A SYSTEM MODEL FOR MARKET DEVELOPMENT PLANNING: NORTHEAST BRAZIL

Thesis for the Degree of Ph. D.

MICHIGAN STATE UNIVERSITY

THOMAS R. WEBB

1969

This is to certify that the

thesis entitled

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FOR MARKET DEVELOPMENT PLANNING:
NORTHEAST BRAZIL

presented by

Thomas R. Webb

has been accepted towards fulfillment
of the requirements for

Ph.D. degree in Marketing

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ABSTRACT

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BY

Thomas R. Webb

This thesis presents a detailed description of a general systems model of a regional sub-sector of Northeast, Brazil. The Recife Systems Model focuses on the economic exchange relationships between the major urban center of Recife and the surrounding four-state area which is Recife's primary foodshed. The purpose of this modeling effort is to provide a framework for development planners to assess alternative investment programs in the coordination of market processes for an underdeveloped economy. Computer simulation and systems analysis are combined to build the model. The development of the model is part of an ongoing interdisciplinary research effort to describe and analyze the role of marketing in facilitating and simulating economic growth.

The model's structure provides a detailed description of production, distribution, and consumption sectors emphasizing the flow of goods, services, and income within the internal market economy. The structure is divided into two parts: the basic internal structure of the system represents the central economic sectors, their internal

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characteristics, and the interaction between them; the second major part centers on the planner oriented characteristics of the model.

The internal structure defines six economic sectors: The urban Recife Consumption-Income Sector; the Recife Distribution Sector; the Recife Industry Sector; the Other Recife Sector (containing all other urban economic activity); the Rural Sector (including components for production, distribution, and consumption in the four-state area); and an Import-Export Sector linking the system to the "rest of the world". The emphasis in building the internal structure is to provide a framework with enough flexibility and disaggregation to permit the user to alter key behavioral and economic assumptions. Data for the model was derived from the large scale survey research conducted in Recife.

The planner oriented characteristics of the model focus on the development of "planner entry routines" which allow the user to enter the system and change the structural and behavioral relationships and evaluate potential reform programs. Two decision routines and an Investment Sector are defined. "Planner entry routines" are also utilized to build the important link between policy variables and the economic behavior of the system.

The model has been used to examine some of the possible economic effects of selected marketing reforms. Five year simulations which include hypothesized changes from each reform are compared to a "base simulation" which excludes the recommended reforms. The model showed itself capable of analyzing alternative reform options. The results, while presented illustratively, demonstrate that a general systems model does have the ability to analyze the impact of reform programs in a way that focuses on the interaction between and within sectors in the economy.

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With all its assets, the model should not be used as the only device for evaluating the desireability of a reform program. Non-economic considerations must be included. The intuition and experience of the planner should be brought to bear on the results of the simulations to determine their "reasonableness" relative to the economic, social, and political system under analysis. The model's principle advantage is in its flexibility to provide a basis for systematic appraisal of decision alternatives.

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Department of Marketing and Transportation

1969

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ACKNOWLEDGMENTS

The research, analysis and writing for this thesis was done while the author was working as a research associate with the Latin American Market Planning Center at Michigan State University from July 1966 to July 1968. The United States Agency for International Development provided the funds for Michigan State University to draw together an interdisciplinary research team. As part of that research team, the author was able to draw upon the talents of many individuals representing several disciplines.

The author was priviledged to have the total support and guidance of his Doctoral Committee, Dr. Charles C. Slater, Chairman; Dr. Herman Koenig; Dr. Donald S. Henley; and Dr. R. Vincent Farace. Professor Slater provided the stimulus, theoretical background, and perserverance necessary for me to accomplish the task of building the Recife Systems Model. When the likelihood of achieving the objectives seemed very low, his personal support made the difference between success and failure.

The belief of Professor Koenig, Chairman of the Systems Science Program in the College of Engineering, in the applicability of system theory to socio-economic problems and his ground-breaking work in direct and practical applications opened the door to this author of the potentialities of this methodology to analyzing economic processes.

Dr. Henley, Dr. Farace, Dr. Edward P. Holland and Mr. Martin Stoller made valuable contributions through their comments and suggestions on

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structuring the presentation and content of the material. Their councel from their particular fields of professional interest assisted this author at crucial points in the research effort.

To Allan Dale of Systems Research Incorporated must go a major acknowledgment. Without his assistance and knowledge of computers this model would not exist. The size and complexity of the program provided major technical problems, beyond the scope of this author's knowledge. He taught the author many of the "tricks" of using the computer efficiently and guided its progress through more than 100 runs on the computer before a valid simulation run was achieved.

This author had always questioned the inclusion of the "thanks for the endurance of my wife" statement. But now, after having "gone through the mill", my wife, Mary, in dedication, understanding, and sacrifice over these years must stand out above all the rest.

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In the early stages of a scientific breakthrough, there is a great risk of miscalculation. If we fail to press our insight, however vague or ill defined they may be, we may never realize our potential and advance toward ultimate goals. Scientific exploration cannot guarantee discovery. If we seriously exaggerate the prospects, we not only waste valuable time and resources but our miscalculation brings down upon us the ill will of those we seek to aid. In science, as in politics, we shall find a happy interaction between the "conservatives" and the "liberals", the restraint of one serving as a check on the excesses of the other.[1]

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[1] Peter Langhoff, "The Setting: Some Non-Metric Observations," Models, Measurement, and Marketing, edited by Peter Langhoff (Englewood Cliffs, New Jersey: Prentice Hall, Inc., 1965), p. 4.

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CHAPTER I

MARKET PROCESSES AND MODELING: AN INTRODUCTION

Introduction

The Purpose

This thesis presents a detailed description of the development of a general systems model of a regional sub-sector of Northeast Brazil. The structure of the model, called the Recife Systems Model, focuses on the economic exchange relationships between the major urban center of Recife, capital of the state of Pernambuco, and the four states surrounding Recife which supply the urban center with a large portion of its agricultural requirements. The fundamental purpose of this modeling effort is to provide a framework for the decision-maker responsible for development planning to assess alternative investment programs in the coordination of market processes for an underdeveloped economy. The methodology of systems analysis and the technique of computer simulation are utilized in developing this economic planning model for the analysis of programmed change in an internal economic system.

There are three prime objectives of this modeling effort. First, as a methodological exercise, the model is intended to improve understanding of the technical problems and benefits of utilizing computerized systems model in the planning process. Further, the thesis shows the flexible applicability of systems analysis to the analysis of complex socio-economic

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systems. Second, as a research aid, the model grows out of a struggle to develop a research analysis framework which can assist researchers in developing operational hypotheses, explicit information needs, and integrated analysis of results. Conversely, the research provided the model with the basic information necessary to determine its structural relationships and primary data inputs since virtually all available secondary and other source information about the system was either in the wrong form or not of appropriate accuracy.[1] Third, as a training device, the process of building correcting, and applying this model demonstrates the ability of the model to assist host country government personnel and private sector investors in improving their general understanding of the economic system, in integrating their planning efforts and improving communications between planning groups, and in advancing their working knowledge of advanced management planning techniques.

The Model and the Research

As part of an ongoing interdisciplinary research effort this particular application of general systems analysis and computer simulation to market process study was the result of two interrelated factors: first, the increasing concern about the interactive and dynamic consequences of market changes in developing communities; and second, the developing skill in the application of general systems modeling techniques to socio-economic problem analysis.

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[1]Holland discusses the problems involved in obtaining a workable and realistic information base, encountered in all modeling efforts. He stresses the importance of combining judgement, historical data, and future expectations in constructing the data base. Edward P. Holland, Dynamic Models for Simulating the Venezuelan Economy (New York: The Simulmatics Corporation, 1966).

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The results of the research work in Puerto Rico supported the initial hypothesis that marketing functions and institutions could play a significant role in stimulating change both in consumption and supply characteristics.[3] Further, it became evident that while the assessment of first order impact of market changes was relatively easy, the second order effect between sectors in the economy and third order effects over time were much less apparent.

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[2]This research project was financed by the U.S. Agency for International Development. Called "A Comparative Study of Food Marketing Systems in Selected Latin American Countries" (Contract number: AID/TCR-786), it was conducted for the Technical Cooperation and Research Branch of USAID, Washington.

[3]For an in depth analysis of the Puerto Rican research work see: Latin American Studies Center, Food Marketing in the Economic Development of Puerto Rico (East Lansing, Michigan: Latin American Studies Center, Michigan State University), in press. For a shorter summary of the results see: Robert W. Nason (ed.), The Role of Food Marketing in the Economic Development of Puerto Rico, Seminar Summary (East Lansing, Michigan: Latin American Studies Center, Michigan State University, 1966).

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Thus, to justify investment in market oriented reforms and meet practical concerns it was evident that these second and third order effects had to be determined. For example, the positive impact of lower food prices and more equal distribution of income had to be compared to the potentially large negative impact on employment and wages generated in the distribution sector with the implementation of major modernizing programs in marketing.

A method permitting analysis of the complex interactions between sectors and over time which takes place in an economic system under change was needed. Without this type of planning tool, the ability to understand accurately and to predict the implications of market process changes would be extremely difficult. While some of the key factors influencing market processes such as relative prices of food, income distribution, employment characteristics, institutional structures, and investment strategies were known and rough first order approximations of the impact of market process changes could be made, an improved, integrative technique was needed.

During the same period the Systems Science Group at Michigan State University, under the leadership of Dr. Herman Keonig, had begun a major investigation to transfer the technology of systems analysis developed for the physical sciences to new applications in social and economic problem areas. Under a National Science Foundation grant, a systems model of Michigan State University had been developed to assist administrators in both short and long-term planning of resource allocation for student, faculty, research, and facility needs.[4]

After extensive interaction between members of the LAFS project and the Systems Science Group on the feasibility and desirability of

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[4]Herman E. Koenig, et. al., "State-Space Models of Educational Institutions," Organization for Economic Cooperation and Development, Proceedings of the Second International Conference, Paris, (January 25, 1967).

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attempting an interdisciplinary modeling effort, it was decided to attempt the construction of an aggregated model of Puerto Rico based on census information and the research information already gathered in the LAFS project. The basic purpose of the Puerto Rican model was to test the feasibility from a methodological viewpoint of utilizing systems analysis as a tool to improve understanding of market processes within the more general sphere of economic development. Combining other modeling techniques such as input/output analysis and national income models, which did not treat the distribution sector explicitly, into the systems analysis framework, Griggs developed a model which did include the distribution functions in order to analyze the employment-income effects of changes in market processes.[5]

A second contract between USAID and Michigan State University created the Latin American Market Planning Center (LAMP) which operated through the Latin American Bureau of USAID, Washington with Dr. Slater as director.[6] The LAMP project expanded the scope of concern of the Michigan State research team to include the marketing of farm inputs and selected industrially produced consumer goods. While the first project, LAFS, was primarily designed to provide diagnostic and description information about food marketing processes, the central concerns of the LAMP project were a much broader approach to the understanding of the general role of market processes in economic coordination and growth. The purposes of the LAMP project emphasized the need to develop viable market reform programs and evaluate their potential consequences.

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[5]John E. Griggs, "Evaluating the Consequences of Marketing Change: An Application of System Theory" (unpublished Ph.D. dissertation, Michigan State University, 1968).

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An explicit provision was included in the contract expanding the efforts to develop systems models as an analytic technique to aid development planners in assessing the cost and benefit consequences of the alternative market development programs suggested by the research.

Learning from the research work done in Puerto Rico, the next phase of the LAFS and LAMP projects moved to Recife, Brazil and LaPaz, Bolivia in late 1966.[7] The third phase began in Cali, Columbia in June of 1968. By far the largest of the interdisciplinary research efforts was conducted in Recife where the project was carried forward through a three party agreement between USAID, Michigan State University, and the Brazilian government agency in charge of development planning for the Northeast region of Brazil -- SUDENE.[8]

The "memorandum of understanding" formalizing the joint effort stated five major objectives for the research work:

1. To conduct a diagnostic study of the existing marketing system for food, selected agricultural products and inputs, and for selected locally produced consumer goods.

2. To formulate recommendations for improvements in marketing system based upon the diagnostic studies.

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[7]For a summary of some of the Bolivian research results see: Donald Henley and R. Vincent Farace, "Consumer Buying and Communication Patterns in Bolivian Urban Food Retailing: A Preliminary Report," Proceedings of the American Marketing Association, Washington, D.C., (Winter 1967), and M.J. Moran, "An Evaluation of Market Coordination in the Bolivian Rice Industry" (Unpublished Master's thesis, Michigan State University, 1968). A report of the entire research is now in press with the Latin American Studies Center at Michigan State University.

[8]The team of researchers and SUDENE technical personnel with fifty interviewers conducted over 3000 personal interviews, case studies, and field surveys. They included rural and urban consumers, retailers, wholesalers, rural assembly market operators, farmers, farm input distributors, food processors, consumer goods manufacturers, farm input producers, and officials from most of the government agencies who influence the marketing process.

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3. To develop systematic procedures for evaluating selected potential marketing reforms and arriving at policy decisions.

4. To evaluate hypotheses and draw conclusions about the role of marketing in the development of countries in the early stages of economic growth.

5. To provide research and analytic training for the Brazilian and Michigan State University Market Development Specialists participating in this program.[9]

Because of the comprehensive nature of the research effort, it was decided that the modeling work would be integrated into the larger scale survey research program done in Recife. Building on the Puerto Rican model, the Recife model would be a second generation model more closely linked to primary research information and of a scale sufficiently large and disaggregated to allow more planner oriented analysis of specific market reforms and their consequences. Thus, the Recife Systems Model became the first large scale quantitative modeling effort directly linked to a survey research effort serving as a guide for the research and in turn receiving the information necessary to structure and use the model.

The Setting: Recife, Brazil

Recife is the largest urban concentration in the Northeast of Brazil, with a population of over one million people which has been growing at about 6% per year.[10] The Northeast is a nine-state area of

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[9]"Program for the Development of Marketing in Northeast Brazil, Memorandum of Understanding," Recife, Brazil, 1966, (in files of Latin American Market Planning Center, Michigan State University).

[10]For an excellent general summary of the historical background see: Latin American Studies Center, Market Processes in the Recife Area of Northeast Brazil (East Lansing, Michigan: Latin American Studies Center, Michigan State University, 1969), Chapter 2. For those interested in more detailed information about the Northeast the following sources are given: Stefan H. Robock, Brazil's Developing Northeast: A Study of Regional Planning and Foreign Aid (Washington, D.C.: Brookings Institute, 1963); Celso Furtado, The Economic Growth of Brazil (Berkeley and Los Angeles:

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25 million people and the four state "foodshed" around Recife, which was the focal point of the research, has a population of over 9 million people and an area twice that of the state of New York. With a 1960 percapita income of $140, the Northeast is one of the poorest areas of South America.[11]

During the 17th Century the area was extremely prosperous in the New World based on a slave, sugar plantation economy supplying most of the world's sugar demands. With the decline of sugar prices, the growing population of the Northeast migrated to the semi-arid interior where subsistence and cattle farming were the primary economic activities. Periodic droughts and floods forced most of the population to live in starvation and misery. Principle economic and political control, formerly centered in the Northeast for the entire country of Brazil, moved to the Center-South of the country.

In the late 19th Century the Brazilian federal government started a program of building reservoirs to hedge against drought but progress fluctuated for another fifty years because irrigation projects were thwarted by the Land Tenure Policies. In 1951 President Getulio Vargas revised the program which lead to the establishment of the Bank of the Northeast development agency. With the occurance of a particularly devastating drought in 1958 and a continuing decline in percapita income relative to the rest of the country, an increased emphasis on more general development activities caused the creation of the Superintendency for

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University of California Press, 1963); Werner Baer, Industrialization and Economic Development in Brazil (Homewood, Illinois: Richard D. Irwin, Inc., 1965); and Albert O. Hirschman, "Brazil's Northeast," Journeys Toward Progress (New York: The Twentieth Century Fund, 1963).

[11] Robock, p.46.

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Development of the Northeast (SUDENE) which was given control over planning and coordination of all policies and investment in developmental activities of the region.

In the first two "master plans", SUDENE's emphasis was on increasing production and productivity in the agricultural sector. The third and fourth "master plans" maintained these objectives but are distinguished from them by their emphasis given to investment for improvement of the marketing system.[12]

In the industrial sector job creation did not keep pace with additions to the labor force from natural population growth and migration to the cities. Unemployment and underemployment were mounting problems. In order to counter this trend investment incentives through liberal tax rebates for industrial investment in the Northeast were incorporated into the SUDENE master plans. Hirschman estimates that industrial capacity will double by 1977 because of the incentive program.[13] Though the program for investment incentives is perhaps the most dramatic and consequential growth process initiated in the Northeast since the 17th Century, problems of creating capacity faster than the growth in effective demand have already begun to arise.

In Recife there is a small concentration of diverse industry. It includes such food processing industries as beverages, vegetable oils industry, meat, fruit, and wheat processing; agricultural input industries

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[12] Brazil, III Plano Director de Desenvolvimento Econômico e Social do Nordeste, 1966-1968 (Recife, Brazil: Div. de Documentação da SUDENE, 1966), p.24.

[13] Albert O. Hirschman, "Industrial Development in the Northeast and the Tax Credit Mechanism of Article 34/18," a preliminary draft report prepared under contract AID-12-544 for the United States Agency for International Development, July, 1967, p.16.

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such as fertilizer, farm implements, and irrigation industries; consumer goods manufacturers in textiles, furniture, appliances and soap; and some small scale assembly plants for buses and cars. These industries are small and Recife, as in the entire Northeast, is dependent on the Center-South for most manufactured goods and even large quantities of food.

The General Thesis of Internal Market Processes

That economic development is complex, dynamic and uncertain is obvious to anyone exposed to the process.[14] Movement to increasing levels of development do not seem to be automatic or intuitive, there are constantly occurring forces and counterforces both from within and without the economic system, making it exceedingly difficult for the development planner to understand and stimulate positive economic co-ordination and growth.

The dilemma faced by planners is compounded by the conflicting goals of development. Increasing the gross product or income of a community and rising levels of productivity are often cited as the goals of development. Development theorists such as Galbraith, Zimmerman, and Currie add to increasing levels of income and productivity

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[14]For an historical development of thought on economic development and growth, see: John R. Wish, "Food Retailing and Economic Development: Puerto Rico 1950-1965" (unpublished Ph.D. dissertation, Michigan State University, 1967). There have been numerous papers written on the thesis of market process coordination, three which summarize the argument well are: W.W. Rostow, "The Concept of a National Market and Economic Growth," Proceedings of the American Marketing Association, (Winter 1965), pp. 14-15; Charles S. Slater, "Marketing Processes in Developing Latin American Societies," Journal of Marketing (July, 1968); Harold M. Riley, "Evaluation of Marketing Systems in Latin America," A paper presented to the Markets and Trade and Economic Development Workshop, North Carolina State University, Raleigh, North Carolina, (February 20, 1968).

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the criteria of increasing percapita income, less concentrated distribution of income, and increased productive employment.[15,16,17]

As Slater points out the goals of increasing the level of income and equalizing income distribution could be viewed as mutually exclusive.[18] The conflict arises because increasing levels of income require capital investment to improve productive capacity and technology. To have increased investment implies increases in internal savings and/or outside investment. But savings are generated by wealthier members of the community and it can thus be argued that to increase savings and concurrently investment, it is necessary to increase income concentration. If, on the other hand, more equal distribution of income is stressed, then the lower income consumers who tend to spend more and save less have a larger share of gross income and the savings of the community are lower.

Further, efficient transfer of savings to investment through the financial markets are usually inefficient in less developed systems. Slater suggests that the very inefficiency of the capital market in transferring savings into effective investment means that improvement in the efficiencies of market process operations may be critical. He points out that:

> It is precisely because the financial markets in the less developed communities are often inefficient in translating

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[15]John Kenneth Galbraith, Economic Development (Cambridge, Mass.: Harvard University Press, 1964).

[16]Lauchlin Currie, Accelerating Development (New York: McGraw Hill Book Company, 1966).

[17]L.J. Zimmerman, Poor Lands, Rich Lands: The Widening Gap (New York: Random House, 1965).

[18]Charles C. Slater, "Market Channel Coordination and Economic Development," A paper presented to the Vertical Marketing Systems Workshop, Northwestern University, (November 6, 1968), p.2.

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> private savings into effective income expanding investment that improvements in the efficiencies with which marketing channels operate may be crucial in improving the reinvestment process.
>
> Improvements in the vertical coordination of marketing channels can induce the entrepreneurs operating in these distribution channels to become more efficient by increasing their output through utilizing more efficiently their present capacity with relatively small increments of capital. The argument also suggests that horizontal improvement in the coordination and efficiency with which market channels operate can be important in the demand-expanding side of the equation of development. The extent that market channel coordination fosters fuller utilization of the productive capacity of the community, it contributes to increased output.[19]

Viewing the marketing system as a primary investment mechanism for coordination and stimulation of production, distribution and consumption for goods, services, and information has not been accepted generally by development planners or scholars. Researchers, scholars, and planners have stressed many different development strategies. One viewpoint places emphasis on infra-structure build-up of communication, transportation, and power systems. While much of this is necessary for development, investment often ends up in what Galbraith calls "symbolic modernization" which is impressive but not urgent to the development task.[20] A second viewpoint emphasizes large capital investment in primary industrial capacity.[21]

In View from the Seventh Floor, Rostow notes four factors which take place as industrialization gains momentum:

> First, there is some industrial capacity, usually developed to substitute for the import of certain kinds of consumers' goods . . . This both saves foreign exchange and permits industrialization to begin, and it is no great trick to market for a rich urban middle class.

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[19]Ibid., p. 4.

[20]Galbraith, p. 4.

[21]Hirschman, Journeys Toward Progress.

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W.W. Rostow, View fro
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> The second characteristic of these countries is that, leaving the textiles aside, the market for these manufactured goods is small; and there is a tendency for industrialization to slow down, once the substitution for imports has mainly taken place.
>
> A third characteristic of such countries is that, although some agricultural development is taking place, the gap between rural and urban life is widening.
>
> Finally, as a result of this imbalance, men and women move from the countryside to the cities, where often they remain unemployed and impose a burden on government budgets for housing, education, and so on, even though they live in urban slums.[22]

The last two points made by Rostow lead to a third viewpoint in development strategy. It becomes increasingly important to emphasize rural food production to feed the large and growing urban centers. John Brewster effectively summarizes the evolving emphasis on rural food production:

> Agricultural progress is equated with the expanding capacity of farm people to play an increasingly effective part in accelerating the national output through supplying their total economy with foods and fibers appreciably faster than population growth adds new mouths to feed. Only as agricultures meet this test of proficient performance do they become capable of enabling an ever larger proportion of the total population to help expand the national output through engaging in non-farm employments, including those which generate the increasingly productive farm technologies and related skills and knowledge, which in turn enable farmers to make steady increases in their productivity.[23]

Seldom, however, have any of these combinations measured up to expectations in their impact on increasing the general economic welfare of the system. Of course the mismatching of these economic efforts with

[22]W.W. Rostow, View from the Seventh Floor (New York: Harper and Row, 1964), pp. 133-135.

[23]John M. Brewster, "Traditional Social Structures as Barriers to Change." Agricultural Development and Economic Growth, (eds.) Herman M. Southworth and Bruce F. Johnston (Ithaca, New York: Cornell University Press, 1967), p.66.

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the political, social, and cultural environment may in part be responsible for the divergence between actual and expected results. Another could be the gap between development strategy and implementation. But until fairly recently, most development strategists have either overlooked or assigned a passive, neutral role to the impact of marketing activities and institutions in the process of economic development. The general feeling is summarized by Moyer.

> The argument is that marketing is a self-adjusting mechanism that alters itself in response to changes in the rest of the economic system. Being both a passive and automatically adjusting mechanism, marketing, it is argued, can be ignored.[24]

The nature of market linkages within sectors and between sectors for goods, services, and information becomes a more apparent concern as planners and theoreticians increasingly stressed the importance of looking at the development process through inter-sectoral analysis emphasizing the interdependence between sectors in an economic system.[25] With the emergence of a more integrative approach to development and the expanding of development goals to include more consumer oriented objectives the role of the exchange process could no longer be denied.

During this same period preliminary information had been gathered that improvements in market linkages are crucial.[26] The 1967 report on the world food problem by the President's Science Advisory Committee emphasized:

> The improvement of food storage, processing and distribution systems in the developing nations is as important as increasing production. The encouragement of private investment to develop facilities for storing, processing

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[24]Reed Moyer, Marketing in Economic Development, Occasional Paper No.1 (East Lansing, Michigan: Institute for International Business Studies, Michigan State University, 1965), p.5.

[25]Wish, pp.16-20.

[26]Richard H. Holton and John K. Galbraith, Marketing Efficiency in Puerto Rico (Cambridge, Mass.: Harvard University Press, 1955).

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> and distribution goods deserves a high priority. Governments of developing countries must provide a climate hospitable to the kinds of private enterprises that can stimulate change from a subsistence-oriented farming economy to a market-oriented one.[27]

If it is no longer assumed that the role of marketing is passive then what impact on the development process does marketing have? First, the consumer can be better off with improved marketing systems. Decreased loss and spoilage, increased more stable volume, and lower and more stable prices certainly would be beneficial to the urban consumer. And, lower food prices to the poor consumer who spends a large proportion of income on food can have an important income redistributive effect. A second area of potential gain is the effect which increases in market efficiency can have on increasing production at lower costs, better quality, and in more rational alignment with market demand. From the producer's standpoint improved marketing efficiency can affect him in two ways.

First, on the supply side the marketer who is willing to vertically coordinate backward to insure quality, quantity and a consistent supply, improve storage, grading and price stability can have significant impact on the risks perceived by the rural producers. By lower risks and price variability it is quite likely that a supply response could be elicited.

And second, on the factor input side, the marketing system can provide the producer with improved factors, incentives, and information. Thus, lowering the risks of technological change and facilitating production expansion and improved resource utilization.

Thus, at various entry points in the economic system, e.g. input factor marketing, rural and urban food distribution, and industrial distribution, market processes can play both facilitory and stimulative roles in

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[27]President's Science Advisory Committee, "Report of the Panel on the World Food Supply," Vol. II, The World Food Problem (Washington, D.C.: U.S. Government Printing Office, 1967), p. 539.

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economic development. From a facilitory point of view, the role of marketing as a mediator between supply and demand means that changes in either supply or demand sectors must have incorporated with that change, alterations in the distribution system in order to obtain the most benefit for the total system. In the active role of directly stimulating change in the system, market processes are also important. Marketers who perceive price elasticities of demand, product adjustment to target markets and are willing to coordinate market channels, horizontally and vertically, can have significant impact on the consumption characteristics of demand sectors and production characteristics of supply sectors.

Rostow, Slater, and Riley especially have stressed the importance of viewing the economic system as a "national market" by forging much stronger links between the urban and rural sectors, whose welfare are so intimately linked, in order to improve resource allocation (including income distribution) and to stimulate growth. Rostow summarizes his notions of national market development.

> . . . That there are four major jobs that must be done, and they should be done simultaneously as part of a conscious national strategy, shared by the public and private authorities. The four elements are these: a build-up of agricultural productivity; a revolution in the marketing of agricultural products in the cities; a shift of industry to the production of simple agricultural equipment and consumers' goods for the mass market; and a revolution in marketing methods for such cheap manufactured goods, especially in rural areas.[28]

Without careful attention to the exchange process, market risks can inhibit investment, restrict supply and induce high consumer prices which impedes growth. Potential users of new technology or institutional innovators are faced with enough uncertainties without adding those which arise from a poorly coordinated marketing system where input availability and

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[28]Rostow, View from the Seventh Floor, p. 136.

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costs, product prices, channels, and demand are uncertain in consistency and character. When low capital reserves are added to the level of uncertainty, it makes the most progressive producer and consumer reluctant to accept the risk associated with innovative change.

Slater states that market process coordination points to a theory of internal market integration which can assist in the development process:

> If one postulates certain behavioral assumptions regarding consumers' propensities to consume, save and shop as well as producers; attitudes toward risk and uncertainty in relation to their output levels, a theory can be suggested:
>
> 1. Initial lower prices on frequently purchased goods as a result of
> 2. horizontal market coordination will
> 3. lead to vertical market coordination to assure supplies and
> 4. thereby cut producers' risks which
> 5. in turn can reduce selected producers' costs and
> 6. increase through output in the system.[29]

This thesis assumes that economic development can be driven by expanded consumption and shifting consumption function as well as by expanded investment, employment, income, etc. Selective market institution reforms can cut risk, induce investment, increase supply of consumer necessities, reduce prices, yet increase producers' incomes. This process of market coordination starts with horizontal market coordination at the demand end of the channel. An effort to stimulate the growth of modern discount food operators with a low margin-high volume philosophy combined with attempts to aid more traditional retailers is the entry point into the system. Some market institution reforms may displace labor in the distribution system even though the total level of wages generated in the system may rise. Thus, other coordinated labor absorbing activities may be needed.

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[29]Slater, "Market Channel Coordination . . . ," p. 5.

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The following Figure 1.1 suggests the complexity of the process involved.[30] This figure represents the hypothesized flow of change deriving from an emphasis on distribution activities and institutions in the economic system. Added to the entry point stated above in the urban food distribution system are three others: production and distribution of consumer oriented industrial goods; rural assembly market systems, and rural distribution system for farm inputs and consumer goods. The figure makes the interaction between these entry points evident.

A case could be made for market reform programs directed toward the rural assembly markets with improvements in physical facilities, transportation, storage and grading. Adding price stabilization programs and improved information systems could reduce production uncertainties and costs and, thus, stimulate production at lower prices -- providing price and outputs were such that markets could be cleared.[31]

Improved economic performance in rural production could also be made with the introduction of new technology in production. This could be started by increasing the availability, increasing information and knowledge, and reducing costs of industrially produced farm inputs. Not only would rural food output be increased but the higher level of industrial demand would generate increased output and wages in the urban industrial sector, thus expanding urban consumer demand.

The entry point into the industry sector is also important. Initiating marketing reforms in the production and distribution of low-priced

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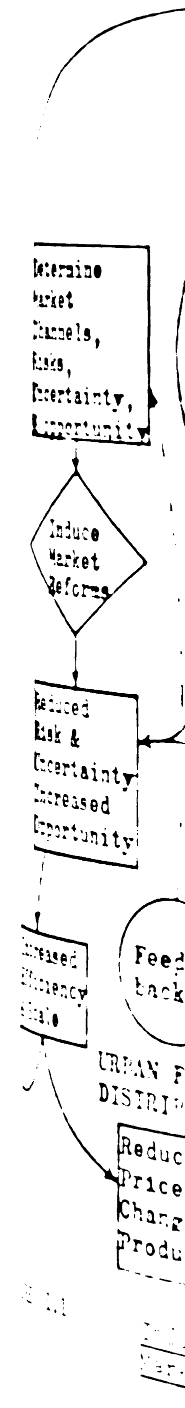
[30]Robert W. Nason, "Urban Market Processes in Recife Brazil", (unpublished Ph.D. Dissertation, Michigan State University, 1968), p. 35.

[31]Riley.



Determine Market Channels, Risks, Uncertainty, Opportunity
Induce Market Reforms
Reduced Risk & Uncertainty Increased Opportunity
Increased Efficiency
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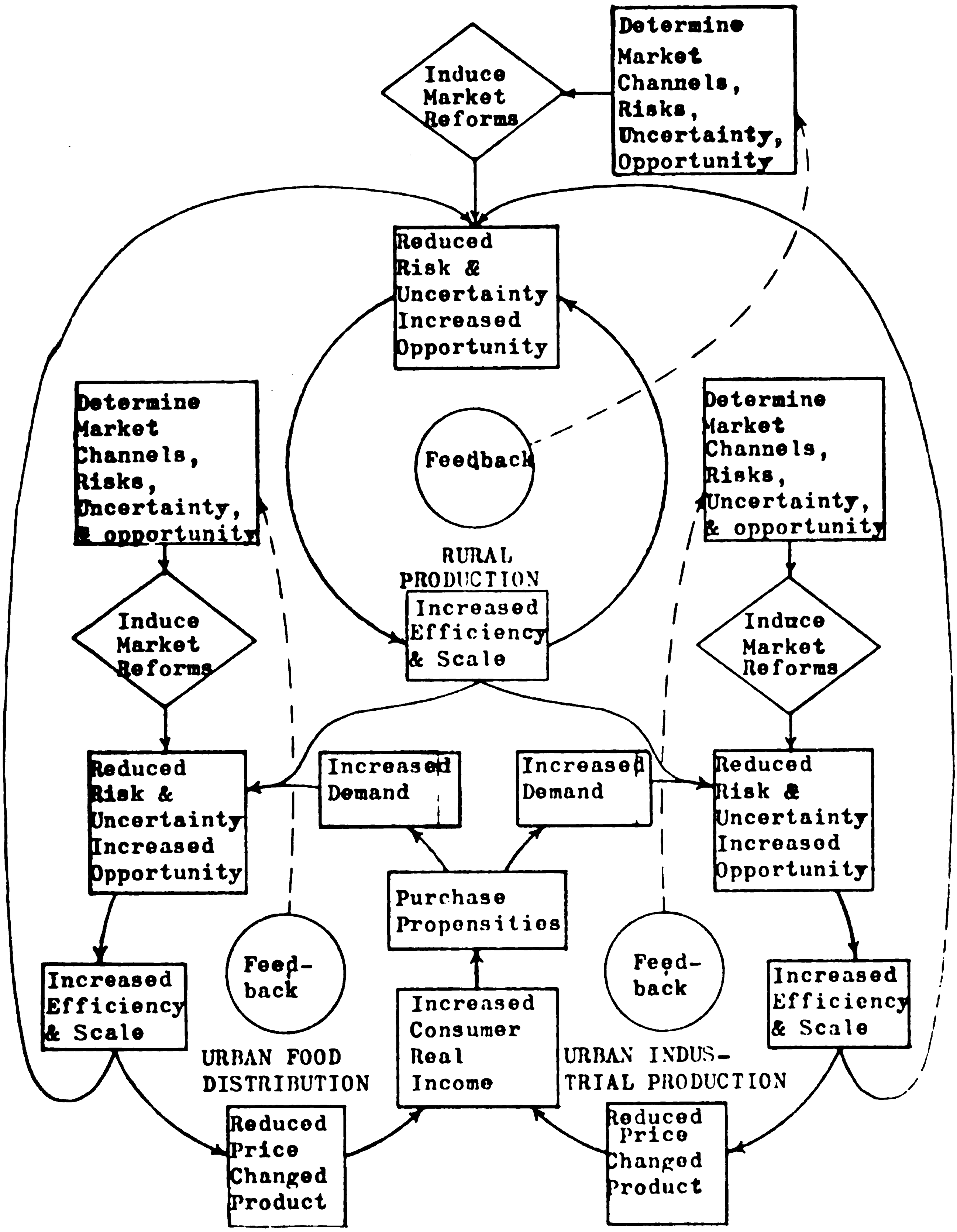

FIGURE 1.1 Inducing Internal National (Regional) Market Development

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consumer goods and simple agricultural inputs could lower prices and increase availability especially in the rural sector which could start the process of market coordination in the other sectors.[32]

However, the development achievements in all of the above areas could be limited by constraints in consumer purchasing power. Also an emphasis on a rapid technological changes, primarily in rural food production, could have a severe adverse effect on product prices as increased output meets relatively inefficient channels and inelastic consumer demand.

Thus, a more comprehensive and coordinated set of market reform programs are suggested to stimulate effective interaction between rural and urban areas.

Figure 1.1 contains more than the hypothesized economic structure of the process of market integration. Previous to actual entry into the system, research studies must be conducted to carefully map the flows of goods and information in the system, analyze the present institutional barriers to change, and diagnose the current risks and uncertainties which participants percieve limit their alternatives to change. Only after a careful description and diagnosis of the current system and how it interacts within sectors and between sectors can the appropriate combinations of market reform programs be formulated and then induced. The complexity of the economic process alone is great and when combined with the steps of information gathering and analysis, program formulation, and implementation into that complex system, the task facing the development planner is obviously intricate and uncertain.

The complexity of the development process in general and market process coordination specifically is evident. As stated, it may be fairly

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[32]<u>Ibid</u>.

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easy to assess the first order impact of change but, when inter-sectoral and dynamic interactions are added and multiple entry points considered, the development decision-maker needs some kind of analytic tool to assist him in keeping track of these interactions. The nature of market processes, the need to analyze the costs and probable benefits of market process changes, and the desire to build a tool which is usable and understandable to the planner, place certain requirements on the type of model which should be developed. The next section outlines the requirements for a model that arise from the three factors stated above. These requirements then become the operational goals toward which this modeling effort is directed.

The Requirements for the Model

If market development programs are to take their place alongside the other major development strategies then the full benefits of internal market coordination must be explicitly defined. The lessons learned in the Puerto Rican phase of the research work showed the need to develop a tool which more broadly assesses the impact of market changes in the distribution sector as well as in the supply and demand sectors of the system. When dealing with market processes it is impossible to analyze just one sector or sub-sector of an economic system. By definition the process deals with the interaction between sectors in the system. Of prime importance are the linkages between the rural and urban sectors.

Further, analysis within sectors is crucial. For example, with improved urban food distribution through modernization a negative income effect could be generated due to displacement of marginal traditional retailers. For the planner this negative effect could have repercussions beyond economic considerations depending on the power of the traditional retailers in the community. Certainly, it is important for any model not these kinds of sub-s

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to bury these kinds of sub-sectoral effects when analyzing reform alternatives. At the same time shifts in consumer buying characteristics, the degree to which modern techniques supplant traditional ones in food production, industrial plant capacity within very specific industry types relative to effective demand are important considerations in evaluating the costs and benefits of market process coordination. Information of an aggregative nature is also important in such areas as gross regional product growth, tax revenue generation, and the net import/export balance.

Thus, if the full benefits of marketing reforms are to be understood analysis must be allowed at various levels of disaggregation. At each level the decision-maker requires detailed systematically organized information within the scope of his assumptions about: the current system, what the system can expect to be like if no reforms are implemented, and what the system would be like given the implementation of market reforms.

By their nature programs to change present market processes cause interdependent and dynamic effects on the economic system. The model should be able to permit the decision-maker to analyze first, second, and third order change taking place in the system as a result of programmed change. First order change is the analysis of change within the prime sector in which the reform is implemented. Second order analysis is of change between sectors of the economic system. And third order change is the analysis of change over time as effects cumulate and multiply.

To be of maximum value the model should allow the planner to enter the model at various "entry points". Market coordination can be started at the various points in the system initially or in a combination of entry points at more than one place in the system. Thus, the ability to compare expected outcomes of change initiated at different points in the system is important.

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Besides describing the environment the development planner decides on what changes to make, how and where to make them in the system, and what resources are necessary and available to implement the program. Then he must be able to predict the effect of those changes imposed on the system. In doing this the planner at least implicitly, makes assumptions on the relevant variables, their magnitudes and the relationships between them, Thus, the model should assist in the planning process by forcing the decision-maker to make his assumptions more explicit. Further, the steps between understanding the system, developing a program for change which relates policy variables to the key change variables in the system and the implementation program are often difficult to link effectively together. The utility of the model is determined practically by how well it assists the planner in coordinating these three steps in the planning process.

The planner should be able to participate actively in the development and use of the model. In order for the planner to justify his use of the model, he needs to understand the methodology, structure, and assumptions. Also active planner participation in all phases of the modeling work is necessary to insure that the variables and relationships included are those believed important to the decision-maker and not just to the modeler.

Most decisions are not made by one planner alone and the participants in the decision are not frequently in complete agreement on the assumptions or and structure of the system. This means that the model should be able to incorporate more than one set of economic assumptions and at the same time form a basis for forums between the development planners in building development policy and programs of reform.

Finally, a model should never be considered "completed". While the information on which this model is built is better than in the previous model, it is stil

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Puerto Rican model, it is still very imperfect. As methods of information gathering and parameter measurement improve the model ought to improve with them. As changes take place in the system which reinforce assumptions made or demonstrate that errors have been made it is imperative that the model structure be flexible enough to permit corrections and refinements. Therefore, the model must be structured to permit refinement in one or more sectors while not forcing a totally new structure for the entire model. This requirement is imperative if the model is to be viewed as a long range effort to improve the understanding of market processes and to increase the level of planning sophistication associated with evaluating alternative development policy programs.

In summary, the desire to build a model which can assist the planner in evaluating the positive and negative impact of reforms in market process coordination within all parts of the economic system leads to a set of at least eleven requirements. They provide the goal framework in which this model was built.

1. The model structure should permit the comparison of marketing reforms with reforms suggested by other development strategies.

2. Anytime the model is simulated on a computer, it should give the planner detailed sets of economic information about all levels of change occurring in the system.

3. Analysis must be permitted at various levels of disaggregation from small sub-sectors to the total system.

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4. First, second, and third order effects of hypothesized development programs must be measurable.

5. The model should allow the decision-maker multiple entry points into the system in order to evaluate various strategies.

6. The model should be structured with variables and relationships defined in such a way that they force the planner to be more explicit and logical in his evaluation of reform alternatives.

7. Parameter variables must be operationally defined and very clearly evident so they are understandable to the planner and data can be gathered on their current values and expected values.

8. The model must be built to assist the decision-maker in evaluating his alternatives as he moves from description to investment policy programs to explicit implementation plans.

9. The planner must be able to actively participate in building and using of the model.

10. The model should be structured to allow variation in economic assumptions between simulations.

11. The model should be problem oriented and flexible enough to permit major structural refinements in one sector without having to re-do the entire model.

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A Review of Other Modeling Efforts

Before beginning the description of the Recife Systems Model, a brief review of other modeling efforts which helped shape the Recife model is presented. The emphasis is on their general orientation and the direction to which they point for further refinement and application. The work of Koenig and Griggs provided the primary modeling framework for this effort and thus they are stressed in the following review.

Simulation and Systems Analysis

Modern management quantitative techniques such as "critical path analysis", PERT, simulation, and systems analysis are presently being utilized by some decision-makers in planning economic development. Simulation of economic systems has evolved as one of the most interesting and potentially powerful tools available for analyzing economic problems. Through simulation techniques the economist, researcher, or planner has the means for observation and experimentation which have long been the essence of the approach of the physical scientist. Building and running a simulation model permits observation of the dynamic behavior of a system under controlled conditions, and experiments may be run to test hypotheses about the system under study.

Systems analysis stresses an integrative approach to aid a decision-maker in choosing a course of action by systematically investigating his objectives, comparing quantitatively where possible the costs, effectiveness, and risks associated with alternative policies or strategies for achieving them[33]. General systems theory according to Boulding is:

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[33]E.S. Quade (ed.), Analysis for Military Decisions (Santa Monica, California: The Rand Corporation, 1964), p. 4.

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> The skeleton of science in the sense that is aims to provide a framework or structure of systems on which to hand the flesh and blood of particular disciplines and particular subject matters in an orderly and coherent corpus of knowledge.[34]

"Systems theory", as used in this thesis, identifies a specific formalized mathematical methodology developed in the physical sciences.[35,36] Using the technique of systems theory a physical system can be "built" in mathematical terms and its behavior analyzed on a computer prior to its actual construction.[37] Applications to non-physical systems have been relatively limited. Such diverse "systems" as a university, a recreational system, a church, and a company have been studied using systems theory as a basic research technique.[38,39,40]

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[34]Kenneth Boulding, "General Systems Theory: The Skeleton of Science," General Systems, Vol I, 1956, p. 17.

[35]Herman E. Koenig and W.A. Blackwell, Electro-Mechanical System Theory (New York: McGraw-Hill, 1961).

[36]H.K. Kesavan and P.H. Roe, Networks and Systems (Waterloo, Ontario: University of Waterloo Press, 1963).

[37]There are many books and articles on the theory of system analysis. Two sources are suggested. For the highly technical analysis of the theory, see: Herman E. Koenig, et.al., Analysis of Discrete Physical Systems (New York: McGraw Hill Book Company, 1966). For an excellent qualitative description of the meaning and structure of systems analysis, see: Griggs, Chapter IV.

[38]Thomas J. Manetsch, "Simulation and Systems Analysis of the U.S. Softwood Plywood Industry," (unpublished Ph.D. dissertation, Oregon State University, 1964).

[39]J.R. Ellis, "Outdoor Recreation Planning in Michigan by a Systems Analysis Approach; Technical Report NO.I", State Resource Planning Program, Michigan Department of Commerce, (May, 1966).

[40]Frank H. Mossman, and Robert J. Gonzales, "Investigation of the Application of System Theory to the Capital Budgeting Problem, Working Report No. 1", East Lansing, Michigan, Michigan State University, (May, 1967).

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However, those familiar with the methodology of systems theory do not claim that its application will lead immediately to the development of sophisticated models of socio-economic systems. Griggs states:

> The basic value of systems theory in modeling socio-economic systems as this stage . . . is in the structured approach it provides for the development of a mathematical model. The methodology provides a technique for constructing a model of a system as an explicit function of the behavior of the identified components and their interactions.[41]

Other Modeling Efforts

Attempts to build reasonable disaggregated models of economic processes for practical applications to the analysis of growth and structure within an economic system have had an impressive and well-documented history. The Keynesian revolution, the investment oriented growth models by Harrod and Domar, detailed inter-industry (input/output) analysis of Leontieff, and national income models have expanded the scope and flexibility of economic analysis.[42,43]

Econometric models of the type developed by Duesenberry, Fromm, and Klein employ relatively sophisticated statistical methods to estimate the parameters of equations and build the structure of the models.[44] The models consist of listed equations with parameters determined from such methods as simple and multiple regression analysis, linear programming, and various physical system analogs. Simulation models of economic

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[41]Griggs, pp. 50-51

[42]Evsey D. Domar, "The Problem of Capital Accumulation", American Economic Review, 37 (December, 1948).

[43]Griggs develops an outstanding analysis of both input/output models and national income models in: Griggs, pp. 28-46.

[44]James S. Duesenberry, et. al., The Brookings Quarterly Economic Model of the United States (Chicago: Rand McNally and Company, 1965). See also: L.R. Klein, "The Social Science Research Council Econometric Model

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processes such as the Venezuelan simulation model developed by Holland and Gillespie, on the other hand, use planner and researcher knowledge of the system, historical data, trial and error, or simple statistical procedures to make the needed estimates.[45] Tustin's early work helped bridge the gap between econometric models, simulation models, and system models. He emphasized the similarity between the flows in economic systems and in electrical control systems.[46]

Holland's Venezuelan Model

Holland and his associates in accompanyment with local Venezuelan counterparts developed a series of simulation models of the Venezuelan economy directly oriented to the planner for use in studying the nation's development strategy.[47]

The major version of the model Holland develops combines current macro-economic theory, planner judgements, and historical information in the determination of its structure and parameters. The model is dynamic in character in that most variables vary continuously through time and the relationships in the dynamic process do not necessarily force an equilibrium solution.

The model is composed of three sectors: the petroleum sector, the public sector, and all nonpetroleum enterprises. Both determination of

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of the United States", Econometric Analysis for National Economic Planning (London: Butterworths, 1964), pp. 129-169.

[45]Edward P. Holland, and R.W. Gillespie, Experiments on a Simulated Underdeveloped Economy (Cambridge, Mass.: MIT Press, 1963).

[46]A. Tustin, The Mechanism of Economic Systems (Cambridge, Mass.: Harvard University Press, 1953).

[47]Holland, Dynamic Models . . . .

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current output and capital formation are considered. Consumption functions, import functions, and governmental income and foreign payment accounts are used to complement the emphasis on the petroleum and public sector. The model is highly aggregative and oriented to the analysis of the economy's relation with the "outside world" more than with the internal structure of the economic system. Various levels of government expenditures and investments combined with differing values for petroleum exports and prices are simulated in order to determine their impact on the three interrelated outputs of government revenues, inflation, and balance-of-payments.

The authors suggest that a model with higher disaggregation should be built and they outline its structure, which stresses the use of a "social accounting matrix" similar to that developed by Richard Stone in the Cambridge Growth Project.[48] But with all the disaggregation, no mention is made of the importance of the exchange process. Holland's contribution demonstrates that quantitative modeling can be applied to economic systems and shows the importance of orienting a model to the development planner. As he admits, the model is less than optimal, but it is a working simulation related to a "real world" situation.

Nigerian Beef Industry Model

Manetsch, Hayenga, Johnson and Halter are part of an interdisciplinary team which is developing a computer simulation model of the Nigerian agricultural economy. It is their ultimate effort to construct a model of the total agricultural sector by building individual component models and then linking them together to form a model of the system. The initial attempts have been focused on a more micro-model of the beef industry.[49]

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[48]Richard Stone, A Programme for Growth-3 Input-output Relationships (Cambridge, Mass.: The MIT Press, 1962).

[49]Glen L. Johnson, Thomas J. Manetsch, et. al., "A simulation Model

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The purpose is to use this model as a testing ground for future work and as one segment of a larger model.

The model is largely production oriented with only rudimentary consideration of the related distribution and input sectors. The major component in the model describes the beef production system under alternative management policies of modern and traditional conditions. In the simulations, various policy alternatives are used such as expenditures on tsetse fly eradication, land allocation between cash and animal feed crops, the development of grazing reserves, and output prices. Various combinations of the policy parameters cause different degrees of shifting between the modern and traditional production sectors. The results of the simulations are presented as performance criteria such as discounted return on investment, foreign exchange generated, nutrient output of production, and income generated to the farmers. This modeling effort again demonstrates the ability to construct a working model oriented to development planner. Further, the inclusion of modern and traditional sectors and specifically stated performance criteria point to important directions of concentration for the Recife Systems Model.

Though a micro-oriented model such as the Nigerian Beef Industry Model permits rather detailed analysis of a single industry, it does not permit the analysis of the interrelated parts of the total system. Mantesch and his associates are approaching the building of a more general model from small pieces. Though the ultimate aim of this modeling effort and the Recife Systems Model are similar the paths of approach are from opposite directions. The Recife Model must begin with a macro-oriented model in order to assess the impact of the exchange process on development. Future

of the Nigerian Agricultural Economy: Phase I - The Northern Migerian Beef Industry", A progress report to the Agency for International Development, Contract Number AID/csd - 1557, Michigan State University, (April 26,1968).

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50 W.G. Keeney, H.E. K... ...(East Lansing, ...State University, J...

51 Ibid., p. 1.

refinements in the Recife model will come from developing individual sectors more definitively and improving behavior assumptions.

A Systems Model of Higher Education

Koenig's work on the development of a system model for higher education was one of the initial attempts to build a system model of a socio-economic process directly oriented to planners.[50] Major objectives of the higher education model were:

> 1. First, by analysis of the existing structure and procedures, the relationships of the various components of the institution are clarified, and the patterns by which university administrators currently allocate scarce resources to meet constantly changing demands are described quantitatively. The model reveals trends or changes in demand, output, and policy-making which have been and are occurring. It identifies those variables which might be termed the control variables of the system i.e. those factors which may be manipulated by policy makers . . .
>
> 2. The mathematical model serves as a guide in policy-making for the future, and provides a tool for experimenting with alternatives in allocation of resources as demands and needs change.
>
> 3. A well-constructed and properly designed model can also serve as a building block for simulating the interaction between institutions of higher education and the national economy. In this role it serves as a tool for investigating the demands placed on education by economic and social development, and for experimenting with alternative national policies relating to the development of higher education in response to economic and social changes.[51]

Koenig's effort is clearly oriented to the planner. He is not developing a model as a theoretical statement but as a practical aid to decision-makers.

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[50]M.G. Keeney, H.E. Koenig, R. Zemach, State-Space Models of Educational Institutions (East Lansing, Michigan: Division of Engineering Research, Michigan State University, January 23, 1967).

[51]*Ibid*., p. 1.

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52 Ibid., p. 5.

Keonig stressed the importance of looking at the model as only one tool for the planner where the results must be "weighed or tempered by less tangible considerations".[52]

The structure of the model contains the demand sectors which describe the demands placed on the system by the students in various academic programs, and production sectors that supply credit hours of education and research used in teaching or as an exogenous output to other systems such as government. In order to produce the output of education and research the inputs to the production sector consist of various resource combinations of man-hours of faculty and staff, support facilities, non-academic programs, and graduate assistants.

For the total system the "internal states" consist of student enrollment levels and areas and the imputed costs per student. The inputs into the system are man-hours of faculty and staff, capital investment in facilities, and fellowship and research grants. The outputs then are the students leaving the system at various levels and the exogenous output of research. The basic flows in the system include credit hours, research-teaching, and important "feedback loop" denoting the use of graduate assistants in the production sector while they are a part of the student demand sector.

The pioneering work of Keonig to apply the methodology of systems theory to the analysis of socio-economic problems has formed the guide for the model presented in this thesis. He has continually emphasized the importance of orienting model building to the decision-maker and his work has shown that effective communications can be developed between decision-makers and modelers.

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[52] Ibid., p. 5.

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The Puerto Rican Model: A Macro-Model of Market Processes

The first explicit attempt to use system theory in the analysis of market processes was conducted by Griggs. The model, called MOD II, which evolved from the Puerto Rican phase of the LAFS project was the first model to include a separate distribution sector between the production and consumption sectors of an economy. MOD II represents a major breakthrough in the systematic analysis of market process change in developing countries. Its primary purpose was to evaluate the income-employment effects of reforms in the marketing system. Griggs states the primary problem he attempted to resolve:

> One of the many problems which faced the research team was the development of analysis tools to provide for emperical estimations to the effects of changes in the food marketing system of Puerto Rico.[53]

The model developed by Griggs adapted existing national income models and input/output models for use within the framework of systems theory. For the general modeling effort input/output models were found inappropriate because the distribution process was not treated as a productive sector. Value added by distribution was typically included in the production sectors. Also national income models lacked the ability to analyze the effects of market reforms because the prime drivers in these types of models are financial in nature rather than price and output oriented. But each type of modeling approach had parts which were useful in developing the Puerto Rican model. Griggs combined the demand orientation of the national income models, the flexibility of input/output analysis to deal with inter-industry transactions,and the ability to systems analysis to describe the behavior of a collection of components

[53]Griggs, p. 3.

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Ibid., p. 72.

Ibid., p. 128.

which function interdependently to construct the simulation model. MOD II is a simultaneously solved set of 38 equations, able to analyze the gross impact of market process changes on the Puerto Rican Economy.

MOD II is composed of three basic sectors: production, distribution, and consumption. The production sector is composed of two sub-components: food production and non-food production. The distribution sector contains sub-components for distribution of food and non-food through retail and wholesale channels. The consumption sector is characterized by three consumer classification representing high, middle and low income groupings. Figure 1.2 presents the structure of MOD II.[54]

The components are linked by vectors which define the flow (quantity) and propensity (price) characteristics. In order to test the impact of changing prices on consumers and producers it was necessary to develop some unique definitions of units and prices for aggregated mixes of food and non-food goods. A common unit of goods was defined as the amount of food or non-food consumed by an average family in one year with the price then representing the value of those expenditures in one year. The flow unit of wage income was chosen to be the number of workers in a sector whose agerage wage per year defined the price.[55]

The production sector uses input/output techniques in the determination of the intermediate demand between the food and non-food producing units and adds to that intermediate demand final demands placed on it from the distribution sector, government, and exports. Both wage and non-wage incomes are generated in this sector along with the level of import necessary given demand and inter-industry transactions.

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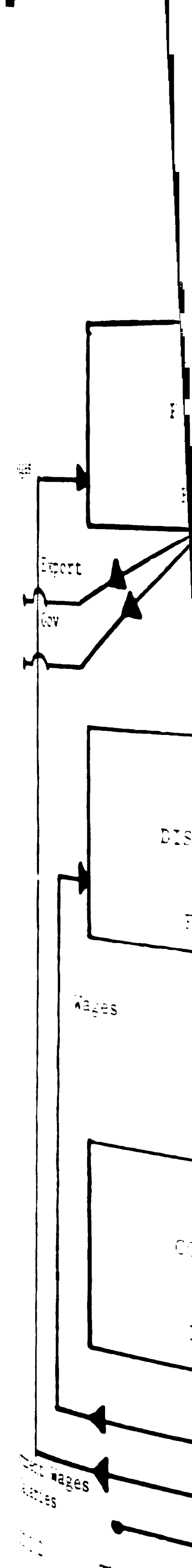
[54] Ibid., p. 72.

[55] Ibid., p. 128.



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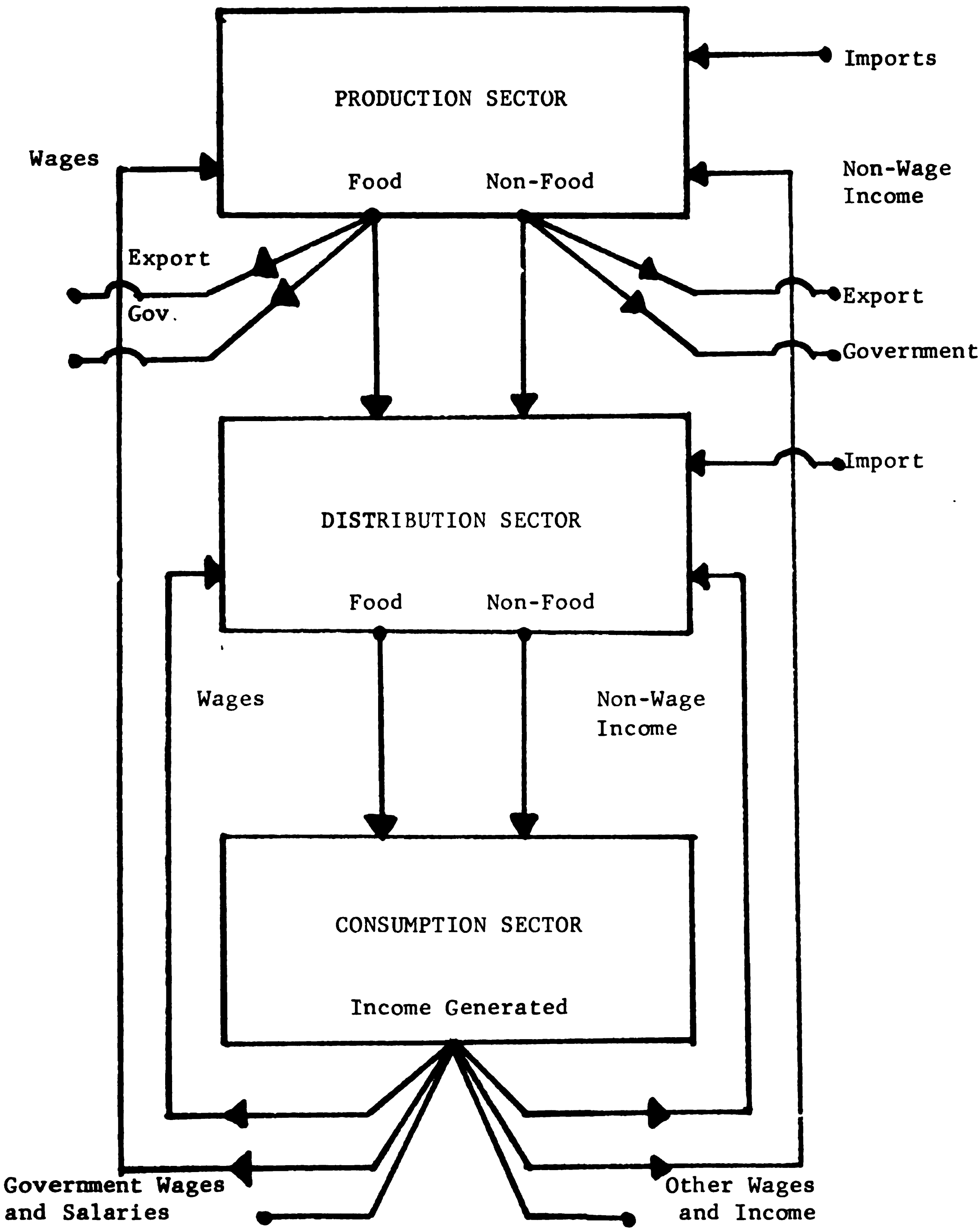

FIGURE 1.2 The Sectors and Flows Defined in MOD II

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In the distribution sector, inputs from the production sector, imports and wage income are related to final sales in a "unit to unit" ratio of inputs to outputs. Importantly Griggs also develops the imputed costs of producing one unit of output given the costs of the inputs stated above. A margin is added over this imputed cost to give the price per unit of output to the consumption sector. This margin reflects an approximation of value added in distribution. Multiplying units of output and prices per unit gives total sales of food and non-food. The distribution sector also determines the units of labor input and the value of that input along with non-wage income.

In the consumption sector, income is generated from the production sector, distribution sector, government and other non-wage incomes. This is split between the three income classes defined and multipled by the average propensity to consumer food and non-food in each class to give final expenditures.

Simulation of MOD II results in the solution to the sets of simultaneous equations defining the model structure. The model is designed to "indicate the level of output and income generated by any specified set of production and distribution technical coefficients and prices, as well as specified consumption propensities, income level and income distribution."[56] The effects of changing margin over imputed costs, the technical coefficients for labor in distribution result in alternations in the price and quantity of food and non-food purchases, income level, employment in production and distribution, and level of imports. Interrelated sets of reforms combining changes in both distribution and production/importation can also be analyzed. For example, the effect on income, prices and quantities of food purchases with changes in the level of importation and

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[56]Slater, "Market Channel Coordination . . ..

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a concurrent program to modernize the distribution sector causing lower labor technical coefficients and margins. Taxes and investment are exogenous to the model and can only be indirectly indicated.

Griggs showed clearly that systems analysis, as a technique, could be applied to the analysis of socio-economuc systems, especially the analysis of marketing in economic development. Griggs discusses the problems of aggregation, behavioral relationship development, and an adequate information base. In concluding his thesis, Griggs makes four recommendations:

> First, it is suggested that improvements be made in the model itself. The assumptions made about the behavior of the defined sectors of the model need to be improved; in the same vein, the sectors of the model need to be treated in a more disaggreated form.
>
> Second, it is suggested that the data collection and measurement problems be addressed in greater detail. A systems model, such as MOD TWO, needs information on the actual flow pattern of goods. Current information sources report little on actual flow paths nor is data presented in both unit and price per unit terms. Further research into the types of measurement definitions usable for the flow and propensity variables needs to be conducted.
>
> Third, the problem of the valuation of the costs incurred in a specific parameter change or set of parameter changes needs to be considered. The cost of altering certain parameters must certainly be viewed as part of the problem in evaluating the results of a marketing change.
>
> Fourth, it is suggested that future models developed be more directly usable by those in a decision making capacity. This would involve, perhaps, greater ease in altering parameter values and interpreting results.[57]

Summary: The Recife Systems Model Builds on the Puerto Rican Model

In summary, many efforts to model economic processes have influenced the structure and use of the Recife Systems Model. But the model builds most directly on the Griggs's Puerto Rican model. The Recife Systems Model carries forward the modeling of market processes in economic development by concentrating on the four recommendations stated above.

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[57]Griggs, p. 184.

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First, the Recife model is much larger and more disaggregated to permit more refined definitions of behavioral relationships. Where the Puerto Rican Model was a simultaneous solution to 38 equations, the Recife Systems Model utilizing a sequencial solution of more than 3,000 equations and identities.

Second, in order to solve the data collection and measurement problems faced by Griggs, the Recife Systems Model was directly integrated into the large scale survey research effort in Recife. The research gained from being forced to develop compativle, systematic, and operational parameter information required by the model. The modeling effort gained the most, however, because from the large quantity of data collected by the research team the structure and inputs for the model were determined.

Third, relating the evaluation of investment costs, implementation plans, and the impact of the various policy variables on the economic system was attempted in the Recife model. Through the use of specifically defined "planner routines" and decision routines the problems associated with linking the programming of investment and planning policy to the key parameters in the model while not solved is at least made very explicit.

Last, the need to make the model directly usable by those in decision making capacities was the central concern in building the Recife Systems Model. The way in which sectors are structured, variables defined, and relationships assumed was determined largely by their applicability to planner utilization of the model as an aid in program analysis. The "planner entry routines" and decision routines were specifically included to assist the planner by allowing variability in economic assumptions and forcing the decision-maker to be explicit in his assumptions relating the policy variables such as investment, technical assistance, credit, and tax rate to the economic process under study. The planner has the ability his own assumptio

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Thesis Organization

This chapter has presented the frame of reference in which this modeling effort should be viewed. The importance of analyzing the costs and benefits associated with changes in market process coordination, the need to offer the planner improved analytic tools to evaluate this complex process, and the large scale research work done in Recife, Brazil determined the nature and scope of the Recife Systems Model developed in this thesis. The work of Keonig and Griggs in developing general systems models formed the technical foundation on which this model was built. The remaining chapters of this thesis describe in detail the structure of the Recife Systems Model and how it was used.

Chapter II presents an overview of the model. Included is a general description of each sector and many considerations which overlap sector lines. Chapter III through VI detail the structure of each sector: Chapter III the Consumption Income Sector; Chapter IV the Distribution Sector; Chapter V the Industry Sector; Chapter VI the Rural Sector, the Other Recife Sector, and the Import/Export Sectors. In Chapter VII the planner oriented characteristics of the model are presented in detail including "planner entry routines", decision routines and the Investment Sector.

Chapter VIII presents a general analysis of how the Recife Systems Model can be used and then describes some illustrative reform simulations suggested by the research work done in Recife on market process coordination.

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Chapter IX summarizes and concludes the thesis. The explicit mathematics of the model, parameter evaluation used in the illustrative simulations, and examples of the computer print-out are included in Appendix A and Appendix B.

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CHAPTER II

THE RECIFE SYSTEMS MODEL:
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Introduction

The Recife Systems Model is an economic planning model of a regional sub-sector of Northeast Brazil. The methodology of systems analysis and the technique of computer simulation are combined in the construction of the model which focuses on the exchange relationships between urban Recife and its primary rural "foodshed". Within the framework of market process analysis, the purpose of the model is to assist development decision-makers in choosing a course of action after systematically investigating objectives and comparing potential economic cosequences associated with alternative policies or strategies for achieving the objectives.

The structure of the model is divided into two major categories. The first is the basic internal economic structure of the system under analysis containing the central economic sectors, their internal characteristics, and the flows of goods and services between the sectors and the rest of the world. The second major category centers on the planner oriented characteristics of the model. "Planner entry routines", decision routines, and an Investment Sector provide the means by which the user of the model enters the system to alter economic relationships and evaluate potential reform programs.

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The Recife Systems Model has certain characteristics:

1. The model is oriented to the analysis of change. It is structured so that change can be assumed within the internal system or exogenously induced from outside the system.

2. The model is predictive in the sense that it evaluates the effects of various selected reform options on the current economic system.

3. An effort has been made to provide structural flexibility in the model to permit the analysis of multiple inputs and interrelationships. However, the flexibility was limited to preserve identifiable relationships between the model's inputs, functional interrelationships and outputs.

4. This model is oriented to "economic activity" in that every variable, relationship and component serves to improve the description and analysis of the type of goods flowing through the system, their orientation and destination. Thus, costs, flows, mix, and stocks of economic goods are of central concern.

5. The model is mathematical in that all relationships are in either quantitative mathematic form or math logic statements.[1]

The Internal Economic Structure

The internal economic structure of the model contains basic accounting identity relationships, behavioral assumptions central to the analysis of market reforms, and other relationships necessary to facilitate the analysis of those market oriented reform programs.

There are two distinct levels in the internal economic structure of the model. The first level consists of defining the basic internal economic system via a graphic description of the economy. This includes defining

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[1]The technical math is not presented in the description of each sector of the model (Chapters III to VI) but instead are included in Appendix A. Appendix A contains the equations for the model in verbal format, examples of the printout, and general comments on the technical aspects of the computer program for the model.

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the boundaries of the system, determining which sectors to include, the components within sectors considered important, and the inter-sector flows of goods and services which link sectors within the system. Thus, this first level is a simple map or topography of the economic system which defines basic identities. An example of this type of identity would be taking the flow of income to a consumer group, splitting that flow according to average propensities to consume food, consumer goods, and other expenditures plus savings, then splitting food expenditures by location of purchase.

The second level of the internal economic structure is the set of behavioral assumptions which make the economic system act as it does. The factors determining output of industry classes, the relationship between consumer prices and consumer location of purchase are examples of important functions to consider. There are a wide variety of interactions which could be developed, each with varying degrees of complexity. It is important to stress those relationships which are most relevant to the particular problems under analysis. For the Recife model, market process is central; thus, emphasis is on margin, spoilage, purchase behavior and food production rather than production functions for capital goods industries.

If the model is to be oriented to planner use, it is important to permit the user of the model wide latitude in determining the magnitude and content of behavioral relationships. The user of the model may want to test the effect of a program under a variety of hypothesized behavioral reactions to the change. And, when evaluating different policy programs, the user may want to stress the importance of different behavioral relationships. What variables are included in a given relationship and the accuracy demanded from that relationship varies then with the kind of analysis undertaken and the nature of results desired. For example, if program centers on

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a reform program centers on changes in food distribution the accuracy of production functions for consumer goods is much less important than if the market reforms were consumer goods oriented.

Therefore, instead of rigidly defining all of the behavioral assumptions, the internal structure of the model provides a flexible structure to the user. This flexible structure permits the user to change the degree of relationships between variables, add other variables to a relationship perceived important in the analysis of particular programs or reform situations, or build entirely new relationships, without altering the basic internal model structure.

For example, in the determination of food production special modern and traditional producers are defined with a very simple transition relationship between the two which moves land from traditional to modern production. But the extent to which the switching would take place as a function of such variables as fertilizer availability and output prices is left open for the user of the model to define. This might be done through consultation with "experts" in the area or after completion of specific feasibility studies. (The internal structure of each sector is detailed in Chapters III through IV).

Planning Oriented Characteristics of the Model

The planning oriented aspects of the Recife Systems Model also can be classified into two rather distinct levels. The first is user's ability to change or refine the behavioral assumptions within the internal structure.

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The second is in the nature by which the planner controls or influences the behavior of the system through use of the policy tools available to him.

As stated previously, the internal structure of the model is built to allow the user to refine, add to, or change many of the behavioral relationships assumed in the internal structure. The flexibility retained in the internal structure places an added burden on the user of the model. He must decide, through research, experience, or hypothesis, the final composition of the behavioral characteristics of the economic system. In order to facilitate this process, "planner entry routines" are developed which are clustered around the internal economic structure of the model. These routines are the focal point of planner interaction with the model. Most data inputs required by the internal model structure can be determined in the "planner entry routine" (PERs); thus, they offer to the user the ability to vary a wide range of behavioral and structural conditions in the system. For example, the labor demanded by a particular industry type is a function only of its output in the internal structure. It is structured, however, to permit the user to expand that relationship to include a variable such as level of capacity utilization. This relationship would be developed in a "planner entry routine" (or PER) as an input to the internal model structure. Any number of PERs can be built and attached to the core structure in this way.

In the present model two PERs are developed -- Decision Routine-Consumer I and Decision Routine-Capital II. The purpose of both routines is to allocate any short-run differences between local supply and demand according to a predefined set of decision rules. Consumer I allocates supply and demand differences between the Industry and Rural Sectors and the urban Distribution Sector for food and consumer goods, and Capital II short-term supply a

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handles short-term supply and demand differences for capital equipment, farm inputs, and construction materials -- all investment oriented goods. (See Chapter VII - Page 170).

The second level of planner orientation is in control. (In the sense of a means to guide or influence the behavior of a system.) Given the system's economic behavior, the planner must relate the tools at his disposal, policy variables such as taxes, credit, investment incentives, or technical assistance, to their impact on the economic behavior of the system. "Planner entry routines" are also used to develop this link between policy variables and economic behavior. An Investment Sector is included in the model to provide the framework in which these important relationships can be structured (See Chapter VII - Page 174).

Thus, by utilizing PERs already developed or by building others, the planner can assess the impact of various economic assumptions or evaluate the effect of different hypothesized policy programs on the behavior of the system over time.

With this brief introduction to the nature of the Recife Systems Model structure, the internal economic structure of the model is described first in general and then sector by sector, followed by an analysis of the "planner entry routines" and how they affect the structure and use of the model.

The Internal Economic System

Defining the System

In defining the system for the model, the interaction in the two-way flow of goods between urban and rural areas is of central importance. The boundaries of the economic system included in the Recife Systems Model along geograp

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are defined along geographic lines: the urban center of Recife and the four states immediately around Recife of Pernambuco, Alogoas, Sergipe, and Paraiba. The metropolitan area of the country of Recife with a population of about 1.5 million people is the largest urban concentration in the Northeast, and it is the major "supply town" for the surrounding four states for both locally produced goods and imports. The rural area has a population of approximately nine million people with two-thirds living on farms and the remainder in cities and small towns in the region. This rural area is the primary supplier of staple food items to Recife. Any larger rural area would have forced the inclusion of another large metropolitan area: Salvador in the state of Bahia to the south of Fortaleza in the state of Ceara to the north.

The rural area supplies Recife with food, raw materials, and some consumer goods for urban industry, distribution, and final consumption. In turn the urban center provides rural production and consumption with consumer goods, processed food, and agricultural supplies and equipment from its industrial and distribution base, as well as financial and logistical support. Import and export sectors link the defined economic system to the other parts of the Northeast, Center-South of Brazil, and international markets. Most importation and exportation go through the port of Recife or a few major assembly markets near Recife. The inclusion of import and export sectors is extremely important because a significant amount of regional income is generated in the export of commodities such as sugar and cotton; and, on the other hand, the region is dependent on the Center-South of Brazil for some food products, much of its consumer goods demand, and all capital equipment.

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Defining the Sectors

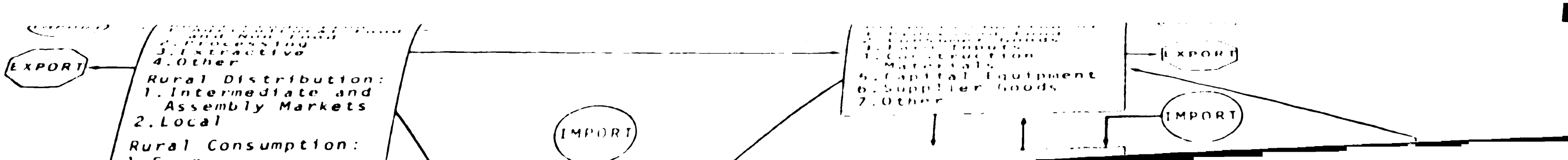
The basic unit in the internal structure of the model is the "sector". There are many potential ways in which the system can be broken down into sectors. The defined sectors in the Recife Systems Model are built relative to the major problems to which the model is oriented, the data base available, and the limits of computer capacity.

The primary economic sectors in the model are the Consumption-Income Sector, the Distribution Sector, the Industry Sector, and the Rural Sector. These sectors form the central economic structure of the model, and were the focus of the LAMP/LAFS Research project. They are the sectors included in the most detail and are those for which reforms are simulated and their major impacts measured. Because of the importance of importation and exportation, an Import Sector and an Export Sector are defined. In order to "round out" the structure of the system a conglomerate Other Recife Sector is built to facilitate the analysis of the interactive and dynamic effects of selected reform alternatives on the total system.

The Mapping of Flows

Figure 2.1 shows the interconnection pattern between all the sectors in the model. The lines (edges) represent the flow of a vector or group of goods between the economic sectors. Each flow is an input to some sector and an output of another. Criteria for the inclusion of a flow edge between any two sectors were:

1. Is there a significant flow in the current system?
2. Is it likely that there will be a significant flow in the future?
3. Would any of the reform options or other hypothesized changes in the system warrant the use or development of a flow between sectors?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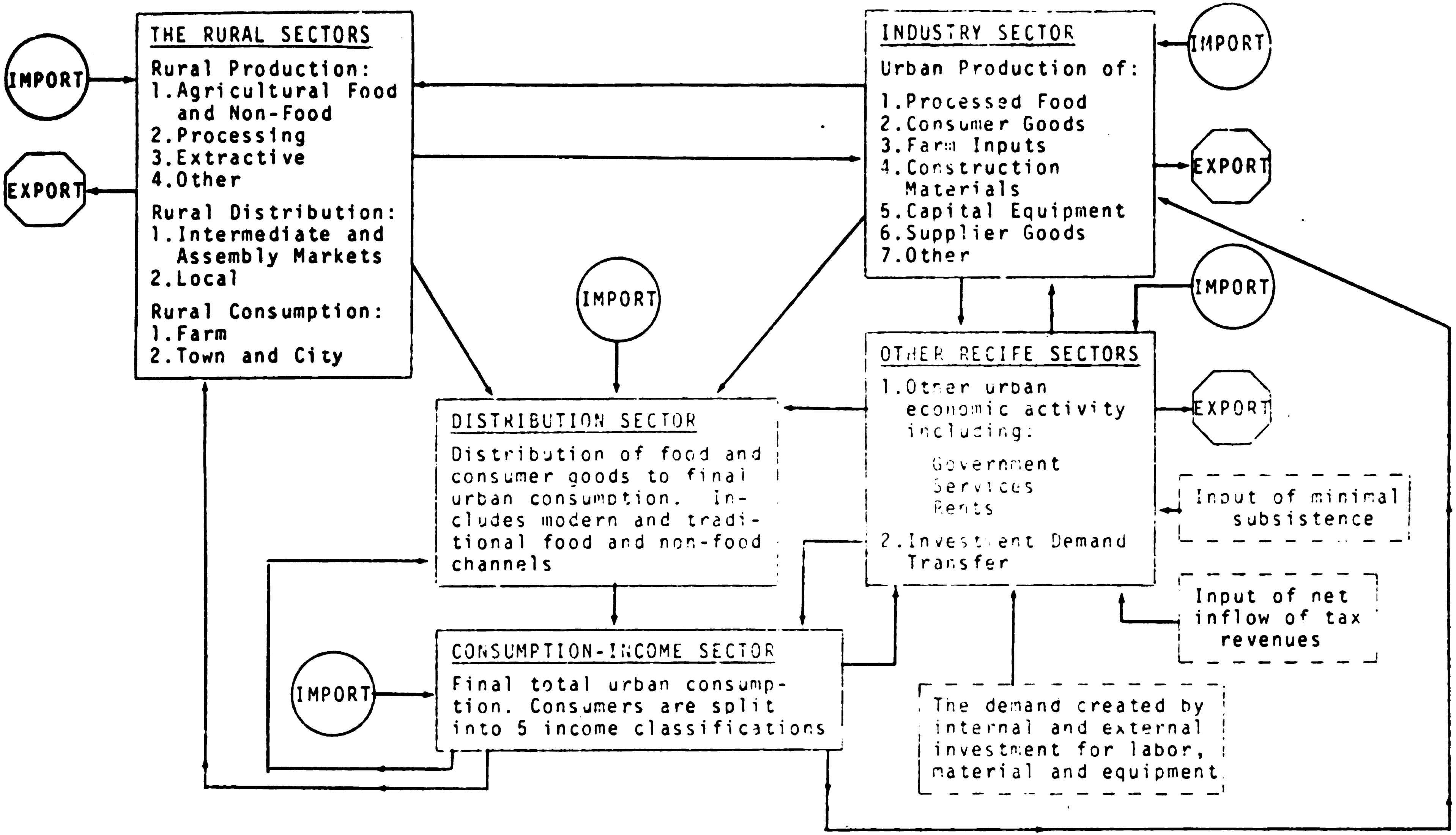

FIGURE 2.1 The Recife Systems Model: The General Structure and Inter-Sector Flows

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With this map of the system, the "structure" of the model is defined. Within each of the sectors, further breakdowns into components are incorporated to differentiate significant "behavioral differences", but in all cases the relationships must be in terms of the interfaces or terminals of the sectors, i.e. where they connect to other sectors.

A Brief Description of the Sectors

The Consumption-Income Sector

This sector represents the urban Recife consumers -- their income and expenditure patterns. Consumers are divided into five income categories from high to very low, each having particularly defined consumption and buying behavior. In each consumer category, disposable income after taxes is spent on food, non-food consumer goods, other expenditures (transportation, rents, services, etc.) and savings. The expenditures for food and non-food consumer goods are further broken down by the type of outlets in which these expenditures are made (modern and traditional food outlets and modern and traditional non-food outlets). This last expenditure split defines consumer "shopping propensities". Incremental real income is generated to each consumer group as a function of changing relative prices in the retail outlets and shifting shopping behavior from higher to lower priced retailers. Thus:

$$\text{Consumer Expenditures} = F\left[\begin{array}{l}\text{Shopping propensities, average propen-}\\\text{sities to consumer, disposable income,}\\\text{and relative retail prices}\end{array}\right]$$

The Distribution Sector

Urban wholesale and retail distribution to final urban consumption is included in this sector. Only that part of distribution which deals with final demand in the Consumption-Income Sector is considered. (Distribution to other sectors is included in originating source sectors.)

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The Distribution Sector contains six types of wholesale retail channel arrangements:

1. Modern food channel (selling food and non-food)
2. Traditional street and public market food channel (selling food and non-food)
3. Traditional "neighborhood stores" (selling food and non-food)
4. Other food channels (such as restaurants)
5. Modern non-food merchandising channel
6. Traditional non-food merchandising channel

It should be evident that this structure offers a great deal of flexibility in hypothesizing various demand shifts between modern and traditional channels and between food and non-food consumption.

The inputs of labor, other variable costs and fixed expenses are included in a simple input/output fashion with a given percentage of units needed per unit of goods which flow through the channel (sales plus spoilage). Raw material demands for food and consumer goods are based on gross margin and cost of goods sold determination then demand is split between local industry, the rural area, and importation. The Decision Routine-Consumer I compares this demand to local supply and resolves any differences. Cost and profit schedules are developed and sources and destination of goods determined.

The Industry Sector

The Industry Sector represents all manufacturing and processing that is done in the urban Recife area. It is developed as a seven-industry model composed of the following: food processing, consumer goods, farm inputs, construction materials, capital equipment, industrial supplier goods industry, and other industry. Each industry type requires given amounts of inputs per unit of output with these inputs being supplied sectors in the

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The outputs, in turn, are distributed among receivers in the Recife Distribution Sector, the Other Recife Sector, the Rural Sector, exportation, and other industries within the Industry Sector. The level and distribution of outputs are finalized in the decision routines as a function of production capability and demand. Cost and profit schedules are derived along with sources of purchase and allocation of output tables.

The Other Recife Sector

This sector contains all economic activity not explicitly defined in the other urban primary sectors. It contains the components of the urban economy which were not studied in depth and on which scanty information is available. These include: government, services, transportation, and housing. Further, the net inflow of government revenues from outside the system and any consumer income discrepancies are included in this sector. The primary function of the Other Recife Sector is as an income generator for the Consumption-Income Sector from other urban economic activity.

The other Recife Sector is also used as a "demand transfer" vehicle for the investment funds input into the system. Investment expenditures are translated into demands for labor, equipment, and construction materials. Then these are split between the possible sources of purchase from local or imported supply, and they are finalized in the Decision Routine-Capital II.

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The Rural Sector

The Rural Sector is a composite of the four-state area around Recife and is a much more broadly defined primary sector because it includes production, distribution and consumption components. The importance of including this sector cannot be underestimated. Inherent in market process coordination is the tenet that there is a high correlation between reforms and action in the urban area and reforms and action in the rural area. This interaction between the urban center and the rural area is a major criteria used in defining the internal characteristics of the sector.

Grouped into the Rural Sector is all economic activity taking place in the four-state area. This includes agricultural food and non-food production, extractive industries, food processing, consumer goods and other production. Also present is the rural distribution of food and non-food output and farm input marketing. Finally, the rural consumers are represented either as farm or non-farm consumers in their income and buying patterns.

The Rural Sector is structured to enable detailed analysis of up to five selected commodities or commodity groups between modern and traditional production methods, at the discretion of the user. With the determination of these special output types and the other generally defined rural outputs, on farm consumption and spoilage are deleted. Then margin and loss during distribution within the Rural Sector is determined. Finally the several types of outputs are distributed between local rural consumer demand, rural industry demand, demand from Recife, and exportation. Final consumer demand is determined in the consumption component of the sector, and Recife demand depends on the results of the decision routines.

Given rural output, the inputs required to sustain that output are determined through technical coefficients on such inputs as labor, farm inputs, agricultural and non-agricultural inputs with profit and potential investment funds residual.

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The Import-Export Sectors

These two sectors tie the economic system to the "rest of the world". The regional economy of Recife and its "foodshed" depend on importation and exportation with the other parts of the Northeast, the Center-South of Brazil, and international markets. For both the import and export sectors the above three sources and receivers of goods are defined. These sectors play a vital role in the structure of the model. Combined with accumulated inventories, they are the suppliers and demanders of last resort. Thus, for example, if local supply of consumers' goods is insufficient to meet demand then the deficit is met with importation from the Center-South of the country.

Defining the Components within Sectors

In each of the previously defined sectors several components are defined. This has been done for three basic reasons:

1. To define homogeneous constant-time groups within sectors.

2. To define modern and traditional units for the express purpose of testing their reactions to change.

3. To obtain a finer breakdown of a Sector for more detailed analysis.

An example of the components defined is in the Consumption-Income Sector. The income types are defined as groups of consumers which have relatively homogeneous and constant buying behavior. This means that basic parameter inputs determining buying behavior, e.g. average propensity to consume, can be assumed constant. Thus, as the percentage of consumers in each changes, the overal

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A second example is characterized in the Distribution Sector which defines modern and traditional food outlets. This is important when considering the placement of investment funds. The differences between the modern and traditional would tend to show divergent impacts of equal investment funds allocated to each. Further, it is important from the standpoint of development to have some understanding of what happens when some percentage of the output of a component shifts from generally traditional to more modern performance.

The particular components defined within the various sectors of the model have been included to permit improved analysis of the market reforms to be considered. The model is structured to permit the user to change, add, or subtract components within a sector without having to restructure the entire model. There is only one criteria which must be met in doing this. When linked back into the model system the terminals or connection points with the other sectors must be identical, nonecan be added without major restructuring of the entire model and computer program. Thus, it is important that in defining the flows (edges) between sectors, which determine the terminals, all inter-sector flows which may be used in analysis are included. Having a few extra is better than too few because any flow can be valued at zero if not utilized in a particular analysis.

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The Planner Oriented Characteristics of the Model: "Planner Entry Routines"

The outline of the economic sectors which comprise the internal structure of the model focused on the interaction between the urban and rural economies through the exchange process. The sectors are so structured to permit the analysis of changes in the process of distribution and its impact on industrial and rural production and final consumption. This section outlines the meaning and use of "planner entry routines" (PERs), the decision routines Consumer I and Capital II, and the Investment Sector.

In segmenting these planner oriented characteristics from the internal economic structure, the Recife Systems Model makes a major departure from other systems models and other general economic models. Ordinarily, the functional relationships are assumed in the structure of the model and thus, their accuracy determines the actual representativeness of the model to the system under analysis. In the Recife Systems Model an effort is made to include in the internal structure as few of these functional relationships as possible. The determination of the behavioral and structural relationships is not avoided, but they are located in a position where the user of the model can closely inspect their characteristics and easily make changes depending on the scope of analysis undertaken, the nature of programs implemented, and the type results desired. As stated in the introduction to this chapter, there are two distinct purposes of these computerized routines which are clustered around the internal economic structure of the model.

First, the accounting identities and behavioral relationships defined in the internal structure are developed to permit the user of the model flexibility in refining, adding to, or constructing new economic behavioral and

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structural relationships. Essentially the PERs provide the interface between the user of the model and the model's structure. But this interface is extremely flexible. At one extreme the user defines no "planner entry routines" and just inputs the necessary parameter values required by the internal structure. Any computational relationships are done outside the model. At the other extreme, detailed computerized routines which determine the values of basic parameter inputs are constructed and linked to the internal structure through a general computerized input routine.

The second purpose of the "planner entry routines" is to provide the user with a means to related policy variables which are at his disposal to guide and influence the economic system to their impact on the behavior and structure of that system. When implementing reform programs into the system, assumptions are made on the influence of various policy variables such as minimum price programs, credit, and investment incentives on key economic relationships in the system. No one combination of policy variables should be defined in the model because with different reform programs the use of policy tools will vary in content, degree, and combination. Thus, it is the second purpose of the "planner entry routines" to focus the attention of the user on this crucial set of relationships while still allowing him (in fact almost forcing him) to evaluate his estimates of the impact of those tools on the economy's behavioral and structural relationships.

The Characteristics of "Planner Entry Routines" (PERs)

The term "planner entry routine" is used to denote any relationships explicitly defined outside the internal structure of the model whose purpose is to refine currently assumed behavioral relationships or to develop new relationships between policy variables and that internal economic structure.

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Most parameter inputs required by the internal model could be used as a basis for a PER. Of course during any one simulation only a few would be appropriate to define relative to the evaluation of program reforms being tested. They focus the planner's attention on the structure of the system, the information required to analyze and understand the system, and the relationship between reform programs, the tools available to implement the program, and the impact of the change on the system.

The nature of the "planner entry routines" permits the planner or researcher to insert, at his discretion, the values of a significant number of the determining relationships in the system. They can be developed from experience, "best estimate", or research; and there are few limitations on the types of relationships which can be used. For example, in the Consumption Sector, consumption expenditures to the Distribution Sector are expressed as a function of shopping propensities, average propensities to consume food and non-food, and disposable income. Through the use of sub-routines incorporated into the model, a PER can assume a wide range of functional relationships in determining shopping propensities. The shopping propensities can be a function of economic variables such as price, quality and location and/or of behavioral variables such as innovativeness and modernity.

The programming of this model for the CDC 3600 computer allows any number of PERs to be incorporated in the "running model" as sub-routines determining various input information for the central core model. The following are the means by which the input values can be derived:

1. Exogenously given each time period from research data, experience, or for some hypothesized situation. This essentially has the "paper work" done outside the model.

2. Functional relationships may be incorporated within model sub-routines. These would be used in deriving the parameter values. These relationships have the following characteristics and limitations:
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   b. They may relate prices, flows and stocks.

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c. All variables must be quantified.[2]
d. Variables explicitly used in the model may be used in the routines as long as their value is known at the point in calculation where the PER needs them.
e. Any variable not explicitly included in the model can be used. Examples are attitude and communication variables and other economic variables if they can be explicitly related to the input parameters the model demands from the "planner entry routines".

Within the structure of the Recife Systems model there are three general variable inputs which are used throughout most of the sectors of the model. They represent the prime potential for being developed as "planner entry routines" and constitute over 75% of all parameter inputs required by the internal model structure.

First, the technical coefficient matrices relate inputs to outputs. In the Consumption Sector the "average propensity to consume" is one such matrix. In distribution, industry and the rural sectors there are specifically defined technical coefficient matrices which, given output, determine the values of labor, taxes, other variable costs, etc. Technical coefficients determine the relative efficiency with which inputs are transformed into outputs. This is especially important where a particular resource input is scarce or where input substitution may take place (capital labor substitution for example).[3]

Source of purchase parameters are the second general type of input. They occur in every sector of the model. Their function is to take the

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[2]Quantification does not necessarily mean that cardinal or ratio measurement scales are required. Ordinal or interval quantification is sufficient. Acceptable logic statements include: conditional step-functions, "if" statements, "more than and less than" statements, and ranking functions. Most of the input parameters in the model are cardinal in character (with the exception of the decision routines) and thus any ordinal measurement could condition alternative defined parameter inputs.

[3]For a more detailed discussion of the technical coefficient see Chapter V, The Industrial Sector.

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given total value of an input demand and "split" it among the various sources of supply which are available. Generally these sources are other sectors in the model or importation. For example, the "shopping propensity matrix" takes the total demand for food and non-food consumer goods and splits it among the different types of suppliers defined in the Distribution Sector as channel/outlets types.

The third type of parameters are the receiver split parameters. These inputs, similar to the source of purchase parameters, apply to the distribution of output from the components within sectors. For example, in the Recife Industry Sector the output from the consumer goods industry is split into the various locations which can purchase the output: Recife Distribution Sector, the Rural Sector (consumption), and the South/Export Sector.

Other important entry points are relative price indices, margin valuation, and capacity determination. The source of purchase and the output receiver parameters are important in the consideration for PERs because of their impact on such important economic criteria as import substitution and balance of trade.

The Decision Routines: Consumer I and Capital II

Two "planner entry routines" have been developed for the initial simulationsof the Recife Systems Model. They are Decision Routine-Consumer I and Decision Routine-Capital II. Both center the attention of the user on the understanding and analysis of basic supply and demand characteristics in the urban area. Central considerations are how demand is fulfilled, how much supply is made available, and how that supply and demand are distributed. Besides reconciling short-term supply and demand differences, they allow the user to make a variety of assumptions about the economic structure of the production and distribution sectors in the model.

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Decision Routine-Consumer I brings together the Distribution Sector, Industry Sector, the Rural Sector, and the Import/Export Sectors. The routine allocates any short-run differences which develop between the local supply and demand for processed food, non-processed food, and consumer goods. This allocation process is accomplished through a set of "decision rules" which allow utilization of accumulated surpluses, changes in output in current time period or in later time periods, alterations in the distribution of a supply sector's output, or changes in imports and exports. The user of the model decides which decision rules are used, in what order they are used, and the maximum impact which a decision rule can have on resolving a surplus or deficit condition. Different combinations of decision rules define different allocation processes and permit varying degrees of supply flexibility. For example, the supplying sector can be assumed to be totally rigid and not response to demand changes or a deficit/surplus condition, or the supplying sector can be assumed to be completely flexible and accept whatever demand is placed on it.

Decision Routine-Capital II brings together the Recife Industry Sector, the Rural Sector, the Other Recife Sector, and the Import/Export Sectors. The purpose of the routine is to allocate any differences in local supply and demand of investment oriented goods such as capital equipment, construction materials, and farm input equipment. This routine analyzes the impact of investment expenditures on the region's capacity to fulfill demand for materials and equipment. The routine is less flexible than Consumer I because the exact priorities on the allocation of demand are set. Local Recife supplying sectors have first priority in fulfilling demand, the Rural Sector second priority, and the South/Import Sector last priority. Any surplus in supply is allocated to an accumulated inventory account or to exportation. Any deficit in supply is met through importation.

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The Investment Sector

An Investment Sector is developed for the Recife Systems Model in order to provide a framework in which the decision-maker can analyze the sources, applications, and effects of investment in the economic system. In measuring the effects of investment the sector on the rest of the system, two methods are used. First, the sector forces the user to focus attention on investment decisions made internally or from planned reform programs which affect the behavior of the economic system through changes in parameter input values or behavioral relationships.

Second, the Investment Sector provides the information necessary to complete the "economic flows" required for a model solution. Investment expenditures produce a "construction effect" demand for equipment, material and labor which are important factors in the final determination of industrial production and consumer income.

Structural Limitations in the Recife Systems Model

The flexibility which the "planner entry routines" offer to the model is significant. There are, however, certain very important structural limitations which are present and need to be stated to evaluate the effectiveness of this model.

Any model-building exercise faces the general problems of data requirements, measurement, and quantification of behavioral characteristics and action. They are present in this model as well. Certain of the latter limitations have been offset by the use of the "planner entry routines." While the PERs do not solve these problems, they permit a variety of assumption and force the user of the model to deal directly with these problems. The assumptions are not "buried" in the intricacies of mathematical relationships.

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How well these limitations are dealt with can only be assessed after a thorough understanding of the model is obtained and an analysis of results completed.

Throughout the development of this model, two problems have repeatedly appeared. The first is the problem of the aggregation of flows and how compatible these flows are between sectors. The definition of units and prices is dependent on how much aggregation takes place. The task of clearly defining units and prices is made more difficult as the degree of aggregation increases.

The second major problem area is the use of a sequential solution to the model's relationships. This has forced certain assumptions to be made on the ordering of economic activity in the system under analysis. The problems of "order" are less acute in the use of a simultaneous solution, but the size of the model and the desire to retain flexibility in economic assumptions made it desirable to use the sequential technique.

Within these two general problem areas are most of the assumptions in the internal structure of the model. Thus, these problems are introduced and detailed further in the analysis of each sector in the following chapters. The emphasis in this section is on how these problems might influence the results which are obtained from a given simulation run.

The Problem of Sequencing

The structural solution to the model could be accomplished in two ways: simultaneous solutions or through proper sequencing of computation. The latter is chosen for both technical and behavioral reasons.

Technical Flexibility. -- The first is a technical consideration. The size of this model (over 1200 input parameters needed each time period within a simulation run) makes a simultaneous solution a very complicated method. The solution to every equation in the model must be made relative "terminal points'

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to the "terminal points" in the whole system (where it connects with the "outside world") which are exogenously given.

From a technical point of view the sequential solution means that an exact order is given to each stage in the computations depending on the input requirements at a particular state. For example, the Other Recife Sector cannot be computed until after the Consumption-Income Sector, the Distribution Sector, and the Industry Sector because each of these sectors provides values of variables needed by the Other Recife Sector.[4]

Instead of using the simultaneous solution, the two decision routines were developed which permitted the continued use of the sequencing nature of the model. (Other techniques such as the iterative solution method could have been utilized.) The sequential technique enables the user to view any resolving of differences between supply and demand explicitly and not have only a final solution to the equations.

Behavioral Flexibility.-- The second reason for using the sequential technique was the effort to retain as much flexibility as possible in the determination of flow equalities in the model. The technique permits the user of the model to assume various reactions and resolutions to the allocation of differences which develop between the supply and demand at different levels in the system.

One of the most important points is the equating of income generated in the model to the income used in the determination of expenditures. If a simultaneous solution was used, no difference could be permitted. It is felt that with certain analyses it would be desirable to describe the functioning of the present system under various levels of final consumer demand and how that system reacts by means of the income it generates. Can the system support that level of final demand under given conditions? What conditions would have to be met in order for income generated to be equal

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[4]The exact sequencing used in the computer program of the model is presented in Appendix A.

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The Problem of Flow Aggregation

Flow aggregation arises when products are grouped together and assumed to be a single unit. For example, the "flow of non-processed food" is a highly aggregated flow of products containing various products such as beans, pineapple, and tomatoes. Each has different unit measures and when combined, do not lend themselves to easy unit and price definitions.

Three considerations are used in making the decision on the level of aggregation to be used:

1. The technical ability to model.
2. The practical limits of data.
3. The express purpose of the model and the analysis of reforms.

From a technical standpoint, building a completely disaggregated model would involve a quantity of mathematical formulations and computer programming which is not feasible. As it is the present model requires computer storage capacity much larger than all but the biggest machines.

From a practical viewpoint, the data required to build a highly disaggregated model is beyond the scope of this dissertation and the total research effort of which it is a part. For example, if ten products are brought through the channel from production to consumption, the consideration of their inter-related demands would force estimation of almost 45 cross-elasticities. And, since the parameter inputs which are used by the model would have to be multiplied by ten, the result would be a staggering quantity of information required.

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The third consideration is the expressed purpose of the model to assess the impact of some specific set of market process reforms on other sectors in the economy, the distribution sectors, and on the general economic growth of the system. A totally aggregated model would not permit enough detailed analysis of intra-sector effects to evaluate effectively market reforms. On the other hand, the size constraint imposed by using a totally disaggregated model would not allow all facets of production, distribution, and consumption to be included. Thus a compromise must be made: enough disaggregation to permit analysis of the impact of changes between and within sectors and enough aggregation to permit analysis of the impact of change for the entire system under study.

Increased flexibility could have been derived if food had been split between such items as fruits and vegetables, meat and poultry, dry goods, and milk and dairy products. This would have a significant effect on the input of margins, sources of purchases and sales, and would have given more finely-defined market baskets for the consumers to purchase. But it would have required a much more sophisticated computer program, a larger machine, and input information far beyond the scope currently attainable.

The Problem of Flow Compatibility

Each time two flows meet in the model, the problem of compatibility between the product mix of supply and demand arises. This is a result of the high degree of aggregation in the supply and demand flows.

When the output of the consumer goods industry in Recife is split between the Recife Distribution, the Rural Sector, and the South/Export Sector, it is assumed that the product mix in each flow is compatible with demand and allows distribution to take place. The use of the decision routines permits the shifting of demand from one supply source to another.

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The decision routines force the assumption that the "mix" in each flow is substitutable to the degree that any shifting takes place. It does not assume that all the products are identical in each flow or that they are even completely substitutable.

An example may serve to clarify this point. The Distribution Sector's demand for consumer goods could be composed of "pots and pans" and "soap." The local industry supply could also be made up of "pots and pans" and "soap." The assumptions enter in the following manner: If local supply and demand are equal, then it is assumed that "pots and pans" and "soap" are supplied in the appropriate demand proportions. If local supply is insufficient, the remainder will come from the south. The consumer goods imported are assumed to be composed of "pots and pans" and "soap" in such a proportion that when combined with local supply the appropriate demand proportions are met.

If the partial substitutability cannot be proven, then the allocations between supply and demand would lead to misleading results. In the discussion on flow aggregation, a compromise can be reached and units and prices are defined. (See Chapter III - Page 86.) In the problem of flow compatibility, no compromise beyond that stated in the basic assumption can be made. It must stand as defined.

Summary

The internal structure of the Recife Systems Model and its planner oriented characteristics have been discussed. Utilizing systems theory and computer simulation, the model focuses on the exchange relationships between urban Recife and its four state "foodshed". The internal structure of the model contains the basic structure of the economic system and those accounting and behavioral relationships essential to the analysis of market process reforms. Wh

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process reforms. Where possible flexibility to alter the internal relationships has been retained in order to permit the user of the model latitude in defining crucial behavioral assumptions and in relating policy variables to the economic relationships in the internal structure. "Planner entry routines" are the focal point for the decision-maker to enter the model and change structural and behavioral assumptions. Two PERs are defined, Consumer I and Capital II, which are present to ameliorate any differences which arise between local supply and demand in the system. An Investment Sector is included which analyzes the sources, allocations, and effects of investment expenditures on the economic system.

Each sector is briefly defined. Included are: the Consumption/Income Sector, the Distribution Sector, the Industry Sector, the Other Recife Sector, the Rural Sector, and the Import/Export Sectors. Finally, the structural limitations of a sequential solution, flow aggregation, and flow compatibility are discussed.

The next five chapters present in detail the structure and use of each economic sector included in the model. In most cases a general format is followed to facilitate the description. First the purpose and orientation of the sector is discussed; then the sector is defined in detail and the flow of computations presented in text form; next the flexibility, assumptions, and limitations are outlined and the chapters concluded with a statement of the "points of entry" which are most likely to be used in analyzing market process reforms. For those readers interested in the detail of the computer program and the specific equations utilized in each sector, Appendix A contains a technical description of the model, the computer program, and a set of "verbal equations" which presents the relationships assumed in the internal structure of the model. It may be appropriate to read the relevant section of Appendix A along with each of the following chapters.

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CHAPTER III

THE CONSUMPTION-INCOME SECTOR

The Purpose and Orientation

The Consumption-Income Sector is a major driver for the Recife Systems Model. Because this model is consumption oriented, the urban consumption sector becomes a focal point for evaluating change in other parts of the system. The Recife area is largely a "consumer market". It lacks large scale industry and a central capital market and most industry present is for consumer type goods. Thus, income and the resulting final consumer expenditures determine, to a large extent, the level of economic activity which is taking place in the urban area.

Central to the types of reform changes which will be tested with this model are issues of employment, income generation, demand characteristics, and the effect of changing food prices on consumer behavior. The consumer will play the major role in determining the effects of the reforms in the marketing and distribution systems and the production of food and other consumer oriented goods. It is the reaction of the consumers to changes in the other sectors that is crucial to the effects of change. How the consumer perceives them and acts relative to them determines the real results of distributive reforms in the system. Changes in investment, capacity, and technical coefficients in the other sectors only create the "potential" for effective demand change.

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Defining the Consumption-Income Sector

The Consumption-Income Sector of the Recife Systems Model is composed from all metropolitan Recife consumers. The sector receives consumer total income either exogenously or from income generated in the other sectors in the model and determines the character and level of consumer expenditures and savings in the urban center. The sector is so structured to focus on buying behavior resulting from changing conditions in price, product, mix, and retail outlet availability in the Distribution Sector.

Defining Consumer Types

The first action is the determination of the number and characteristics of the consumer types within the sector. From one to five types may be defined in the current structure. The basic criteria used in the determination of the consumer types is that they should be relatively homogeneous in their consumption behavior. The effort is to define groups of consumers that have similar buying patterns and "stick together" in these patterns over time. This homogeneity includes the general breakdown of expenditures, shopping behavior, their likelihood to shift their shopping behavior, and in the sources of their income. The consumer types must be defined so that total income which each receives can be calculated for each type. This must be done so that the sources of income in the other sectors can be directly attributable to each consumer type.

Five types of consumers are defined within this sector for the initial simulations. They are: very high income consumers, high income consumers, middle income consumers, low income consumers, and very low income consumers. The LAMP/LAFS consumer survey conducted in Recife found that income is a good predictor of expenditure patterns, location of purchase, and general basket characteri

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Very High	15,00
High	9,50
Middle	3,70
Low	1,00
Very Low	35
Total (Average)	1,80

Source: LAMP/LAF
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market basket characteristics.[1] The following table summarizes how the urban consumers are divided and the importance of each in numbers and income in the urban community.

TABLE 3.1 Definition of Consumer Classifications

Income Class	Avg. Family Income US$/Year	% of Family	% of Total Consumer Income Generated	Avg. Propensity[2] to Consume Food
Very High	15,000	1	11.	9.1
High	9,500	2	11.	14.9
Middle	3,700	25	48.	36.9
Low	1,000	47	25	59.6
Very Low	350	25	5	89.
Total (Average)	1,800	100	100	38

Source: LAMP/LAFS Report, Chapter 4, Tables 4.1 and 4.2

[1]Latin American Market Planning Center, Market Processes in the Recife Area of Northeast Brazil (Final Review Draft) (East Lansing, Michigan: Latin American Studies Center, Michigan State University.) Chapter 4, pp. 19-23. All footnotes from the LAMP/LAFS project report are referenced to the Final Review Draft which was available at the time of publication of this thesis. Currently in press is the final report to be published also by the Latin American Studies Center. Thus, chapter numbers will be given in footnoting to make reference with the final document easier. Throughout the text of this thesis the term "LAMP/LAFS Report" is used to reference the report.

[2]Defined as the average percentage of disposable income spent on food by each income class of consumers.

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Defining Sources of Income

On the income side of the Consumption Sector there are five potential sources of income. They are: (a) from rural income coming to Recife and income generated from the movement of rurally produced commodities through Recife to export outside the defined economic system, (b) from the Distribution Sector in the form of direct labor wages and distributed profits used as income, (c) from the Industry Sector for direct labor in manufacturing and distribution and distributed profits, from Other Recife Sector for income generated by government, from other expenditures (auto-transport, services, housing-rent, etc.), (d) from construction, and from "minimal subsistence" (See Chapter VI - Page 128), (e) and other income sources such as dividends, interest, and net rents. (For explicit definitions of each of these flows, see the respective sectors descriptions.)

Given these sources of income, each source is split according to the percentage which goes to each consumer type defined, then the amount going to each consumer type is summed over sources to obtain the total income available for each consumer type. This is done whether the system is assumed "open" or "quasi-closed." (See Page 78). This income generated becomes a comparative tool when the system is "open" since the level of income used in determining expenditures is independent of income generated. But when the system is assumed to be "quasi-closed" the income generated is used as the initial income in the model for the next time period.

The Structural Relationships--
The Expenditure Patterns

Given the income to each consumer type, either exogenous to the model or from the solution of the rate of income generation within the expenditure patt

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model, expenditure patterns are developed for each type. (See Appendix A - Pages 262 to 268 for verbal equations.) The final result is the level of expenditures by each consumer type in the following categories:

1. Food expenditures in:
    a. Modern food outlets
    b. Traditional food outlets
    c. Other food outlets
2. Consumer goods expenditures in:
    a. Modern food outlets
    b. Traditional food outlets
    c. Modern non-food outlets
    d. Traditional non-food outlets
3. Other expenditures on:
    a. Automobile -- transportation
    b. Services
    c. Housing -- Rent
    d. Miscellaneous
4. Consumer goods purchased directly from importation and not flowing through the Distribution Sector.
5. Taxes
6. Savings

Two definitions are needed at this point in the discussion. First, average propensity to consume is defined as the proportion of disposable income spent in a given category of consumption (1-4 above) for each class of consumers.[3]

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[3]The sum of the consumption propensities and the savings propensity must be one. But the consumption propensities alone could add to more than one showing a negative savings rate or a depletion in the stock of savings. Thus, this might be utilized to include major increases in consumer credit

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Second, the average shopping propensity is defined as the proportion of a given category of expenditures which is spent in a given location (the letters under each numbered category above).

The level of these final expenditures by location of purchase is a function of the total income generated to an income classification, the average propensities to consume and save, the average shopping propensities and the relative prices between the outlets in the Distribution Sector. Figure 3.1 outlines the structure of a typical consumer class.

Determination of Disposable Income and Taxes

Given total income, the first computation is the proportion of income which is for direct taxes with the remainder being disposable income. (Though not considered in the initial illustrative simulations, it is possible at this point to add to the above determined dispcsable income any income not subject to tax such as welfare payments and "in kind" assistance such as a "free food" program. (The discussion of these forms of income are detailed further in Chapter VI - The Other Recife Sector.)

The Intermediate Determination of Expenditures

Intermediate expenditures are determined as a function of the amount of incremental real income generated from shifts in buying behavior from the last time period within each consumer type. As the consumers shift to lower priced outlets, it is assumed that they will initially buy the same quantity in the new purchase outlet as in the old. This leaves some money

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by having the initial purchase cause a major decrease in savings (possibly to a negative value) and then as "payments" are made (or credit is tightened) the increments are put back into savings stocks. This type of consideration would have to be developed outside the model or in a PER, and further shows the flexibility of the model structure.

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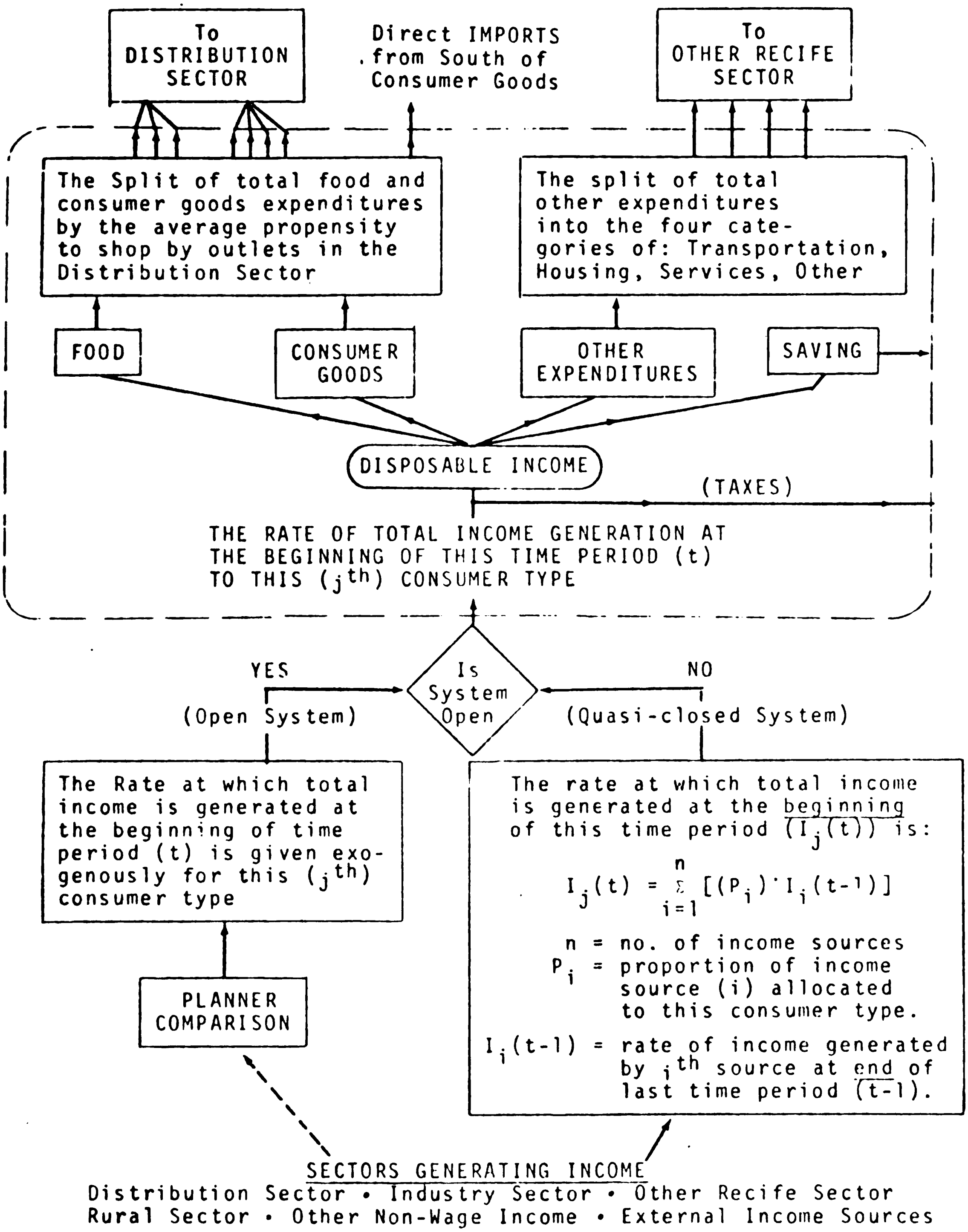

FIGURE 3.1 The Consumption-Income Sector: The Internal Component Structure of a Typical Consumer Type

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left after buying the same amount at lower prices. The amount of "freed income" or incremental real income generated is a function of the relative prices between retail outlets and the degree to which shopping propensities shift in favor of the lower priced outlets. The "freed income" can be spent according to current average propensities to consume (in the same manner as all the rest of income is spent) or according to a set of marginal propensities (applicable only to additions in income). This difference in value is then put back through the average (marginal) propensity to consume matrix and the new shopping propensity matrix in order to compute the intermediate expenditures.

Final Determination of Expenditures

The next step is the final determination of expenditures. Not only is the real income to the consumer affected by shifting buying behavior but also by the change in the level of prices within retail outlets, usually caused by competitive reaction within the Distribution Sector.[4] Thus, there is a second type of incremental real income generated to the consumers as a function of the change in relative prices from the last time period within retail outlets. This is computed using the same assumptions on "freed income" derived from buying the same quantity and then spending that "freed income" according to a predefined set of average or marginal propensities. The result is the allocation of final expenditures according to the list defined at the beginning of this section. The printouts for the Consumption-Income Sector give details for each consumer type and the sector as a whole for the current time period and rates of change from the previous time periods.

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[4]Robert W. Nason, "Urban Market Processes in Recife, Brazil" (unpublished Ph. D. dissertation, Michigan State University, 1968) pp. 254-272.

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Income and its distribution, location of purchase, and source and level of incremental real income generation are included.

Flexibility, Assumptions, and Limitations

This section discusses the structural aspects of the Consumption-Income Sector which determine its validity in presenting the behavior of the defined consumer types. The following topics are detailed:

1. The effects on the model of the "open" or "quasi-closed" nature of income generation.

2. The importance of the average propensity to shop parameters within the present structure on shifting proportional expenditures between retail outlets.

3. The significance of including changes in real income into the sector.

4. The assumptions which are implied relative to income and price elasticity.

5. Definition of units and prices.

The "Open" or the "Quasi-Closed" System

In the Recife Systems Model it is possible to assume (1) the total rate of income generation for each consumer type is exogenously given to the sector, or (2) income is developed in a PER, or (3) income is derived internally from the income generated in the other sectors in the model. The first one falls within the assumption of the "open" system, the third assumes the "quasi-closed" system, and the second may be either depending on the type of functional relationships assumed.

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Using the model in an "open" sense permits exogenous determination of demand and the level of income which is generated in the system from that final demand level. This exposes any wide disparities that arise between expenditures and income generated by the system for that given level of demand. Further, it demonstrates the level of demand necessary to "support" the system at a given level under current social technical, and structural relationships. When the model is "open", PERs permit development of a variety of income functional relationships. It may be desirable to have total income as a function of population and per capita income in a time-variant sense, for example.

By having the model "open", various assumed "migrations" between consumer types are allowed. Each consumer type is assumed to act homogeneously. Thus, it could be implied that these types will have "constant behavioral conditions" and certain migrations are assumed between types of consumers. This is an expedient means to achieve dynamic behavior within the sector. Each component in the sector is constant, but the number in each of the component types changes over time; thus the sector itself becomes dynamic over time. This "bin to bin" movement contains two characteristics which cause shifts in the number of each type: first, in the general increase in numbers from "outside" the system; i.e., births and in-migrations from other areas; second, the internal migration between constant consumer types. (An important consideration if marginal propensities are defined.) In using the model in the "open" sense, the problems of parameter estimation are not avoided. They are merely transferred outside the model.

In this model, a simultaneous solution is not used when the model is "closed". The system is closed through the sequential generation of income from time period to time period. This process is called "quasi-closed". (See Appendix A - Pages 251 to 252 for the technical requirements the "quasi-closed" s

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of the "quasi-closed" system.) The initial income is assumed to represent the income at the beginning of the time period and, as changes take place within the system (in such things as price, shopping behavior, etc.) during the given time period, a new income "rate" is generated by the end of the time period. This ending income becomes the initial income "rate" for the next time period. At best this is an average, but so too is that developed in a simultaneous solution. Under the simultaneous solution, the "rate" is the average over the time period.

Using a "quasi-closed" system permits analysis of the effect of changes in the system in one time period and their repercussions through time (multiplier effects). In measuring the effects of some of the reform options introduced into the model, this will be an important consideration. But when the model is closed, it becomes more important to have all income sources well-defined and have accurate estimates of parameters splitting the income flow between each source of income and each receiver or consumer type.

The Average Propensity to Shop -- Changes and Limitations

The value of the individual shopping propensity parameter inputs determines the location of consumer purchase in the Distribution Sector given the expenditure levels on food and consumer goods.

Under current assumptions and in order to stay within realistic limits on the data base which is available, there are certain strict limits on how average propensities to shop can be changed over time within any given simulation run. (These limits are not present between simulation runs.) The following directional shifts in the proportion of expenditures spent in distribution outlets are permitted:

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2. A shift in consumer goods expenditures from traditional food outlets to modern food outlets.

3. A shift in consumer goods expenditures from traditional non-food outlets to modern non-food outlets.

In all cases the sum of the proportions spent in the three classes stated above must be the same within a simulation run. For example, the total proportion of food expenditures in traditional and modern food outlets may shift, but their sum must remain constant.

This assumption is forced on the model by the nature of the aggregative flows being considered. The types of goods are different enough between food and non-food that no shifts are permitted because of the problem of defining relative price differences in the purchases. The product mix difference is great enough between expenditures in food outlets and non-food outlets for consumer non-food expenditures to make the same relative price determination exceedingly difficult and arbitrary.

There is another important consideration which must be taken into account when shifting the average propensity to shop in each of the outlets.

By definition, there has to be some rationale for shifting consumers between types of outlets; e.g., lower prices, or more availability. In any exogenously given set of shopping propensities or in any functional relationships included in PER sub-routines, competitive reaction in the Distribution Sector must be considered as the consumer shifting takes place.

Thus, if in any time period there are changes in price within traditional food outlets caused by losing business to lower priced modern outlets, the change in the shopping propensity must be the difference between what is shifting to the modern outlet and perhaps some amount which then stays (but would have shifted if traditional operators had not reacted) or shifts back to the traditional outlets as their prices drop.

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The result is that any shift in the shopping propensity is a balance of the net effects generated by changing conditions in both the modern and traditional retail outlets. The internal structure of the model assumes that this balancing has taken place when it receives and uses the average propensity to shop for each consumer type.

The following Figure 3.2 shows the type of balancing which takes place when assumed shifts in the shopping propensities take into consideration changing relative conditions in the modern and traditional types of retailers. The straight line might be the hypothesized shift if the "traditional types" do not competitively react and the curved line then represents the shift taking into account that the traditional channel does react over time. The shift in expenditures to modern outlets would tend to slow as the traditional types reacted competitively. This reaction may be in price, product mix, product quality, location, or other service changes.

The Inclusion of Incremental Changes in Consumer Real Income

The major purpose for introducing real income changes into the model is to show how changing relative price structures and changing consumer behavior could induce increases in the real wealth of final consumers and force changes in income distribution. Although this is an initial attempt, it has proven very useful in the analysis of reforms in the Distribution Sector. Stated incremental real income is derived in two ways.

First, from shifting of shopping habits from traditional outlets to lower priced modern outlets for both food and consumer non-durable goods. Second, from changes in prices within an outlet/channel over time, generally considered as a reaction to "leader" price cutters or from direct reform action in the traditional channels.

It should be noted that these two means to increase real income are "sequentially introduced" in the model. First the real income generated

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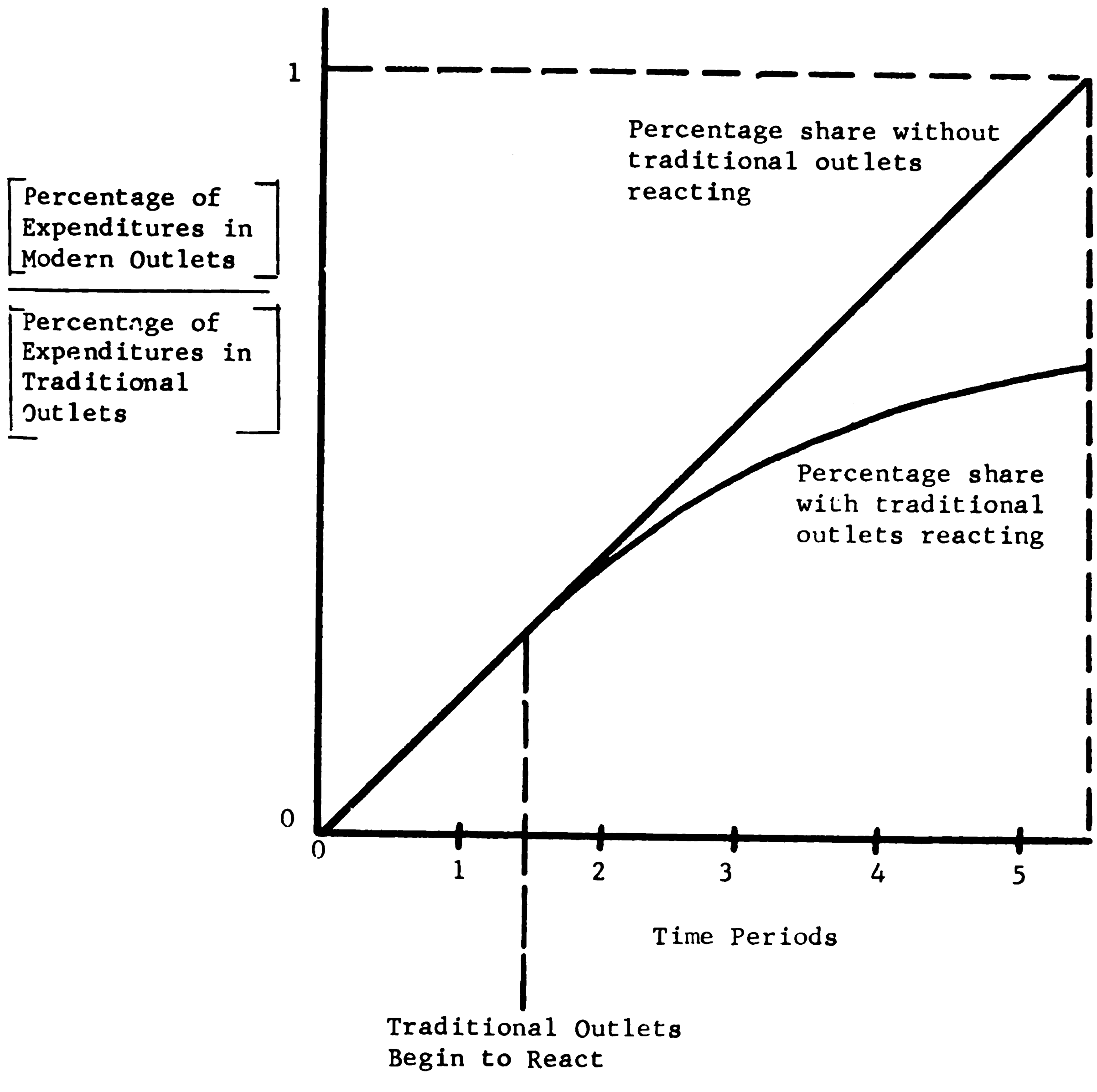

FIGURE 3.2 The Effect of Traditional Competitive Reaction on Shifting Shopping Propensities

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from changing shopping behavior and second the real income generated from price changes within outlet types. This was done on the basis that the second is a reaction to the first. Certainly they go on simultaneously with constant balancing taking place, but the sequential nature of the basic change, the general "initial-ending" orientation on rate of income generation, and the research data argued for the approach used.

The inclusion of changes in real income in this sector has an effect on the constancy of the initially input "average propensity to consume" which splits disposable income into the major spending categories. The "freed income" or increases in real income are put back through this same matrix of average propensities to split the way in which the consumer will spend that real income. Since total income has not changed, this reallocation of some portion of that income indicates that the average propensities will change slightly.

The mathematics of the model is so arranged as to permit the inclusion of marginal propensities on the changes in real income which are generated. It is assumed in the initial structure that average and marginal propensities are the same in the short-run. With five income levels and the slight variation in average expenditures, this assumption appears reasonable. The use of a marginal propensity on all additions to income for a consumer type could also be very misleading since part of the increase is derived from increasing the number of consumers in the class (where an average propensity would want to be used) and the other part is from increases in per capita income. As stated earlier these two income effects could be divided with the development of a PER. The difficulty in operationally obtaining marginal propensities is one other reason making the current assumption attractive.

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Assumptions on Elasticity

Closely related to the inclusion of changes in real income is the problem of elasticity. In any model of consumer behavior there are assumptions as to the degree of price and income elasticity for the various classes of expenditures defined.

The meaning of elasticity has been broadened with the inclusion of incremental real income changes. Normally, the substitution and income effects associated with lower prices is product-oriented. Here the significance of elasticity is widened to include the income and substitution effects between institutions, i.e. modern and traditional retail outlets.

The consumer substitutes in favor of the lower priced outlets, which creates increases in real income and permits the consumer to attain a higher indifference curve. The break between the substitution and income effects is at the point of buying the same quantity or basket of goods, i.e. Hicks definition of "apparent real income".[5] Thus, in the substitution effect perfect inelasticity is assumed and when the income effect is included the final elasticity assumption is somewhere between perfect inelasticity and unitary elasticity. (An assumption justified in most consumer research in developing countries.)[6]

The second type of real income generated from lower prices within outlets and contains both the effects, also. The income effect is the same as above and is the most obvious. The substitution effect is oriented

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[5] Milton Friedman, Price Theory (Chicago: Aldine Co., 1966), p. 51,

[6] For example, see: Robert D. Stevens, The Elasticity of Food Consumption Associated with Changes in Income in Developing Countries, Foreign Agricultural Report No. 23, Economics Research Service (Washington D.C.: U.S. Department of Agriculture, 1965).

more along product lines than the first since the lower price is on some part (or all) of the market basket which is purchased from the outlet.

By careful manipulation of the average propensity to shop it is possible to widen the range of permissable elasticity infinitely. Further, developing "planner entry routines" for the average propensity to shop would allow the definition of elasticity to include such important variables as consumer attitudes, location or availability or outputs, and product mix.

Thus, the conclusion can be made that the use of changes in real income have permitted rather flexible assumptions on income and price elasticity and an altered definition of elasticity to include an institutional purchase elasticity which considers more than just price or income. To conclude this section, a certain note of caution should be stated. The significance of elasticity measures may lose some of their meaning in an economic system which is experiencing high rates of differential inflation and rapid economic change. Income elasticity and institutional cross-elasticities may be more relevant than price elasticity.

The Definition of Units and Prices

The flows which have been defined in this sector are money flows of expenditures or income. Each of these flows is composed of some number of physical units flowing between two points and a price per unit associated with that physical flow.

For example:

$$\begin{bmatrix} \text{Expenditures} \\ \text{on} \\ \text{Food} \end{bmatrix} = \begin{bmatrix} \text{Price/Unit} \\ \text{of} \\ \text{Food} \end{bmatrix} \times \begin{bmatrix} \text{Number of} \\ \text{Units} \\ \text{of Food} \end{bmatrix}$$

Units and prices must be defined in order to assess some of the reforms which will be applied to the system and to develop the changes in real income from shifting shopping behavior and changing prices.

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Actual "real" units such as pounds or quarts cannot be defined because of the composite nature of the product mix. Griggs develops a unique definition of units.[7] A unit according to Griggs is the package of goods purchased by one family in one year. The associated price variable then is the amount spent by a family for that "basket" or package of goods. The definition used in this model builds on what Griggs developed. Certain alterations were necessary because a finer breakdown in product types is needed, the simulation runs would cover more than one time period, and incremental consumer income generation defines changing units and prices.

The problem is resolved as follows: The basic definition of a "unit" is that package of goods which an average family purchased in the initial time period (usually one year). This unit will be referred to as a CUG or a "common unit of goods". There are four basic CUG packages which are defined:

1. Food
2. Consumer non-durable goods
3. Other expenditures (rents, services, transportation,etc.)
4. Savings

The second CUG category is delineated further into consumer goods purchased in food outlets, consumer goods purchased in non-food merchandising outlets.

In order to attach numbers to the units and prices, the first step is to input to the model the number of families in Recife at the beginning of the initial time period and how that number will change over the time of the simulation. This will equal the number of CUGs at the initial point in time. The price per CUG is the expenditures for that category divided by the number of CUGs. The meaning of price then is the average cost to an average family for that category. Table 3.2, taken from some preliminary simulations of the Consumption Sector, explains further this point.

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[7]Griggs, pp. 127,129.

TYPE OF CUG	(1) Total Consumer Expenditures	(2) Average Price ... CUG[a]	(3) Consumer Expenditures (in millions of $US)	(4) Expenditures per Family (in $US)

TABLE 3.2 The Different "Common Units of Goods" (CUGs), Price per CUG, and Relative Consumer Purchases

TYPE OF CUG	(1) Total Consumer Expenditures on CUGS (in millions of $US)	(2) Average Price per CUG[a]	(3) Consumer Expenditures (in millions of $US) High Income	(3) Low Income	(4) Expenditures per Family (in $US) High Income[b]	(4) Low Income[c]
Food	122	740	4.9	46	1485	590
Modern Outlets	15	91	1.2	4.6	365	59
Traditional Outlets	97	590	3.1	38.6	940	495
Other	10	59	.6	2.8	180	36
Consumer Goods	78	470	11.5	15.4	3500	198
Other Expenditures on Goods and Services	93	560	13.2	15.7	4000	202
Saving	16	97	3.3	0	1000	0
	$309	$1867	$32.9	$77.1	$9985	$990

[a] The average price per CUG is Total Expenditures divided by Total Initial Number of CUGs. The Initial Number of CUGs is defined as the total number of family units (165,000) at the beginning of the time period under study.

[b] The number of high income families in urban Recife is 3,300, developed from Table 4.2.

[c] The number of low income families in urban Recife is 78,000, developed from Table 4.2.

SOURCE: SUDENE/MSU Consumer Surveys (1967) and "Base" Simulation-Time Period 1.

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For example, the average family pays $740 for food in one year. The very low income family would buy less than one CUG and thus spend less per family; likewise, the high income family buys more than one CUG per family and thus pays more per family. The comparison between the price of a CUG for the high income class and the low income class is dependent on where they buy their CUGs and the relative prices in those buying locations. If the high income class purchased relatively more in the modern food outlets which were lower in price than the traditional outlets, then the price per CUG to the high income person would be lower than the price to the low income person.

It is important to understand the impact of changing real income on both the number of CUGs consumed and the prices of the CUGs. As was described in the analysis of the shopping propensity matrix, there are assumptions made on the action of the consumer in each consumption type. When the consumer shifts food and/or consumer goods expenditures from one type of outlet to another he will initially consume the same amount of goods, i.e. the same number of CUGs of food and the same number of CUGs of consumer goods. If the price level in new outlet of purchase is lower incremental real income is generated. When that freed income is split according to his average propensity to consume, he will be buying <u>more of all the types of CUGs</u> defined, though relatively less <u>value</u> of expenditures on the CUGs with lower prices.

Now the price per unit in the modern and traditional outlets has not varied, but the proportion of units which he buys in each outlet has altered. Thus, the average price per unit to the consumer will have lowered. (That per unit price change will be different for each consumer type depending on the amount which each type shifted to the lower priced outlet.) The consumer will also be purchasing more CUGs of food and consumer goods. The

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prices on the CUGs of savings and other expenditures will not vary but the consumer will be buying more (saving more) and thus the number of units of each will have risen.

Points of Planner Intervention

When using the Recife Systems Model, the planner must decide what parameter values he will change with the implimentation of a reform option. "Points of planner intervention" are the potential key places where the planner can enter the model through directly changing the values of input parameters or by developing various functional relationships through the "planner entry routines" in order to determine a required parameter value. The PER can be used to expand the behavioral relationships or hypothesize the impact of policy variable changes. Outlined below are the most important "points of entry" which the planner should consider any time a reform option is simulated.

1. Total Income. Total wage and non-wage income can be exogenously given each time period in which a simulation is run or only in the initial time period with the "quasi-closed" system generating sequentially over time the income generated by the system. Income is defined as the rate at which wage and non-wage income is generated for each consumer type from all sources at the beginning of any given time period. By the end of a time period the "rate of income generation" is likely changed due to general growth and changes in the system caused by the implimentation of reforms. The ending rate of income generation is then assumed to be the beginning rate for the next time period.

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2. Effective Tax Rate. The tax rate is defined as that proportion of total income to each consumer class which is currently being allocated to direct personal taxes of all kinds. This rate is input each time period.

3. Average Propensity to Consume. The average propensity to consume is defined as the proportion of total disposable income (after taxes) which is spent in the following categories:

   a. Food

   b. Non-food -- General consumer non-durable goods

   c. Other

   The average propensity to consume is input into the model only in the initial time period of any given simulation run for each consumer type.

   The average propensity to consume may not remain constant over the time periods of any given simulation run. The reason is that as changes in real income are generated from shifting buying behavior and changing prices, the actual dollar amount spent in each type of expenditure will change slightly.

4. Average Propensity to Save. The average propensity to save is defined as the proportion of total disposable income which is allocated to current savings; i.e. not spent this time period. It may be negative or it may re-enter the consumption sector in later time periods as delayed consumption; for example, saving for the

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future purchase of some durable good. When added to the three proportions defined in average propensity to consume, the sum must be unity; i.e., all income must be allocated.[8] Like the Average Propensity to Consume, it is input only the initial time period and will change slightly as real income is generated.

5. Average Proportional Breakdown of "Other Expenditures". This is defined as the proportion of "other expenditures" spent in the following categories:

a. Automobile -- Transportation

b. Services

c. Housing -- Rent

d. Miscellaneous

This must sum to unity and is input each time period for each consumer type.

6. Proportion of Consumer Non-Food Expenditures Directly South. This is defined as the proportion of total consumer non-food expenditures which can be allocated to expenditures directly to the South of Brazil or for imports, that do NOT go through the Recife distribution system. This is input only the first time period and cannot be changed between time periods within a simulation run. The use of this variable is generally for the higher income classifications in the Consumption Sector and may be zero for the lower classifications.

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[8]See footnote 2 of Chapter III.

7. Average Propensity to Shop by Distribution Outlet Type. The average propensity to shop is defined as the proportion of food (non-food) expenditures which are spent in the various distribution channel/outlets defined in that sector and must be defined for each consumer type for each time period.

   a. The proportion of food expenditures spent in:

      1. Modern food outlets

      2. Traditional food outlets

      3. Other food outlets

   b. The production of consumer non-food expenditures spent in:

      1. Modern food outlets

      2. Traditional food outlets

      3. Modern non-food outlets

      4. Traditional non-food outlets

   The first, (a), must sum to unity, and the second, (b), when added to the proportion of direct purchases South must also sum to unity.

The shopping propensity matrix is the major source of change in the Consumption Sector and thus offers the greatest potential as a PER. The changing of the average shopping propensities must follow the rather strict limits which have been defined earlier.

These limitations on the technical changing of the input parameters are:

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a. From traditional food outlets to modern food outlets for food expenditures.

b. From traditional food outlets to modern food outlets for consumer goods expenditures.

c. From traditional non-food outlets to modern non-food outlets for consumer goods expenditures.

2. Food Expenditures in the other food outlets expenditures cannot vary within a simulation run.

3. The sum of the proportions spent in the following outlets by food and consumer goods expenditures must remain constant:

a. Modern food outlets plus traditional food outlets for food.

b. Modern food outlets plus traditional food outlets for consumer goods.

c. Traditional non-food outlets plus modern non-food outlets for consumer goods.

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CHAPTER IV

THE DISTRIBUTION SECTOR

The Purpose and Orientation

The Distribution Sector is explicitly included in the Recife Systems Model in order to analyze the impact of the market process change on the economic system. The research conducted in Recife and the tenets of the internal market process thesis suggest that changes in the Distribution Sector affect consumer buying behavior, consumer income, level and distribution, and the total supply of food and consumer goods in the system.

This sector is the focus of the reform options which are simulated with the model. (See Chapter VIII - Page 196.) The emphasis is on measuring the effects of changing distribution prices, margins, spoilage, and purchase location on the Consumption-Income Sector through changes in consumer real income and buying habits, and on the local supply sectors performance in meeting local demand.

The pioneering work of Griggs in including a separate distribution sector in an economic model is expanded in this model to involve both modern and traditional channels for food and consumer goods. Further, the relationships are structured to permit the development of "planner entry routines". The Distribution Sector is sufficiently disaggregated for the analysis of the urban exchange process in relation to local supply and demand conditions. Combined with the Consumption-Income Sector, the Distribution Sector forms the central core of the model.

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Defining the Distribution Sector

The Distribution Sector is defined as that set of channel relationships in urban Recife which satisfy final consumer demand for food and most consumer goods. This includes retailers, wholesalers, and other urban distribution agents associated with supplying food and consumer goods to Recife consumers. Thus, this sector is consumer oriented and does not consider the distribution of capital goods and inter-industry distribution. Distribution for these cases is handled within the respective productive sectors or the Other Recife Sector. For example, the distribution structure and costs for the construction materials industry in Recife are included within the structure of that industry type.

The export of goods which flow through Recife but are only handled or transported in Recife are analyzed within the analysis of the supplying sector. For example, the export of sugar and cotton that flows through Recife from the Rural Sector are considered within the rural region. The handling and distribution costs left in Recife are defined within the rural sector with the wages and variable costs generated in Recife assigned to the appropriate urban sectors.

Defining Distribution Components

The Distribution Sector is divided into six distribution types. The distribution channel/outlet types defined in the sector are as follows:

1. Modern food channel/outlets. These include what has been defined as modern retailers and their major wholesale suppliers in the Recife area. The basic definition used for inclusion of a channel member into this group is whether his operation at the retail level is self-service selling both food and consumer goods.

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2. Traditional "type one" food channel/outlets. These are street and public markets and other atomistic channel members both wholesale and retail which operate within relatively large economic groupings around the city. This channel is also considered to have both food and non-food consumer goods flowing through it.

3. Traditional "type two" food channel/outlets. These are the small and neighborhood retailers and wholesalers that operate on an independent basis and are generally not grouped into the type of "markets" defined in traditional "type one". They have fixed location for business and some kind of "structure" in which business is conducted; i.e., a "store". This channel is also considered to have both food and non-food consumer goods flowing through it.

4. Other food channel/outlets. This is the grouping of all other channels which food takes to the final consumer. The restaurant trade represents the major portion of this type.

5. Modern non-food channels. This channel is composed of the large scale merchandising methods consistent with department stores and discount houses. At the present time, only two retail outlets in Recife are classified within this group.

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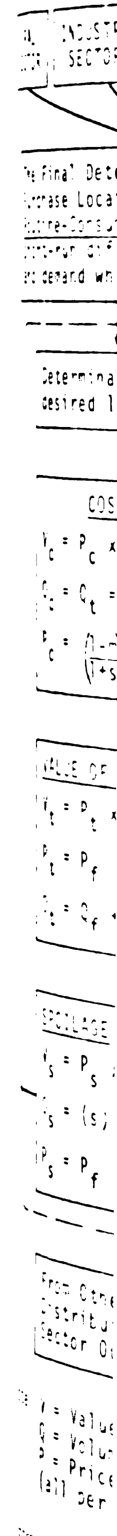
6. Traditional non-food channels. This is all other non-food consumer goods trade carried out in Recife. It includes everything from furniture to shoes to clothes.

The Structural Relationships

The Consumption-Income Sector determines the final demand for food and consumer goods placed on the Distribution Sector. Given that final demand and the internal characteristics of each distribution component, the input demand for food and consumer goods by each component type is calculated and the demand for other inputs determined. (See Appendix A - Pages 273 to 279 for verbal equations and flow of computations.)

Figure 4.1 summarizes the type and sources of inputs necessary for the Distribution Sector to meet final consumer demand and it presents an outline of the computational structure used. The Distribution Sector's demand for food and consumer goods is a summation of the individually computed demand of each distribution component. The individual demands are a function of consumer demand and the level of gross margin (one minus gross margin equals the cost of goods proportion.) Gross margin, in turn, is a function of the level of spoilage, price per unit sale, and cost per unit purchase. The result is the total volume of goods, called "goods throughput", which the sector <u>must</u> purchase from local Recife industry, rural agricultural production and industry, or importation.

Once total input demand is determined, it is tentatively split according to the source of purchase for each distribution component. This may not be the final actual source of purchase, however. At this point the Decision Routine-Consumer I is called in order to compare the demand by source of purchase over all distribution components to the supply which each of the supply sources is willing to make available to the Recife urban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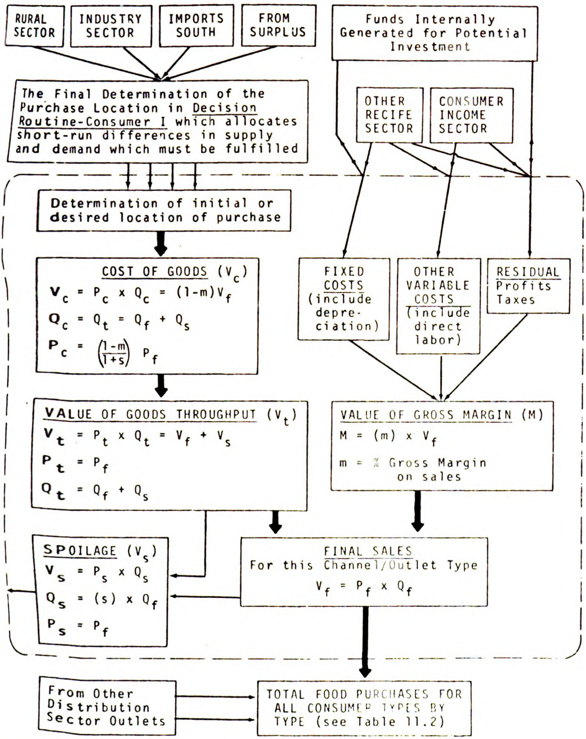

note: V = Value of a flow
Q = Volume of a flow
P = Price of a flow
(all per unit time)

FIGURE 4.1 The Distribution Sector: The Internal Component Structure for a Typical Distribution Component er econo

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consumer economy. Any short-term local surpluses or deficits are resolved in Consumer I and it sends back to the Distribution Sector finalized source of purchase for processed food, non-processed food, and consumer goods. Any changes from the initial tentative source of purchase calculations depends on the level of local supply available and the "decision rules" employed in allocating the supply and demand differences.

The level of labor demand and other variable costs is a function of the "good throughput" in each distribution component and then summated to obtain the total for the sector. "Goods throughput" is equal to the total volume of goods purchased or final sales plus level of spoilage. Thus, changing spoilage without any changes in final sales will still alter the level of labor and other variables costs input. Taxes are a function of gross margin. This is assumed due to the nature of the tax structure in Brazil based on the payment of a certain percentage of a "quasi" value added at each level in the distribution system where a sale is made. Fixed charges and depreciation are given exogenously or determined in a PER.

Residual net profits are distributed or left undistributed. The distributed profits are allocated to the Consumption-Income Sector as consumer income. Undistributed profits and depreciation are combined to give the level of internal funds generated for potential investment or hoarding. All of these calculations are brought together in the determination of a cost and profit schedule for each distribution component and for the sector as a whole by product type and by consumer type. Potential investment funds are automatically funneled to the Investment Sector where the decisions are centralized on the rates of internal reinvestment for each component in the Distribution Sector and the level of externally supplied funds are determined by the model user. Value added for each distribution component and the entire sector is also determined as a function of gross profit level and direct wages

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paid. (See Appendix A - Pages 280 to 283 for examples of the detailed print-out for this sector containing economic information about each component and the sector as a whole.)

Flexibility, Assumptions, and Limitations

Definition of Product Breakdown

In the first three defined channel components of modern and traditional food outlets, both food and consumer goods flow through each channel. The food portion consists of all processed and non-processed foods. The non-food portion consists of general consumer goods handled by the food outlets.

The "mix" of products in the non-food category are relatively homogeneous within the three defined food channels. Examples are such items as wax, soap, brooms, dishes, pots, etc. Product mix is very different in the two non-food channels which sell products ranging from shoes and clothes to radios and refrigerators. This is why the shifts in shopping propensities described in the Consumption Sector are limited in directional changes.

On the Definition of the Channel

The types of components defined within the Distribution Sector are described as a set of channel components which include retailers, wholesalers and other urban channel members.

At this point no interchannel flows have been considered. The basis for this assumption lies in the conclusions from the urban surveys on retailers and wholesalers conducted in Recife which showed a relatively low degree of interchannel flow at the present time.[1]

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[1]LAMP/LAFS Draft Report, Chapter 5.

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The low degree of interaction in the buying and selling of goods does not mean that none takes place, but its value is insignificant relative to the major flows in the sector. Further, concentration was desired on the characteristics of vertical channel arrangements.

With relatively little reworking of the internal mathematics and program, intertype flows could be incorporated into the structure of the Distribution Sector. In the present structure it is not assumed that an entire firm or type of institutional structure for example, large wholesalers, are completely in one channel type. Their output can be split between channels. Of course, however, intra-component transactions are defined as goods move from wholesalers to retailers.

One important flexibility in the Distribution Sector is that the "content" of any channel/outlet type can be altered. This is done in some of the simulation runs which are conducted. In re-defining the distribution types it is crucial that the "average shopping propensity" matrix in the Consumption Sector be altered to fit the re-defined Distribution Sector components. This must be done because that matrix defines the proportional split on expenditures by <u>outlet type</u> in the Distribution Sector. Thus, if outlet definitions are changed, shopping propensities are also altered.

The Shopping Propensity Matrix and the Distribution Sector

In the Consumption Sector, one of the major parameter inputs is the shopping propensity matrix. This matrix determines the location of purchase for all the consumer types. Thus, it is important to understand its implications on the operation of the Distribution Sector because the actions of participants in the Distribution Sector will, to a large extent, determine the degree of consumer shifting from one type of outlet to another. In the consumer surveys conducted in Recife, the consumers put high priority ze and l

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on price and location in the choice of place of purchase.[2] Also important is the mix of products which the distribution outlets offer. For example, until very recently, none of the self-service operators offered any fresh fruits or vegetables and all such purchases had to be made in the street and public markets. With the inclusion of a more complete product mix, the shift of buying habits may be altered further. Thus, the characteristics of the modern and traditional outlets must be explicitly defined for each simulation run in order to insure that the correct shopping propensity matrix is used.

The Significance of Modern and Traditional Types

Specific modern channel arrangements are defined in the Distribution Sector which permits the analysis of demand and supply relationships under various assumed structural arrangements. The modern food channel includes large scale retailers and wholesalers which have a general philosophy of "low margin and high turnover", and a modern non-food channel consists of large scale merchandising stores for more durable consumer goods. These modern types are included in the model to permit the analysis of the effect of modernized institutions on (1) the horizontal competitive structure within the Distribution Sector, (2) on the consumer buying habits and resultant effects on income spent on food vs. non-food consumption and (3) on the vertical buying patterns and coordinating effort of the Distribution Sector itself.

The characteristics of the modern types can vary between simulation runs. For example, in one initial run, all self-service outlets are included in the modern food channel/outlet type. In other runs, only the large-volume low-margin units are included. The results show significant differences in both buying and selling. Further, it is hoped to be able to show the

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[2] Ibid., Chapter 4, Table 4.8,

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effects on the traditional operators of competitive pressure from the modern operators. For example, traditional operators can react to changes in the Distribution Sector by increasing efficiency through coordinated action or by dropping out of the system.

Margin, Spoilage, and Input Demand

The determination of gross margin and spoilage are outside the internal structure of the Distribution Sector. They are entered exogenously or through "planner entry routines".

It is important to understand the implications of changing either the gross margin or the rate of spoilage. Without proper adjustments in these highly related variables, results could be very misleading. For example, the effect of lowering a food margin, while holding sales and price constant would be to increase the demand for food by the Distribution Sector (or an increase in the cost/unit of input making the value but not the quantity of input change). Thus, careful analysis of the effects of changing margin must be done before any alteration is attempted.

In case of spoilage rate, the interdependence with other factors is even more important. For example, when we reduce spoilage significantly, how will the retailer react? Will he keep his present actual margin and cut price significantly, will he try to achieve his current mark-up per unit, thus increasing profits but not lowering the price? Further, with the decrease in spoilage, how will the poorer consumer react when less of the "spoiled but salable" goods are available to those who traditionally buy these spoiled goods. (Lowering spoilage could hurt the poorer consumer [sic].)

With a given level of demand, the lowering of spoilage rates forces at least one of the following variables to change in the model:

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3. A rise in the input cost/unit

Since the first two are exogenous inputs into the internal structure of the Distribution Sector, unless specifically altered any change forces a rise in the input cost/unit, which is not an intuitively logical result of lowering spoilage. Normally it would be assumed that input cost/unit would remain the same. In order for this to happen, price and/or margin must be altered taking into account the incentives to increase profits and volume and any costs associated with the investment necessary to lower the rate of spoilage.

The high interdependence of price, cost, margin, and spoilage rates demonstrates further the potential usefulness of "planner entry routines". There are a number of assumed relationships which could be applied under various hypothesized external, competitive, and reform situations. By not limiting the operation of the model to one set of relationships, the flexibility of the model to deal with broader problem analysis is enhanced.

Variable Inputs as a Function of Goods Throughput

The variable inputs of labor and other variable costs such as services, transportation, and suppliers are a function of total goods throughput and not just final sales. The effect of this assumption is seen clearly with an example. If spoilage is decreased and the flow of output was increased but not the amount of goods purchased, the demand for labor would not change. The result would be lower labor per unit output caused by the lowering of spoilage.

Fixed Versus Variable Costs

The model of the Distribution Sector allows for the inclusion of both fixed and variable costs. In the short-run it is obvious that there are certain fixed costs of operation for an individual economic unit. The definition sed vs.

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of fixed vs. variable costs becomes somewhat dimmed when the time consideration is lengthened and the number of economic units within any given component becomes rather large. For example, rent for a single economic unit may be fixed over one to five years, but over longer periods of time it is a variable cost. Further, when 1000 of these units are grouped together in one component having variable sales, new entrants, other dropping out, and the ability on the part of some units at any given time of changing their rents, the total amount of rents becomes much more variable in nature. Thus, rents do not remain constant as output rises for the distribution component in the aggregate.

Points of Planner Intervention

Through exogenous input or the development of PERs, the user of the model can alter spoilage rates, margins, technical coefficients, and source of purchase each time period within a simulation run for each distribution component. Of course the degree of change depends on the type of reform implemented.

1. Gross Margin. Gross margin is defined as the proportional difference between the value of goods purchased and the value of goods sold. Thus, one minus gross margin equals the "cost of goods sold". This parameter must be given to the model each time period for each of the channel types. It should be remembered that this margin applies to the total urban channel and not to just the retailers or wholesalers alone. Further, gross margin will differ from "mark-up" per unit when there is spoilage or loss present. Given a "mark-up", the higher the spoilage or loss, the lower is the gross margin.

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2. Rate of Spoilage. For each of the channel types and product breakdowns within types (for modern and traditional food channels only), a rate of spoilage is input each time period. The rate of spoilage is defined as the proportion of spoilage to total sales. Included in this spoilage factor should be all spoilage or loss which takes in an urban distribution channel. A problem arises with the consideration of partially spoiled products. In the simulation runs conducted partially spoiled but sellable goods are included at a discount rate equal to the reduction in price which is necessary to sell the goods. Thus, if 10% is totally spoiled or lost and 20% is partially spoiled to the point where a 25% reduction in price is necessitated the total rate of spoilage input is 15% (10% + .25 x 20%).

3. Technical Coefficients. Technical coefficients may be altered in each channel type for labor, other variable costs, and taxes. Each coefficient is a "value coefficient" rather than a "unit to unit" coefficient. For labor only direct labor expenses are included with the ability to have residual profits considered as wages to the small traditional operators in the system. Other variable costs should include supplies, utilities, advertisment, etc. On the other hand the tax coefficients are considered a proportion of the value of gross margin (as opposed to sales.)

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4. Source of Purchase. A "source split matrix" is input each time period for each channel type which gives the proportional split on where the Distribution Sector components purchase the processed food, unprocessed food, and consumer goods. The alternatives available are: the Recife Industry Sector, the Rural Sector, and/or the South-Import Sector.

   The final values in this matrix are dependent on the decision rules employed in the Decision Routine-Consumer I. It is possible to keep the original values or permit alteration within a given time period conditional on the reaction of the Distribution Sector to differences between supply and demand. Thus, the input of source of purchase proportions may be "actual" or developed as a "potential or desired" demand to be altered in the Decision Routine.

5. Relative Price Index. The input of the relative price indices is crucial to the analysis of reform options implemented in the Distribution Sector. This will determine the amount of real income generated in the Consumption Sector from shifting shopping behavior and lower prices within channel types.

   Price indices are given each time period for each channel type. In all cases these indices relate the price in the traditional outlet to the price in the mode

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modern outlet. Thus, the traditional outlets or channel act as the base of comparison. For example, in the initial year the price of food in the traditional food channel is assign a value of one. If the relative price in the modern food outlets is 8% lower then it is given an index of .92. As time periods progress over a simulation run the prices in both outlets may vary freely so that by the fifth time period traditional food prices are .95 and modern prices are .92. In all cases the index is always relative to the initial price level in the traditional channel type.

6. Special Information Inputs. In the Distribution Sector special information inputs are permitted in order to analyze various conditions within a given channel type or the sector as a whole. The following inputs are permitted: the total level of employment, number of establishments, area, asset value, and capacity. These are generally used in the development of measures useful to a planner such as capacity utilization and sales per employee.

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[1]Ibid.

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CHAPTER V

THE RECIFE INDUSTRY SECTOR

The Purpose and Orientation

The Industrial Sector in Recife is small with it accounting for only about 10% of wages generated in the urban center.[1] There are three specific reasons why this sector is included in the model.

First, the internal market thesis stresses the importance of increasing the availability of consumer goods in both the urban and rural areas. At the same time the processed food industry can act as a coordinator of production and distribution of food within a region through its large single unit buying power and ability to coordinate vertically.

Second, extensive study of the farm input industry, consumer goods industry, and processed food industry was conducted in Recife LAMP/LAFS research project.[2] The purpose was to identify the character and potential of industrial growth oriented to the final consumer and rural farmer. The model of this sector portrays the expected changes in industrial structure which the research suggested.

Third, while the current Industrial Sector in Recife is small, it is a crucial component in the urban system. Generally the Industrial Sector must grow in order to provide the jobs necessary to offset the high degree of urban migration which is taking place. In this respect the Industry

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[1]*Ibid.*, Chapter 4, pp. 6-7.

[2]*Ibid.*, Chapter 3.

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Sector provides a major area of potential reform and growth within the total economic system under analysis. For this reason industrial components other than the three prime areas of concern are included to give good estimates of the total industrial activity taking place in Recife. Though output in such areas as construction materials and capital equipment are minute, their future impact on economic growth could be great. Further, it is advisable to include them in order to interpret the potential effects of large investment decisions in these areas as opposed to investments in the areas more closely identified with the research work carried out in Recife -- such as processed food farm inputs, and consumer goods.

Defining the Recife Industry Sector

The Industry Sector constitutes the industrial productive enterprises in and around Recife. The criteria for inclusion of a firm in the urban Industry Sector is whether their contribution of wages are primarily to the urban Recife consumer. The model of local Recife industry consists of manufacturing, assembling, and processing firms categorized into seven industry groups or types as follows:

1. Agricultural inputs production.
2. Processed food production
3. Consumer goods production
4. Construction materials production
5. Captial Equipment and Other equipment
6. Industry intermediate supplier products manufacturing
7. All other manufacturing and processing not explicitly included in the other six categories.

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Within each of the seven industry types are the sub-industry divisions which make-up the total industry type. Agricultural inputs are composed of fertilizer and insecticide producers. Processed food production comes from the following variety of sources: beverages, vegetable oils, fruit and vegetable processors, milk processors, flour mills (wheat and manioc), candy and baby food producers, and meat and poultry processing. Consumer goods are composed of a diverse mix of operations such as soap production, pots and pans, matches, plastics, furniture, textiles, cigarettes,and electrical appliances. The supplier product type is generally packaging manufacturers and other such suppliers of goods for use in industry. In the Recife area most construction materials production is in the forms of bricks, cement, roofing and wall tiles, and some other fabricating products. Equipment manufacturing is composed of farm implements, irrigation tubes, and final assembly of some processing machinery. The last industry type is the "other" category, it contains very little at the present time with its main firm a small scale operation for the final assembly of jeeps and small trucks.

The Structural Relationships

The internal structure of each of the seven industry types differs only in the method of determining final output and its distribution. There are three groupings of the industry types which have different means of output determination and distribution: (1) processed foods and consumer goods production, (2) the supplier industry type, and (3) the other four industry types.(See Appendix A - Pages 284 to 289 for the verbal equations and flow of computations.)

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Output Determination and Distribution

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The outputs of these two types is given by a simple dynamic growth function, which states that output next time period is (1 + expected growth rate) on the output of the type last time period. Thus, the output of the type is "determined" within the Industry Sector and is not directly a function of the final demand placed on the industry type. This does not mean, however, that the output is not conditioned by the expectations of demand by the firms in the industry type. Figure 5.1 presents the structure of the processed food industry component, except for output determination, it is identical for the other industry components.

The industry components determine a "preliminary" level of output and its distribution, then calls the Decision Routine-Consumer I to allocate any differences that exist between local supply and demand generated by local final consumption. Output and its distribution is finalized in Consumer I as a function of local demand, initial output allocated to fulfill local demand, and the flexibility of the component to adjust its present output and sales locations (determined by the type and level of decision rules used in Consumer I). In Consumer I the Recife Industry Sector has the first opportunity to offset any differences which exist between short-run local supply and demand, if any remains the rural productive components can attempt to offset the rest, any residual is allocated to/from an accumulated surplus account or the import/export sectors.

The use of the Decision Routine can alter the previously determined output. For example, one of the decision rules permits a time variant increase in output if a deficit exists or an output decrease if a surplus exists.

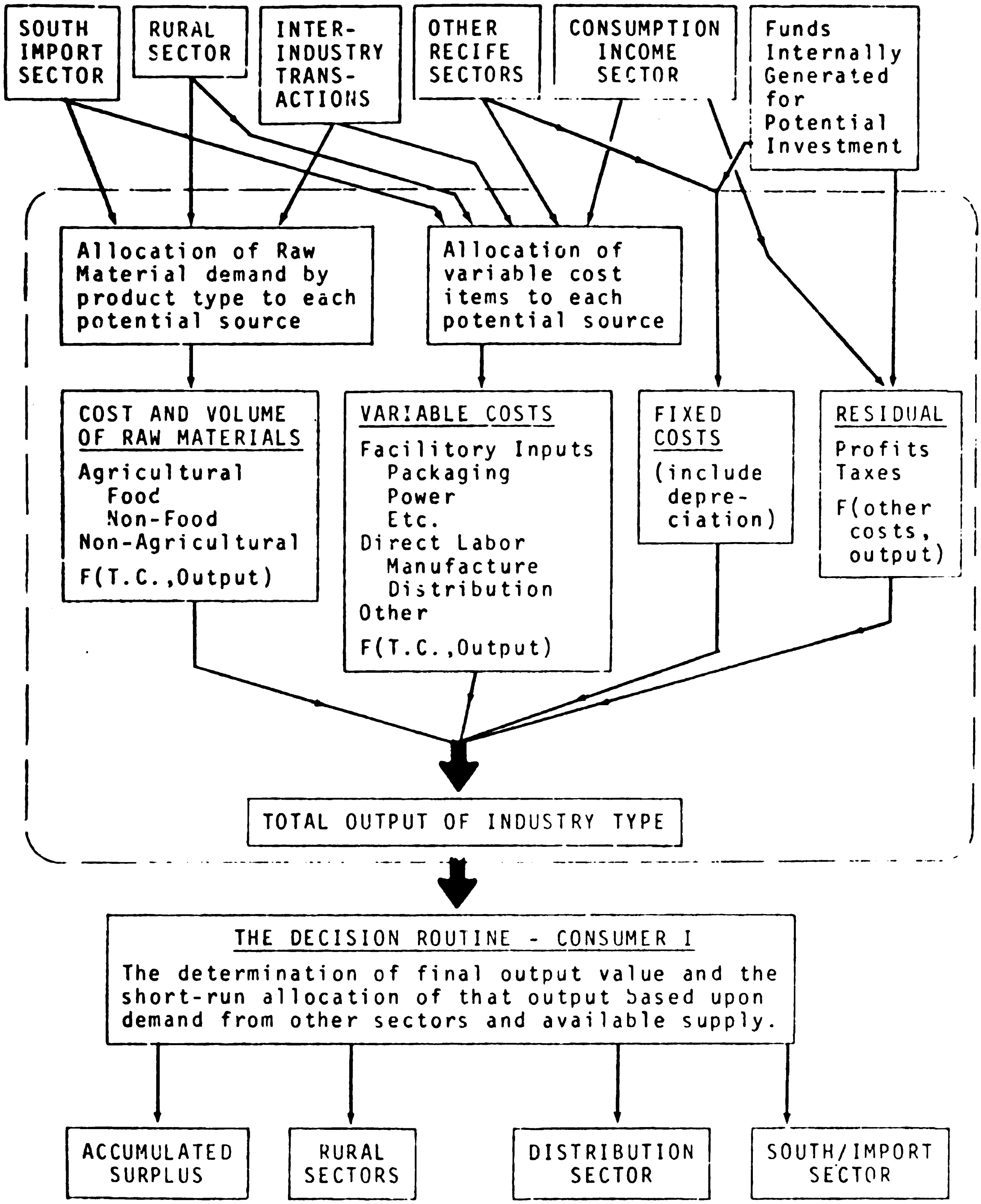

FIGURE 5.1 The Recife Industry Sector: Internal Component Structure of a Typical Industry Type--The Processed Food Industry Component

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Also, the final allocation of its total output may be changed within the routine depending on the decision rules employed.

The potential effects on the industry types of processed foods and consumer goods of this decision routine can be great. At one extreme total rigidity can be assumed, i.e. not allowing the industry type to react to potential surpluses or deficits. Or at the other extreme, negating any of the above output determination, the industry type can be permitted to accept passively whatever the Distribution Sector demands, i.e. complete demand reaction or supply flexibility.

Construction Material, Capital Equipment, Farm Equipment, and Other Industry Components

The output for each of the four types included in this section are determined exactly as for the other types already described: A simple dynamic growth rate on the output of the type for the last time period.

The major difference between the processed food and consumer goods type and those included here is in the allocation of the output once it is determined. In the first case, the outputs are split preliminarily and then those results go to the Decision Routine-Consumer I for final solution according to the prescribed set of decision rules. In this case, the output which is determined by the growth function will be the actual output of the industry type. It will not be changed by any future action in the model within a given time period.

For these four industry types a separate routine very similar to Consumer I is developed called the Decision Routine-Capital II. The primary difference between the two routines is that Capital II defines the exact allocation process while Consumer I allocation process is flexible. Briefly Capital II determines the distribution of the given output of each of the four industry types. A priority on demand is given to local Recife demand.

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If an output surplus remains, the Rural Sector demand is considered next, followed by exportation or additions to accumulated inventories. The routine can allocate only the given output and does not have the power to alter it. The rationale for the assumption of "output determination" is given in the section on Flexibility, Assumptions, and Limitations in this chapter. Any supply deficit is offset by importation or the utilization of past accumulated inventories, if existent.

The Supplier Goods Industry Component

In this industry type, output is a function of the demand placed on it from the Rural Sector and the interindustry demand from all of the other industry types. The supplier component produces certain types of facilitory inputs such as packaging materials which are locally consumed. It was found in the industry studies done in Recife that the firms in this type were often closely tied (frequently by ownership) to the final goods producing firms.[3] There output was closely correlated to the total final demand on the other industry types.

Input Determination and Sources of Purchase

Input determination is not made until the decision routines have finalized the level of output and its distribution. Once the output of each of the seven industry components is computed, the inputs required to produce that output are determined. Figure 5.1 graphically presents the computational structure utilized in a typical industry component and it is applicable to all components. The inputs are divided into seven categories:

1. Inputs of agricultural products both food and non-food raw materials.

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[3] Ibid., Chapter 3. p. 11. Much more detail on the extent of interlocking ownership was included in the "Field Draft Report", December 1967, Chapter 5.

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2. Inputs of non-agricultural products for raw materials.
3. Facilitory inputs such as packaging materials, transportation, and other supplies.
4. Other variable costs such as electricity and advertising. These are all "locally oriented" expenses.
5. Direct labor expenses in manufacturing and assembly.
6. Direct labor expenses from distribution within the Industry Sector which is not associated with the wholesale and retail costs included in the Distribution Sector.
7. Taxes paid to all government units.

The value of each input is determined by a value technical coefficient on the total output of the industry type. Thus, for every value unit of sales some proportion (the technical coefficient) is demanded of each of the inputs. At any given point in time this makes the assumption of constant returns to scale, but the ability to change technical coefficients each time periods alleviates this limitation.

Once the total value of each input is determined, the location of purchase is computed. This is done through the use of a source split parameters on each of the inputs. Each input can come from various other sectors in the model, from within the Industry Sector in the case of facilitory inputs, or from importation in the following categories (See Figure 5.1):

1. Agricultural and non-agricultural raw materials can come from the South/Import Sector or from the Rural Sector.

2. Facilitory inputs can be purchased from Recife Supplier Industry, Other Recife Sector, the Rural Sector, and the South/Import Sector.

3. Other variable costs can be derived from the Other Recife Sector or from the Rural Sector.

4. All labor is assumed to come from the Recife Consumption/ Income Sector.

5. Taxes are assigned the government component in the Other Recife Sector.

Fixed charges and depreciation are based on current asset values and capacity. Profits are determined as the residual and are allocated as either distributed or undistributed. Distributed profits are combined with wages paid to determine the level of final consumer income generated in each industry component and then summed to determine the total sector contribution. Undistributed profits and depreciation are combined to determine the level of internal funds generated for potential investment. Again these funds are given to the Investment Sector to determine levels of reinvestment, additions to the capital stock, and their effects on capacity and technical resource utilization. Value added by each component is calculated from the addition of net profits, wages paid, and taxes. All these calculations are combined in the development of a detailed cost and profit schedule for each industry component and the Industry Sector as a whole. Further, tables are presented in the printout which show the balance of trade by industry component and type of input. (See printout examples in Appendix A - Page 290 to 294).

Flexibility, Assumptions, and Limitation

Flexibility in Defining Industry Types

The structure of the Industry Sector permits easy alterations in the content of one or more of the seven industry components described. Any number of types from one to seven may be defined in using the present mathematics and computer program. This flexibility is possible because each of the first six industry types are, from a mathematical standpoint, technically identical. They vary only in the determination of output and the values of the technical coefficient parameters. Industry inputs are defined generally enough to accommodate numerous groupings of the industry types.

The flexibility in structure has allowed a number of various industries to be included in different simulation runs. For example, in one set of simulations, the output of a given industry types can be split between the current traditional operators and the modern operators presently in the system or expected to enter. This is the attempt to assess the differential impact of these types of enterprices on the supply, demand, and income generated into the system. Using the PER to split the output, identify different technical coefficients between modern and traditional outlets, and different sources of purchase allow the current model structure of one industry type to expand to fit this type of consideration.

The Significance of Industry Determining its Own Output Independent of Demand

For all but the supplier industry type, output is at least initially determined independent of demand. Technically this means that a sequential solution to the model is used versus the simultaneous one. Thus, the possibility exists for differences to exist between the outputs of the industry types and the demands placed on their outputs from the other sectors in the

model. These differences are ameliorated in the decision routines. Chapter VII on the two routines, details the structure of these routines, here only the rational for these routines relative to industrial output is considered.

The rate of industrial output is so low relative to demand that a significant portion of demand is satisfied from importation through the South-Import Sector. Having demand technically independent of supply permits analyzing potential effective demand on local industry without actually creating the supply. This difference between potential and effective demand is one measure of the degree of balanced growth which is taking place within the urban system.

At the other extreme, supply can be created through increased capacity and the model permits the analysis of the effect of that supply on wages and thus demand in order to determine if that industrial output is "self-sustaining". Excess capacity or output is not automatically demanded and the present structure allows for the evaluation of excessive capacity in one industry and lack of capacity in others. Further, the structure permits flexibility in the assumptions of economic rigidity or flexibility to shifting demand situations.

A behavioral consideration of importance is that the output decision-makers within the system do determine their perception of demand; so that the rate of output assumed in the model while technically independent is still very much economically dependent on the demand expectations. One of the efforts of the simulations of the model is to demonstrate the impact of poor communications and information systems causing bifurcation between supply and demand conditions.

The industry types for which the Capital II routine is used are not final consumer oriented. The construction materials industry, equipment and farm inputs are generally more concentrated and dependent on the rate of investment in a sector. A small number of changes in demand where each demanded

unit is large can have significant impact on the supply and materials purchased. The information available on the four industry types included in Capital II, their very small value of current output, and their highly dependent nature relative to the availability of investment funds defines much less short-run flexibility.

Technical Coefficients and Change

The use of a value technical coefficient must be discussed. If a technical coefficient remains constant it assumes that the industry type is facing constant returns to scale. This assumption is not acceptable in the framework of change to which this model is oriented. Thus, the technical coefficients are input to the sector each time period instead of only the initial time period. This exogenous input each time presents the potential for an important PER especially when considering input substitution of labor and capital as an industry component modernizes. Labor will be used as an example of the use of a PER in changing technical coefficients, but the following discussion is equally applicable to other inputs.

The first consideration is on a means to change the technical coefficient given some intra-component structure such as part of the output coming from modern operators and part from traditional operators with the proportion changing over time. The first step is to identify the output which is ascribed to each type of operator, this can be done by such things as a simple first or second order "Markov chain" which switches a given proportion each time period from one type to another. On each output different labor technical coefficients are defined. Then by weighting the resultant technical coefficient for a given time period is input into the coefficient matrix.

Changes in the technical coefficient could be done directly with a "switching chain" on the technical coefficients themselves so that over time the values of the coefficients could be assumed to approach some optimum value.

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Also the technical coefficient computations in the internal structure could be suppressed with ease and a new input determination routine instituted such as:

$$\text{Input of S} = (A - kA + kA^1)\ \text{Output}$$

Where A is the technical coefficient on the traditional units and A^1 is the coefficient on modern units, with k equaling the proportion of output which is attributable to the modern operators.

Another problem arises in the use of the particular type of value technical coefficient defined. The value technical coefficient describes the relationship between value of input and value of output. Thus, in both cases it is measuring a flow which is price times quantity. It may be desirable to have the technical coefficient on a quantity base instead of a value base. Given that the user of the model can define the "price of the input" this can be done easily in the planner routine context. Define the quantity coefficient in the sub-routine and then through the proper calculations it is obvious that it could be converted each time period to the appropriate value coefficient used in the internal structure of the component model.

The possibility of including other functional relationships is present. In the short-run consideration when output is approaching capacity the efficiency of the industry type may decline and thus input costs and quantities may rise. This could be included in a PER through the use of a variable step function on capacity (variable in the sense that its steps shift with changes in capacity).

Interindustry Flows and Investment Funds

Only in the supplier industry type are explicit interindustry flows considered. A question arises relative to the allocation of the outputs of the construction materials and capital equipment output industry types. It seem

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would seem that a large share of their output is sold to other firms in the Recife Industry Sector.

The allocation of the output of these two industry types is largely a function of the level and location of investment taking place in the system (industrial, distributive, housing, public works, etc.). Thus, it is assumed that their demand would not be a direct function of output in industry but directly related to the level of investment determined in the Investment Sector. Total demand for construction materials and equipment is determined in the Investment Sector and then put through the Other Recife Sector which acts as a "transfer agent" in allocating the investment funds between labor, materials and equipment. Out of the Other Recife Sector flows the total demand for capital equipment and construction materials from all investment sources. This demand is then split between local production and importation in Capital II depending on the current level of local output and demand.

Other Considerations: Employment and Cost of Capital

In the development of the explicit needs of the internal structure of the model of this Industry Sector no need is stated for such terms as number of employees and capacity. These types of terms are not needed for the specific solution of the Industry Sector model. However, they may be included for one of two reasons.

First, they may be used in the development of some PER. For example, technical coefficients being a function of the degree of capacity utilization. Second, they may be input in order to calculate various relations between them and the values developed in the model for informational purposes or determination of some defined performance criteria measures. Some examples are the number of employees per unit sales and the capital output ratio.

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Finally, the cost of capital as an input expense is not explicitly included in the model. Little information was available on present levels of equity and debt financing in the Industry Sector and,with the high degree of differential inflation, interest rate determination is difficult. Consideration of cost of capital should be divided between equity and debt proportions of the total asset value of a firm. Distributed profits become at least a partial measure of equity costs since these are returns to the owners. Debt costs could be included in a separate input value or with other variable costs, but it would seem more advisable not to have capital costs a function of output. Rather they should be a function of capacity or net asset value of the firm. Within that framework it is possible to exogenously input capital cost proportions as asset value and depreciation are and subtract the expense from net profits before distribution takes place. This was not done in the initial simulations because of the lack of information.

Points of Planner Intervention

The growth rates on output, technical coefficients, and location of purchase proportions are all potential points of planner entry. Thus, they are readily open for variation between time periods as functional relations to such variables as output and capacity or simply input exogenously each time period for each industry type.

1. Output Determination. The character and assumptions underlying the different types of output determination have been discussed in detail. In any simulation run the initial time period output for all but the supplier industry type must be input. For consumer goods and processed food production care must be taken to coordinate this output determination and the assumed growth rate in output relative to the decision rules utilized in Consumer I.

2. Technical Coefficients. Each time period for each industry type technical coefficients for: agricultural raw materials input, non-agricultrual raw materials, facilitory inputs, other variable costs, direct labor in manufacturing and distrubution, and taxes are necessary. The coefficients relate the proportional value of an input to the value of output. Methods of determining these coefficients have been detailed.

3. Location of Purchase Parameters. The inputs which the Industry Sector requires to produce its output can come from a variety of other sectors in the model. They include: the Rural Sector, the South-Import Sector, the Other Recife Sector, the Consumption-Income Sector, and within the Industry Sector from the supplier industry type. For example, agricultural inputs can be imported or come from the Rural Sector; facilitory inputs are purchased from the supplier industry type, Other Recife, the Rural Sector, and from importation; and all labor accrues from the Consumption-Income Sector.

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CHAPTER VI

THE OTHER RECIFE SECTOR, THE RURAL SECTOR, AND THE IMPORT-EXPORT SECTORS

The Other Recife Sector

The Purpose and Orientation

This sector is composed of a large conglomeration of economic activity. They are the activities about which the most limited information is available and are less important than the others for the analysis of the market oriented reforms presented. This is not to say they are not important in the region -- they are. For the purposes of this model Other Recife's contribution to the total framework lies in two major areas:

1. As a generator of income for the Consumption Sector from other urban economic activities, government, public transfer payments, and investment.

2. As an investment demand transfer mechanism where investment expenditures are translated into specific economic flow demands for labor, construction materials, and equipment.

This sector is included in the model to "round out" urban Recife economic activities by including the other economic components in the city in order to facilitate more detailed analysis of the other principle sectors the mod

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in the model. The mathematical structure of this sector utilizes input/output matrix inversions with source and receiver split matrices to determine the level of inputs from other sectors or from intra-sector transactions required to fulfill the defined terminal demand placed on it by other sectors in the model. It acts passively in that all output of the sector is totally a function of the demand which other sectors place on it and the level of intra-sector transactions. (See Appendix A - Pages 295 to 299 for a technical discussion of the input/output technique used, the verbal equations for the sector, and a flow chart of computations.)

The Definition of Other Recife Components

The conglomeration of economic activity present in this sector is divided between eight components.

1. Automobile and Transportation
2. Service Industry
3. Housing and Rents
4. Construction Demand
5. Capital Equipment Demand
6. Minimal Subsistence Unit (unaccounted income and "in kind" transfers)
7. Government revenues, expenditures, and public transfer payments
8. Other Miscellaneous

The first component, automobile and transportation, emphasizes the sales and services associated with the demand for vehicles in the urban area. This demand originates from all three of the other urban sectors (Consumption-Income, Industry, and Distribution). The service industry is primarily oriented to the final consumers in Recife.

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The flow of all housing expenses and rent payments enter the Other Recife Sector. This component acts as a transfer agent for these payments. The appropriate expenses associated with maintenance, labor, materials, and taxes are deleted from total payments and the remaining net value of payments are considered available profits to be distributed or undistributed (and thus available for future investment).

The construction and capital equipment components are also transfer agents for the urban sectors whose investment expenditures create a demand for construction and equipment. This demand is transferred to the Other Recife Sector through the Investment Sector. There are, however, additions to that demand from components within the Other Recife Sector such as demands originating from housing, government, and transportation. These components act to allocate the total external and internal demand between labor, construction materials and equipment. Then the material and equipment demand is split between local and importation depending on the availability of local supply.

The terminal demand for investment funds is split into two kinds of construction demand and capital equipment demand. The first kind of construction demand is "non-industrial" construction. This includes the investment in the construction of housing, apartments, schools, hospitals, and public works. They are included only to show the "construction effect" which the investment expenditures generate in the form of economic flows within the economy (demand for equipment, material, and labor). The second type of construction demand is industrial or distributive capacity increasing investment. The differentiation between the two is outlined further in the analysis of the Investment Sector in Chapter VII.

A minimal subsistence unit is included to enable the balancing of low and very low income people in the Consumption-Income Sector. The ability to identify their wage and income sources is extremely difficult and in many

cases payment is in "kind" rather than money income. Thus, a "best estimate" lump sum amount is included to offset any apparent divergence in the income generated to the Consumption-Income Sector.

The "miscellaneous other component" is included to permit further expansion or disaggregation in future simulations. Currently there is no economic activity assumed to be moving through this unit.

The last component in this sector is government. Government is an important part of the urban Recife economy but little information was developed in the LAMP/LAFS research study. It was impossible to include all of the intricate activities which take place within the government sector which affect the flows of revenues and expenditures in the region. It is important to understand that government has been incorporated only to facilitate the analysis of the other sectors and the reform options oriented to other parts of the system. In this regard the major impact of the government sector in economic flows is in the consumer income generated, transfers, and tax revenues. In the Recife Consumer Study almost one-third of all respondents indicated that a major portion of their income was derived from some government associated unit.[1]

Thus, within the Other Recife Sector the emphasis on government is in the explicit economic flows which it stimulates. Of course other important governmental activities must be considered in the total picture of the system. The particular areas of regulation, investment expenditures and investment incentives are analyzed within the framework of the Investment Sector.

The Structural Relationships

Since the Other Recife Sector is oriented to facilitate the analysis of the other parts of the Recife Systems Model, its structure passively receives

[1] *Ibid.*, Chapter 4, pp. 6-7.

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the demands placed on it from the other sectors. Other expenditures from the Consumption-Income Sector, the variable and fixed charges in distribution and industry, the inflow of investment both internal and external to the system, and all taxes are the "demands" placed on this sector. Other exogenous inputs such as minimal subsistence and the net flow of tax revenues from outside the system are also included. These form the "terminal demand vector" which is then split between the eight components within the Other Recife Sector. For example, all consumer rents are directed to the housing-rent payment component and variables costs of distribution are split between transportation, rents, and services.

The result is the total demand on the eight components from outside the sector. At this point the traditional Leontief input/output coefficient matrix is used to determine the "intermediate demand" which arises from transactions within the sector between the eight components. For example, the total "output" of the services component consists of the terminal demand placed on it by the Consumption, Distribution, and Industry Sectors plus the "intermediate" demand generated from other components within the sector such as automobile-transportation, housing-rents, and government.

Given total output, the demand for inputs is also split between internally generated supply and the demand placed on other sectors in the model. Thus, by definition the "intermediate" supply (that part supplied internally by other units in the sector) is identical to "intermediate demand". The rest of the value of output is composed of the demand transfer for equipment and materials, and value added (net of taxes) generated by the eight components. Value added is split between wages and distributed profits going to the Consumption-Income Sector and undistributed profits available for future investment. The transfer demand for construction materials and equipment enter the Decision Routine-Capital II are compared to local supply of those products alloc

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and allocated according to the decision rules employed in Capital II. (See Chapter VIII - Pages 300 to 301).

Thus all output is allocated to: value added including net profit allocation to taxes, distributed, or undistributed (thus available for investment) and wages; intra-sector "intermediate demand", and demand transfer arising from investment expenditures for construction materials and capital equipment.

Flexibility, Assumptions, and Limitations

Two different aspects of this sector must be considered in deciding the effectiveness with which it deals with the remainder of the Recife economy. First the sector as it represents major sets of economic activity such as government; and second, the sector as a demand transfer agent for other sectors in the model.

In the latter, little fault is found in the structure and use of the sector as a technical means to allocate rents between expenses and income, and investment funds between the demands for labor, equipment, and material. It is in the first area that this sector may lack the sophistication necessary for a total economic system analysis. The most serious limitation is the lack of information on the level of economic flows between the components. Best estimates are made of the current level of interaction from what scanty data is available. In none of the reform options analyzed were explicit changes made in parameter values for this sector. If the analysis of change in any part of the sector is contemplated in future,use a more disaggregated sector would have to be developed. This would be especially important for the government component.

Thus, for the purposes of the analysis of reform options relative to the research and the internal market thesis this sector can adequately reflect

the gross magnitudes of economic activity taking place, provide the necessary consumer income generation, and present a means to transfer investment demand between sectors in the model. The Other Recife Sector then is sufficient in its role as a "facilitator" to the analysis of other sectors in the model. But if future simulations contemplate larger scale economic analysis, this sector should be re-worked to include better information and more disaggregated flows.

Points of Planner Intervention

If the user of the model chooses there are three areas where PERs or changes in input parameters can be made. First, the split of terminal demands between the various components in the sector can be changed each time period for each type of terminal demand.

Second, the allocation of transfer demand and value added can also change over time. Any change on these inputs which determine the location of purchase should be done in connection with the Capital II routine which handles the allocation of local output of investment oriented goods.

Last and most important is the input/output matrix identifying the intra-sectoral transactions taking place and determine intermediate demand.

The Rural Sector

The Purpose and Orientation

The Rural Sector of this model constitutes the four-state area surrounding Recife of Pernambuco, Alogoas, Serigipe, and Pariba. This area is chosen because it represented the major geographic region which supplies most of the locally produced food products for the Recife urban market and offers the market area for Recife industrial output of farm inputs, consumer

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goods, and equipment. This four-state area contained almost all of the rural and assembly market survey research which was conducted by the project.[2]

Within the four-state area much more than just food is produced and of all output including food, less than one-half goes to Recife for final consumption. But the concentration of effort in building the rural section is on the rural-urban interaction with the major urban center of Recife. The rest of Agricultural production, both food and non-food, and other rural industry which does not effect Recife is included to give the picture of the "product" of the region and thus the income generated for consumers and industry that in turn creates demands on the urban area for goods and services.

The Structure of the Rural Sector

The structure of the Rural Sector can be divided into four parts:

1. Rural farm and town final consumption determination
2. Production determination and evaluation of factor inputs
3. Rural output markets
4. Rural input markets

Figure 6.1 outlines the major components in the Rural Sector and the basic flows which are considered.

The final consumption component in the Rural Sector is composed of both rural or farm consumers and non-farm consumers living in the small towns and cities scattered throughout the four-state area.

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[2]Donald W. Larson, "A Diagnosis of Product and Factor Market Coordination in the Bean Industry of Northeast Brazil" (unpublished Ph.D. dissertation, Michigan State University, 1968), and " LAMP/LAFS Draft Report", Chapter 7 through 10.

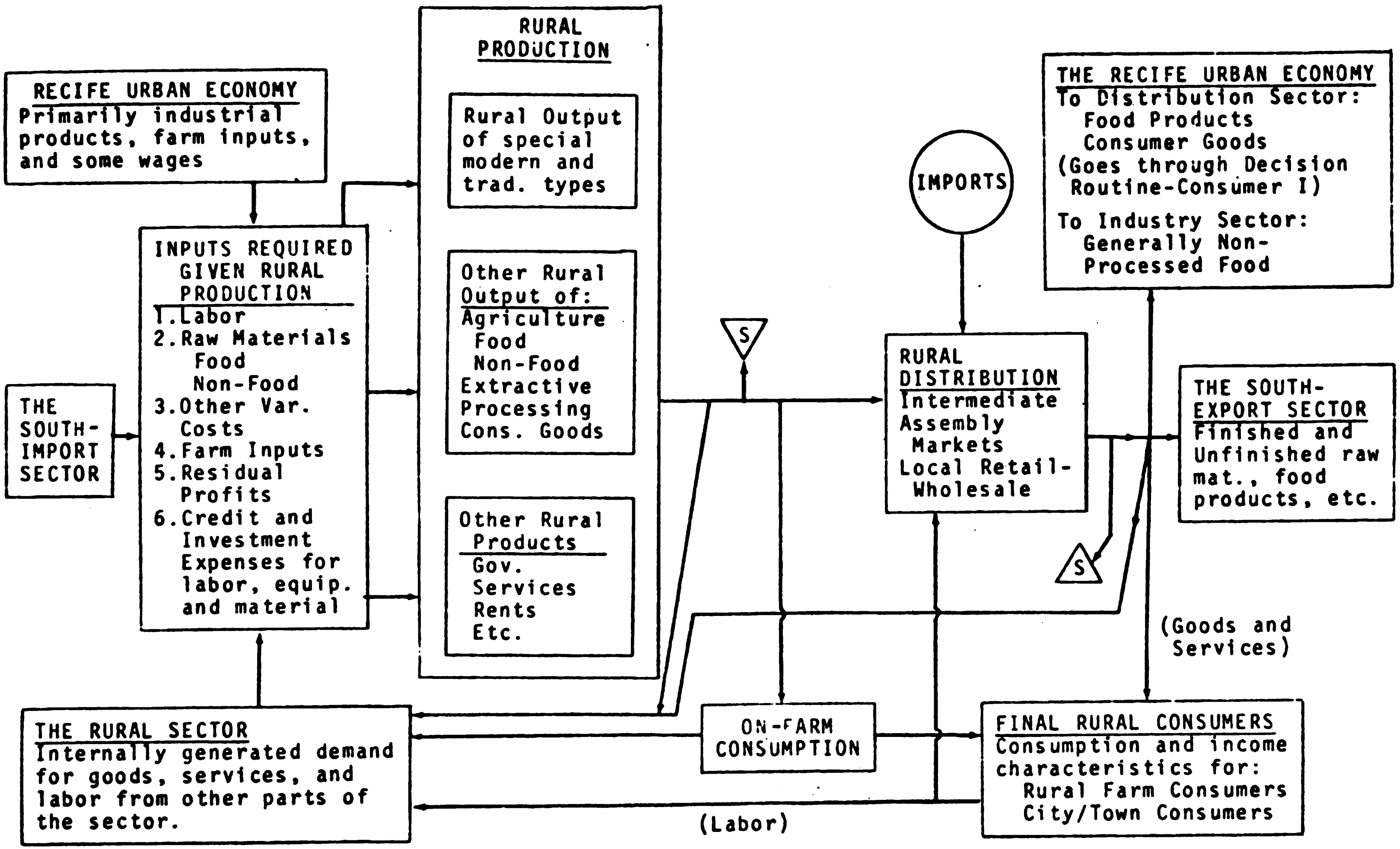

FIGURE 6.1 The Rural Sector

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The productive component in the Rural Sector incorporates all types of rural output. Concentration is on the production of food and food related products and the option is open to explicitly delineate specific products or product types within the productive component between modern and traditional production methods.

Included in the distribution component are all activities associated with the distribution of all types of rural output within the rural area. Again the emphasis is on the distrubution of food products. Rural assemblers, truckers, and brokers are an integral part of this component. For final consumer demand within the Rural Sector the rural wholesale and the retail activities are added.

The determination of rural inputs is a function of the level of total rural output and the technical coefficients relating inputs to outputs. Several different types of inputs are included along with the sources of purchase for those inputs within the Rural Sector, from Recife, or from importation (See Appendix A - Pages 302 to 313 for the verbal equations and the flowchart of computations.)

Rural Final Consumption Determination

The determination of final consumption expenditures for the Rural Sector is divided into farm and non-farm consumers. As was done in the Consumption Sector, the option is present to have an open or a "quasi-closed" system for rural income generation. Initially only these two major income groups have been defined. It is possible to incorporate a further breakdown within either or both of the major types of farm and non-farm by level of income such as high, middle, and low. This would follow closely the definitions and limitations stated in the Consumption Sector for the determination of consumer types.

Once this income has been determined, it is split according to an average propensity to consume the following:

1. Food
2. Consumer Goods
3. Miscellaneous (services, rents, taxes, etc.)
4. Savings

The expenditure split of income is done separately for the farm and non-farm consumers. Thus, it is necessary to input each time period two sets of average propensities. For the farm consumer on farm consumption is subtracted in order to get the actual value of food purchased. The expenditures in the defined four classes are then summed over consumer types in order to obtain the total Rural Sector final consumption expenditure patterns. Miscellaneous expenditures are further split by taking out the estimated proportion which represents taxes to local government units, the remainder going for such items as services and rents.

At this point tentative splits on the location of purchase are made. This means that only that proportion of food and consumer goods sales which must come from the South are allocated to purchases from the South. The remainder then is a quantity which could be purchased from the rural area and from Recife. The Decision Routine-Consumer I gives back to the Rural Sector the amount of processed food and consumer goods which are produced in Recife and sold to the rural area. All the remainder of demand could be purchased from rural production if it is available. The local demand for products is then compared to the supply which is made available from local production. If that supply is sufficient then final consumers will purchase what they have demanded from local producers, if that supply is insufficient then the demand will be met from purchases from the South/ Import Sector.

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Rural Sector Output Determination

The determination of outputs of the Rural Sector is divided into two categories: modern-traditional special types and other rural output. This has been done to permit a partial breakdown in products which are the most important or on which specific study is desired.

Modern-Traditional Special Types. -- The first category into which rural outputs are divided is for the specific analysis of products or product types. From one to five types may be analyzed. For each of the products chosen the total output is divided between modern and traditional operators, with the output of each being the multiple of yield (productivity) and land in use. Thus,

$$\text{Output}_{\text{mod}} = \text{Yield}_{\text{mod}} \times \text{Area}_{\text{mod}}$$

$$\text{Output}_{\text{trad}} = \text{Yield}_{\text{trad}} \times \text{Area}_{\text{trad}}$$

$$\text{Total Output} = \text{Output}_{\text{mod}} + \text{Output}_{\text{trad}}$$

This type of structure permits the switching of land use from traditional to modern operations. It also permits the model user to make yield or land use dependent on other variables such as expected product price, input prices, labor availability, equipment available, credit, and weather conditions.

For the determination of the output of the special modern-traditional types, the average yield per hectare and the number of hectares under cultivation are parameter inputs. These inputs are necessary for both the traditional and modern operators in any set of special products or product groups defined.

The potential make-up of these five types can come from food production or non-food agricultural production or from products which have both food and non-food parts such as cotton.

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<u>Other Rural Output</u>. -- The second category for rural output determination includes all rural production not explicitly considered in the first special categories. This output is divided into the following four classes.

1. Agricultural food production
2. Agricultural non-food production
3. Extractive industries
4. All other (such as manufacturing, processing, etc.)

For the determination of output in each of the four classes a simple growth function is assumed on the output of each class.

$$\underset{\text{(This time period)}}{\text{Output}} = \text{(1 + Growth Rate)} \times \text{Output (last time period)}$$

Two special product classes are computed within this part of rural output determination. They are consumer goods production and processed food production, which are needed explicitly for the Decision Routine-Consumer I. They are computed in the same manner. This output is considered to be all within the fourth class of general outputs listed above and is included in that output figure.

At this point there are two sets of output figures which have been computed. The first is on some defined sub-set of the rural agricultural output on which special study of modern and traditional analysis is desired. The second is on the other general output of the Rural Sector. These two are grouped by defining a matrix conversion on the specially defined types in order to transform them into the four possible classes of outputs. Thus, for example if beans, rice, cotton and sisal are specified in the modern-traditional breakdown a matrix conversion is input which says that all beans and rice are agricultural food, cotton is split by some percentage between food and non-food, and sisal is all non-food agricultural production. With this conversion, which is done separately for the modern and traditional parts, the specially defined outputs are conformable to the second general set of rural output classes and total rural output by class can be calculated.

Distribution of Rural Output

After Total output is determined the distribution of that output is computed. Following is the procedure which the model follows:

1. On farm use is computed for the modern-traditional types as some proportion of total output, and for the first class (food production) on the general output category. This then is split into on farm consumption and on farm input use for such things as seed.

2. Next on farm spoilage or loss is computed as a proportion of total output and subtracted from total output. The net amount is that which is potentially available for sale. Farm consumption is subtracted and the balance is that quantity which is actually sold.

3. The net quantity above then enters the distribution system and any spoilage which occurs within the rural distribution system is deleted, and the appropriate margins added.

4. Agricultural food sold is then split into the three locations of purchase of the Rural Sector itself (for final consumption and for industrial use in processing), Recife (for final consumption and the demand from Recife Industry), and the South/Export Sector. Different spoilage rates and margins can be assumed for each source of

purchase because they may go through different channels. The exact flows are not finalized until the decision routines have allocated local supply and demand differences.

5. The output of consumer goods, processed food, and non-processed food (defined in step four), is then communicated to Consumer I for final allocation determination.

6. The last three Rural Sector output classes (non-food, extractive, and other net of consumer goods and processed food) are then split into sectoral demands from Recife Industry, South/Export, and rural use in final consumption and in rural industry.

7. The splits determined in step 6 are finalized after the comparison with the demand which the rural final consumers and rural industry places on outputs of the Rural Sector. If the output made available to the Rural Sector is less than that demanded then the remainder of demand is fulfilled by importation. If the output is larger than local demand, the net remaining output is allocated to export or accumulated surplus.

Rural Sector Input Determination

This section discusses the development of the demand for factor inputs into the Rural Sector's productive units defined in the previous section on output determination. Thus, these inputs must be defined for each of the four types of rural product and independently for the special modern-traditional types.

The inputs are divided into seven categories which, when summed, equal the value of total output. They are as follows:

1. Direct labor input.
2. Farm inputs such as fertilizer and insecticides.
3. Raw materials input of food products.
4. Raw materials input of other products.
5. Other variable costs (including taxes).
6. Investment related expenses (including the purchases of construction materials, labor, and capital and other equipment).
7. Net profit.

The last two are considered residual allocations and depend on the amount available after other expenses. In the determination of these inputs different technical coefficients are used for the modern and traditional operators defined, and a third set of coefficients is input for the other rural output category and its four classes of output. The resulting vector of the values of each of the seven inputs is modified before it is split according to location of purchase. These modifications are:

1. The amount of food used by farmers for on farm use for such things as seed is subtracted from the total value of raw materials demand for food.

2. Added to the expenditures on investment is that part of miscellaneous final consumption expenditures which have this type of applicability. Primarily, this will be composed of a portion of rent payments.

With these small modifications the vector of inputs give the total value of input demand by the Rural Sector's productive enterprises. After

determining the magnitude of input demand potential sources of purchase are calculated. For example, all labor will come from the Rural Sector itself thus generate income to the final rural consumers. Farm inputs can come from Recife industry, local rural industry, or from the South.

Net profits are dealt with somewhat differently. Initially, some proportion of net profits is allocated to potential future investment or hoarding. The remainder is distributed and becomes income to rural consumers. Much of the income generated by net profits goes to higher income people which make expenditures directly in Recife or in the South which do not go through the rural distribution system. These are handled in the same method as is done in the Consumption-Income Sector.

Summary Calculations and Final Supply-Demand Allocations

The final determination of the sources of purchase for inputs demanded by the Rural Sector and the allocation of rural output to other parts of the economy can only be finalized after the decision routines are completed.

The Decision Routine-Consumer I determines the distribution of rural produced processed food and consumer goods and the amount of non-processed food which Recife will demand from the rural area. Further, this routine allocates the quantity of processed food and consumer goods produced in the Recife Industry Sector which is made available to the Rural Sector.

Capital II determines if the demand for certain of the inputs required by the Rural Sector from Recife can be fulfilled by the Recife Industry Sector. In the case where the supply is insufficient the demand is transferred to importation.

The results of the decision routines are combined with the demands by final rural consumers and input demand by the rural production components. The rest of the calculations comprise the comparison between the total demands

for goods by the Rural Sector and the total supplies which the sector can make available to meet those internal demands. Any excess of supply in the four categories is either allocated to surplus or to exportation. Any excess in demand is automatically transferred to an increase in importation.

Finally, the proportion of total exports which flow through the port of Recife are determined and the wages which that generates to the Consumption-Income Sector in Recife calculated. These wages include such items as storage and handling costs. This income is added to the part of distributed profits which are "spent" in Recife (primarily by higher income consumers) for consumer oriented goods to give the total consumer income generated to Recife from the Rural Sector.

Points of Planner Intervention

Inputs for Final Consumption

1. Total Income. It is necessary to input the total income to the farm and non-farm consumers the initial time period. Income is defined as the rate at which total income from all sources is generated at the beginning of the time period.

2. Average Propensities to Consume. The input of the average propensities to consume must be for each of the two types of consumers, split into four expenditure categories:

    a. Food

    b. Consumer goods

    c. Miscellaneous (services, rents, taxes)

    d. Savings

Other inputs needed that are related to propensities to consumers are:

a. Proportion of food expenditures which are for processed food.

b. Proportion of miscellaneous expenditures which are considered taxes.

c. Proportion of following expenditures which must come directly from the south.

   1. Non-processed food expenditures

   2. Consumer goods expenditures

d. The proportion of savings which is considered to be applicable for future consumption.

Inputs for Output Determination and Output Distribution

1. Modern-Traditional special types. The first determination is of the specific types of products or product groups which will be included in this section of output determination. There can be any number from zero to five with the limit that they fit into the general function of:

   (Output) = (Yield) x (Area in use)

   Given the special types the following parameter inputs are needed for both the modern and traditional operators within each type.

   a. Average yield per unit area defined in value terms. Thus, this is quantity yield per unit area times the price per quantity unit.

   b. The total area on which the above yield is applicable.

c. The proportional breakdown of output into the four defined classes of output defined in next paragraph. This is a conversion matrix which permits the special types output to conform to the basic four classes of output.

d. The rate of switch between modern and traditional land use.

2. Other Rural Output. For all other rural output an initial time period output and a growth rate is needed on the four classes of output defined of:

   a. Agricultural food production

   b. Agricultural non-food production

   c. Extractive industries

   d. Other (including all else such as miscellaneous manufacturing and processing).

3. On Farm Consumption. A proportion of the food output from each source (modern special, traditional special, and other) goes on to farm use either for final consumption or as inputs into the operation.

4. On Farm Spoilage. Again for each of the three output sources (modern, traditional, and other) on farm spoilage must be defined as some proportion of total output.

5. Distribution Spoilage. A proportion on the net quantity available for sale, for further spoilage in the rural distribution. For agricultural food products it is permissible to have a different spoilage rate depending on the location

of sale (Recife, Rural, and South/Export) but for the last three classes only one rate is assumed for each.

6. Split on Net Rural Output. On each of the four classes of output, estimates are needed as to the proportion which is available to the rural area for rural consumption. (The rest is allocated to exportation to Recife and the South for food and to the South for the last three classes.

7. Processed Food and Consumer Goods. Within the fourth class of general outputs is included the production of processed food and consumer goods. It is necessary to specifically break-out these two classes of goods in order to solve the Decision Routine. Thus, it is necessary to determine the initial output of these two types of products and the tentative split on output to Recife, Rural and the South/Export Sectors. The output is determined as a simple growth function on output last time period and the splits are in the normal receiver split matrix proportion form.

Inputs for Rural Input Determination

1. Technical Coefficients. For each of the three output types (modern, traditional, and other) technical coefficients are needed for the following inputs.
    a. Labor direct
    b. Food and raw materials
    c. Non-food raw materials
    d. Other variable costs including taxes

e. Farm inputs including fertilizer and insecticides

f. Investment expenses (labor, construction materials, and equipment) (as a residual)

g. Net profit (as a residual)

The other coefficient oriented input is a split on the net miscellaneous expenditures by the final consumers between labor and materials. These miscellaneous expenditures constitute the output of services and rents for the rural area.

2. Location of Purchase Parameters. For each of the above inputs the proportional distribution of purchase location is needed for the three potential sectors which serve as suppliers:

   a. Recife

   b. Rural Sector itself

   c. South/Importation

3. Other Inputs Necessary to Input Determination:

   a. The proportion of net profit which are considered to be hoarded or are potential future investment.

   b. Proportion of current investment expenditures in rural area (as defined in the resultant of the multiplication of the source split matrix and the total value of inputs) which are considered wages.

The South/Import and South/Export Sectors

The regional economy of Recife and its "foodshed" is not self-sufficient. The final report of the research conducted in the Northeast

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of Brazil shows that the region is a net importer of large quantities of food products, consumer goods, and most capital equipment.[3] The importation of these goods come primarily from the Center-South of Brazil with some generated from the other areas of the Northeast. Those that are imported from the international market frequently enter the region via the South. Exportation is limited to a few major commodities such as sugar and cotton, a few other food products, and manufactured goods on a very small scale.

The region is heavily dependent on other parts of Brazil to obtain balance in final consumer goods consumption. The importance of including this sector then becomes self-evident. Essentially, this sector in the model is defined as the "rest of the world sector", any transactions between participants in the defined economic system and other parts of Brazil or internationally flow through this sector. Three types of "terminals" or "interfaces" between the economic system under study, Recife and its four-state "foodshed", and the "rest of the world" are defined:

1. Other Northeast
2. Center-South of Brazil
3. International markets.

The South/Import and South/Export Sectors play a vital role in the structure of this model. Combined with accumulated inventory accounts, they are the "suppliers and demanders of last resort". In most of the sectors, specific demands for imports and supplies of outputs for export are determined which arise largely out of the type of goods involved. For example, cotton is an export crop and most capital equipment must be imported. But further, since no simultaneous solution within the short-run is attempted (or desired) differences between local supply and demand can develop. If a deficit in local supply exists, after all attempts by the decision routines to offset

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[3]"LAMP/LAFS Draft Report", Chapter 2 and 3.

it have failed, it is automatically assumed to be allocated to increases in importation when no accumulated surpluses are available. If a current surplus exists, it is assumed to be allocated to an accumulated surplus account or exported. The nature of the model forces this sector to act as a passive giver of goods to the system and in part a passive receiver.

The Import/Export Sectors then act as a prime balancer for the entire model. It is the one place in the model which does not place any conditions on the quantity of input it accepts or the quantity of output it gives; and there is no functional relationships assumed that limit outputs given inputs or inputs given outputs.

Throughout the development of the model a basic concern has been the action of the system given some level of demand, if the local production centers can not supply that demand, it must by definition come from somewhere and that somewhere can only be the South/Import Sector. With this consideration the assumption is not too noxious.

Finally the Import/Export Sectors are the interfaces which can be used if the model of this system is connected with another model of other parts of the Northeast. "Planner entry routines" could be developed which do place conditions on the degree of passivity currently assumed in these sectors. For example, the three export components may only accept exports if the price is below a certain level or transportation costs plus the price are below the purchase price of locally produced goods. On the other hand, the Import Sectors may only be willing to provide imports if the price less transportation is above what they could receive locally. Also, constraints could be placed on the level of imports perhaps as a function of the level of surpluses over local consumption which can be generated. Because the present model stresses the economic relationships of the internal market

system of Recife and its "foodshed" none of the above have been included in the initial simulations. But if the type of reform programs implemented into the system vary or the scope of the modeling effort expands they may become important considerations.

Summary

The last four chapters have defined in detail the internal structure of the Recife Systems Model. The Consumption-Income Sector and the Distribution Sector are the two central sectors defined in the model. These sectors are the focal point of the market process reforms which are analyzed in Chapter VIII and they were the sectors on which the most accurate information was available from the LAMP/LAFS research project. The Consumption-Income Sector contains five consumer components defined by level of income. The emphasis in the sector is on measuring the impact on consumers of changes in the Distribution Sector. A method for generating incremental real income from shifting shopping behavior to lower priced outlets and from lower relative prices within retail outlets was described. The assumptions on the "quasi-closed" system, elasticity, and price/unit definitions were outlined. In the Distribution Sector, composed of six different channel components, the structure and implications of changing spoilage, margin, and prices were stressed along with their impact on consumer behavior and local supply and demand of food and consumer goods.

The seven component Industry Sector of urban Recife is the third sector described. The most detailed components of this sector are in processed food, consumer goods, and farm input manufacturing. The more investment oriented industries of construction materials and capital equipment are also included in the sector. The structure and assumptions relative to the decision routines, location of purchase parameters, and technical coefficients were discussed in detail.

Finally, the Other Recife Sector, the Rural Sector and the Import/Export Sectors were defined. The Other Recife Sector, composed of eight components, is a large conglomerate of economic activity which is in the model to generate the necessary income to final consumers and to act as an investment demand transfer mechanism. The Rural Sector is the largest sector in the model and represents the production, distribution, and consumption functions in the four-state area around Recife. The interaction of the rural area and the urban area was the primary determinant in defining the structure of the Rural Sector.

The following chapter presents a detailed description the "planner entry routines" that are developed for use in the initial simulations of the Recife Systems Model. The Decision Routine-Consumer I, the Decision Routine-Capital II, and the Investment Sector are discussed with an emphasis on how they affect the internal structure of the economic sectors of the model and the means by which the user of the model enters the system to alter or augment its internal assumptions through the routines. Following Chapter VII the results of three illustrative reform simulations are presented.

CHAPTER VII

"PLANNER ENTRY ROUTINES": THE DECISION ROUTINES CONSUMER I AND CAPITAL II AND THE INVESTMENT SECTOR

Introduction

The discussion of the economic sectors which comprise the internal structure of the Recife Systems Model centered on the basic structure; the flow of computations; and the flexibility, assumptions and limitations within each sector. Chapter II described the general character of "planner entry routines" and their purpose in the modeling effort. The sectors defined in the internal structure are so defined to permit flexibility in behavioral assumptions as a function of the type of analysis undertaken with the model. The purpose of the "planner entry routines" is to provide the user of the model with a framework in which to incorporate his assumptions about the economic system and the relationship between policy variables at his disposal and that economic system. The PER does not make the decision-making process any easier; in fact, they force the user of the model to be very explicit in his assumptions about the current economic system and how that system might change over time with the implementation of alternative reform programs.

Throughout the description of the economic sectors, potential "planner entry routines" have been discussed. The purpose of doing this was not to present an exhaustive list of the possible PERs which could be built, but only to augment the discussion of PERs in Chapter 2 to insure that the purpose, meaning and use of these routines is clear. Of course there are many other routines which could be developed in each sector or in relating two or more sectors.

This chapter presents the description of the three "planner entry routines" that are utilized in the initial illustrative simulations of market reform programs discussed in the next chapter. The Decision Routine-Consumer I is presented first followed by Capital II and then the chapter ends with a description of the Investment Sector.

The Decision Routine-Consumer I

The Purpose and Orientation

The Decision Routine-Consumer I is a "planner entry routine" included to focus attention of the planner on the problems which arise in equating local supply and demand for final consumer oriented goods and the allocation process which must take place in meeting demand from local, rural and import supply sectors. Besides reconciling the supply-demand differences, it permits the user of the model to make a variety of assumptions about the economic structure of the industrial and distributive sectors in the model.

Consumer I brings together the Recife Distribution Sector, Industry Sector, the Rural Sector, and the Import Sector. The routine's explicit purpose is to allocate any short-run surplus or deficit which develops between local supply and demand for processed food, non-processed food, and consumer goods. Figure 7.1 illustrates the interdependence of the supply and demand sectors brought together in Consumer I. The demand for these three product categories is determined from the level of consumer

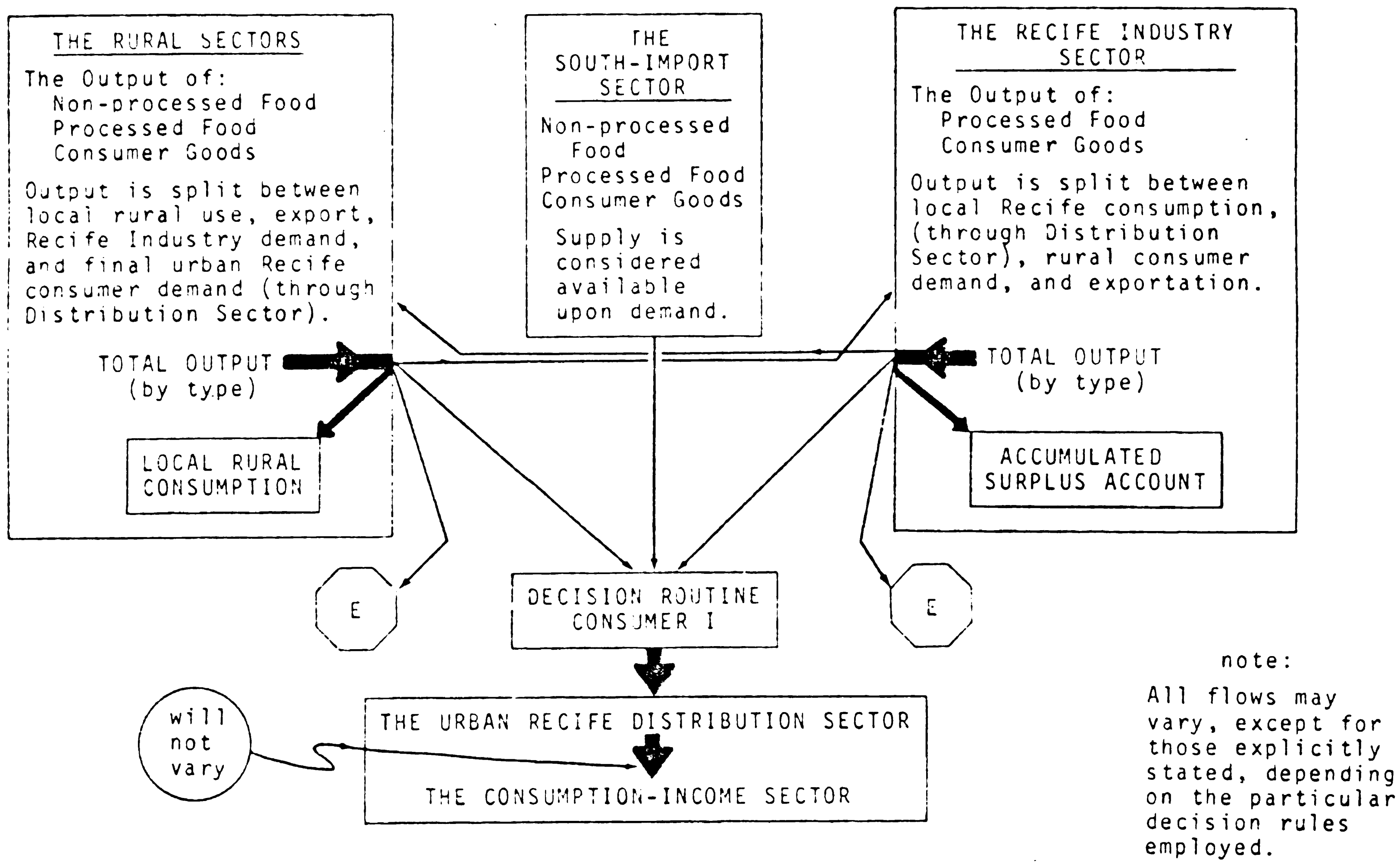


FIGURE 7.1 The Decision Routine-Consumer I: The Interaction with the Other Economic Sectors in the Model

demand placed on the Distribution Sector by the Consumption-Income Sector. Given the characteristics of the Distribution Sector components in levels of spoilage and margin, that sector demands a given level of product from the productive sectors within the system or from importation.

On the production side, the local Recife Industry and the Rural Sectors have certain productive, technical, and managerial characteristics combined with their level of market knowledge which determines their output and its initial distribution. Consumer I enters the model because the flow of goods through the system is "determined" at both ends, but when they "meet" they must be equal. Because they are independently derived in a mathematical sense, there is no reason to believe that they would be equal unless some type of allocation routine is included to ameliorate any differences which develop between these flows.

For example, if the quantity "A" is demanded of an industry component and the quality "B" is the industry component's supply, at any given point in time they may not be exactly alike. This problem would not arise if the flow is determined at only one end or terminal and the other passively accepts the given demand or supply. Therefore, if the industry produced only what was demanded, unit for unit, then "A" would equal "B" and no difference would exist. In the same way, if consumers accepted whatever was supplied, no difference would exist. But, the coordination between buyers and sellers is seldom good enough to avoid at least short-run production deficits and surpluses.

The decision routine is structured to permit a number of alternative ways in which that difference could be allocated. These alternatives, called "decision rules", can be used in various combinations and can vary in magnitude of effect on the allocation process. For example, in the event that the production of processed food in Recife industry could not fill the demand placed on it by the Distribution Sector, the model user, based on research or his own judgment, could designate any combination in order or relative magnitude of the following ways of equalizing the deficit supply: the utilization of accumulated surpluses if existent, shift part of the demand to non-processed food, increase industrial output this time or in following time periods, shift some of the output presently sold to other areas (rural or exportation) back to Recife to fulfill local demand, or shift the demand for processed food to other supply sources such as importation.

The two central criteria in the allocation process is that the demand placed by the Distribution Sector must be fulfilled from some source of supply (local industry, rural production, or importation), and total adjusted output of local industry must be allocated (to local consumption, rural consumption, export, or accumulated surpluses). In deficit conditions the Import Sector acts as the final source of product if none other is available, and in a surplus condition the Export Sector and an accumulated surplus account act as final receivers of output not demanded by Recife or the Rural Sector.

The assumption that "demand must be fulfilled" becomes more evident when it is remembered the nature of expenditures in the Consumption-Income Sector. Given some level of income, there is a defined and actual demand which occurs. It is important to note that this is not necessarily the amount of goods "needed" or "wanted"; it is what they do, in fact, buy. The orientation of the Consumption Sector and thus Consumer I is on determining the supply of goods required to uphold a given level of demand. If the local areas cannot supply that demand then it is imported.

It is possible that the nature of goods available for consumption are such that the consumer (or perhaps just one or two of the consumer types) would prefer to transfer funds out of consumption into savings. This implies a change in the average propensities to consume. Consumer I includes the provision for handling this situation by including a decision rule utilized at the beginning of the allocation process which places limit on the size of permissible deficits by product category. If this size is exceeded the computer is instructed to abort the simulation to permit the user to alter consumption propensities or purchase locations designated in the Distribution Sector. It is also possible to construct a separate PER which would take into consideration the possibility of this situation developing.

Consumer I focuses on the allocation process of consumer oriented goods at the point in the economic system where the goods enter the distribution system not at final consumption. In the process of allocating the supply and demand differences at this level, it presents a clear picture of the purchase decisions of consumer goods production, processed food production, and agricultural non-processed food output. Further, the routine brings the role of the decision-maker within the economic system into sharp focus. In determining the values of input parameters for Consumer I, the user of the model is forced to make assumptions on how the participants will react to various supply and demand situations, and analyze the problems of effective communication between the demanders and suppliers in the system.

Consumer I also permits flexibility in the assumptions on the general economic structure along a range from perfect supply inelasticity to perfect supply elasticity. The supply sectors can be allowed to react completely to any demand placed on them or they can be prevented from altering the initially determined level of output. Further, the routine can analyze the differences between "effective" and "potential" demand conditions. Consumer I can be used to evaluate the impact of the import dependency of the region and of the major changes in industrial capacity taking place due to government investment incentive programs.

The Structural Relationships: The Sequence of Decision Rules

In order to effectively use the decision routine it is imperative to understand the specific sequence which takes place in the allocation process. Figure 7.2 outlines the flow of decision rules and it is followed by a listing of the sequence of the routine for deficit and surplus conditions. The letters and numbers in the boxes of Figure 7.2 correspond to the sequence listing which follows the figure.

1. Sum the demands for local industry and the Rural Sector by product classification -- processed foods and consumer goods. Non-processed food only comes from the Rural Sector so no summation is needed. Sum the supply which the Rural Sector and local Recife Industry Sector have allocated to the Recife market by product classification. Again, non-processed food supply is not summed.
2. Compare the total supply from local sources to the total demand on the local sources. If they are equal, continue on to next set of comparisons and allocations. If there is a potential deficit or suplus, continue. At any point in the decision routine where the deficit is completely allocated, skip the remaining decision rules and go to the next product classification comparison. For non-processed food, go through decision loop for a deficit or a surplus only once for the Rural Sector.
3. Against the given criteria, is the surplus or deficit too large to be realistic under present conditions in the economy. If so, stop computation, exit from computer and state reason. Recompute supply and demand conditions and start the simulation run again.

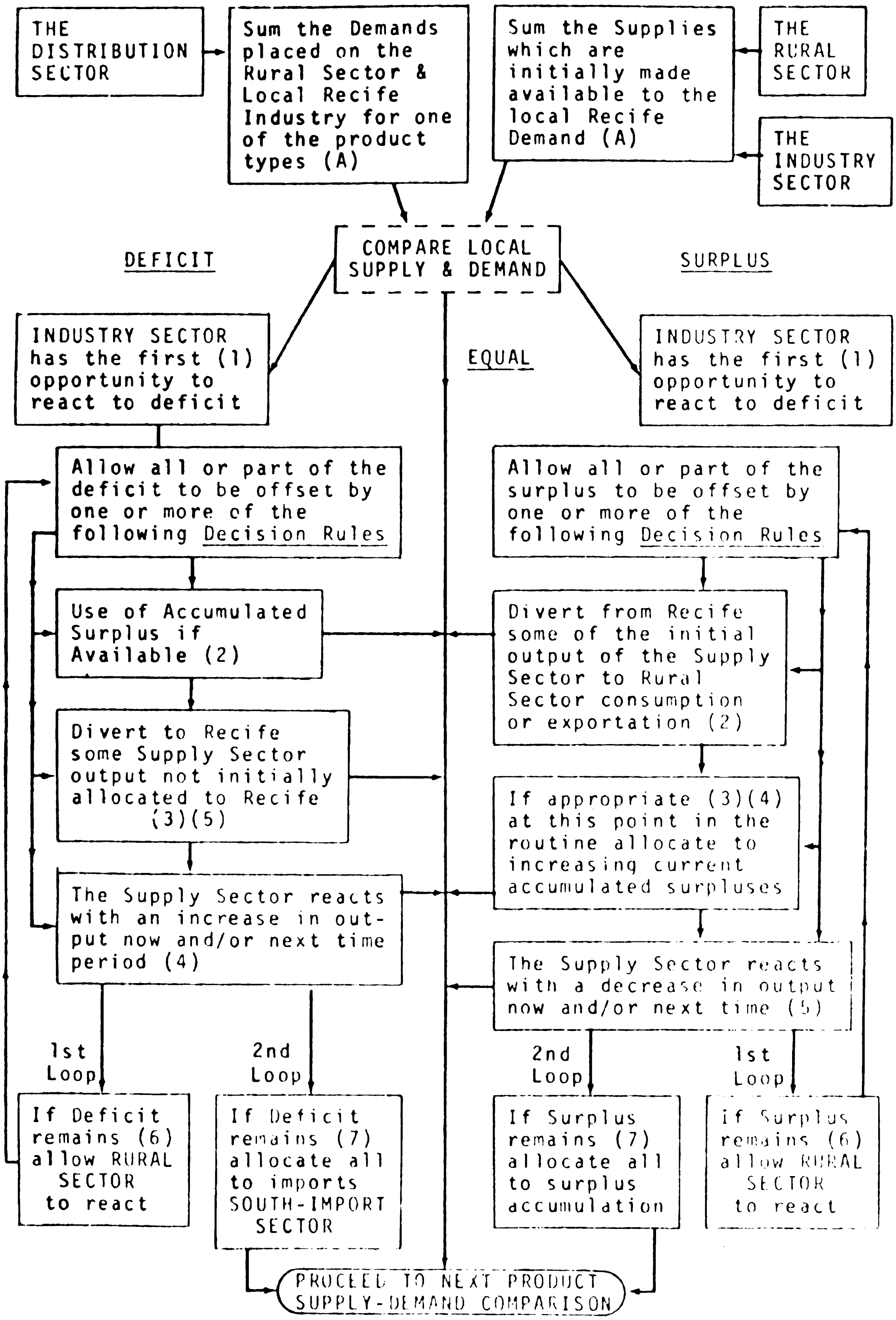


FIGURE 7.2 The Decision Routine-Consumer I: The Flow of Decisions

A Deficit Condition

1. Given that a deficit exists, allow the local Recife industry Supply Sector to have the first chance to offset that deficit through the use of the following decision rules.

2. Given that there is currently some accumulated surplus for this classification of goods, can some proportion of that be made available at this time to offset the deficit? (If this is the second time through the "loop", can surplus be made available at that time?)

3. Given that a deficit still remains, is it appropriate at this point to attempt to divert sales of the Supply Sector to other regions back to Recife? If yes, what proportion of the sales or output to the Rural Sector and to the South/Export Sector can be diverted to offset all or part of the potential deficit which exists between local supply and demand?

4. Given that a deficit still remains, can the Supply Sector react to that potential deficit by increasing output this time period and/or next time period?

5. Given that a deficit still remains, is it now appropriate to attempt to divert some (more) of the output allocated to other regions back to Recife? If yes, what (added) proportion of the sales to the Rural Sector and the South/Export Sector can be diverted to Recife to offset the remaining local deficit?

6. If this is the first time through the "loop", then numbers 2 to 5 applied to local Recife Industry. If there is any remaining deficit, now allow the Rural Sector's economic units which produce this product classification to attempt to offset the remaining deficit. Thus, return to step number 2, if the Rural Sector has had the chance to offset the deficit and insufficient supply has been made available, continue.

7. Any remaining deficit is automatically assumed to be purchased from the South/Import Sector in order to meet the defined final demand for this product classification in the Recife area.

8. All deficit has been allocated, continue to the next comparison.

A Surplus Condition

1. Given that a surplus exists, allow the local Recife industry to have the first chance to offset that surplus through the use of the following decision rules.

2. By what maximum proportion can the Supply Sector's sales to the Rural and South/Export be augmented to alleviate all or part of the current potential surplus which exists?

3. Given that a surplus remains, is it now appropriate to allocate some portion of that remaining surplus to an accumulated surplus condition? (If any surplus remains after all decision rules have been used in Recife Industry

and the Rural Sector, it will go to surplus automatically.) If it is desirable to place some output into temporary surplus at this time, what criteria for that placement will be used?

4. Will placement into surplus be a function of the remaining surplus or a function of the available storage facilities? In the first case, what proportion of the remaining surplus will be allocated to a surplus condition? In the latter case, what maximum proportion of the total storage available can be made available to handle the surplus?

5. Given that a surplus remains, can the Supply Sector react to that potential surplus by decreasing output this time period and/or next time period? If possible, by what proportion of total output?

6. If this is the first time through the "loop", then numbers 2 to 5 apply to local Recife Industry. If there is still a remaining deficit, now allow the Rural Sector's economic units which produce this product classification to attempt to offset that amount remaining. Thus, return to step number 2. If the Rural Sector has had the chance to offset the remaining surplus and it was not able to offset all the remainder, continue. Any residual surplus is automatically assigned to an accumulated surplus condition or exportation with the following option. Of the excess supply, what proportion will be lost, damaged, spoiled, or destroyed and thus not be available for sale in some

future time. All the rest will be assumed available for future use as assigned to an accumulated surplus account.

7. All surplus in local supply has been allocated; continue to the next product classification comparison.

Flexibility, Assumptions, and Limitations in the Decision Routine-Consumer I

The assumptions which underlie the use and sequence of the decision routine have a significant bearing on how the decision rules are used and their applicability under the numerous possible situations which this routine can present. Below are described each of the important assumptions, why they were made, and their impact on the use and applicability of the routine.

Some Comments on General Sequencing

The specific steps in the decision routine have been discussed in detail. At this point a few comments on the flexibility and limitations of the sequencing are discussed. For cases where the exact sequence is followed, there is little trouble in seeing the effects or limits of the decision rules in offsetting any surplus or deficit existing.

Frequently specific results can be obtained or different sequencing used by inputting the appropriate input values to the decision rules used. A few examples are sufficient to clarify this point. First, by zeroing out all parameter inputs, all of the deficit will automatically be filled from the South/Import Sector; and all of the surplus is allocated to accumulated surplus. Second, if reaction is desired only from the the Rural Sector, the respective entries for industrial Recife reaction can be input as zeros. Third, it may be required that the Supply Sectors respond in full to any deficit with changes in output to match the difference present. This essentially means that the Supply Sectors lose their option to determine their own output and the model reacts to make demand the determinant of supply. This is easily included in the routine by having all entries but output reaction equal to zero and entering a very large number in the maximum potential increase in the supply sector's output. In this way the difference is all put into output changes, but it is only the difference -- no more and no less.

The Grouping of Local Supply and Demand

In structuring the Decision Routine, it is assumed that the demand and supply situation between local Recife industry production and the Rural production of processed foods and consumer goods are not independent. Generally speaking, the decision-maker in the Distribution Sector is as willing to buy products made in the surrounding rural areas (rural cities) as from Recife, but would likely give local Recife production the "first crack" at the adjustment of any differences which existed.

Allocating a deficit in the local Recife industry production of processed foods and in the Rural production of processed foods on a completely independent base is not believed wise. The result is a "grouping " of supply and demand for these two types of product classes before any allocation is made. Thus, the Distribution Sector demand for processed food is summed over local Recife Industry and the Rural Sector, and the supply available from both sectors is summed. At this point, the comparison is made between total local demand and total supply.

The largest dollar value category in the decision routine is that of non-processed food. This is by far the largest supply and demand flow. In general it follows the conditions and assumptions which have been previously outlined and its sequence follows generally the following description of the ordering of the decision routine. Where differences occur they are noted.

The primary divergences from the consideration of consumer goods and processed food is in the grouping of flows. It is assumed that the supply of local non-processed food will only come from the Rural Sector. Thus, no grouping is needed and the decision sequence is only done once for the allocation of any deficit or surplus which exists between Recife demand for non-processed local food production and the local (Rural Sector) supply made available to Recife.

The Allocation of Changes Caused by the Use of the Consumer I Routine Back to Individual Supply and Demand Sectors

In the comparisons between supply and demand, only the aggregate quantities are considered and not the individual economic unit's supply or demand situation, even though demand is a function of individual channel component demand characteristics. This causes the loss of some flexibility in the response patterns that could be illicited from a firm or a distribution channel member. To alleviate this to some degree no effort has been made in the routine or the models of the individual sectors to assign any changes which take place as a result of using the decision routine. Thus, after the results are obtained, they may be allocated between supply and demand types within a sector as the user of the model desires. For example, all reaction can be assumed to come from the modern units as opposed to the traditional units, or from the large versus the small units.

Product Mix Compatibility

This limiting assumption is described in more detail in Chapter II. It is mentioned here to note that its applicability is equally important in the use and reality of results of the Decision Routine. Implicitly the assumption is made that the product mix or make-up of the various flows are compatible when taken in the aggregate. Within the conglomeration of types of products which make up the product classification processed foods, it is assumed that sufficient substitutibility exists that permits the comparison of flows and the allocation from one sector flow to another to be approximately accurate. If this is proven to be wrong the significance of the results are limited.

Points of Planner Intervention in Consumer I

The inputs necessary to operate Consumer I are composed of estimating the maximum responses which each decision rule could contribute to the amelioration of supply and demand differences. Some of these are in the form of percentages such as a maximum percentage by which output could be increased this time period, and others are in the form of actual quantity limits such as the maximum amount of available storage facilities. Thus, if a zero is input into any decision rule, it is not used in the allocation process. For each input parameter, five estimates are necessary -- one for each of the five supply - demand comparisons:

1. Recife Industry-processed food
2. Recife Industry-consumer goods
3. Rural Sector production of processed food
4. Rural Sector production of consumer goods
5. Rural Sector production of non-processed foods.

In making the estimates various sequences can be assumed. Generally, however, the local industry is given first priority to react to any surpluses or deficits which exist, then the Rural Sector (of course for number five above the Rural Sector is given first priority), and if all local sources are unable to get supply and demand equal the Import/ Export Sectors and accumulated surplus are utilized. In determining input values it is important to keep in mind the sequence assumed.

Inputs for an Assumed Deficit Condition

1. Decision Rule One. Some maximum proportion can be obtained from current surplus accumulated to this time period.

   Input: The maximum proportion which can be made available from current accumulated surpluses.

2. Decision Rule Two. Some maximum proportion of the Supply Sector's output to other areas than Recife can be diverted to the Recife demand sector.

   Inputs: The maximum proportions of the output to the Rural area and the South/Export Sector which can be diverted back to Recife.

3. Decision Rule Three. The Supply Sector can react this time period or next time period to the potential deficit which exists.

   Input: The maximum proportions which the Supply Sector can increase its output 1) this time period, 2) next time period over its current expected growth rate.

4. Decision Rule Four. Given that decision rule two was not used because of sequence variation desired or lack of initial responsiveness, or the possibility that the Supply Sector could react further, what proportion of sales to other sectors could now be diverted back to Recife (same inputs as decision rule two)?

Inputs for an Assumed Surplus Condition

1. Decision Rule One. What maximum proportion could current output distributed to other sectors be augmented to alleviate part of the surplus in the Recife area?

   Input: The maximum proportions by which sales to the rural area and sales to exportation could be increased as a proportion of initial sales to each area.

2. Decision Rule Two. Given the desire to allocate some of the surplus to accumulated surplus at this point in the decision sequence, what amount could be diverted to a surplus condition? (The last decision rule in the sequence permits residual additions to the accumulated surplus account.)

   Input: Will that amount added to surplus be a function of total storage available (code "0") or will it be a function of the remaining surplus which exists (code "1")?

   Input: Given a code "1" what proportion of remaining surplus could be allocated to accumulated surplus condition?

   Input: Given a code of "0", what is the total available storage?

   Input: Given code of "0", what maximum proportion of total available storage can be made available to offsetting current potential surplus?

3. Decision Rule Three. How can the Supply Sector react this time period and next time period by lowering its output in reaction to the current potential surplus condition?

   Input: By what maximum proportion can the Supply Sector lower its output 1) this time period, 2) next time period?

   Any remaining surplus is allocated to a surplus account report. At this point, what is the expected proportion of that surplus which will actually remain in accumulated surplus and be available for future use and what proportion will be lost, spoilage, or destroyed?

   Input: The proportion of remaining surplus which would actually go to a surplus condition i.e. one minus proportion equals amount spoiled or lost and thus not available for future use.

Decision Routine-Consumer I
Computer Printouts

The computer printouts have been written in such a way that they permit exact analysis of which decision rules are used, which are not used, what the effect of each one is, and a summary comparing the initial pre-allocation conditions to the final conditions after operating Consumer I. Each parameter value is stated along with the potential effect which that given decision rule could have and the effect which it does have in the sequential allocation process. (See Appendix A - Pages 316 to 319 for some examples of the text format printout which is unique to the routine Consumer I.)

The Decision Routine-Capital II

Capital II, another "planner entry routine", brings together three sectors in the model: The Recife Industry Sector, the Other Recife Sector, and the Rural Sector. The purpose of this routine is to analyze the impact of investment expenditures on the region through the allocation of the output of investment oriented products for the following Recife Industry types:

1. Farm inputs production
2. Construction material production
3. Capital equipment manufacturing
4. Other Recife Industrial output

The Capital II provides the mechanism for distributing the given output of these four types according to a specific sequence of allocation. Each industry type has demands placed on it generated from the Rural Sector and investment demand transferred through the Other Recife Sector.

In the Rural and Other Recife Sectors a "potential" or "desired" demand for the products from Recife are determined. These are conveyed to the Capital II routine which compares those demands with the supply available. Any differences between the supply and demand are ameliorated in the routine. After the routine is completed the parameters in the Other Recife and Rural Sectors are automatically altered to reflect the new conditions of location of purchase between Recife and importation. The following figure 7.3 portrays the relevent flows which the Justify Routine can affect.

In allocating the output of the four industry types between the Other Recife Sector, the Rural Sector, and exportation, the following sequential assumptions are made for each output type (Figure 7.4 portrays the sequence graphically):

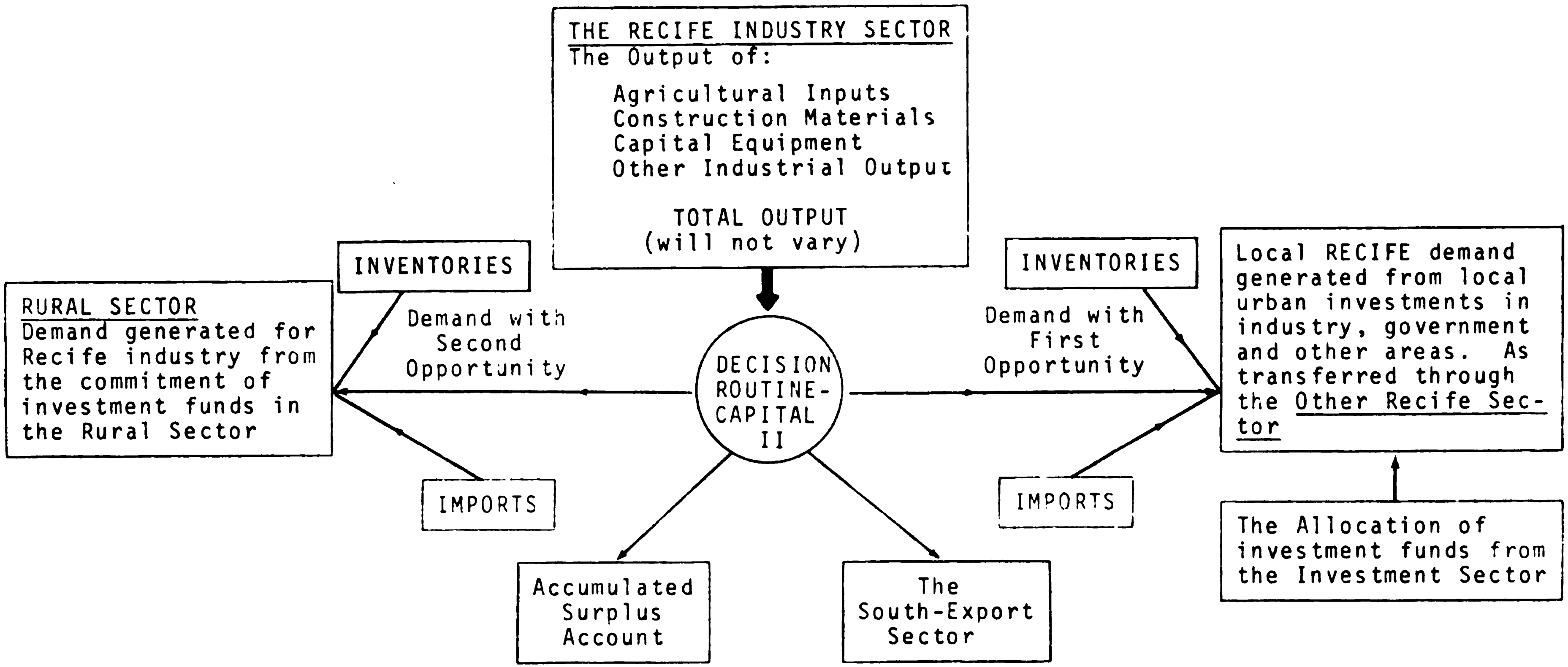
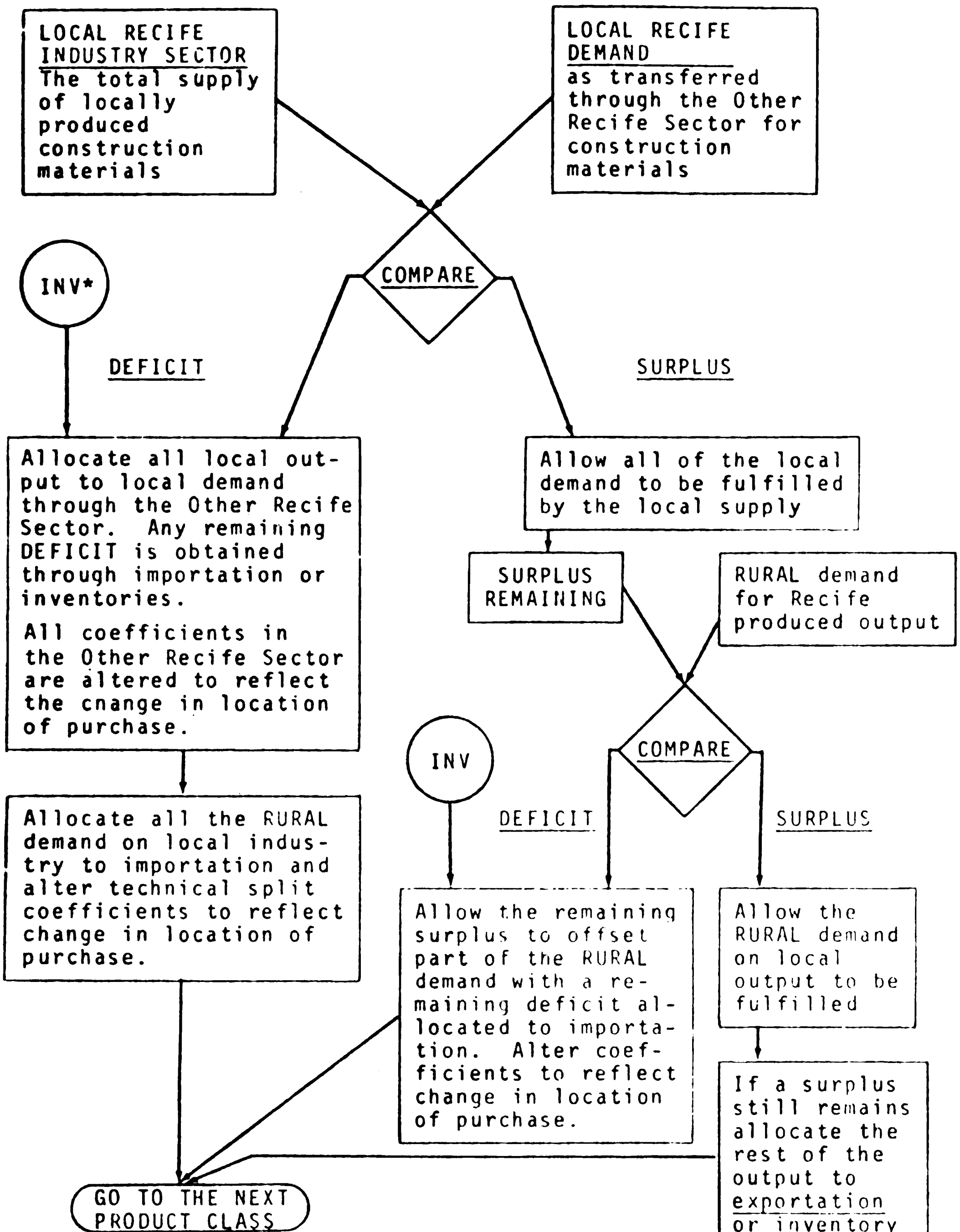


FIGURE 7.3 The Decision Routine-Capital II: The Interaction with the Other Economic Sectors in the Model



*INV = accumulated available inventories by product class

FIGURE 7.4 The Decision Routine-Capital II: The Flow of Decisions for the Local Recife Output of Construction Materials

1. The output of the four types is as determined and will not be altered by the routine. Any deficit in supply will be augmented from the South/Import Sector or from inventories generated in previous time periods by local industry.

2. In the allocation of the output of the four types a specific order of fulfilling demand is assumed.
   a. First the demand from Other Recife (local demand) will attempt to be filled, if the supply is not adequate for this demand then all the remainder of the Other Recife demand will be shifted to the South/Import Sector or accumulated inventories.
   b. If there is any supply left over after fulfilling the local demand it will be made available to the Rural Sector. If the remaining supply is not sufficient for the demand which the Rural Sector has, the remainder of the demand will be shifted to the South/Import Sector.
   c. If there is any excess supply after filling both of the above demands the rest of the output supply is assigned to the South/Export Sector or allocated to an accumulated inventory account.

Thus, Capital II is similar but much simplier than the Consumer I routine. It is oriented to the allocation of industrial output which is investment related. The routine allocates the output of our industry types: construction materials, capital equipment, agricultural input equipment, and other industry output. The South/Import-Export Sectors and inventory accounts act as buffers in the allocation of the differences in supply and demand for the output of the four industry types. In reality the inventory account plays only a small role since the region is such a large net importer of the product groups represented in the solution. But as capacity increases, it offers the ability to analyze how well productive capacity is coordinated to effective demand for these investment related goods. Figure 7.4 portrays the sequence of computation as stated in the preceding verbal description.

The Investment Sector

The Purpose and Orientation

The Investment Sector in the Recife Systems Model focuses the attention of the planner on the sources, applications, and effects of investment in the economic region. Investment is defined as the creation, modernization, or replacement of the capital stock of the system. Essentially capital formation corresponds to increases in the capacity of various production activities whether it is industrial, highways, apartments, or schools. The production activities can be manufacturing, processing, distribution, social or economic infrastructure, or education.

Into this Investment Sector flows all internally generated funds which are available for investment from all other sectors in the model (primarily undistributed profits and depreciation) and any exogenously available funds placed in the system. The impact of the Investment Sector on the other sectors centers on two points:

1. If focuses the attention of the user on all investment decisions in the model, and thus forms the central framework for the analysis of reform options through the determination of investment costs and the effect of changing policy variables associated with a reform program on the behavior of the system.

2. The second function of the Investment Sector is to provide the information to complete the "economic flows" necessary to a model solution. These flows are the investment oriented expenses for capital equipment, construction materials, and labor. By definition, virtually all demand for capital equipment and construction materials arises from investment and a major portion of final consumer income is generated from investment related expenditures.

An example of these two effects is an investment taking place for increasing capacity in an industrial enterprise. The level of investment is a cost which must be known in measuring the effect of that change in capacity. The first direct effect on the economy, however, enters as a "construction effect" created by the demand for labor, construction materials, and capital equipment (and any interest income generated from the investment). These enter the model as explicit economic flows through the Other Recife Sector and demonstrate the second effect listed above. These are direct demands placed on the economic region and must be fulfilled locally or through importation. Their level, duration and location of purchase certainly influences the evaluation of the initial investment. Finally, with the creation and use of the capacity, certain technical relationships may be altered such as technical coefficients for labor and raw materials, the location of the purchase of material may change and prices could vary.

The Sources, Applications, and Effects of Investment

The basic sources of investment funds are private and business savings local and federal government funds, and foreign funds. Of the total funds available for investment, their applications are in public and private investment, net importation of goods, and hoarding or disfunctional investments (such as luxury apartment buildings). The following equation illustrates the relationship:

[Private and Business Savings] + [Government Funds after all costs] + [Foreign Assistance] =

[Public Investment] + [Private Investment (productive)] + [Net Importation of goods (mainly capital goods)] + [Hoarding or Disfunctional Investment]

Figure 7.5 outlines the potential sources of investment funds from both internal and external sources for ongoing investment and exogenously stimulated investment. Given these sources, there are various applications or types of "investment" which can be made with the available funds. With these applications there can be certain effects which derive from a given application on the economic flows in the model and the basic input parameters used in the model.

The figure does not breakdown the sources, applications and effects by sector. Within each internally generated source of funds are those funds directly generated from each of the sectors in the model and the types within sectors. Each application and effect must enter the model through a specific sector and sector type.

Two types of investment are considered: internally generated investment and externally generated or exogenous investment. The development of the internal investment function is split into two categories.

1. That part which "a priori" is assumed to take place in the system, a simple growth rate or some other function could be assumed.

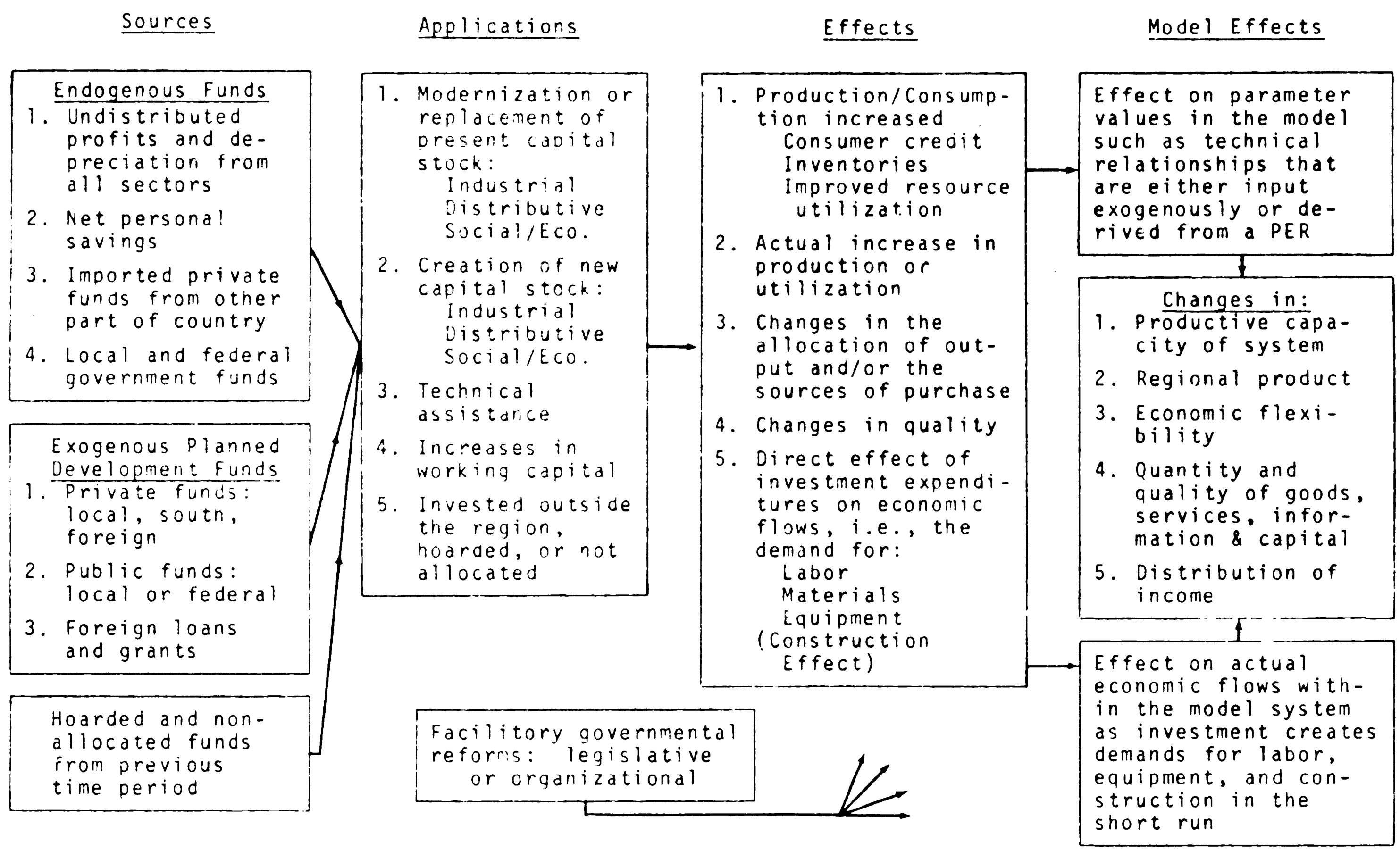


FIGURE 7.5 The Investment Sector: Sources, Applications, and Effects of Investment in the System

2. That part which is more planner oriented in its determination and thus is more a function of output or expected output within the particular sector of the economy and types of reforms implemented.

Some Considerations on the Use of the Investment Sector

Currently, no explicit consideration of the commercial banking system and the money market is included in the model. They are, however, implicitly included with the emphasis on the sources, uses, and effects of investment. Any impact of the money market must be done outside the model and can then be included in the allocation and sources of investment funds. This sector, in the initial runs, has been left relatively unstructured with the exception of the flows necessary to complete the results of the model such as wages from construction and equipment demand. It is possible to develop through use of the "planner routines" the impact of the money market on investment and general economic level of activities through the allocation of investment funds (both internally and externally generated).

An important consideration is the time lag associated with the disposition and effects of investment. It is broken down as follows:

Initiate Project	Appropriate Funds	Letting of Contract	Orders Issued	Investment	Effects
T_1	T_2	T_3	T_4	T_5	T_6

Time

In the Investment Sector, certain groupings of the above have been assumed to facilitate analysis. The major interest is on the effects of of an investment which is made on the basic parameters of the model and the economic flows which it creates. At the point in time when an investment is made (T_5) it is assumed that in previous time periods the necessary actions have been made to permit the investment. It is possible with the flexibility of this sector to permit the "effects" of that investment to accrue in the same time period as the investment or in the next few time periods. Thus, the first four steps (T_1 to T_4) are completed in the prior periods. In the fifth step the money enters the model as the initial construction effect; the sixth step, the effects, can be instigated in the same and following time periods at various rates. This becomes important because certain of the economic flows such as construction materials demand and labor are needed before the changes in parameters are made i.e. the capacity must be built before it can be used.

Minimum Specific Outputs Required by the Rest of the Model

A few specific outputs are required from the Investment Sector in order for the model to function. All of these outputs relate to the economic flows directly relevent to the solution of the model. While the changes in parameters which investment generates are necessary for the analysis of reform options, they are not technically necessary for the solution of the model.

The following outputs are required for the Other Recife Sector:

1. The demand for construction materials and labor from industrial or distributive capacity increasing investments.

2. The demand for construction materials and labor from other investments such as hospitals, schools, and apartments.

3. The demand for capital equipment.

4. The generation of other income generated from investment such as interest payments.

In the use of the model these needed values may be input exogenously, part of functional relationships included in the Investment Sector, or developed in separate PERs associated with the Investment Sector. If inadequate data is available any or all of the outputs may be assumed to be zero.

Appendix A - Pages 320 to 322 contains a description of capacity determination considering the importance of additional investment in the Rural, Industry, or Distribution Sectors.

The "planner entry routines" developed for the initial simulations utilizing the Recife Systems Model have been discussed. The decision routines and the Investment Sector form the central points of planner intervention into the structure and relationships of the internal model. The description of the Recife Systems Model is completed; the internal structure of the model has been outlined in detail sector by sector and the planner oriented aspects of the model related to the use and structure of the model. We now turn to the use of the model. Chapter VIII discusses in general how the model is used and then presents the results of three illustrative simulations based on the findings of the LAMP/LAFS research.

CHAPTER VIII

THE ANALYSIS OF MARKET REFORM ALTERNATIVES: AN ILLUSTRATION OF THE USE OF THE MODEL

Introduction

The purpose of the Recife Systems Model is to provide a tool for the development planner to analyze the impact of market process change within Recife and its four-state "foodshed". Viewing the development problem from the perspective of market processes provides some unique opportunities to evaluate the impact of a wide variety of reforms. This is so because of the pervasive, cross-sectoral linkages of market processes in any economy. It is equally true that consideration of development from the marketing viewpoint poses some special problems of organization for policy implementation. In conjunction with the research conducted in Recife, a series of illustrative reform simulations were undertaken. The reform programs utilized in the simulations are developed from those suggested by the results of the LAMP/LAFS research.[1] In abbreviated form the simulation results presented in this chapter are included in the final report, too.[2]

This chapter first presents a general description of how to use the Recife Systems Model; and second, three illustrative reform programs are defined and simulated utilizing the model.

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[1] Ibid., Chapter 12

[2] Ibid., Chapter 13

Using the Model -- A General Description

Before the development of the illustrative reform analysis, a more general description is made on the use of the model. There are a number of steps which must be made before the model can be actually simulated. Each of these steps is listed below and then followed by a brief discussion of each step.

1. The determination of the types of reforms to be implemented, their form, character, and timing.

2. The evaluation of the resources necessary for implementation. The types of resources, the level of use, and the timing of use are important considerations.

3. The valuation of input parameters for the "base run simulation", used as a reference for comparing simulation results.

4. Determination of points of entry into the model for planner use and the transformation of reform options into parameter value changes.

5. Simulating the reform options using the Recife Systems Model according to the type of model structure assumed.

6. Evaluation of the results relative to the performance measures to be used.

The Determination of Reform Options

Reform programs must be explicitly defined for analysis utilizing the Recife Systems Model. The determination of the types of reforms, which are illustratively simulated in the present model, are derived from the results of the survey research. The model is best suited to analyze reform programs oriented to both rural and urban distribution, in order to assess their impact on distribution, consumer demand, and supply interrelationships. Reform programs may center within one sector of the model in order to test their effects on that sector and interdependence with other sectors in the model. Or, reforms can be implemented which are intersectoral in nature, testing the impact of a more comprehensive change program.

In structuring alternative reform programs for analysis, it is possible to use the "building block" approach by simulating successively one small reform package, then incorporating larger programs while increasing the magnitude of change in the system. In the analysis of the costs and benefits of successively more inclusive reform programs the point is usually reached where the investment costs show decreasing returns. This should assist the planner in determining the size and scope of reform programs to be implemented.

The Evaluation of Resource Needs

Intervention into the system for the purpose of change can be gained through the direct investment of money, technical assistance, or through government action.

1. Changes in regulations
2. Change in the level of taxation and expenditures.
3. Incentives or obstacles to private investment or action

4. Monetary policy changes such as credit and interest-rate policy

5. Change in foreign trade policy in such areas as tariff quotas or exchange rates

6. Price, rents or wage controls[3]

Reform packages must be developed which incorporate the above tools into a viable program of action. The planner must determine that combination which he feels will achieve the desired goal, determine where in the system to use or implement those tools, ascertain the timing or sequencing of action to obtain maximum results, and finally develop the expected costs and cost timing of implementing the reform.

The infusion of investment funds into the system enters the model through the Investment Sector as described earlier. Knowledge of the resources necessary and the timing of use of those resources enter the model in two ways: first, through their effect on the direct parameters in the model such as technical efficiency, margins, location of purchase, capacity increases, etc.; second, through the explicit effect of those funds on the demand for labor, equipment and construction materials i.e. the "construction effect".

The Valuation of Input Parameters

The link between the model and the "real world" is found in observation and measurement. There is always a compromise made in developing the information base used in a model.

Measurement is always inexact. But this places an added burden on the user of this type of model. He must be able to accept measurements that are imperfect for if he waits until they are perfect the situation which was measured has usually changed. Peter Langoff said:

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[3]Richard J. Ward, The Challenge of Development (Chicago: Aldine and Co., 1967), p. 20.

> Moreover, measurements that enter into any planning computation embracing human affairs are, perforce estimates. There intended service is to represent what the conditions will be when the plan is operational, not what the conditions were when the measurements were taken. Hence, it is wasteful of time and resources to attempt exceedingly precise measurement for planning decisions and it is unreasonable to expect them.[4]

C. West Churchman when discussing the rapidity with which information becomes obsolete stated:

> Hence, we have arrived at a conclusion about the manner in which the models of science are tested and, therefore, become realistic. As the tests become more precise, the need to assume more about reality becomes greater. The more realistic a certain aspect of a model becomes, the greater the need to make assumptions about one thing, the more you have to assume about everything.[5]

The information which is necessary to simulate using the Recife Systems Model can be divided into three categories. First, the data for the description of the current system; second, estimates on how that system is expected to change over the relevant time period without the institution of the reform programs; and third, the changes in parameter values which arise from the implementation of the particular reform options being tested.

Parameter Estimation for the Current System

Values for all parameter inputs must be determined for the current system as a basis for using the model. There are approximately 1200 parameter values which must be given to the model each time period of a simulation.

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[4]Peter Langhoff, "The Setting: Some Non-Metric Observations," Models, Measurement and Marketing, ed. Peter Langhoff (Englewood Cliffs: Prentice Hall, Inc., 1965), p. 18.

[5]C. West Churchman, "Reliability of Models in the Social Sciences," Ibid., p. 33.

To a large degree, the accuracy of their valuation determines the accuracy of the model in predicting the impact of reform changes.

This model presents a major step forward in the valuation of these base parameter values. From the outset of the research, an effort was made to build effective interaction between the survey research and the process of building the model. In this way, the model could provide a framework for the survey research and the research provides information on the general structure of the system and importantly, much of the data used in estimating these base parameters. This integration between the modeling effort and the survey research has been quite effective and 80% of the parameter inputs are derived directly from the survey results or a combination of survey results and other information sources such as federal, state, and SUDENE census and survey publications. The opinions of the research staff and local Brazilian officials provided the other major information for parameters on which no other source was available and to modify available information where it was not directly compatible with parameter definitions.

Parameter Estimation for the Base Simulation Run

The second step in the determination of information requirements is evaluating which parameters are expected to change in the system without the reform programs being implemented. This is very important because all reform simulations over a given time period must be compared to a base simulation run over the same time period in order to have a means of realistically reflecting the effects of those reform options.

Typical parameters which can be expected to change are: total income to each consumer type, the natural shift in shopping behavior, the rate of growth in industrial output and rural output, and relative prices.

In determining the degree of change in the current base parameters the survey research again played an important role. Because of the nature of the economic system in the process of change, historical data was not extensively used. (In fact, very little was available.) By definition, these estimates are less exact than those made for the current system and must represent the best expectations of researchers and planners on how the system changes over the relevant time period (usually five years).

In all cases the results of the current system simulation were compared with the results which the researcher staff felt to be reasonable. In this way, gross errors in estimates spotted were refined. Further, where significant question as to the reliability of a parameter value perceived important to the results of simulation, a sensitivity run was conducted to determine if the system was sensitive to changes in that parameter. Again, refinement in estimates were made if sensitivity in the system was high.

Parameter Estimation for Reform Options

Before the simulation can be conducted, the reform programs must be translated into parameter values at the potential points of entry into the system. Most parameter inputs may be altered to reflect expected change caused by a reform option (some technical parameters would not be changed). But of the 1200 input parameters, only a relatively small number would likely be changed in simulating any particular reform program.

There are several general areas where the planner must consider intervention into the system in order to effectively evaluate the impact of a reform on the system.

1. Technical coefficients relating the amount of input needed per unit of output enter the model in each sector. In the Consumption Sector, the average propensity to consume is a technical coefficient. In the other sectors, the labor coefficients may be of special interest.

2. Given the value of an input, sources of purchase parameters determine where that input is purchased. These parameters determine the degree of intra-sector transactions, intersector flows, and the level of import dependence. In the Consumption Sector, the average propensity to shop is such a parameter. For example, it splits the demand for food between the different types of channel outlets in the Distribution Sector. All other sectors for all inputs require the valuation of this type of a parameter.

3. Within the Distribution Sector, there are three other points of intervention which are especially important to the general types of reforms suggested by the market development approach: relative price indices between distribution outlets, level of gross margin, and the proportion of spoilage or loss.

4. In the Rural Sector, important consideration must be given the five special modern/traditional types of rural output. The yield rates and amount of land in cultivation are the basic inputs required. Also, on farm consumption rates, on farm spoilage, rural distribution spoilage rates and margin levels, and the proportional distribution of rural output are important factors to consider in the implementation of commodity oriented reform programs.

5. The last general area of intervention occurs in the Decision Routine-Consumer I. For the three product categories (non-processed food, processed food, and consumer goods) supplied by the local Recife Industry Sector and the Rural Sector, a careful examination of the alternative decision rules shows that a significant amount of flexibility is permitted. The value of the entry points generally fall between allowing the local supply sector (industry or rural) to react fully to any surplus or deficit, or to have any deficit allocated to increasing importation and surplusses to increasing accumulated inventories. .

Once the parameters which will be changed are determined, the degree to which they will change over the time period must be decided. That decision depends on the types of changes indicated by the economic research, the theoretical underpinning assumed, and the expectations of the development planners. These estimates are less precise than either of the first two sets of parameter values. The speed of computer simulation, however, permits more than one set of estimates to be evaluated. Thus, while the model, in any given run is deterministic in character, simulating random choices of high and low estimates on key variables around a "best estimate" gives results which would contain a range of expected values for the important performance measures chosen to evaluate the impact of the reform program.[6]

For example, the location of purchase by the Distribution Sector between importation and local demand is a parameter which is changed with the implementation of one of the reform programs. It suggests that the implementation of the reform would mean that imports are relied upon less.

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[6]David B. Hertz, "Risk Analysis in Capital Investment", Harvard Business Review, Vol. 42, No. 1, January 1964, pp. 95-106.

Along with the best estimate of that shift in purchase behavior by the Distribution Sector, high and low estimates are determined by asking the following question. Within what range of values would the parameter be expected to fall 80% of the time or four out of five times?

Simulation of Reform Options

The Flexibility of the Model in Simulation

The Recife Systems Model is constructed as a set of individual sectors and then linked by the intersector flows of goods, services, labor and capital which take place in the system. The explicit computer program for the model and the flexibility built into the model through the "planner entry routines" permits the model to be used in more than one way. The type of use to which the model is put will, of course, depend on the character of the analysis and results desired. Below is a list of some of the ways in which the Recife Model can be simulated.

1. The model is so structured that an individual sector or group of sectors can be simulated separately.

2. Since the time period is arbitrary, the model can be used for very short-run forecasting by assuming time periods of one month or one week, or it can be used for longer run analysis by assuming that each time period is a year or more in length.

3. Currently, the model deals with all goods flowing in the system. It is feasible to narrow the scope of the model to deal with one product or group of products without changing the structure.

4. Through sensitivity analysis, a given parameter can be tested in order to understand the effect of various degrees of change in that parameter on the system in general. This type of analysis is useful in determining the accuracy of estimation needed for a parameter.

The Development of Reform Options, Costs, and Parameter Changes: The Forum

When developing reform programs, costs, and parameter changes, a "forum" where decision-makers would be able to evaluate the consequences and interrelationships of actions proposed and compare and discuss the assumptions underpinning their specific plans for development may be useful. A brief discussion of the type of "forum" used in developing the reform options presented here serves to illustrate how parameter estimates for reform options can be developed.

In most of the group meetings held for this purpose there were staff representatives who had done work in the rural areas, the urban areas, one or more of the project leaders, and the author as the "quantitative man". When discussing urban reform programs more staff was brought in whom had done work either in industry, distribution, or legislative analysis and usually a representative of the rural research staff was present. The same balanced representation was done when discussing rural reform options. Large working paper tablets, blackboards, draft reports, source information, and calculating machines were always on hand. The discussions lasted a minimum of two hours and on some occasions all-day sessions were held.

Staff members responsible for a particular area of concentration outlined the reform options which his research suggested and lengthy debate argued the validity of his analysis and the feasibility and implications of his suggestions. Finally a "reform package" was agreed upon and the estimation of the resources necessary to implement those reforms detailed.

Planning costs, foreign technical assistance, local country technician needs, support costs were outlined for each part of the reform package. Then estimates on the amount and timing of investments for equipment, construction, subsidy, and working capital were estimated along with the participants perceptions as to the need for changes in government regulations and policy.

At this juncture this author as representative of the modeling work reviewed the kinds of parameters which could be changed in the model and the implication of each change. (Importantly, most participants were familiar with the general structure and workings of the model.) Discussions followed on which parameters seemed to be most affected by the reforms and the degree to which they might be expected to change. All experience and sources of information were used to the fullest to develop estimates of parameter changes which seemed realistic. A most expected estimate evolved first, followed by the estimates of expected variation in parameter reaction resulting in high and low estimated parameter response. During these discussions factors potentially impinging on the parameters from revolution to drought were raised.

Test simulations followed to give the research staff the opportunity to see the results which were generated by the parameter changes they estimated. If a variable was shown to be highly sensitive, further refinement was attempted and any unlikely results were analyzed in order to determine if they seemed reasonable from that expected by staff members' knowledge of the system. Revisions were made and the final simulations run.

When reform programs were grouped, for example a program which suggests the implementation of both an urban distribution reform package and a rural package, further discussions determined if further parameter changes were necessary due to overlapping effects of the individual programs.

Evaluation of Simulation Results

Performance Measures

The success of this modeling effort depends on effectively relating the roles of the planner, researcher, and modeler. In order for this interaction to take place, one of the necessities is the specification of a set of performance measures. Their purpose is to present an explicit statement of the crucial factors by which alternative reform options can be evaluated. In essence, the model must be able to give the planner a set of comparative measures of performance relative to the developmental planning goals on which a decision can be based.

As was described earlier, only economic variables are included in this model. Thus, only economic measures are used in the analysis of alternative reform options. The performance measures used here are only a sub-set of those which are employed in the final decision. The social, cultural, and political effects of the reform must be included in that final decision. However, the knowledge of the economic impact of reforms can often be used by the sensitive development planner in evaluating the expected social and political effects of the proposed reform programs.

The performance measures which systems analysis and this model emphasizes center around the concept of flow. Specifically, the emphasis is on the flow of goods and services through the system as opposed to the level of stocks in the system such as quantity of storage, number of dwelling units, etc. Thus, the volume of flow, the rate of flow, the mix of the flow, and the distribution of the flow of goods, services and income through the system form the foundation on which the performance measures for this model are built. Below, is a list of a few of the potential measures which this model can give as results. The explicit choice of criteria depends on the information which the planner feels is important in making a decision.

1. The value of consumer income generated, its distribution and rate of change by consumer type and economic sector source.

2. The value of incremental real income generated to final consumer from shifting buying behavior and changing relative prices.

3. The level of labor demanded by sector.

4. The level of importation, the mix, and the rate of change in importation by sector (import substitution measures).

5. The output of each sector and its sales distribution between local consumption and exportation.

6. The internal characteristics of each sector and each components within a sector in such areas as rates of spoilage or loss, capacity and capacity utilization, value added, profit levels, changes in efficiency as measured by changes in technical coefficients, the location of factor input purchases, and the level of potential investment funds generated.

7. For the system as a whole the above measures can be combined and others computed to obtain information for the total economic system. Possibilities include

the level of regional product (absolute and rates of change), value added by region, total regional intersectoral transactions, and trade balance and degree of import substitution taking place in the system (and where it is taking place). These are just a few examples of the many systems criteria which could be developed.

Evaluation and Action

Once the simulations have been run, the results must be evaluated relative to the performance measures developed. These will give the estimates of the internal system costs and benefits derived from the reforms. These are then compared with the investment necessary to implement the reform. The results give a representation of the economic feasibility and desirability of the given reform. The development planner then can access the economic implications in comparison with its social and political implications. A decision can be made to act on the reform, to defer action until parameter estimates are more accurate, or until research reveals more fully the functional relationships within the model. In short, the decision-maker (model user) can act or defer action; if action is deferred, improved information may be sought. (Improved accuracy must be balanced against the added costs of obtaining better information and of delaying action.) (Figure 8.1).

The Recife Systems Model offers a unique flexibility in the type of evaluation which is conducted on the results of a simulation run. As stated, the general results are seen in the values of the performance measures chosen. The computer program for this model permits exact computation of these criteria from other internally generated results in the model. For a simulation of five time periods, there are about 310 pages of detailed economic information.

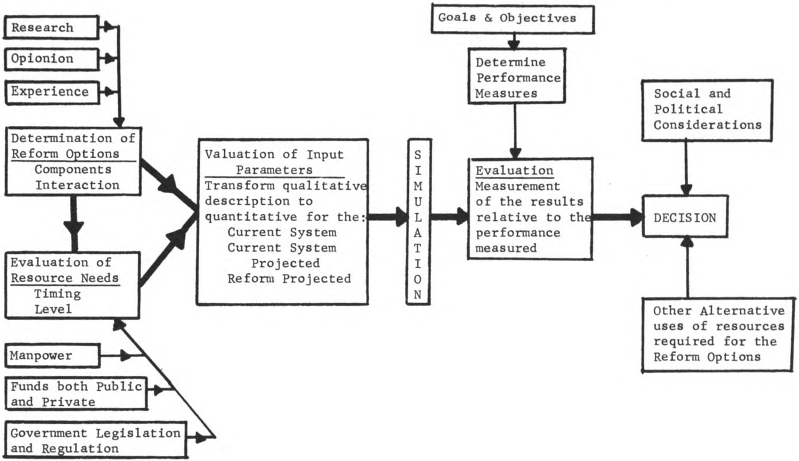

FIGURE 8.1 A Summary: The Process of Using the Model

The structure of the economy is presented in detail for each sector in the system, for each component within a sector, and summary statements developed. Cost-profit schedules for the Distribution Sector and the Industry Sector are presented, rates of changes on most parameters and calculated results are computed, etc. Further, in the Decision Routine-Consumer I, the decision rules are presented in text form accompanied by their use and affect on the system.

Thus, the performance measures give an overview of the results of the simulation, but there remains the flexibility to analyze in detail any portion of the economic system desired. This becomes important when considering the differential impact of reforms within a given sector. For example, the results of one of the marketing reforms showed the total wages generated in the Distribution Sector were only slightly lower than what could have been expected without the reform. A careful investigation of the detailed printout showed that modern food outlets had gained a large increase in wages and the traditional outlets had lost a large amount of wage income. To the planner who is trying to ascertain the "real" economic impact of a reform and also judge some of the non-economic results, this knowledge of the differential result on wages would be of importance.

The Use of the Model: Evaluating the Impact Of Market Development Programs

Reform programs recommended in Chapter 12 of the final report of the research done in Recife are combined with the general systems model structure to illustrate the uses of the model through computer simulation as an instrument capable of assisting the planner in program appraisal. The internal structure of the systems model portrays the basic market system of Recife and its "foodshed". The simulations presented here are mathematical representations of the dynamics of internal market processes based on the research done in Recife. The specific parameter estimates and economic assumptions in such areas as income distribution, consumer expenditure patterns, product distribution, and technical coefficients are generated directly from the research. The content of the reform programs was developed by the research team members, and the links between these programs and the key economic variables and relationships in the system were estimated by the research team in extensive workshop sessions. Also developed in these workshops were preliminary investment cost estimates for program implementation of the reforms. These cost estimates are presented in order to demonstrate the need to compare them with the cost/benefit consequences of the reforms arising within the system and are offered only as very preliminary estimates of the likely costs to achieve the reform goals identified by the research.

If the decision-maker wishes to utilize the model to test different assumptions about the functional relationships between sectors of the economy, different behavioral assumptions, or the impact of different policy variables, the present model structure provides the capability to accommodate a variety of changes. The basis for any adjustments in parameter values or model structure can be prior knowledge, further research to improve the accuracy of estimation, or merely the exploration of the consequences of different assumptions about consumption, distribution, production, government action, or investment. Thus, while the model can become an increasingly accurate reflection of the processes of the marketing system of Recife, it can also be used to consider the economic and social consequences of hypothetical changes which might be induced by reforms upon the workings of the market process of the community. When the planner has substituted his revised data, the general systems model can be simulated again to evaluate performance indicators.

The general systems model structure is designed to allow the planner a broad range of options in evaluating the character and magnitude of change in the economic system. The flexibility built into the internal model structure permits variationsin parameter valuation, in economic structure, and in the effect of policy variables on the economic system over-time. Thus, the internal model structure can be utilized fully as a computer simulation planning tool only with the active participation of the planner because he provides the final assessment of parameter values and fundamental economic relationships. More importantly, the planner is the key link between the policy variables, program implementation, and the economic process relationships in the "real" economic system.

It should be stressed that these simulations are illustrative applications. The research team members are not decision-makers for the Northeast of Brazil. The recommended reforms have been based upon the diagnostic research. The parameter estimates, investment cost estimates, and the estimated impact of policy variable changes are not those of the "planner" but were developed for purposes of analysis and to demonstrate the research potential of the approach. Detailed feasibility studies should underpin estimates of investment costs and the potential impact of program implementation. Thus, the anticipated results of the recommended reforms are also very preliminary estimates that illustrate what might happen if the reforms were undertaken. The purpose, then of this section is to show how the general systems model as a computer simulation tool can be used and the kinds of results which the model is capable of giving when evaluating internal market process reform programs.

Also, it should be remembered that the model developed for this project was a large scale model, utilizing a large scale computer.(See Appendix A - Page 252 to 254.) This was done because the research was designed to most efficiently demonstrate the feasibility of this approach. Later application calls for modifications in the model in order to utilize local computer facilities and much more fully involve policy makers in the use of this tool to evaluate the consequences of alternative reform programs.

The Review of Critical Questions

The evaluation of the consequences of the reform programs, identified in the previous chapter, does permit us to test some important questions about the impact of marketing changes upon the performance of the economy. The costs and benefits associated with specific reform programs can be evaluated by utilizing the general systems simulation. Five critically important questions are reviewed through the simulation analysis.

1. Will the labor-saving technological changes in marketing alone, such as the current development of discount supermarkets, yield an increase in income for the community as a result of the lowered prices or will the decreases in employment occasioned by the new technology of distribution more than offset the price reductions?

2. Will a combined urban marketing development program which not only supports the efforts to expand discount supermarkets but also offers technical assistance and improved capitalization to traditional food merchants yield a smoother transition and avoid some of the unemployment consequences implicit in the development of discount supermarkets alone?

3. Will a rural marketing development program add to the effect of the urban marketing reforms?

4. Can the increases in rural demand, associated with the increases in urban expenditures for foods, provide an expanded market for urban industrual products?

5. Will the benefits of such programs likely offset the construction costs and technical costs associated with the programs?[7]

The Reform Options Considered

The three reform programs chosen for this illustration are drawn from the recommendations of the LAMP/LAFS research. Each successive reform

[7]LAMP/LAFS Draft Report, Chapter 13, p. 11.

program simulated includes the earlier ones. Thus, these preliminary simulation applications of the systems model to market process study illustrate the probable cumulative effect of these programs over time and as they become more inclusive in nature. In order to keep within a realistically accurate "planning horizon" each of the reform simulations is "run" for a five year period. Therefore, the cost/benefit analysis and estimates of investment resource needs are appraised only for five years.

Reform Program One: Modern Discount Supermarkets

This reform "package" recommends financing and technical assistance for ten additional modern discount food operations in the city of Recife. The emphasis in these operations would be on high-volume, and low-margins for basic food staples. They would be located to obtain patronage from the lower income classes. In addition, they would be encouraged to increase direct buying and vertical coordination of supply channels.

Reform Program Two: A Total Urban Retail Reform Program

This reform includes the first program for modern discount supermarket operations and adds programs oriented to the current traditional operations in the urban distribution system. The effort is to make those more traditional retailers and wholesalers competitive and consumer responsive. This program includes:

1. For street and public markets, a program for the ten largest centers for the promotion of sales through facility improvements, advertising, and a retail merchant cooperative buying and trade credit program for their purchases of goods through the new wholesale facilities in Recife called CARE.

2. For small superettes and neighborhood stores (the largest 100) the development of a voluntary or cooperative chain which would permit group wholesale purchasing and some direct vertical coordination back to producers or rural assemblers.

3. Provide improved facilities at the urban assembly wholesale market, CARE, to permit more economical space utilization, including a credit and banking program to permit the smaller retailers to buy on credit and to receive some technical assistance.

Reform Program Three: An Urban-Rural Reform Program

In combination with the Total Urban Retail package described above, a rural reform program augments those centered in the Urban Sector. The rural reform package concentrates on the major rice and bean producing areas in the four-state "foodshed" of Recife. The program is:

1. A seed multiplication, distribution and improvement program to include research on seed varieties.

2. A program to increase the use of fertilizer in the selected areas of rice and bean production. The programs would include fertilizer response research, demonstration plots, subsidies for the farm input producers and a change in tax laws to exempt fertilizers from the current circulation tax.

3. The expansion of the current price stabilization program for basic food crops, and increased feasibility planning of storage requirements.

4. An input credit program which would extend lines of credit to farmers and develop a revolving semi-supervised credit plan.

5. The planning and development of market information programs.

6. An increased stress on the distribution of urban produced consumer goods to the rural area.

7. In conjunction with the urban reform package, the needed planning and working capital would be provided that appears to be necessary to implement more vertical coordination in the purchase of locally produced food items.

The Evaluation of Resource Needs

The estimates of the investment resources necessary for the implementation of the three reform programs should not be viewed as exact, but only as values which seem reasonable without detailed feasibility and cost studies. They are presented as an example of the types of consideration which must be given in determining resource needs and in evaluating reform results.

Reform Program One: Modern Discount Supermarkets

It is estimated that this reform would require approximately $3.6 million of planning and technical assistance, construction and equipment, and working capital for implementation. Planning and technical assistance is estimated to require at least two man-years of effort -- that includes consultants with specialties in warehousing, handling of perishables, merchandising, and general management. For construction and equipment, each store is estimated to require about $150,000 or $1.5 million for ten stores. In order to have at least one month's inventory "on hand" and assuming average weekly sales of $50,000 per store, the total working capital needs amount to about $2 million. A portion of the required investment can be generated by the supermarket operators themselves. One of the simulation results is the incremental change in the level of undistributed profits generated by the modern retailers. This will give an estimate of the level of outside public funds necessary to implement the reform. It is appropriate to mention that the presently reported plans of current supermarket operators are such that some limited expansion based upon their own investments can be anticipated. This investment and expansion of supermarkets is anticipated in the "base simulations" presented later. The "base simulation" is a representation of the market system over the next five years assuming the suggested market development schemes are not carried forward.

TABLE 8.1 Estimated Investment Funds Necessary for Reform Program One (in millions of dollars)

	Modern Discount Supermarkets
Planning and Technical Assistance	$ .1
Construction and Equipment	1.5
Working Capital	2.0
Total	$3.6

These funds are assumed to be allocated as follows over the first three years of the simulation: first year $1.1, second $2.0, and third $.5 million.

Reform Program Two: Total Urban Retail Reform Package

The three programs for the traditional retailers in the urban area are estimated to cost \$3.1 million with the major portion coming from public funds with technical assistance provided from foreign funds. Requirements of each program are:

1. The street and public market reform program is estimated to cost \$1 million. Technical assistance and planning is estimated to be \$150,000 consisting of two man-years of consultant time and the hiring and training of at least 10 local technicians. Construction and equipment expenses for renewing tables and signs would require about \$100,000. The largest funding requirement is for a working capital revolving fund providing an average of \$300/stall for 2500 stalls or a total fund of approximately \$750,000. The loan agency for these funds would be located at the CARE wholesale center.

2. The organization and operation of a voluntary or cooperative chain for superettes and neighborhood stores is estimated to cost \$2.1 million. Some of these funds can be generated internally but most will come from public funds for working capital. Again, an estimated two man-years of technical assistance would be required including experts in retail cooperative warehousing and wholesaling, managerial assistance, and local training of technicians. Construction and equipment expenses would

be borne by the CARE facilities for warehousing, handling equipment,etc. This is estimated to be about a $500,000 expense. Working capital is the largest expense estimated to be 1.5 million. One million of that would be provided by CARE and it is expected that one-half a million could be generated internally. The estimate is based on $1,500 per store for one-hundred stores.

TABLE 8.2 Estimated Investment Funds Necessary for Total Urban Retail Reform
(in millions of dollars)

	Modern Discount Supermarkets	Traditional Urban-Retail Programs	Total Urban Retail Package
Planning and Technical Assistance	$ .1	$ .25	$ .35
Construction and Equipment	1.5	.6	2.10
Working Capital	2.0	2.25	4.25
Total	$3.6	$3.1	$6.7

These funds for the traditional operators are assumed to be allocated over the first four years of the simulation in the following volumes: the first through the fourth year respectively $1.0, $1.75, $.25 and $.1 million. When combined with the investment necessary for the modern discount operations, the timing of the investment funds commitment for the total urban retail package is: $2.1, $3.75, $.75 and $.1 million over the first four years of the simulation.

Reform Program Three: The Urban-Rural Reform Package

The largest scale reform program builds on the first two with the addition of the rural oriented program to achieve a better coordinated food production-distribution system. This combined rural-urban reform program is estimated to cost $13 million. Of that amount, $6.7 million is committed to the urban reforms leaving $6.3 million as the amount of estimated investment funds required for the rural portion of the reform program.

1. For the seed improvement program, an estimated $2.04 million is needed in both the bean and rice areas. Planning and technical assistance consists of two man-years of in-the-field consulting and five man-years for a Brazilian technician in each producing area. The total estimated planning and technical assistance cost would be approximately $440,000. Minor equipment needs are estimated to be $100,000. Working capital needs are estimated to be $1.1 million for beans and $.4 million dollars for rice. These funds are necessary for the distribution and application costs for improved seed.

2. The fertilizer program is estimated to cost $.7 million for beans and $.58 million for rice for a total of $1.28 million. The major expense in this program is for subsidy funds for the production and distribution of fertilizer. These were estimated to be about $.6 million. Construction and equipment costs were estimated at $180,000 for both rice and bean areas together. Planning and technical

assistance expenses amount to the other major expense. The $500,000 allocated for these costs is split equally between the bean and rice areas and are allocated primarily to technical services, demonstration plots and experimentation.

3. The credit expansion program involves the establishment of a revolving fund costing, over the five year simulation period, $2.5 million with $1.5 million allocated to the bean area and $1.0 million to the rice area.

4. The marketing information services are relatively low cost with an estimated total expenditure of $480,000 over the simulation period. The cost includes three model transmitting and receiving units with the personnel necessary to operate in each of the two producing areas.

TABLE 8.3 Estimated Investment Funds Necessary for Total Urban-Rural Reform Programs
(in millions of dollars)

	Modern Discount Supermarkets	Traditional Urban Retail Programs	Rural Bean-Rice Reforms	Total Urban-Rural Package
Planning and Technical Assistance	$ .1	$ .25	$1.12	$ 1.47
Construction and Equipment	1.5	.6	.58	2.68
Working Capital	2.0	2.25	4.6	8.85
Total	$3.6	$3.1	$6.3	$13.00

The timing of the commitment of the funds for the rural program is concentrated more in the middle years of the simulation due to the need in early years for research and demonstration with the bulk of the working capital needs starting in the second and third years. The total rural reform cost is allocated over the five years as follows: \$.75, \$1.5, \$2.0, \$1.5, and \$.55 million. Combining this with the total urban reform program, the amount and timing of investment funds for the total reform program are: \$2.85, \$5.25, \$2.75, \$1.6, and \$.55 million respectively over the five years of the simulation run.

Determination of Base Parameters

In order to have a base for comparison, a "base run simulation" is done on which all comparisons of the changes caused by the reform programs are analyzed within the five year planning horizon. The explicit determination of the data inputs is developed from a combination of survey results census data, and "best estimates" of the particular research team members most capable of making a judgement.[8] Once the base period data are determined, estimates are made on how the system might be expected to change without the implementation of the suggested reform programs. Again, the explicit value of the parameters and the rates at which they are expected to change over time is given in Appendix B. The following parameter changes are made over the five year base simulation run:

1. Changes in Total Income. Total urban consumer income is assumed to grow at 6% per year over the simulation

[8]Appendix B of this dissertation contains a detailed summary of: the definition of each parameter inputs, source of information for simulations, and the values utilized in the simulations.

run. That average increase is composed of 4.5% increase in population and 1.5% increase in per capita income. It is assumed that the 6% increase applies to all consumer types. It is assumed that higher income consumers will probably have a higher per capita increase than 1.5% but a lower population growth rate. On the other hand, it is assumed that lower income consumers will probably have slightly less than a 1.5% increase in per capita income but a higher population growth rate.

2. Average Propensity to Shop for Food and Consumer Goods. Without the implementation of the reform programs in the urban area, some shifting in consumer shopping behavior to modern outlets is expected to take place naturally. As consumers become increasingly aware of the price, quality, and selection advantages of supermarkets, more consumers are likely to use their facilities as these facilities become available. However, the switch to supermarkets will probably be concentrated in the middle and upper income groups and not in the lower income groups. Over the five year period of the simulation very high, high and middle income consumers are assumed to increase food and consumer goods purchases in modern food outlets by 40% or an average of 10% per year. Thus, at the end of five years, very high income consumers would be expected to make 42% of food expenditures in modern outlets while the high and middle income groups

are expected to purchase 31% and 21% respectively in modern food outlets. Consumer goods expenditures in modern outlets, as a proportion of total consumer goods expenditures in the fifth year of the simulation, are assumed to reach 4.2%, 4.8% and 5.8% respectively for the very high, high and middle income groups. All other shopping propensities are assumed to remain constant.

3. Other Parameter Changes. Other base run parameter changes included an average growth rate of industrial output of 5%, increases in exogenously given minimal subsistence wages, net tax revenues flowing into the area from the federal government, and the level of investment in the urban area.

TABLE 8.4 Other Estimated Parameter Changes in the Base Run Simulation (in millions of dollars)

Time Period	Minimal Subsistence	Net Inflow of Taxes	Level of Investment Expenditures
1	65	50	55
2	70	55	58
3	75	60	61
4	80	65	64
5	85	70	67

Source: Simulation Run-Base

4. In the Rural Sector, total farm output was increased at about 4% per year in the four major product categories, rural town income was increased at 4% and farm income at 3.5% per year.

<u>Determination of the Parameter Value Changes for the Reform Options</u>

Modern Discount Supermarket Reform

For this limited reform option shopping propensities, price indices, margins, spoilage rates, location of retailer purchases, and the level of exogenous investment are considered the important points of entry into the model. All the parameter changes assumed in the base simulation are repeated except the level of investment and the shopping propensities which are further altered in this reform. (For a detailed listing of parameter estimates for the supermarket reform simulation see Appendix B - Pages 351 to 353 .)

1. <u>Average Propensity to Shop</u>. Concentration on the modern operators at the expense of the traditional operators means that the traditional operators will become even less competitive. As availability of supermarkets offering low prices increases and the lower income consumer is attracted to these outlets which seem more directly oriented to his needs, the shift in shopping behavior will be significant. Thus, it is assumed that for the very high and high income consumer, expenditures in modern outlets for food and consumer goods will double to 60% and 50% of their respective total food budgets. It is expected that the percentage of the total food budget extended through modern outlets by middle income consumers will increase even more sharply from 15% to 40%. With this reform, the low and very low income consumers will begin shopping in these outlets though not to the degree of the middle and upper income groups. It is assumed that the low income consumer will increase the percentage of his food budget extended in modern outlets from 10% to 30% on the average and that the very low income consumer, who in the base year spent no money in modern outlets, will be spending an average of 20% of his food budget in modern outlets in the fifth year.

2. <u>The Relative Price Index</u>. This index compares the price level of food and consumer goods between the traditional and modern outlets. It is assumed that competition among the modern outlets would force their price (already 8% lower than the traditional outlets) down slightly more over the five year period (1% over the total five years). The prices in the traditional outlets would fall some (2% assumed) but not enough to become competitive because of the financial and technical factors limiting improvements by traditional operators.

3. <u>Spoilage and Margin</u>. They are altered in the modern outlets for food. Margin is dropped from 20% to 19% gradually over the five year period due to increased vertical coordination. Spoilage, however, is assumed to increase from 1% to 2.5% in the modern outlets as they broaden their product mix to include more non-processed and perishable food items.

4. <u>The Origin and Type of Channel Supply Purchases</u>. These parameters are also expected to change only for modern outlets. There is an assumed increase from 20% to 31% in the amount of non-processed food purchased from the Rural Sector as a proportion of the total food purchases by modern outlets. This develops as non-processed food becomes relatively more important in their product mix and as vertical coordination efforts are continued.

5. Construction Effects. The level of exogenous input of investment funds is augmented according to the previously developed investment cost schedule for this reform option. For the first three years, there was an added investment inflow of $1.1, $2.0 and $.5 million dollars respectively.

The Total Urban Retail Refrom Program

The same entry points are considered for the total urban retail reform package as for the more limited modern discount supermarket reform. The values of the parameter changes are different, however. (See Appendix B - Pages 353 to 366 for a complete listing of parameter estimates under the total urban retail reform simulation.)

1. Shopping Propensities. The change in shopping propensities is somewhat less than that suggested in the modern discount supermarket reform but still more than in the base simulation, because this total urban package contains programs for the traditional operators, they can be expected to react more constructively to the modern discount supermarkets. For the total urban reform package, it was assumed that during the five years: very high income consumers would increase the percentage of their food budget spent in modern outlets from 30% to 50%; high and middle income groups would increase from 20% to 41% and 31% respectively, low income consumers would double their purchases from 10% to 20%, and very low income consumers would go from no purchases in modern outlets to 12% of their total food purchases.

2. The Relative Price Index. It is assumed that the increased buying power and competitive viability of the traditional outlets permits them to reduce the average relative food price by 5% over the five year period. Further reaction in the modern outlets is assumed lowering prices another 2%.

3. Spoilage Rates. The rate of spoilage in both the modern and traditional outlets, is changed as a result of the reform package. In the modern outlets, the change is similar to that in the first reform i.e., a slight increase of 1% over the five year period due to the increase in sales of perishable items. In the traditional outlets, however, there was a significant drop in the rate of spoilage or loss in food items. For street and public markets, the spoilage (mostly perishable foods) cut in half over the five year period from 20% down to 10%. For the neighborhood stores, the rate of spoilage is decreased from 10% to 6%. All other spoilage rates are held constant.

4. Margin. The margin is again changed only for the modern channel outlets by slightly less than 2% over the five year period. The margin in the traditional outlets is not changed because it is assumed that the lowered spoilage and the relative decrease in buying costs over selling costs allowed the traditional retailer to keep the same gross margin. With the lower spoilage countered by the lower selling price, the net profit to traditional retailers is not expected to change significantly.

5. Purchase Location. The location of purchase and the proportion of processed food vs. non-processed food purchases are also changed in the total urban reform package. Added to the 10% shift assumed in the modern outlets from processed food to non-processed food purchased in the rural area, it is assumed the emphasis on processed foods as a proportion of total sales in the neighborhood stores will also shift in favor of the locally produced non-processed foods by about 5% over the five year period.

   This shifting of demand away from processed food does not mean that the demand for processed foods falls, it in fact still rises. But, as the modern and traditional neighborhood stores grow and take on a more rounded mix of products, they will be buying a larger relative proportion of non-processed and perishable foods. Currently, both types of outlets are heavily concentrated in canned and other types of processed foods.

6. Construction Effect. Over the first four years of the simulation run current expected investment is increased \$2.1, \$3.75, \$.75, and \$.1 million respectively.

The Urban-Rural Reform Program

Added to the total urban retail reform program is a major production and distribution reform package for beans and rice in the Rural Sector. All parameter changes estimated for the total urban program are retained in this reform package and additional parameter changes in the Rural Sector are incorporated.

The implementation of the rural reform package brings into use the special modern and traditional production types defined in the Rural Sector. These permit a delineated study of from one to five commodities. The entry points considered in this reform option are the rates of yield and land use for total bean and rice output in the four-state area, gross margins of assemblers, processors, and transporters in the rural area for food, and the exogenous input of investment funds into the Rural Sector. (For a detailed listing of parameter changes, see Appendix B - Page 356 to 358.)

1. Yield. The yield of the traditional farmers are assumed to remain constant at .6 tons/hectare for beans and 1.7 tons/hectare for rice. For the modernized farmers, yields are assumed to increase 40% in the second year, 20% in the third, 20% in the fourth and 10% in the fifth year. By the end of the fifth year, potential yields on the modernized land are expected to be 1.14 tons/hectare for beans and 3.2 tons/hectare for rice. These estimates are based on the expected returns from research, fertilizer use, and improved seeds.

2. Land Use. The degree to which the modern yield rates are realized is determined by the amount of land which is put to use under the modernized conditions. The area to which the reform is applicable accounts for about 464,000 hectares or 24% of bean plantings in the four-state area and about 73,000 hectares or 42% of rice plantings in the four states being considered. Within the reform areas, the switch rate from traditional to modern farming is assumed to be 2% of the total producer population in the second year, 8% in the third, 20% in the fourth, and 20%

in the last year so that by the fifth year 50% of the land in the pertinent reform areas is assumed to be converted to modern production. This, then, means that of the total area producing beans and rice, 12% conversion in beans and 21% conversion in rice is assumed.

3. Margin Decreases. With the improvement in market information and urban vertical coordination in selected areas, the overall gross margin generated in the rural area for food is assumed to fall 2% over the five year period. Though the gross effect is small, in the areas and products affected, gross rural margin drops by one-third (10%) but it only represents about 20% of the total food production in the Rural Sector (2% is 20% of 10%).

4. Investment Increases. As in the urban reforms, the investment funds necessary to implement the reforms are input into the Rural Sector as demands for labor, construction materials, equipment, and changes in the ability to buy farm inputs i.e., an increase in the technical coefficient relating farm input value per unit output.

5. Construction Effects. Incorporated into the Rural Sector are the investment funds necessary to implement the rural reform program. Over the five year period, the investments generated by the rural reform program are: \$.75, \$1.5, \$2.0, \$1.5, and \$.55 million respectively.

> Thus, for the total urban-rural program, investment funds will be increased in the system (both urban and rural) by $13 million split over the five years of the simulation as follows: $2.85, $5.25, $2.75, 1.6, and $.55 million respectively.

Evaluation of Simulation Results

The simulations were run on the CDC 3600 computer at Michigan State University. Each simulation of five time periods took approximately two minutes of computer time and generated 310 pages of detailed economic information about each sector and a condensed set of performance measures for the system in general. In the actual use of the simulations and their evaluations, the development planner would want to carefully examine not only the values of the performance measures but also the more detailed results before making a decision on the economic feasibility and desirability of any of the reforms. The evaluation of the impact of the reform contained herein is presented illustratively and thus should not be considered as a complete analysis for development planning.

Since each simulation assumes a five-year planning horizon, it is expected that the results will be conservative since most of the investment costs are incurred in the first three years but the costs and benefits arising within the economic system will continue to be generated after the first five years. The assumption of an open system relative to consumer income generation also tends to underestimate results because certain multiplier effects are not automatically taken into consideration. Assuming the open system, i.e. consumer income is given exogenously to each consumer type each year, was necessary in order to avoid potentially large misleading results in income multiplier effects. Parameter estimates for the crucial link between major sources of income generation (about 80% of all consumer income) and the individual consumer types receiving that income were not available at the time these illustrative simulations were run. Careful checks were made, however, in a *post hoc* manner, to verify the consistency between total consumer income generated and expended. A variance of one percent or less was achieved in all simulations.

The results of the simulations demonstrate the importance of comparative analysis between various options and a *base simulation* representing the expectation of how the system would operate without these specific reforms. The base simulation projects the present system for five years including development changes expected to take place independent of the reform programs analyzed here (such as industrial expansion through 34/18 investment).

The simulations will suggest the nature of the consequences of implementing these reform options and show the type of analysis which can be expected from the Recife Systems Model. The results of each successively more inclusive reform program is presented separately, and, then finally summarized with the calculation of one potential measure of social return on investment relating investment costs to additions in consumer buying power generated by the reforms.

Modern Discount Supermarket Reform Program

With the implementation of this reform program of ten additional modern discount operations, the annual sales of food in modern outlets rises from $14.9 million in the first year to $52 million in the fifth year of the simulation, Table 8.5. By the fifth year, this represents an increase over that expected without the reform of more than 100% -- $23.8 million versus $52 million. At the same time, the annual sales in the traditional outlets fell absolutely. Street and public market sales decreased from $51.2 million to $46.1 million and the annual sales of traditional neighborhood stores dropped to $40.9 million from $45.5 million. This sales decline does not present the entire picture, however. The annual sales decline in traditional outlet is even more significant when compared to the sales which the traditional operators could have expected in five years if no reform had been implemented. Expected annual sales in the fifth year for the base simulation were $62.2 million for the street and public markets compared to $46.1 million under the supermarket reform simulation. Similarly, neighborhood store sales amounted to $55.1 million in the fifth year for the base simulation compared to $40.9 million under the supermarket reform simulation. The modern operator share of the market rose from 12.3% to 34.3% with this reform compared to the no reform situation where their market share rose only to 15.5%.

TABLE 8.5 Annual Sales in Selected Distribution Sector Channel--Outlet Components (in millions of dollars)

Sales in:	Time Period				
Supermarkets	1	2	3	4	5
Base Simulation	14.9	16.8	18.9	21.2	23.8
Supermarket Reform	14.9	22.4	31.3	41.1	52
Street and Public Markets	1	2	3	4	5
Base Simulation	51.2	53.7	56.4	59.2	62.2
Supermarket Reforms	51.2	50.4	49.3	47.8	46.1
Traditional Neighborhood Stores	1	2	3	4	5
Base Simulation	45.5	47.6	50.	52.5	55.1
Supermarket Reform	45.5	44.7	43.7	42.4	40.9

Source: Simulation Runs "Base" and "Mods only - III"

Table 8.6 shows that total annual wages and distributed profits generated in the Distribution Sector increased over the five year period from $30 million to $36.2 million but that increase is $1.6 million less than expected with no reform. The traditional operators in the sector fared much worse than the average, however. Annual wages and income generated dropped absolutely in both traditional types, and when compared to expectations without the reform, the decrease in wage and income generated is $4 million in the fifth year. Modern outlets took up $2.4 million of the expected loss to traditional retailers. The wages and distributed profits generated in the Distribution Sector, while absolutely higher by an annual $6.2 million over the current year, are a total of $3.7 million lower than would be expected with no reform over the entire five years. Thus, relative to expectations and in absolute terms, the traditional operators have been dealt a severe blow because they could not or would not react competitively. It should be remembered that it is the shifting consumer preferences to more modern, lower priced and more convenient retail outlets which provides the driving force behind these expected changes.

TABLE 8.6 Direct Wages and Distributed Profits Generated in the Distribution Sector for Food Sales (in millions of dollars)

Wages and Distributed Profits generated in:	Time Period				
Total Sector	1	2	3	4	5
Base Simulation	30	31.7	33.6	35.6	37.8
Supermarket Reform	30	31.4	32.9	34.5	36.2
Supermarkets	1	2	3	4	5
Base Simulation	1.9	2.1	2.3	2.6	2.9
Supermarket Reform	1.9	2.6	2.4	4.3	5.3
Street and Public Markets	1	2	3	4	5
Base Simulation	8.8	9.3	9.7	10.2	10.7
Supermarket Reform	8.8	8.8	8.7	8.6	8.4
Traditional Neighborhood Stores	1	2	3	4	5
Base Simulation	6.6	6.9	7.3	7.7	8.
Supermarket Reform	6.6	6.6	6.5	6.4	6.3

Source: Simulation Runs "Base" and "Mod only - III"

Total wage income and distributed profits from all sectors increased over the five year period but are still \$1.9 million below that which would have been expected without the reform. The negative effect in the Distribution Sector is more than offset by the "construction effect" of the added investment funds input into the system in the first three years of reform implementation, but by the fourth and fifth years the money income begins to fall below base simulation expectations.

These negative income effects are completely offset relative to the base simulation when the incremental consumer real income generated to final consumers from their shifting buying behavior to lower priced outlets is considered. Thus, given a level of money income, consumers' "buying power" is increased in the aggregate. Over the five years more than \$5 million of incremental real income is created for consumers. Table 8.7 summarizes the timing of this incremental real income generated from lower relative food prices.

TABLE 8.7 Incremental Consumer Real Income Generated From Lower Prices and Changing Buying Behavior (in millions of dollars)

	1	2	3	4	5	Total
1. Base Simulation	0	.09	.1	.1	.11	..4
2. Modern Discount Supermarket Reform	0	1.22	1.27	1.32	1.37	5.18
3. Net Additions to real Consumer Income (2-1)	0	1.14	1.17	1.22	1.27	4.8
4. Changes in Buying Power (all sources) (Change in money income and price effects)	0	1.1	.9	.7	.2	2.9

Source: Simulation Runs "Base" and"Mods only - III"

Thus, while retailers operators in the distribution system lose relative wages, the consumers in the aggregate improved their net "buying power" over the base simulation where no reform is assumed by $2.9 million.

With the modern discount supermarket reform, imports rise by $2.2 million over what would have been expected without the reform, to a level of $49.2 million in the fifth year (Table 8.15). This is caused by the consumer shift to the modern outlets which depend much more on importation than the traditional operators. While the modern operators do shift in some degree to more local purchasing it is not sufficient to offset the magnitude of imports given the great increase in their sales.

Internally generated undistributed profits and depreciation (potential investment funds) increased over the base simulation by $1.2 million dollars over the five years. These arise primarily from the modern retailers and can be expected to pay for at least a part of the total investment commitment necessary for the implementation of the reform.

While incremental real income is increased to the urban consumer, this reform option does not look very attractive when compared to the costs in expected wages, increases in importation and the dislocation caused among the traditional retailers in the distribution system.

The Total Urban Retail Reform Program

The reform program which concentrates only on modern supermarkets produces significant negative effects which the simulation clearly shows. With the implementation of the total urban reform program the results are very different within the Urban Sector.

Table 8.8 shows annual sales of modern outlets still rising significantly above base simulation expectations without a reform program by almost \$13 million in the fifth year. This is however, a much smaller increase than with the modern discount reform alone, (\$36.5 million vs. \$52 million). Thus, while annual sales in the modern operations more than double over the five-year period from \$14.9 million to \$36.5 million)the increase is not so great that the traditional operators record an absolute loss in annual sales. Obviously their sales are below those expected without the reform but by the end of the fifth year, their annual sales have risen absolutely by over \$2.7 million. The ability of the traditional operators to react to competitive conditions has increased sufficiently with the implementation of reforms oriented toward improving their operations. As a result of the total urban reform package they are able to at least "hold their own" in terms of total annual sales.

As seen in Table 8.9 the level of wages and income generated annually by the Distribution Sector with this more inclusive reform program also shows a different picture than the modern discount supermarket reform. Total annual wages and distributed profits generated in the Distribution Sector from all outlet types is only \$300,000 below the expected wages under no reforms. This is in sharp contrast to the \$1.6 million difference in annual wages under the modern discount reform. Also in the aggregate, total wages and distributed profits for all five years are only \$.6 million below base simulation expectations versus \$3.7 million below in the modern discount retail reform. This gain in income arises largely from the traditional retailers as their competitive ability increase. Income generated by the modern outlets, while more than doubling over the five years, is \$1.3 million below that generated by the modern discount reform alone. In contrast the

TABLE 8.8 Annual Sales in Selected Distribution Sector Channel-Outlet Components (in millions of dollars)

Sales in:	Time Period				
Supermarkets	1	2	3	4	5
Base Simulation	14.9	16.8	18.9	21.2	23.8
Supermarket Reform	14.9	22.4	31.3	41.1	52.0
Total Urban Reform Package	14.9	19.8	25.4	31.6	36.5
Streets and Public Markets	1	2	3	4	5
Base Simulation	51.2	53.7	56.4	59.2	62.2
Supermarket Reform	51.2	50.4	49.3	47.8	46.1
Total Urban Reform Package	51.2	51.7	52.1	52.4	52.7
Traditional Neighborhood Stores	1	2	3	4	5
Base Simulation	45.5	47.6	50.0	52.5	55.1
Supermarket Reform	45.5	44.7	43.7	42.4	40.9
Total Urban Reform Package	45.5	45.8	46.2	46.5	46.7

Source: Simulation Runs "Base", Mods only - III, and Total Urban - III

TABLE 8.9 Direct Wages and Distributed Profits Generated in the Distribution Sector for Food Sales (in millions of dollars)

Wages and Distributed Profits Generated in:	Time Period				
Total Sector	1	2	3	4	5
Base Simulation	30.0	31.7	33.6	35.6	37.8
Supermarket Reform	30.0	31.4	32.9	34.5	36.2
Total Urban Reform Package	30.0	31.7	33.5	35.4	37.5
Supermarkets	1	2	3	4	5
Base Simulation	1.9	2.1	2.3	2.6	2.9
Supermarket Reform	1.9	2.6	3.4	4.3	5.3
Total Urban Reform Package	1.9	2.3	2.9	3.4	4.
Street and Public Markets	1	2	3	4	5
Base Simulation	8.8	9.3	9.7	10.2	10.7
Supermarket Reform	8.8	8.8	8.7	8.6	8.4
Total Urban Reform Package	8.8	9.1	9.4	9.7	10.
Traditional Neighborhood Stores	1	2	3	4	5
Base Simulation	6.6	6.9	7.3	7.7	8.
Supermarket Reform	6.6	6.6	6.5	6.4	6.3
Total Urban Reform Package	6.6	6.7	6.9	7.	7.1

Source: Simulation Runs "Base", Mods only - III, Total Urban-III traditional operators have absolute increases in income at about the same level as the modern outlets because of their increased ability to react to competition and hold sales that would have been lost. Wages rise from \$6.6 million to \$7.1 million and again are less than one million below that expected if no reform program was implemented. Clearly the more inclusive reform program that aids the traditional operator produces beneficial results to the modern operators though not to the degree that they might like and it does not create unemployment or reduce sales of the traditional operators. Now it is important to compare this benefit with the changes in incremental consumer real income from lower relative food prices generated to all final consumers.

For the final consumer the more inclusive reform program produces even more positive results. Incremental consumer real income generated from lower prices totals \$7.8 million over the five years compared to almost nothing if no reform is implemented and compared to \$5.2 million for the modern discount retail reform alone, as Table 8.10 demonstrates.

TABLE 8.10 Incremental Consumer Real Income Generated From Lower Prices and Shifting Buying Behavior (in millions of dollars)

	Time Period					
	1	2	3	4	5	Sum
1. Base Simulation	0	.09	.1	.1	.11	.4
2. Modern Supermarket Reform	0	1.23	1.27	1.32	1.38	5.2
3. Total Urban Reform Package	0	1.87	1.92	1.97	2.04	7.8
4. Net Additions to real consumer Income (3-1)	0	1.78	1.82	1.87	1.93	7.4
5. Changes in Buying Power in aggregate (all sources)	0	2.4	2.3	2.4	1.8	8.9

Source: Simulation Runs "Base", Mods-Only-III, and Total Urban-III.

The increase in real income generated derives directly from the increased ability of the traditional operators in the distribution system to react to the competition of the modern outlets. The consumer not only benefits from lower food prices because he shifted to modern outlets but also because the food prices within the traditional outlets lowered.

Until the fifth year of the simulation, total annual consumer income is above base simulation expectations. But by the last year the income produced by the reform's "construction effect" are declining and total annual consumer income falls below the base simulation value. For the entire five year period, however, total wages and distributed profits still remain significantly higher than in the base simulation assuming no reform. An additional \$1.5 million in money income over base simulation consumer income from all sectors results from this reform program. This is \$3.4 million greater than income expectations for the modern discount retail reform alone. Consumer buying power over the five years increases by \$8.9 million (the sum of increases above the base simulation in wages and distributed profits, \$1.5 million, and incremental consumer real income from lower prices and shifting shopping behavior, \$7.4 million). (Table 8.10).

In the analysis of incremental consumer real income effects the influence on income distribution is important. Table 8.11 and Table 8.12 show that 93% of the real income generated by the total urban program went to the middle and lower income groups, with 50% going to the low income groups. The tables show that the impact on total consumer income is much greater for the lower income groups than for the higher groups.

TABLE 8.11 The Percentage Which Each Income Class Receives of the Incremental Real Income Generated

	Consumer Income Classifications				
	V.H.	High	Middle	Low	Very Low
Supermarket Reform	5	6	45	35	9
Total Urban Reform Package	3	4	44	37	12

Source: Simulation Runs Mods only - III and Total Urban - III

TABLE 8.12 Each Consumer Type's Incremental Real Income as A Percent of Their Total Real Income

	Consumer Income Classifications				
	V.H.	High	Middle	Low	Very Low
Supermarket Reform	.1	.2	.4	.5	.8
Total Urban Reform Package	.1	.2	.6	.9	1.4

Source: Simulation Runs Mods only - III and Total Urban - III

The level of undistributed profits falls by slightly more than \$.5 million relative to the modern discount retail reform program because the modern operators have a smaller sales increase and the traditional retailers generally use all of their profits as income i.e. all profits are distributed. Thus, the modern retailers cannot be expected to finance as much of the reform costs as they might in the modern discount retail program alone.

Another positive feature of the total urban reform program is that imports, while rising over the five year period, fell relative to what would have been expected if no reform program had been attempted. Over the entire five year period, the decrease in imports relative to the base simulation is \$2.7 million.

The choice between the two reform programs is not difficult to make. The total urban program generates more consumer buying power and money income, lower imports, and does not cause major employment problems for the traditional retailer in the distribution system.

The Total Urban-Rural Reform Program

The total urban retail program has been demonstrated to have significant positive effects on the urban sectors but little or no effects on the Rural Sector except for some increases in vertical coordination. The implementation of the total urban program in combination with the rural reform program designed to stimulate farm production by stabilizing markets and improving the distribution of key farm inputs among rice and bean farmers produces some interesting results.

For the rural reform, the sum of rural output for the five years is $11.6 million more than the base simulation expectations. This increase arises only from bean and rice production and is steadily increasing over the five years of the simulation. (Table 8.13). The level of farm inputs of seeds and fertilizer and equipment grows and generates increased demand for those products which can be partially supplied by the urban area of Recife.

Added income generated in the Rural Sector from rice and bean producers and distributors amount to $8.5 million over the five year period as Table 8.14 shows. Increases in productivity accounted for 60% of that increase with the remainder being generated by the influx of investment funds from the implementation of the reform program which generated a "construction effect" in the rural area, thus increasing the demand for labor, materials, and equipment.

TABLE 8.13 Rural Food Output
(in millions of dollars)

	Time Period 1	2	3	4	5	Sum
Base Run Simulation	256.3	268.9	282.2	296.2	310.7	
Rural Reform Package	256.3	269.	283.1	299.4	318.1	
Difference in Output	0	.1	.9	3.2	7.4	11.6

Source: Simulation runs Base and Urban-Rural II

TABLE 8.14 The Total Increase in Consumer Buying Power Generated to both the Urban and Rural Sectors by the Implementation of each Reform Program (a)
(in millions of dollars)

Reform Program	Time Period 1	2	3	4	5	Sum
Supermarket Reform	0	1.1	.9	.7	.2	2.9
Total Urban Reform Package	0	2.4	2.3	2.4	1.8	8.9
Rural Reform Package	3	.5	1.8	3.5	2.4	8.5
Total Urban and Rural Reform Packages	.3	3.2	4.7	6.8	5.3	20.3
In Urban Area	0	2.7	2.9	3.3	2.9	11.8
In Rural Area	0	.5	1.8	3.5	2.4	8.5

Source: Simulation Runs "Base", Mods Only - III, Total Urban - III, and Urban-Rural - II

(a) The total increase in buying power consists of: incremental increases in real income from lower prices and shifting buying habits and increases (decreases) in wage, non-wage, and distributed business profits generated to the final consumers from the sectors in the economy. All figures are relative increases in buying power over the base simulation which assumes none of these reform programs was implemented. Thus, these figures are year for year comparisons (year 3 of reform to year 3 of base simulation) and not a comparison with the initial time period which could be very misleading.

In the urban area, the combination of the urban and rural reform programs increases the returns to the consumer when compared to the urban reform program alone. When the two programs are combined, wage and non-wage income generated in the Urban Sector over the five year period increased by $4.5 million, or $3 million above the increases in income generated by the urban reform program alone. Thus, total consumer buying power in the urban area is almost $12 million over base simulation expectations. This can be directly traced to the added impact of the investment funds on wages and the increase in output of the farm inputs industry in Recife in response to the added demand placed on it by the Rural Sector. Smaller increases are also present in consumer goods and processed foods production as the rural demand for these items is expanded due to higher farm income.

In the total urban and rural reform simulation, Table 8.15 shows that the level of annual imports by the Urban Distribution Sector drops even lower than with the urban reform program alone. The effect of implementing both rural and urban reforms is to reduce annual imports by $2.3 million over the five years compared to the urban reform alone and by $5 million over the base simulation expectations with no reform being implemented.

TABLE 8.15 Value of Imports of Food and Consumer Goods into the Urban Distribution Sector (in millions)

	Time Periods				
	1	2	3	4	5
Base Simulation Run	36.4	38.8	41.2	43.9	47.
Supermarkets	36.4	39.4	42.5	45.7	49.2
Total Urban Reform Package	36.4	38.5	40.8	43.2	45.7
Total Urban Reform Package and the Rural Reform Package	36.4	38.3	40.2	42.6	44.8

Source: Simulation Runs: "Base",Mods Only - III, Total Urban - III, and Urban-Rural - II

The Impact of the Exogenous Investment Funds

The effect on wage and non-wage income in the urban and rural areas caused by the "construction effect" of investing $13 million in reform programs has been outlined. This investment causes an increase in wages in the first years of the reform but by the fourth and fifth years the effect tapers off. In so doing, the investments are able to offset lower wages generated in other areas in the early years or augment income increases in other sectors.

Besides adding income, their investment funds created demand for construction materials and capital equipment. Due to the continued lack of supply in the Recife area, a significant portion of the demand is funnelled to the South/Import Sector. Thus, some of the potential benefits of the reform option within the region are lost.

A Summary Comparison of the Three Reform Programs

The importance of building a balanced reform program is very apparent with the careful analysis of these results. Successively more inclusive programs produced greater economic benefits in the form of increased wage and non-wage income, higher consumer buying power, lower prices, and reduced imports. Further, there seemed to be less negative effects caused by modernization when the traditional retailers were given the opportunity to improve their competitive ability with the modern operators "leading the way". Table 8.14 demonstrates the compound effects which could be gained through reform programs interrelating the Urban and Rural Sectors. The total additions to consumer buying power generated by the Rural and Urban reforms, if implemented separately sums to $17.4 million, but when combined, the total increase in real income amounts to $20.3 million over the income generated in the base simulation.

The simulation model has been able to present information which might not otherwise have been available. The fact that with the total urban retail program, which included a major program for increasing the importance of modern discount supermarkets in the Urban Sector, the annual wages to the traditional operators still increased over the current level is important information for the planner, (see Table 8.9). The concentration of incremental real income from lower relative prices generated in the middle and lower income groups not only helps the low and middle income consumer, but by this slight redistribution of income, it frees some savings (previously held by high income consumers) to be spent on food and consumer goods which would further increase their demand, (see Table 8.12). One important negative effect of the modern discount reform when implemented alone, was the increase in imports above those expected without a reform. Table 8.15 shows that only in that reform were imports higher than in the no-reform situation. Many other points could be outlined and much further information could be gained from a careful analysis of the detailed economic data generated by the simulation printouts (see Appendix A for examples of the type of economic information which the printout of the simulation generates) but the ability of the model to assess the interdependence of reform programs within a large system and at the same time analyze their impact in a sector and within types defined within a sector has been demonstrated.

One Measure of Social Return on Investment: A Buying Power Index

The economic benefits generated by these illustrative reforms must be compared to the costs of implementing those reforms. Earlier in this section it was stated that the successively more inclusive (and more costly) programs produced greater economic benefits; but, from an economic standpoint, only if the benefits are relatively greater than the increase in investment can they be justified.

One means to accomplish this is to contrast the explicit investment cost over the five-year period with the increase in the buying power generated from lower prices, shifting buying behavior, and increases in wage and non-wage income. This could be considered one of the measures of "social return" on the investment in the reform programs.[9] The financial definition of "rate of return" can be altered here by developing that rate of return which "discounts" to zero the time variant costs of the investment relative to the time variant returns in increased buying power. Essentially, it determines that percentage rate of return on the investment which is generated in the form of added consumer real income to the society over what could have been expected if the reforms were not implemented.

Table 8.16 summarizes the level and time commitment of the investment funds estimated for all three reform programs. It is quite possible that while the total urban-rural reform program is expected to produce the most benefits, the implementation costs would be high enough to result in a lower rate of return in consumer benefits than for one of the less inclusive programs. Thus, these costs must be compared with total real income generated over the same time periods for the three reform programs. Table 8.14 summarized the real income benefits. Then by subtracting the investment costs from the income or buying power benefits, as seen in Table 8.17, the net value of benefits for each reform program is determined for the five-year period.

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[9]Many other "social rates of return" could be considered here. Because of the general concentration on consumer benefits in this analysis of the reform programs, the "consumer buying index" is defined as an illustration of a general system performance indicator. Perhaps the most logical other "social rate of return" which could have been presented would be a comparison over time of the investment funds committed and the total net incremental additions to "value added" in each sector in the economic system. The structure of the analysis would be identical but undistributed business profits and changes in tax payments by business at all levels in the economy would be added to present additions in "buying power" to more accurately reflect true "value added".

TABLE 8.16 The Estimated Level of Investment Funds Committed for the Reform Programs (in millions of dollars)

Reform Program	Time Periods 1	2	3	4	5	Sum
Supermarket Reform	1.1	2.	.5	0	0	3.6
Total Urban Reform	2.2	3.75	.75	3.1	0	6.7
The Rural Reform Package	.75	1.5	2.	1.5	.55	6.3
Total Urban and Rural Reform Packages	2.85	5.25	2.75	1.6	.55	13.0

Source: Tables 8.1, 8.2, and 8.3

TABLE 8.17 The Net Value of the Difference Between the Incremental Real Income Generated and the Investment Funds Committed. (in millions of dollars)

Reform Program	Time Periods 1	2	3	4	5	Sum
Supermarket Reform	-1.1	- .9	.4	.7	.2	- .7
Total Urban Reform	-2.1	-1.35	1.55	2.3	1.8	2.2
Rural Reform Pack.	- .45	-1.	- .2	2.	1.8	2.15
Total Urban and Rural Reform Package	-2.55	-2.05	1.95	5.2	4.75	7.3

Source: Table 8.14 minus Table 8.16

Table 8.18 summarizes the results of those computations in determining the "Buying Power Index".

TABLE 8.18 Consumer Buying Power Index

The estimated Annual Rate of Return on the committed investment funds relative to additions in consumer buying power (added real income over base simulation) generated by the reforms for a five-year period

Urban Supermarket Reform Program	Negative Return
Total Urban Market Reform Package	22%
The Rural Reform Package	27%
The Total Urban and Rural Reform Packages	40%

As in most of the other performance measures which have been chosen in the comparative analysis of these reforms, when the real added consumer buying power is compared to investment costs and the discounted rate of return computed the more inclusive and balanced combination of the urban and the rural reform programs results in a significantly higher rate than any of the others.

The returns in total incremental real income do not stop in the fifth year; they will continue at a somewhat lower rate. This will further increase the rate of return which could be expected from the reform programs. For example, if it is assumed that the total urban and rural reform program continued to generate additions to real income at a much lower rate of $3 million per year for another five years, the rate of return would increase to over 50%. The other reforms would show similar gains in return.

Conclusions Drawn from the Simulation Analysis

The Recife Systems Model has shown itself capable of analyzing alternative reform options. The results, while presented illustratively, demonstrate that a general system model, utilizing the technique of computer simulation does have the ability to analyze the impact of reform programs in a way that focuses on the interaction effects between the sectors in the economy. At the same time, the model is disaggregated sufficiently to permit analysis of the effect of a reform within sectors and sub-sectors. This is vitally important to the development planner. Though not presented here, the detailed economic information which accomapnies the results of all simulations further refines the knowledge of the system which the development planner can obtain, (See Appendix A for some examples).

With all its assets, the model should not be used as the only device for evaluating the desirability of a reform program. The non-economic consideration must be included (though knowledge of economic consequences can often give insight into the non-economic implications of change). The intuition and experience of the planner should be brought to bear on the results of the simulation to determine their "reasonableness", relative to the economic, social and political system under analysis. Further, while a general systems model can be a powerful planning tool, it can also be a way to "prove" a politically motivated objective. The analysis that can be undertaken by a general systems model can be extraordinarily complex and thus, sometimes appear dazzling. The results, however, are no more accurate than the assumptions. The analysis results are determined by the data input and assumed relationships which are explicit but not necessarily accurate. Perhaps the most precarious assumptions lie in the area which links the policy variables at the discretion of the planner to the key economic variables in the system. For example, the impact of credit policy on the rate of fertilizer utilization.

The virtue of a general systems model is the flexibility of the model to provide a basis for analysis. The objectives of the analysis must be those of the decision-makers who are attempting to utilize this research tool to evaluate the very complex interactions and consequences of individually explicit and, indeed, individually simple relationships.

The reform programs that are tested here are, in fact, based on the conclusions drawn by the LAMP/LAFS marketing research team. Other development requirements and goals, (for example, health and educational goals) are not explicitly included in this design. Developmental experts more concerned with other development goals might seek to change the model variables to evaluate other approaches to programming development.

The effort has been to convey that a systems model can be an enormously useful and powerful analytical device capable of arithmetic tasks through computer simulation that would otherwise be extraordinarily difficult. The important gain from a general systems approach to examination of a social process such as the marketing processes of Recife is in the orderliness of the approach. Major assumptions must be made explicit in the model; hence, differences in the opinions of important decision-makers can be more fully identified and evaluated. It is in this sense that earlier referred to the general systems model as a basis for forum discussions among decision-makers.

CHAPTER IX

SUMMARY AND CONCLUSIONS

A Review

This thesis has presented the detailed results of an effort to build and use a general systems model. Computer simulation and systems analysis have been combined in the Recife Systems Model in order to provide a flexible framework in which to evaluate the impact of market process reforms on the internal economic structure of an undeveloped region. The emphasis has been on the possible applications of a general systems model to evaluate market reform programs not merely because it is a novel tool of analysis for assessing the benefits and costs associated with specific reforms, but because it permits a fuller analysis of a process of change. The complex and interdependent changes that occur when market processes are modified demand the kind of systematic appraisal that has been demonstrated to be feasible with the Recife Systems Model.

The internal structure of the Recife Systems Model has been detailed, the planner oriented characteristics analyzed, and the results of using the model in simulation evaluated. The internal structure was defined to permit flexibility in the determination of key behavioral and structural relationships. It presents a disaggregated structure that allows analysis of inter-sector and intra-sector change.

The Consumption-Income Sector with five income classifications stresses the analysis of consumer buying behavior and its impact on the level and distribution of real consumer income. The Distribution Sector has six channel components defined with special emphasis on modern and traditional operators in the system. Margin, spoilage, and price levels are key determinants used in analyzing the behavior of Distribution Sector participants. In the Industry Sector seven industry components are defined with the concentration on those producing consumer oriented goods for the urban and rural areas. Also included are components for investment oriented goods such as capital equipment and construction materials. Technical coefficients, source of purchase parameters, and output functions form the central structure of each component.

The Other Recife Sector is a conglomeration of the other economic activity taking place in Recife. Its primary purposes are to "roundout" the economic structure of the urban area, provide the source of major income flows to urban consumers, and act as an investment expenditure demand transfer mechanism. The Rural Sector includes components for production, distribution, and consumption in the four-state area around Recife. The emphasis in determining the structure of this sector was on the level of urban-rural interaction taking place in the system from the rural area supplying food and other consumer goods to Recife and the urban area supplying basic farm inputs and consumer goods to the Rural Sector. Import and Export Sectors are defined which link the internal economic system with the other parts of the Northeast, the Center-South of Brazil, and international markets. These sectors act as the "demanders and suppliers of last resort" in the model.

In order to focus the attention of the planner on the behavioral and investment assumptions, "planner entry routines" are defined and clustered around the internal structure of the model. The PER provides the vehicle by which the user enters the model and alters its structure to fit particular analysis requirements. The decision routines and the Investment Sector are examples of the types of "planner entry routines" which could be developed. The Decision Routine-Consumer I forces the planner to consider the implications of differences in supply and demand for consumer oriented goods in the system at the level between production and distribution. The Decision Routine-Capital II does the same type of comparison for investment oriented goods. The Investment Sector presents a framework in which the user can analyze the sources, applications, and effects of investment expenditures on the economic system.

Through the simulation of three reform programs suggested by the LAMP/LAFS research, the model was tested in actual use. It demonstrated that it had the ability to carryout detailed economic analysis at different levels of disaggregation and present clear and concise evaluation. The results of the simulation point to the model's capacity to analyze interactive reform programs.

The model is designed for use in the planning process by providing a framework or structure for understanding a complex economic system under change. It is not meant to be the only tool used in the decision process nor is it designed to do the work of the planner. More, it assists the planner in his work, forcing structure and rigor into his analysis. Within this framework of improved systematic analysis, the model helps the user in defining the relevant system, sectors, and components and forces logical specification of assumptions about the present system and hypothesized changes in the institutions and behavior of that system.

The model should help the planner in building an efficient information retrieval system which contains the type, form, and level of information necessary for the decision process. The model enables the planner to develop detailed development programs of institutional or policy change and evaluate their economic consequences on each part of the system and on the system as a whole, given his assumptions. The user can compare his hypothesized behavior to a base simulation; and he can measure the growth and distributive effects of change in the first, second, and third order consequences. The user can change economic assumptions and develop economic behavioral relationships in the system. Several entry points are available through which the user can test reform programs. And finally, the model gives the planner detailed economic information and analysis in clearly understandable format at many different levels of aggregation.

Contribution and Suggestions

Much work still needs to be done before the Recife Systems Model is ready to be considered for use in on-line operational planning. The model needs further testing and certain of the sectors may need to be refined. The information base and the institutional structure in which the model operates need improvement. But, even at its present state the model can be a useful aid in the decision process. The model's most important contribution at this point is as a heuristic device. It presents a basic structure upon which the planner can build detailed programs and forces him to think through his assumptions about the system and the programs of change he proposes. It provides the framework in which planners from different areas of responsibility can get together and discuss development programs and their implications along broad intersectoral lines.

After building and using this model, there are a few specific areas which must be improved before this type of general system simulation model can be a truly effective tool for the planner.

First, while this is the first large scale modeling effort which has made extensive use of survey research techniques in building the data base required for the model, there must be significant effort placed on developing a broad and accurate information system. Further, integration with survey research techniques could prove very fruitful in defining an improved data base. There are three types of information which are needed:

1. Improved knowledge of the economic and behavioral relationships within the current system and the key indices which seem to be the most predictive.

2. The development of ongoing data collection systems for continual updating of a model and providing feedback on the relationships assumed.

3. Increased emphasis on the analysis of the potential effects of change in the system. Good information on the current system is needed but without improved knowledge of how the system is expected to change, the predictions of a simulation model are not enhanced.

The interaction between the modeler and the planner has not always been optimal. All too frequently they have not had the level of communications necessary to build a model which the planner is willing and able to use. It is strongly suggested that in any modeling effort that there be continued interaction with people in decision-making positions. Planners, economists, researchers, other social scientists, and modelers must work together. The use of "forums" to develop both the structure of the model and the types of analysis may be one way to accomplish this needed interaction.

Future models should move away from a strict deterministic structure to include probabalistic analysis. The commitment of large amounts of money and uncertainty do not mix well. Uncertainty arises within the system itself and with the accuracy of the information available about the system. Added to an "expected result" should be the "expected variability" in that result. The inclusion of "planner entry routines" in the Recife Systems Model provides a means of including such stocastic analyses. Not only would the usefulness of the results given by the model improve, but the development of this information on variability from close interaction with the planners would sharpen their focus on the types and level of uncertainty present in their decisions.

Some Comments on Implementation

The implementation of this type of model into the planning process of development agencies, such as SUDENE in the Northeast of Brazil, would require significant work in training, the development of information retrieval systems, the building of a process for continual evaluation and improvement for the model, and an institutional structure which facilitated the building and application of intersector models.

The objective of the modeling effort done in conjunction with planning agencies of underdeveloped countries is to transfer the modeling concepts, technology, and integrative planning orientation into their planning process so that they have an independent capability to utilize the model and refine it further within their own particular requirements. This means that training programs would have to go far beyond a relatively simple program to transfer model technology to a select group of technicians. Active decision-makers, economists, researchers, and modelers must work together on a continual basis in order to develop the necessary expertise. The model with poor information is almost useless but even with good information it may still not be useful unless it is directly linked to the needs of the planner. To a large degree the success of any modeling effort depends on the skill and ingenuity of the planners, researchers, and modelers working together. Perhaps the best means to accomplish this type of training is in the actual process of building a model. For better than coming to a development agency and saying "here is the model and we will train you to use it" would be to have representatives from the various areas stated above included in all phases of the modeling effort from problem identification to "debugging" the computer program.

Of course the development of an accurate and efficient data retrieval system is imparative. There are some planners and scholars who say that the information system must be developed first and then the model can be built. A frequent criticism of the Recife Model has been that the information base was imperfect and there was not sufficient historical data to verify its structure and behavioral assumptions. The logical extension of this argument may be that no model could ever be constructed because without knowing the model requirements there is a high probability that information would be collected in the wrong form or quantity. It is extremely important to understand that a model structure may have to be present and quite detailed <u>before</u> any effective information retrieval system can be developed. The ease of falling into the trap of saying that since data is imperfect a model cannot be built or used could be dangerous. The development of the model and the information system to service the model must be intimately linked. The model should never be considered a static "finished" product. The implementation process is thus one of continued adaptation and refinement as the model is incorporated into the planning process at increasing levels of sophistication and operational applicability.

Information is needed on the structure of the system, the behavioral relationships, and the magnitude of those relationships in the system at at least three levels of accuracy: the current system, a projection of the current system, and a projection of the system under hypothesized change. Each succeeding level is by definition less accurate than the preceding. This defines that the information and thus the model will always be imperfect because the model deals with the impact of change on the system at some future time. But its imperfection does not mean the model could not be useful. In determining the validity of a model it should be compared to the present "state of the art" in decision-making and not to the perfect ideal. Only upon this criteria would a model ever have a chance of success.

Unless there is an institutional structure present, in which the modeling work can be conducted effectively and where communications between planners in various sectors and the modeling activity can interact continually, it would be very difficult to achieve success. The Recife Systems Model has demonstrated that the benefits of reforms embrace the exchange processes permeating the entire economic system. Thus, without planner participation from various sectors of responsibility the model could not really be effectively used. However, in the Northeast, as in most developing countries, planning activities are organized along vertical sectoral lines, namely agricultural, industry, intrastructure, natural and human resources; and there is frequently very little communication between the sectoral planning groups. The systems approach imposes a demand for a horizontal, cross-sectoral view of the general planning process. There is the need for an integrative, comprehensive planning unit which would be free of exclusive bureaucratic or professional allegiance to a single sector or sub-sector of the system.

The Recife Model is extremely large and complex in nature and needs a computer at least the size of the CDC 3600 in order to simulate efficiently. The structuring of the model, building the computer program, verifying the assumptions, and obtaining realistic information on which to base simulations pose problems in manpower, time and equipment that should not be underestimated.

This type of modeling effort could not be carried out in most of the underdeveloped areas without a sufficient commitment in financial and human resources. But is crucially important that the reader understand that the conceptual framework which has been presented does not need a large complex computer to be an effective aid to development planners.

For the planner this conceptual framework points to the way in which the planner views the complex environment in which he has responsibility. The idea of looking at a system as a group of interrelated sectors, breaking down the system into identifiable parts, structuring the make-up of those parts, and analyzing the flows of goods, services, and even information between sectors can be done on a much smaller scale. Certainly not all the intricacies can be analyzed but the framework and orientation can still be of significant usefulness to decision-makers.

A Concluding Word of Caution

In conclusion, a final word of caution is presented. As Farace and Carroll point out, "systems analysis and computer simulation are relatively new additions to the methodological repertoire of social scientists, particularly where research and theory development in developing countries is concerned. In some circles, these techniques have been attributed a rather awesome status as a magical road to infallible answers. In other circles, criticisms are voiced that these techniques are unproved and unworkable, and the potential users become skeptical at the first mention of them as possible aids to solving a particular problem."[1] From the modelers viewpoint both

[1]Tom W. Carroll and R. Vincent Farace, "Systems Analysis, Computer Simulation, and Survey Research (East Lansing, Michigan: Computer Institute for Social Science Research, Michigan State University, 1968), p. 1.

extremes are to be feared. Creatively used in an environment where restraint and innovation are present, a model such as the Recife Systems Model, can be one useful analytic tool available to assist in the complex job of stimulating economic development.

APPENDICES

APPENDIX A

THE RECIFE SYSTEMS MODEL: STRUCTURE AND EQUATIONS

Organization of the Appendix

Appendix A is meant to serve the reader who wants to analyze in more depth the structure and relationships of the model. The appendix is divided into two parts:

1. Some general comments on the technical characteristics of the model including a brief summary of the computer program's structure.

2. Verbal equations, graphic flow charts, and printout examples for each sector in the model.

The computer program is not included in this dissertation because of its length and limited usefulness to all but the most technically minded. However, the computer program and a workbook detailing its use are available, at costs, from the Latin American Market Planning Center at Michigan State University.

The General Structure of the Model

The Model Solution

The means to obtain a solution in any time period within a simulation run is sequential in nature and not simultaneous. Thus, the model is termed "quasi-dynamic". Instead of obtaining an averaged result for each time period the sequential solution requires inputs at the beginning of a time period and states results at the end of that time period. The results at the end of a previous time period become the initial inputs for the beginning of the next time period. Thus, for example, the sequential solution demands an input definition of income which is the rate at which income is being generated at the beginning of a time period. After simulation for the time period, considering all changes taking place in the system, a new rate of income generation results for the end of the time period. This rate is used as the rate of income for the beginning of the next time period and so on.

The effects of utilizing the sequential solution are that the planner has more flexibility in determining what variables or relationships "drive" the system and disequilibrium solutions are permitted. When the model is used in short-run simulations (say time periods of one to three months) this disequilibrium quality could be very useful.

Model Sub-routines and the Computer Program

There are fout distinct types of sub-routines in the program of the model:

Algebraic Manipulation Sub-routines

These sub-routines service the model by providing efficient calculations in such areas as matrix multiplication, addition, subtraction, transposes, and inverses. One particular sub-routine called "move" adds significant flexibility and efficiency to the program. Written in CDC Compass Assembly language under the drum scope system, it permits any matrix entry or systematic set of entries to be moved to another matrix of different dimensions to form a different arrangement of entries. Thus, matrix rows can be moved to columns, columns to diagonals, and a sub-set of a vector

or systematically chosen set of entries to any systematically chosen set of entries in any other dimension matrix. This routine is also used to store information between time periods. The algebraic sub-routines are written in either Fortran IV or CDC Compass Assembly language.

Internal Structure Sub-routines

These sub-routines are the primary economic sectors defined in the model. Consumption-income, Distribution, Industry, Rural, Other Recife, and South Import/Export. Each economic sector is a separate sub-routine built independently then linked to the other sectors by the nature of inter-sector flows of goods and services in the system. Many different kinds of mathematical and logic statements are included in this segment of the model. Approximately 5,000 statements are in the main program and economic sub-routines. Very little direct mathematical manipulation is done, however, in any of these routines with a large percentage of the statements "calls" to the algebraic sub-routines. Some of the types of statements are:

1. Economic identities such as food purchases in supermarkets equaling the proportion of food expenditures spent in supermarkets times the level of food expenditures.

2. Economic relationships such as inputs equaling a technical coefficient times output.

3. Logic statements which permit various assumptions on location and magnitudes of flows and on relationships within economic sectors.

All relationships are deterministic in nature but by utilizing the PERs (Planner entry routines) this assumption can be modified. Also, most of the relationships are non-time variant in the internal structure of the model which permits wide flexibility in the choice of dynamic relationships but they must be incorporated in PERs not the internal structure. Virtually all parameter inputs are given to the model each time period so that sub-routines containing dynamic relationships can be "hooked-up" to the internal structure with little difficulty. Parameter inputs, about 1200 per time period, can be received by the internal sub-routines through exogenous input or from the PERs.

It is this segment of the computer program, the internal economic structure of the model, which is expanded in detail via verbal equations and parameter definitions, values, and sources.

Planner Entry Routines (PERs)

Clustered around the internal structure sub-routines are any number of Planner Entry Routines which provide the primary planner focus of the model. It is through the utilization of these routines that the planner can enter the model. Essentially the flexibility to:

1. Change economic relationships in such areas as economic supply and demand rigidity, and expand functional relationships to include other variables.

2. Quantify assumptions of program implementation which relates policy variables under his control (generally not included in the internal structure) and the prime economic variables in the system.

The first is accomplished through utilization of the Decision Routines (Consumer I and Capital II) or by developing new PERs to fit particular problem analyses or hypothesized structural conditions. Thus, for example industrial demand for labor (internally a function only of output) can be expanded by relating it to capacity and capital changes. The second is accomplished via the Investment Sector where routines can be built which explicitly relate investment factors and policy variables (such as credit) to economic variables (such as technical coefficients, margins, land yield, or spoilage) utilized in the internal structure or developed in another PER. For example, developing a PER which relates investment changes to the values of particular decision rules in the Decision Routine-Consumer I (another PER).

It was mentioned in the previous section that most of the relationships are non-time variant and all are deterministic in the internal structure of the model. The PERs provides the opportunity to utilize dynamic relationships and random or probabalistic relationships. Further, while the results in any given simulation may be deterministic, over simulations there is flexibility to test distribution variability of input values and functional relationships.

Any time the model is simulated the absence or presence of PERs determine the final economic structure assumed for that particular simulation. For example, if no explicit PER is developed for determination of industrial labor demand then the assumption within the internal structure (only related to the level of output) is in force. Frequently, however, many of these relationships can be computed on "pencil and paper" outside the model and then time-variant parameter inputs are given each time period to the internal structure which approximate the assumed relationships.

The parameter inputs demanded by the internal structure provides the link between the PERs and the internal structure. Further, PERs can use other input information or pull together multiple parameter inputs into one relationship as dependent or independent variables. The only requirement is that when the internal structure "needs" a parameter value it is available either from an exogenous source or from a PER.

Included in the verbal equations is a description of two PERs -- the Decision Routines-Consumer I and Capital II.

Simulation Print Routines

One of the unique features of the Recife Systems Model is the extensive and detailed information which is calculated and printed each time period of a simulation. Sixty pages of printout are generated each time period, which includes detailes of assumed input parameters, costs and profit accounting schedules, and basic economic analysis for each sector and each component within a sector of the model. Also a brief summarative analysis for the total system is presented. All results are printed in easily understood table and chart format with the exception of the Decision Routine-Consumer I. This routine utilizes a text format to clearly present the various decision rules, how they were used and their effects. Examples of the printouts are presented in the following sections after the verbal equations for each sector are detailed.

The Computer Program

The sub-routinized structure of the computer program for the model has been outlined. The program is composed of four interrelated sets of sub-routines: Algebraic service routines, internal structure sub-routines, Planner Entry Routines, and print routines. The model can be simulated for any number of time periods with each period run consuming about 25 seconds. The model is setup to run under the Fortran Overlay System of a Control Data 3400/3600/3800 computer system using the drum scope operating system. Using the overlay system requires about 28,000 memory units which could be reduced if greater segmentation was attempted in the overlay system. This would sacrifice significant operating efficiency, however. The program can be run without overlays in a minimum of 40,000 available memory units.

With the exception of a few of the data manipulation routines written on CDC Compass Assembly language all programming is in Fortran IV.

The program is structured to allow any sector or sub-set of sectors in the model to be simulated independently. This would require virtually no alteration the present program beyond certain control statements.

Figure A.1 presents the actual computational sequence of the Recife Systems Model solution. The solid line gives the actual sequence of the computer simulation program and the dotted line shows other information transfers between sectors in the model.

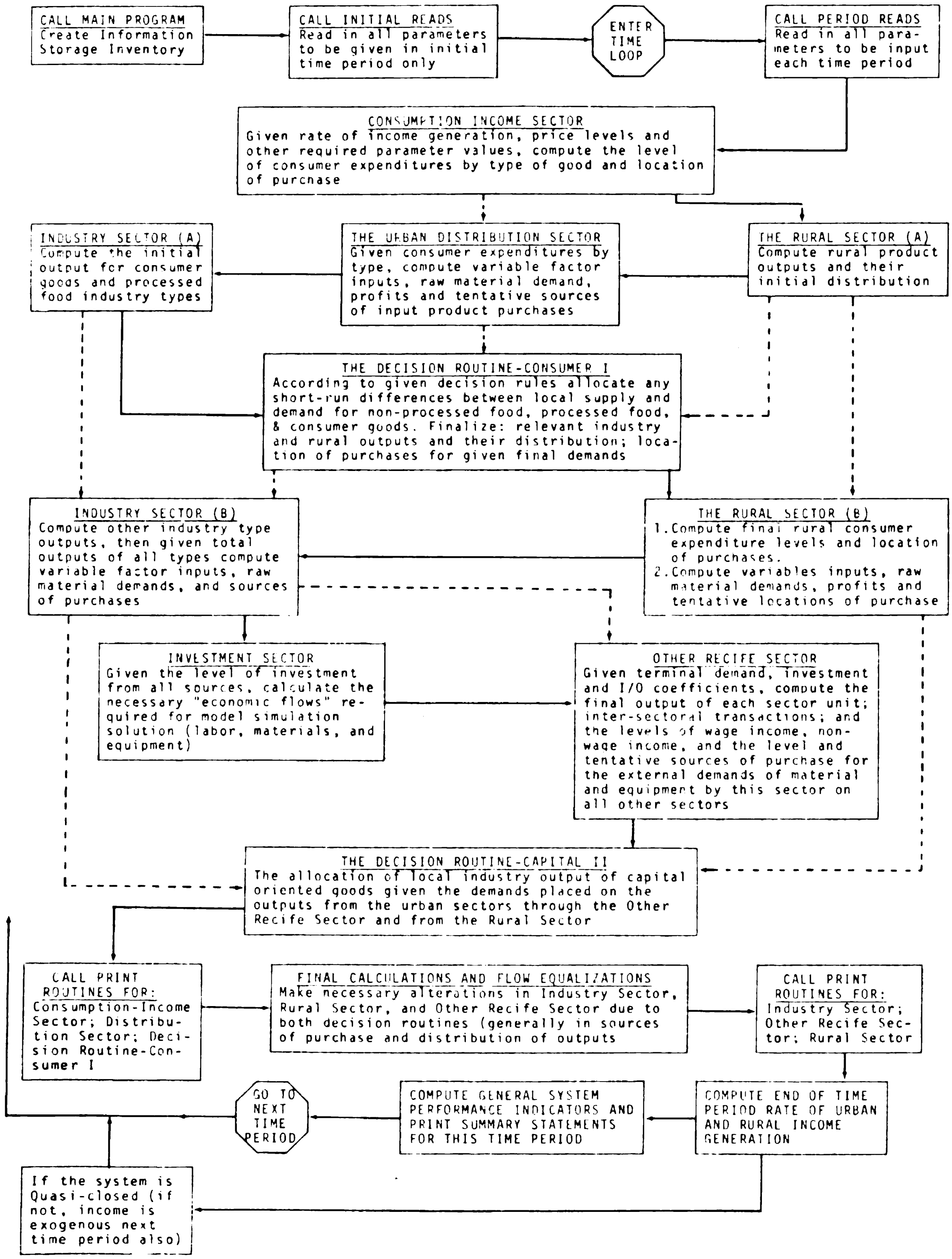

FIGURE A.1 Simplified Computational Sequence for the Recife Systems Model

The Internal Structure of the Model: Equations in Verbal Form

The equations which follow outline in verbal form the character of the internal structural relationships and of the Consumer I and Capital II Planner Entry Routines for the Recife Systems Model. The definitive statement of the entire model is contained in the computer program and associated workbook. The program is not included in this appendix because it was developed for and is compatible only with the Control Data 3600 system and because of its length (100 pages alone, with reference tables 300 pages).

By presenting the mathematics of the model in verbal form, the major emphasis is placed on explaining the assumed internal structural relationships. Therefore, there is no attempt to justify matrix order for proper mathematical manipulation. The abstraction from the program and the flexibility permitted in carrying out mathematical operations (such as the "Move" routine defined earlier) makes matrix justification impossible. Presenting the mathematical structure formally would be exceedingly long and complex, and the structural assumptions would not be as clearly stated as they are in the verbal format used.

Initially the chart of the general model is repeated to present the framework in which to view the relationships and identities presented verbally (Figure A.2).

Because the emphasis in this section is on presenting the economic assumptions as clearly as possible, the verbal equations are cross referenced with the discussion on parameter definitions, values, and sources presented later. All equations are numbered to the right side of the page and these numbers are used in identifying the location of the equation when discussing the parameter inputs. In Appendix B all parameter input definitions are listed and numbered. Where applicable these numbers have been placed at the top of the appropriate verbal matrices in the following equations.

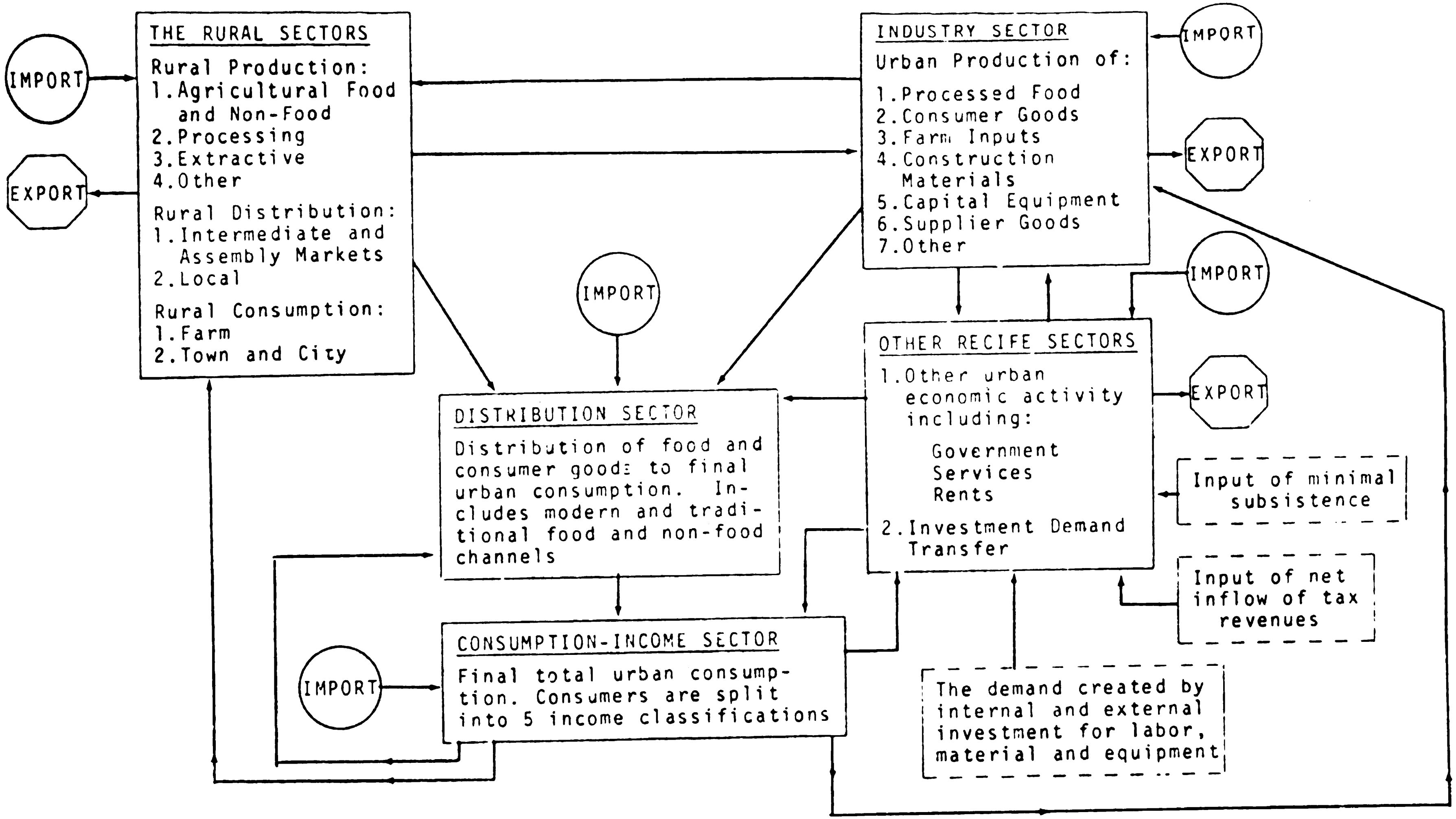

FIGURE A.2 The Recife Systems Model: The General Structure and Inter-Sector Flows

The Consumption-Income Sector

The following equations represent the structure of a typical consumer type. The structure is identical for each of the five consumer classifications from very high income to very low income. The differences lie in the value of initial income and the input values of the basic parameters such as average propensity to consume and the average propensity to shop by type of outlet in the Distribution Sector. Figure A.3 portraying the flow of computations preceeds the equations and shows that after disposable income is determined incremental real income from shifting buying habits and then sequentially incremental real income from lower prices within outlets is calculated. The result gives the final value of consumer expenditures. After computations are done for each consumer class, the final expenditures are summated across all consumer types to give the total value of expenditures by the Consumption-Income Sector by product category and location of purchase.

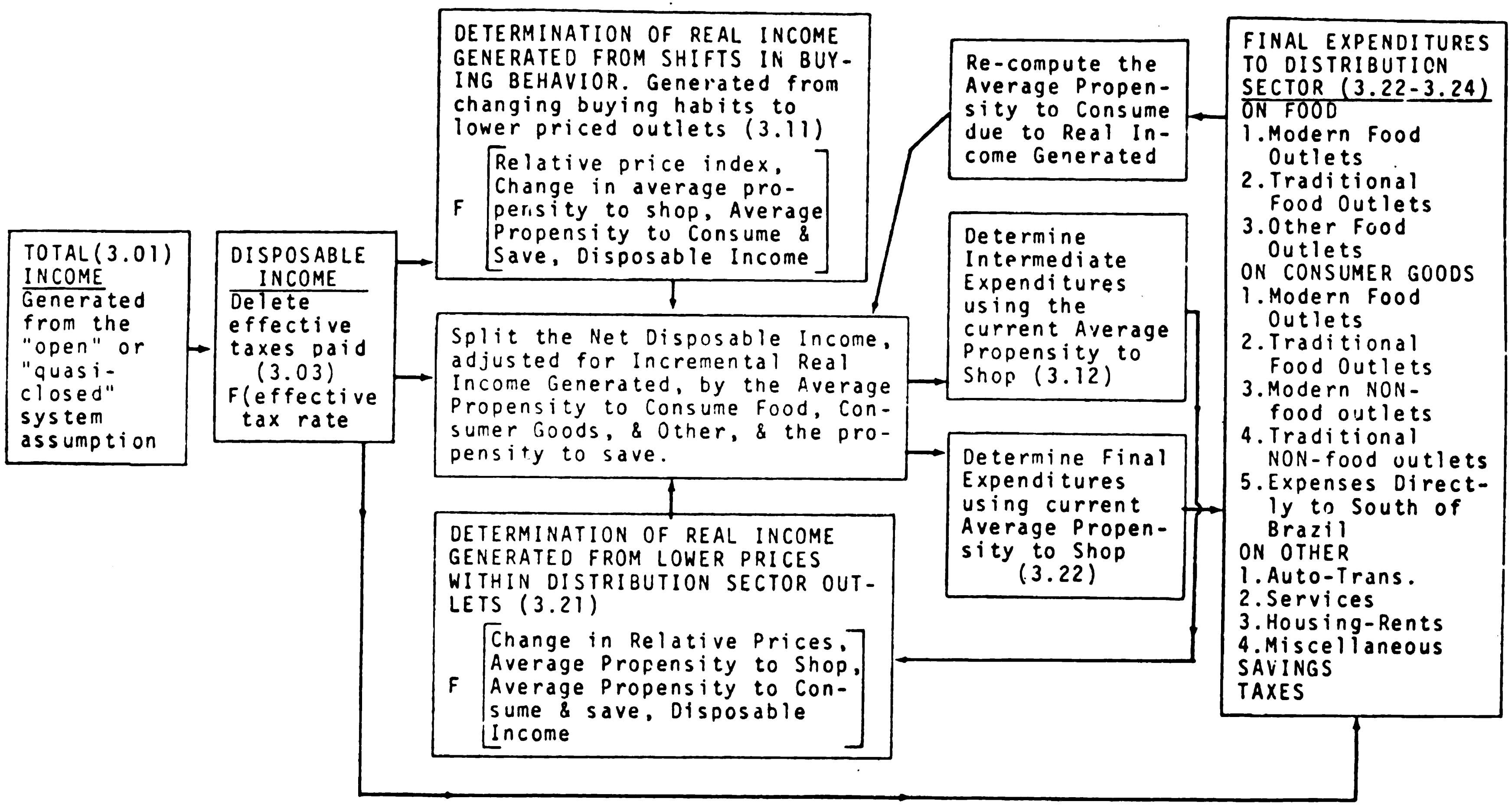

FIGURE A.3 The Consumption-Income Sector: The Flow of Computations for One Typical Consumer Classification

Determination of Consumer Income

Total Consumer Income of J^{th} consumer type given open system	=	F	(1) [The rate at which total income is generated at beginning of time (t) is a known exogenous time variant input]	3.01
Total Consumer Income of J^{th} consumer type given a quasi-closed system (t)	=	F	(2) [The rate at which total income is generated at beginning of time (t) is composed of contributions from all sectors in wages, distributed profits, transfers, and other income. Thus: $I_j(t) = \sum_{i=1}^{n} (P_i) \cdot I_i(t-1)$ n = number of income sources P_i = proportion of income source (i) allocated to this consumer type $I_i(t-1)$ = rate of income generated by i^{th} source at end of last time period (t-1)]	3.02
Disposable Consumer Income (t)	=		$\left[1 - \right.$ (2) The effective tax rate on total income$\left.\right]$ x Total consumer Income (less transfers)	3.03

Intermediate Determination of Expenditures for the j^{th} Consumer Type

The Value of Incremental Real Income generated from changes in shopping behavior in outlets of the distribution sector. (t)	=	The relative price difference between retail outlets. $1 - \frac{\text{Price in Modern}}{\text{Price in Trad.}}$ Calculated at beginning time period prices	x	The change in shopping behavior from (t-1) to (t).	x	APC* for food and consumer goods (t)	x	Disposable Income (t)	3.11

The intermediate value of expenditures for food and consumer goods that are purchased in the distribution sector by type of retail outlet.	=	(4) APS** for food and consumer goods for each retail outlet in the distribution sector.	x	(3) APC for food, consumer goods	x	{ The SUM of incremental real income generated in modern retail outlets (Vector Σ 3.11)***	
	+	Disposable Income (t) }	-	The value of incremental real income by retail outlet (equation 3.11)			3.12

* APC = average propensity to consume (program equations permit separation of APC into marginal propensity and average propensity components)

** APS = average propensity to shop

*** Vector sum of equation 3.11

The intermediate value of expenditures for the "other expenditure" category = (5) The prop. breakdown of "other expend." into: Auto-Trans., Services, Home-Rent, Misc. x (3) APC to consume for the "other expend." category x {The SUM of incremental real income generated in modern retail outlets (vector Σ 3.11) + Disposable Income (t)} 3.13

The intermediate value of savings = (3) The average propensity to save (t) x {The SUM of incremental real income generated in modern retail outlets from changing shopping behavior + Disposable Income (t)} 3.14

The intermediate value of expenditures directly going south (direct import) = (6) The proportion of consumer goods expenditures going directly south x (3) APC for consumer goods x {The SUM of incremental real income generated in modern retail outlets (vector Σ 3.11)

+ Disposable Income (t)} 3.15

The Final Determination of Expenditures for the j^{th} Consumer Type

The Value of Incremental Real Income generated from changes in relative prices within retail outlets of the distribution sector by outlet type. (t)	=	The changes in relative prices within each retail outlet from time (t-1) to time (t). Each entry is: $1 - \frac{\text{Price in outlet (t)}}{\text{Price in outlet (t-1)}}$	x	The intermediate value of expenditures for food and consumer goods purchased in the distribution sector by type of retail outlet (equation 3.12)		3.21
The final value of expenditures for food and consumer goods purchased in the distribution sector by type of retail outlet. (t)	=	The intermediate value of expenditures for food and consumer goods (equation 3.12)	+	{ (4) APS for food and consumer goods by retail outlet x (3) APC for food and consumer goods		
	x	{ The SUM of incremental real income generated from change in prices within retail outlets (vector Σ 3.21)	-	The value of incremental real income generated from changing prices within retail outlets by outlet type (equation 3.21) }		3.22

The <u>final</u> value of expenditures for the "other expenditure" category. (t)	=	The intermediate value of expenditures for the "other expend." category (equation 3.13)	+	{ (5) The prop. breakdown of "other expend.": Auto-trans. Services Rent Misc.	x	(3) APC for "other" category	x	The SUM of incremental real income generated from changes in prices within retail outlets (vector Σ 3.21) }

3.23

The <u>final</u> value of savings. (t)	=	The intermediate value of savings (equation 3.14)	+	{ (3) Average propensity to save	x	The SUM of incremental real income generated from changes in prices within retail outlets (vector Σ 3.21) }

3.24

The <u>final</u> value of expenditures directly going south (direct import)	=	The intermediate value of expenditures going directly south (equation 3.15	+	{ (6) The proportion of consumer goods expenditures going directly south	x	APC for consumer goods
	x	The SUM of incremental real income generated from changes in prices within retail outlets (vector Σ 3.21) }				

3.25

Recomputation of Average Propensity to Consume and Save

Average propensity to consume in the following categories: Food Consumer Goods Other and the average propensity to save are recomputed for use in (t+1)	=	Final expenditures in each of the categories from vector summation of equations 3.22, 3.23, 3.24 and 3.25, respectively	$\div$	Total consumer income for the j^{th} consumer type	3.31

Printout Examples

Table A.1, A.2, and A.3 are examples of the type of detailed economic information generated in the Consumption-Income Sector. The first table shows the breakdown of total income and expenditures for all consumer classifications, the proportion which each consumer class is of a given income or expenditure line, and absolute and proportional changes in income and expenditures from last time period.

Table A.2 presents expenditures as proportions of total income and disposable income plus absolute and proportional changes from last time period. A.3 shows the breakdown and sources of incremental real income by consumer classification and for the sector as a whole. Incremental real income is calculated as a proportion of each income class's total income and how it has changed from last time period.

TABLE A.1 Printout Illustration: The Gross Breakdown of Income and Expenditures as a Proportion of Total Income

TIME PERIOD 4

CONSUMER TYPES BY INCOME CLASSIFICATION

THE GROSS BREAKDOWN OF INCOME AND EXPENDITURES FOR CONSUMPTION SECTOR	VERY HIGH (MILLIONS OF DOLLARS)	HIGH	MIDDLE	LOW	VERY LOW	TOTAL	V. HIGH (PROPORTION OF DOLLARS)	HIGH	MIDDLE	LOW	V. LOW	TOT
TOTAL CONSUMER INCOME	45.00	42.00	189.00	98.00	18.20	392.20	0.115	0.107	0.482	0.250	0.046	1.00
TOTAL TAXES PAID	0.90	2.52	15.12	5.88	0.18	24.60	0.037	0.102	0.615	0.239	0.007	1.00
TOTAL DISPOSABLE INCOME	44.10	39.48	173.88	92.12	18.02	367.60	0.120	0.107	0.473	0.251	0.049	1.00
FOOD EXPENDITURES	3.92	5.76	63.16	54.41	16.00	143.24	0.027	0.040	0.441	0.380	0.112	1.00
CONSUMER GOODS EXPEND.	16.34	13.85	43.78	18.62	0.92	93.50	0.175	0.148	0.468	0.199	0.010	1.00
TOTAL OTHER EXPENDITURES	17.21	15.91	58.16	19.09	1.11	111.48	0.154	0.143	0.522	0.171	0.010	1.00
TOTAL CONSUMER SAVINGS	6.64	3.97	8.79	0.00	0.00	19.39	0.342	0.205	0.453	0.000	0.000	1.00

CHANGES IN GROSS INCOME AND EXPENDITURES	VERY HIGH (ABSOLUTE CHANGES IN $)	HIGH	MIDDLE	LOW	VERY LOW	AVERAGE	V. HIGH (PROPORTIONAL CHANGES)	HIGH	MIDDLE	LOW	V. LOW	AVE.
TOTAL CONSUMER INCOME	3.00	3.00	10.00	6.00	1.30	23.00	0.071	0.077	0.056	0.065	0.058	0.06
TOTAL DISPOSABLE INCOME	2.94	2.82	9.20	5.64	0.99	21.59	0.071	0.077	0.056	0.065	0.058	0.06
TOTAL TAXES PAID	0.06	0.18	0.80	0.36	0.01	1.41	0.071	0.077	0.056	0.065	0.058	0.06
FOOD EXPENDITURES	0.23	0.37	3.33	3.18	0.97	7.68	0.063	0.069	0.050	0.062	0.057	0.06
CONSUMER GOODS EXPEND.	1.09	1.00	2.41	1.20	0.05	5.76	0.072	0.078	0.058	0.069	0.064	0.07
TOTAL OTHER EXPENDITURES	1.16	1.16	3.26	1.26	0.07	6.92	0.073	0.079	0.059	0.071	0.066	0.07
TOTAL CONSUMER SAVINGS	0.45	0.29	0.49	0.00	0.00	1.23	0.073	0.079	0.059	0.000	0.000	0.07

TABLE A.2 Printout Illustration: Disposable Income, Taxes, and Expenditures as a Proportion of Total Consumer Income

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TABLE NUMBER TIME PERIOD 4

CONSUMER TYPES BY INCOME CLASSIFICATION

DIS. INCOME, TAXES AND EXPENDITURES AS A PROPORTION OF TOTAL INCOME (AS A PROPORTION OF INC)	VERY HIGH	HIGH	MIDDLE	LOW	VERY LOW	AVERAGE
TOTAL DISPOSABLE INCOME	0.980	0.940	0.920	0.940	0.990	0.937
TOTAL TAXES PAID	0.020	0.060	0.080	0.060	0.010	0.063
FOOD EXPENDITURES	0.087	0.137	0.334	0.555	0.879	0.365
CONSUMER GOODS EXPEND.	0.363	0.330	0.232	0.190	0.050	0.238
TOTAL OTHER EXPENDITURES	0.382	0.379	0.308	0.195	0.061	0.284
TOTAL CONSUMER SAVINGS	0.147	0.094	0.046	0.000	0.000	0.049

CHANGES FROM LAST TIME IN PARAMETER VALUES	(ABSOLUTE CHANGES) VERY HIGH	HIGH	MIDDLE	LOW	VERY LOW	AVERAGE	(PROPORTIONAL CHANGES) VERY HIGH	HIGH	MIDDLE	LOW	VERY LOW	AVERAGE
TOTAL DISPOSABLE INCOME	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TOTAL TAXES PAID	0.000	-0.000	0.000	-0.000	0.000	-0.000	0.000	-0.000	0.000	-0.000	0.000	-0.001
FOOD EXPENDITURES	-0.001	-0.001	-0.002	-0.002	-0.001	-0.002	-0.008	-0.007	-0.005	-0.003	-0.001	-0.005
CONSUMER GOODS EXPEND.	0.000	0.000	0.001	0.001	0.000	0.001	0.000	0.001	0.002	0.003	0.005	0.003
TOTAL OTHER EXPENDITURES	0.000	0.001	0.001	0.001	0.000	0.001	0.001	0.002	0.003	0.005	0.008	0.004
TOTAL CONSUMER SAVINGS	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.002	0.003	0.000	0.000	0.005

EXPENDITURES AS PROPORTION OF DISPOSABLE INCOM (AS PROP. OF DIS.INCOME)	VERY HIGH	HIGH	MIDDLE	LOW	VERY LOW	AVERAGE
FOOD EXPENDITURES	0.089	0.146	0.363	0.591	0.888	0.390
CONSUMER GOODS EXPEND.	0.370	0.351	0.252	0.202	0.051	0.254
TOTAL OTHER EXPENDITURES	0.390	0.403	0.334	0.207	0.061	0.303
TOTAL CONSUMER SAVINGS	0.150	0.100	0.051	0.000	0.000	0.053

CHANGES FROM LAST TIME IN PARAMETER VALUES	(ABSOLUTE CHANGES) VERY HIGH	HIGH	MIDDLE	LOW	VERY LOW	AVERAGE	(PROPORTIONAL CHANGES) VERY HIGH	HIGH	MIDDLE	LOW	VERY LOW	AVERAGE
FOOD EXPENDITURES	-0.001	-0.001	-0.002	-0.002	-0.001	-0.002	-0.000	-0.000	-0.000	-0.000	-0.000	-0.005
CONSUMER GOODS EXPEND.	0.000	0.000	0.001	0.001	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.003
TOTAL OTHER EXPENDITURES	0.000	0.001	0.001	0.001	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.004
TOTAL CONSUMER SAVINGS	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.005

RECIFE SYSTEM SIMULATION MODEL

TABLE A.3 Printout Illustration: Real Income Generated from Shifts in Buying Behavior and Price Changes

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TIME PERIOD 4

REAL INCOME GENERATED FROM SHIFTS IN BUYING HABITS AND PRICE CHANGE	CONSUMER TYPES BY INCOME CLASSIFICATION (IN MILLIONS OF DOLLARS) VERY HIGH	HIGH	MIDDLE	LOW	VERY LOW	TOTAL	(PROPORTION OF DOLLARS) V. HIGH	HIGH	MIDDLE	LOW	V. LOW	TOT
FOR FOOD--FOOD OUTLETS	0.03	0.05	0.54	0.44	0.13	1.21	0.029	0.041	0.450	0.368	0.111	1.00
FOR C.GOODS-FOOD OUTLETS	0.01	0.01	0.05	0.03	0.00	0.11	0.101	0.113	0.454	0.312	0.020	2.00
FOR C. GOODS-MER. OUTLET	0.00	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.000	0.000	0.000	2.00
TOT. REAL INCOME DERIVED	0.05	0.06	0.59	0.48	0.14	1.32	0.035	0.047	0.451	0.363	0.104	1.00
TOTAL REAL INCOME GENERATED AS A PROPORTION OF												
TOTAL INCOME							0.001	0.001	0.003	0.005	0.007	0.00
TOTAL DISPOSABLE INCOME							0.001	0.002	0.003	0.005	0.008	0.00

CHG IN REAL INCOME GENERATED FROM LAST TIME P.	(ABSOLUTE CHANGE IN $) VERY HIGH	HIGH	MIDDLE	LOW	VERY LOW	AVERAGE	(PROPORTIONAL CHANGE) V. HIGH	HIGH	MIDDLE	LOW	V. LOW	AVE.
FOR FOOD--FOOD OUTLETS	0.00	0.00	0.01	0.02	0.01	0.04	0.035	0.045	0.028	0.043	0.039	0.04
FOR C.GOODS-FOOD OUTLETS	0.00	0.00	0.00	0.00	0.00	0.01	0.077	0.083	0.063	0.073	0.067	0.07
FOR C. GOODS-MER. OUTLET	0.00	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.00
TOT. REAL INCOME DERIVED	0.00	0.00	0.02	0.02	0.01	0.05	0.045	0.052	0.031	0.045	0.039	0.04

PRICE INDEXES FOR EACH TYPE OF OUTLET	(RELATIVE PRICE INDEXES) MOD FOOD	TRAD F	OTHER F	MOD CG	TRAD CG	MOD FOOD	TRAD F	OTHER F	MOD CG	TRAD CG
FOR FOOD PRODUCTS	0.911	0.985	1.000							
FOR CONSUMER GOODS	0.931	0.991	0.000	0.930	1.000					

CHANGES IN PRICE INDEXES FROM LAST TIME PERIOD	(ABSOLUTE PRICE CHANGE) MOD FOOD	TRAD F	OTHER F	MOD CG	TRAD CG	(PROPORTIONAL CHANGE) MOD FOOD	TRAD F	OTHER F	MOD CG	TRAD CG
FOR FOOD PRODUCTS	-0.003	-0.005	0.000	0.000	0.000	-0.003	-0.005	0.000		
FOR CONSUMER GOODS	-0.003	-0.003	0.000	0.000	0.000	-0.003	-0.003	0.000	0.000	0.000

RECIFE SYSTEM SIMULATION MODEL

The Distribution Sector

The Distribution Sector is composed of six separate components; modern food distribution channel, traditional street and public markets, traditional neighborhood stores, other food channel, modern non-food merchandising channel, traditional non-food merchandising channel. Through the first three food channels consumer non-durable goods flow. Thus, there are nine distinct classifications or "product-channels". Figure A.4 illustrates the flow of computations followed by the verbal equations applicable to each of the nine product-channel types. The verbal equations for one of the nine product-channels are presented. Differences between channels lie in the nature of the product mix and the particular values input for such parameters as labor technical coefficients, gross margin, and spoilage. Other more complex differences can be developed by utilizing PERs (planner entry routines).

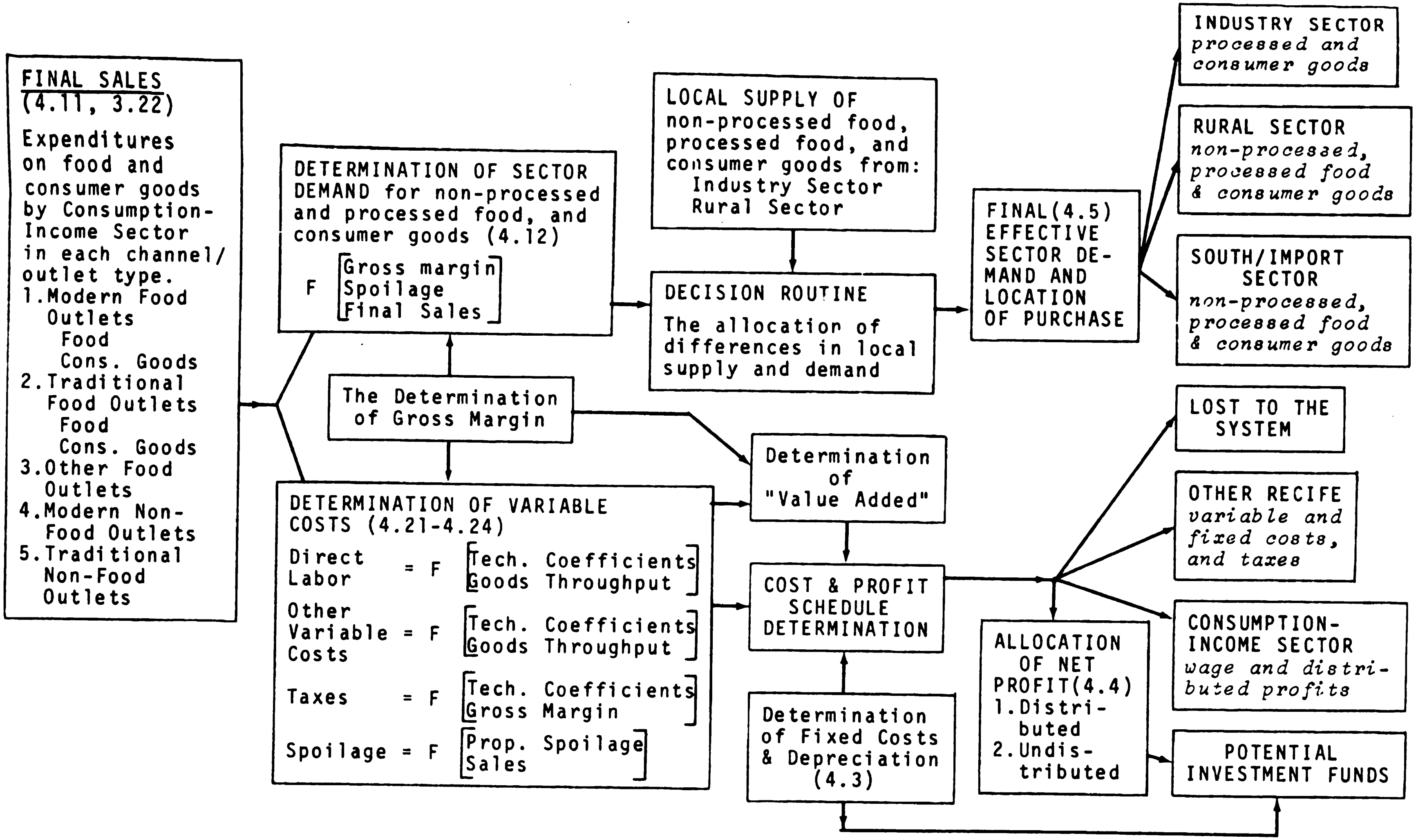

FIGURE A.4 The Distribution Sector: The Flow of Computations for a Typical Distribution Channel-Outlet Component

Determination of Final Sales for k^{th} Channel-Outlet Component

$$\text{The value of final sales for } k^{th} \text{ product channel in time (t).} = F\left[\text{The summation of final consumer demand for this product in this channel over the five types of consumers defined in the Consumption-Income Sector (see equation 3.22)}\right] \qquad 4.11$$

Determination of Cost of Goods, Spoilage, and Gross Margin

$$\overset{(8)}{\text{Gross margin as a proportion of final sales}} = \left[1 + \text{The rate of spoilage as a proportion of final sales}\right] \times \text{Mark-up per unit as a proportion of final sales} - \overset{(9)}{\text{The rate of spoilage as a proportion of final sales}} \qquad 4.21$$

OR

$$\text{Mark-up per unit as a proportion of final sales} = \left\{\overset{(8)}{\text{Gross margin as proportion of final sales}} + \text{The rate of spoilage as a proportion of final sales}\right\} \div \left[1 + \text{The rate of spoilage as a proportion of final sales}\right] \qquad 4.22$$

$$\text{The relative cost per input unit of this product into this channel} = \left[1 - \text{Gross margin as proportion of final sales}\right] \div \left[1 + \text{The rate of spoilage as a proportion of final sales}\right] \times \text{Relative final price per unit index} \qquad 4.23$$

$$\text{The value of spoilage as final sale prices} = \text{The rate of spoilage as a proportion of final sales} \times \text{Final sales} \qquad 4.24$$

$$\text{The value of gross margin} = \text{Gross margin as a proportion of final sales} \times \text{Final sales} \qquad 4.25$$

$$\text{The value of goods throughput (sales plus spoilage) as final sale prices} = \left[1 + \text{The rate of spoilage as a proportion of final sales} \right] \times \text{Final sales} \qquad 4.26$$

$$\text{Cost of goods--the value of goods throughput as input prices} = \text{Final sales} - \text{The value of gross margin} \qquad 4.27$$

The Value of Variable and Fixed Inputs and Depreciation

$$\text{The value of direct labor wages generated} = \overset{(10)}{\text{The technical coefficient for this product-channel on labor input per unit of "goods throughput"}} \times \text{The value of "goods throughput" (equation 4.26)} \qquad 4.31$$

The value of other variable costs = (11) The technical coefficient for this product-channel on other variable costs per unit "goods throughput" x The value of goods throughput (equation 4.26) 4.32

Total variable costs = Cost of goods + Value of direct labor wages + Value of other variable costs 4.33

The value of fixed costs = F [(13) Exogenously given to this product-channel each time period or developed in a PER where it could be made a function of such variables as number of units or capacity] 4.34

The value of depreciation = F [(15) Exogenously given each time period or developed in a PER where it could be a function of such variables as capacity, asset value and/or net investment] 4.35

The value of taxes paid = (12) The proportion which taxes are of gross margin x The value of gross margin 4.36

Determination of Value Added, Net Profits, and Profit Distribution

The value added by this product-channel = Final sales - Cost of goods - Other variable costs - Fixed costs 4.41

The value of net profit after taxes = Value added - Value of direct labor wages - Value of depreciation - Value of taxes paid (4.42)

The value of distributed profits = The proportion of after-tax net profit distributed [14] x After-tax net profit (4.43)

The value of undistributed net profit = Net profits after taxes - Distributed profits (4.44)

Total consumer income generated by this product-channel = The value of direct labor wages paid + Distributed profits (4.45)

The value of total funds available internally for investment = Undistributed profits + Depreciation (4.46)

These calculations are carried out simultaneously for all nine product-channels. In order to determine total product input demand for the entire distribution sector, they are summed by the product types: non-processed food, processed food, and consumer goods.

$$
\begin{array}{l}
\underline{\text{Demand placed by the Distribution Sector (by sector source \& by product type)}} \\
\text{Input demand from:} \\
\underline{\text{Industry Sector}}\text{ for} \\
\quad\text{Processed Food} \\
\quad\text{Consumer Goods} \\
\underline{\text{Rural Sector}}\text{ for} \\
\quad\text{Non-processed} \\
\quad\text{Processed Food} \\
\quad\text{Consumer Goods} \\
\underline{\text{South/Import Sector}} \\
\text{for} \\
\quad\text{Non-processed} \\
\quad\text{Processed Food} \\
\quad\text{Consumer Goods}
\end{array}
= \sum_{n=1}^{9}
\overset{(16)}{\begin{bmatrix}
\text{The proportional} \\
\text{split of each} \\
\text{product-channel's} \\
\text{demand by potential} \\
\text{source of purchase:} \\
\quad\text{Industry Sector} \\
\quad\text{Rural Sector} \\
\quad\text{South-Import/} \\
\quad\quad\text{Export Sector}
\end{bmatrix}}
\times
\begin{array}{l}
\text{Each product-channel's demand} \\
\text{for: non-processed food, or} \\
\text{processed food, or consumer} \\
\text{goods}
\end{array}
\qquad 4.5
$$

With this tentative breakdown of the demand for basic product mixes by the distribution sector, the Decision Routine-Consumer I is employed to compare local supply and demand and allocate any differences which exist according to the set of decision rules employed in the routine.

Other inputs are used in the distribution sector for comparative purposes in print-out and statistical analyses, but are not directly used in the computational format. They may, however, be used in developing PERs. These include: dollar valuation of assets, number of employees in each channel, total area, the number of economic units. All this information is developed from the Nason Thesis, Tables 3.3, 3.4, 4.1, and 4.2.

Printout Examples

Tables A.4, A.5, and A.6 are examples of the detailed economic information generated in the Distribution Sector. The first summarizes the sales of each distribution type and the sources of consumer purchases by consumer type. The second is a cost and profit schedule for the sector, and the third summarizes the distribution of net profits and sources of investment funds internally generated.

TABLE A.4 Summary of Distribution Sector: Printout Illustration

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TIME PERIOD 4

SUMMARY OF DISTRIBUTION SECTOR-- ALL RESULTS REAL IN MILLIONS OF $	MODERN FOOD CHANNEL FOOD	MODERN FOOD CHANNEL C.GOODS	MODERN FOOD CHANNEL TOTAL	DISTRIBUTION CHANNELS: OPEN AND PUBLIC MARKET TRADITIONAL FOOD CHANNEL FOOD	OPEN AND PUBLIC MARKET TRADITIONAL FOOD CHANNEL C.GOODS	OPEN AND PUBLIC MARKET TRADITIONAL FOOD CHANNEL TOTAL	SMALL AND OTHER TRADITIONAL FOOD CHANNEL 2 FOOD	SMALL AND OTHER TRADITIONAL FOOD CHANNEL 2 C.GOODS	SMALL AND OTHER TRADITIONAL FOOD CHANNEL 2 TOTAL	CHANNEL OTHER FOOD	CHANNEL MODERN C.GOODS	CHANNEL TRAD. C.GOODS
SOURCES OF SALES BY TYPE OF CONSUMERS(LINE ITEMS)												
VERY HIGH INCOME												
FOOD	2.045			0.573			0.508			0.790		
CONSUMER GOODS		0.824			0.260			0.213			1.635	10.953
TOTAL			2.870			0.833			0.721	0.790	1.635	10.953
HIGH INCOME												
FOOD	2.546			1.332			1.181			0.697		
CONSUMER GOODS		0.837			0.676			0.553			1.109	9.960
TOTAL			3.383			2.008			1.735	0.697	1.109	9.960
MIDDLE INCOME												
FOOD	20.660			19.147			16.979			6.370		
CONSUMER GOODS		2.955			4.374			3.579			2.191	30.600
TOTAL			23.616			23.521			20.558	6.370	2.191	30.600
LOW INCOME												
FOOD	13.460			19.962			17.700			3.291		
CONSUMER GOODS		1.203			4.449			3.640			0.373	8.952
TOTAL			14.663			24.408			21.340	3.291	0.373	8.952
VERY LOW INCOME												
FOOD	2.350			6.805			6.035			0.807		
CONSUMER GOODS		0.013			0.349			0.282			0.000	0.275
TOTAL			2.364			7.152			6.317	0.807	0.000	0.275
TOTAL SECTOR SALES												
FOOD	41.063			47.814			42.403			11.955		
CONSUMER GOODS		5.832			10.104			8.267			5.308	60.840
TOTAL			46.895			57.920			50.670	11.955	5.308	60.840
RAW MATERIALS PURCHASED												
FOOD	33.220			33.471			31.802			7.173		
CONSUMER GOODS		4.024			6.264			5.456			3.291	34.070
TOTAL			37.244			39.734			37.258	7.173	3.291	34.070
T. GROSS MARGIN REALIZED												
FOOD	7.843			14.345			10.601			4.787		
CONSUMER GOODS		1.808			3.839			2.811			2.017	26.770
TOTAL			9.651			18.184			13.411	4.787	2.017	26.770
VALUE OF SPOILAGE/LOSS												
FOOD	0.780			9.563			4.240			1.793		
CONSUMER GOODS		0.058			0.404			0.248			0.053	1.825
TOTAL			0.839			9.967			4.488	1.793	0.053	1.825

RECIFE SYSTEM SIMULATION MODEL

TABLE A.5 Printout Illustration: Distribution Sector Cost and Profit Schedule

TIME PERIOD 4

DISTRIBUTION SECTOR COST AND PROFIT SCHEDULE (IN MILLION OF DOLLARS	MODERN FOOD CHANNEL FOOD	MODERN FOOD CHANNEL C.GOODS	MODERN FOOD CHANNEL TOTAL	DISTRIBUTION CHANNELS: OPEN AND PUBLIC MARKET TRADITIONAL FOOD CHANNEL FOOD	OPEN AND PUBLIC MARKET TRADITIONAL FOOD CHANNEL C.GOODS	OPEN AND PUBLIC MARKET TRADITIONAL FOOD CHANNEL TOTAL	SMALL AND OTHER TRADITIONAL FOOD CHANNEL 2 FOOD	SMALL AND OTHER TRADITIONAL FOOD CHANNEL 2 C.GOODS	SMALL AND OTHER TRADITIONAL FOOD CHANNEL 2 TOTAL	CHANNEL OTHER FOOD	CHANNEL MODERN C.GOODS	CHANNEL TRAD. C.GOODS
TOTAL SECTOR SALES												
FOOD	41.063			47.516			42.403			11.955		
CONSUMER GOODS		5.832			10.184			8.267			5.308	60.840
TOTAL			46.895			57.920			50.670	11.955	5.308	60.840
2-LESS:THE COST OF GOODS												
FOOD	33.220			33.471			31.802			7.173		
CONSUMER GOODS		4.024			6.244			5.456			3.291	34.070
TOTAL			37.244			39.734			37.258	7.173	3.291	34.070
RESULT (1-2) EQUALS:												
3-GROSS MARGIN(VALUE ADD												
FOOD	7.643			14.345			10.601			4.782		
CONSUMER GOODS		1.808			3.839			2.811			2.017	26.770
TOTAL			9.651			18.184			13.411	4.782	2.017	26.770
4-LESS:DIRECT LABOR COST												
FOOD	1.046			0.861			1.166			2.062		
CONSUMER GOODS		0.147			0.158			0.213			0.643	8.773
TOTAL			1.193			1.019			1.379	2.062	0.643	8.773
5-LESS:VARIABLE COST MIS												
FOOD	2.511			4.884			3.731			2.062		
CONSUMER GOODS		0.353			1.261			0.681			1.072	11.260
TOTAL			2.864			6.144			4.413	2.062	1.072	11.260
6-LESS:TAXES PAID												
FOOD	0.941			1.148			1.060			0.383		
CONSUMER GOODS		0.217			0.307			0.281			0.242	2.409
TOTAL			1.158			1.455			1.341	0.383	0.242	2.409
RESULT(4+5+6)EQUALS:												
7-TOTAL VARIABLE COSTS												
FOOD	4.498			6.894			5.958			4.507		
CONSUMER GOODS		0.718			1.726			1.175			1.958	22.462
TOTAL			5.216			10.620			7.133	4.507	1.958	22.462
8-TOTAL FIXED CHARGES												
FOOD	0.000			0.000			0.000			0.000		
CONSUMER GOODS		0.000			0.000			0.000			0.000	0.000
TOTAL			0.000			0.000			0.000	0.000	0.000	0.000
9-TOTAL DEPRECIATION												
FOOD	0.000			0.000			0.000			0.000		
CONSUMER GOODS		0.000			0.000			0.000			0.000	0.000
TOTAL			0.000			0.000			0.000	0.000	0.000	0.000
RESULT(3-7-8-9)EQUALS:												
10-TOTAL NEW PROFIT FOR												
FOOD	3.145			5.451			4.643			0.275		
CONSUMER GOODS		1.090			2.114			1.636			0.059	4.307
TOTAL			4.436			7.565			6.279	0.275	0.059	4.307

TABLE A.6 Printout Illustration: Cost and Profit Splits and Other Characteristics of the Distribution Sector

TIME PERIOD 4

COST AND PROFIT SCHEDULE OTHER ITEMS AND SPLITS (IN MILLIONS OF DOLLARS)	MODERN FOOD CHANNEL FOOD	MODERN FOOD CHANNEL C.GOODS	MODERN FOOD CHANNEL TOTAL	DISTRIBUTION CHANNELS OPEN AND PUBLIC MARKET TRADITIONAL FOOD CHANNEL FOOD	C.GOODS	TOTAL	SMALL AND OTHER TRADITIONAL FOOD CHANNEL 2 FOOD	C.GOODS	TOTAL	CHANNEL OTHER FOOD	CHANNEL MODERN C.GOODS	CHANNEL TRAD. C.GOODS
SPLIT OF NET PROFIT TO VARIOUS EXPENDITURES												
MANAGEMENT/OWNER INCOME	2.342	0.763	3.105	5.451	2.114	7.565	3.714	1.308	5.023	0.247	0.036	3.446
SAVINGS(BUSINESS)	0.502	0.164	0.665	0.000	0.000	0.000	0.511	0.180	0.691	0.016	0.012	0.775
INVESTMENT (DIRECT)	0.502	0.164	0.665	0.000	0.000	0.000	0.046	0.016	0.063	0.011	0.012	0.086
THE TOTAL WAGE BILL FROM EMPLOYEES AND OWNERS												
TOTAL WAGES PAID	3.388	0.911	4.298	6.312	2.271	8.583	4.881	1.521	6.402	2.310	0.679	12.219
THE TOTAL AVAILABLE FUNDS FOR INVESTMENT												
SAVE+INVEST+DEP.	1.004	0.327	1.331	0.000	0.000	0.000	0.557	0.196	0.753	0.027	0.024	0.861

TIME PERIOD 4

OTHER GENERAL SECTOR CHARACTERISTICS-NUMBERS IN(FOR S) REST(000,000)	MODERN FOOD CHANNEL FOOD	MODERN FOOD CHANNEL C.GOODS	MODERN FOOD CHANNEL TOTAL	DISTRIBUTION CHANNELS OPEN AND PUBLIC MARKET TRADITIONAL FOOD CHANNEL FOOD	C.GOODS	TOTAL	SMALL AND OTHER TRADITIONAL FOOD CHANNEL 2 FOOD	C.GOODS	TOTAL	CHANNEL OTHER FOOD	CHANNEL MODERN C.GOODS	CHANNEL TRAD. C.GOODS
TOTAL NUMBER OF EMPLOYES	0.300	0.100	0.400	8.800	2.400	11.200	3.000	1.200	4.200	5.000	0.300	20.000
TOTAL NUMBER OF UNITS	0.042	0.042	0.042	0.045	0.045	0.045	2.285	2.285	2.285	2.500	0.003	4.000
NUMBER OF FEIRANTES				5.560	1.500	7.060						
TOTAL AREA-SALES/STORAGE	8.400	3.150	11.550	31.500	6.750	38.250	30.270	20.000	50.270	42.500	2.250	700.000
TOTAL ASSET VALUE	1.200	0.800	2.000	0.630	0.230	0.860	7.000	4.500	11.500	15.000	0.750	110.000
TOTAL POTENTIAL CAPACITY	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

The Recife Industry Sector

The Recife Industry Sector is composed of seven industry components; processed food, consumer goods, agricultural inputs, construction materials, capital equipment, the supplier goods, and other. The assumptions and calculations are similar for all but the supplier goods industry type where output is a function of the level of interindustry demand which is generated in the sector. The Decision Routine-Consumer I is employed in determining the final output and the distribution of that output for the industry types of processed food and consumer goods relative to local demand. The Decision Routine-Capital II is used in the allocation of the output of agricultural inputs production, construction materials, capital equipment, and other industrial production. Once output is determined the internal calculations which follow are identical for all seven industry types. See Figure A.5 for an illustration of the flow of computations in the Industry Sector.

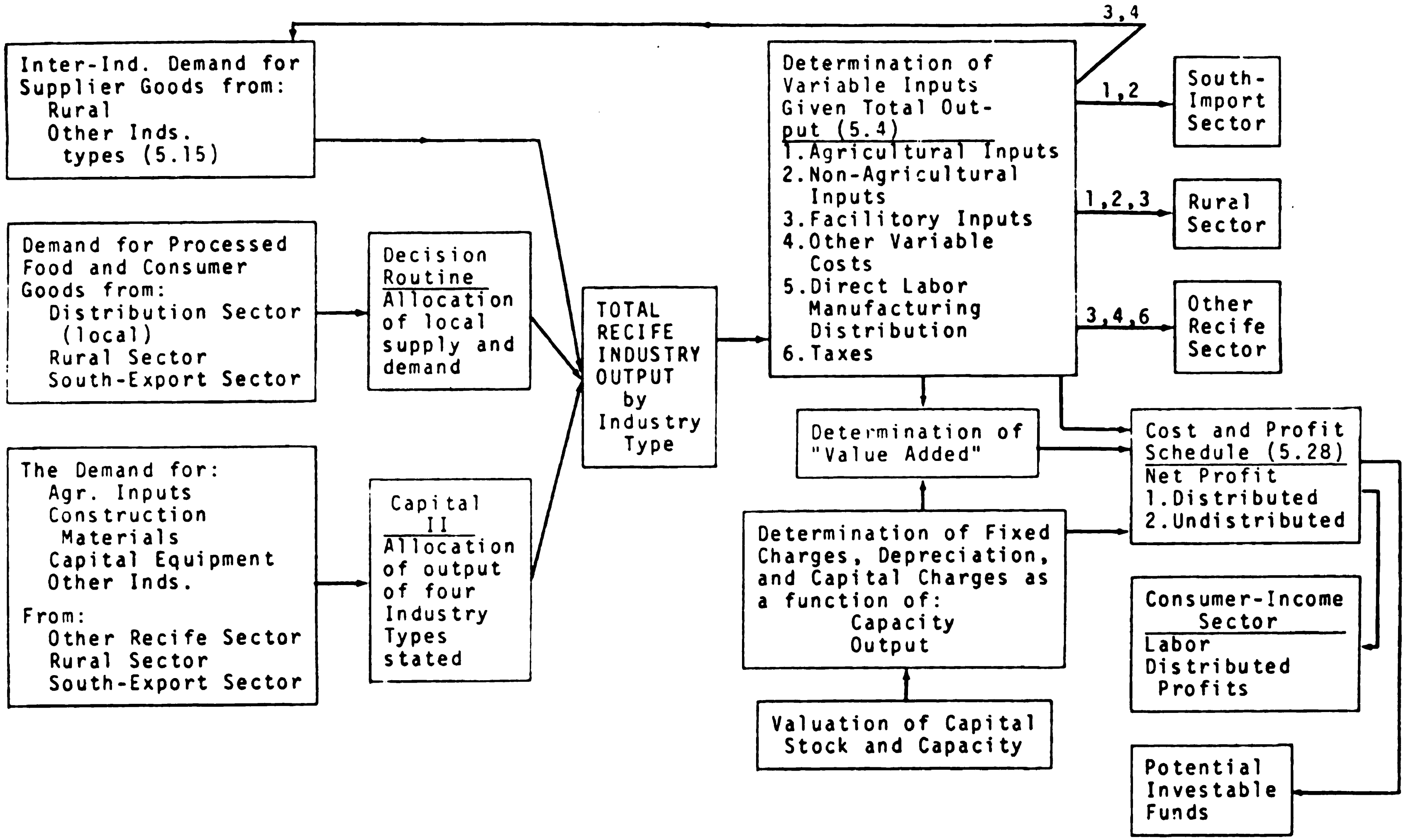

FIGURE A.5 The Industry Sector: The Flow of Computations

Initial Output Determination

The initial expected output of each industry type in time (t) except supplier goods	=	[1 + (19) The expected growth rate on the output of the industry type from time (t-1)]	x	(18) Output of the industry type last time period (t-1)		5.11
The output of the industry supplier goods type in time period (t)	=	The level of intermediate demand within the firms in the industry supplier goods type	+	Final demand placed on this supplier goods type from other industry types and the rural sector		5.12
The level of intermediate demand	=	The proportion of the output of the supplier type demanded by other supplier type firms	x	The output of the industry supplier goods type		5.13
Final demand placed on the supplier goods types from other industry and the rural sector	=	{ (21) The proportion of facilitory inputs used by other industry types which is demanded from the supplier goods type	x	(20) The technical coefficients on facilitory inputs for the other industry types		
	x	The output of each Industry type }	+	The demand placed on the supplier goods industry type from the rural sector		5.14

Output of the industry supplier goods type (equation 5.12)	=	Final demand placed on the supplier goods industry from the other industry types and the rural sector (eq. 5.14)	÷	[1 - The proportion of the output of the supplier goods type demanded by supplier goods type firms]	5.15

Determination of the Value of Inputs and Sources of Purchase

The total demand for inputs by a given industry type Agricultural Raw Materials Non-agricultural Raw Materials Facilitory Inputs Other Variable Costs Direct Labor Expenses in Manufacturing Direct Labor Expenses in Distribution Taxes Paid	=	(20) The respective technical coefficients on the value of an input per unit value of output	x	The output of an industry type	5.21
The source of purchase for each of the inputs by industry type by location of purchase The Other Recife Sector The Rural Sector The Supplier Goods Industry Type within the Industry Sector The South/Import Sector The Consumption-Income Sector	=	(21) The respective proportions of each input which comes from each potential source	x	The total demand for inputs by each given industry type Agricultural Raw Materials Non-agricultural Raw Materials Facilitory Inputs Other Variable Costs Direct Labor in Manufacturing Direct Labor in Distribution Taxes Paid	5.22

Determination of Value Added and Net Profits

The value added by each industry type = Final sales − Cost of goods (Agr. raw materials, Non-agr. raw materials) − Facilitory input costs and other variable costs − Fixed costs (5.31)

The value of after-tax net profits = Value added − Direct labor expenses in manufacturing and distribution − Depreciation − Taxes (5.32)

Distributed profits = Proportion of after-tax net profits distributed (23) x Net after-tax profits (5.33)

Undistributed profits = Net after-tax profits − Distributed profits (5.34)

Total consumer income generated by this industry type = Direct labor expenses in manufacturing and distribution + Distributed profits (5.35)

The value of funds generated internally by this industry type for potential investment = Undistributed profits + Depreciation (5.36)

Output Distribution and its Finalization

			(22)	
The distribution of total output for processed food and consumer goods between: Local Consumption Rural Consumption Exportation	=	F	[A tentative allocation of output is made between these three receivers which may be altered in the Decision Routine I conditioned by the choice of decision rules employed]	5.41
The distribution of total output for agricultural inputs, construction materials, capital equipment, and other between: Local Consumption Rural Consumption Exportation	=	F	[The output is allocated according to the predefined rules established in the Decision Routine II, which give priority to local, then rural, and finally export demands]	5.42

Printout Examples

Table A.7 presents the Industry Sector output by industry component and by location of sale. Table A.8 shows the cost and profit schedule for each industry component and the sector in total. The location of purchase of each raw material input by component is also included in this table. The last two tables, A.9 and A.10 presents an aggregated summary of factor inputs purchased by the sector and the location of purchase. Table A.10 points out how the purchases of inputs has shifted from last time period.

TABLE A.7 Printout Illustration: Industrial Sector Outputs and Receiver Sectors

TIME PERIOD 4

INDUSTRIAL SECTOR OUTPUTS AND RECEIVER SECTORS

EACH INDUSTRY'S OUTPUT AND SECTOR PURCHASES	RECIFE DISTRIBUTION	RURAL SECTOR	SOUTH-IMPORT SECTOR	OTHER RECIFE SECTOR	INTER-IND. SUPPLY IND.	CURRENT SUR-PLUS-DEFICIT	TOTAL IND. OUTPUTS	ACCUMULATED SUR.-DEF.
AGRICULTURAL IMPLEMENTS AND INPUTS INDUSTRY								
DOLLAR VALUE(X000000)	0.00	7.66	0.00	0.00	0.00	0.00	7.66	
PERCENTAGE OF TOTAL	0.00	100.00	0.00	0.00	0.00	0.00	100.00	
PERCENT CHANGE(LAST)	0.00	5.00	0.00	0.00	0.00	0.00	5.00	
FOOD PROCESSING INDUSTRY								
DOLLAR VALUE(X000000)	36.38	31.69	10.56	0.00	0.00	0.00	78.63	
PERCENTAGE OF TOTAL	46.24	40.39	13.43	0.00	0.00	0.00	100.00	
PERCENT CHANGE(LAST)	6.92	7.29	7.21	0.00	0.00	0.00	7.07	
NON-FOOD CONSUMER GOODS INDUSTRY								
DOLLAR VALUE(X000000)	22.15	41.95	40.53	0.00	0.00	0.00	104.64	
PERCENTAGE OF TOTAL	21.17	40.09	38.73	0.00	0.00	0.00	100.00	
PERCENT CHANGE(LAST)	7.33	8.38	8.34	0.00	0.00	0.00	8.16	
MISC. AND OTHER INDUSTRY								
DOLLAR VALUE(X000000)	0.00	4.08	0.00	8.08	0.00	0.00	12.16	
PERCENTAGE OF TOTAL	0.00	33.56	0.00	66.44	0.00	0.00	100.00	
PERCENT CHANGE(LAST)	0.00	2.50	0.00	6.31	0.00	0.00	5.00	
CONSTRUCTION MATERIALS PRODUCTION INDUSTRY								
DOLLAR VALUE(X000000)	0.00	4.80	6.77	37.06	0.00	0.00	48.62	
PERCENTAGE OF TOTAL	0.00	9.86	13.92	76.22	0.00	0.00	100.00	
PERCENT CHANGE(LAST)	0.00	4.69	-3.38	6.60	0.00	0.00	5.00	

TABLE A.7 (continued)

TIME PERIOD 4

INDUSTRIAL SECTOR OUTPUTS AND RECEIVER SECTORS

EACH INDUSTRY'S OUTPUT AND SECTOR PURCHASES	RECIFE DISTRIBUTION	RURAL SECTOR	SOUTH-IMPORT SECTOR	OTHER RECIFE SECTOR	INTER-IND. SUPPLY IND.	CURRENT SUR-PLUS-DEFICIT	TOTAL IND. OUTPUTS	ACCUMULATED SUR.-DEF.
CAPITAL EQUIPMENT INDUSTRY								
DOLLAR VALUE(000000)	0.00	0.00	0.00	18.23	0.00	0.00	18.23	
PERCENTAGE OF TOTAL	0.00	0.00	0.00	100.00	0.00	0.00	100.00	
PERCENT CHANGE(LAST)	0.00	0.00	0.00	5.00	0.00	0.00	5.00	
SUPPLIER GOODS INDUSTRY (ONLY INDUSTRIAL USES)								
DOLLAR VALUE(000000)	0.00	11.77	0.00	0.00	9.37	0.00	21.14	
PERCENTAGE OF TOTAL	0.00	55.66	0.00	0.00	44.34	0.00	100.00	
PERCENT CHANGE(LAST)	0.00	4.95	0.00	0.00	6.84	0.00	5.78	
GRAND TOTAL INDUSTRIAL OUTPUT OF SECTOR								
DOLLAR VALUE(000000)	58.53	101.95	47.94	63.34	9.37	0.00	291.08	
PERCENTAGE OF TOTAL	20.11	35.02	19.88	21.77	3.22	0.00	100.00	
PERCENT CHANGE(LAST)	7.38	6.93	6.69	6.14	6.84	0.00	6.74	

RECIFE SYSTEM SIMULATION MODEL

TABLE A.8 Printout Illustration, Cost and Profit Schedule for the Industry Sector

TIME PERIOD 4

C O S T A N D P R O F I T S C H E D U L E F O R I N D U S T R I A L S E C T O R

ACTUAL VALUE (IN MILLIONS OF US$)	AGRICULTURAL INPUTS IND.	PROCESSED FOOD IND.	CONSUMER GOODS IND.	OTHER INDUSTRY	CONSTRUCTION INDUSTRY	CAPITAL EQUIP. INDUSTRY	SUPPLIER INDUSTRY	TOTAL OVER INDUSTRIES
1-TOTAL INDUSTRY SALES	7.66	78.63	104.64	12.16	48.62	18.23	21.14	291.08
MATERIALS INPUT COST SPLITS								
2-AGRICULTURAL MATERIALS	0.00	28.31	25.11	3.65	4.86	0.00	0.63	62.56
FROM RURAL SECTOR	0.00	19.82	13.81	1.82	3.65	0.00	0.63	39.73
FROM SOUTH/I.SECTOR	0.00	8.49	11.30	1.82	1.22	0.00	0.00	22.83
3-NON AG. MATERIALS	3.68	1.57	9.42	3.65	24.31	10.94	8.03	61.59
FROM RURAL SECTOR	0.92	0.00	0.00	1.82	2.43	0.00	0.00	5.17
FROM SOUTH/I.SECTOR	2.76	1.57	9.42	1.82	21.88	10.94	8.03	56.42
4-PRIME FACILITORY INPUT	0.84	12.58	7.32	1.22	4.86	1.82	0.63	29.28
FROM LOCAL INDUSTRY	0.17	5.03	2.20	0.30	1.22	0.46	0.00	9.37
FROM OTHER RECIFE	0.17	1.26	1.83	0.30	1.22	0.46	0.25	5.49
FROM RURAL SECTOR	0.00	1.26	1.10	0.30	1.22	0.46	0.00	4.33
FROM SOUTH/I.SECTOR	0.51	5.03	2.20	0.30	1.22	0.46	0.38	10.09
5-OTHER VARIABLE COSTS	0.31	3.15	3.14	0.36	1.46	0.55	0.63	9.60
FROM OTHER RECIFE	0.25	1.57	1.57	0.18	0.73	0.27	0.51	5.08
FROM RURAL SECTOR	0.06	1.57	1.57	0.18	0.73	0.27	0.13	4.52
6-T.INPUT COSTS(2+3+4+5)	4.82	45.61	44.90	8.87	35.49	13.31	9.94	163.04
7-VALUE ADDED BY INDUSTRY GROUP (1-6)	2.83	33.03	59.64	3.28	13.13	4.92	11.20	128.04
8-DIRECT LABOR COSTS	0.69	6.29	10.44	1.34	5.35	2.01	2.11	28.25
MANUFACTURING	0.61	5.50	9.42	1.22	4.86	1.82	1.90	25.34
DISTRIBUTION	0.08	0.79	1.05	0.12	0.49	0.18	0.21	2.91
9-DIRECT TAXES PAID	1.15	11.79	15.70	1.82	7.29	2.73	3.17	43.66
10-NET PROFIT BEFORE DEPRECIATION CHARGE(7-8-9)	1.00	14.94	33.48	0.12	0.49	0.18	5.92	56.13
11-DEPRECIATION CHARGES	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12-NET PROFIT (10-11)	1.00	14.94	33.48	0.12	0.49	0.18	5.92	56.13
13-ALLOCATION OF THE NET PROFIT TO:								
MGT./OWNER INCOME	0.50	7.47	16.74	0.06	0.24	0.09	2.96	28.06
INVESTABLE FUNDS	0.25	3.74	8.37	0.03	0.12	0.05	1.48	14.03
SAVED-HOARDED-EXP.	0.25	3.74	8.37	0.03	0.12	0.05	1.48	14.03

TABLE A.9 Printout Illustration: Industrial Sector Inputs and Sources--Actual Value

TIME PERIOD 4

INDUSTRIAL SECTOR INPUTS AND SOURCES

ACTUAL VALUE (IN MILLIONS OF US$)	CONSUMPTION SECTOR	OTHER RECIFE SECTOR	RURAL SECTOR	SOUTH-IMPORT SECTOR	TOTAL OVER ALL SECTORS
AGRICULTURAL MATERIALS	0.00	0.00	39.73	22.83	62.56
NON-AGRICTURE MATERIAL	0.00	0.00	5.17	56.42	61.59
PRIME FACILITORY INPUTS	0.00	5.49	4.33	10.09	29.28
OTHER VARIABLE COSTS	0.00	5.08	4.52	0.00	9.60
LABOR DIRECT-MANUFACTURE	25.34	0.00	0.00	0.00	25.34
LABOR DIRECT-DISTRIBUTIN	2.91	0.00	0.00	0.00	2.91
MANAGER/OWNER INCOME	28.06	0.00	0.00	0.00	28.06
DIRECT TAX PAID	0.00	43.66	0.00	0.00	43.66
PURCHASES BY INDUSTRY FROM OTHER SECTOR-TOTALS	56.31	54.23	53.75	89.34	263.01

TABLE A.10 Printout Illustration: Industrial Sector Inputs and Sources--Percentage Change

TABLE NUMBER TIME PERIOD 4

INDUSTRIAL SECTOR INPUTS AND SOURCES

PERCENT CHANGE IN EACH LINE ITEM FROM LAST TIME	CONSUMPTION SECTOR	OTHER RECIFE SECTOR	RURAL SECTOR	SOUTH-IMPORT SECTOR	TOTAL OVER ALL SECTORS
AGRICULTURAL MATERIALS	0.00	0.00	7.13	7.32	7.20
NON-AGRICTURE MATERIAL	0.00	0.00	5.00	5.68	5.63
PRIME FACILITORY INPUTS	0.00	6.55	6.39	6.74	6.68
OTHER VARIABLE COSTS	0.00	6.68	6.83	0.00	6.75
LABOR DIRECT-MANUFACTURE	6.67	0.00	0.00	0.00	6.67
LABOR DIRECT-DISTRIBUTIN	6.74	0.00	0.00	0.00	6.74
MANAGER/OWNER INCOME	7.51	0.00	0.00	0.00	7.51
DIRECT TAX PAID	0.00	6.74	0.00	0.00	6.74
PURCHASES BY INDUSTRY FROM OTHER SECTOR-TOTALS	7.09	6.71	6.84	6.22	6.65

The Other Recife Sector

The Other Recife Sector comprises the remainder of the urban economic activity in Recife. It contains the eight defined economic units as listed in the chart which illustrates the flow of computations. The Sector has two major purposes. First, the roundingout of economic activity, value added, wages, and net profit distribution from other economic units and investment demand. Second, the transfer of investment demand to capital goods, construction, and wages. Simple calculations are included in this explanation of the sector in order to show more clearly the structure and assumptions inherent in this conglomerate sector. In the sector the mathematical technique of the input/output matrix inversion is employed to develop the level of interunit or intermediate demand generated within the eight economic units of this sector.

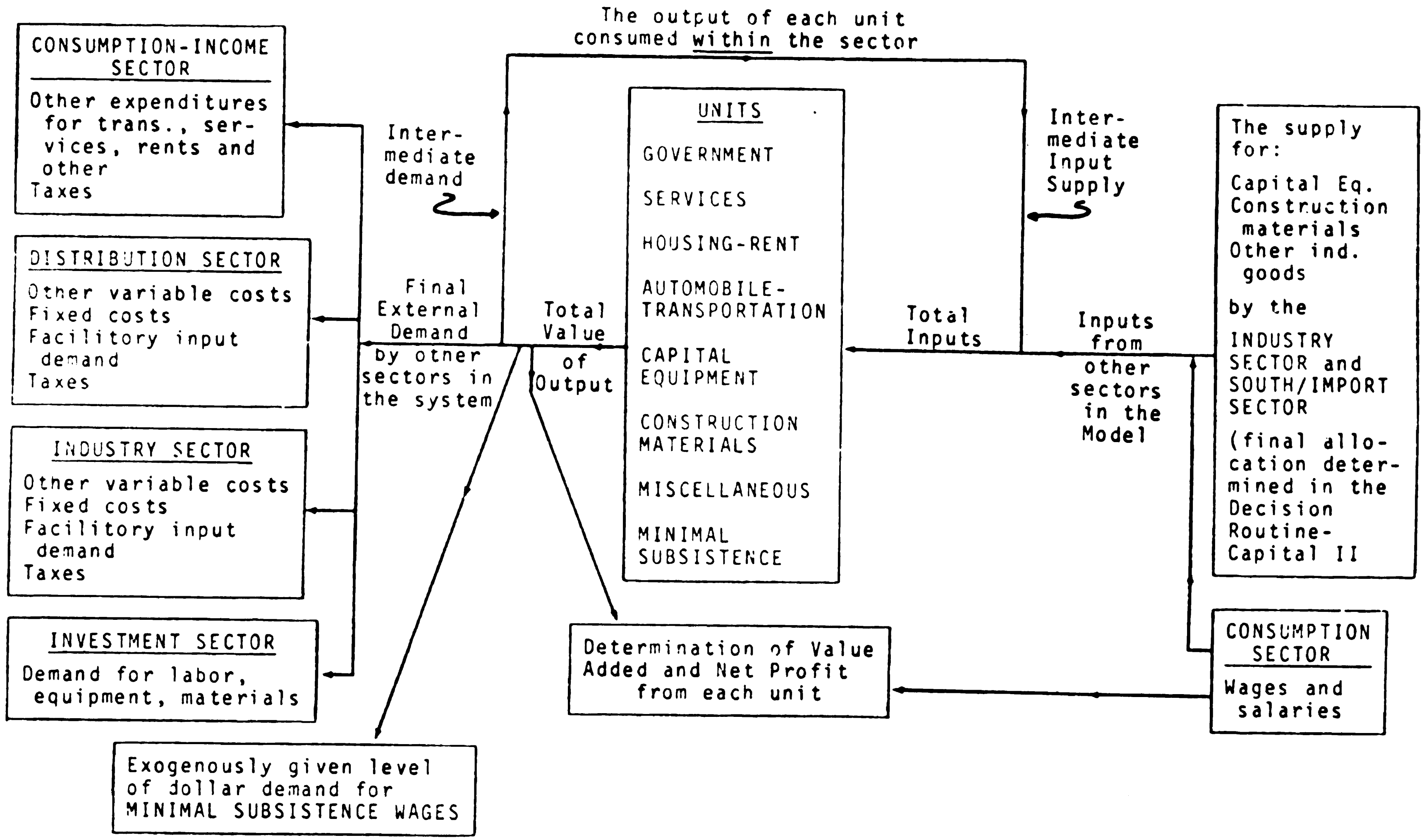

FIGURE A.6 The Other Recife Sector: The Flow of Computations

Determination of the Total Output of the Sector

Total output of the other Recife sector by the nine economic units (OUTPUT)	=	The intermediate demand created by transactions between the nine economic units in the sector (I.D.)	+	Final demand placed on the other Recife sector by other sectors in the economic system. (F.D.)	6.1
		(24)			
Final demand (F.D.) by other sectors on each of the nine units	=	The proportional allocation of terminal demand between each of the nine economic units. (C)	x	Terminal demand and transfers generated from other sectors in the economic system. (T.D.)	6.11
		(25)			
Intermediate demand (I.D.) from "inter-unit" transactions	=	The inter-unit transaction matrix, where each entry is the proportion of a given unit's output sold to each of the other units. (A)	x	Total output of each of the nine economic units in the sector. (OUTPUT)	6.12

Thus,

$$(\text{OUTPUT}) = (\text{I.D.}) + (\text{F.D.}) \qquad 6.1$$

$$(\text{OUTPUT}) = (\text{A}) \times (\text{OUTPUT}) + (\text{F.D.}) \qquad 6.13$$

Or,

$$(\text{OUTPUT}) = (\text{U} - \text{A})^{-1} \times (\text{C}) \times (\text{T.D.}) \qquad 6.2$$

Verbally,

Total output of the nine economic units in the other Recife sector (OUTPUT)	=	The inverse of the "unit matrix" less the "inter-unit" transaction matrix. $(U - A)^{-1}$	x	Proportional allocation of terminal demand. (C)	x	Terminal demand (T.D.)	6.2

The Determination of the Demand Placed by the Sector

Value added and external demand placed <u>by</u> the other Recife sector <u>on</u> the other sectors in the economic system (E.D.) 1. Value added (wages, net profit, depreciation) 2. Net profit after taxes (undistributed and distributed) 3. Wages generated 4. Construction materials demand transfer 5. Capital equipment demand transfer 6. Other industrial demand transfer	=	(26) The proportional allocation of value added (less taxes) between profits, wages, and depreciation and Allocation of direct investment demand transfer to wages, equipment, and material (B)	x	Total output by unit	6.3

Thus, final external demand is:

$$(E.D.) = (B) \times (U - A)^{-1} \times (C) \times (T.D.) \qquad 6.31$$

The columns in matrices (B) and (A) represent each economic unit in the other Recife sector. Each entry in a column of both matrices denotes a proportional allocation of the total output of the unit which that column represents. Thus, the sum of the column entries in (A) plus those in (B) must sum to unity, i.e., all output is allocated to inter-unit transactions, external demand, or value added. The final demand for construction materials, capital equipment, and other industrial products, generally investment oriented, go to the Decision Routine-Capital II. In that routine this total demand by the other Recife sector (representing the total demand of the urban economy for construction materials and equipment from investment) is compared to local supply from the Recife industrial sector. Excess supply is allocated to exports, excess demand to imports. (See the description of the Decision Routine-Capital II for full details.)

Printout Examples

Only one page of the economic information generated for the Other Recife Sector is presented here as an example. This table summarizes the location of purchase and the type of inputs demanded by the nine types within the sector from other sectors in the economy. The first entry is the value of the demand and the second is the proportion of total output which that demand for input represents.

TABLE A.11 Printout Illustration: Demand by the Other Recife Sector by Type and Location on the Other Sectors in the Economy

TIME PERIOD 4

ANALYSIS OF OTHER SECTORS IN THE RECIFE URBAN ECONOMY(NOT INCLUDED EXPLICITLY IN OTHER MODEL COMPONENTS)

SPLIT OF TERMINAL FINAL DEMANDS BY RECEIVER	AUTO-TRANSPORT	SERVICES	HOUSING-RENT	OTHER	CONSTRUCT TYPE 1	CONSTRUCT TYPE 2	CAPITAL EQUIPMENT	MINIMAL SUBSIST	GOVERNMENT REVENUES	GRAND TOTAL
AUTO-TRANS.(CONSUMER)	27.847	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	27.847
	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000
SERVICES (CONSUMER)	0.000	19.799	0.000	0.000	0.000	0.000	0.000	0.000	0.000	19.799
	0.000	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000
HOUSE-RENT (CONSUMERS)	0.000	0.000	51.948	0.000	0.000	0.000	0.000	0.000	0.000	51.948
	0.000	0.000	1.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000
OTHER GOODS (CONSUMERS)	0.000	0.000	0.000	11.882	0.000	0.000	0.000	0.000	0.000	11.882
	0.000	0.000	0.000	1.000	0.000	0.000	0.000	0.000	0.000	1.000
V. COSTS(DISTRIBUTION)	11.935	8.951	5.967	2.984	0.000	0.000	0.000	0.000	0.000	29.837
	0.400	0.300	0.200	0.100	0.000	0.000	0.000	0.000	0.000	1.000
F. COSTS(DISTRIBUTION)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000
VAR. COSTS(INDUSTRY)	1.016	1.016	2.032	1.016	0.000	0.000	0.000	0.000	0.000	5.080
	0.200	0.200	0.400	0.200	0.000	0.000	0.000	0.000	0.000	1.000
FIXED COSTS(INDUSTRY)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000
FAC. INPUTS(INDUSTRY)	2.743	2.195	0.549	0.000	0.000	0.000	0.000	0.000	0.000	5.487
	0.500	0.400	0.100	0.000	0.000	0.000	0.000	0.000	0.000	1.000
CONSTRUCTION-TYPE 1	0.000	0.000	0.000	0.000	36.400	0.000	0.000	0.000	0.000	36.400
	0.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000	0.000	1.000
CONSTRUCTION-TYPE 2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000	1.000
CAPITAL EQUIPMENT	0.000	0.000	0.000	0.000	0.000	0.000	28.400	0.000	0.000	28.400
	0.000	0.000	0.000	0.000	0.000	0.000	1.000	0.000	0.000	1.000
MINIMAL SUBSISTENCE	0.000	0.000	0.000	0.000	0.000	0.000	0.000	80.000	0.000	80.000
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000	0.000	1.000
TAXES (CONSUMER)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	24.602	24.602
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000	1.000
TAXES (DISTRIBUTION)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	6.988	6.988
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000	1.000
TAXES (INDUSTRY)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	43.661	43.661
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000	1.000
TAXES(RENTS AND N-W-I)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	10.390	10.390
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000	1.000
NET TAX REVENUE IN	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	65.000	65.000
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000	1.000
TOTAL TERMINAL FINAL DEMAND TO OTHER RECIFE	43.541	31.961	60.494	15.882	36.400	0.000	28.400	80.000	150.641	447.321

The Rural Sector

The Rural Sector is the largest sector in the model both from the standpoint of economic activity internal to the sector and from the quantity of mathematics necessary to construct its structural assumptions within the model. There are six well-defined components within the Rural Sector: aggregated rural production split into four major product classes; disaggregated rural production where up to five product groups may be defined separate from the more general output determination (for in depth analysis of traditional-modern transformation); rural farm input distribution; rural output distribution to local consumption, Recife, and export; rural farm and non-farm consumption; and other rural economic activity (services, government, etc.). The primary links with the other sectors in the model are with the Distribution Sector and Industry Sector of urban Recife. The Distribution Sector is linked to the Rural Sector through the Decision Routine-Consumer I which coordinates the demand placed on the Rural Sector for food by Recife Consumers and the supply which the Rural Sector can make available to Recife. The Industry Sector has many links with the Rural Sector: through the input factor market, industry supplies agricultural farm inputs, through output distribution industry demands agricultural food and non-food products from the Rural Sector, through the Decision Routine-Capital II which determines the availability of investment oriented goods from Recife relative to Rural Sector demand, and finally through the Decision Routine-Consumer I where industry is in competition with the Rural Sector in supplying urban demand for processed food and some consumer goods.

The verbal equations which follow are divided into four categories: Output determination, final consumption determination, input factor determination, and summary calculations. The summary calculations are necessary to balance supply and demand flows for the entire sector, its interaction with the rest of the system, and Import/Export. First, Figure A.7 shows the general flow of the sequential computations for the Rural Sector.

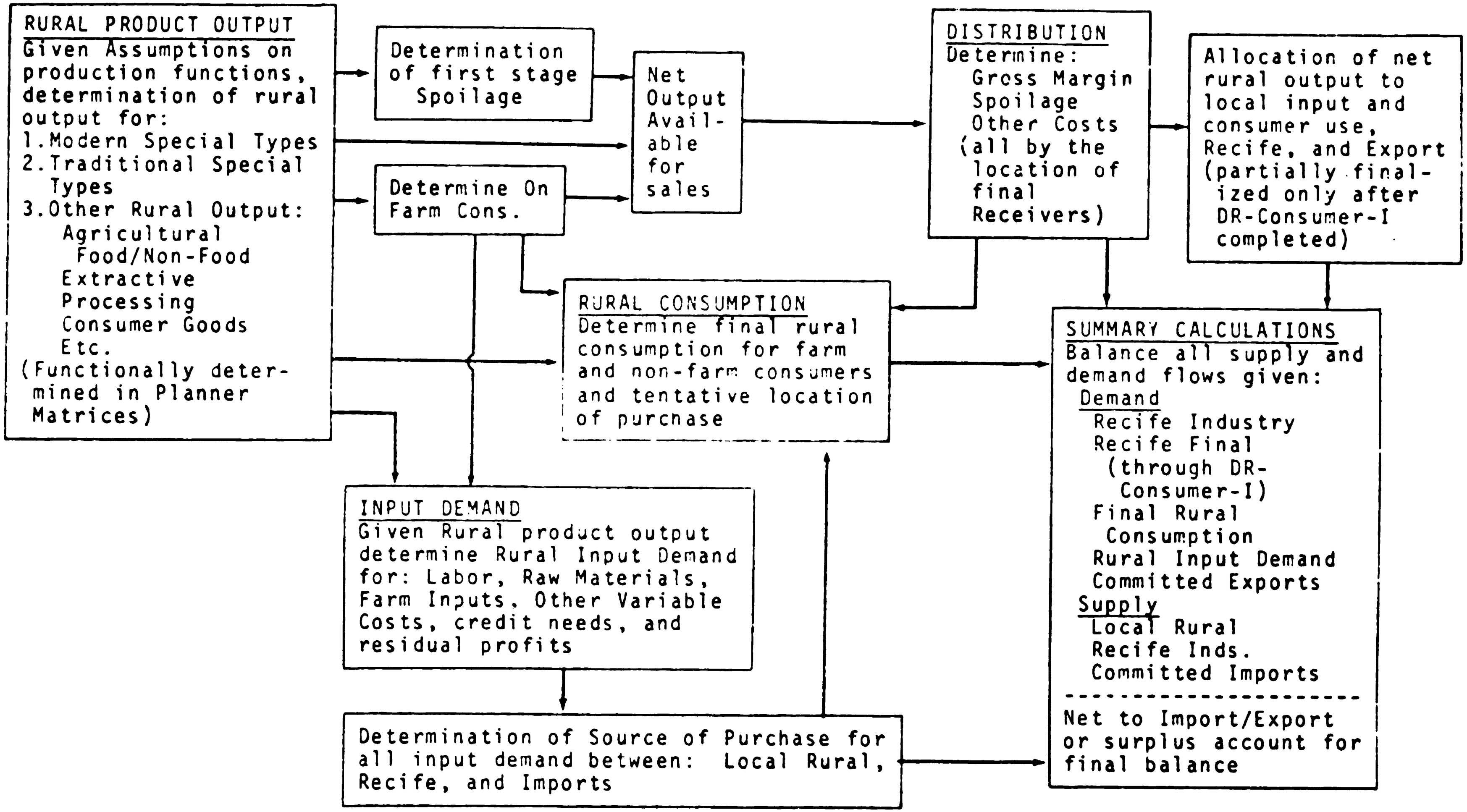

FIGURE A.7 The Rural Sector: Simplified Flow of Computations

Output Determination

Output of modern special types (explicitly defined product groups separated for in-depth analysis	=	(30) Value yield of modern types defined	x	(31) Land area applicable to modern output defined			7.11
Output of traditional special types (explicitly defined product groups separated for in-depth analysis	=	(32) Value yield of traditional types defined	x	(33) Land area applicable to traditional output types			7.12
Other primary rural output of: Food, Non-food agriculture, Extractive, Other	=	(35) [1 + The expected growth rate on output]	x	(34) Output last time period			7.13
Total rural output by the four classes of production defined: Food, Non-food agriculture, Extractive, Other	=	Output of special modern types by the four product classes (eq. 7.11)	+	Output of special traditional types by the four product classes (eq. 7.12)	+	Other primary rural output by the four product classes (eq. 7.13)	7.14

Total on-farm consumption	=	(35) Proportion of modern output used on the farm	+	(36) Proportion of traditional output used on the farm	+	(37) Proportion of other food output used on the farm		7.15
Portion of on-farm consumption used as final consumption	=	Proportion of on-farm consumption in modern, traditional, and other rural food output used as final consumption	x	On-farm consumption by type of output: Modern, Traditional, Other food				7.16
On-farm consumption used as farm inputs (e.g., seeds)	=	Total on-farm consumption by type of rural output	-	Portion of on-farm consumption used for final consumption				7.17
Total on-farm spoilage (before the first sale) by type of output	=	(38) (39) Proportion of modern and traditional output that spoils before first sale, respectively	x	Output of modern special types --- Output of traditional special types	+	(40) Proportion of other rural output by the four classes that initially is spoiled or lost	x Other rural output by four output classifications	7.18

$$\text{Total value of rural output available for sale} = \text{Total rural output by product type} - \text{Total on-farm consumption (applicable to food only)} - \text{Total initial spoilage before the first sale} \quad 7.19$$

Distribution of rural food output to:

- Local rural consumption (input use and final use)
- Recife
- South/Export

$$= \frac{\text{Rural food output that is available for sale} \times \overset{(42)}{\text{Proportional split of output between receiving sectors}}}{1 - \overset{(48)}{\text{Gross margin on the value of sales by the receiving sector}}} \quad 7.20$$

Distribution of all other rural output to:

- Local rural use
- Recife
- South-Export

$$= \frac{\text{Rural output of non-food agricultural goods, extractive and other "available" for sale} \times \text{Proportional split of the 3 types of rural output between the receiving sectors}}{1 - \text{Gross margin on the value of each type of output by the receiving sectors}} \quad 7.21$$

$$\text{The value of** the rural output of consumer goods and processed food} = \left[1 + \text{Expected growth rate on current output}\right] \times \text{Output of consumer goods and processed foods last time period} \quad 7.22$$

**The output of consumer goods and the processed food is part of the last classification of rural output--"other." It is split out specifically from the "other" category in order to compare and assess the impact on distribution and urban consumption through the use of the Decision Routine-Consumer I.

Spoilage or loss in rural distribution by product type and destination of goods	=	(41) The proportion of rural output which is available for sale that is spoiled or lost by product type and destination	x	Rural output available for sale by product type and destination (eq. 7.20, 7.21)		7.23
Total value of spoilage or loss in the rural sector by type of rural output at output prices	=	Spoilage or loss occurring before the first sale by type of output product valued at sales price	+	Spoilage or loss occurring in distribution by product type valued at cost of goods		7.24

Final Rural Consumption

Final consumer expenditures for: Food Consumer Goods Miscellaneous (services, rents) Taxes Savings	=	(46) Average propensity to consume (save) each expenditure type by non-farm consumers	x	(44) Total income to non-farm consumers	+	{ (47) Average propensity to consume (save) each type of expense by farm consumers	
	x	(45) Total income to farm consumers	-	On-farm consumption }			7.31

Rural Input Determination

The total value of inputs demanded by rural production for the following classifications:

1. Labor
2. Farm Inputs
3. Raw Materials Food
4. Raw Materials Non-food
5. Other Variable Costs
6. Investment-generated expenses for material equipment & labor
7. Residual net profit for income and future investment

= (49) Input value technical coefficients on the output of the explicitly defined Special modern types × Output of the modern types + (50) Input value technical coefficients on the output of the explicitly defined special traditional types

× Output of the traditional types + (51) Input value technical coefficients on the output of the other rural productive units × Other rural output

7.41

The breakdown of miscellaneous consumer expenses for rents and services between labor and material expenditures** = The proportional split of consumer miscellaneous expenses between labor and materials × Miscellaneous consumer expenses

7.42

**Add to input (1) in equation 7.41 the above value of labor expenditures, add to input (6) the above value of material expenditures, subtract from input (3) the value of on-farm consumption used as farm inputs (such as seed).

The distribution of the demand for inputs into the rural productive sector from the source sectors of: 1. Internally generated within rural sector 2. Recife industry sector 3. South-Import	=	(52) Proportional source split on each input into the three potential source sectors of purchase	x	The total value of inputs demanded by the rural sector		7.43
Investment funds available for future use or hoarding within the rural sector	=	Net savings	+	Undistributed net profits and depreciation generated internally		7.44
Total rural income generated within the rural sector botn farm and non-farm	=	The value of labor demand by the rural productive sector from all sources	+	Value of income wages generated from other rural economic activity (rents, services, etc.)		
	+	Wages and income generated in distribution within the rural sector (assemblers, wholesalers and retailers)	+	The exogenous input of the value of government wages generated in the rural sector		7.45

Total value of government revenues generated	=	Personal taxes paid by consumers	+	Business taxes generated by rural production and distribution	+	The net flow of government revenues from sources outside the rural sector

7.46

Summary Calculations

Before the final determination of the allocation of outputs of the rural sector can be done, the Decision Routine-Consumer I must calculate and allocate any difference between local supply and urban demand. For this, Consumer I uses that part of equation 7.20 which is the food production allocated to Recife, and equation 7.22, which is the output of consumer goods and processed food by the rural sector. After the Decision Routine has been completed, it sends back to the rural sector these final distributions.

Before final determination of the sources of purchases for inputs can be determined, the Decision Routine-Capital II must decide if the demand placed on Recife for inputs stated in 7.43 can be fulfilled. After the Capital II has determined the allocation of the urban industry sector, it sends back to the rural sector the final supply which can be made available. Before entering the summary calculations, these alterations have already been made in the relevant decision routine calculations.

The net total demand for food products by the rural sector <u>on</u> the rural sector	=	Final consumer demand for food products, including "on-farm consumption"	+	The demand by rural production for input of food raw materials	-	Initial demand for imports by consumers and producers

7.51

The net supply of food products which the rural sector can make available to the rural sector demand	=	The total rural output of food	-	Total value of spoilage	-	That part of rural food output which is by its nature exported		
	-	That part of rural food output allocated to the Recife industry sector and to final urban consumption through the distribution sector						7.52
The total value of food imports from the south-import sector by the rural sector	=	Initial demand for food imports (by their nature) by consumers, producers	+	The net total demand for food products by the rural sector	-	The net total supply of food products of the rural sector		7.53
The net total demand for other rural sector output	=	Final consumer demand for other goods	+	Rural productive demand for other goods	-	That portion of input demand initially imported		7.54
The net total supply of other goods which the rural sector can make available to meet the demand	=	Total rural output of all goods	-	Spoilage or loss	-	Output initially allocated to exportation		7.55

The total value of other goods imported into the rural sector	=	The value of imports initially for consumers and producers (by their nature)	+	Net total demand (eq. 7.54)	-	Net total supply (eq. 7.55)	7.56

Printout Example

Table A.12 is an example of the printout for the Rural Sector. It summarizes the total output of the sector and the distribution of that output to internal use within the Rural Sector, to Recife industry or consumption (through the Distribution Sector), to exportation, and the level of spoilage and loss for each major class of rural output.

TABLE A.12 Printout Illustration: Rural Sector Output (Gross Sectoral Product)

PAGE 287

TIME PERIOD 4

RURAL SECTOR OUTPUT (GROSS SECTORAL PRODUCT)

	AGRICULTURAL NON-PROCESSED FOOD PRODUCTION		RURAL SECTOR PRODUCTION OF PROCESSED FOODS		RURAL SECTOR OUTPUT OF OTHER PRODUCTS (EXTRACTIVE, AG.NON-FOOD, OTHER INDUSTRY)		OTHER INCOME GENERATING ACTIVITIES SUCH AS SERVICES, RENT		TOTAL RURAL PRODUCT (OUTPUT)	
	ACTUAL VALUE	COLUMN PERCENT	ACTUAL VALUE	COLUMN PERCENT	ACTUAL VALUE	COLUMN PERCENT	ACTUAL VALUE	COLUMN PERCENT	ACTUAL VALUE	COLUMN PERCENT
TOTAL OUTPUT BY TYPE	296.17	100.00	24.31	100.00	335.26	100.00	42.93	100.00	698.68	100.00
LINE PERCENT	42.39		3.48		47.99		6.14		100.00	
ALLOCATION OF OUTPUT :										
RURAL SECTOR (INTERNAL)	177.84	60.04	21.88	90.00	223.61	66.70	42.93	100.00	466.25	66.73
LINE PERCENT	38.14		4.69		47.96		9.21		100.00	
RECIFE(CONSUMER/INDUSTRY	54.25	18.32	2.43	10.00	41.23	12.30	0.00	0.00	97.91	14.01
LINE PERCENT	55.41		2.48		42.11		0.00		100.00	
SOUTH-IMPORT/EXPORT	25.37	8.57	0.00	0.00	62.64	18.68	0.00	0.00	88.01	12.60
LINE PERCENT	28.83		0.00		71.17		0.00		100.00	
SPOILAGE OR LOSS	38.71	13.07	0.00	0.00	7.79	2.32	0.00	0.00	46.50	6.66
LINE PERCENT	83.25		0.00		16.75		0.00		100.00	

RECIFE SYSTEM SIMULATION MODEL

The Decision Routine-Consumer I: The Printout

The routine is composed of a complex set of 500 mathematical operations, logic alternative statements, and print statements. The purpose of this routine is to allow the planner to determine the process by which short-run supply and demand for food and consumer goods are balanced according to a defined set of decision rules. The ability of Consumer I to carry out the necessary operations is important, but also stressed is the ability to present the results of using Consumer I. Thus, within the routine, a readable text format output is utilized stating which decision rules were used and what their impact would be on allocating any short-run surplus or deficit. Tabular summaries for the entire routine are also presented. (Over 50 print format statements are defined to achieve this result.)

The user of Consumer I inputs two kinds of parameters. First, "keys" which determine which decision statements to use; and second, the level of impact which a given decision statement can have on a surplus or deficit.

The rational and the general structure of Consumer I are adequately described in Chapter VII. The exact "flow chart" for the computer program of the routine is not incorporated in this appendix but is available in the workbook which accompanies the computer program.

The most unique printout generated in the model is that for Consumer I. The following two tables are representative of the format which has been structured in order to present the results of the decision routine clearly. Table A.13 is an example of results which are printed for each of the five product supply-demand comparisons. The table permits an easy understanding of the exact computational flow of the routine in allocating the deficit condition for the non-processed food from the Rural Sector. Each decision rule is stated and its potential and actual effect on allocating the deficit presented. The user knows exactly what rules were used and their impact on the deficit condition. The printouts for the other product comparisons and for surplus conditions are similar.

Table A.14 is a summary statement for non-processed food. Summary tables are also calculated for processed food and consumer goods. This table shows the net results after utilizing the routine and summarizes how the particular deficit condition was resolved.

TABLE A.13 **Printout Illustration: Example of Text Format for Consumer I**

```
                                                                                              PAGE  175

          RURAL BASIC FOOD PRODUCTION                                 4

     DECISION POINT: IS THERE A SURPLUS, DEFICIT,             CONCLUSION: THE  POTENTIAL
     ****************OR ARE SUPPLY-DEMAND EQUAL               ********    DEFICIT  OF:  $     8.59 EXISTS

  A POTENTIAL DEFICIT CONDITION EXISTS FOR RURAL BASIC FOOD PRODUCTION

  GIVEN A DEFICIT OF $   8.59 WHAT CHANGES IN SUPPLY AND DEMAND WILL TAKE PLACE IN ORDER FOR
  THE URBAN DISTRIBUTION SECTOR TO MEET THE FINAL DEMANDAND HOW WILL THE SUPPLY SECTOR RESPOND
  ****************************************************************

REMAINING        ALTERNATIVES OPEN          ACTIONS TO BE TAKEN         THE RESULTS DERIVED
DEFICIT          TO CONSIDERATION           FOR THIS ALTERNATIVE        FROM THE ACTION TAKEN
********         ****************           ****************            ****************

         1-THE POTENTIAL DEMAND IS TO LARGE TO
           BERRALISTIC UNDER CURRENT CONDITIONS.

                             BECAUSE OF THE LACK OF APPLICABILITY, INFORMATION OR FOR
                             OTHER SUBJECTIVE REASONS THIS ALTERNATIVE WAS NOT USED

                                                    SINCE THIS ALTERNATIVE WAS NOT USED, GO TO THE THE NEXT
  8.59                                              ALTERNATIVE. THERE IS STILL A REMAINING DEFICIT OF $   8.59

         2-SOME PERCENTAGE OF ACCUMULATED SURPLUS CAN BE
           MADE AVAILABLE TO OFFSET ALL OR PART OF THE DEFICIT.

                             BECAUSE OF THE LACK OF APPLICABILITY, INFORMATION OR FOR
                             OTHER SUBJECTIVE REASONS THIS ALTERNATIVE WAS NOT USED

                                                    SINCE THIS ALTERNATIVE WAS NOT USED, GO TO THE THE NEXT
  8.59                                              ALTERNATIVE. THERE IS STILL A REMAINING DEFICIT OF $   8.59

         3-SOME MAXIMUM PERCENT OF THE SUPPLY SECTOR'S OUTPUT
           TO OTHER REGIONS CAN BE DIVERTED TO RECIFE.

                             OF AN OUTPUT TO THE RURAL SECTOR OF $ 149.19
                             A MAXIMUM OF 0.05CAN BE DIVERTED TO RECIFE OR $    7.57
                             OF AN OUPUT TO SOUTH/EXPORT SECTOR OF $  13.52
                             A MAXIMUM OF 0.01CAN BE DIVERTED TO RECIFE OR $    0.34
                                  THUS, A MAXIMUM ABLE TO BE DIVERTED TO RECIFE IS $    7.90

                                                    THIS ALTERNATIVE PROVIDED FOR ONLY $   7.90 OF THE DEFICIT OF $    8.59
  0.69                                              GO TO THE NEXT ALTERNATIVE.  THERE IS STILL A REMAINING DEFICIT OF
                                                    $    0.69

         4-THE SUPPLY SECTOR CAN REACT TO THE POTENTIAL DEFICIT WITH AN
           INCREASE IN SUPPLY THIS TIME PERIOD OR THE NEXT TIME PERIOD.

                             BECAUSE OF THE LACK OF APPLICABILITY, INFORMATION OR FOR
                             OTHER SUBJECTIVE REASONS THIS ALTERNATIVE WAS NOT USED

                                                    SINCE THIS ALTERNATIVE WAS NOT USED, GO TO THE THE NEXT
  0.69                                              ALTERNATIVE. THERE IS STILL A REMAINING DEFICIT OF $   0.69

         5-DUE TO CONDITIONS IN THE SUPPLY SECTOR,IT WOULD NOT OR COULD NOT DIVERT OUTPUT FROM OTHER
           AREAS EARLIER BUT NOW SOME MAXIMUM PERCENT CAN BE DIVERTED TO THE RECIFE SECTION.

                             BECAUSE OF THE LACK OF APPLICABILITY, INFORMATION OR FOR
                             OTHER SUBJECTIVE REASONS THIS ALTERNATIVE WAS NOT USED


                                                    SINCE THIS ALTERNATIVE WAS NOT USED, GO TO THE THE NEXT
  0.69                                              ALTERNATIVE. THERE IS STILL A REMAINING DEFICIT OF $   0.69

         6-DUE TO THE LACK OF RESPONSIVENESS IN THE SUPPLY SECTOR, ALL OR THE
           REMAINING DEFICIT IS OFFSET BY PURCHASAS FROM THE SOUTH OR IMPORTATION.

                             SINCE ALL OR THE REMAINING PART OF THE DEFICIT IS OFFSET
                             FROM THE SOUTH OR OTHER AREAS OF BRAZIL, NO DEFICIT REMAINS

                                                    THE QUANTITIES CURRENTLY BEING PURCHASED FROM THE SOUTH/EXPORT AREAS
 [illegible]                                        ARE AUGMENTED BY THE REMAINING DEFICIT OF $   0.69
```

TABLE A.14 Printout Illustration: Summary Statement of Non-Processed Food Products for Consumer I

```
                                                                                      PAGE 176

SCHEDULE                     TIME PERIOD      4

SUMMARY STATEMENT OF DECISION ROUTINE FOR: NON-PROCESSED FOOD PRODUCTS
*********************************************************************

INITIAL CONDITIONS OF: SUPPLY TO RECIFE                          DEMAND FROM RECIFE

          RURAL FARM OUTPUT AVAIL-                                 DEMAND FOR LOCAL RURAL
          ABILITY TO RECIFE AREA    $   38.15                       PRODUCED FOOD PRODUCTS $    44.76

          ACCUMULATED SURPLUSES     $   0.00
          ********************************************************************************

THUS, A DEFICIT EXISTED BETWEEN SUPPLY AND DEMAND IN
RURAL FARM NON-PROCESSED FOOD OUTPUT AVAILABLE TO
RECIFE OF $    6.61

IT HAS BEEN ALLOCATED AS FOLLOWS:

          FROM/TO SURPLUS OR LOST TO SYSTE                        0.00          0.00

          PART OF RURAL SECTOR OUTPUT
          TO OTHER REGIONS DIVERTED
          TO/FROM THE RECIFE AREA:
                RURAL SECTOR                             6.33
                SOUTH/IMPORT SECTOR                      0.28
                TOTAL                                    6.61          1.00

          OUTPUT RESPONSE GAIN(UP OR DOWN)                        0.00          0.00

          PURCHASE FROM SOUTH(IF DEFICIT)                         0.00          0.00

          % RESPONSE IN OUTPUT NEXT TIME                          0.00
**************************************************************************************

FINAL SUPPLY AND DEMAND CONDITIONS FOR RECIFE: TOTAL DEMAND IS $  55.64

                RURAL SECTOR                              44.76

                SOUTH/IMPORT SECTOR                       10.88

                ACCUMULATED SURPLUSES                     0.00


                               RECIFE SYSTEM SIMULATION MODEL
```

The Investment Sector: Some Comments on Capacity Determination

The creation of capacity is one of the major uses of investment funds. Other applications have been outlined in Chapter VII and are important, but further explanation of the means to include increases in capacity is necessary. Capacity functions can be developed for each of the defined components in the Industry and Rural Sectors. It could also be done for the Distribution Sector, though capacity has less meaning due to the degree of flexibility in output given a physical facility.

The following function is used in determining capacity:

$$\left[\begin{array}{l}\text{Percentage}\\\text{Increase}\\\text{In}\\\text{Capacity}\\\quad D\end{array}\right] = \left[\begin{array}{l}\text{Percentage}\\\text{Attributable}\\\text{To Normal}\\\text{Growth}\\\quad A\end{array}\right] + \left[\begin{array}{l}\text{Percentage}\\\text{Attributable}\\\text{To Exogenous}\\\text{Simulated}\\\text{Growth}\\\quad B\end{array}\right] + \left[\begin{array}{l}\text{Percentage}\\\text{Attributable}\\\text{to Output}\\\text{Responsiveness}\\\quad C\end{array}\right] \qquad 8.1$$

$$\text{Capacity(N)} = (1+D) \times [\text{Capacity (n-1)}] \qquad 8.11$$

$$\begin{array}{l}\text{Change in}\\\text{Capacity}\end{array} = D \times [\text{Capacity (n-1)}] \qquad 8.12$$

$$\left[\begin{array}{l}\text{Investment}\\\text{Necessary}\\\text{For}\\\text{Increased}\\\text{Capacity}\end{array}\right] = (D) \times (\text{Value of Current Assets}) \times [u(n)] \qquad 8.2$$

Where:

$$\left[\begin{array}{l}\text{Value of}\\\text{Current}\\\text{Assets}\end{array}\right] = \left[\begin{array}{l}\text{Total Current}\\\text{Dollar Value}\\\text{Of Plant and}\\\text{Equipment}\end{array}\right] \quad \underline{\underline{\text{OR}}} \quad \left[\begin{array}{l}\text{That Amount}\\\text{of Investment}\\\text{Necessary to}\\\text{Increase capacity}\\\text{by 100\%}\end{array}\right] \qquad 8.21$$

$$U(n) = 1 \quad \text{IF} \quad D \geq 1$$

$$= 1+K_1 \quad \text{IF} \quad .5 \leq D < 1$$

$$= 1+K_2 \quad \text{IF} \quad D < .5 \qquad 8.22$$

K_1 and K_2 = Incremental factor necessary where Increases in capacity are small which tend to make cost per unit increase in capacity higher than if increase is greater than 100%.

$$\begin{bmatrix}\text{Current}\\ \text{Assets}\\ (n)\end{bmatrix} = \begin{bmatrix}\text{Current}\\ \text{Assets}\\ (n-1)\end{bmatrix} + \begin{bmatrix}\text{Investment necessary}\\ \text{for the increased}\\ \text{capacity}\end{bmatrix} \qquad 8.3$$

$$\begin{bmatrix}\text{Demand}\\ \text{For:}\\ \text{Equipment}\\ \text{Construction}\\ \text{Materials}\\ \text{Labor}\\ \text{Other}\end{bmatrix} = \begin{bmatrix}E_1\\ E_2\\ E_3\\ E_4\end{bmatrix} + \begin{bmatrix}\text{Investment necessary}\\ \text{for the increase in}\\ \text{capacity}\end{bmatrix} \qquad 8.4$$

It is possible to include a simple step function in equation 8.1 on the last term which is the addition to capacity due to output responsiveness that will make this term applicable only when capacity utilization reaches a given level. Thus, 8.1 could be restated:

$$D = A + B + C\,[V(n)] \qquad 8.5$$

Where:

$V(n)$ = 1 IF Capacity utilization rate is greater than some given proportion 8.51

$V(n)$ = o IF Capacity utilization rate is lower than some given proportion 8.52

$$\text{Capacity Utilization Rate} = \frac{\text{Output (n-1)}}{\text{Capacity (n-1)}} \qquad 8.53$$

$$\text{Capital Output ratio} = \text{Current Assets/Output} \qquad 8.54$$

Once the demand for input is determined from equation 8.4 it will flow into the model through the Other Recife Sector and be allocated according to the rules which have been input into that sector to handle the distribution of investment funds, such as splitting demand for construction materials between local industry and importation.

Along with this increase in capacity is the effect which that increase will have on such variables as the technical coefficients which determine each input given the output of the sector or component within a sector. It is likely that the changes in coefficients will not occur in the same period as the construction of new capacity but in the next time period and following time periods at potentially different rates. Thus, changes in basic input parameters for the sector or type which has had the capacity increase are input the next and each succeeding time period according to the hypothesized results which are expected. This can be done either through direct input of the coefficients each time period i.e. exogenously, or though the use of a PER by inputting and altering the coefficients over time according to a predescribed functional pattern.

APPENDIX B

DEFINITIONS, SOURCES, AND VALUES OF INPUT PARAMETERS UTILIZED IN THE INITIAL SIMULATIONS

Organization and Purpose of the Appendix

The purpose of this appendix is to present in detail specific parameter input information for the base simulation and reform simulations described in Chapter VIII. For every parameter utilized in the simulation runs the definition, source of information, and the values used in the simulation are listed.

In assessing the validity of the information used, it is important to understand that there are three very distinct levels of information accuracy present in a set of simulations. first, information about the current system; second, information projecting the current system over the time periods of the simulation (in these cases five years); and third, information projecting the impact of the programmed change hypothesized by the reform options. Each level is by definition less accurate than the preceding one.

The parameter values used in the simulation came from many sources and were developed during intensive workshop sessions with the research staff of the project. Generally, the information level was considered good for all the simulations, but on specific parameters reliability varied from very high to very low. There are about 1,200 input values which must be determined each time period, but these can be grouped into about 75 parameter definitions. For example, under the parameter "shopping propensities", 35 estimates are required (five consumer classes times seven distribution outlets). The job is simplified because many of the parameters will not be changed over time or when a reform program is implemented into the system. Thus, all parameters must be valued only for the current year of the base simulation. Some of these may be assumed to change over time in the base simulation; others may be assumed to change with reform implementation.

Information for this section was obtained from published materials, unpublished work, and research staff estimates. Instead of footnoting each reference, an abbreviated reference title (as listed below) is used in the source statements accompanied by page or table references.

1. Where no information was available, the most qualified research staff members (who had generally had responsibility in a research area) were the source of parameter data. Often this included experiences or information from other areas of South America (especially important in assessing reform program implications).

2. Unpublished research information and analysis. Much of the information developed from the research done in Recife is not published in this or any other document, but was used in determining parameter values. These included frequency charts, ACT analysis, and chi-square analysis of variables in particular surveys. The nature of the analysis, survey name, and variable numbers are included in the source statements.

3. Preliminary report of research. Some detailed information presented in the rough draft report of the research work done in Recife is deleted in the final draft, but was useful in developing parameter estimates for a number of inputs. This is especially true of the Industry Sector work done by Mark Doctoroff (termed "Rough Draft Recife Report" in the source statements).

4. Some of the data for specific parameters is included in the LAMP/LAFS Draft Report as previously footnoted. References are made by chapter, page or table.

5. Other specific references are:

   a. Robert W. Nason, "Urban Market Processes in Recife, Brazil", (unpublished Ph.D. thesis, Michigan State University, 1968). Termed: "Nason Thesis".

   b. IBGE National Statistics Council, Statistical Annuals of Brazil, (Rio de Janeiro: National Statistics Council, 1964-1967). Termed: "IBGE", years, pages.

   c. Getulio Vargas Foundation, Projections of the Supply and Demand for Farm Products in Brazil, (Rio de Janeiro: Getulio Vargas Foundation, Vols. I, II), 1966. Termed: "GVF", page or table.

   d. Department of Defense, Northeast Brazil Nutrition Survey, March-May 1963, A Report for the Interdepartmental Committee on Nutrition for National Development, (Washington, D.C.: Department of Defense), May 1965. Termed: "Nutrition Study", page or table.

This Appendix is divided into two parts. The first names the parameter, states the source for the base simulation values, and lists the values of the parameter for the current year and changes over the five years assumed in the base simulation. The second part lists all additional changes in parameter values hypothesized for the three reform programs.

Each parameter is numbered and these numbers are cross-referenced in the verbal matrices of the equations presented in Appendix A. After the parameter name, in parenthesis, are equation numbers which correspond also to the verbal equation in Appendix A where the parameter is functionally used. Following the equation numbers may be the letters "B", "M", "U", or "T". They signify that time-variant parameter changes are made in the base simulation, "B", in the modern discount supermarket reform, "M", in the total urban reform program, "U", and in the total urban and rural reform package, "T". If no such designation is stated, the parameter is assumed not to vary over time or with the implementation of any reform program.

In order to identify specific parameter values, it is important to know row and column definitions for the input matrices. Many of these are repeatedly used in identical order, so "common type definitions" are stated at the beginning of each set of parameter values for a sector. These "common type definitions", called "CTDs", are applicable to rows and columns. For example, there are three "CTDs" for the Consumption-Income Sector. In listing the input values for average shopping propensities, the table has seven rows and five columns. The columns represent income classes (CTD-1) and the rows represent location of purchase (CTD-2). By looking at the listing under the "common type definitions" it is possible to identify the meaning of each entry in the table.

Parameter Inputs for the Consumption-Income Sector

Listed below are the "common type definitions" used in the Consumption-Income Sector.

Common Type Definition-1 (CTD-1)

1. Very high income group
2. High income group
3. Middle income group
4. Low income group
5. Very low income group

Common Type Definition-2 (CTD-2)

1. Food expenditures
2. Non-food consumer goods expenditures
3. Other expenditures (including automobile-transportation, services, and housing rent payments)
4. Savings

Common Type Definition-3 (CTD-3)

1. Modern food outlets --food products
2. Modern food outlets -- non-food products
3. Traditional food outlets -- food products
4. Traditional food outlets -- non-food products
5. Other food outlets (primarily restaurants)
6. Modern non-food merchandise outlets
7. Traditional non-food merchandise outlets

1. Total Consumer Income (3.01, 3.02), (B)

Definition: The rate at which the total consumer income is generated to each consumer type. This includes wages, distributed profits, transfers, and other income (in millions of U.S. dollars).

Source: Nason Thesis, page 68, gives the average per capita income. This, multiplied by the current population of 1.1 million, produces a total urban consumer income of US$330 million. This is split by income category using Table 2.2 of Nason Thesis with an assumed average family size of six (from MSU/SUDENE consumer surveys).

Base Values:

Consumer Classes (CTD-1)

Year	1	2	3	4	5
1	37.8	35.0	159.0	82.0	15.3
2	40.0	37.0	168.0	87.0	16.2
3	42.0	39.0	179.0	92.0	17.2
4	45.0	42.0	189.0	98.0	18.2
5	48.0	45.0	201.0	104.0	19.3

2. Effective Tax Rate (3.03)

Definition: The proportion of total income paid in all personal consumer taxes by consumer class. Effective rate vs "legal rate".

Source: Estimates are based on discussions with local officials in municipal and state government and from some businessmen in the urban area. It is assumed that the middle income class paid the largest effective rate, with higher and lower income groups paying a lower proportion of income in taxes.

Base Values:

Consumer Classes (CTD-1)

1	2	3	4	5
.02	.06	.08	.06	.01

3. Average Propensity to Consume (General use in 3.1 and 3.2)

Definition: The proportion of disposable income spent on each of the four major types of expenditures or savings. Only the initial time period is input to the model, but it will change internally as incremental real income is generated from changing shopping behavior and price.

Source: Nason Thesis Table 2.2 modified to include the purchase of food in restaurants and bars. This food consumption is estimated to be higher in upper income classes (20%) than in the low income class (5%). The estimates are built on the basis of US$12 to 15 million in such sales.

Base Values:

		Consumer Classes (CTD-1)				
		1	2	3	4	5
Type of	1	.091	.149	.369	.596	.89
Expenditure	2	.37	.35	.25	.2	.05
(CTD-2)	3	.389	.401	.331	.204	.06
	4	.15	.1	.05	0	0

4. Average Propensity to Shop (General use in 3.1, 3.2) (B,M,U)

Definition: The proportion of food and consumer goods expenditures spent in each given type of outlet defined in the distribution sector.

Source: Nason Thesis, pages 88 and 193. Estimates for non-food expenditures made from survey on non-food retailers and selected questions in the MSU/SUDENE consumer survey (not reported). Base simulation changes over time estimated from Nason Thesis Chapter 3, Summary and Conclusions, Chapter 5, page 254, and in general Chapter 6.

Base Values:

Time Period 1
Consumer Classes (CTD-1)

		1	2	3	4	5
Types of distribution outlets (CTD-3)	1	.3	.25	.15	.1	0
	2	.03	.04	.05	.05	0
	3	.5	.63	.75	.84	.95
	4	.05	.11	.2	.45	.7
	5	.2	.12	.1	.06	.05
	6	.1	.08	.05	.02	0
	7	.67	.72	.7	.48	.3

Changes in Base Values:

a. Expenditures in modern food outlets for food (Row 1)

Consumer Classes (CTD-1)

Year	1	2	3	4	5
1	.3	.25	.15	.1	.0
2	.33	.265	.165	.1	.0
3	.36	.28	.18	.1	.0
4	.39	.295	.195	.1	.0
5	.42	.31	.21	.1	.0

b. Expenditures in traditional food outlets for food (Row 3)

Consumer Classes (CTD-1)

Year	1	2	3	4	5
1	.5	.63	.75	.84	.95
2	.47	.615	.735	.84	.95
3	.44	.6	.72	.84	.95
4	.41	.585	.705	.84	.95
5	.38	.57	.69	.84	.95

c. Expenditures in modern food outlets for consumer goods (Row 2)

Consumer Classes (CTD-1)

Year	1	2	3	4	5
1	.03	.04	.05	.05	0
2	.033	.042	.052	.05	0
3	.036	.044	.054	.05	0
4	.039	.046	.056	.05	0
5	.042	.048	.058	.05	0

d. Expenditures in traditional food outlets for consumer goods (Row 4)

Consumer Classes (CTD-1)

Year	1	2	3	4	5
1	.05	.11	.2	.45	.7
2	.047	.108	.198	.45	.7
3	.044	.106	.196	.45	.7
4	.041	.104	.194	.45	.7
5	.038	.102	.192	.45	.7

e. All others constant over time

5. Breakdown of Other Expenditures (3.13, 3.23)

Definition: The proportion of other expenses spent on transportation, housing-rent, services, and miscellaneous.

Source: Nason Thesis Chapter 2, which contains estimates on the percent of households owning automobiles, and average rent and ownership payment. Other information built from unreported consumer survey results and interviews.

Base Values:

Consumer Types (CTD-1)

		1	2	3	4	5
Type of Other Expenses	Auto-Trans.	.2	.3	.27	.2	.1
	Services	.4	.2	.15	.05	.05
	Rents	.3	.4	.45	.7	.8
	Misc.	.1	.1	.13	.05	.05

6. Proportion of Consumer Goods Expenditures Directly South/Import (3.15, 3.25)

Definition: That part of all consumer goods expenditures not spent in the Recife Distribution Sector but going directly to importation and final consumers. Must remain constant within a given simulation run.

Source: Estimate based on residual expenditures not accounted for in Distribution Sector (no direct data sources).

Base Values:

Consumer Types (CTD-1)				
1	2	3	4	5
.15	.05	0	0	0

7. Relative Price Index (3.1, 3.2) (B,M,U)

Definition: The level of relative prices between traditional and modern outlets using the traditional outlets as base. An input used to construct relative price matrices in 3.11 - 3.21.

Source: Nason Thesis 3.13 weighted according to consumption patterns for food products listed.

Base Values:

Type of Distributive Outlets (CTD-3)						
1	2	3	4	5	6	7
.92	.94	1.	1.	1.	.93	1.

Parameter Inputs for the Distribution Sector

Listed below are the "common type definitions" used in the Distribution Sector.

Common Type Definition-4 (CTD-4)

1. Modern food outlets -- food
2. Modern food outlets -- consumer goods
3. Street and public markets -- food
4. Street and public markets -- consumer goods
5. Small and neighborhood stores -- food
6. Small and neighborhood stores -- consumer goods
7. Other food outlets (primarily restaurants)
8. Modern non-food merchandixe outlets
9. Traditional non-food merchandise outlets

Common Type Definition-5 (CTD-5)

1. Recife processed food industry
2. Recife consumer goods industry
3. Rural processed foods industry
4. Rural consumer goods industry

5. Rural agricultural food (non-processed)
6. South import sector -- processed food
7. South import sector -- consumer goods
8. South import sector -- non-processed food

8. Gross Margin (4.21) (B,M,U)

Definition: Sales minus the cost of goods divided by sales.

Source: Nason Thesis Chapter 3, Table 3.15.

Base Values:

Distribution/Product-Channel Types (CTD-4)

1	2	3	4	5	6	7	8	9
.2	.31	.3	.38	.25	.34	.4	.38	.44

9. Rate of Spoilage (4.21, 4.22) (B,M,U)

Definition: Spoilage factor for each urban distribution product-channel for food and consumer goods. Each entry is one plus the percentage of spoilage as a proportion of total sales.

Source: Nason Thesis Table 3.14.

Base Values:

1	2	3	4	5	6	7	8	9
1.01	1.01	1.2	1.04	1.1	1.03	1.15	1.01	1.03

10. Technical Coefficients for Direct Labor (4.31)

Definition: Technical coefficient on direct labor. Per unit expenditure for direct labor as a proportion of goods throughput (goods throughput equals sales times 1 plus rate of spoilage).

Source: Nason Thesis Chapter 3, Table 3.4.

Base Values:

Distribution/Product-Channel Types (CTD-4)

1	2	3	4	5	6	7	8	9
.025	.025	.015	.015	.025	.025	.15	.12	.14

11. Technical Coefficient Other Variable Costs (4.32)

Definition: Other variable costs as a proportion of goods throughput.

Source: Recife retailer surveys, frequency counts, variable numbers 448-457, wholesaler surveys same variables.

Base Values:

Distribution/Product-Channel Types (CTD-4)

1	2	3	4	5	6	7	8	9
.06	.06	.12	.12	.08	.08	.15	.20	.18

12. Tax Rate (4.36)

Definition: The proportion of effective taxes paid to gross margin value.

Source: Retailer surveys, frequency counts, variable number 453 and wholesaler survey same variable.

Base Values:

Distribution/Product-Channel Types (CTD-4)

1	2	3	4	5	6	7	8	9
.12	.12	.08	.08	.1	.1	.08	.12	.09

13. Fixed Charges (4.34)

Definition: Value of total fixed charges in given time period by channel type, input in millions of U.S. dollars.

Source: Due to lack of information, fixed cost estimates were included as other variable costs.

14. Proportional allocation of Net Profit (4.43)

Definition: This parameter allocates the value (after taxes) of net profit between distributed and undistributed net profits.

Base Values:

Distribution/Product-Channel Types (CTD-4)

	1	2	3	4	5	6	7	8	9
Distributed	.7	.7	1.	1.	.88	.88	.9	.6	.8
Undistributed	.3	.3	0	0	.12	.12	.10	.4	.20

15. Depreciation (4.35)

Definition: Total value of depreciation of channel outlet type input in millions of U.S. dollars.

Source: No estimate attempted, input "0" assuming investment allocation of residual net profits.

16. Source of Raw Materials Purchases (4.5) (B,M,U,T)

Definition: Source split matrix on the purchase of raw material inputs of food and consumer goods into distribution sector. Each entry is the proportion of a given raw material input purchased from a given source. There will be entries in this matrix only where rows and columns are of the same product type. For example, column 1, representing product-channel 1, can have entries in rows 1, 3, 5, 6, and 8 corresponding to food; but not in rows 2, 4, and 7, which correspond to consumer goods.

Source: Current year, Nason Thesis Chapter 3, Table 3.7 and Chapter 4, Table 4.4

Base Values:

Distribution/Product-Channel Types (CTD-4)

		1	2	3	4	5	6	7	8	9
	1	.42	0	.16	0	.48	0	.35	0	0
	2	0	.7	0	.6	0	.6	0	.3	.5
Location	3	.03	0	.02	0	.02	0	.1	0	0
of	4	0	.1	0	.1	0	.1	0	0	0
Purchase	5	.21	0	.72	0	.27	0	.35	0	0
(CTD-5)	6	.25	0	.02	0	.1	0	.05	0	0
	7	0	.2	0	.3	0	.3	0	.7	.5
	8	.09	0	.08	0	.13	0	.15	0	0

17. Breakdown of Sales between the Two Types of Traditional Outlets (4.11)

Definition: Before calculations in the distribution sector can continue, the total value of traditional sales generated in the consumption sector for food and consumer goods must be split between sales in street and public markets and neighborhood stores. This split proportion defines the food and consumer goods sales in street and public markets as a proportion of total traditional food channel sales.

Source: Nason Thesis, Table 3.2.

Base Values:

For Food Sales	.53
For Consumer Goods	.55

Parameter Inputs for the Recife Industry Sector

The "common type definitions" for this sector are:

Common Type Definition-7 (CTD-7)

1. Agricultural farm inputs industry
2. Processed foods industry
3. Consumer goods industry
4. Other Recife industry (flexible)
5. Construction materials industry
6. Capital equipment industry
7. Supplier good industry (all intermediate sales)

Common Type Definition-7a (CTD-7a)

1. Agricultural inputs -- Rural Sector
2. Agricultural inputs -- Import Sector
3. Non-agricultural inputs -- Rural Sector
4. Non-agricultural inputs -- South Import Sector
5. Facilitory inputs -- Industry Sector supplier type
6. Facilitory inputs -- Other Recife Sector
7. Facilitory inputs -- Rural Sector
8. Facilitory inputs -- South Import Sector
9. Other variable costs -- Other Recife Sector
10. Other variable costs -- Rural Sector

18. Initial Industry Output (5.11)

Definition: The initial output of all but the supplier goods industry type is given to the model at the beginning of each simulation run. The input is in millions of U.S. dollars.

Source: For processed food and consumer goods output values were compiled from raw data information sheets of industry survey conducted by Mark Doctoroff, Table 5.d.1 in "Rough Draft Recife Report", and estimates compiled from IBGE, 1966, pages 132, 117.

Base Values:

Agricultural inputs	6.3
Processed food	60.0
Consumer goods	75.0
Other industry	10.0
Construction materials	40.0
Capital Equipment	15.0

19. Expected Annual Growth Rate in Industry Output (5.11)

Definition: This growth rate is input each time period for each of the industry types (except supplier goods) and is the expected increase over the last time period. This growth rate may be altered in the decision routines, depending on the type of decision rules employed.

Source: See Table 5.d.1 of "Rough Draft Recife Report" and raw industry data sheets of industry interviews conducted by Doctoroff.

Base Values:

5% for all six industry types. (This may be altered by the supply and demand conditions which develop internally in the model.)

20. Technical Coefficients of Inputs to Industry Sector (5.21)

Definition: For each of the seven "inputs" defined for the Industry Sector, technical coefficients related the value per unit input to the value per unit output.

Source: These technical coefficients are developed from the raw data sheets of the Industry interviews and from Table 5.d.1 of the "Rough Draft Recife Report".

Base Values:

Industry Types (CTD-1)

	1	2	3	4	5	6	7
Agricultural inputs	0	.36	.24	.3	.1	0	.03
Non-agricultural inputs	.48	.02	.09	.3	.5	.6	.38
Facilitory inputs	.11	.16	.07	.1	.1	.1	.03
Other Variable costs	.04	.04	.03	.03	.03	.03	.03
Labor-manufacturing	.08	.07	.09	.1	.1	.1	.09
Labor distribution	.01	.01	.01	.01	.01	.01	.01
Taxes	.15	.15	.15	.15	.15	.15	.15

21. Purchase Source of Inputs to Industry Sector (5.22)

Definition: The proportion of each raw material input which is purchased from a given sector source in the model.

Source: Table 5.d.1 of "Rough Draft Recife Report" and raw data industry sheets from industry survey.

Base Values:

Industry Types (CTD-7)

	1	2	3	4	5	6	7
1	0	.7	.55	.5	.75	0	1.
2	0	.3	.45	.5	.25	1.	0
3	.25	0	0	.5	.1	0	0
4	.75	1.	1.	.5	.9	1.	1.
5	.2	.4	.3	.25	.25	.25	0
6	.2	.1	.25	.25	.25	.25	.4
7	0	.1	.15	.25	.25	.25	0
8	.6	.4	.3	.25	.25	.25	.6
9	.8	.5	.5	.5	.5	.5	.8
10	.2	.5	.5	.5	.5	.5	.2

22. Tentative Distribution of Industrial Output of Processed Food and Consumer Goods (%.41)

Definition: Proportion split of output of these two types between local, rural, and export demand.

Source: Table 5.d.1 of "Rough Draft Recife Report" and raw data sheets of industry survey.

Base Values:

	Processed Food	Consumer Goods
Recife distribution sector	.452	.188
Rural Sector	.411	.413
Export	.137	.399

23. Proportion Split on Net Profits (5.33)

Definition: Split net profits (after taxes) between distributed and undistributed components.

Source: Based on estimates developed by Doctoroff from industrial case studies. (no direct source)

Base Values:

		Industry Types (CTD-7)						
		1	2	3	4	5	6	7
Net Profit Allocation	Distributed	.5	.5	.5	.5	.5	.5	.5
	Undistributed	.5	.5	.5	.5	.5	.5	.5

Parameter Inputs for the Other Recife Sector

Listed below are the "common type definitions" used in the Other Recife Sector:

Common Type Definition-8 (CTD-8)

1. Automobiles and transportation
2. Services
3. Housing-rent
4. Other miscellaneous

5. Construction for industrial capacity (transfer)
6. Other construction (housing, apartments, schools, etc.) (transfer)
7. Capital equipment transfer demand
8. Minimal subsistence
9. Governmental revenues and allocations

Common Type Definition-9 (CTD-9)

1. Consumption Sector automobile transportation expenditures
2. Consumption Sector services expenditures
3. Consumption Sector housing-rent payments
4. Consumption Sector other expenses
5. Distribution Sector variable cost
6. Distribution Sector fixed cost
7. Industry Sector variable cost
8. Industry Sector fixed cost
9. Industry Sector facilitory inputs
10. Investment Sector investment demand for industrial and distributive capacity creating construction generated internally or from programmed change
11. Investment Sector investment demand for other construction
12. Investment Sector capital equipment demand generated internally
13. Minimal subsistence exogenously input
14. Consumption Sector taxes
15. Distribution Sector taxes
16. Industry Sector Taxes
17. Amount of total rent payments allocated to taxes
18. Net flow of government revenue from other areas of the country

Common Type Definition-10 (CTD-10)

1. Net profits from all units
2. Income generated --government
3. Income generated -- from other consumer expenditures
4. Income generated -- from construction
5. Income generated -- from minimal subsistence
6. Net demand transfer from industry sector for construction materials
7. Net demand transfer from industry sector for capital equipment
8. Net demand transfer from industry sector for other industry type output
9. Net demand transfer from south import sector for construction materials
10. Net demand transfer from south import sector for capital equipment
11. Net demand transfer from south import sector for other industry type output

24. Allocation of Terminal Demand to Each Type within the Other Recife Sector (6.11)

Definition: This is a receiver split matrix on terminal demand which allocates the 18 categories of terminal demand to the 9 function types defined in the Other Recife Sector.

Source: Most of the entries are non-variable direct allocations. Where splits had to be made on the terminal demand, they were estimated by the research staff.

Base Values:

Units Defined in Other Recife Sector (CTD-8)

Terminal Demands (CTD-9)	1	2	3	4	5	6	7	8	9
1	1	0	0	0	0	0	0	0	0
2	0	1	0	0	.	.	.	.	.
3	0	0	1	0	.	.	.	.	.
4	0	0	0	1	.	.	.	.	.
5	.4	.3	.2	.1	.	.	.	.	.
6	0	0	0	0	.	.	.	.	.
7	.2	.2	.4	.2	.	.	.	.	.
8	0	0	0	0	.	.	.	.	.
9	.5	.4	.1	.	0	.	.	.	.
10	0	0	0	.	1	0	.	.	.
11	.	.	.	.	0	1	0	.	.
12	.	.	.	.	.	0	1	0	.
13	.	.	.	.	.	.	0	1	0
14	.	.	.	.	.	.	.	0	1
15	.	.	.	.	.	.	.	.	1
16	.	.	.	.	.	.	.	.	1
17	.	.	.	.	.	.	.	.	1
18	0	0	0	0	0	0	0	0	1

25. Inter-function I/O matrix (6.12)

Definition: The parameters included in this matrix measure the degree of inter-unit transactions which take place between the nine economic units defined in this sector. Each I/O entry is the technical coefficient on the column unit's output which is demanded from the row unit.

Source: Very little information was available on these relationships. The estimates were made by the research staff.

Base Values:

Units Defined in Sector (CTD-8)
(these units sell to)

Units defined in Sector (CTD-8) (these units buy from)		1	2	3	4	5	6	7	8	9
	1	0	.05	.05	.05	.15	.15	0	0	.1
	2	.05	0	.05	.05	.05	.05	0	0	.05
	3	.08	.1	.05	.05	.01	.01	0	0	0
	4	0	0	0	0	0	0	0	0	.05
	5	.05	0	0	.05	0	0	0	0	0
	6	0	.05	.40	.05	0	0	0	0	0
	7	0	0	0	.05	0	0	0	0	.1
	8	0	0	0	0	0	0	0	0	0
	9	.1	.1	.1	.1	.05	.05	0	0	0

26. <u>Source Split Matrix on the External Input Demand Transfers and Income by the Other Recife Sector</u> (6.3)

Definition: This matrix of parameters determines the location of purchase of the externally demanded inputs of labor, material and equipment. Each column represents the proportional allocation of that unit's input demand.

Source: Again, no direct data source can be cited for this split on external demand. Best estimates were developed by the research staff.

Base Values:

Units Defined in the Other Recife Sector (CTD-8)

Sources of Purchase of external demands by product type		1	2	3	4	5	6	7	8	9
	1	0	0	.2	0	0	0	0	0	0
	2	0	0	0	0	0	0	0	0	.5
	3	.2	.7	.15	.6	0	0	0	0	0
	4	0	0	0	0	.2	.2	0	0	0
	5	0	0	0	0	0	0	0	1.	0
	6	0	0	0	0	.25	.25	0	0	.1
	7	0	0	0	0	0	0	.1	0	.1
	8	.1	0	0	0	0	0	0	0	0
	9	0	0	0	0	.29	.29	0	0	0
	10	0	0	0	0	0	0	.9	0	0
	11	.42	0	0	0	0	0	0	0	0

27. Minimal Subsistence Income (6.1)

Definition: Exogenously input value of wages which cannot be accounted for in the current system. This input is a balancing term for income sources in the system.

Source: For the initial time period in the model, this figure is derived from the difference between the expected level of income and the level of income actually generated by the explicitly included sectors in the model.

Base Values:

Time Period				
1	2	3	4	5
65	70	75	80	85

28. Net Tax Inflow (6.11)

Definition: The value of the net inflow of government revenues from all other regions in the country (primarily federal). Input in millions of U.S. dollars.

Source: Derived from estimates on the level of government wages generated in Recife area and the proportion which wages are to total revenue. (no direct data source)

Base Values:

Time Period				
1	2	3	4	5
50	55	60	65	70

29. Exogenously Input Investment Funds (6.1)

Definition: The value of exogenous investment funds applied to the purchase of labor, material, and equipment in the Recife area. This includes all investment internally generated in all of the other sectors except within the Other Recife Sector.

Source: These base estimates were generated from estimates of internally generated funds in the Distribution and Industry Sectors and the commitment of "34/18" funds in the area. See Rough Draft Recife Report Chapter 5, Tables 5.c.3, 5.c.4, and 5.c.5.

Base Values:

Year	Construction	Equipment
1	30	25
2	32	26
3	34	27
4	36	28
5	38	29

Parameter Inputs for the Rural Sector

30. Modern Land Yields(7.11) (T)

Definition: Average yield for modern special types of producers. The value of output per hectare (in US$ 000)

Value per hectare = US$ exchange rate to NCr x NCr$ price per ton x tons produced per hectare (000)

Source: Not used in base simulation (see Rural reform option)

31. Modern Land Area (7.11) (T)

Definition: Total land area to which modern yield applies. Input in thousands of hectares.

Source: Not used in base simulation (see Rural reform option)

32. Traditional Land Yields (7.12)

Definition: Average yield for traditional special types of producers. The value of output per hectare (see #30).

Source: For rice, see Chapter 9 of the LAMP/LAFS Report, Table 9.22; for beans and cotton, see Table 8.2.

Base Values:

Beans $.075 = (.037 \times 3400 \times .6) \times 10^{-3}$
Rice $.114 = (.037 \times 1800 \times 1.7) \times 10^{-3}$
Cotton $.037 = (.037 \times 3000 \times .33) \times 10^{-3}$

33. Traditional Land Area (7.12) (B,T)

Definition: The total land area which applies to the traditional special types defined for reform analysis. Input in thousands of hectares.

Source: LAMP/LAFS Report, Table 8.1.

Base Values:

Year	Beans	Rice	Cotton
2	486	76.5	860
3	510	80.5	870
4	535	84.5	880
5	560	88.5	890

34. Initial Rural Output (7.13)

Definition: Initial time period output of the Rural Sector; input in millions of U.S. dollars. All rural output is included in this sector except that defined in the special modern-traditional types. This is input only in the initial time period.

Source: Based on IBGE, 1966, pages 101-108, 112, 113, 117, 132. The estimates generated from this source were increased by 5% and inflated to reflect the increased rate of exchange and dividend by the base year rate of exchange. See also LAMP/LAFS Draft Report, Table 7.2

Base Values:

1.	Agricultural food output	200.0
2.	Agricultural non-food output	28.6
3.	Extractive Industry	4.7
4.	All other industry	238.0

35. Growth Rate in Rural Output (7.13)

Definition: The expected growth rate in output in the four major rural product types. Input in millions of U.S. dollars.

Source: Based on extrapolations of 1966 IBGE information; LAMP/LAFS Draft Report, Table 7.2; and Projections of the Supply and Demand for Farm Production in Brazil, Getulio Vargas Foundation Study, Vol. 1, 1966, pages 65, 75, and 93.

Base Value:

Estimated at 5% per year.

36. On-farm Consumption for Traditional Operators (7.15)

Definition: The proportion of total output of traditional special types considered on-farm use for both consumption and input.

Source: Estimated by rural staff compiled from LAMP/LAFS Draft Report, Chapter 9, Tables 9.a.5 and 9.b.5.

Base Values:

Rice	.2
Beans	.15

37. On-farm Consumption for Other Rural Food Output (7.15)

Definition: Proportion of total food output which is considered on-farm use for both consumption and as an input factor.

Source: Estimated by rural staff from extrapolations of the information collected in the four-state area and project working memorandums.

Base Values:

.2

38. On-farm Rate of Spoilage for Modern Producers (7.18)

Definition: Spoilage as a proportion of total output value (only spoilage before first sale).

Source: Estimated by rural staff based on current traditional spoilage rate and project memoranda on some demonstration projects.

Base Values:

Rice	.01
Beans	.03
Cotton	.01

39. On-farm Rate of Spoilage among Traditional Producers (7.18)

Definition: (see #38 above)

Source: LAMP/LAFS Draft Report, Chapter 9

Base Values:

Beans	.08
Rice	.04
Cotton	.02

40. On-farm Spoilage for Other Food Production (7.18)

Definition: (see #38 above)

Source: Estimated by rural staff using information from farmer survey and Getulio Vargas Study, page 65.

Base Value:

.06

41. Rate of Spoilage in Distribution for Food Products (7.23)

Definition: The proportion of total food available for sale assumed to spoil in rural distribution by location of sale.

Source: LAMP/LAFS Draft Report, Chapter 8 and 9, Getulio Vargas Study, page 65.

Base Values:

Local rural use	.12
Recife	.06
Export	.03

42. Allocation of Rural Food Output (7.20)

Definition: Proportional split of rural food output between Recife, the Rural Sector, and exportation.

Sources: Compiled by project staff from estimates of exportation, and channel maps in Chapter 9 of LAMP/LAFS Draft Report.

Base Values:

Recife	.15
Rural	.73
Export	.12

43. Allocation of Other Rural Output (7.21)

Definition: Proportion of non-food agricultural output, extractive production, and other rural output which is exported.

Source: Estimated by rural staff from information in IBGE on exportation, the Hawaiian Agronomic Report, Statistics from Recife Port Authority, and Table 9B2 in LAMP/LAFS Draft Report.

Base Values:

.05
.5
.2

44. Base Year Non-Farm Income (7.31) (B)

Definition: Total value of income to rural non-farm consumers. Input in millions of U.S. dollars.

Source: Estimated by Webb, Larson and Harrison. Constructed from estimated per capita income in the towns of the four-state area times the estimates of population in those towns derived from IBGE and Pernambuco state statistics. Estimated current per capita income is $70 and population 2 million.

Base Values:

Time Period				
1	2	3	4	5
140	147	154	162	170

45. Total Farm Income (7.31) (B)

Definition: Total value of income of rural farm consumers. This includes on-farm consumption valued at final prices. Input in millions of U.S. dollars.

Source: Derived from population and per capita income estimates and from Chapter 7 of the Final Report. Estimated current per capita income of $65 and population of 5 million.

Base Values:

Time Period				
1	2	3	4	5
325	338	352	366	380

46. Average Propensity to Consume -- Non-farm Consumers (7.31)

Definition: Proportion of total income spent for food, consumer goods, miscellaneous (services, rents, taxes) and savings.

Source: Estimates derived from basic data in LAMP/LAFS Draft Report, Chapter 8; farmer surveys; Getulio Vargas Study, pages 45 and 57; and U.S. Department of Defense nutritional study.

Base Values:

Food	.65
Consumer goods	.18
Miscellaneous	.15
Savings	.02

47. Average Propensity to Consume -- Farm Consumers (7.31)

Definition: (see #46 above). This includes portion of food used on the farm.

Source: Farmer surveys; Getulio Vargas Study, pages 45, 47, and 57; and Northeast Brazil Nutrition Survey.

Base Values:

Food	.7
Consumer goods	.2
Miscellaneous	.09
Saving	.01

48. Rural Distribution Margins for Food (7.20)

Definition: Gross margin as a proportion of output available for sale to rural internal consumption, Recife and export.

Source: Chapter 9 Final Report modified by rural project staff. See respective channel maps in Chapter 9.

Base Values:

Rural internal	.07
Rural consumption	.15
Recife	.3
Export	.1

49. Technical Coefficients -- Modern Operators (7.41)

Definition: Technical coefficients on all inputs of modern special types, measured in value input to value output.

Source: Technical coefficients on inputs for modern operators estimated by rural staff. Based on evidence of what a few modern operators in Bahia and other areas demonstrated and an extrapolation of Getulio Vargas Study results.

Base Values:

	Beans	Rice	Cotton
Labor	.5	.55	.5
Farm inputs	.1	.1	.1
Raw material --food	.07	.07	.07
Raw material --non-food	.03	0	.02
Other variable costs	.03	.03	.03
Residual investment expenses	.15	.12	.15
Residual profits	.12	.13	.13

50. Technical Coefficients -- Traditional Operators (7.41)

Definition: Technical coefficients on all inputs for traditional special types. Input as value of input to value of output.

Source: Technical coefficients on inputs for traditional farmers, see Chapter 8 of LAMP/LAFS Draft Report.

Base Values:

	Beans	Rice	Cotton
Labor	.8	.85	.8
Farm inputs	.05	.02	.05
Raw material --food	.03	.05	0
Raw material -- Non-food	0	0	.03
Other variable costs	.03	.01	.03
Residual investment expenses	.04	.02	.04
Residual profits	.05	.05	.05

51. Technical Coefficients on Inputs for the Other Four Rural Categories of Output (7.41)

Definition: Technical coefficients on all inputs for the four major categories of rural output. Input as value of input per unit value of output.

Source: Estimated by Webb, Larson and Harrison based on data from IBGE, rural surveys, and industry survey; U.S. Department of Defense nutritional study; Getulio Vargas Study, page 82; staff memos and labor information in farmer surveys.

Base Values:

	Other Food	Non-Food Agruculture	Extractive	Other
Labor	.72	.72	.65	.15
Farm inputs	.05	.05	0	0
Raw material -- Food	.03	0	0	.15
Raw material -- Non-food	.03	.03	.1	.4
Other variable costs	.02	.05	.1	.15
Residual investment expense	.05	.05	.05	.05
Residual profits	.1	.1	.1	.1

52. Source Split Matrix on Rural Factor Inputs (7.43)

Definition: Source split matrix on the total demand for inputs by the Rural Sector. Each entry is the proportion of a given input which comes from a given source

Source: Estimated by project staff using IBGE data, project memoranda, and MSU/SUDENE rural surveys.

Base Values:

	Location		
	Recife	Rural (internal)	Import/Export
Labor	0	1	0
Farm inputs	.6	0	.4
Raw material -- Food	0	.8	.2
Raw material -- Non-food	.2	.4	.4
Other variable costs	.2	.7	.1
Investment-associated expenses	.15	.45	.4
Net Profit allocation	.2	.55	.1

Hypothesized Parameter Changes with Reform Options

All estimates made in the previous section are utilized in the reform simulations except where specifically noted below. Of the parameters assumed to be time-variant in the base simulation, shopping propensities and traditional land areas under production of beans, rice and cotton are further altered. Other time-variant changes are retained in the simulation of reform programs. Additional time-variant parameter changes are added to those assumed in the base simulation.

Modern Discount Supermarket Reform Program

A. Average Propensity to Shop (4)

Source: Again Chapters 3,5, and 6 of the Nason Thesis present the justifications for these changes, especially the summary and conclusions of Chapter 3.

Reform Simulation Values:

Expenditures for Food in Modern Food Outlets

Consumer Types (CTD-1)

Year	1	2	3	4	5
1	.3	.25	.15	.1	0
2	.375	.315	.21	.15	.05
3	.45	.38	.27	.2	.1
4	.525	.445	.33	.25	.15
5	.6	.51	.39	.3	.2

Expenditures for Food in Traditional Food Outlets

Consumer Types (CTD-1)

Year	1	2	3	4	5
1	.5	.63	.75	.84	.95
2	.425	.565	.69	.79	.9
3	.35	.5	.63	.74	.85
4	.275	.435	.57	.69	.8
5	.2	.37	.51	.64	.75

Expenditures for Consumer Goods in
Modern Food Outlets

Consumer Types (CTD-1)

Year	1	2	3	4	5
1	.03	.04	.05	.05	0
2	.037	.047	.056	.055	.005
3	.044	.054	.062	.06	.01
4	.051	.061	.068	.065	.015
5	.058	.068	.074	.07	.02

Expenditures for Consumer Goods in
Traditional Food Outlets

Consumer Types (CTD-1)

Year	1	2	3	4	5
1	.05	.11	.2	.45	.7
2	.043	.103	.194	.445	.695
3	.036	.096	.188	.44	.69
4	.029	.089	.182	.435	.685
5	.022	.082	.176	.43	.68

B. Relative Price Index (7)

Source: Chapter 3 section on summary and conclusions of the Nason Thesis.

Type of Distributive Outlet (CTD-)

Year	1	2	3	4	5	6	7
1	.92	.94	1.	1.	1.	.93	1.
2	.917	.937	.995	.997	1.	.93	1.
3	.914	.934	.99	.994	1.	.93	1.
4	.911	.931	.985	.991	1.	.93	1.
5	.908	.928	.98	.988	1.	.93	1.

C. Gross Margin (8) and Rate of Spoilage (9)

Source: See Table 3.14 in Nason Thesis for some of the basic information used in estimating these changes.

Reform Simulation Values:

Modern Outlets (food sales)

Year	(1-Margin)	Spoilage
1	.8	.01
2	.803	.013
3	.806	.016
4	.809	.019
5	.812	.022

D. Location of Purchase of Food by Modern Outlets (16)

Reform Simulation Values:

	Processed Food		Non-Processed Food
Year	Recife Industry	South-Import Sector	Rural Sector
1	.42	.25	.21
2	.407	.237	.236
3	.394	.224	.262
4	.381	.211	.288
5	.368	.198	.314

E. Investment Expenditures (due to the implementation of the reform program) (29)

Source: Expected level of investment expenditures associated with the implementation of this reform option with expected costs for four-year period (millions of U.S. dollars).

Reform Simulation Values:

Year	
2	1.1
3	2.0
4	.5

Total Urban Modern and Traditional Market Reform

A. Average propensity to Shop (4)

Reform Simulation Values:

Expenditures for Food in
Modern Food Outlets

Consumer Types (CTD-1)

Year	1	2	3	4	5
1	.3	.25	.15	.1	0
2	.35	.29	.19	.125	.03
3	.4	.33	.23	.15	.06
4	.45	.37	.27	.175	.09
5	.5	.41	.31	.2	.12

Expenditures for Food in
Traditional Food Outlets

Consumer Types (CTD-1)

Year	1	2	3	4	5
1	.5	.63	.75	.84	.95
2	.45	.59	.71	.815	.92
3	.4	.55	.67	.79	.89
4	.35	.51	.63	.765	.86
5	.3	.47	.59	.74	.83

Expenditures for Consumer Goods in
Modern Food Outlets

Consumer Types (CTD-1)

Year	1	2	3	4	5
1	.03	.04	.05	.05	0
2	.035	.044	.054	.053	.003
3	.04	.048	.058	.056	.006
4	.045	.052	.062	.059	.009
5	.05	.056	.066	.062	.012

Expenditures for Consumer Goods in
Traditional Food Outlets

Consumer Types (CTD-1)

Year	1	2	3	4	5
1	.05	.11	.2	.45	.7
2	.045	.106	.196	.447	.697
3	.04	.102	.192	.444	.694
4	.035	.098	.188	.441	.691
5	.03	.094	.184	.438	.688

B. Rate of Spoilage (9)

Reform Simulation Values:

Type of Outlet

	Modern		Traditional 1		Traditional 2	
Year	Food	C. Goods	Food	C. Goods	Food	C. Goods
1	1.01	1.01	1.2	1.04	1.1	1.03
2	1.013	1.01	1.175	1.04	1.09	1 03
3	1.016	1.01	1.15	1.04	1.08	1.03
4	1.019	1.01	1.125	1.04	1.07	1.03
5	1.022	1.01	1.1	1.04	1.06	1.03

C. Margin in Modern Food Outlets for Food (8)

Reform Simulation Values:

Year	
1	.8
2	.803
3	.806
4	.809
5	.812

D. Relative Prices (7)

Reform Simulation Values:

Type of Outlet

	Modern		Traditional	
Year	Food	C. Goods	Food	C. Goods
1	.92	.94	1.	1.
2	.915	.935	.987	.995
3	.91	.93	.974	.99
4	.905	.925	.961	.985
5	.9	.92	.948	.98

E. Location of Purchase of Food by Modern Outlets (16)

Reform Simulation Values:

(Same values as used in Modern Discount Supermarket reform, "D".

F. Location of Purchase of Food by Traditional Neighborhood Stores (16)

Reform Simulation Values:

Non-Processed Food

Year	Rural Sector	South-Import Sector
1	.27	.13
2	.283	.117
3	.296	.104
4	.309	.091
5	.322	.078

G. Investment Funds Committed to Reform Program (in millions of U.S. dollars)

Reform Simulation Values:

Year	
1	2.1
2	3.75
3	.75
4	.1

The Total Urban and Rural Reform Program

This reform program includes all parameter changes incorporated for the total urban reform program and adds additional parameter changes in the Rural Sector. See the preceding section for an outline of the parameter changes in the Urban Sector. Below are only those parameter changes in addition to one for the urban modern-traditional reform program.

A. Rural Output. Rate of increase in the output of farm inputs in the Recife Industry Sector is assumed to increase from 5% to 15% over the five-year period. (This, of course, is conditioned by the effects of Decision Routine-Capital II.)

B. Distribution Gross Margins (48)

Reform Simulation Values:

Year	Margin on goods staying in rural area for internal final consumption	Margin on goods going to Recife
1	.15	.3
2	.15	.3
3	.15	.3
4	.14	.29
5	.13	.28

C. Modern Land Yields (30)

Source: The hypothesized increases in yield were estimated using demonstrated effect on some farms in the areas and referring to NO Easy Harvest by Millikan and Hapgood as well as Sugestoes para Adubacao by Robert Cate. (See parameter definition 30 for method of calculation of yields.)

Reform Simulation Values:

	Product Type		
Year	Beans	Rice	Cotton
1	.105	.16	.056
2	.105	.16	.056
3	.12	.182	.056
4	.135	.205	.056
5	.142	.217	.056

D. Modern Land Area (31)
(in thousands of hectares)

Reform Simulation Values:

	Product Type		
Year	Beans	Rice	Cotton
1	0	0	0
2	2.3	.64	10.
3	12.2	3.40	10.
4	38.4	10.60	10.
5	67.0	18.40	10.

E. Traditional Land Area (33)
(in thousands of hectares)

Reform Simulation Values:

	Product Type		
Year	Beans	Rice	Cotton
1	464.0	73.0	852.0
2	483.7	75.9	860.0
3	497.8	77.1	870.0
4	496.6	73.9	880.0
5	493.0	70.1	890.0

F. Investment Fund Committee for Reform Implementation (29)

Year	Urban	Rural	Total
1	2.10	.75	2.85
2	3.75	1.50	5.25
3	.75	2.00	2.75
4	.1	1.50	1.60
5	0	.55	.55

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