant size
- capital cost of representative plant
- annual output of representative plant
- annual operating and maintenance cost of representative plant
- thermal efficiency of representative plant
- first year of commercial availability of each technology
- planning lead time

- capital spending lead time
- technological change (learning curve) parameters
- useful life of representative plant

One of the most difficult problems faced in the Argentine assessment was the realization that large plants such as would be constructed in industrialized countries such as the United States would probably not be constructed in Argentina. Their sheer size would *swamp* the economic system. It would be more likely that smaller increments of capacity would be added in Argentina, even if on a per unit basis smaller increments were more expensive. This is particularly true during the initial years of economic development.

Recognizing that smaller representative plant sizes were probably more appropriate for Argentina, we were then faced with the question: Could we reasonably extrapolate cost and performance estimates from the United States to the Argentine situation? In particular, for the smaller plants that were likely to be built in Argentina, is the specific capital cost (defined as the capital cost divided by the annual output from a representative sized plant) the same as for a large plant built in the United States? If not, how could the United States numbers be extrapolated? The answer was not completely satisfying. Indeed, the smaller plants likely to be built in Argentina tended to have a higher specific capital cost because they will have fewer economies of scale. However, there is a paucity of published data on smaller plant sizes, either in Argentina or in the world literature. This paucity is, we feel, a significant detriment to effective planning in developing and industrializing countries. We hasten to point out, however, that this paucity of small plant data is not a problem with the GEMS--it is a data problem that plagues all analytical approaches.

The comments made previously regarding capital cost apply equally to the other parameters that characterize conversion technologies: operating and maintenance costs, thermal efficiencies, and lead times.

We should make several special points regarding planning lead times and capital spending lead times. These times are invariably long in semisocialized economies for the simple reason that time is not such a pressing factor for government as it would be for a private company that must pay the full financing cost--debt and return on equity--during the entire construction period. A significant exception to this general rule would be the purchase of standardized or prefabricated plants or components, where the only construction task is field assembly. Such plants would have about the same lead time whether built by government or industry. If the full financing costs during construction are recovered in the revenue stream from a plant, it is clear that longer lead times will require higher revenue streams, i.e., higher prices.

Offsetting the argument that lead times will be longer in semisocialized economies is the previous argument that smaller economies will build smaller plants. It is generally true that smaller plants will have slightly shorter lead times.

The paucity of technical data applies to lead times just as it applies to costs. In the absence of detailed studies regarding lead times or detailed published information in the world literature, we were obliged for the early applications to adopt lead time estimates from experience in free-market industrialized economies. Recognizing that this is at best a very gross approximation, we have begun to study the lead time question in our own economy in more detail. In particular, we are attempting to analyze why our large hydroelectric projects and our offshore exploration and development projects have had such long lead times relative to industrialized countries. Again, this paucity of information is not specific to the GEMS approach; it is simply a data problem that would plague any analytical effort.

Related to the size and lead time questions is the question of what is the useful operating life of a plant once built? Analysts in all countries uniformly observe that plants last much longer than the estimate of plant life that was made when the plant was built. The problem of properly estimating plant lives is, like the other problems discussed here, problematic in all economies--free market, semisocialized, and centrally planned.

It is known that the 100th plant of a particular type is invariably cheaper to build and operate (in real terms) than the first plant of that type. That is, there is *evolutionary* technological change as experience is gained with a particular technology. In industrialized countries, we conjecture that such experience is probably lower in magnitude than it is in developing or industrializing countries. The reason is that developing countries typically have less prior knowledge or experience and thus stand to learn relatively more as time goes on. In spite of this argument that experience might be a bigger factor in developing countries, the total dearth of data obliged us to simply accept learning estimates from industrialized countries. It is clear that basic research and data are needed to even crudely characterize learning and experience in developing economies.

The GEMS process modules contain a representation of industry finance and taxation that includes a number of *generic* taxes (e.g., income taxes, property taxes as a percent of asset value, various tax credits, Btu taxes) and that distinguishes debt financing from equity financing. These modules were found to apply relatively well to the private sector of the Argentine economy, and appropriate parameter values could be estimated. We should point out, however, that at the very high and dramatically varying inflation rates that have recently characterized the Argentine economy, these generic tax rules gave counterintuitive (but probably correct) results for private industries. In particular, the extremely high inflation rates in Argentina have, we conjecture, induced industry to use extremely high discount rates on equity (often called corporate hurdle rates) to hedge themselves against the uncertainties in the inflation rate.

With regard to state owned and operated companies, it is interesting to note that debt is in effect *guaranteed* by the government. This allows such companies to operate at extremely high debt-equity ratios, borrowing virtually all their capital requirements on world debt markets. (This is not unusual for government owned enterprises even in free-market economies. The Tennessee Valley Authority in the United States has an extremely high proportion of debt because it is guaranteed by the U.S. government. By contrast, privately held companies in the U.S. such as oil companies typically operate at 20 percent debt and 80 percent equity.) In Argentina, debt-equity ratios typically occur in the range of 90 to 10, reflecting an extremely high degree of implicit subsidy of debt by government debt guarantees. This is an implicit subsidy in the sense that a private company pursuing an identical project would not be able to borrow more than say 20 to 50 percent of the construction funds simply because the market would make any additional debt financing prohibitively expensive or in fact unavailable.

To represent the difference in financial structure between government and private industries, we require two modules--a government module and a private module. We found that we could use the same calculation method for each but with different parameter settings to reflect each type of financing.

A parameter that is of more importance in developing countries than it is in industrialized countries is the initial age distribution of capital stocks in place. How many hydro facilities and of what ages are there in Argentina? How many oil boilers and of what ages are there in Argentina? This historical data (which we found to be readily available) is an important part of the initial situation in Argentina because it affects the economically optimal construction strategy for the first ten or twenty years of the model horizon: the number and type of plants built in the near to intermediate term will depend on the capital stock in place today. We emphasize, however, that the importance of the initial capital stocks diminishes steadily over time as those stocks wear out and are replaced. The GEMS model reflects this capital stock turnover quite nicely.

5.6.1 Primary Resources

We have discussed previously in this section our observations regarding primary resource production in semisocialized economies and how changes in parameter inputs (the discount rate) allow the current logic to reflect current decision making practice in the country. In this section, we discuss more fundamental issues such as the extent and distribution of the domestic resource base.

In Argentina, just as in every resource-producing country, the following types of questions are fundamental to public policy analysis in the energy sector:

- How much oil is in the ground?
- Where is it located?
- At what cost can it be extracted?
- How fast can it be produced?

Such questions must be answered not only for oil but also for gas, coal, uranium, renewables, and in fact all potentially economic primary resources in the country.

The GEMS provides a particularly convenient format for quantifying such estimates. The GEMS requires a long run supply curve for each resource in each region, this supply curve characterizing simultaneously the extent of the resource deposit and its cost of production. Such information is crucial to public policy making, which is designed in large part to determine the best domestic extraction rate in terms of economic growth, investment requirements, etc. Although such data is difficult and expensive to assemble, it is nonetheless sufficiently fundamental that it cannot be shortcut. And the GEMS provides motivation to do the job correctly.

5.6.2 Price-Sensitivity of Market Shares

How sensitive are market shares to the relative prices of the competing alternatives? For example, if gas furnaces can produce heat at a cost 1 percent below oil furnaces, how many people will choose gas? If gas furnaces can produce heat at a cost 10 percent below oil, how many people will choose gas? What about 50 percent below?

Such questions are difficult to answer in semisocialized economies because of the degree of influence of the government in setting relative prices and in controlling the degree of private response to those relative prices. For example, the government might ban altogether the use of electric furnaces for social policy reasons. In such a situation, even if electrically-produced heat had a lower cost, consumers would not choose it no matter what the relative prices.

Lacking sufficient data for the Argentine situation, we were obliged to use price sensitivity estimates (which are input directly to the GEMS) extrapolated from industrialized countries. Sensitivity analysis to these price sensitivity parameters quickly convinced us that significant, Argentine-specific work was required. DFI has developed a number of methods to estimate these parameters. The first (and simplest) is direct subjective estimation by experts familiar with each market in the country. The second (and probably more satisfying) is an econometric method based on price-quantity time series in each market in the country. We hope to pursue the latter method in the future, but the former method is perceived to be better than mere extrapolation from the United States and other industrialized countries.

5.7 PRICE REGULATIONS

We have mentioned repeatedly that semisocialized economies are often characterized by rigid price controls throughout the economy. The GEMS allows ceiling price regulations to be imposed on any fuel in the economy. The resulting solution can be used to explicitly quantify the degree of subsidy (i.e., the degree of economic inefficiency) caused by such price regulations. In particular, it is often argued by policymakers that *prices must be kept low to encourage full utilization.* However, our results have shown that such low prices induce overconsumption and therefore induce a very high degree of required investment. We emphasize that *too much* is not necessarily better than *too little* investment.

Chapter 6

EXPANSION OF THE GEMS TO SOLVE ENERGY-ECONOMIC PLANNING PROBLEMS IN SEMISOCIALIZED ECONOMIES

This concluding section offers a summary description of the problems identified in applying the GEMS to semisocialized economies related not to input data or to network structure. Specifically, this section describes in some detail the particular issues in semisocialized economies that require structural changes in the calculation methods in the GEMS. Again we caution the reader that this section is not intended as an indictment of the GEMS; indeed, we feel GEMS is the best available tool by far. Rather, this section offers specific, concrete suggestions as to how the already good GEMS approach can be made even better for semisocialized economies. Our intent is to communicate at a fundamental level desirable changes in the GEMS to allow it to better represent the nuances of semisocialized economies.

The GEMS model can be profitably used in its current state, comparing many different scenarios to infer policy decisions. In particular, the GEMS allows policy makers to determine explicit quantitative values to particular public policies, i.e., how much would a particular public policy cost in economic terms?

This concluding chapter provides a summary of a large number of desired changes in the GEMS. These suggested changes are intended as a blueprint to analysts, policy makers, funding agencies, and all other parties to public policy analysis in semisocialized economies. We have attempted to specify the location of the suggested changes in the GEMS as specifically as possible: by sector, type of variable or parameter, optimization function, etc. We also offer several new modeling concepts to measure key phenomena such as overall social benefit, welfare, cash-flow, and so forth.

Because we suspect most readers are familiar with free-market economics, we will make liberal comparisons and contrasts with the standard free-market economic model.

6.1 CHANGES ARE DRIVEN BY PROBLEM CONFIGURATION

Tables 5-1 to 5-3 in Chapter 5 summarized specific requirements for the GEMS in order that it apply correctly in a semisocialized economy. We reemphasize that these needs result entirely from the fact that semisocialized economies are distinct in many ways from free-market economies in industrialized countries. When the GEMS logic, which was purposely created to represent the free market situation, was applied to the semisocialized economy in Argentina, many limitations became apparent. Some of these limitations were eliminated by data or network modifications. While not necessarily simple, such modifications are not the subject of this section. The subject of this section is those modules of GEMS that have been changed or should be changed in the future to better represent the situation in semisocialized economies.

Again we emphasize that the reader will get the most out of this section if he becomes familiar with the basics of the GEMS. We encourage the reader to obtain and read the basic GEMS documentation referenced in Chapter 4.

Tables 6-1 to 6-5 summarize the list of issues that we felt required modifications in the model logic in order to more accurately represent the situation in semisocialized economies such as Argentina. We have also proposed in the tables as specifically as possible tentative solutions to the problems posed. We view these problem statements and tentative solutions as fruitful directions for further research, and they are directed at decision makers who might fund them as well as technologists who might implement them.

6.2 SPECIFIC PROPOSITIONS TO ADAPT GEMS LOGIC TO SEMISOCIALIZED ECONOMIES

Table 6-5 summarizes the ideas that will be elaborated in this section. Column (1) characterizes the perceived degree of importance of each issue as it affects policy making in a semisocialized economy. In assessing the importance of each issue, we have attempted to consider to what extent the particular public policy issue is *believed* or *felt* by the citizenry, i.e., how strong is its *popular acceptance* by the populace. In short, how much a part of the institutional fabric of Argentina is each issue?. Column (2) details the corresponding public policy in the semisocialized environment that lies behind the problem configuration. We emphasize that similar government policy actions can have distinctly different effects in semisocialized and free-market economies. Because the frame of reference of many readers and many approaches is the free-market, we have found it convenient to explain in column (4) how the given policy issue might affect a free-market economy. This allows a cross-check with the recommended model modifications in column (3) for a semisocialized economy.

Table 6-1

LACK OF DATA AND ERRONEOUS PROBLEM CONFIGURATION

Propositions made to solve their consequences and degree of importance

1 CALCULATION PERFORMED	2 WHERE?	3 TYPE OF INFORMATION NOT AVAILABLE	4 CONSEQUENCE BROUGHT BY (3)	5 PROPOSITION MADE TO SOLVE (4)	6 CONVENIENCE AND RESPONSIBILITY OF (5)	7 DEGREE OF IMPORTANCE OF (6) FOR SEMI- SOCIALIZED ECONOMIES
Aggregated final demand.	Overall demand by sectors	1.- short, mid and long-term price elasticities for the overall economy 2.- idem, for each individual economic sector.	1.- each sector will keep its base year share on total energy consumption. 2.- sectoral consumption will not vary in time in accordance to prices. It will use fixed amounts exogenously fed per working period, 3.- final effects of pricing policies will not be observed	1.- investigate price elasticities in detail at overall and end-use demand levels, 2.- calculate demand applying price to quantity relationships	1.- it's not advised because semi-socialized economic markets do not entirely respond to prices. If done, it will be used for comparison purposes. 2.- it's an analyst's work	1.- Not too important since nobody expects, in semi-socialized countries, any fair response to prices.
Sectoral demand	idem, R/C/P	1.- sectoral $\Delta E/\Delta$pop. relationships. 2.- idem, for each sub-sector	1.- it doesn't allow to measure the influence of welfare and economic growth on living standards separating it from public growth. 2.- it's not possible to evaluate housing programs.	1.- draw a different sectoral network separating residential, commercial and public 2.- investigate the distinctive R/C/P E/ pop relationships and apply than to 1 3.- If not obtained use R/C/P to GDP. 4.- investigate a new Res/pop function related to welfare and living standards*	1.- very convenient, easily performed by analyst 2.- the new function could be performed by either the analyst or any other institution. Translog equations and adaptation to logics by logics makers	1.- It's most important for public policy guidance and social affair analyses.
	idem, industry, mining	idem	1.- idem 2.- doesn't allow to represent the impact of population growth on private and public industrial demand 3.- industrial activities can't be grouped by temperature range 4.- it's not possible to visualize the impact of the mining sector by itself	1.- draw different sectoral networks based on: 1.1.- dynamism of economic groups (veget., semi-veg, and dyn.) 1.2.- public and private sectors 1.3.- temperature ranges 2.- investigate their E/Pop. relationships, 3.- if not obtained, use E/GDP 4.- investigate a new function for E/Pop introducing welfare and economic growth for the private group of 1.2-3.- 5.- if found, replace it in 3	1.- very necessary because allows comparisons with E/GDP growth 2.- to be performed by analyst's, institutions or logic makers. Translog equations and adaptations to logics by logics-makers	1.- idem
	idem, agriculture	1.- $\Delta E/\Delta GDP$ for arid and semi-arid regions where irrigation and fertilizers will be a determinant for more production 2.- Difficulties in distinguishing both due to different investment levels generally made by the public sector.	1.- it's not possible to measure the influence of irrigation, fertilizers and public works 2.- doesn't allow to visualize the impact of public policies on long-term planning for the extension of the agricultural frontier.	1.- draw a network where arid and semi-arid regions are a sub-sector 2.- find the adequate E/GDP relationships 3.- investigate a new function of E/GDP for arid, semi-arid regions based on public investment levels	1.- convenient, some times imperative for agriculturally-based countries 2.- it should be made by analyst and logics makers	1.- very high
	idem, transpor-	1.- E/ GDP for public and private sectors.	1.- it's not possible to evaluate the impact of public and private investments 2.- doesn't allow to control the effects of pricing policies on the short and mid-terms	1.- draw the corresponding network dividing public and private. 2.- find the necessary E/GDP relationships 3.- run the model under different pricing assumptions	1.- very convenient 2.- to be made by analysts	1.- very high

*5.- if found, replace it in 3

Table 6-1 (continued)

LACK OF DATA AND ERRONEOUS PROBLEM CONFIGURATION

Propositions made to solve their consequences and degree of importance

1	2	3	4	5	6	7
CALCULATION PERFORMED	WHERE?	TYPE OF INFORMATION NOT AVAILABLE	CONSEQUENCE BROUGHT BY (3)	PROPOSITION MADE TO SOLVE (4)	CONVENIENCE AND RESPONSIBILITY OF (5)	DEGREE OF IMPORTANCE OF (6) FOR SEMI-SOCIALIZED ECONOMIES
Sectoral demand Demand	idem, non-sustitutable fuels	1.- $\Delta E/\Delta GDP$ for 1.1.- petrochemical feedstocks 1.2.- lubricants 1.3.- self-generated electricity	1.- doesn't allow to evaluate the petrochemical sector by itself, 2.- it's not possible to visualize the prospective growth of self-generated electricity if line supplies fail to grow, 3.- doesn't represent the effects of different petrochemical pricing policies and hydroelectrical scenarios	1.- draw a network separating feedstocks and self generated electricity from the rest 2.- find their E/GDP relationships 3.- run the model under different pricing policies for feedstocks and selected hydroelectric scenarios	1.- idem	1.- utmost importance for highly industrialized countries
Conversion of fuels	all sectors of final demand	1.- data on industrial processes by temperature ranges 2.- many new future devices	1.- restricted number of possibilities for substitutions 2.- limited introduction of new technologies	1.- same as items 1; 1.3 before 2.- use foreign data	1.- it's possible but takes too long 2.- analyst's work	1.- average, for energy planning 2.- high, for development planning
Unconventional resources	idem	1.- new possible technologies	1.- idem	1.- use foreign data	1.- idem	1.- low
Price and quantity of imports	importation	1.- benefits not computed	1.- oil prices off-set 2.- effects of public policies on the oil sector not clearly perceived	1.- use the present GEMS logics	1.- possible and fast 2.- analyst's work	1.- high

Table 6-2

DIFFERENCES WITH THE LOGICS

Propositions made on their consequences. Relative degree of importance

1	2	3	4
CALCULATIONS PERFORMED	WHERE?	IS THE NEEDED LOGICS AVAILABLE ?	CONSEQUENCES BROUGHT BY AN INADEQUATE LOGICS
Hydro-resources	Electric sector	- no	1.- not possible to include real hydro-projects in accordance with plans, therefore: 2.- impact of public policies not shown 3.- errors in substitutions 4.- subsidies paid by the economy not shown 5.- possibilities of incorporating hydro on a competitive basis not feasible
Depletable resource price	all sectors	- no	1.- the true price of depletable resources will never be found since "scarcity rent" is not included and will seldom be, 2.- public policies call for "overall benefits" and that is not shown here, as well as a "minimum investment" scenario, 3.- the price presently computed is a theretical one thus distorting future investment allocations, 4.- no comparisons made with world oil prices
Resource conversion	oil, natural gas, coal	- no	1.- public criterion on the "optimization function" is based on overall benefits for the entire economy 2.- "minimum cost" approach not important 3.- the private sector follows "minimum cost"

5	6	7
PROPOSITIONS MADE TO SOLVE (4)	CONVENIENCE AND RESPONS BILITY OF (5)	DEGREE OF IMPORTANCE OF (6)
1.- a separate sub-sector should be drawn, including a few real works with their planning times, financial charges, economic values, etc. These works are the ones that will surely be built. Its price could be calculated from p_f= SCC.c + VOC , assuming an efficiency of 1 for the process. 2.- a "theoretical hydro "module for the country, but a"true one" for the world, should be added to compete with other available electric sources, 3.- a "true price" should be computed for all those included in (2), but quantities from (1) will be incorporated as usual. New additions of "theoretical modules" will come on line if their price is competitive.	1.- the analysts could easily draw the network adding the data 2.- to be made by logics makers, institutions, etc. 3.- idem	- the utmost for energy, regional and development planning
1.- a new optimization function should be advised based on "maximum benefits" 2.- "maximum benefit" could be defined in a semi-socialized economy as the minimum investment with the minimum possible +"cash-flow" (scarcity rent=0) 3.- a price should be computed for the above mentioned function 4.- a comparison should be made between this price and that one obtained by applying the present logics,relating the world oil trends to the domestic situation	1,2,3 to be done by logics makers 4.- it's the analyst's work	- the utmost for energy, regional and planning development
1.- idem	1.- to be performed by logics makers 2.- the private sector could work under the present conditions	- idem

Table 6-3

- PARAMETERS LACK OF DATA AND ERRONEOUS PROBLEM CONFIGURATION

Propositions made to solve their consequences and degree of importance

1	2	3	4	5	6	7
PARAMETERS	IN WHICH PROCESS?	TYPE OF INFORMATION NOT AVAILABLE	CONSEQUENCES BROUGHT BY (3)	PROPOSITION MADE TO SOLVE (4)	CONVENIENCE AND RESPONSIBILITY OF (5)	DEGREE OF IMPORTANCE OF (6) FOR SEMI-SOCIALIZED ECONOMIES
Specific Capital Cost (SCC) Labor fraction of SCC, (CLFR) Variable operation cost (VOC) Labor fraction of VOC (OLFR) Efficiency (EFF) Characteristic life (CLIFE) Aging parameter, (VOAGRT)	Conversion	1.- True representative capacities 2.- data on old plants exceeding their scheduled life-time	1.- The final values only show the modern and large plants 2.- The final values don't show the degree of obsolescence of the system 3.- The operating cost increases more than two times producing a negative cash-flow:	1.- Obtain better data from medium and small-size plants 2.- Mantain under operation existing non-competitive plants 3.- compensate resulting negative cash-flows as explained under processes 4.- allow the system to work under new conditions and old ones as well	1 and 2.- It's possible and the analyst's work 3.- strongly recommended, to be made by logics makers	- high
Planning lead time, (IPLTIM)	Conversion	1.- Length of planning lead times	1.- Public sector depicted as it is, but not the public one	1.- distinguish, when possible, into government and private modules	1.- it's convenient; analyst's work	- high
Year of availability (IYRAVL) Early avail. penalty (EARLY) Tech.limit on cap. (CLIM) Tech. limit on SCC (CRATE) Tech.limit on eff. (EFLIM) Tech.rate on VOC (VOCRAT) Tech. limit opening (PRELIM) Tech.limit prod. (POSTLM)	Conversion Resource	1.- Domestic technological developments are scarce and hard to predict when available	1 and 2.- It is difficult to know when the technologies will be adopted and their future learning curves	1 and 2.- Obtain more accurate data or use foreign values	1.- it's convenient, analyst's work	- not important
Tax life, (ITXLIF) Debt life (IDLIFE) Equity fraction (EQFR)	Conversion Resource	1.- Short times for returns on capital in the private sector 2.- State-owned concern borrow most of the capital required for new investments	1 and 2.- Higher prices than free-market economies	1 and 2.- Divide into two different modules: government and private	1 and 2.- it's convenient, it's analyst's work	- high

Table 6-3 (continued)

.- PARAMETERS LACK OF DATA AND ERRONEOUS PROBLEM CONFIGURATION

Propositions made to solve their consequences and degree of importance

1	2	3	4	5	6	7
PARAMETERS	IN WHICH PROCESS?	TYPE OF INFORMATION NOT AVAILABLE	CONSEQUENCES BROUGHT BY (3)	PROPOSITION MADE TO SOLVE (4)	CONVENIENCE AND RESPONSABILITY OF (5)	DEGREE OF IMPORTANCE OF (6) FOR SEMI-SOCIALIZED ECONOMIES
Initial capacity change rate(RATIM) New capacity flexibility (NEWFLEX) Spending lead time fraction (CFLDR)	conversion	1.- Capacity changes and new capacities projected	1.- Results offset	1.- Obtain better and more updated data	1.- it's convenient, analyst's work	- average
Deposit decline rate (DCLN) Half depletion VOC multiplier (HDCMLT) Full depletion cost multiplier (FDCMLT) Final to initial cost (TRMULT)	Resource	1.- deposit decline rates 2.- depletable effect on VOC	1.- Results offset	1.- Search for better data	1.- it's convenient, analyst's work	- high
Owner's discount rate (ROWN)	Resource	1.- Private and government estimations differ sharply because the optimization criteria are different	1.- none	1.- Induce state-owned companies to use different ROWN values	1.- it's convenient; to be made by logics makers	- high

Table 6-4

PARAMETERS DIFFERENCES WITH THE LOGICS

Propositions made on their consequences. Relative degree of importance

1	2	3	4	5	6	7
PARAMETERS	WHERE?	IS THE NEEDED LOGICS AVAILABLE ?	CONSEQUENCES BROUGHT BY AN INADEQUATE LOGICS	PROPOSITIONS MADE TO SOLVE (4)	CONVENIENCE AND RESPONSABILITY OF (5)	DEGREE OF IMPORTANCE OF (6)
VOC multiplier in capacity factor, (CFMULT) Capacity factor sensitivity (CFSEMS)	Conversion	- no	1.- Scale factors are not considered	1.- investigate a new equation for $\gamma = 2\ln(9)/\ln W$ as a function of the plant size	1.- it's convenient; to be made by logics makers	- low
Initial resource cost, (INRCST) Capital charge fraction (CCCF) Base price (BASEPR) New resource capital cost fraction (NCCF) Undiscovered reserves base, (UNRCRS) Undiscovered reserves 2xBase	Resource	- no	1 to 4 .- See Table II depletable resource pricing 5.- Do not consider non-economic facilities	1 to 4 .- See Table II depletable resource pricing 5.- Rework definitions including non-economic facilities and total possible reserves	1,2,3.- to be done by logic makers 4,5.- it's convenient, analyst's work	- very important for energy, regional and planning development - high
Share sensitivity parameter (SHSENS) Behavioral lag (BELAG)	Allocation	-no	1.- It does not represent future variations in market shares due to real salary increases and the introduction of newer technologies	1.- investigate the market share parameter as a function of real salaries, technological advancement, imports and savings, instead of prices	1.- it's convenient; to be done by logics makers	- high
Subsidies to consumers		- no	1.- There is a conceptual difference between "restriction to quantities" and "subsidies on prices" that is not present in the logics	1.- create new logics based on price subsidies substracted from final prices 2.- for the public sector replace their equivalent amount with funds taken from the "cash box" 3.- do not take any action on private concerns	- imperative;to be made by logics makers	- high

Table 6-5

SEMI-SOCIALIZED AND FREE-MARKET PUBLIC POLICIES ON ITEMS WHERE GEMS SHOULD BE MODIFIED

1	2	3	4
DEGREE OF IMPORTANCE FOR A S.S.E (SECTOR)	PUBLIC POLICY "DRIVING " THE PROBLEM CONFIGURATION (S.S.E)	PROPOSITIONS MADE ADAPTING GEMS TO INTERPRET (2)	EQUIVALENT PUBLIC/PRIVATE POLICY IN A FREE-MARKET ECONOMY
very high (R/C/P demand)	1.- living standards and social welfare should underlie public sector residential housing programs. The less the welfare, the more the need of housing programs. 2.- as an extension it could be applied to the overall economy	1.- distinguish the residential energy demand as a sub-sector 2.- investigate a new E/pop demand function, based on economic growth/welfare(real salaries, savings, assets,etc), parameters and apply 1, 3.- run sensitivity analyses for welfare components	1.- idem for governmental housing programs. The less the importance of these programs the more . . . . . private housing to be built, 2.- the overall economy demand responds to price incentives. The better the response, the higher the welfare.
very high (agriculture demand)	1.- public investments lie ahead of private penetration into arid and semiarid regions	1.- distinguish the agriculture sector into fertile and arid/ semiarid sub-sectors, 2.- investigate a new E/GDP demand function related to public investments levels and apply 1 3.- run sensitivity analyses for public investment components	1.- the private sector will take care of these investments
very high (industrial demand)	1.- the private industrial sector will grow if the governments action benefits overall welfare	1.- distinguish private industrial energy demand 2.- investigate a new demand E/GDP function for the private sub-sector modified 3.- run sensitivity analyses for welfare components	1.- not needed, the government is run by private sectors
low (overall demand and any sector)	1.- prices should be based on an "overall social benefit" criterion rather than "maximun benefit to producer"	1.- investigate price elasticities in detail al overall and end-use demand levels 2.- calculate demand by applying price to quantity relation - ships.	1.- the government should not interfere with private business
very high (hydroelectric supply sector)	1.- hydro-projects are an issue of political decision due to the investment and regional commitments involved. Price considerations are not the main reason	1.- distinguish as a "dummy" those main projects that have political and investment approval 2.- include as one more option a "theoretical module" to compete in prices with the different electric energy supply alternatives 3.- calculate the "shadow price" as usual including 2, 4.- develop a function to compute the "true price" from all those in 2	1.- hydro-projects should be selected on a competitive basis with any other available electric energy source
very high (nuclear supply sector)	1.- nuclear projects are a resultant of political, technological and national policy decisions. Price or supply considerations are not the main reason. (same as hydro)	1.- distinguish as a "dummy" the true commitments 2.- calculate an overall "shadow price" 3.- use GEMS as usual	1.- idem
very high (depletable resources, all supply sectors)	1.- "self-sufficiency" in domestic supplies, rather than "economic benefits" should be reached by all means, 2.- market prices should guarantee economic development, 3.- reserves should be kept in accordance to "national security standards" 4.- overall energy investments should be as low as possible	1.- a new optimization function should be devised based on minimum investments and national security reserves standards, thus avoiding "scarcity rents" assumptions. Cash-flows should be the maximum possible ones. 2.- the difference between a negative cash-flow and positive should be compensated by a "deposit box" thus restoring the equilibrium of the system 3.- a new price should be computed from 1 4.- a permanent comparison should be run between the above mentioned price and that computed from the present logics, to show magnitudes of subsidies and departures from world oil prices	1.- prices should reflect "scarcity rents", be related to world oil levels and ensure positive cash-flows 2.- the overall economic systems should not loose to avoid inflation

Table 6-5 (continued)

1	2	3	4
DEGREE OF IMPORTANCE FOR S.S.E (SECTOR)	PUBLIC POLICY "DRIVING" THE PROBLEM CONFIGURATION (S.S.E)	PROPOSITIONS MADE ADAPTING GEMS TO INTERPRET (2)	EQUIVALENT PUBLIC/PRIVATE POLICY IN A FREE-MARKET ECONOMY
very high (resource conversion all secotrs)	1.- public sectors work under "Overall benefit" assumptions, thus "maximun benefit" is not so important 2.- private sectors follow "maximum benefit"	1-2-3 and 4.- idem	1.- the producer's maximum benefit should be guaranteed
very high conversion Parameters SCC, CLFR, VOC, OLFR, EFF, CLIFE, COAGRT	1.- those explained under d,e,f,g and h for the public sector, including employment level for social reasons 2.- not-needed employment, is better than overt unemployment	1.- distinguish public sector 2.- mantain under operation non-competitive capacities 3.- compensate resulting negative cash-flows as explained under processes 4.- allow GEMS to work under new and old conditions	1.- plants should be shut-off when VOC reaches two-times the initial values 2.-productivity is higher when operating costs are lower and plants competitive 3.- unemployment is compensated by means of social security
very high conversion parameters CFMULT, CFSENS	1.- idem	1.- determine a new equation for γ = 2ln9/lnW as a function of the true plant size	1.- plants should have an optimal production size to be competitive
very high resource parameted ROWN	1.- public concerns, because are part of the Central State, should not be charged any owner's rent 2.- this is not shared by the provinces that claim that in accordance to the Constitution and the Mining Law that natural resources belong to them, but are obliged to yield to the central government	1.- use the same existing equation asigning different values of ROWN to public concerns 2.- negative cash-flows should be deducted from the"cash-box"	1.- discount rates should be applied taking into consideration competitetiveness, financial needs and investment risks 2.- the surface owner has all the property rights, including subsurface. It's up to the leaser to make a agreement or not
high resource parameters INRCST, CCCF,BASEPR NCCF, UNRCRS, UCCF, 2xBase	1.- INRCST, CCF, BASPRF, NCCE same policies as depletable resources, all supply sectors(g) 2.- UNRCRS, 2xBase ultimate reserves are never referred to prices. The dominating concept is "maximun recoverable possibilities" expressed in quantities not mattering their economics	1.- same as (g) (3) 1 to 4. 2.- rework parameter definition to produce two-supply curves as follows: 2.1.- the present one , 2.2.- a second one where the tree points are: a) the marginal cost vs. quantities for it, b) the base price vs. proven reserves, where: base price= marg. cost + scarcity rent+ profit, c) base pricex 2 vs. total available resource 3.- the "loss" between the two curves should be recorded in the "cash-box" 4.- the model will work with curve 2.2 to be realistic	1.- same as (g) (4) 1.- 2.- reserves are only those amounts that could be recovered at a competitive price
high allocation parameter SHENS, BELAG	1.- the introduction of new technologies should be oriented in accordance to development plans, 2.- imports should fit those plans	1.- investigate the market share parameter as a function of real salaries, technological advancement and imports instead of prices	1.- technologies are developed or bought freely, 2.- imports are almost unrestricted 3.- market shares are driven by prices
general subsidies to prices	1.- subsidies aim to artificially lower prices thus facilitating the acquisition of goods. They are implemented through "regulatory policies" and the amounts thus obtained go to the State	1.- create new logics substracting prices from final prices 2.- for public companies replace their equivalent amount with funds taken from the "cash-box" 3.- do not take any action on private ones	1.- subsidies should be "incentives" that lower producer's prices allowing larger market shares 2.- "incentives" should be placed only on certain determined cases specially when developing new technologies

6.2.1 Demand Sectors

Residential/Commercial/Public (high importance)

We emphasized in earlier sections of this report that usable energy demand in these sectors is a complex function of many factors in the economy in addition to the cost of those services. Our experience indicates that it is very important to experiment with alternative behavioral models of this sector that reflect different welfare and lifestyle assumptions and different economic growth assumptions. For example, in a semi-socialized economy, it would seem appropriate to assume that

- welfare is a function of real salary levels, leisure time, educational levels, medical services, etc., and,
- economic growth is a function of employment rates, investment, savings and assets.

More robust models that consider these parameters have been built in the past, at least in rudimentary form (e.g., IIASA's MAED model or Stanford's PILOT model). The PILOT model assumes, for example, that the primary objective of public policy should be to provide a high (undiscounted) standard of living. Alternative policies are compared by measuring their impact on living standards (i.e., overall consumption levels), higher consumption levels being associated with higher welfare.

The equivalence of consumption and welfare is in our opinion not applicable in many semisocialized countries where very weak currencies, high inflation rates, or sheer political instability encourage extremely high levels of consumption over long periods in spite of stagnant or decreasing income levels. In particular, consumption is often subsidized by holding prices artificially low, i.e., below cost. Clearly in such economies, consumption is very high; yet most would agree that welfare is low. As an alternative, we suggest that research be directed at developing a more enlightened measure of welfare for incorporation into GEMS that reflects real salary paid to the workforce and its implications for leisure, education, and savings.

Another example of the difficulty of associating consumption with welfare is the distortion that invariably occurs in the housing markets in semisocialized economies. Large housing projects can be argued to increase GDP, at least in the near term. However, it is true that such housing projects severely distort the construction sector, often eliminating private housing altogether. In such a situation, housing shortages will occur if the government slows or stops public housing projects because of the inability of the private sector to make up the difference. Therefore, there is a systematic tendency to overinvest in housing and thereby to deny funds to other sectors in which the funds might bring greater economic benefit (e.g., health care, education). This therefore leads to an overall lower level of long-term GDP growth.

Agriculture (high importance)

Most of the less developed nations have arid and semiarid regions. Land under current cultivation is typically intensively cultivated, implying that no expansion of agricultural activity can occur on that land unless agricultural productivity is increased. Increasing agricultural activity necessarily requires that arid and semiarid land be reclaimed for agricultural purposes.

Private entrepeneurs are reluctant to engage in such reclamation since land-use policy is so strongly influenced by the government in semisocialized economies. In general, if new land is to be brought into production, it will have to be done (or subsidized) by the government. To reflect this situation, GEMS should be modified as follows. Once the network has been divided into fertile and arid/semiarid sub-sectors, a demand function for the latter category must be developed that relates productivity to government investment for reclamation purposes. Thereafter, different reclamation policies can be tested in terms of their effect on the agricultural sector in particular and the economy as a whole.

Industry (high importance)

To better represent industrial demand, we suggest detailed analysis and econometric estimation of the price-elasticity of demand for each end-use category. That is, at a given price level, what will be the demand for industrial indirect heat (steam)? For a percentage change in price, how much will the demand change?

Although not as important in price-driven free-market economies, this work would nonetheless be enlightening to policy makers. If it can be shown that these elasticities are within certain levels, the government might well decide to let the price system operate to a higher degree. Conversely if they are at other levels, the government might well decide to set prices at different levels by maintaining price controls.

6.2.2 Supply Sectors

Depletable Resources, All Sectors (high importance)

Semisocialized economies invariably strive for *self-sufficiency* with regard to key resources such as oil rather than more vague objectives such as *economic benefits.* Rational or not, the objective of self-sufficiency is intrinsic to countries (and we observe many free-market countries), arising from nationalism, national security, national defense, and other considerations. A corollary of the quest for self-sufficiency is the implementation of policies to maintain reserves of *strategic* supplies while attempting to keep the level of domestic investment at a manageable and reasonable level.

The invariable quest for self-sufficiency explicitly rules out the use of resource models optimization or *maximum benefit* to the producer considering scarcity rents, world price levels, or positive cash flows. We see the need for a new optimization model for primary resource production that maximizes some combination of the following objectives:

- Self-sufficiency, which is achieved by favoring domestic production over imports regardless of the cost of domestic production relative to the price of imports.

- Minimum level of reserves based on national defense considerations. This implies in practice the policy goal that domestic oil will be used exclusively up to a certain minimum level of consumption. For levels higher than that minimum, the country will consider imports as an option. The rational of course is for the country to maintain a certain minimum level of productive capacity. Such a policy is easily achieved in the GEMS by applying quantity restrictions that reflect the minimum quantities.

- Minimum level of investment, which implies minimum drain on the capital resources of the economy. Any capital resources not used for energy production are necessarily freed up for other uses in the economy in other sectors where they might have a larger positive effect on GDP.

- Cash flow, which should be as positive as possible in the aggregate. When cash flows become negative for a long period of time, the resource sector must draw from the central banking system. This *draw* can be supported by acquiring debt from external sources (foreign debt) or by *printing money*, which many argue would fuel inflation. Whatever method is used to provide money for this draw, the magnitude of the draw itself gives a measure of the cash cost of a given policy.

Hydroelectric Sector (high importance)

In Argentina, the hydroelectric sector is owned and operated by the state. Hydroelectric project decisions are almost entirely political in nature, owing largely to the substantial interregional considerations and the substantial implications for foreign debt and construction expertise. Because hydro decisions are based almost completely on national and regional politics, they are necessarily not based on national or regional cost and market considerations. In particular, such decisions rarely consider the true cost (true cost including capital cost, return on capital, and variable cost) relative to the true cost of regional competitors.

In practice, no government can simultaneously fund all possible hydroelectric development projects--projects must be prioritized. We would argue that such prioritization can and should be carried out based on estimates of true cost. To begin to reflect the priorities of hydro sites, we might modify the GEMS as follows. We might distinguish

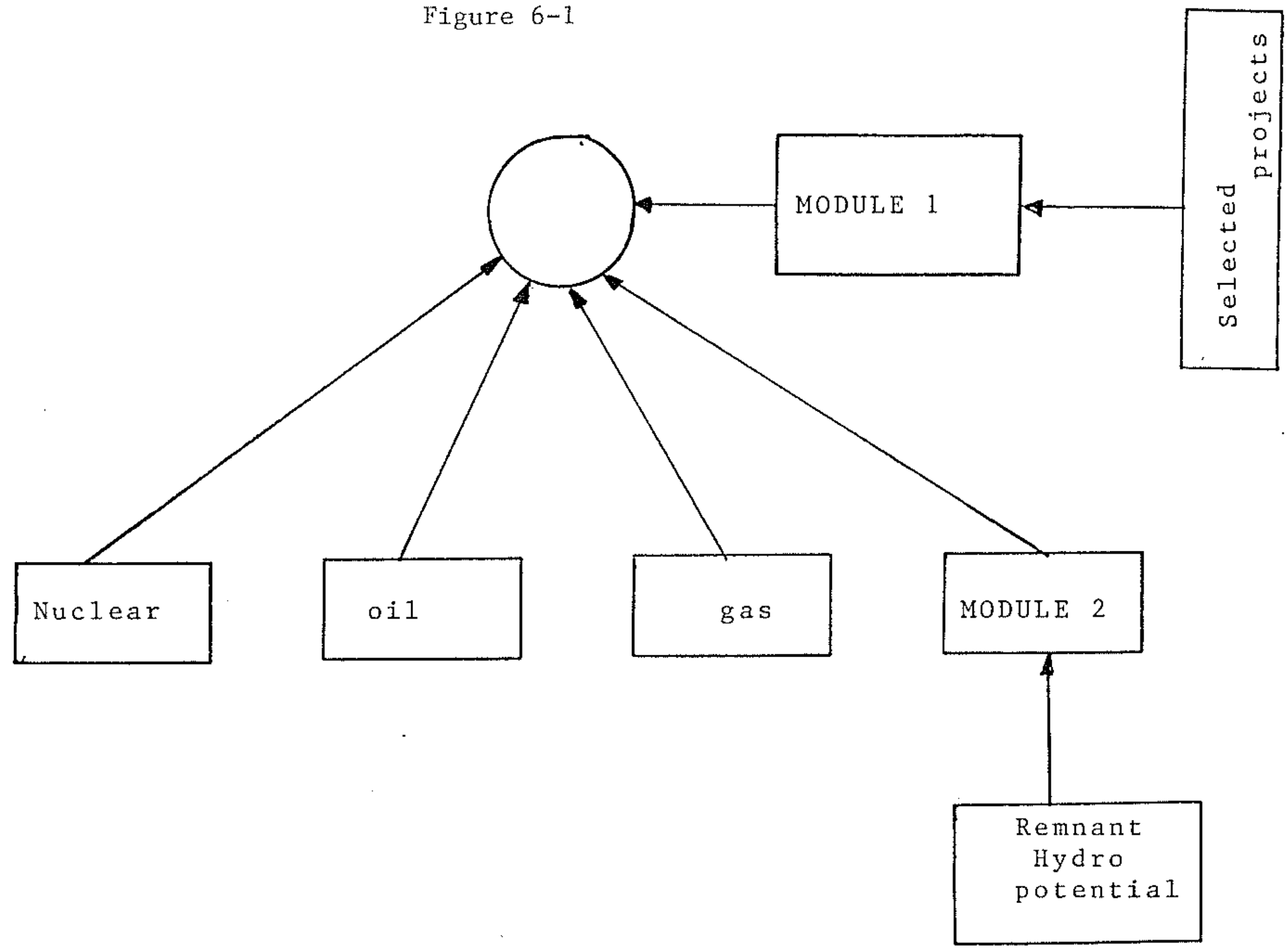
- projects that are currently committed as a result of public policy decisions already made. These projects will be *forced* into the model solution, reflecting the fact that they will be built.
- projects not currently committed but prioritized according to true cost. These projects will have to compete among themselves and with alternative generation methods on a regional basis.

Figure 6-1 illustrates how this can be accomplished in the GEMS. Module 1 in the figure represents currently operating and currently committed capacity, which will be obligatorily introduced into the solution. Module 2 in the figure represents the collection of all currently uncommitted hydro sites, which must compete according to their true costs (i.e., prices). Module 2 must represent the economics and capacity of all currently uncommitted sites, i.e., it is tied to real-world technical judgments.

The combination of Modules 1 and 2 represents aggregate committed and uncommitted hydro capacity. This aggregate hydro capacity will have to compete against all other sources--nuclear, coal, oil, gas, and renewables--presumably based on cost. The GEMS can simulate this cost competition among uncommitted hydro, committed hydro, and other generation technologies. This simulation can be made at the national aggregate level or, more accurately, at the specific regional level where specific hydro and other sites can be distinguished.

The advantages of this more complete model of hydro include the following:

Figure 6-1


MODULE 1
Selected projects
Nuclear
oil
gas
MODULE 2
Remnant Hydro potential

- the true relationships between hydroelectric and other technologies in the energy-economic network will be represented.
- political decisions regarding hydroelectric technology can be represented by simulating different degrees of price competition, different levels of committed capacity, and so forth.
- the aggregate investment requirements under different political and economic assumptions can be computed.

Nuclear Sector (high importance)

Invariably, the nuclear sector is owned and operated by the state. Similarly to hydroelectric generation, nuclear generation decisions are almost totally political because of the technological, national security, and capital implications of nuclear technology. Given that nuclear plants might be forced into the economic system for other than economic reasons, we suggest that the same modification in GEMS be made for the nuclear sector as was made for the hydroelectric sector. That is, a module representing committed nuclear facilities must be incorporated, and the size of this module must represent the committed capacity. As yet uncommitted nuclear capacity would reside in a parallel module which competes with coal, oil, gas, hydroelectric, and renewable generation sources.

6.2.3 Negative Cash-Flow, Any Process. Total Loss of the Energy-Economy System

In general public decisions aim to maximize some implicit or explicit notion of welfare or benefit or well-being of the population. In striving to maximize benefit, it might occur that national cash flows will be negative over a significant period. For example, elimination of imports might require high domestic investment, which implies negative cash flows during the periods of heavy domestic investment. Negative cash flows must in reality be replaced in semisocialized countries by the state through the Central Bank. Many argue that when the Central Bank provides currency to offset negative cash flows, the result is devalued currency and accompanying inflation. Furthermore, it is generally true that governments and quasi-public bodies are willing and able to withstand negative cash flows much longer than private companies.

Given their willingness and ability to withstand major negative cash flows, whenever public enterprises are present in an economy, they must be explicitly distinguished from their private sector counterparts. To do so, public sector processes might be connected to what we will call a *cash box* model that keeps track of the net cash flow--positive or negative--borne by the public sector process. The *draw* on this cash box will represent the aggregate net negative cash flow by all processes in the network, i.e., the required financial shortfall that must be made up by money from the Central Bank.

Now, if all the negative draws on the cash box are added, we will obtain the *total cash loss by the semisocialized economic system* depicted by the network. We emphasize that this cash draw does not represent a deadweight loss to the economy as a whole because we are dealing only with a partial equilibrium representation. However, even keeping track of the draw on the cash box from a subset of the economy can give important and insightful results regarding sensible economic policy.

6.2.4 Employment

In its present form, GEMS represents employment requirements at the level of individual processes in the network. Therefore, the GEMS computes aggregate employment requirements arising from the portion of the economy being represented. That is, GEMS can be used to measure the difference in domestic employment between different scenarios assuming identical labor cost in each scenario. In GEMS, it is implicitly assumed that underemployment will not result in reduced labor costs.

The GEMS might be profitably improved by better representing underemployment of labor factors in the economy. We recognize that microeconomic theory has little to say about this matter; however, the lack of theory does little to blunt the importance of the problem. We should point out that privately owned industries in the economy are less prone to swings in over and underemployment--they tend to maintain a relatively constant level of employment. To represent the difference in employment between public and private industries, we recommend that GEMS by modified to

1. distinguish the public and private sectors,
2. explicitly represent underemployment in the public sectors,
3. compensate negative cash-flows in public industries from the hypothetical cash box as explained previously,

Plant Capacity Factors

Different plants of different sizes and different ages tend to run at different capacity factors. It often occurs that publically owned plants run at very low capacity factors for very long periods of time for political reasons in semisocialized economies. This could be represented by modifying either the parameters or the functional forms of the capacity factor functions used in the GEMS. Clearly more research is needed to improve the capacity factor logic in the GEMS.

Resource Owner's Discount Rate

The resource owner's discount rate represents the intertemporal tradeoffs between producing a domestic resource now versus waiting until some future year before producing it. As discussed previously in this volume, the owner of the resource is the state and the organization leasing the resources is a government-owned company. Quite often, mineral rights are controlled in part by provincial governments as well as the national government. Thus the owner's discount rate must represent the aggregate of national and regional government decisions regarding each mineral deposit. In fact, it is often true (as it is in Argentina) that the Constitution guarantees a high degree of local sovereignty, implying that the resource deposits in fact belong to local governments.

For public policy analysis, it is necessary to analyze both extremes: total national ownership and control versus total local ownership and control. These extremes allow us to recommend more enlightened resource development policy that balances local needs with national needs. In particular, we recommend that the analyst:

1. Analyze different owner discount rates to simulate local versus national control.

2. If negative cash flows for domestic resources occur, offset them by draws from the cash box. This allow quantification of the implicit subsidy of using too high a resource owner's discount rate.

Extent of the Domestic Resource Base

In general in a semisocialized economy, reserves are not quantified in terms of quantity and cost but only in terms of quantities available without explicit consideration of cost. For example, we often hear terms such as *maximum* recoverable resource. Unfortunately, the lack of association of economics with estimates of resource base often seduces decision makers into the perception that resource prices can be set autonomously by the government. This perception obfuscates the fact that controlling resource prices at low levels but producing them anyway represents an implicit subsidy.

Whether or not this subsidy is in the national interest, it is nonetheless a national policy which cannot be easily changed and therefore must be implemented within the GEMS. To properly represent resource pricing subsidies, we recommend:

1. use the optimization function proposed in Section 6.2.2,

2. use the traditional Hotelling model of primary resource production, which will equate resource prices with world prices and set the

domestic production schedule accordingly. Furthermore, the extent of the resource base will satisfy the economic definition that the resource base is fully depleted when domestic production cost rises to the world oil price. The discount rate for this calculation should be no lower than the interest rate on external debt.

3. the *loss* between the two curves should be recorded in the *cash-box*. It can be interpreted as the economic welfare loss from pricing at a level other than the world oil price. Whether or not this cost should be borne is a matter for public policy debate.

Sensitivity of Market Shares to Relative Prices

The present allocation process assumes that demand is allocated according to relative supply prices as derived from the theory of aggregated markets. The allocation process is designed to represent technology selection in free-market economies in which there are no policy, import, or other restrictions against one or more alternatives.

In order to represent the reality in semisocialized economies that certain sources are differentially favored over other sources (or restricted relative to other sources), we advance three basic attributes of comparison: technology by which the source is produced, degree of substitutability (termed appeal), and the nature of the final use to which they are to be applied:

Source	Technology	Appeal	Final Use
natural gas fields	identical	identical	identical
nat. gas/syngas	different	identical	identical
electr./nat. gas	different	different	similar
cars,diesel/gasoline	different	similar	equivalent
TV color/B&W	different	different	equivalent

In general, the final prices of these products will not embody all these differences in attributes, yet these differences in attributes are likely to cause differences in consumer selection. Obviously we need a selection function that explicitly considers these attributes in addition to prices. Probably the simplest extension of the current logic can be illustrated by gas-versus-electric competition. One could assess penalties or premiums to be added to prices that would adjust the two sources to the same basis from the point of view of decision makers. These sources would then by assumption compete on the basis of adjusted (penalized/premium) prices.

To confound the relatively simple situation of gas-versus-electricity, we note that autos and television sets for example compete not only on the basis of price. Indeed, real salaries, savings, and educational standards, and a range of other attributes might enter in. The problem that some interfuel and intertechnology competition is not price-based is a problem that is not limited to semisocialized economies. Nor has a general solution to the problem been implemented in industrialized, free-market, semisocialized, or other economic settings. Again, we suggest as a gross approximate solution the imposition of customized price premiums/penalties. Or, if one wished, one could appeal to more sophisticated economic theory such as multiattribute utility theory or revealed preference theory to develop an advanced allocation process in which market shares are functions of prices, technological advancement allowed, availabilities of imports, real salaries, etc.

This last item, real salary level, is included for semisocialized economies to reflect a fundamental difference with free-market economies. In semisocialized economies in which salaries are low, the government will usually lower commodity prices through subsidies to provide at least subsistence-level consumption of commodities. Producers are therefore shielded from direct consequences of consumption decisions. By contrast, in free market economies, product prices are set by equilibration of supply and demand between consumers and producers; consumption decisions are felt by producers through the price system.

6.2.5 Price Subsidies

We have continually emphasized that when real salaries are low in semisocialized countries, the government usually implements subsidies on basic commodities to make them affordable to consumers. The pressure for such subsidies is enormous--it is feared that without them, consumers simply will not purchase high priced commodities, they will flatly refuse to pay utility bills, and they will create social chaos. Because of such pressures, government-owned concerns are lucky indeed if they are able to operate in the black. Indeed, often the pervasive role of government in such economies drives private companies into the red as well, requiring direct subsidies of such companies.

To reflect such price subsidies, it is necessary to generalize the price regulation logic within the GEMS. This section suggests a specific approach:

1. Implement new logic that subtracts subsidies from the overall equation for final prices,

   $$pf = (VOC + SCC*ccr + pi/eff) = subsidies$$

2. For each publically-owned concern, reimburse the aggregate subsidy from the *cash-box*,

3. Use the currently existing logic to represent private companies.

This modification is of crucial importance given the pervasiveness and importance of price subsidies in semisocialized economies.

6.3 CONCLUSIONS

The modifications proposed in this chapter are motivated by the fundamental differences between two distinct socio-economic systems: free-market systems and semisocialized systems. It is clear that if a quantitative model is to have a major impact on semisocialized economies, it must reflect the institutions, culture, traditions, etc. in that society, the relative role of the government and private industry, and the impact of all of the above on individual and collective decisions in the economy. It is inappropriate, indeed arrogant, to blindly assume that techniques developed to apply in free market economies will apply without modification in semisocialized economies. Similarly, it is inappropriate and arrogant to assume that techniques developed because of the convenience of a particular mathematical modeling technique (e.g., linear programming, nonlinear programming, system dynamics) will apply in semisocialized economies. Indeed, it is necessary to customize one's quantitative modeling approach to the particular country at hand. This philosophy of customized quantitative modeling has permeated this report, and we argue should permeate applied public policy analysis.

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