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AGRICULTURAL DUALISM AND BRAZILIAN DEVELOPMENT

This research clearly demonstrated the disparities in agricultural growth between groups of farmers in Brazil, especially in the wheat region, and noted the broader interregional disparities which historically existed and appear to be even more accentuated in recent years. This process of growth has contributed to increased dualism in Brazilian agriculture: highly capitalized mechanized farms with low labor/land ratios, and under capitalized traditional small farms using large amounts of labor and little new technology. The dilemma appears to be the classic one of growth versus distributive equity, a theme of increasing importance in developing countries. As noted above, the policies affecting Brazilian agriculture to the greatest extent in the post World War II period are associated into two major sub-periods of development strategies in the country: the first characterized by general neglect and occasional discrimination against agriculture, especially in the 1947-61 period of intense import substitution industrialization, resulted in agricultural growth largely along the extensive margin; the second, beginning in the mid-1960's and continuing to the present, represents a period in which policies have been aimed at agricultural modernization and expanded traditional and nontraditional exports. In the first period, the objectives for agriculture were limited primarily to producing an adeuqate supply of reasonably priced food for urban wage earners and secondarily, generate foreign exchange to finance the importation of the industrial raw materials and capital goods. The assistance granted to agriculture consisted largely of improving extension and marketing services. Since the mid-1960's much greater emphasis has been given to modernization, and accelerating the growth of output and exportation. Emphasis on research increased in the early 1970's. Generally Brazil has been quite successful in meeting its economic objectives. In fact, the high growth rates since 1968 have caused people to speak of the "economic miracle" and make comparisons with countries like Japan. This euphoria may be a bit premature, particularly in view of current energy problems, but clearly the performance has been exceptional in the past few years, in large part due to expert decision making. The emphasis, at least in agriculture, however, has been largely on growth rather than growth with equity. Given the state of the economy when the military took power in 1964, it is easy to understand this orientation. But it is also necessary to call attention to the potential structural problems arising from this approach which may hamper future economic growth and development. The experience of other countries has demonstrated the difficulty in achieving equity, in spite of good intentions, once great inequities have arisen. Perhaps some loss in growth rate occurs when increased equity is pursued, but the results of this and other research, which suggest relatively constant returns to scale in agriculture over a wide range of output levels, imply that the losses might not be that great. If more broadly based growth is desired, the challenge to policy makers is clear and complex. It requires a fundamental rethinking of how millions of Brazilian farmers respond to policies. The tendency has been to view policy making as essentially a "top-down" activity with relatively little feedback about the dynamics of policy impacts. The observed inequalities in resource use, income and growth logically result. A growth-with-equity strategy would have to take into account the heterogeneity of farms and farmer response. Policy making would then involve identifying groups of farmers that are relatively more homogeneous and developing a specific set of policy incentives for each group. The recent efforts of the quasi-public national agricultural research institute (EMBRAPA) to develop region and crop specific technological packages is a promising attempt clearly in the right direction. The scientists and technicians of this institution are to be commended for this

initiative and their appreciation of the complexities of the agricultural development process. Another clear implication of this research is the crucial role which product and factor pricing has on the pattern of farm growth. Brazilian policy makers have consistently espoused the role of the market in allocating resources, yet continuously intervene in the market process in order to influence prices for some specific objective. Generally such intervention has been directed towards increasing the use of certain inputs, expanding output of selected products, or reducing consumer prices. The resulting distortions have helped meet the objectives, at least in the short-run, but have also contributed to resource misallocation and an unequal pattern of participation in the growth process by various groups of farmers. These inefficiencies and inequities could well frustrate future broad based rapid growth. Furthermore, the slow growth in effective demand of the marginalized segment of the rural population may frustrate the continued growth of the industrial sector. Solely removing pricing distortions, as important as that may be, may not constitute, however, the necessary and sufficient conditions for broader based agricultural development. Structural change needs to be attacked simultaneously. This research has shown how differential resource endowments and access to resources and policy incentives contributes to uneven farm growth. Land reform, credit for land purchases, effective land taxation, and improvements in the land market may be necessary to form the basis for more equitable growth where agricultural production is still largely a function of combining land with labor. More yield increasing technologies are also required so that increases in income are not restricted just to enterprise changes or mechanization. Rural education, now lamentably inadequate, must be improved and universalized so that farmers are better prepared to seek out and understand new information as well as provide a more productive source of labor when they choose urban employment. Extension workers must be provided with a larger stock of technological alternatives and must be freed of a myraid of administrative functions and a bias to concentrate their efforts on large farms. Lastly, signs are beginning to appear in Brazil that the past emphasis on the macro approach to the study of agricultural problems is waning and a new interest is emerging in the study of the microeconomics of the agricultural sector. The research reported in this volume has made a small dent in this vast uncharted field. Hopefully it will encourage some of the extremely talented young Brazilian men and women now studying at home and abroad to delve into the problems faced by farms and rural markets which have only been touched upon here. Studies related to such problems as the determinants of consumption and savings, creation of employment, returns from new technology, bottlenecks in input and product markets, impact of inflation and income distribution, exchange rate and other trade policy influences on agricultural trade, and financial market contributions to capital allocation and savings accumulation represent a few of the most crucial items in a long list of research priorities. Of immediate importance is the initiation of a nationwide system for the collection of farm level time series data absolutely essential to effective economic research. This research and the rapidly growing literature on economic and agricultural growth and development in Brazil show that the sleeping giant of the southern hemisphere awoke with a start in the latter half of the twentieth century and shows great potential for becoming a commanding influence in the economy and politics of Latin America. It holds untapped and underutilized agricultural resources that could become one of the important breadbaskets to help feed the hungry world. By achieving high growth rates for several years, it has demonstrated a capability to effectively draw some of these resources into production. But if it is to

realize its true economic potential and maintain long term high growth rates, it must begin to more effectively harness its most valuable resource, a resource largely overlooked in recent years - the growing quantity and quality of its peoples. When that occurs, we can justifiably refer to the "Brazilian Economic Miracle."

FINAL REPORT

June, 1975

FARM GROWTH IN BRAZIL

CHAPTER ELEVEN

The Ohio State University Research Team

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PREFACE

In 1969 the U.S. Agency for International Development through its Technical Assistance Bureau contracted with the Research Foundation of The Ohio State University to conduct an "Analysis of Capital Formation and Technological Innovation at the Farm Level in LDC's," (hereafter referred to as the Capital Formation Project). USAID financial support covered the period July 1, 1969 through October 31, 1974.

Responsibility for the Capital Formation Project rested with the faculty of the Department of Agricultural Economics and Rural Sociology. Norman Rask was the research team leader throughout the life of the project. Richard Meyer served in Brazil as Project Chief of Party coordinating the extensive primary data collection and preliminary analysis efforts. Upon return to Columbus, he served as a member of the research team and with Norman Rask coordinated the writing of this monograph which constitutes the final report of the project. Members of the research team, responsible for specific areas of project research included Dale Adams, David Francis, Terry Glover, Donald Larson and Inderjit Singh.

The principal project objectives were: (1) To investigate and describe capital formation and utilization at the farm level, including the impact of technological change on the need for capital and on the capital formation process, and (2) To evaluate the implications and impact of selected policies designed to stimulate capital formation. Research was initiated in Brazil and was limited to that country when conditions prevented expanding the research to India as originally planned.

The farm firm was the principal unit of analysis for the investigation and was viewed as the primary building block in the chain of production and marketing firms involved in development of the agricultural sector. The research procedure was to discover, measure and better understand the impact on farm firm decisions of major changes in government programs, world market conditions, and new technology. Such analysis required extensive farm level data and little existed in Brazil. As a result, collaborative research arrangements were established with several Brazilian institutions. The institutions were selected because of their knowledge of particular agricultural regions and expertise to assist in designing survey instruments and in collecting the data through personal interviews with farmers.

Utilization of the research results and improvement of local research capabilities were also important considerations. Thus during the course of the research, several efforts were made to communicate and interpret preliminary results for several Brazilian agencies and professionals and the local USAID Mission through seminars, meetings, and informal contacts. Furthermore, students and faculty at each of the collaborating institutions were involved in questionnaire design, sampling, interviewing, data manipulation and analysis, and in all cases a set of data was retained by the local institution as part of data banks that were being developed.

In any project of this scope many individuals play key roles and many institutions make significant contributions. We would like to mention some of those without whom the research could not have been initiated or conducted. In USAID/Washington Dr. Erven Long was an

instrumental force in the project's inception and provided counsel throughout its duration. Members of the USAID/Washington Technical Assistance Bureau who assisted were: Dr. Douglas Caton, Dr. Larry Witt, Dr. Arthur Coutu, Dr. Harold Jensen and Dr. Lehman Fletcher. In the USAID Mission to Brazil, William Ellis, Mission Director; Michael N. Galli, Deputy Chief of ARDO; William Rodgers, Chief of ARDO; Dr. Harlan Davis, Agricultural Economist; Ralph Miller, Deputy Chief USAID/PASA; Dr. Stanley Krause, Agricultural Economist; and David Cohen, Program Office; as well as several other members of ARDO and the USAID staff provided much appreciated in-country support and administrative backstopping.

The Central Bank and the Ministry of Agriculture served as official contact with the Brazilian government and provided encouragement for the initial studies. In particular Ary Burger, Director of the Central Bank provided valuable assistance. The Instituto de Estudos e Pesquisas Economicas da Universidade Federal do Rio Grande do Sul was the first institution to conduct a survey under the Project. We owe a great deal to the foresight and effort of Mauricio Filchtiner, Director and Eli de Moraes Souza, Chief of the Agricultural Economics and Rural Sociology Section, in getting that survey underway and to several other staff and students that so successfully completed subsequent surveys and analysis on the data collected in that state. Closely related to this first effort, a survey was conducted in the state of Santa Catarina in conjunction with the Instituto de Pesquisas e Estudos Economicos da Universidade Federal de Santa Catarina with Carlos Jose Gevaerd playing an important role in that work. An old friend and distinguished col-

league, Paulo F. Cidade de Araujo, was instrumental in assisting with the research that was conducted in Ribeirao Preto in the state of Sao Paulo in 1970. Several other staff members and students in the Departamento de Ciencias Sociais Aplicadas of the Escola Superior de Agricultura "Luiz de Queiroz," including Joaquim J. de Camargo Engler who later became head of the department, were very supportive of the several economic and sociological studies conducted in Sao Paulo, and were patient and much appreciated counselors and hosts to the several OSU staff that resided in and passed through Piracicaba. The research conducted in the state of Minas Gerais owed much to Helio Tollini, then Director of the Instituto de Economia Rural, Universidade de Minas Gerais in Vicosa; H. Evan Drummond, Ph.D. student at Purdue University; and Julian H. Atkinson, Chief of Party of the Purdue-Vicosa Institution Building Project.

While analysis of the data collected in these four states moved forward, the USAID Mission contracted with Ohio State University to provide support to the newly created Escritorio de Analise Economica e Politica Agricola of the Ministry of Agriculture. The first director of that office, Francisco Vera Filho, and his successor, Alberto Veiga, along with Iby Pedroso organized a survey in the state of Ceara which collected data similar to the type collected in the four other states and made it available to the Project. Faustino de Albuquerque Sobrinho of the Universidade Federal do Ceara and Roger Fox of the University of Arizona - Ceara Institution Building Contract were instrumental in making local arrangements. The Banco do Nordeste contributed resources and staff to that survey as well.

Special appreciation is also extended to the many interviewers and drivers in each survey region that spent long, hot, dusty hours locating and interviewing farmers. The Brazilian farmers we interviewed displayed great patience and excellent cooperation by completing long interviews as accurately and thoroughly as possible. To them we extend special thanks.

The research that went into this report involved many staff and students at both OSU and several of the institutions just mentioned. The training of graduate students was an integral aspect of the Project, both in the U.S. and Brazilian Universities and will no doubt remain one of its chief benefits long after the findings of this research become outdated.

Clearly, the research findings summarized in this report emanate from a successful team effort. However, it is appropriate to recognize explicitly those individuals most directly responsible for major parts of the report.

Chapter 2	Douglas Graham
Chapter 3	Richard Meyer
Chapter 4	Norman Rask and Richard Meyer
Chapter 5	Norman Rask
Chapter 6	Terry Glover
Chapter 7	Donald Larson and Richard Meyer
Chapter 8	David Francis
Chapter 9	Donald Larson
Chapter 10	Dale Adams
Chapter 11	Inderjit Singh and Choong Yong Ahn

Chapters 1 & 12 Group Effort

In addition, significant contributions to the Project were made by several other OSU faculty members, in particular Bernard Erven, John Sitterley, Francis Walker and Kelso Wessel. Kelso Wessel was a member of the OSU Institution Building Project at ESALQ, Piracicaba, during the initial phase of data collection in the state of São Paulo. He worked with Brazilian faculty and graduate students on questionnaire construction, survey design and supervision of some of the interviewing.

Mrs. June Blind and Ms. Malinda Brenner shared most of the typing of the final version and were ably assisted by several other secretaries in the department on earlier drafts. Ms. Barbara Durman, and Mrs. Margie Butz were responsible for data organization and storage. Mark Hinnebusch did much of the computer programming during the latter part of the Project. The Statistics Laboratory helped with figures, tables and overload typing, while Ms. Marilyn Chute served as a most capable administrative assistant throughout the life of the Project.

While more than forty graduate students have assisted with the processing and analysis of data and many have used portions of the data for their own M.S. theses and Ph.D. dissertations, 9 individuals who were then Ph.D. candidates, deserve special recognition for contributions to the overall Project: John Stitzlein, William Nelson, Gerald Nehman, Hagop Kayayan and Solon Guerrero each spent a year or more in Brazil assisting with data collection and processing; Roger Baur and Choong Yong Ahn assisted with data processing and analysis in Columbus. Joaquim J. de Camargo Engler and Iby Pedroso worked with their respective institutions in data collection and used part of the data for their dissertations.

We would also like to express appreciation to G. Edward Schuh and Pan A. Yotopoulos for highly useful detailed comments each made on an earlier draft of this report. J. K. McDermott also contributed a helpful reaction as did several people in Brazil during a round of seminars conducted in October, 1974. Of course, the authors assume sole responsibility for the contents. The views and opinions expressed do not necessarily represent the views of any persons or institutions in Brazil or the U.S. that collaborated with the Project.

David Boyne
Project Supervisor

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CHAPTER 11

THE MACROECONOMICS OF PRODUCTION: A DYNAMIC MODEL OF THE WHEAT PRODUCING AREAS IN RIO GRANDE DO SUL*

INTRODUCTION

The central theme that has been pursued in this overall report is that the development of the agricultural sector has proceeded successfully in an environment of distortions. This theme is approached from the micro level in Chapter 6 whose purpose was to identify and confirm some of these distortions by examining the microeconomics of production at the farm level. The purpose of this chapter is to approach this problem from a more aggregate point of view, in order to examine the broader impact of these distortions. To do this a model is developed at the regional level to examine some of the macroeconomics of production. Although still partial and regionally confined the model permits us to measure the social welfare costs of the resource misallocation brought about by policy distortions. This chapter thus presents a description

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of a dynamic model of agricultural development for the mainly wheat producing areas in the Northwest region of Rio Grande do Sul in Southern Brazil. The modeling effort is geared to analyzing the impact of the same set of broad policy distortions that are the central theme of the other chapters. This is done through the use of counterfactoral arguments and their simulation using the model.

There are five other objectives of this modeling effort. First, as a methodological exercise, the model is based on an integration of micro-economic firm-household decisions and is intended to show the usefulness of dynamic models as tools for understanding and planning regional development in the agricultural sector. Second, as an analytical tool, the model provides a means for simulating the economic history of regional development by tracking the dynamic path of economic outcomes through time. Third, as a research tool, the model provides a framework for tracing out the expected consequences, in detailed and quantitative terms, of various policy options posited as counterfactual arguments on a variety of indicators. These include regional indices of output, employment, farm incomes, resource allocation and income distributions. These detailed results permitted by this type of exercise are of interest to development economists as well as project administrators. Fourth, as a part of the total effort to understand capital formation and technological change in the agricultural transformation of a region, it complements the descriptive and econometric studies of these processes described in earlier chapters by a) extending the analysis to a regional aggregate and b) examining the detailed cumulative processes of this transformation in a dynamic context. Lastly, as a device for perspective planning it

provides a means for weighing the future consequences of current or contemplated policy choices by supplying short and/or long run projections of regional development.

As a caveat it is useful right at the start to mention some of the severe limitations of the exercise that follows so that the reader also becomes aware of what the model does not do.

To begin with there are the obvious limitation of any attempt to quantify the process of economic transformation. Quantity is arithmomorphic while reality is not as Georgeson-Roegen has pointedly shown.[1/] Thus any tool purporting to describe real processes with quantitative measures alone is likely to be an abstraction. Secondly, institutions and institutional processes which are clearly at the heart of the transformation process are altogether neglected or the "mutatis mutandis" assumption is made in their regard.[2/] We postulate here how decisions are made by farmers and measure their outcomes. We have little to say about the development of institutional infrastructure that must have aided, abetted or impeded these outcomes. Thirdly, although less partial than the analysis of production at the farm level, the model is still partial and totally open. Pertaining to a given region characterized by particular production opportunities, it does not even relate to the agricultural sector in the entire state of Rio Grande do Sul

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1/ Arithmomorphic concepts are those that are discrete and do not overlap. In contrast dialectical concepts which best describe social reality according to Georgeson-Roegen, overlap and violate the principle of contradiction. See [69] Ch. 5.

2/ That is the assumption that attitudes and institutions will automatically be adopted or adaptable to the extent required to allow development to proceed. See [70], Appendix III.

With the enormous diversity in Brazilian conditions for agricultural production its conclusions cannot even apply to the wheat sector of the economy as a whole although it will be argued that the results are indicative of the directions and are useful. Further although some attempt is made to incorporate the impacts of the industrial and foreign sectors and changes in policy decisions on agricultural production, these changes are treated exogenously. No attempt is made to explicitly model the complex intersectoral relationships that evidently have characterized the development of agriculture in Brazil as shown in Chapters 2 and 3. Fourthly, a particular set of optimizing rules are used to define dynamic economic behavior at the farm level and although some primitive attempts are made to incorporate a variety of behavioral rules to enrich the description of the decision process, the model leaves much to be desired, and we are aware of its' limitations. Simplifying assumptions had to be made in order to allow aggregation to the regional level of analysis. Although a more refined model is theoretically possible we also wanted one that was computable with data; one that could become operational. Data and computing costs forced us to tread the middle road and make assumptions that allowed us to actually compute the model. Even so it remains fairly complex. Lastly, we were again forced to concentrate on a small set of policy issues that we felt were important, to the neglect of others that no doubt seem more important in hindsight. Furthermore, stating complex and real policy options as simple counterfactual arguments has its limitations. The almost infinite combinations and permutations of policy parameters that were possible could not all be analyzed. Any particular choice always leaves the curiosity unsatiated and

the results open to question, because other choices were always possible, and in view of someone else more interesting or important.

We hope however that even given these limitations the exercise that follows has some contributions to make both as a methodological device for analyzing complex and dynamic behavior, as well as a tool for analyzing real policy options and better understanding the process of farm growth in Brazil.

The Background

Modern agricultural transformation in the LDC's has been characterized by 1 technological change, both biological and mechanical, which has often been a critical element; 2) mainly privately operated decision making units and 3) strong government participation, either directly through the allocation of scarce resources or indirectly through established markets often effectively directing (distorting) the development process.

The importance of technological change, especially biological innovations associated with the use of high yielding varieties, water and fertilizers, has received considerable attention in recent years. It has been viewed as a necessary and sometimes sufficient ingredient in any plan for increasing agricultural output, productivity, and incomes.[3/] Indeed much of the empirical work in developing agriculture has concentrated on the problems relating to the engineering, economics,

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3/ Biological technologies have repeatedly been emphasized as critical by Hopper [26], Schultz [55] and more recently by Hayami and Ruttan [21].

and diffusion of technological change.[4/]

This singular emphasis can be somewhat misleading, for in its most simplified form, it asserts that without structural change related to the use of new and land intensive technologies, transformation of the agricultural sector in the LDC's would be most difficult if not impossible. This viewwould regard changes in the policy environment, as an "engine of growth," only insofar as policy changes provide the proper "incentives" for the adoption of these and related new technologies. The role of policy incentives in the absence of new technologies is regarded as minimal, and often ignored as a viable alternative strategy for agricultural transformation.

This single minded emphasis on new land-intensive technologies of-course stems from the preoccupation with those LDC's where the land/population ratios are low and declining due to high rates of population growth. This has led to the growing interest in the successful transformation in countries such as Japan, Korea, and Taiwan. Given the urgency of the problem and the large populations involved in LDC's that have such low land/population ratios this preoccupation will continue to occupy center stage, and continue to call for strategies that focus on increasing physical output per hectare.

But this cannot be the total concern of all those studying agricultural development. In other developing countries, characterized by relatively high land-man ratios, considerably different strategies have been used. Here price incentives to stimulate production have often

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4/ The problems of diffusion have not received the attention they deserve by economists in spite of the pioneering work by Griliches [20] in the U.S. indicating their critical importance. Diffusion has been the prime domain of sociologists like Rogers [52] and more recently of geographers like Brown [8] interested in its spatial aspects.

formed the core of the development strategy. Through a variety of market and non-market intervention, government policies, especially in product and factor markets, have been critical. Where land is available, the goal has been to bring it into use at the extensive margin, by providing the incentives for doing so. These strategies, designed mainly to stimulate production also have however had an impact on the efficiency of resource allocation, employment and income distribution that has not been fully understood or taken into account.

The development in Southern Brazil, especially in the wheat producing areas of Rio Grande do Sul, is a case in point. During the decade of the sixties, this region saw considerable growth in real agricultural output and a persistent transformation of the regional economy from range livestock production to intensive crop production. This transformation was made possible through a large program of price supports for wheat producers tied to subsidized credits available for the purchase of modern capital intensive inputs. As a consequence, total output, factor productivity and farm incomes increased substantially bringing considerable economic prosperity to the region.[5/] However, little change occurred in the biological conditions of production. Yields per hectare and per animal remained relatively stagnant throughout the decade. The distribution of farm incomes worsened while a considerable misallocation of scarce resources, especially capital resulted, as we hope to show in our analysis.

In this context, the role of pricing policies and their impact takes on a special significance and becomes a point of departure for the study

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5/ For a detailed description of this process, see Rask [42], Rask and Meyer [47], and Chapters 4 and 5.

of agricultural transformation in Southern Brazil. Government pricing policies, however, do not operate in a vacuum. Their eventual impact depends upon how they affect decision makers on the farm and in the market. With respect to the allocation of scarce resources, decision making at the farm level becomes the eventual filter through which both technological change and government policy have to pass in order to have any impact. Thus, an understanding of farm level decision making also becomes a central feature in this study. Government policy actions, especially those relating to price incentives, are viewed as affecting either the payoffs (opportunities) and their expectations or the resource endowments (constraints) facing farm level decision makers in the farm sector.[6/]

This interaction of policy and farm level decisions is further complicated by two factors. First, the farm involves two distinct but interdependent decision units--the farm and the household. In this and in a development context, production decisions involving the allocation of scarce firm resources cannot properly be separated from investment decisions and household consumption and resource use decisions.[7/] This interdependence and its consequences for studying the development process is receiving increasing attention. In the absence of a well formulated theory of firm-household decision making, little empirical work has attempted to incorporate these decisions within a single

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6/ See Day and Singh [12] for further treatment of how policy changes can be treated in regional agricultural sector models.

7/ See Day and Singh [12] Adams and Singh [3] and Singh [56] for a discussion of some of these relationships.

framework.[8/]

A second complication arises from the fact that farms and farmers are not homogeneous, either with regard to their relative factor endowments or in their response to economic incentives. Many though not all of these differences, not directly related to the difference in the physical environment of production-soil, climate, topography- which are obviously critical to agricultural production - are associated with the size of the operational unit.

The importance of farm size and its relation to such factors as economies of scale, risk and uncertainty and market response has long been emphasized by many economists.[9/] Heady suggests that the difference in farm size is one of the most important factors explaining differences in the decision making process of farm-firms, especially in response to various economic opportunities involving risk and uncertainty. More recently, in the study of agricultural development in the LDC's, special emphasis has been given to the nature of subsistence production and the market response in small farm peasant agriculture.[10/] Where such units exist, side by side with larger and more commercialized units, the larger farms through their greater access to technology, management

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8/ This interdependence and its consequences have been emphasized by Mellor [36], Nakajima [38], and Heady et.al. [23]. Although empirical work emphasizing microeconomic decisions has been very limited, not until the recent work by Becker [71] has attention again been focused on this interdependence. Some notable attempts can be cited (Yotopoulos [68] and Raj Krishna [31]).

9/ See Steindl [63], Hicks [25] and Heady [22, Ch. 8].

10/ That is where a large proportion of the farm output is retained for family consumption and a large proportion of the total labor input is family labor. See Singh [57], C. Wharton, Jr. [66] Nakajima [38] for a more detailed exposition on the nature of subsistence production and its implications for economic analysis of agricultural production.

and factor and product markets, usually reap a disproportionate share of the gains when transformation gets under way.

These differences are critical in a region like Southern Brazil where the size of the operational unit may vary from less than ten hectares to several thousand hectares. Regional aggregates, in such a case, tend to obscure rather than highlight these differences in farm endowments, farm response and policy impact. Thus, farm size and the resulting differences in resources, both initially and as they become cumulative over time, need to be explicitly treated.

In the context of these specifications, this study seeks to model regional agricultural development and attempts to track the process of transformation that occurred in the Northeastern region of Rio Grande do Sul in the decade of the sixties. It does this by analyzing the role of selective policies in which this transformation occurred. Further it integrates firm-household decisions and although regional and aggregate in scope, it treats farm size differences explicitly.

For these purposes the model that is developed attempts to: 1) focus on the decision making process at the farm level, and integrates consumption, production and investment decisions in a single framework; 2) incorporate both the biological and mechanical components of technological change; 3) trace the path of regional development of farms of different size, with different initial factor endowments, which compete for common regional resources; 4) test the model in terms of its ability to capture the process of regional transformation; 5) trace quantitatively (i.e. simulate) the impact of major policy changes, both for the subsector and by farm size, on such factors as output, employment, capital and

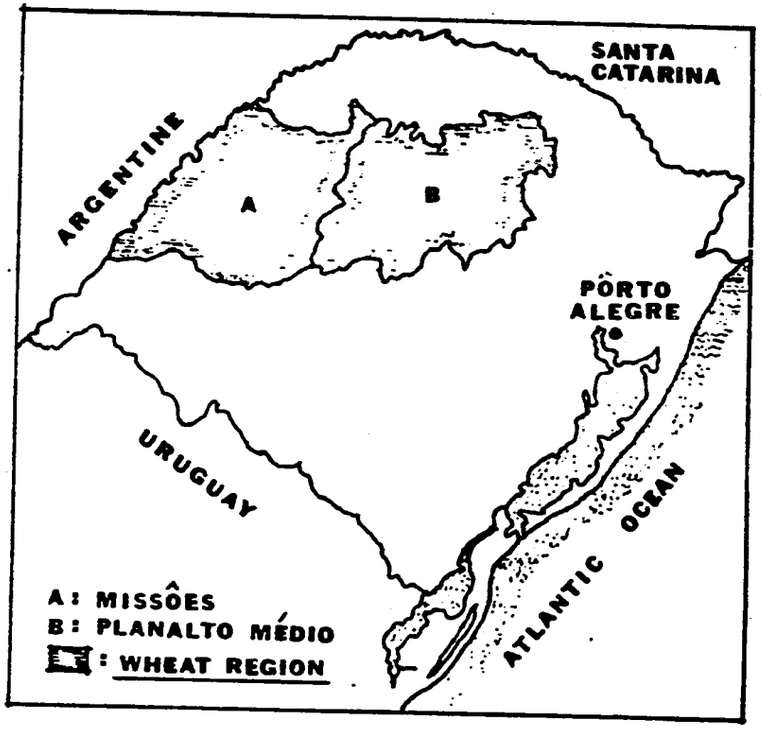
credit use, choice of technologies, factor productivities, factor proportions and farm income distribution. The model uses an essentially "bottoms-up" approach by aggregating respesentative microeconomic units to the regional or subsector level. This methodology is in a growing tradition which emphasizes the use of quantitative models for the analysis of the process of development in the agricultural sector.[11]

THE WHEAT REGION IN RIO GRANDE DO SUL

The present study and model structure have been tailored to the wheat growing areas of Rio Grande do Sul in Southern Brazil. These comprise some 24 municipios in two adjacent regions called Planalto Medio and Missoes.[12] This fairly homogeneous region includes some 5.7 million hectares of cultivated land - about a quarter of the total land area in the state. In 1970, the state of Rio Grande do Sul accounted for some 87 percent of the area sown to wheat, while the region of study accounted for 42 percent of the area sown to wheat in the state. So it is fairly representative of the main wheat growing regions in Southern Brazil. In addition to wheat, the region also accounted for about a third of the soybean area and production in Brazil. Corn production among small farmers and beef production on extensive pastures among larger farmers are also among the important agricultural enterprises in the region.

11/ See the reviews by Thorbecke [65] and Singh [58] on new methods in agricultural sector analysis and Rice et.al [51] for a review of earlier work in this area.

12/ These municipios and the corresponding micro-regions in Rio Grande do Sul are listed in Ahn [4]. See Figures 1 and 2 for general location of the municipios.



RIO GRANDE DO SUL

FIGURES 1 and 2: Principal Wheat Producing Regions, Rio Grande do Sul

As shown in Table 1, there is a wide distribution of farm size in the region resulting in substantial differences in relative resource endowments at the farm level.[13/]

TABLE 11-1

Farm Size Distribution in the Wheat Region of Rio Grande do Sul in 1967

Hectares	Number of Farms	Percent of Total Farm Area	Land Used (1000 Ha)	Percent of Total Land Used
0-25	65,054	67.32	753,155	13.76
26-50	15,807	16.35	541,606	9.89
51-100	7,485	7.74	506,092	9.25
101-1,000	7,558	7.82	2,112,646	38.61
1,011-10,000	729	0.77	1,557,784	28.49
Total	96,633	100.00	5,471,283	100.00

Source: Estrutura Fundiaria do Rio Grande do Sul - Instituto Brasileiro de Reforma Agraria Delegacia Regional do Rio Grande do Sul.

Until the early sixties, most of the region was given over to large estates for the production of beef on extensive natural pastures. With the advent of special pricing and credit incentives, this region underwent a rapid transformation. These policies - which included price supports for wheat and liberalized credit - were designed to increase the production of wheat. Their detailed impacts are described elsewhere.[14/]

The price support program for wheat was started in 1962 with the Bank of Brazil standing ready to purchase wheat at the official support

13/ Rask [42], [43].

14/ See Chapters 4, 5 and Rask and Meyer [47].

price. By 1970, this support price stood at a level nearly 80 percent above the U.S. export price.[15/] The relative profitability of wheat increased substantially compared to traditional activities such as beef production as stated in Chapter 3. The ratio of wheat to beef prices in the domestic market nearly doubled between 1963-70. By way of contrast this ratio in international markets continued to decline steadily during the same period as shown in Table 2. This meant that there was an effective program of import-substitution in the production of wheat, made possible partly by the wheat price supports. By 1970 the ratio of wheat to beef prices in Brazil was nearly four times larger than this ratio in international markets.[16/]

The improved profitability for wheat was accompanied by large credits, tied to the purchase of modern inputs, on very liberal terms. After 1964, modern variable inputs, such as seed, nutrients and pesticides could be purchased 100 percent on credit, at a nominal interest rate of 15 percent per annum, while farmers could obtain long-term, low-interest financing for agricultural machinery with a 25 percent down payment at a 7 percent rate of interest. Meanwhile the wholesale price index for foodstuffs increased by an average of 60 percent annually between 1960-66 and 23 percent annually between 1967-71. Thus, in effect, due to inflation, the real rate of interest on farm credits was

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15/ Since 1962 the domestic wheat price steadily rose above the U.S. export price of wheat. For example, in 1970 the Brazilian Government fixed the domestic wheat price at U.S. $100 per metric ton, while the price for imported wheat is U.S. $58 per metric ton, see Engler [15].

16/ The international wheat and beef prices here refer to the F.O.B. prices of U.S. wheat (unmilled) export and the Argentina beef (chilled and frozen) export prices respectively.

Table 11-2. Prices for Wheat and Beef in Brazil and in International Markets (1960-1970)
In Cr$/Kilogram

	WHEAT (unmilled)		BEEF (Chilled & frozen)		Ratio of Wheat to Beef Prices		Exchange Rate*
Year	Brazil[a]	U.S. Exports[b]	Brazil[c]	Argentine Exports[b]	Domestic Market	International Market	Cr$/US$[d]
1960	0.0164	0.0127	0.072	0.0913	0.228	0.139	0.205
1961	0.0224	0.0207	0.104	0.1295	0.215	0.159	0.318
1962	0.04	0.0316	0.173	0.1692	0.231	0.186	0.475
1963	0.0647	0.0407	0.291	0.2387	0.221	0.17	0.620
1964	0.1446	0.1224	0.533	0.9659	0.271	0.126	1.850
1965	0.206	0.1333	0.627	1.407	0.329	0.095	2.220
1966	0.254	0.1378	0.721	1.339	0.352	0.103	2.220
1967	0.3005	0.1740	0.815	1.45	0.369	0.120	2.715
1968	0.3635	0.2358	0.849	2.117	0.428	0.111	3.830
1969	0.4265	0.2539	0.993	2.184	0.429	0.116	4.090[e]
1970	0.49	0.2793	1.10	2.7578	0.445	0.101	4.572[e]

* In New Cruzeiros/U.S.$. The export prices are F.O.B. prices for U.S. wheat (unmilled) and Argentine beef (chilled and frozen).

Sources:

a) Annuario Estatistico do Brasil, 1960-1970, and Annuario Estatistico do Trigo, 1965-1969.
b) Yearbook of International Trade and Statistics, 1960-1970.
c) Annuario Agro-Pecuario, 1960-1970.
d) U.N. Statistical Yearbook.
e) Conjuctura Economica, vol. 17, no. 9, 1970.

negative during the entire decade.

This combination of policies made wheat, often double cropped with soybeans, highly profitable, and fueled a program of import substitution in wheat on a massive scale. The area under cultivation and domestic production of wheat increased nearly sevenfold, while domestic production as a percentage of total domestic requirements increased from an average of 9.5 percent for the period 1962-65 to an estimated 50 percent by 1970-71. This increased program of self-sufficiency transformed the regional land use patterns from predominately range livestock production to intensive crop production, accompanied by mechanization on medium and large farms.[17/]

THE MODEL

The model used in this study is similar to the regional models of agricultural development using recursive programing techniques pioneered by Day [11], further extended by Schaller and Dean [54], Heidhues [24], and Cigno [9] and recently applied to agriculture in transition in the LDC's by Singh [57] and Mudahar [37]. These models use a single linear programing model to represent the regional aggregate of all the production plans of farms for a given period of time. Such a regional linear program is an unbiased estimate of aggregate activity levels when certain aggregation conditions are fulfilled.[18/]

17/ For estimates of domestic production and requirements see Engler and Singh [17, p. 31], and for a detailed analysis of the transition to crop production in the region see Rask [47] and Engler [15]. For pricing policies followed for agricultural development in Brazil, see Adams [1], and Smith [61].

18/ For details see Day [11] and Cignio [9].

As we have seen, the region under consideration is characterized by substantial differences in farm size and resource endowments. Consequently, instead of a single regional aggregate, all farms in the region are grouped into three farm sizes --small farms (less than 50 hectares), medium farms (51-300 hectares) and large farms (301-10,000 hectares) -- and it is assumed that all farms within each group satisfy the required aggregation conditions. Further untilizing the decomposition principle of linear programing, the three farm group models are jointly treated in a single model of the region.[19/]

Seven basic components are included in the model. These are (1) a set of farm activities representing decision variables for farms within each size group; (2) an annual objective function measuring the expected revenues from crop sales, the costs of purchased inputs and annual investment charges for resource augmenting investments; (3) a technology matrix representing the traditional and modern input-output structure of cash consumption, farm production, investment, sales, purchase and financial activities; (4) "technical" constraints representing adaptive "safety-first" limitations for protection against mistakes of cropping and investment choices, and representing drags on investment due to "learning" and "unwillingness to change"; (6) feedback functions that relate the parameters of the current programing problem to previous decisions; and (7) exogenously given input and output prices, regional

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19/ In this study, the decompostion principle is used to distinguish resource structures specific to each farm size group and to establish competition for the use of regional resources rather than to partition on a larger matrix to solve a mathematical programing problem. For the theory of the decomposition principle see Lasdon [35] and for its application to agricultural production, see DeHaen [14], chapter 6.

supplies of land and labor resources and exogenously estimated consumption requirements by farm size and supplies of regional wage labor, credit and non-farm quasi-fixed capital goods.

The endogenous variables in the model include for each farm size, the production of crops and livestock (by technology--traditional and modern); investment levels in farm power (tractors, harvestors and draft animals); working capital expenditures on machines, fertilizers, seeds, bone meal, concentrates and fuel; borrowings and savings levels and labor utilization by family and wage labor categories, by individual activity, by season and by crop. The exogenous variables include market prices, interest rates, supplies of land and family labor by farm size, wage labor in the region and non-farm incomes. The parameters of the model include input-output coefficients for each technology, flexibility coefficients by crop, and the average propensity to consume out of gross sales.[20/]

Activities distinguished by farm size include production activities (wheat, soybeans, soybean-wheat rotating, corn, each at two levels of technology (traditional and modern) and beef cattle raised on either natural or improved summer and winter pastures); purchase activities (variable cash inputs such as hired labor, seeds, fertilizers, and livestock concentrates), sales activities (wheat, soybeans, corn and beef), financial activities (include savings, borrowings, and debt repayment) and investment activities (include the purchase of capital goods, combines and draft animals and land improvement). Intermediate transfer activities allow for the use of corn and pasture for livestock production and the

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20/ For a detailed description of the model and its structure see Ahn [4] and Singh and Ahn [60].

conversion of natural to improved pasture or crop land.

Constraints by farm size group include land, labor, power, and working capital supplies. Behavioral constraints defined within farm size groups are individual crop flexibility constraints. Regional constraints include farm credit, wage labor by season and behavioral constraints limiting the rate of investment in mechanical power and the adoption of modern technology.

The model is estimated by setting up and solving a linear programing problem for a given initial year -- 1960 in this case. A new set of limitation and constraint coefficients is then computed by substituting the optimal solution vector just obtained and exogenous data or trends into the feedback functions. A new objective function using exogenous input and output price data is obtained and a new linear programing problem solved. This method generates a sequence of recursive programs with model outcomes for each year.

Detailed data on physical input-output coefficients were constructed from a random sample of some 430 crop and livestokk farms in the region of study supplemented by information obtained from field surveys. The sample also provided data for on-farm resources by farm size which was supplemental by data on regional resources from the Brazilian census, and other published sources.[21/]

MODEL RESULTS (1960-70)

The purpose of this section is (1) to examine the "goodness of fit" of the model results to historical data where available and (2) to describe

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21/ The initial conditions, input requirements for each enterprise, exogenous input and output prices and other data sources used are given in Ahn [4]. For further details also see Engler [16].

the model results as they track the path of agricultural transformation that characterized the wheat region between 1960-1970.

Model Evaluation

Before going into detailed model results, we wish to provide an evaluation of the model. This is done by comparing the predicted model outcomes with observed outcomes for the period 1960-70. In spite of serious difficulties, methodological and practical, in arriving at proper evaluation criteria, several methods have been developed to evaluate such models.[22/] However, in this study we have so far been restricted by the extreme paucity of regional and subregional data from attempting a rigorous evaluation. This would require data for the sub-region by the various outcomes by farm size. All we have by way of time series are the wheat, soybean and corn hectarage for the sub-region (wheat region) and for the entire state of Rio Grande do Sul. Some additional data on wheat hectarage by technology is available but only at the state level.

These are presented in Figures 3 and 4 along with the corresponding model-predicted values for the wheat region.

The model predicts the wheat hectarage fairly closely with slight overpredictions for the years 1964, 1965, and 1966 and small underpredictions for the years for which data are available. In addition, the model does fairly well in predicting wheat hectarage by technology. (For Figure 4 note that observed values are for the entire state, while the

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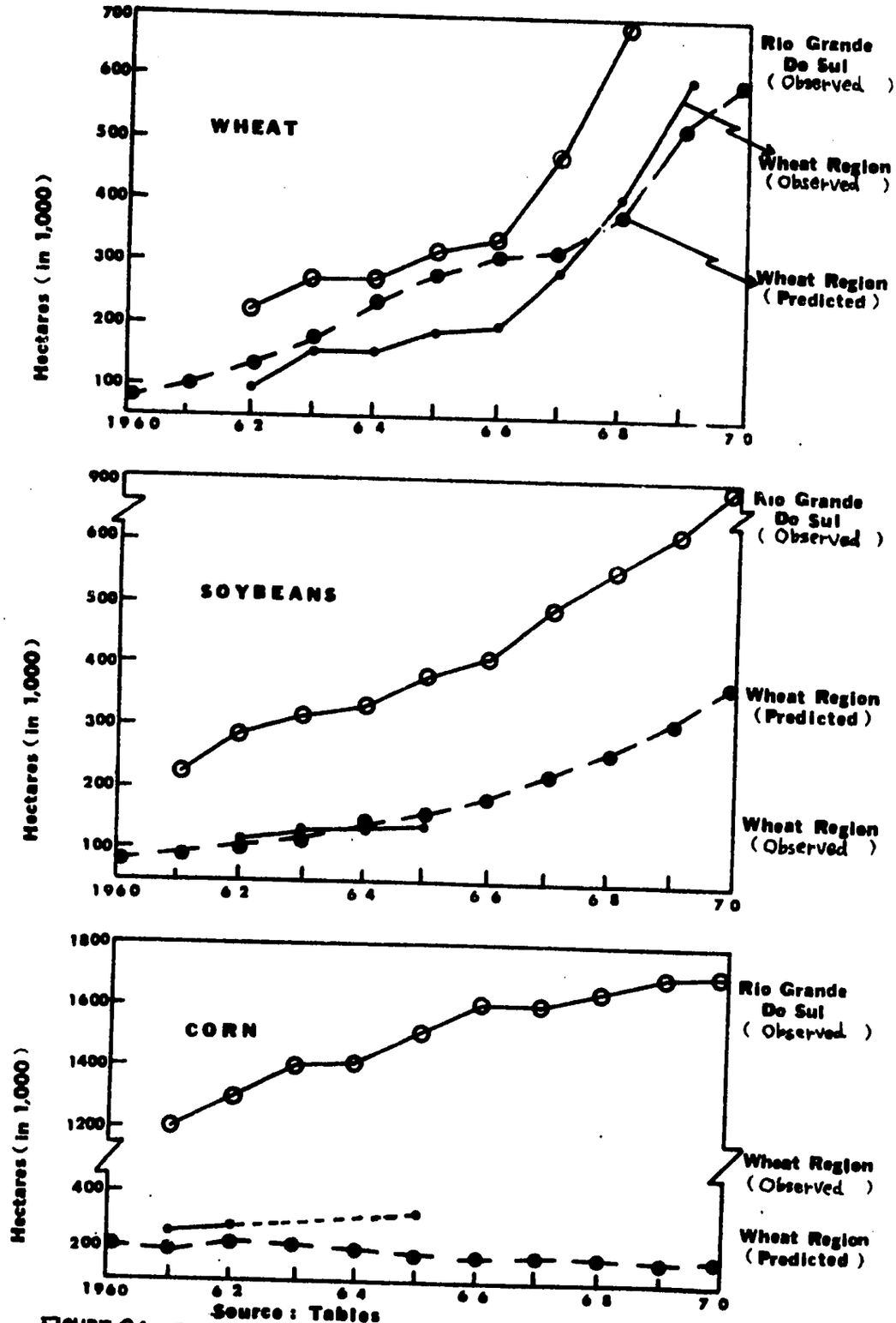
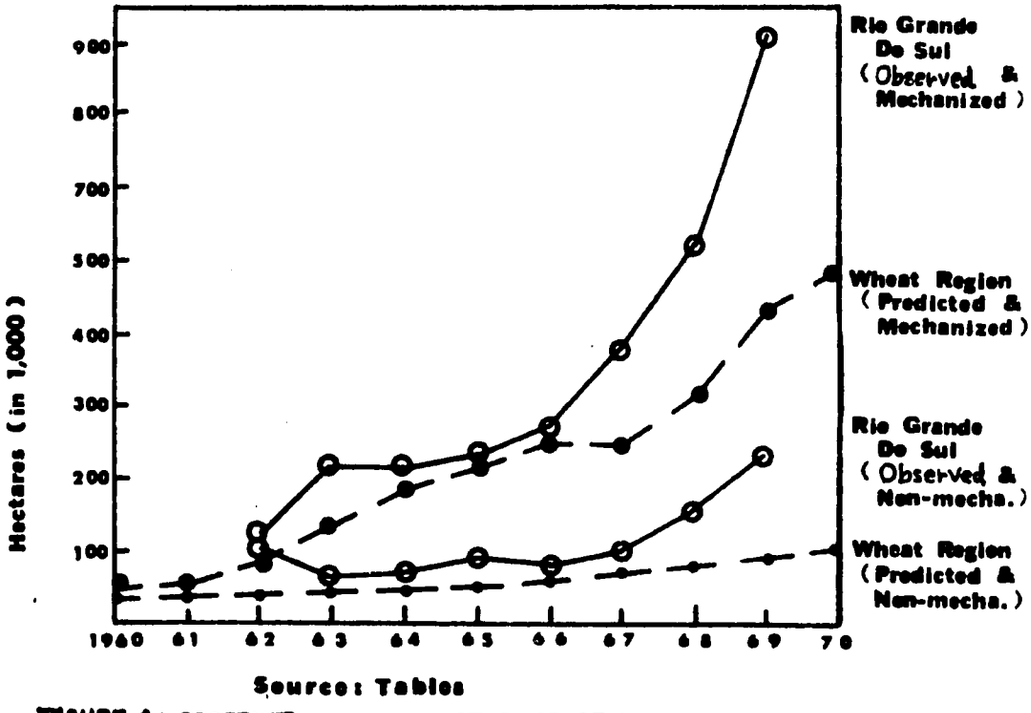
22/ See Johnson and Rausser [27] for a discussion of problems in developing evaluation criteria and Day and Singh [13] for several evaluation techniques that can be used.



Source: Tables

FIGURE 3: OBSERVED AND MODEL PREDICTED HECTARAGE OF FIELD CROPS IN THE WHEAT REGION AND RIO GRANDE DO SUL, SOUTHERN BRAZIL (1960–1970)

NOTE: The Observed Hectarage Data are not Available for Missing Observations.



Source: Tables

FIGURE 4: OBSERVED WHEAT HECTARAGE OF RIO GRANDE DO SUL AND PREDICTED WHEAT HECTARAGE OF THE WHEAT REGION BY MECHANIZATION, SOUTHERN BRAZIL (1960—1970)

NOTE: The Data are not Available for the Missing Historical Observations.

predicted values are for the wheat region only).

This paucity of data at the regional level prevents direct evaluation but corroborative evidence relating to the model's performacce is also available. This is available in the detailed chronicle it provides of the transformation in terms of a variety of variables the model results generate to describe the economic activity. We turn to these detailed results next in order to examine how well the model tracked the development process in the region.

Land Use and Cropping Patterns

Total land use and cropping patterns by farm size predicted by the model are shown in Figure 5.

Several salient features stand out in these model predictions. First, total crop land use has increased more than fourfold. This increase has come mostly from the increase in double-cropping. Second, the most dramatic increases are in the hectarage devoted to wheat, soybeans, and the production of beef on improved pasture systems. Third, the use of natural extensive pasture systems for livestock production, that have long characterized the region, showed a continual decline. Fourth, total corn production, a relatively minor enterprise has remained fairly stable; increases on small farms being offset by decreases on medium and large farms. Lastly, although wheat, soybeans and beef production on improved pastures increased on all farms, these increases were most dramatic on large and least dramatic on small farms.

Thus, the most important predicted changes in the region have involved a transition from extensive livestock production using natural open range pastures to intensive crop and livestock production.

Approximately a million hectares of open range land -- a quarter of the total -- has been converted into intensive crop and livestock production. Range livestock production which accounted for approximately 90 percent of total land use on all farms at the beginning of the sample period, accounted for only 72, 70, and 60 percent respectively on small, medium and large farms by the decade's end. Although another three million hectares of open range land remain, the same inexorable trend is likely to continue. The open range, the gaucho and the way of life associated with a system of beef production on extensive pasture lands is on its way out, to be replaced by intensive and mechanized crop farming mixed with an intensive beef production system.

The main features of these predicted land use patterns and transformation are amply borne out by an examination of the regional data and by other studies.[23/]

Changes in Farm Technology

Although farms of different size follow similar trends in their cropping patterns, their predicted choice of technologies reveal striking differences as shown in Figure 6. Small farms with relatively abundant labor employ only traditional draft animal technologies and at an increasing rate. On the other hand, large farms with relatively scarce labor utilize exculsively modern tractor-combine technologies. Between these two extremes, the medium sized farms show a mixed pattern, but inclined towards the labor-saving modern technologies. The predicted increase in the use of modern farm power is dramatic -- a 3.5 and 4.2 fold increase in tractor use and a 10.3 and 7.1 fold increase of combine

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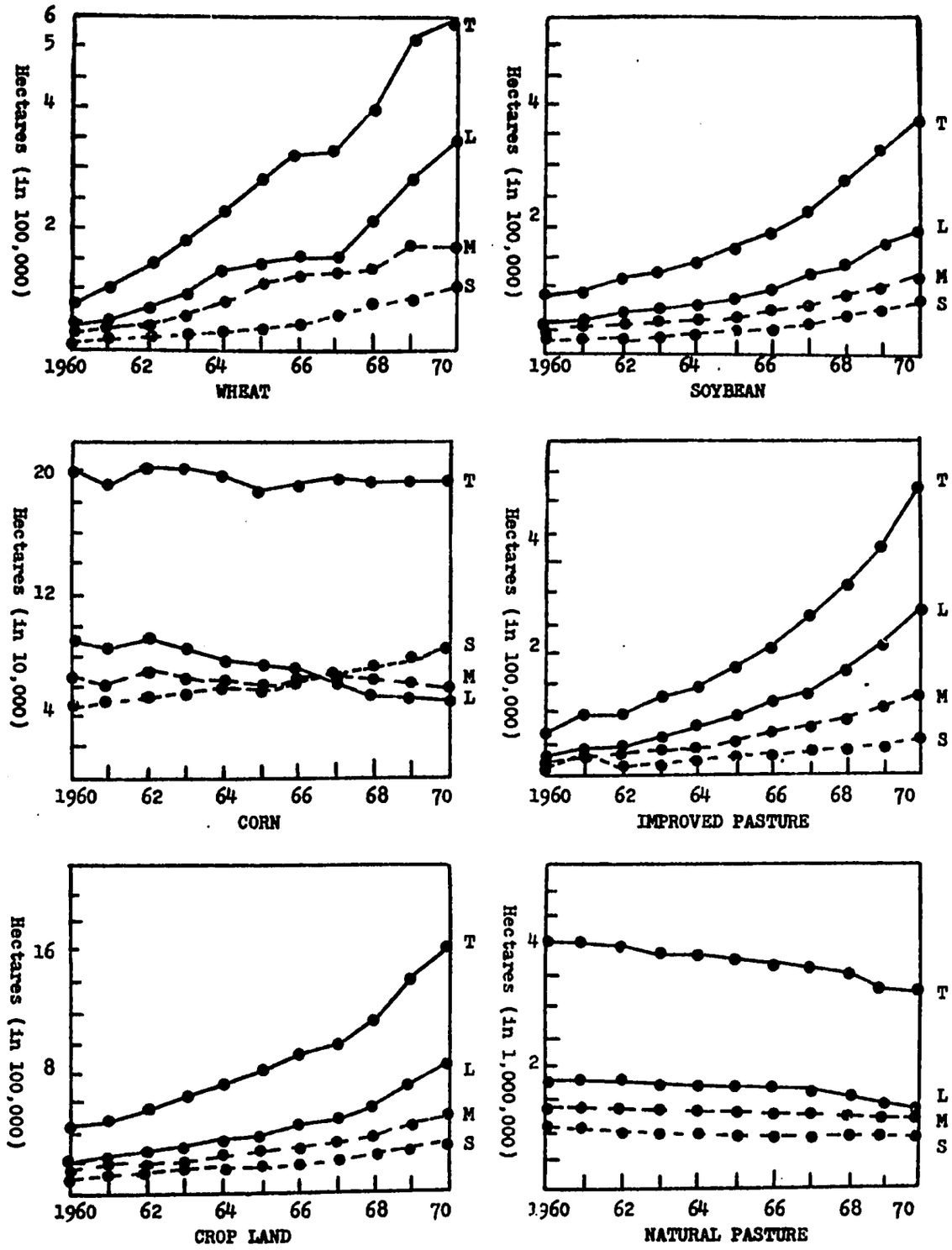
23/ See Rask [42], Engler [15]



S: Small Farms L: Large Farms
M: Medium Farms T: Regional Farms

FIGURE 5: Predicted Land Use and Cropping Pattern

hours on medium and large farms, respectively. However, draft animal use increased 3.4 times on small and about 10 percent on medium farms. Compared to other developing countries however, machine use has not been intensive as can be seen by the relatively low tractor hours used per hectare on both medium and large farms.

Again, these rapid trends in mechanization especially in medium and large farms and the almost exclusive reliance on traditional draft animals technologies on small farms in the region predicted by the model can be amply supported by both observation and other studies.[24/]

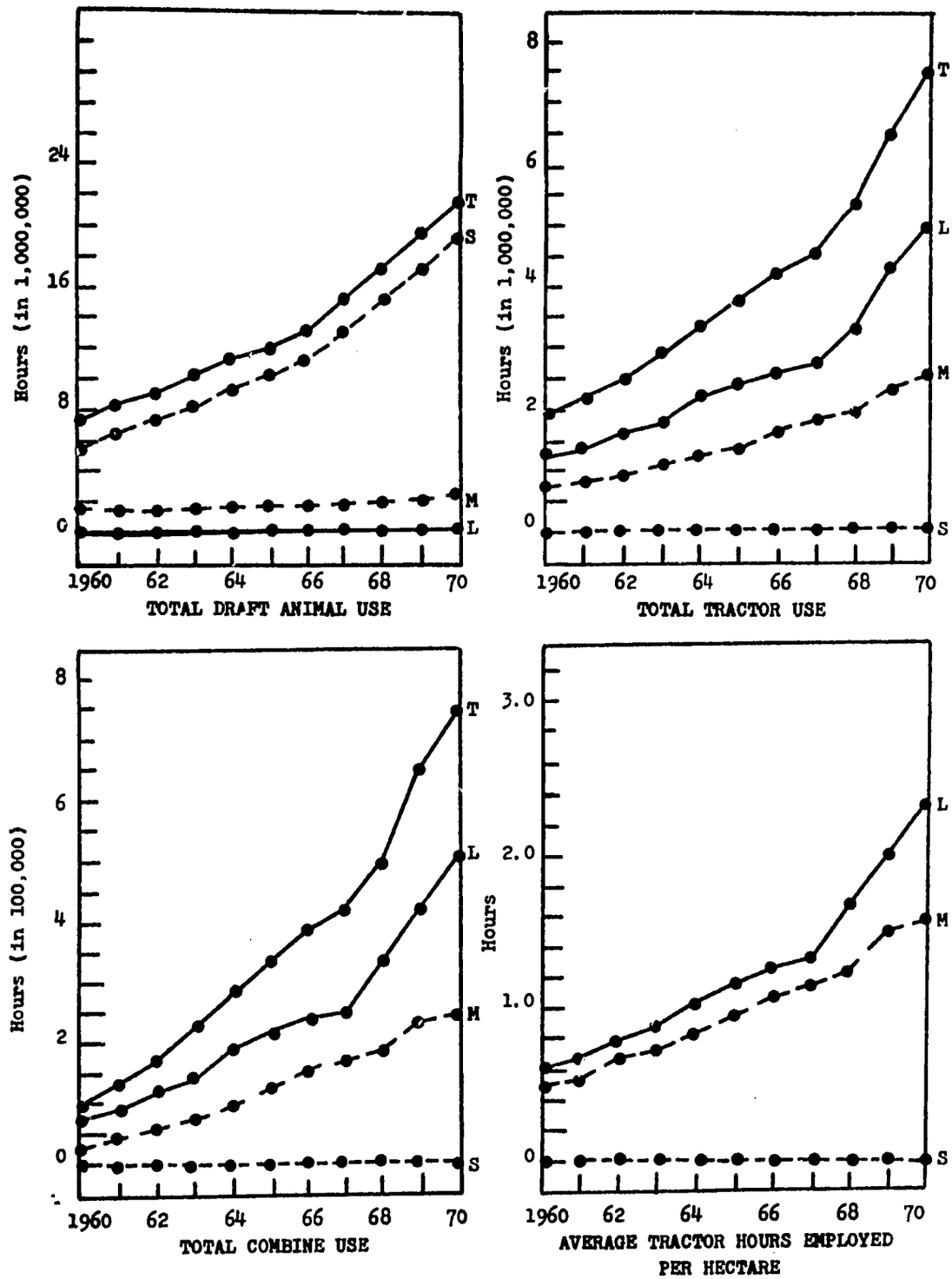
Capital Utilization and Investments

On-Farm Investments

Estimates of on-farm investment patterns are confined to the gross investments in quasi-fixed capacities -- mainly farm power -- predicted by the model. These are necessarily gross underestimates of the total capital investments in the region because they do not include new acquisitions or improvements to on-farm fixed assets like buildings, land purchases and land improvements. In addition, the model provides no estimates for off-farm investment activities either in financial or real assets in other sectors of the economy.[25/]

24/ Rask [42], Stitzlein [64], Sanders [53], and Engler [4].

25/ Partly due to lack of data and partly due to conceptual problems in handling investments in fixed long life assets in short-run optimizing models, investments in farm buildings, land acquisitions and land improvements were not explicitly treated in the model. Land improvements requiring fencing for improved pasture systems and feedlots were incorporated in the capital requirements for beef production. There is evidence that larger crop farms were able to increase the size of their operations by bidding away or renting land from smaller and medium sized farms. Rask [46] and Chapter 5. The intra-farm land market, presenting substantial theoretical hurdles in models of this nature, was not explicitly treated.



S: Small Farms L: Large Farms
M: Medium Farms T: Regional Total

FIGURE 6: Predicted Machine and Draft Animal Use

In spite of the limited scope of the investment activities modeled, there are important reasons for highlighting the predicted gross investments in farm machinery. First, they accounted for most of the gross capital investments, especially on larger farms.[26/] Second, most of the credits advanced for investments were applied to the purchase of farm machinery.[27/]

The predicted on-farm gross investments in draft and machine power sources are shown in Figure 7.

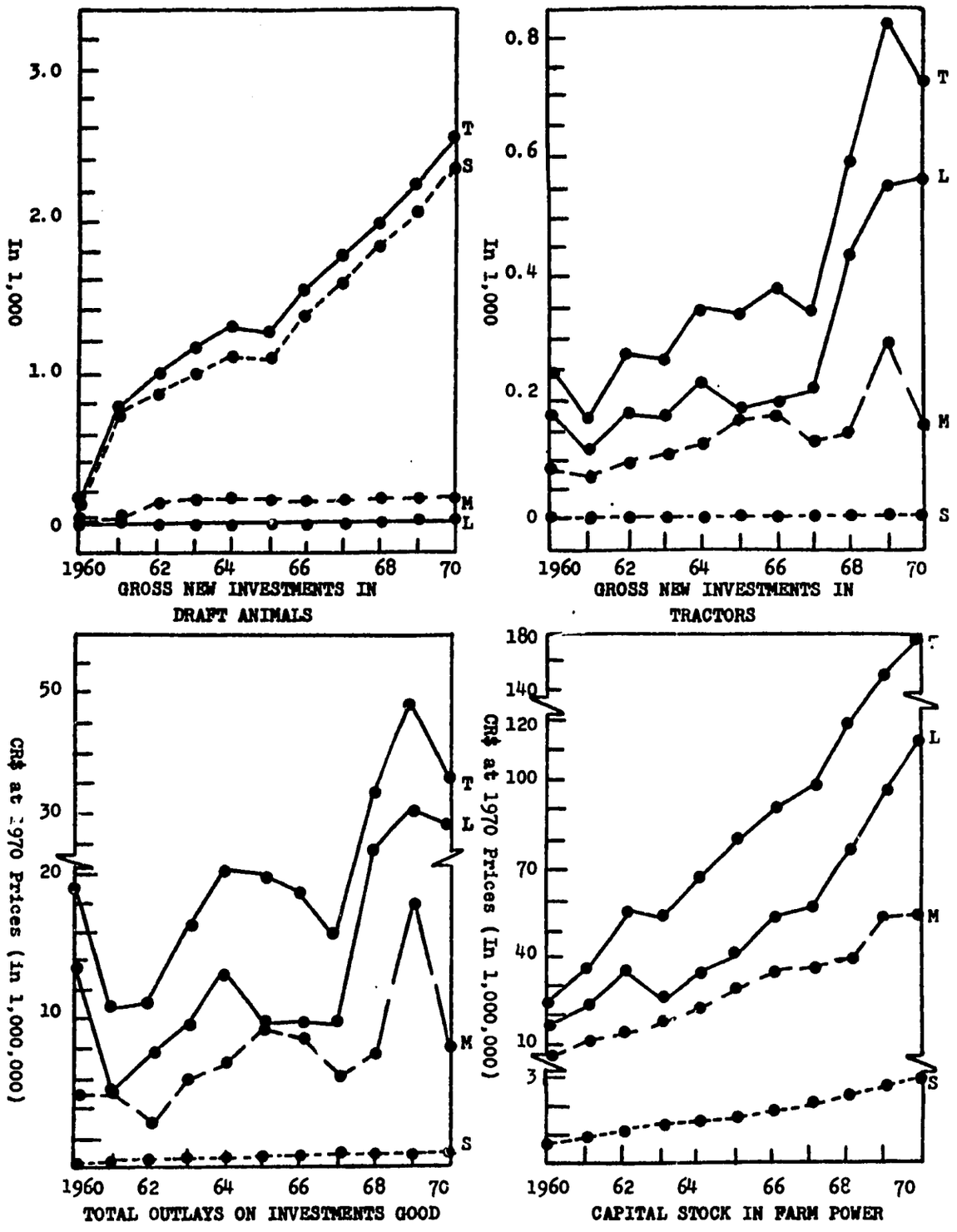
The investment patterns are implicit in the choice of technologies. There is a marked upward trend in gross new investments for draft animals on small farms with roughly a 20 fold increase over the decade, whereas only a slight increase (1.8 times) is evident on medium farms. In contrast, gross new investments in tractors grew by 320 percent on large and 200 percent on medium farms in the same period. As a result, the on-farm quasi-fixed capital stock -- that is the stock of machinery and animals used for farm power less depreciation -- increased ninefold at constant 1970 prices during the period.

These large increases in gross investments in capital stock of quasi-fixed capacities predicted by the model-confined mainly to the purchase of draft animals, tractors, combines and ancilliary equipment -- are supported by other studies also.[28/]

26/ Land acquistions and improvements were the other important categories, but except on small, medium farms between 20-49 hectares these combined investments were less than investments in farm machinery on a per-hectare basis. See Rask [45], [46].

27/ This was so for farms of all sizes, mainly because of the tied credit made available. See Rask and Stitzlein [49].

28/ Particularly see Rask [44], Stitzlein [64] and Sanders [53].



S: Small Farms L: Large Farms
M: Medium Farms T: Regional Total

FIGURE 7: Predicted Gross Investments and Capital Stock in Farm Machinery and Profit Animal

Capital Utilization

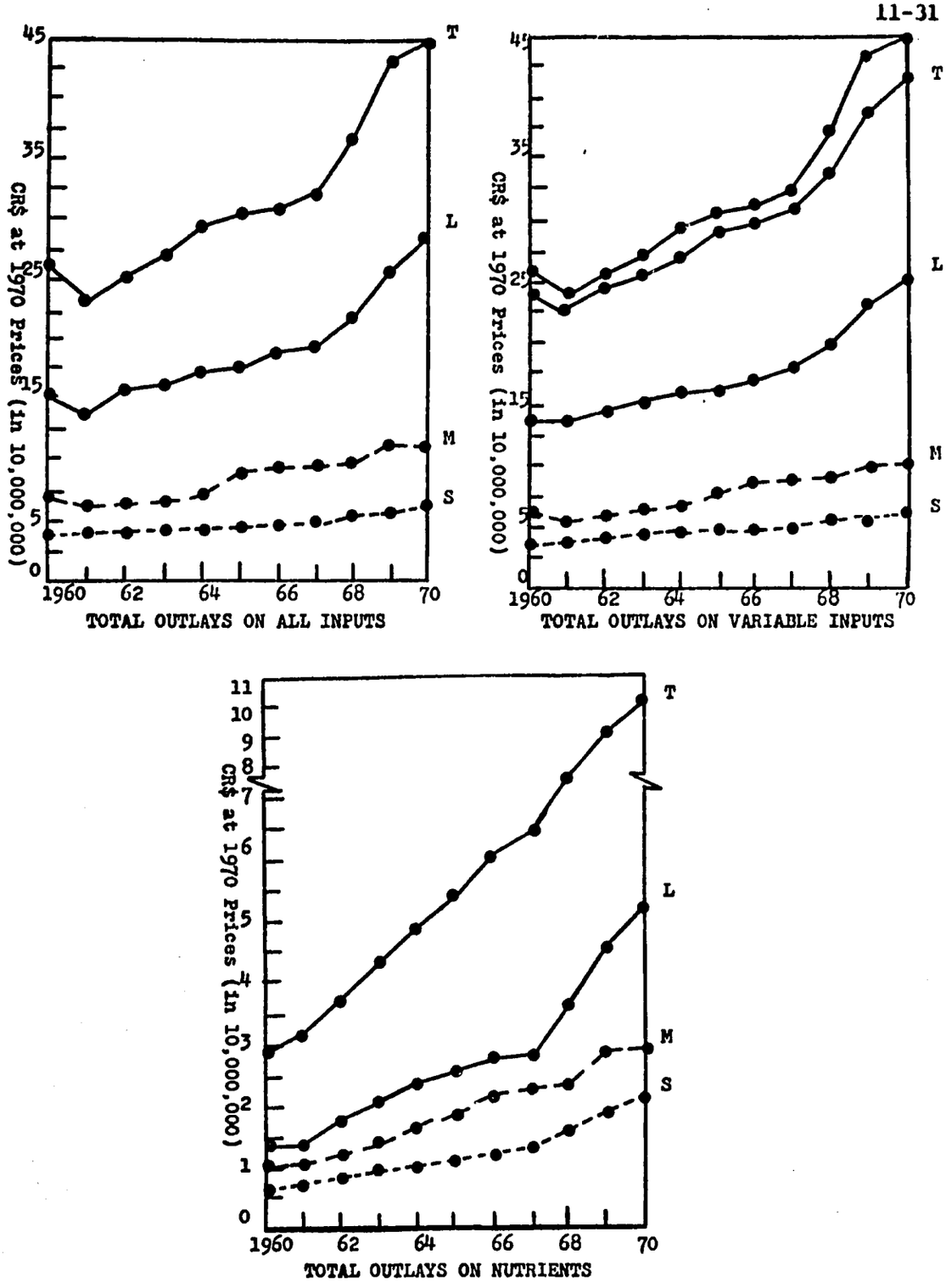
Although the growth in the stock of on-farm quasi-fixed capacity has been impressive, it accounts for only a small proportion of the growth of capital outlays in the region. Equally impressive has been the predicted growth in the use of operating capital -- that is outlays on variable inputs. These predicted results are shown in Figure 8.

Using a weighted index of all inputs at constant 1970 prices,[29/] total cash outlays on small, medium, and large farms increased significantly by 178, 183, and 211 percent, respectively, during the decade of the sixties. This has been the direct result of a transition from extensive livestock operations requiring little operating capital to intensive crop and livestock operations requiring large amounts of operating capital for fuel, hired labor, repairs, pesticides and nutrients. Nearly two-fifths of the predicted increase in operating capital was due to an increased outlay on nutrients.[30/]

The ratio of investment capital to working capital was around 1 percent on small farms, roughly 7 percent on medium farms during the entire period, but grew from 4 percent to 10 percent on large farms between 1961 and 1970. This suggests a positive correlation between the rate of capitalization and farm size with the larger farms becoming capitalized at a faster rate.

29/ That is weighted by the predicted amount of each input used in every period.

30/ Since no nutrients are used on open range pasture, a mere shift to intensive crop farming involving small amounts of nutrient use per hectare has meant a large increase in total outlays on nutrients. Nutrient use per hectare and nutrient yield responses have, however, remained extremely low. See Nelson and Meyer [40], Wright and Meyer [67], and Larson and Cibantos [34].



S: Small Farms L: Large Farms
M: Medium Farms T: Regional Total

FIGURE 8: Predicted Capital Outlays on All Variable and Nutrient Inputs

The varying degree of capitalization on farms of different sizes is more evident when we look at capital utilization on a per hectare basis in Figure 9. Total predicted per hectare capital expenditures on large farms are roughly 70 percent higher than on medium farms which in turn are roughly 20 percent high than on small farms over the period. Similar trends are apparent for per hectare outlays on gross investments and total variable inputs. Outlays on nutrients on a per hectare basis, however, have been increasing but invariant with respect to farm size.[31/] They have increased also as a proportion of total working capital, but account for a larger proportion on small than on medium and large farms.

Growth of Total Farm Capital Stock

Using the information on the value of crop and range land from sample data, an attempt was made to arrive at an estimate of total farm capital stock as the value of the stock quasi-fixed farm power sources plus the value of land-in-use. These predicted estimates are shown in Tables 3 through 5. Although additional components such as the value of inventory and buildings are omitted, this definition of capital stock does provide partial and useful information on the process of capital formation by farm size, since land and quasi-fixed capital provide the major source of this formation.

Using this partial measure of farm capital stock which excludes the value of inventories and farm buildings the estimates show an increase of only about 30 percent during the decade. Large farms accounted for

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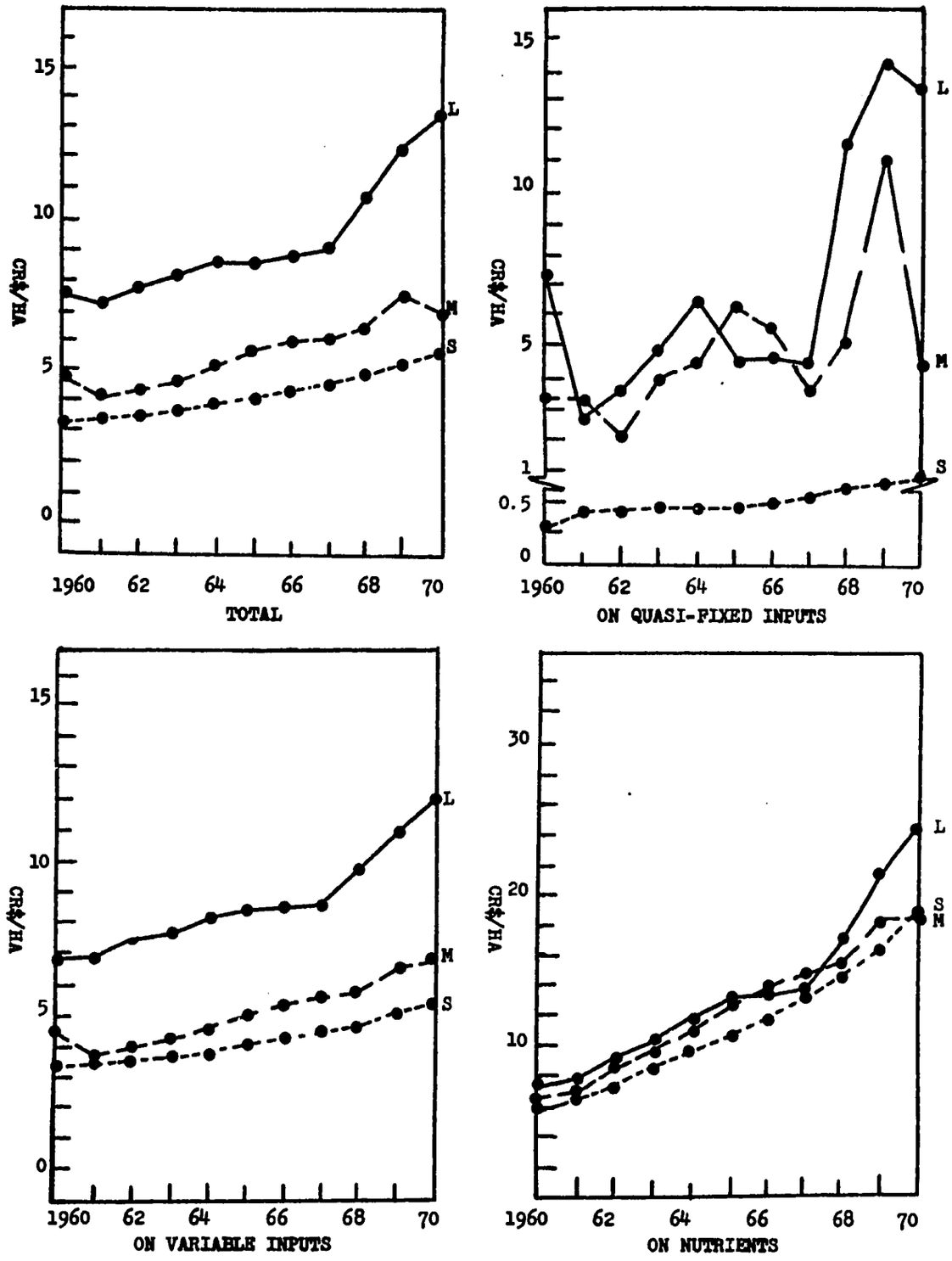
31/ Increased nutrient use per hectare is associated with a shift in enterprise from range livestock to crop farming and not with increasing physical yields per cropped hectare as pointed out earlier.



S: Small Farms L: Large Farms
M: Medium Farms

FIGURE 9: Predicted Capital Outlays Per Hectare

TABLE 11-3 QUASI-FIXED CAPITAL STOCK (CAPITAL FORMATION IN FARM POWER)BY FARM SIZE (IN 1000 CR$ AT 1970 PRICES): WHEAT REGION IN THE STATE OF RIO GRANDE DO SUL, SOUTHERN BRAZIL (1960-1970)*

YEAR	SMALL FARM	MEDIUM FARM	LARGE FARM
1960	849.1	6830.3	18166.8
1961	964.8	10916.3	21769.9
1962	1086.6	12768.9	44036.8
1963	1224.3	17242.6	34388.5
1964	1383.8	22128.9	44036.8
1965	1511.5	28730.0	49079.5
1966	1716.5	33975.6	53771.6
1967	1951.5	35807.9	57598.4
1968	2224.8	39368.5	75994.6
1969	2542.2	52142.1	98577.5
1970	2900.8	53406.6	116869.3

SOURCE: MODEL RESULTS

* Computation of quasi-fixed capital stock that includes draft animals, combines and tractors is carried out as follows:
Capital Stock (t) = (1-d) X Capital Stock (t-1) + Investment Capital (t)
Where d is a depreciation coefficient.
Small farms' d = 20% where capital components are work animals only.
Medium farms' d = 12% where capital components are both work animals and tractors and combines, and hence d for medium farms are weighted average of d's for traditional and modern farm powers.
Large farms' d = 10% where capital components are only tractors and combines.

TABLE 11-4 TOTAL VALUE OF LAND IN USE BY FARM SIZE (IN MILLION CR$ AT 1970 PRICES): WHEAT REGION IN THE STATE OF RIO GRANDE DO SUL, SOUTHERN BRAZIL (1960-1970)**

YEAR	SMALL FARM	MEDIUM FARM	LARGE FARM
1960	277.88	394.12	524.18
1961	278.12	391.91	525.62
1962	278.78	396.16	534.62
1963	279.59	399.60	542.69
1964	282.38	405.32	554.80
1965	283.67	414.55	563.37
1966	288.85	425.65	572.63
1967	295.49	432.10	582.87
1968	303.97	439.13	604.18
1969	311.92	452.66	631.37
1970	319.35	461.09	658.79

SOURCE: MODEL RESULTS

** Land in use includes crop lands and improved pasture lands that are evaluated at 400 CR$ per hectare and land left to natural pasture which is evaluated at 250 CR$ per hectare. The per hectare prices of land are weighted averages obtained from the sample farm record data of the three municipios in the wheat region, namely Carazinho, Nao Me Toque and Sao Borja. For the data description, see Norman Rask,[43].

TABLE 11-5 ESTIMATED TOTAL CAPITAL STOCK (QUASI-FIXED CAPITAL STOCK + VALUE OF LAND IN USE) BY FARM SIZE (IN MILLION CR$ AT 1970 PRICES): WHEAT REGION IN THE STATE OF RIO GRANDE DO SUL, SOUTHERN BRAZIL (1960-1970)

YEAR	SMALL FARM	MEDIUM FARM	LARGE FARM	TOTAL
1960	278.73	400.95	542.35	1222.0
1961	279.08	402.83	547.39	1229.3
1962	279.86	408.93	561.84	1250.63
1963	280.81	416.84	577.08	1274.7
1964	283.76	427.45	598.84	1310.0
1965	285.18	443.28	612.45	1340.91
1966	290.57	459.63	626.40	1376.5
1967	297.44	467.91	641.46	1407.0
1968	306.19	478.50	680.17	1464.9
1969	314.46	504.80	729.95	1549.2
1970	322.25	514.50	775.66	1612.4
Index 1970 (Base 1960 = 100)	115.6	128.3	143.0	131.9
% of Total (in 1970)	20.0	31.9	48.1	100.0

SOURCE: MODEL RESULTS

nearly half of this stock by 1970 and the rate of growth on them has been substantially faster than on small and medium farms. When compared with the rate of growth of capital stock in other developing countries this increase cannot be called spectacular. However when the separate components of this stock are examined we see that although the value of farm machinery and animals is small compared to the value of land on which they are used, this component has increased more than sixfold on large farms which account for 62 percent of the total and nearly eightfold on medium farms that account for another 30 percent of the total. (Table 3).

These predicted trends in total and per hectare capital utilization have been substantiated elsewhere. Only rudimentary studies are available, but they generally also confirm the growth trends in the total capital stock predicted here.[32/]

Credit Use

The substantial increases in operating and investment capital have only partly been financed by increased on-farm cash flows and profits. The model predictions indicate that an increasing share of total cash outlays have been financed through short term credits. These results are displayed in Figure 10.

The predicted short term borrowings increase dramatically especially after 1962 when the wheat support program went into effect. At constant prices, these borrowings grew from 12.6 million CR's in 1963 to 278 million CR's by 1970.

Average credit use per hectare also increased dramatically over this period, especially on large farms. (Credit use per hectare on large

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32/ See Chapter 5 and Rask [43].

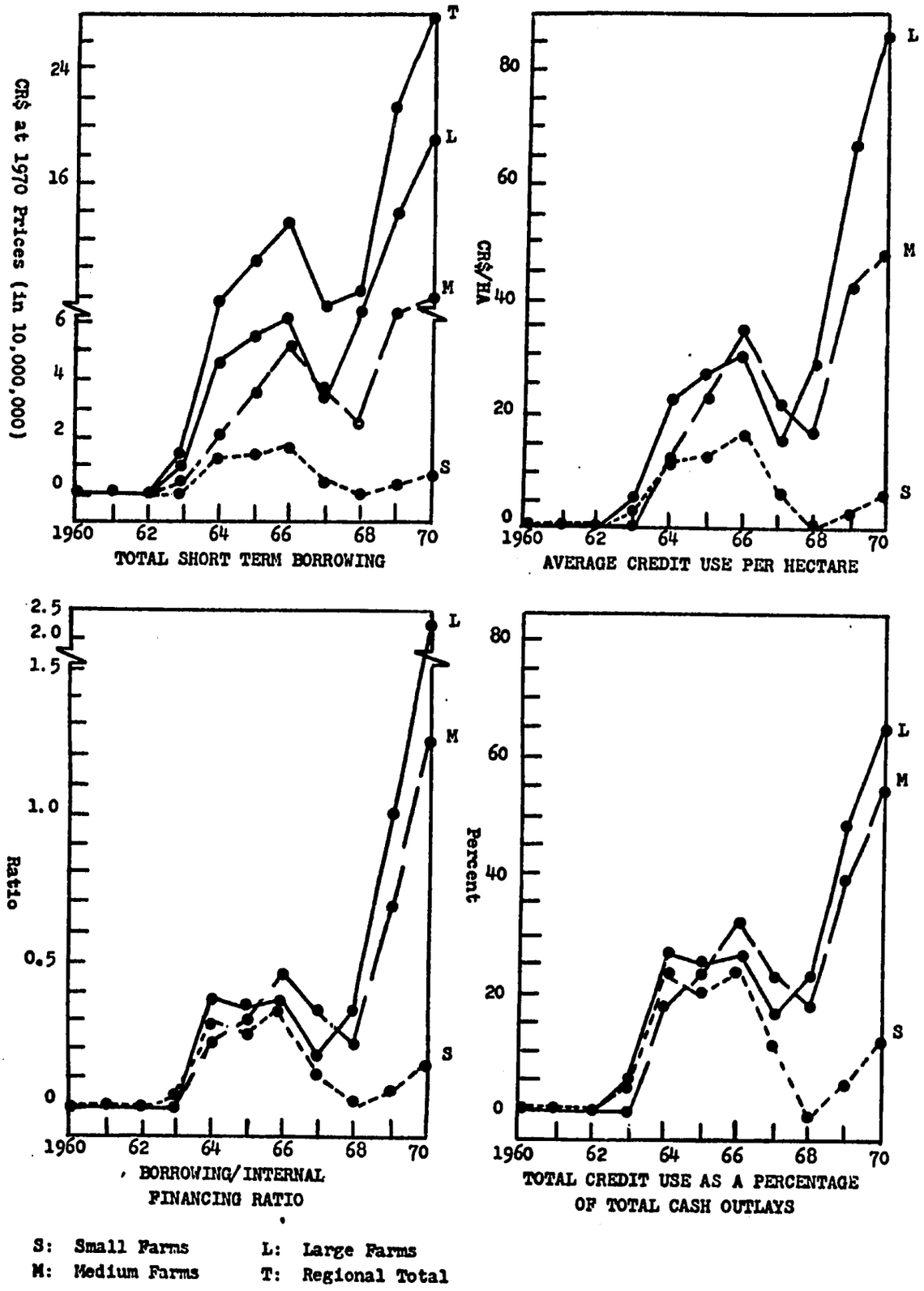

FIGURE 10: Predicted Credit Use

farms is more than 20 times greater than on small farms and 10 times greater than on medium farms.) The continued availability of credits at nominal rates often far below the rates of inflation meant that for all purposes farmers could obtain loans to finance their operations and investments at negative real rates of interest. Further, a credit limit that allocates scarce capital resources on the basis of the volume of gross revenues and ability to repay naturally tends to favor larger over smaller farms.

As a consequence, the dependence on credit to finance operations is predicted to increase dramatically. Total credit use as a percentage of total cash outlays show that by 1970 large farms depended on credit for nearly 70 percent of their cash while medium farms for nearly 55 percent of their cash. Only small farms with little access to credits and at the short end of credit limits favoring larger operations, continue to finance most of their operations themselves.

It would seem apparent that this increasing dependence on credits to finance farm operations, especially on large and medium farms, is directly related to the credit policies that have led to a misallocation of scarce capital resources. However, further analysis will help to establish the critical role of interest rate policies during this period.

The predicted increases in credit use and the growing reliance on credit especially on larger farms has been amply substantiated in other studies.[33/] The role of credit policies is a critical instrument in

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33/ Rao [41], Rask [44] and Chapter 10.

this process has also been argued elsewhere.[34/] These model results tend to bear out these findings more fully.

Farm Employment

The predicted trends in farm employment by farm size are shown in Figure 11. These trends reflect the differences in relative factor scarcities, cropping patterns and the choice of technologies prevailing. Three salient features stand out. First, total employment increased mainly on small farms, more than tripling. Small farms accounted for more than 90 percent of the increase in total employment in the region. Second, large farms accounted for most (the model predicted all) of the hired labor employment in the region, as expected. Third, labor use per hectare is inversely related to farm size. These broad model results stand to reason and have also been substantiated in other studies. [35/]

A shift in the region from range livestock to intensive crop farming, brought about by policies to increase the production of wheat, has had an unexpected beneficial impact on regional farm employment. Even though medium and large farms have moved to intensive crop farming with mechanization, employment among them increased 14 and 23 percent respectively. These are substantial employment gains. Most of the increase however has come where it is most desireable - on small farms - where farm employment increased over threefold, as did the labor use per hectare. Thus the shift to intensive crop farming seems to have had a

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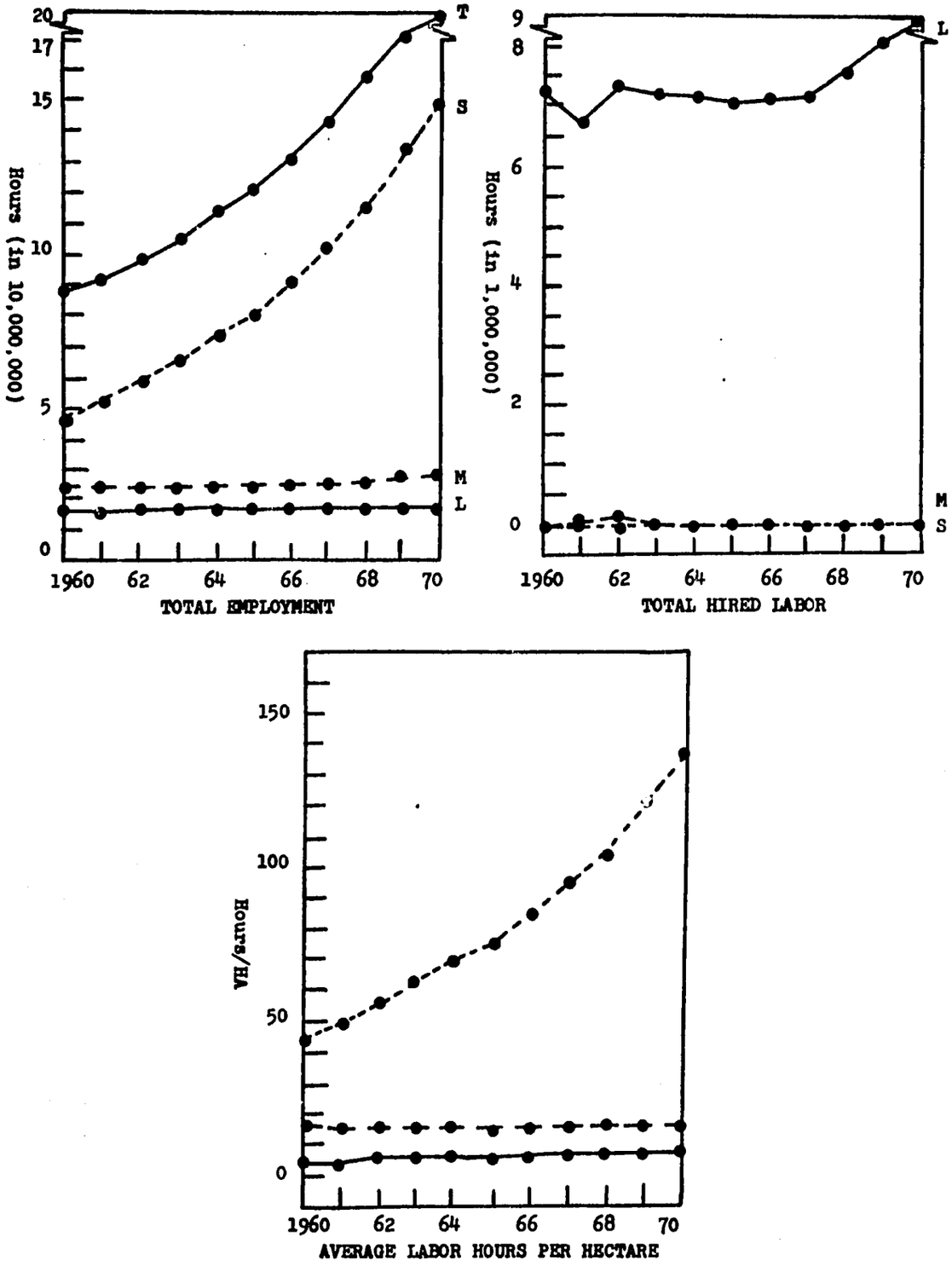
34/ Adams [1], Adams et.al. [2].

35/ See Chapters 5 and 6.



S: Small Farms L: Large Farms
M: Medium Farms T: Regional Farms

FIGURE 11: Predicted Employment

major impact on farm employment in the region. Most of this has come in the form of a more complete utilization of family labor on small farms with the added advantage of a more equitable seasonal distribution of labor use.

These are impressive results for they have been achieved in spite of extensive mechanization and without any sacrifice in terms of output goals. Although substantial capitalization has occured on larger farms this has not been accompanied by labor displacement, for the offsetting output and product mix effects have overwhelmingly favored increasing regional employment.

Total Output and Factor Productivities

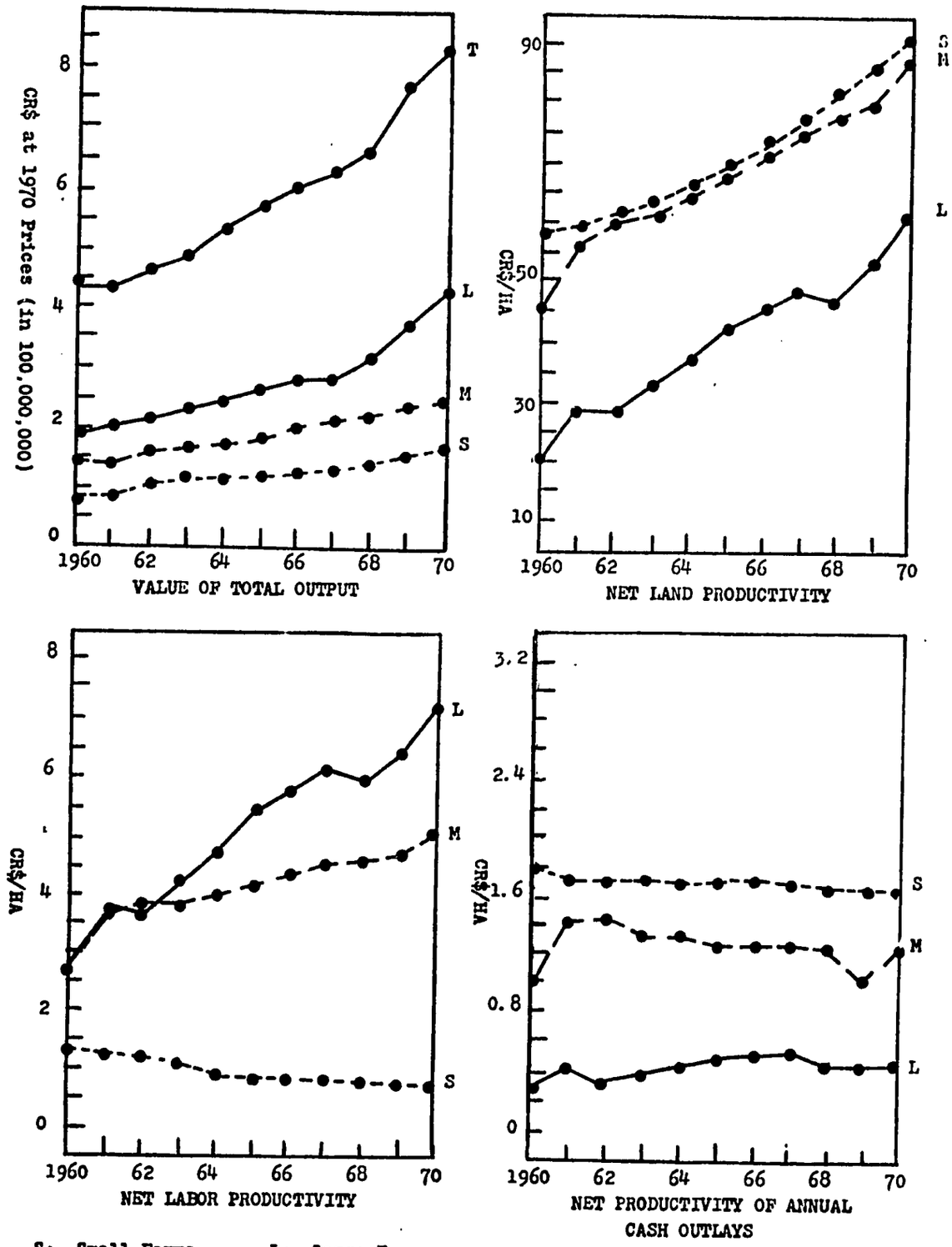
A continued conversion from range livestock to crop farming has generated a substantial growth in the value of total ouput and an increase in the average productivity of most factor inputs. These results are displayed in Figure 12.

The predicted value of total output, at constant 1970 prices increased by 169, 177, and 216 percent on small, medium and large farms, respectively. Total regional output nearly doubled during the decade.

Factor productivities are measured in average and net terms. They are defined as the ratio of the value of total net output (total revenues minus total costs at constant prices) per unit of the principal inputs used -- land, labor and capital.

Land Productivity

Average net land productivity, measured as the ratio of the value of net output to land use, including the double cropped land, increased



S: Small Farms L: Large Farms
M: Medium Farms T: Regional Total

FIGURE 12: Predicted Value of Total Output and Average Factor Productivities

substantially on all farms, growing by 158, 192, and 302 percent on small, medium, and large farms respectively between 1960-1970.

Land is generally most productive on small farms. But because increases in land productivity are directly related to farm size, these differences are predicted as narrowing over time.

Labor Productivity

Average labor productivity shows opposite trends, however. Labor is most productive on large farms. Further while labor productivity on medium and large farms increased by 76 and 162 percent, respectively, it declined on small farms by 48 percent during the decade. So the differences in average labor productivity between farms are increasing over time.

The differences in labor productivity are even greater if one measures net output per family labor available rather than per hour of labor employed. Since labor use on large farms exceeds family labor available, while labor use is less than the available family labor on small farms, the effects of these growing differences on net farm incomes are even greater.

Capital Productivity

Average capital productivity, defined as the ratio of the value of net output to total annual cash outlay (which includes expenditures on variable and quasi-fixed inputs), measures the average returns to cash turnover in any production year. It is not a perfect concept but it does given the idea of where, on the average, cash outlays have been most productive.

The predicted results highlight an important fact: on the average, capital is more productive on small than on medium, and on medium than on large farms. This inverse relationship between average capital productivity and farm size, when compared to the direct relationship between credit allocations and capital use and farm size, suggest that there may have been substantial misallocation of capital resources in the region.

These results are not conclusive in this regard, however, because they give the productivity of cash expenditures on the average. What is needed is their productivity at the margin. In order to arrive at an estimate of these productivities at the margin, incremental capital-output ratios (ICOR's) are calculated using the earlier estimates of capital stock and the value of gross output at constant prices. These estimates are given in Tables 6 and 7.

These estimates show that although ICOR's have increased for all farms, small farms have the smallest ICOR's and medium farms the largest. This confirms our earlier concern with the misallocation of capital and credits because whereas small farms tended to have the highest capital productivity at the margin (in the gross incremental sense), they tended to have the smallest access to these resources. These results have been further confirmed in another study.[36/]

These predicted trends in average factor productivities are partially confirmed by the analysis of farm level data and in the production function studies reported elsewhere.[37/]

36/ Singh and Ahn [59].

37/ See Chapter 6 for a summary of these studies and further references.

TABLE 6: YEARLY CHANGE IN TOTAL CAPITAL STOCK AND GROSS OUTPUT (IN MILLION CR$ AT 1970 PRICES) BY FARM SIZE: WHEAT REGION IN THE STATE OF RIO GRANDE DO SUL, SOUTHERN BRAZIL (1960-1970)

YEAR	SMALL FARM		MEDIUM FARM		LARGE FARM	
	Δ^K	Δ^Y	Δ^K	Δ^Y	Δ^K	Δ^Y
1961	0.35	2.599	1.88	4.282	5.04	8.589
1962	0.78	2.973	6.10	7.243	14.45	12.994
1963	0.95	4.246	15.24	8.834	15.24	14.875
1964	2.95	4.775	21.76	10.888	21.76	20.518
1965	1.42	4.511	15.83	14.551	13.61	12.660
1966	5.39	6.822	16.35	13.640	13.95	11.825
1967	6.87	8.056	8.28	7.191	15.06	11.050
1968	8.75	9.705	10.59	9.221	53.77	38.010
1969	8.27	10.807	26.30	25.408	49.78	49.575
1970	7.79	11.990	9.70	8.374	45.71	44.097

SOURCE: MODEL RESULTS

Where ΔK is a yearly change in value of total capital stock (value of quasi-fixed capital stock and land in use) and ΔY is a yearly change in value of gross output.

TABLE 7: INCREMENTAL CAPITAL-OUTPUT RATIOS (ICOR AT CONSTANT 1970 PRICES) BY FARM SIZE: WHEAT REGION IN THE STATE OF RIO GRANDE DO SUL SOUTHERN BRAZIL (1960-1970)

YEAR	SMALL FARM	MEDIUM FARM	LARGE FARM
1961	0.135	0.439	0.586
1962	0.262	0.842	1.112
1963	0.224	1.725	1.025
1964	0.618	1.998	1.061
1965	0.315	1.088	1.075
1966	0.790	1.199	1.179
1967	0.853	1.151	1.362
1968	0.902	1.148	1.415
1969	0.765	1.035	1.004
1970	0.649	1.158	1.037

Where: $ICOR = \frac{\{\text{Total Capital Stock}(t) - \text{Total Capital Stock}(t-1)\}}{\{\text{Gross Output}(t) - \text{Gross Output}(t-1)\}}$

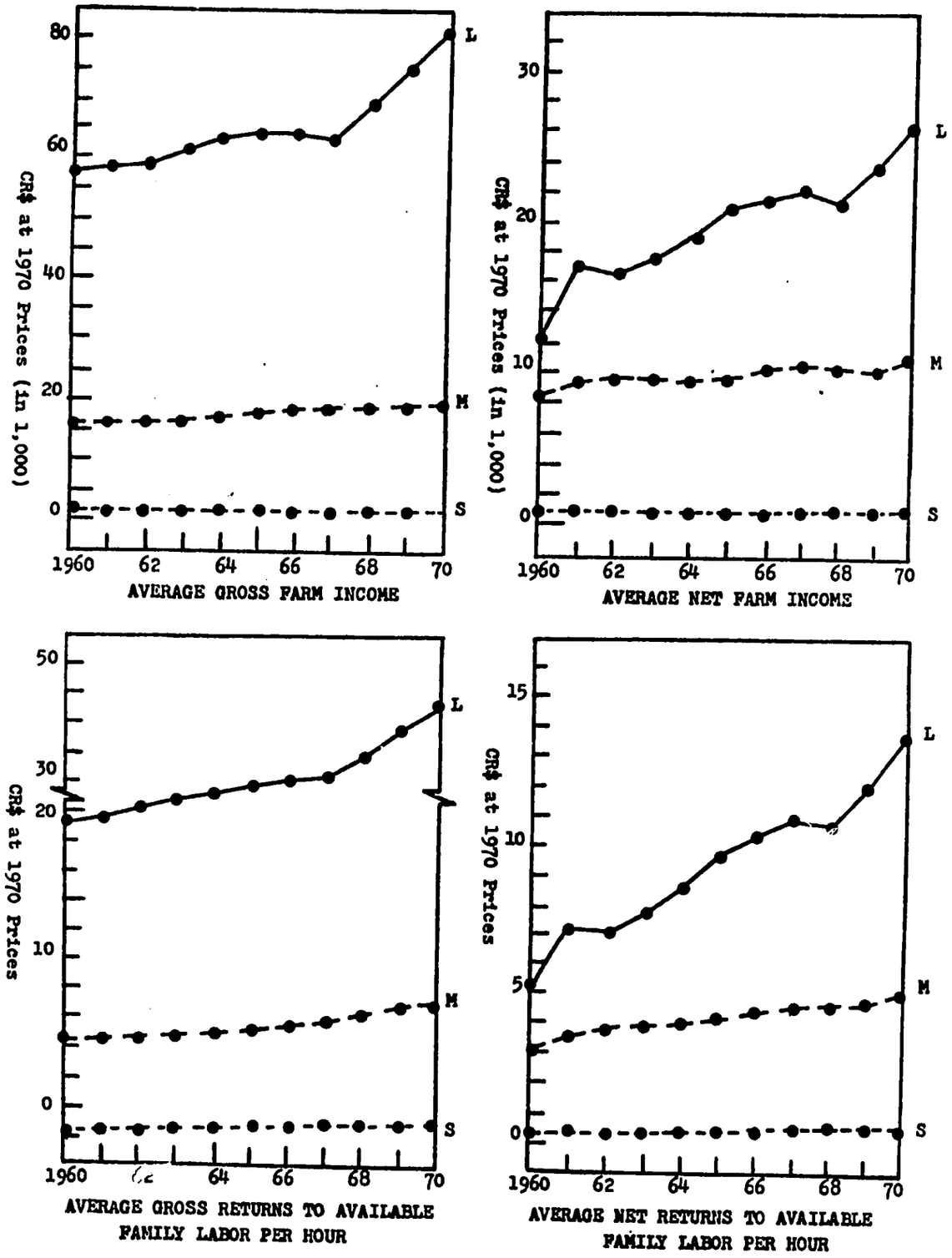
SOURCE: MODEL RESULTS

Income Distribution

The discussion of the model results that pertain to farm incomes is centered around two broad definitions of farm income. They are (1) farm incomes which are estimated on a gross or net basis by dividing the aggregate gross or net incomes of the size group by the number of farms in that farm size group, and (2) returns to available family labor that are estimated by dividing the aggregate gross and net incomes by total family labor available. The number of farms are estimated exogenously, whereas the total family labor available is endogenously generated in the model.[38/]

The predicted growth in total output is distributed most unevenly over different farm size groups as shown in Figure 13. Both gross and net farm incomes at constant prices on small farms remained almost constant during the decade, the former at approximately CR$1,600 and the latter at about CR$1,000. Those on medium farms have grown at a slow but steady rate and are on the average at least 8 times greater than on small farms. Most disturbing of all is the growth of incomes on large farms, with gross farm income increasing by 41 percent and net farm income by 112 percent between 1960-1970. Gross and net farm incomes, respectively on large farms in their turn are 3.4 and 1.5 folds greater than on medium farms in 1960. However, by 1970, gross farm incomes on large farms are 4.2 times higher than on medium farm whereas net farm incomes are 2.4 times greater than on medium farms. This suggests that inequalities in farm incomes have substantially increased over time.

38/ For details on data sources and policy impact on the distribution of farm incomes see Ahn and Singh [5].



S: Small Farms L: Large Farms
M: Medium Farms

FIGURE 13: Predicted Average Farm Incomes and Returns to Family Labor (Gross and Net Basis)

Looking at the income distribution in terms of gross and net returns to available family labor on an hourly basis, the diverging income inequalities are further exaggerated. Since this is a measure of the farm returns to fixed resources (land, family, labor and management) it is a measure more indicative of the real disposable income before taxes left in the hand of farmers. Large farms earned an hourly income to their family labor some 45 times greater than on small farms in 1960. These inequalities can be directly attributed to differences in the initial resource endowments on these farms -- land and capital. By 1970, however, this difference had increased to nearly 57 times. This increasing inequality in the returns to family labor are the outcome partly of the growing differences in the on-farm resource base over time and partly of the unequal impact of selective policy measures that tended to favor larger farms.

Summary of Results (1960-70)

To summarize, the model was able to track in quantitative and detailed terms the main features of the transformation that characterized the development of agriculture in the wheat region of RGS. These features included:

(1) The rapid increases in wheat and soybean production and a relative decline in corn and natural pastures, along with the rapid increase in beef production on improved pasture;

(2) The sharp upward trend in wheat mechanization especially on large farms;

(3) An increased use of and reliance on credit, especially among large and medium farms;

(4) Large investments in new farm power (tractors and harvestors on medium and large farms and the exclusive reliance on draft animals on small farms;

(5) An increase in working capital expenses per hectare on all farms, with larger increases predicted for larger farms;

(6) Diminishing average returns to land and increasing average returns to labor with increasing farm size;

(7) A rise in land and labor productivities on all farms especially after 1964;

(8) Average and incremental returns to capital that are inversely related to farm size;

(9) An increase in farm incomes and the value of both gross and net output, but with larger increases on larger farms; and

(10) A growing inequality in incomes especially between small and large farms, particularly when net hourly returns to family labor is used as the appropriate measure.

These model predictions are further substantial by other studies, and expert opinion and provide further model validation.

While only the availability of better sub-regional data can allow proper validation, we do believe that the model was able to capture the main components in the process of transformation that characterized the wheat region in the decade of the sixties.

MODEL SIMULATION AND POLICY ANALYSIS

Model Simulations as "Hypothetical History"

The focus of the remaining analysis rests on the wheat price support program and credit subsidies that have been credited with playing a

critical role in the development of the region.[39/] The model so far has been used to track economic events as they actually occurred by allowing both these policy instruments to operate. By so doing it was able to shed some light on the process of transformation in the region. This is one of the legitimate tasks of such an exercise. In its ability to track economic outcomes in detail, the model provides a useful description of the process as it occurred. Such a tested model can now be used as an even more powerful tool to form counterfactual arguments to highlight the impact of specific policies.

The use of counterfactual arguments is one of the methodological hallmarks of what has been termed "the new economic history."[40/] A counterfactual argument takes as its starting point something which is known to be false. This is done because "the significance of historical fact [is] revealed by asking what might have happened if things had been different."[41/]

39/ Several studies of the wheat region including an initial static version of this model have stressed the critical importance of these two policy instruments in transforming the agricultural economy of this region. See Rask, et.al. [48], Rask [42], [43], and Rask and Meyer [47] for a description of recent changes in the region; Adams [1], Adams, Davis, and Bettis [2] on the importance of the credit issue; Engler and Singh [17] for results of a static study and Singh and Ahn [59] and Ahn and Singh [5] for other applications of the current model to policy analytic issues.

40/ See the discussions by Fogel [18], Davis [10] on the use of counterfactual arguments in economic history and Redlich [50] for a critique of their use. Further see Gould [19] on some of the methodological pitfalls encountered.

41/ M. R. Cohen quoted by Gould [19].

Thus, in the context of our study, the significant impact of wheat support programs accompanied by credit subsidies can be more readily revealed by asking what might have happened in terms of regional development if these policy instruments had not been used as they were. By assuming conditions contrary to those that actually prevailed, the tested model can be used to track a "hypothetical history," as it were, of regional development. These counterfactual histories can then be compared to each other to ask questions regarding the importance of selected policy choices. Thus Fogel writes:

> "The union between measurement and theory is most evident when one attempts to establish the net effect of innovations, institutions, or processes in the course of economic development. The net effect of such things on development involves a comparison between what actually happened and what would have happened in the absence of specified circumstances.....In order to determine what would have happened in the absence of a given circumstance, the economic historian needs a set of general statements (that is, a set of theories or a model) that will enable him to defend a counterfactual situation from situations and relationships that actually occurred." [18, p. 653]

Thus, the model can be used to simulate alternative regional histories to allow counterfactual inferences to be made. The use of the model for this form of retrospective or backward looking analysis is similar to its use for conditional forcasting under alternative

assumptions.[42/]

The three main hypotheses and their component parts that will be examined can be stated briefly as follows:

(1) that the wheat price support program tied with the availability of institutional credits on very liberal terms were mainly responsible for:

(a) Higher value of regional output;

(b) An increase in the production of wheat and a change in the pattern of land use to c op farming;

(c) Increasing regional employment specially among small farms;

(d) Increasing capital and credit use and over-capitalization especially on medium and large farms;

(e) Increasing inequality of farm incomes;

(2) that a policy of providing price supports was central in explaining the transformation that occurred, although the availability of liberal credits allowed this transformation to be accompanied by

(a) a higher rate of capital and credit use;

(b) a higher level of mechanization;

(c) a greater area sown to wheat; and

(3) that the program of self-sufficiency through import-substitution in the production of wheat was not only successful but in the aggregate

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42/ As Gould [19, page 197] clearly points out: ".... indeed counter-factual historian and economic forecaster are engaged in exactly the same exercise, arguing from known to unknown with the aid of lawlike statements even though the latter's unknown is something which "might happen" in the future and the former's something which "might have happened in the past."

provided positive net social benefits.

Alternative Policy Assumptions

In order to test these counterfactual hypotheses and to highlight the importance of pricing and credit policies, we use the model to simulate the possible development impacts under three policy alternatives for the period 1960-70. These alternatives are the following:

P1: A Policy of Price Supports with Liberal Credits: This is the policy program that was actually followed in the period 1960-70 in the region. These programs included 1) a domestic wheat to beef price ratio increasingly favorable to wheat production between (1960-70) through a wheat price support program;[43/] (2) liberal credits for the purchase of modern inputs with credit limits set at 60 percent of the volume of gross sales by credit institutions;[44/] and a relatively low nominal and subsidized rate of interest of 15 percent on borrowed capital.[45/] The results of this simulation were reported in detail in the previous section, and comprise the actual historical outcome.

P2: A Policy of Price Supports Without Subsidized Credit: The assumptions used in this case are the same as those under P1 except that the nominal rate of interest is increased from 15 percent to 40 percent in order to allow a "real" rate of interest in the range of 10-12.

43/ As shown in Table 2.

44/ That is a "borrowing coefficient" = .6 in equation (10b)

45/ Credits were liberally subsidized during this period. Thus to reiterate, modern variable inputs, such as seed, nutrients, and pesticides could be purchased 100 percent on credit at a nominal interest rate of 15 percent per annum while farmers could obtain long term, low interest financing for agricultural machinery with a 25 percent down payment at a 7 percent rate of interest. Meanwhile, the wholesale price index for foodstuffs increased by an average of 60 percent annually between 1960-66 and 23 percent annually between 1967-71. Thus, in effect, due to inflation and the real rate of interest on credit was negative during the entire decade! See Nehman [39] and Stitzlein [64].

percent per annum, to prevail.

P3: A Policy of No Price Supports or Liberal Credits: The assumptions used are the same as under P2 except in addition (1) international prices are assumed for final traded outputs[46/] and (2) and borrowing limits are changed to half their previous levels (a change in the borrowing coefficient from .6 to .3) to reflect a tighter credit policy on the past of credit institutions.

Policy (P1) is designed to allow the model to track regional development as it occurred during the period 1960-70. The results from this are used to test the model's performance as well as to provide a detailed picture of the process of transformation, as reported in the previous section.

Policy (P2) is designed to evaluate the impact of credit subsidies by asking what might have happened if credits had not been provided at nominal rates of interest below the rate of inflation during this period. This policy alternative has been singled out because earlier analysis showed that there were serious allocative distortions in the use of credit and capital that could have been prevented had credits not been available at negative "real" rates of interest. There is also a growing concern that low interest rates on institutional credits substantially below the market rate have major distributive effects that may

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46/ This consists of substituting the U.S. export prices for wheat and soybeans and the Argentine export price for beef, valued at the going exchange rate for the respective domestic price vectors. Domestic corn prices are allowed to prevail because domestic prices have not differed substantially from international levels. Corn has been marginally imported and exported for a long time and it is for this reason that the domestic prices have been close to international levels. Divergences from time to time have been largely due to exchange rate policy and quotas on exports by the Brazilian government. See Schuh [71].

have specially discriminated against small farmers.[47/]

Policy (P3) is designed to evaluate the joint impact of both the wheat price support program as well as a policy of liberal credits that characterized the period. However, this counterfactual argument is cast in a much broader context. It sets out to ask what might have happened if government intervention in product and capital markets through price controls and credit subsidies had not been taken place and domestic product markets had been open to international competition. Since during the period 1960-70 domestic beef prices had been held below and wheat prices above their levels in international markets, the main transformation consisted of the substitution of wheat-soybean and crop production for extensive beef cattle operations. The focus of this counterfactual analysis is to see if this process would have occurred in the absence of such distortions. Further, since credits were tied relatively to such modern inputs as machinery, seeds and nutrients that are relatively more crop production specific, an attempt is further made to remove this source of distortion and its impact. Thus, both the interest rates are raised and the credit limit reduced. The former corrects for the distortions in the cost of capital while the latter brings the borrowing practices in line with those observed in the agricultural sector in other developing countries.[48/]

47/ For example, simulation results showed that by 1970 large and medium farms accounted for 70 percent and 28 percent respectively of all borrowings in the region, while small farms accounted for only 2 percent. During the same year the average productivity of cash outlays on small farms was eight times that on large farms. See Ahn [4], and Singh and Ahn [59].

48/ A banking rule of thumb that ties the credit limit to the volume of gross revenues is fairly common practice among rural lending agencies in most parts of the world. Only the limit is set at between 20-35 percent of the volume of gross revenues rather than the liberal 60 percent set in Brazil. In the Indian Punjab, a 20-25 percent limit is used. See Singh [57].

Impact of Policy Changes

The highlights of the model simulations are now considered. In the graphical displays that follow the projected time paths are identified by the policy alternatives, P(1), P(2), P(3).

Total Output

The impact on the value of total output of alternative policy programs is shown in Figure 14.

Several useful insights into the role price and credit policies have played in the development of agriculture in Southern Brazil can be gained from these results.

First, when we compare the outcome under policies P(1) followed in the decade of the sixties with the alternative P(3) in which price and credit subsidies are not available and the subsector is left open to international competition we observe that an opportunity for a substantially higher value of farm output hay have been lost during the decade. The estimated total value of regional output under P(3) (evaluated at the international prices that would have prevailed in domestic markets) is nearly twice that under P(1) in nearly all the years.

These changes are due not only to a change in the price of outputs under P(3), but also due to the change in enterprise combinations that result from such a price change. When international prices are allowed to prevail under P(3) the economy instead of switching from extensive livestock to c op production with soybeans, would have continued in livestock production, but with a difference. Since new livestock production technologies had become available - that is an intensive livestock production using improved and fertilized instead of range pastures -

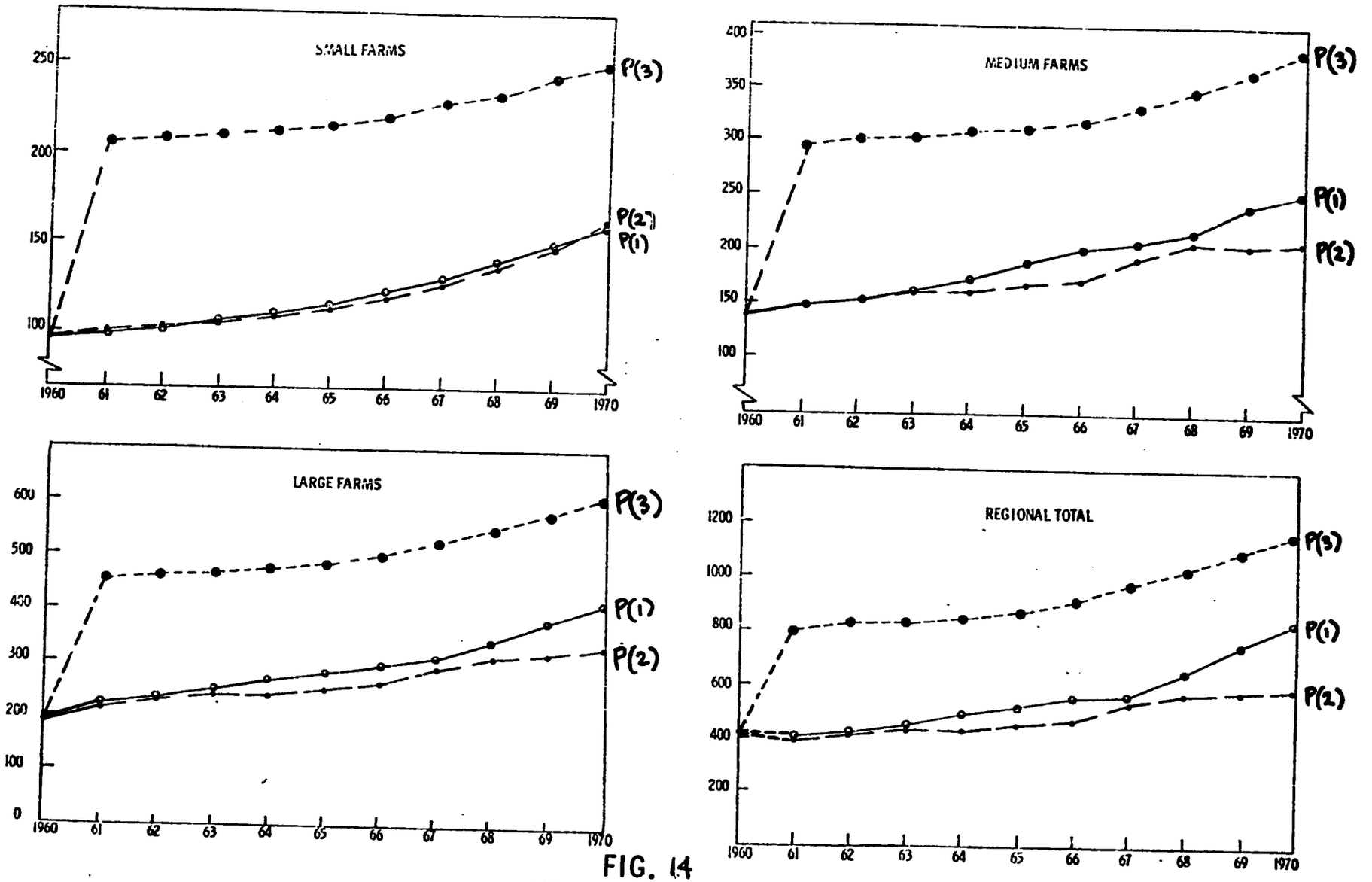

FIG. 14
VALUE OF TOTAL OUTPUT
(In Million Cr. at 1970 Prices)

the economy would have adopted these with an enormously improved output in the livestock sector. With wheat made relatively profitable through price supports even intensive livestock production was not desireable. When the inernational price ratio restores the relative profitability of beef, its production is undertaken with improved technologies. This is what accounts for the sharp differences in the value of output under P(3) and P(1) and P(2) in Figure 14.

Another interesting feature of these results is the uneven impact on the growth of output among farms of different size that can be imputed to the price support and credit subsidies provided in the region.

In order to measure these impacts the compound growth rates of gross value of uutput are computed for the period 1961-70. This is done because it should be borne in mind that the level of gross output under P(3) is substantially higher starting in 1961, when international output prices and their impact are introduced from that year onward. Thus 1960 is not used as a base period because the discrete change from 1960 to 1961 would have inflated the growth rate for P(3). These results are show in Table 8.

It can be observed from these figures that raising the nominal interest rate - policy program P(2) - would have had a substantial impact on the growth of regional output, reducing its compound rate of growth from 6.8 percent to 4.4 percent per annum. However, the impact on growth would have been most uneven, with a decrease in the growth rate to 4.2 percent from 8.1 percent on large farms and to 3.9 percent from 5.9 percent on medium farms, while the growth rate on small farms would have actually increased though very slightly. In the other two

TABEL 11-8 - Compound Growth Rates of Total Value of Gross Output Under Alternative Policy Programs (1961-1970) (Output Valued at Constant 1970 Prices)

Farm Size	Policy Program		
	P(1)	P(2)	P(3)
Small Farms (0-50 Hectares)	5.4%	5.5%	2.1%
Medium Farms (51-300 Hectares)	5.9%	3.9%	2.9%
Large Farms (301 Hectares)	8.1%	4.2%	3.9%
Regional	6.8%	4.4%	3.1%

policy options, the rates of growth are positively correlated with farm size suggesting that the larger capital, land and financial resources of larger farms allow them to grow faster.

The impacts of changing just the nominal interest rate are interesting for they allow us to make two important counterfactual inferences: 1) the wheat price support program often cited for bringing about the rapid rates of growth would not have been as effective without the accompanying credit subsidies and 2) it is the medium and large farms that are most sensitive to changes in interest rate policies, since it is these that depend most heavily on credit and the ones that therefore benefited the most from the credit subsidies. These uneven benefits that occurred, making the larger farms the favored beneficiaries of public policies, are substantially responsible for the worsening income distributions in the region as will be shown later.

Land Use

The main impact of the wheat price support program was to increase the production of wheat substantially, especially on medium and large mechanized farms, at the expense of range livestock farming. Both alternative policy programs P(2) and P(3) would have reduced the production of wheat substantially. This is shown in figure 15. The production of beef is not affected by changes in the interest rate, while it increases when international beef prices are introduced in P(3).

The reduction in wheat hectarage, however, is confined mostly to medium and large farms which have used price and credit subsidies to mechanize their operations substantially. Small farms have not benefited because as we see their wheat production remains essentially unchanged when both subsidies are removed. Thus, the transformation from range livestock production to mechanized crop farming that took place in the decade of the sixties was considerably accelerated by the price and credit subsidies and the major benefits were confined mainly to medium and large farms.

The wheat support programs achieved their stated goals - that of increasing Brazil's wheat production in order to reduce its reliance on imports.[49/]

Employment

The overall impact of raising the interest rate and of further removing the price subisdy is to dampen total regional employment. The

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49/ Thus domestic production as a percentage of total requirements increased from 12 percent in 1962/63 to an estimated 50 percent by 1970/71. See Engler and Meyer [16].

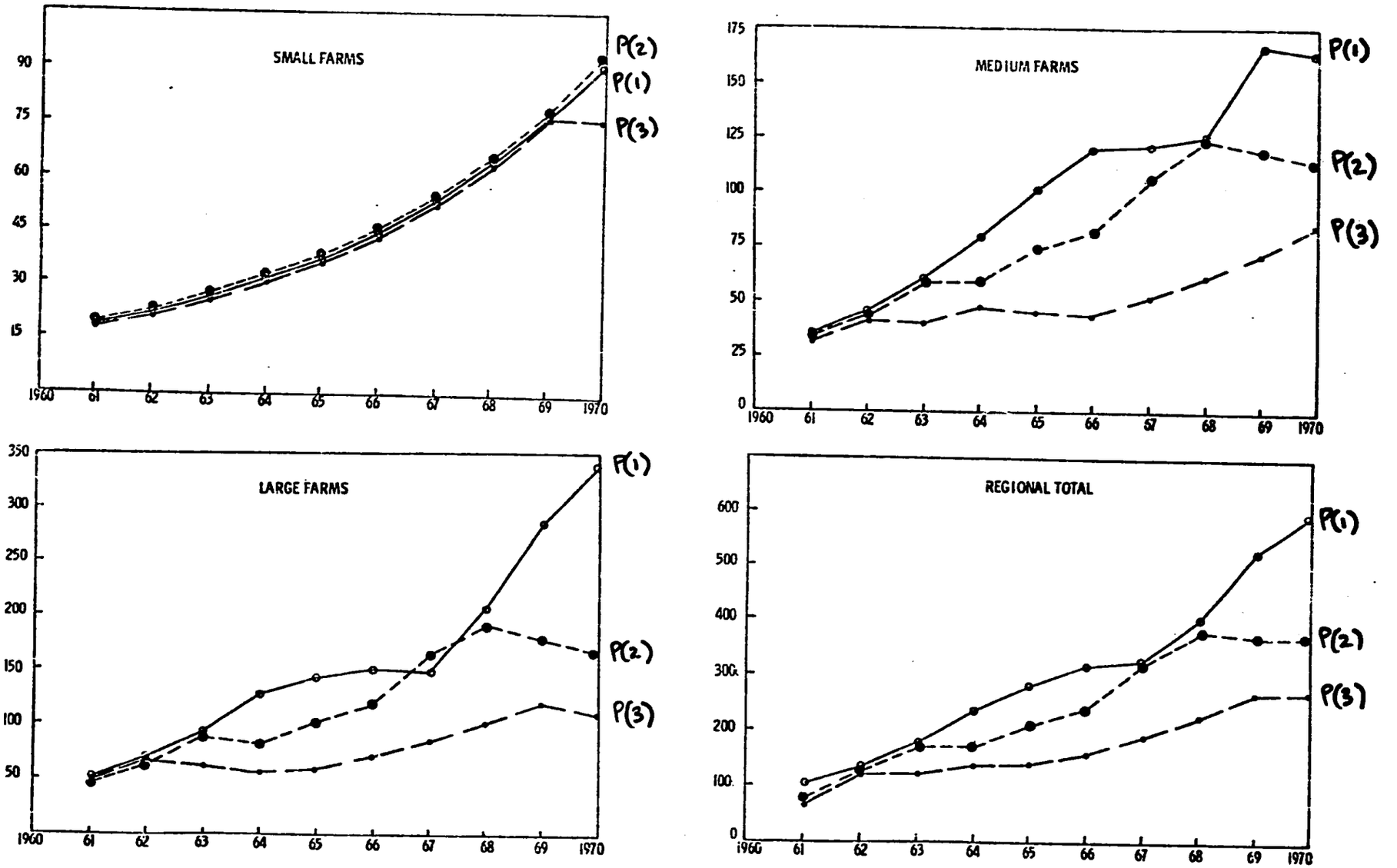

FIG. 15.
AREA SOWN TO WHEAT
(In 1000 Hectares)

decline is confined mainly to small farms as they tend to fall back to livestock and independent soybean production instead of the more labor intensive soybeans following wheat cropping pattern when subsidies are not assured.[50/] Thus, one of the benefits associated with the policies followed in the decade of the sixties was that by making wheat production domestically profitable it provided a much higher level of employment in the region, especially on small farms.

This clearly points out that the impact of a policy program should not be evaluated only in terms of a single criterion such as output but should consider the impact on other factors such as employment, efficiency of resource allocation and income distribution to mention only the economic criteria. These gains in employment have been a significant positive effect of the price support program, and since they effect small farms specially, the net welfare and distributive effects would also have been positive though they are hard to measure directly. These gains alone, however, do not necessarily vindicate the program under P(1).

Capital Utilization and Borrowings

The importance of the interest rate subsidies on short term borrowings on the financial resources available and used especially on large and medium size farms is clearly seen in the reduction in total capital use experienced under policy program P(2) shown in Figure 16. These reductions in total capital use came both from reduced outlays on working capital and substantial reductions in the growth of investment

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50/ See Singh and Ahn [60] for details.

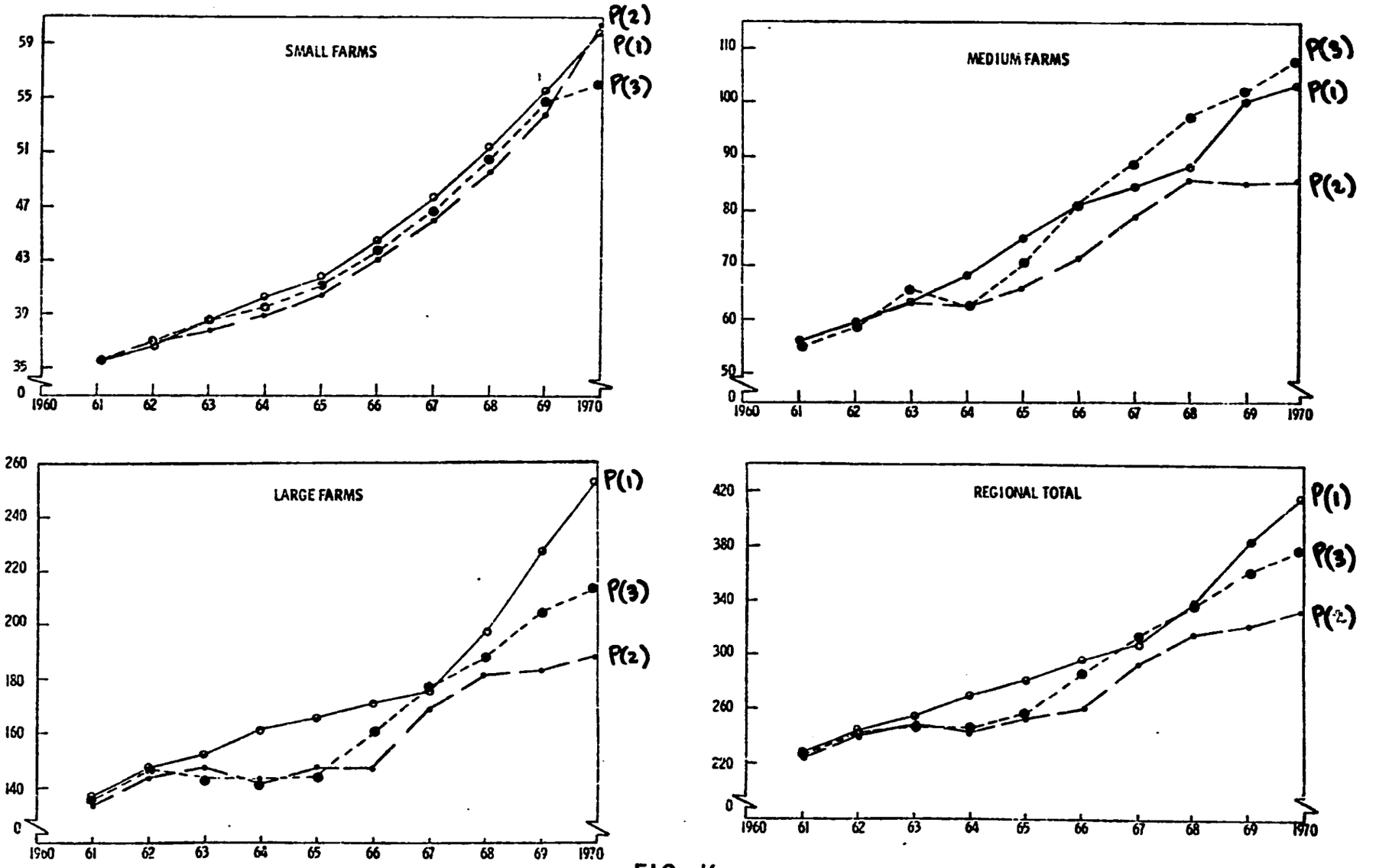

FIG. 16.
TOTAL CAPITAL USE
(In Million Cr. at 1970 Prices)

outlays that had been encouraged by the availability of cheap (negative real interest rate) credits.[51/] Indeed with the nominal interest rates substantially below the rates of inflation, the only limits on the demand for borrowed funds were the limits placed by lending institutions.

Figure 17 shows what happens when the nominal interest rate is raised. The impact on short term borrowing on medium and large farms is immediately felt, for they cease to borrow.[52/] Small farms now obtain access to regional credit supplies previously going to larger farms and increase their levels of borrowings after 1966, whereas their working and investment capital outlays remain unchanged.

When price subsidies are also dropped, short term borrowing disappears, investment outlays and working capital use is further dampened on medium and large farms, but increase only slightly on small farms.

These results again point to the important but unequal impact of price and credit subsidies in the region. Increased wheat price supports made wheat production relatively very profitable after 1964 on medium and large farms. They expanded their production for which they required large investments in farm equipment, (tractors and harvestors mainly) and increased supplies of working capital. These were then forthcoming at obligingly low real interest rates. With greater access to capital markets, and credit rules based on ability to pay rather than on capital productivity, medium and large farmers expanded their credit use enormously, and became increasingly dependent on it over time. The price

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51/ See Singh and Ahn [60] for details.

52/ Except for 1964, the year in which the wheat price support program was widely adopted.

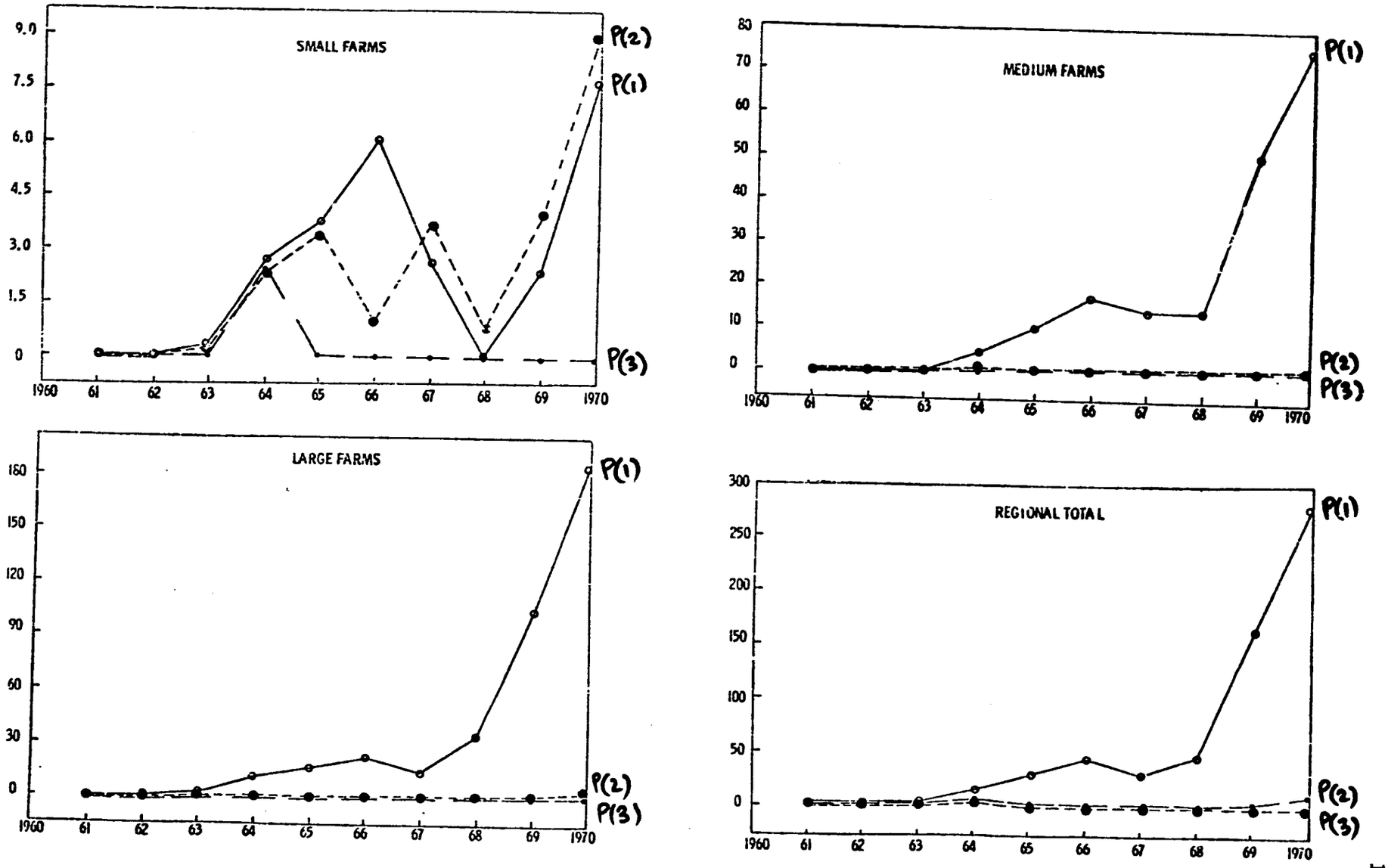

FIG. 17.
SHORT TERM BORROWING
(In Million Cr. at 1970 Prices)

subsidy provided the catalyst (incentive) and the liberal credit terms provided the lubricant for the engine of growth.

Due to institutional factors in the credit markets, factor proportions that encouraged labor intensive technologies and the fact that no real shifts in the biological production function to which farmers had access were involved, the small farmers should have been deprived of the main driving forces behind the regional growth experienced in Southern Brazil. The results should have been inevitable--increasing inequalities in farm incomes over this decade. But this was not the case as small farmers also turned to crop production and made substantial gains. Furthermore, having less access to institutional credits tended to be more efficient in their use of capital.[53/]

Income Distribution

Irrespective of the policies followed there were substantial differences in farm incomes due to initial differences in resource endowments. Thus in 1960, if we examine all differences in net farm output figures we see that medium farms had a net farm output nearly 10 times and large farms nearly 17 times, the net farm output on small farms.[54/] The joint impact of the price support and credit subsidy program was to decrease the inequality of farm incomes. This is shown in Table 9 where the Gini ratios associated with the distribution of net farm incomes are shown.

Thus although income distribution continues to worsen under all

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53/ See Singh and Ahn [60].

54/ That is total net output divided by the number of farms in each farm size group.

TABLE 11-9. Gini Ratios Associated with the Distribution of Net Farm Incomes

Policy/Year	1960	1970
P_3:	0.601	0.639
P_2:	0.489	0.539
P_1:	0.489	0.58

policy alternatives, it would have been the most unequal if policies under P(3) had prevailed. The reason for this result is that under P(3) there would have been a tendency to go from extensive to intensive livestock production - a transformation requiring a great deal of capitalization that only larger farmers could take advantage of. Under the price support programs all farmers could benefit by shifting to crop production regardless of size.[55/]

Evaluating Policy Choices

It is useful to draw specific policy recommendations on the basis of our analysis, but his must be done with care for several reasons. First, though the model attempts to incorporate many microeconomic details in order to track the process of regional development, it also has to abstract and aggregate considerably for various practical reasons. It is more detailed than many models that rely only on aggregate indices, for an attempt has been made to construct it in a "bottom-up" manner, with input-output data obtained from detailed farm surveys. To the

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55/ See Ahn and Singh [5] for details on the impact of alternative policy assumptions on the distribution of farm incomes.

extent that it is based on a detailed knowledge of agriculture in the region, it is fairly "realistic." Furthermore, considerable theoretical support and applied experience lie behind the model components and aggregation procedures used here.

Second, in capturing many of the details its structure is complex, and its very complexity prevents the use of any straight forward procedures for testing its goodness of fit. This is made more difficult by the unavailability of regional data in sufficient detail to test the variables estimated by the model and by the usual inaccuracy in the data. Model tests for the period 1960-1970 suggested that the model was able to track recent events closely, and the testimony of regional experts tended to confirm it. But no statistical significance can be attached to the variety of non-parametric tests often used in evaluating complex simulation models of this kind.

Third, the model is partial and region specific so that policy recommendations that flow from it can at best be partial and region specific. This drawback is partially overcome if we consider the model to be fairly representative of the wheat commodity sector in Brazil as the wheat region modeled accounted for a large percentage of the total production as well as the area sown to wheat in Brazil in 1970.

Fourth, our earlier analysis clearly indicates that the impact of any policy program should not be evaluated on the basis of any <u>single</u> criterion such as output, but should also consider the impact on other factors such as employment, the efficiency of resource allocation and income distributions to mention only a few of the economic criteria. This we have tried to do broadly in the preceeding sections.

Keeping in mind the limitations listed above, let us focus on two alternative policy choices P(1) and P(3) - one that was followed and one that could have been followed - and evaluate the differences between them.

The value of total output in Figure 14 is calculated at 1970 prices. To make output in different years comparable we compound its value at 5 percent per annum to 1970 for the different years and add it up for the alternative policy programs. These values are shown in Table 10.

Comparing P(1) with P(3) we see clearly that approximately CR$5.2 billion in terms of the value of farm output may have been lost in the decade through the imposition of domestic price controls. Furthermore, this figure is probably an underestimate, because we have chosen a relatively low rate of interest at which to compound the values. The compound rate of interest is supposed to reflect the real opportunity cost of capital in the economy and there is evidence to indicate that this cost may have been as high as 15 percent per annum in Brazil during this period.[56/] Thus the program of price supports for wheat designed to bring about self-sufficiency in the production of wheat was very costly if <u>indirect</u> costs in terms of forgone output are measured.

Domestic Resource Costs of Import Substitution

Another way of evaluating the costs of the highly successful program of price supports for wheat is to recognize it as an attempt at import

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56/ That is the real rate of return to capital has been very high in Brazil. See Bacha [7] and Langoni [33]. We are indebted to Professor E. Schuh for bringing this point to our attention.

TABLE 11-10 Value of Total Output Under Alternative Policy Programs Compounded at 5 Percent Per Annum (In Million Cr. at 1970 Prices)

	Policy Assumptions		
Year	P(1)	P(2)	P(3)
1961	691.1	682.2	1,398.6
1962	692.4	683.0	1,358.9
1963	698.9	682.9	1,305.5
1964	714.1	686.8	1,263.9
1965	720.5	644.9	1,228.9
1966	725.3	647.3	1,213.3
1967	734.0	679.8	1,209.5
1968	749.5	697.4	1,207.8
1969	804.5	674.9	1,213.6
1970	830.4	663.6	1,210.6
Cumulative Total	7,361.2	6,743.4	12,611.1

substitution in wheat production. Following Krueger [32] we can analyze the efficiency of the Brazilian "import substitution" program for wheat by using the domestic resource cost (DRC) concept used by her and others.[57/] The DRC measures the opportunity costs of the domestic resources employed directly in the ith output industry as a fraction of the net change in the country's trade balance that would occur were the level of the ith output contracted (expanded) by one unit and is defined as follows:

$$DRC = DC_i/NVA_i$$

where DC_i is the net opportunity cost of domestic resources employed per unit of output and NVA_i is the net international value-added per unit of output in the ith industry.

We have made these calculations for wheat production in 1970 on a per hectare basis in Table 11. To estimate the DRC for wheat we have assumed that all factor inputs used in wheat production are obtained from domestic sources.

These estimates give the direct resource cost for wheat production at 6.63 CR$/$. This implies that in 1970 it costs the Brazilian economy 6.63 CR$ to obtain one dollar's worth of value added, at international prices, through the domestic production of wheat. Comparing this with the ratio of 4.57 for the official exchange rate between Cruzeiros and U.S. dollars, we see that the DRC for wheat is such that Brazil could have imported 1.45 times the value of imported goods for every unit of

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57/ For theoretical discussions and applications of DRC see Krueger [32]. For an empirical application to the Indian caustic soda industry, see Starr, [62].

TABLE 11-11 Domestic Resource Costs for Wheat Production in the Wheat Region in 1970.

Domestic Costs of Inputs*

(per Hectare of Wheat Output)

Land (1ha) : Rental Value	: 82.66
Labor (9 hours)	: 7.66
See (9 kg)	: 63.0
Insecticide	: 8.11
Soil Fumigant	: 5.43
Tractor Oper. Co. (5 Hours)	: 22.75
Fertilizer (250 kg)	:105.00
Combine Oper. Co. (1 hour)	: 11.32
Transportation (1,360 kg)	: 19.04
Depreciation of Tractor	: 6.00
Depreciation of Combine	: 20.40
Administration	: 21.50
Compulsory Insurance	: 3.5
Fertilizing and Seeding	: 16.5
Interest on Short-Term Borrowing	: 17.5
Tax and Registration	: 2.85
TOTAL DC	Cr$ 413.22

Net Value Added in International Markets**: U.S. $62.33

DRC for Wheat = 413.2/62.3 = 6.63

Current Exchange Rate : Cr$/U.S.$ = 4.572
(In 1970)

* Source: (1) Trigo : Estudo do Custo De Producas, Safra De 1971, 1972
(2) Ahn [4] and Engler [15]

** An output of 1.02 metric tons per hectare valued at the U.S. export price of $61.105 per metric ton in 1970.

wheat produced domestically.[58/]

The DRC provides a measure of the loss in terms of the value of imports forgone as a result of import substitution in wheat. We have the model predictions for the total domestic resource costs for each year (DC(t)) and the value of total output at international prices. We can use the same method of analysis to calculate the losses in foreign exchange in each year as a consequence of import substitution in the wheat region.

These calculations are shown in Table 12, where the regional domestic costs and the equivalent import costs are calculated and compounded at 5 percent per annum to allow camparability between years. It would appear on the basis of these calculations that a net savings of U.S. $103.3 million could have been made if import substitution had not been resorted to and wheat had been imported over the period. This of course assumes that wheat could have been imported and that Brazil could have paid for these imports with exports. These assumptions seem wholly tenable for the period under investigation, even though recent events in the world commodity markets seem to suggest otherwise.

These costs are measured in a manner similar to the method used by Knight in estimating the costs of import substitution of wheat [59/] in Rio Grande do Sul. The only difference is that this study provides

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58/ This rate was not a free market rate even though the Brazilians described it as such. It was an official fixed rate. These are results that tend to confirm Knight's [28], [29], [30] earlier analysis, and arguments against import substitution in wheat in RGS.

59/ See Knight [29] and [30].

TABLE 11-12 Domestic Costs and Equivalent Import Costs of Wheat Production at 1970 Prices (Compounded at 5 percent per Annum)

Year	Area Sown to wheat Under P(1) (1000 ha)	Compounded Regional Domestic Costs a/	Compounded Equivalent Import Costs b/
		(In Million U.S.$)	
1960	75.5	11.11	7.67
1961	100.0	14.02	9.66
1962	132.2	17.66	12.17
1963	176.6	22.46	15.49
1964	235.5	28.52	19.67
1965	281.1	32.42	22.35
1966	315.1	34.62	23.87
1967	324.4	33.94	25.0
1968	397.4	39.59	27.3
1969	527.2	50.03	34.5
1970	593.4	53.63	36.98
	TOTAL	338.0	234.66

a/ Area X Cr. $413.2 or U.S.$ 90.376 at the 1970 free market exchange rate of 4.572 Cr.$/$, compounded at 5%

b/ Area X U.S. $62.33 from Table 9, compounded at 5%

a figure for the regional aggregate. In cruzeiro equivalents these amount to some CR$472 millions over the ten year period. However these costs are only partial. They measure only the costs of producing wheat domestically instead of importing an equivalent amount. What they do not measure is the domestic costs in terms of production alternatives forgone - in this case livestock production using intensive pasture systems - when wheat was produced domestically. These costs are the true opportunity cost of import substitution and they are substantially higher as shown in Table 10. Indeed over the ten year period they are ten times greater than the partial costs measured by using the domestic resource method. Therefore we conclude that Knight's analysis was in the right direction but that he may have underestimated the true opportunity cost of import substitution by a factor of ten!

Other Costs

Other costs include the cost of the credit subsidy and administrative costs associated with the program P(1) that could also have been saved. No figures are available on the administrative costs of the program, but the costs of the credit subsidies can be estimated.

The cost of the credit subsidy is the difference between the rate of interest that would have prevailed in open financial markets and the subsidized rate charged by institutions times the differences in total borrowings under the two programs. If a 15 percent real rate of return to capital was prevalent during the period, then certainly real rates of interest could not be expected to be lower. Assuming a low average rate of inflation of 25 percent per annum during the period - an underestimate for many of the years between 1960-70 - a 40 percent nominal

rate of interest would be required to correct for the real opportunity cost of capital. This is exactly the nominal rate used in policy alternatives P(2) and P(3). The subsidy then amounted to 25 percent per unit of credit advanced. Since there were no predicted short-term borrowings under P(3), the total cost of the credit subsidy is 25 percent of the borrowings under program P(1). These compounded at 5 percent per annum and cumulated amount to CR$163 million at 1970 prices during the ten year period.

On the basis of our analysis what can we say about the hypotheses we set out to test using our counterfactual methods? To summarize we can conclude:

(1) that the wheat price support program accompanied by the availability of credits on very liberal terms:

(a) led to substantial growth of output in the region but that this growth was less than would have been achieved otherwise;

(b) resulted in increased output of wheat and changed land use to favor crop farming;

(c) increased regional employment especially among small farms;

(d) led to increased capital and credit use and over-capitalization especially on larger farms with a subsequent inefficiency in the use of this scarce resource;

(e) led to decreasing income inequalities; that although farm income differentials increased these were mainly due to the differences in initial and cumulative resource

endowments and not policy changes;

(2) that a policy of providing price supports was central in explaining the transformtion of an extensive livestock economy to crop production, although the availability of liberal credits allowed this to be accompanied by

(a) higher capital use and borrowing,

(b) higher levels of mechanization, and

(c) a greater area sown to wheat, and

(3) that the program of self-sufficiency through import substitution in agricultural production may have been accomplished at a fairly high net social cost.

But was such a policy desirable. To evaluate this we need to go beyond the issues capable of being examined in the framework of the model used here, however a few tentative policy implications can be drawn

Some Policy Implications and Conclusions

On the basis of the above analysis and calculations a few tentative inferences can be made. Comparisons analyzed indicate briefly that if international output prices had been allowed to prevail and higher nominal rates of interest (positive real rates in the range of 10-15 percent) had been charged on credits a variety of desirable outcomes could have been realized: 1) the accumulated growth of the value of total output achieved could have been substantially larger; 2) less capital and credits would have been used more efficiently, and since total credit use was negligible these credits could have been released for use elsewhere; 3) labor and land productivities would have been higher on all farms and resources would have been allocated in a manner more appropriate to the

comparative advantages in Southern Brazil at international prices; 4) average net incomes on all farms would have been higher; 5) the direct costs of wheat price support and credit programs could have beens saved. Against these substantial losses, the gains in increased employment. especially among small farmers and a slower increase in income inequality must be weighed. These benefits were undoubtedly the unplanned consequently of a policy designed to increase wheat production. The programs initiated in this decade were in response to a political aim to acquire "self-sufficiency" in the production of wheat. This goal though not fully realized through a policy of import substitution substantially reduced Brazil's reliance on international markets for its domestic requirements of wheat.

Further, the alternative strategy of letting international prices prevail in the domestic market to allow the comparitive advantage in beef and soybean production to express itself in domestic production would have meant higher prices for beef in the domestic market. Keeping these prices low for consumers may have been an additional goal of policy makers as noted in Chapters 2 and 3.

Two other factors also need consideration. First, although the main aim of price supports for wheat was to encourage its production, a side effect was to increase the domestic demand for farm machinery. This helped the domestic industry, which in turn may have been supported partly by tariff barriers, as import substitution was also taking place in the industrial sector. In this regard, many Brazilian economists feel that low interest rates on institutional credits were seen as part compensation for the extremely high domestic prices for non-farm inputs.

Second, the program of self sufficiency in wheat transformed open

range livestock farms, especially the large ones into mechanized crop farms. In this transformation of course an entire way of life associated with the 'gaucho' and the old set of socio-economic relationships were destroyed, making way for modern capitalistic farming. This is no doubt a mixed blessing, but to anyone who visits this region, it is obvious that a new vitality and progressiveness are evident in the small farming towns of the region. Grain silos, new roads, banks, large well organized farmers cooperatives, machine shops - all contrast sharply with the old way of life based on traditional unchanging relationships and modes of production and commerce. This change has made way for organizing beef production on modern lines - a possibility that could not have been envisioned if the old modes of beef production and a way of life had not first been destroyed.

Given hindsight and the turbulent nature of commodity markets in the world today (especially with regard to wheat, beef, and soybean shortages experience in the past year), the goal of "self-sufficiency" seems to have been justified. For even though a high price was paid, the dependence on unreliable foreign markets was reduced, and domestic supplies partly assured. However, these gains may be only short lived, while the costs of thwarted comparative advantage may be high. The support given to particular agricultural commodities as "infant industries" will delay the research and extension programs needed to make Brazilian agriculture more efficient and productive. With a growing domestic demand and continuing world shortages of many agricultural commodities, Brazil could plan to take advantage of its vast land resources to produce food and fibers for world markets. It cannot long neglect the problems of stag-

nant yields per hectare and the inefficiency of resource use in the farm sector. It certainly should not encourage them.

There seems to be many cogent reasons on the basis of which one could say that the import substitution of wheat through a program of price supports should not have been undertaken. Yet one hesitates to draw this conclusion because the alternative program would have meant an increasing dependence on foreign markets. This dependence would come from the need to import the domestic requirements for wheat, and the need to find export markets for beef. The prospects for increasing beef exports are not reasonable given the current glut in world markets, while the current prospects of importing wheat to meet growing domestic demand are also not good. How good these prospects were in the past decade had to be evaluated by policy makers. A reliance on international markets may have introduced a large element of uncertainty in the development program in Brazil or any other country and had to be properly taken into account.

Thus the desireability of wheat support programs or their continuation has to be further evaluated in terms of the situation in international markets for wheat, beef and soybean. This is beyond the scope of the current study.

Future policy choices will depend crucially upon the costs and benefits associated with alternative technology and price policy options. The purpose of this study has been to show how models, such as the one presented here, can be used to evaluate alternative policy options and their expected outcomes on a variety of target criteria - output, productivity, employment, allocative efficiency and income distribution. Models of this nature will be increasingly useful, both as a supplement

to the more traditional kinds of production analysis as well as on going tools for policy oriented research.

BIBLIOGRAPHY

[1] Adams, Dale W. (1971), "Agricultural Credit in Latin America: A Review of External Funding Policy," American Journal of Agricultural Economics, Vol. 53 (2), May 1971.

[2] Adams, Dale W., Harlan Davis and Lee Bettis, "Is Inexpensive Credit a Bargain for Small Farmers? The Recent Brazilian Experience," Inter-American Economic Affairs, 1972.

[3] Adams, Dale W. and I. J. Singh, "Capital Formation and The Firm-Household Decision Making Process," ESO #11, Department of Agricultural Economics and Rural Sociology, Ohio State University, 1972.

[4] Ahn, C. Y. (1972), "A Recursive Programming Model of Regional Agricultural Development in Southern Brazil (1960-1970): An Application of Farm Size Decomposition," Unpublished Ph.D. Dissertation, The Ohio State University, 1972.

[5] Ahn, Choong Yong, and I. J. Singh, "Import Substitution and Farm Income Distribution: A Dynamic Analysis of Recent Developments in Rio Grande do Sul- Brazil (1960-1970)," ESO #11, Department of Agricultural Economics and Rural Sociology, Ohio State University, June, 1972.

[6] Ahn, C. Y. and I. J. Singh, "Comparative Dynamics and Policy Analysis: Agricultural Development in Southern Brazil to 1985," in R. H. Day (ed.) Economic Development Models: The Recursive Programming Approach, (Amsterdam: North Holland, 1974).

[7] Bacha, Edmar L., "O subemprego, o custo social de mao-de-obra e a estrategia brasileira de crescimento," Revisita Brasileira de Economia, Vol. 20, No. 1, Jan./March 1972.

[8] Brown, L. A., "The Market and Infrastructure Context of Adoption: A Perspective of the Spatial Diffusion of Innovation," Economic Geography, 1974, forthcoming.

[9] Cigno, A. (1971), "Production and Investment Response to Changing Market Conditions, Technical Know-How, and Government Policies," Review of Economic Studies, 1971.

[10] Davis, Lance, "And It Will Never Be Literature - The New Economic History: A Critique," Essays in Intrepreneunal History, Vol. 6, No. 1, 1968.

[11] Day, Richard H. (1963), Recursive Programming and Production Response, Amsterdam: North Holland Publishing Company, 1963.

[12] Day, Richard H., and I. J. Singh (1971), "A Dynamic Microeconomic Model of Agricultural Development," Paper No. 7135, Social Systems Research Institute, University of Wisconsin, March 1972.

[13] Day, Richard H. and I. J. Singh, Economic Development As An Adaptive Process: A Green Revolution Case Study, London, Cambridge University Press, 1975, forthcoming.

[14] De Haen, Hartwig (1971), Dynamisches Regional Modell der Production and Investition in der Landwirtshaft, Hannover, Alfred Strothe Verlag, 1971.

[15] Engler, J. J. de C. (1971), "Alternative Enterprise Combination Under Various Price Policies on Wheat and Cattle Farms in Southern Brazil," Unpublished Ph.D. Dissertation, The Ohio State University, 1971.

[16] Engler, Joaquim J. de Camargo,,and Richard L. Meyer, "Trigo: Producao, Precos e Produtivadade," (Wheat: Production, Prices and Productivity), Pesquisa e Planejamento Economico, Vol. 3, No. 2, June, 1973, pp. 341-369.

[17] Engler, J. J. de C. and I. J. Singh (1971), "Production Response to Technological and Price Changes: A Study of Wheat and Cattle Farming in Southern Brazil," ESO #33, Department of Agricultural Economics and Rural Sociology, Ohio State University, August, 1971.

[18] Fogel, R. W., "The New Economic History," Economic History Review, Second Series, Vol. XIX, No. 3, December, 1966.

[19] Gould, J. D., "Hypothetical History," Economic History Review, Second Series, Vol. XXII, No. 2, August, 1969.

[20] Griliches, Z., "Hybrid Corn: An Exploration in the Economics of Technological Change," Econometrica, 25(4), 1957.

[21] Hayami, Yujiro and V. W. Ruttan (1971), Agricultural Development: An International Perspective, The John Hopkins Press, 1971.

[22] Heady, Earl O., Economics of Agricultural Production and Resource Use, Prentice-Hall, Inc., 1965

[23] Heady, E. D., W. B. Back and E. A. Peterson (1953), "Interdependence Between the Farm Business and the Farm Household with Implications for Economic Efficiency," Research Bulletin No. 398, Agricultural Experiment Station, Iowa State College.

[24] Heidhues, Theodor (1966), "A Recursive Programming Model of Farm Growth in Northern Germany," Journal of Farm Economics, 48, pp. 668-684.

[25] Hicks, J., Value and Capital, New York, Oxford University Press, 1948.

[26] Hopper, David W. (1965), "Allocation Efficiency in Traditional Indian Agriculture," Journal of Farm Economics, Vol. 47 (3), August, 1965.

[27] Johnson, S. R., and G. C. Rausser (1972), "Notes on Verification Problems for Systems Analysis Approach to Agricultural Sector Analysis at Airlee, West Virginia, May 1972.

[28] Knight, Peter T. (1971), Brazilian Agricultural Technology and Trade: A Study of Five Commodities, Praeger, New York, 1971.

[29] Knight, Peter T., "Substituicao de importacoes na agricultura brasileira: A producao de trigo no Rio Grade do Sul - Uma Nota," Estudos Economicos, Vol. 1, No. 3, 1971.

[30] Knight, Peter T., "Substituicao de importacoes na agricultura brasileira: A producao de trigo no Rio Grande do Sul," Estudos Economica, Vol. 1, No. 3, 1971, pp. 71-101.

[31] Krishna, Raj (1963), "Farm Supply Response in India-Pakistan: A Case Study of the Punjab Region," The Economic Journal, Vol. LXXIII (September 1963), pp. 477-487.

[32] Krueger, Anne O. (1966), "Some Economic Costs of Exchange Control: The Turkish Case," Journal of Political Economy, Vol. LXXIV, No. 5, October 1966.

[33] Langoni, Carlos G., "A Rentabilidade dos investimentos em capital fisico no Brasil," Estudos Economicos, Vol. 1, No. 3, 1971, p. 5.

[34] Larson, D. and J. S. Cibantos, "The Demand for Fertilizer in Southern Brazil, 1948-1971," ESO #188, Department of Agricultural Economics and Rural Sociology, Ohio State University, April, 1974.

[35] Lasdon, Leon S. (1970), Optimizing Theory for Large Systems, The Macmillan Company, New York, 1970.

[36] Mellor, John W. (1965a), "The Subsistence Farmer in Traditional Economies," Paper presented at the A.D.C. Seminar on Subsistence and Peasant Economies, East-West Center, Honolulu, Hawaii, February-March, 1965.

[37] Mudahar, M. S. (1972), Recursive Programming Models of the Farm Sector With Emphasis on Linkages with Nonfarm Sector: The Punjab, India, Unpublished Ph.D. Dissertation, University of Wisconsin, 1972.

[38] Nakajima, Chihiro (1965), "The Subsistence Farmer in Commercial Economics," Paper presented at the A.D.C. Seminar on Subsistence and Peasant Economies, East-West Center, Honolulu, Hawaii, February-March 1965.

[39] Nehman, Gerald I., "Small Farmer Credit Use in a Depressed Community of Sao Paulo, Brazil," Ph.D. Dissertation, Department of Agricultural Economics and Rural Sociology, The Ohio State University, 1973.

[40] Nelson, William, and Richard L. Meyer, "Economics of Fertilizer Use in Brazil," The Ohio State University, July, 1973.

[41] Rao, Bodepudi Prasada, "The Economics of Agricultural Credit Use in Southern Brazil," Ph.D. Dissertation, Department of Agricultural Economics and Rural Sociology, Ohio State University, 1970.

[42] Rask, Norman (1971), "Analysis of Capital Formation and Technological Innovation at the Farm Level in LDC's," Second Annual Report for Research Project, Occasional Paper No. 35, The Ohio State University, July 1971.

[43] Rask, Norman (1969), "Analysis of Capital Formation and Utilization in Less Developed Countries," Terminal Report for Research Project, Occasional Paper No. 4, Department of Agricultural Economics and Rural Sociology, The Ohio State University, December 1969.

[44] Rask, Norman, "The Impact of Selective Credit and Price Policies on the Use of New Inputs," Development Digest, Vol. IX, No. 2, April 1971, pp. 49-54.

[45] Rask, Norman, "The Differential Impact of Growth Policy on the Small Farmer of Southern Brazil," paper prepared for the Purdue Workshop on Empirical Studies of Small-Farm Agriculture in Developing Nations, The Ohio State University, November 13-15, 1972.

[46] Rask, Norman, "Technological Change and the Traditional Small Farmer of Rio Grande do Sul--Brazil," ERS #85, Department of Agricultural Economics and Rural Sociology, Ohio State University, January, 1973.

[47] Rask, Norman and R. L. Meyer (1972), "Semi-Annual Report for Research Project--Analysis of Capital Formation and Technological Innovation at the Farm Level in LDC's," Occasional Paper No. 66, Department of Agricultural Economics and Rural Sociology, The Ohio State University, 1972.

[48] Rask, N., R. L. Meyer and F. Peres (1971), "Agricultural Credit and Production Subsidies as Policy Instruments for PROTERRA," A Draft Working Paper, Department of Agricultural Economics and Rural Sociology, The Ohio State University, 1971.

[49] Rask, Norman, and John N. Stitzlein, "Farm Mechanization - Productivity, Employment and Cost - The Brazil Case," presented at the Annual Meeting of the American Society of Agricultural Engineers, Paper No. 73-514, University of Kentucky, June 17-20, 1973.

[50] Redlich, Fritz, "New and Traditional Approaches to Economic History and Their Interdependence," Journal of Economic History, Vol. XXV, No. 4, December, 1965.

[51] Rice, E. B. and E. Glaeser, Agricultural Sector Studies: An Evaluation of AID's Recent Experience, Aid Evaluation Paper 5, Agency for International Development, Washington, D. C., August, 1972.

[52] Rogers, E. M. (1962), Diffusion of Innovations, New York, Free Press of Glencoe, Inc., 1962.

[53] Sanders, John Houston, Jr., "Mechanization and Employment in Brazilian Agriculture, 1950-1971," Ph.D. Dissertation, Department of Applied Economics, University of Minnesota, 1973.

[54] Schaller, W. N. and G. W. Dean (1965), "Predicting Regional Crop Production: An Application of Recursive Programming," USDA, ERS Tech. Bulletin 329, 1965.

[55] Schultz, T. W. (1964), Transforming Traditional Agriculture, New Haven: Yale University Press.

[56] Singh, I. J., "The Strategic Details of Development in Traditional Agriculture," ESO #18, Department of Agricultural Economics and Rural Sociology, Ohio State University, 1970.

[57] Singh, I. J. (1971), "A Recursive Programming Model of Traditional Agriculture in Transition: A Case Study of the Punjab, India," Ph.D. Dissertation, University of Wisconsin, 1971.

[58] Singh, I. J. "Agricultural Sector Analysis: A Review," Seminar Report Series, A.D.C., New York, Forthcoming, 1974.

[59] Singh, I. J. and C. Y. Ahn (1972), "Employment and Capital-Labor Substitution in South Brazilian Agriculture," Occasional Paper No. 72, Department of Agricultural Economics and Rural Sociology, Ohio State University, 1972.

[60] Singh, I. J. and C. Y. Ahn, "A Dynamic Model of Agricultural Development in Southern Brazil: Some Retrospective Policy Simulations (1960-1970)," ESO #137, Department of Agricultural Economics and Rural Sociology, Ohio State University, November 1972.

[61] Smith, Gordon W., "Brazilian Agricultural Policy, 1950-1967" in H. S. Ellis (ed.), The Economy of Brazil, Berkeley: University of California Press, 1969, p. 213.

[62] Starr, Edward G. (1970), "The Cost of Import-Substitution: The Case of the Indian Caustic Soda Industry," Unpublished Ph.D. Thesis, University of Minnesota, November 1970.

[63] Steindl, J., Economic Problems of Size of Firms, Oxford, Blackwell, 1945.

[64] Stitzlein, John N., "The Economics of Agricultural Mechanization in Southern Brazil," Ph.D. Dissertation, Department of Agricultural Economics and Rural Sociology, Ohio State University, 1974

[65] Thorbecke, Erik, "Sector Analysis and Models of Agriculture in Developing Countries," Bulletin of the Stanford Food Research Institute, September, 1973.

[66] Wharton, Clifton, Jr. (Ed.), Subsistence Agriculture and Economic Development, New York, Aldine Press, 1969.

[67] Wright, Charles and R. Meyer, "Fertilizers in Brazil: Low Yield Response?", Department of Agricultural Economics and Rural Sociology, April, 1974, mimeo.

[68] Yotopoulos, Pan A., Allocative Efficiency in Economic Development, F. Constantinidis and C. Mihalas, Athens, Greece, 1967.

[69] Georgeson-Roegen, Nicholas, Analytical Economics, Harvard University Press, 1966.

[70] Myrdal, Gunner, Asian Drama, Twentieth Century Fund, Inc., 1968.

[71] Schuh, E. G., The Agricultural Development of Brazil, Praeger, 1970.

[72] Yotopoulos, P. A. and L. J. Lau, "On Modelling the Agricultural Sector in Developing Economies: An Integrated Approach of Micro and Macroeconomics," Journal of Development Economies, Vol. 1, No. 2, September, 1974.