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TRANSPORT RESEARCH PROGRAM

Progress Report

The Brookings Institution  
Washington, D. C.  
June 12, 1965

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## Purpose and Scope of the Program

The AID-supported Transport Research Program at the Brookings Institution has now been under way for three years. The purpose of the grant was to establish a major research effort to improve existing knowledge of the role of transportation in achieving the objectives of the foreign assistance program. The kinds of questions that the Brookings program was called upon to consider were the following:

1. What have been the economic and social impacts of transport improvements in the less developed countries in the past decade?
2. What have been the factors that have contributed to the effectiveness of transport investments, including an estimation of the effectiveness of foreign assistance?
3. What are the factors relevant to the choice of alternative transport technology in countries of differing area, population, topography and climate?
4. What possibilities are there for adapting new technologies to the special problems of developing economies?
5. What methods of local government administration and organization in the transport sector are most effective under certain conditions, and what methods are not effective?
6. What possibilities exist for joint public and private operations in the transport sector, of transport companies, of inter-regional arrangements, and of other administrative innovations?
7. What are the possibilities of reducing transport requirements through reductions in cost and demand?

8. What is the role of the transport-supporting industries in accelerating the development of improved transport and higher levels of living?

In addition, the Institution was called upon to provide facilities for training; to make useful information and research findings available to AID and to foreign countries coping with development problems; to stimulate transport research in universities and other non-governmental research agencies; and to conduct studies or provide consultation on specific problems of immediate importance to AID.

This report summarizes the work accomplished during the three-year period and indicates the status of projects which are still under way.

#### The Program at Brookings

Research activities have been carried out partly by a resident staff of ten to fifteen members and partly through contracts with universities and individual scholars. Altogether a total of approximately fifty people have worked on various aspects of the program. Geographic coverage has included Latin America, the Middle East, Southeast Asia, India, Pakistan, and a large part of Africa south of the Sahara.

Initial efforts were made to explore the role of transportation as it relates to development, including the lessons of history and the changing conditions introduced by today's economic, political, and technological environment. The purpose was to begin with an overall picture that would help to identify specific research needs and priorities.

First priority was given to a series of cases designed to measure the development impacts of transport improvements in various parts of the world. The purpose was to furnish some indication of the circumstances under which transport investments can be expected to have significant impacts on levels of living, and when it is likely that disappointing results may follow from such investments. The aim was also to develop practical methods of before-and-after analysis that would make possible a continuing flow of information on past projects to provide developing countries and financing agencies with effective guides for future policy.

A second phase of the initial effort was to examine methods of determining the desirability and feasibility of proposed transport projects. The purpose of this research was to learn from experience what steps might be taken to improve the validity, reliability, acceptability, and economy of future pre-investment analyses. For despite the heavy commitment of resources by developing countries and financing agencies, little had previously been done to assess transport efforts to date and the methods of anticipating the results of such efforts.

Supplementing these studies has been a series of projects relating to the economics, technology, organization, administration, and financing of transport. Among them have been studies of transport's role in the economic integration of Latin America and of the Middle East; industry location studies of Brazil and the Soviet Union; analysis of government controls over transportation in South Central Africa; surveys of transport needs in Colombia, India, Malaysia, and Syria; studies of the relation of transport planning to urbanization, public finance, energy resources policy, and communications policy; the application of modern economic theory, engineering and operations research to transport planning; and the development of models to simulate the relationships between transport and economic goals and to assist in the selection of transport technology.

Following are brief descriptions of individual research efforts in various stages of completion:

#### Strategy for Mobility\*

Wilfred Owen

In the process of development, transport plays the special role of facilitating other objectives: getting land into production, marketing agricultural commodities, making forest and mineral wealth accessible, developing industry, expanding trade, promoting health and education programs, and exchanging ideas. Conversely, poor transport is a major factor in world hunger, and much of the world's resource potential remains idle because of the difficulty and cost of movement and the inadequacy of communications.

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\* Published

This book, which establishes the broad framework of the program, points out that scientific innovations now make it possible to close the transport gap between the rich countries and the poor. Developing nations are in a position to cause transport investments to achieve much greater net increases in national product than ever before. This can be done through the supply of more effective transport technologies as well as through technologies that favorably alter the demand for transport. Transport innovations can make increasingly significant impacts on poor countries, provided they are viewed as an integral part of programs in industry, agriculture, and other sectors.

Eventually, extension of good transport to the poorer countries will prove equally important to the rich. For a rapidly shrinking world makes increasing economic interdependence inevitable, and prosperity for the few untenable. The task of improving the global communications web, therefore, warrants a major international effort. It should be based to a large degree on grants rather than loans, on accelerated worldwide research and development, and on a greatly expanded program of technical assistance.

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- I. Immobility and Poverty
- II. Breaking the Transport Barrier
- III. Transport Requirements for Development
- IV. Choice of Transport Technology
- V. Mobilizing Resources
- VI. New Directions for Foreign Aid
- VII. A Transport Strategy for Development

Transport Investment and Economic Development\*

Edited by Gary Fromm

Transport investment decisions in the less developed nations are made under highly diverse geographic, economic and social conditions. Requirements for roads, rails, shipping and aircraft depend on climate, population density, area, topography, political stability, leadership quality, and the power of vested interests. Transport decisions are also made under the common constraint of a shortage of investment funds. Health, education, power, transport, agriculture, industry--all compete for their share of limited resources. A well-planned transport system can make a major contribution to the achievement of these goals, while poor transport can slow the growth of national income, waste resources, and discourage industry. Because the impacts of transport investment are so significant, there is an urgent need for general guidelines to help design effective transport systems. The essays in this book, which were first presented at a series of graduate seminars at Harvard University, attempt to illuminate the decision-making process in transportation under varying conditions in the developing world.

Contents

- I. Introduction: An Approach to Investment Decisions,  
by Gary Fromm
- II. The Objectives of Transportation, by Hans Heymann, Jr.
- III. Characteristics of Transport Modes, by Richard B. Heflebower
- IV. Transport and Technology, by Wilfred Owen
- V. Design of the Transport Sector, by Gary Fromm
- VI. Economic Development and Regional Growth, by Louis Lefebvre
- VII. Transportation in Soviet Development, by Holland Hunter
- VIII. Regional Development Policy, by Mitchell Harwitz
- IX. Economic Evaluation of Transport Projects, by Hans A. Adler
- X. Pricing Transport Services, by James R. Nelson
- XI. Financing Transport Investment, by A. Robert Sadove and  
Gary Fromm
- XII. The "Railroad Decision" in Chile, by Robert T. Brown
- XIII. Selected Bibliography, by Katherine D. Warden

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\* Published

Government Controls on Transport: An African Case\*

Edwin T. Haefele

This report highlights the waste of resources resulting from transport policies in South Central Africa--an area more than two-thirds the size of the United States. Its objective is to suggest the means of forestalling future transport investments that would mean additional misapplication of resources and resulting impediments to development. The focus is on rail transport, which is of overriding importance in the area, and on copper, which is an important source of traffic and revenues as well as a key factor in a series of agreements and controls to assure certain traffic to particular rail routes.

Legal restrictions on traffic and rate policies, combined with present political patterns, are compelling some African governments to consider seriously an expensive new rail link from Zambia to Dar-es-Salaam which could not be economically justified. An alternative to this course is revision of existing treaties and agreements on traffic and rates to increase utilization of the present rail facilities. Under this plan each country would be allowed to use existing capacity on equal terms. If such policies were adopted through international agreement, it would be possible without change in ownership or management to bring to an end the uneconomical practice of investing in large-scale transport facilities for political reasons.

Transport and the Economic Integration of Latin America\*\*

Robert T. Brown

Transport problems pose a major obstacle to economic integration in Latin America. Present trade is largely restricted to the movement of primary products between adjoining countries. Yet these nations hope to create a continent-wide market to permit the efficient production of industrial goods which are now imported from outside the region but whose production in Latin America is a prerequisite to continuing economic growth

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\* Approved by Reading Committee

\*\* Manuscript being reviewed by a Reading Committee

The fact is, however, that economic integration is impossible unless the goods produced in one Latin American country can be placed in the marketplace of another at competitive prices. The purpose of this book is to show what is required to accomplish this. It presents a series of regional analyses that outline resource potentials and markets, and regional transport requirements. Principal reliance on ocean transport makes the improvement of this method the number one problem, including increased efficiency of ports and liner services. Much can also be done to exploit the potentials of international river transport, air cargo transport, and to improve rail and highway services. Far greater emphasis on these problems will be necessary if the countries of Latin America are to follow the path of the European Common Market.

As a by-product, the author has prepared a detailed analysis of United States and Latin American Maritime Shipping Policies in order to determine how it may be possible for the United States and Latin America to work out compatible maritime policies within a framework of greater control of maritime cargo routing throughout the world. Since the United States itself may in the future wish to apply additional cargo reserves in relation to its own commerce, opposition to the draft maritime convention of the Latin American Free Trade Association at the present time is considered unwise. But the convention should not be used as a vehicle through which ships from Europe or other areas are given artificial protection in commerce between Latin America and the United States. And to the extent that LAFTA utilizes foreign ships for transport within the LAFTA region, U.S. flag carriers should be given equal treatment with these foreign competitors.

The LAFTA members, in turn, should take steps to assure that the maritime policies adopted to increase their merchant fleets do not abort their efforts at economic integration. While they should insist on their right to control the routing of the commercial cargo traded among themselves, they should not exercise this right beyond what is clearly justified economically. Ocean shipping is an important industry, but it is not the only one of interest to Latin America. Blind protectionism is as indefensible in this sector as it is in any other when the result retards economic development.

The Impact of Transport on Economic Development\*

George W. Wilson, Barbara R. Berman,  
Martin S. Klein and Leon V. Hirsch

This volume is an analysis of a series of case studies which were designed to shed light on the role of transport in the development process and to help improve techniques of evaluating future transport project proposals. Among the cases conducted by members of the Brookings staff were roads in El Salvador, Guatemala, Nicaragua, Venezuela and Bolivia. A number of other cases were analyzed which had already been completed by other organizations in India, Thailand, North Borneo, Uganda and Peru.

As both cause and consequence of the increase in mobility which the new roads brought, a sharp rise in production (mostly agriculture) took place, with growing emphasis on production for the market rather than for subsistence. In every case there was a net increase in total mobility, and local traffic was almost completely captured by truck, except for heavy, bulky, low-valued commodities. Even more dramatic was the shift in passenger traffic to bus. The cause of these shifts included sharp reductions in rates and transit time, along with improved service.

The roads which were most successful in assisting economic development were those built to respond to an economic opportunity rather than to create one. Given the existence of a high degree of overall dynamism, a specific investment is more likely to be successful since (1) in such an atmosphere it will serve as a necessary response to prevent or alleviate a bottleneck situation; and (2) in an environment of rapid expansion additional economic opportunity is more assiduously sought and rigorously exploited.

The relative lack of success to date in several of the instances where the road was at least a partial initiator does not detract completely from the importance of the facility. What these examples do suggest is that given a relatively static or deteriorating situation, the extension of transport facilities alone will not be enough. Development

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\* Being revised following Reading Committee review

requires other stimuli to create the productive activity along the route that will cause the transport facility to be used. In such a context pre-investment surveys must be more comprehensive than in more dynamic areas, and they call for more careful appraisal of non-economic factors.

Transport Planning in Developing Countries\*

Clell G. Harral, Tillo E. Kuhn and associates

This study was prepared at the request of AID to provide methods that can be substituted for existing procedures governing the conduct of pre-investment surveys. It provides an analysis of 81 pre-investment studies most of them involving transport projects, sponsored by the Agency for International Development, its predecessor agencies, and the International Bank for Reconstruction and Development. The examination has focused on problems arising from inadequate terms of reference, underestimation of project costs, definition and measurement of benefits, bias in determining economic justification, the excessive time and cost of surveys, and the improper determination and use of benefit-cost ratios. On the basis of this work a conceptual approach is presented to guide the evaluation of transport projects and to indicate the goal toward which transport survey efforts should be aimed.

Spatial Planning in a Developing Economy:  
A Programming Analysis of the Soviet Cement Industry\*\*

Alan J. Abouchar

This study of the impact of one industry's operations on transportation demand in a centrally planned developing economy uncovers significant waste caused by regional misallocation of investment. The misallocation resulted from miscalculation of regional production cost variation, overconfidence in scale economies, and inability to

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\* Manuscript near completion

\*\* Manuscript near completion

forecast demand correctly. A second significant source of transport overexpenditure was in an area far removed from forces normally thought to contribute to transport inefficiency--a too permissive approach to product standardization. This promoted the production of low grade cements and led to higher transport (and production) costs per unit of concrete.

In contrast to this inefficiency, however, was the Soviet accomplishment in short-run product distribution. Comparison between the actual shipping pattern for cement and the optimal linear program solution reveals only a small overexpenditure on transport. The institutional and organizational factors behind this performance are analyzed in terms of their significance for newly developing nations.

#### Transportation in the Middle East\*

Nuhad J. Kanaan

This project includes two studies, one a doctoral dissertation on the transportation requirements of Syria, and the other a study of the transport aspects of integrating the economies of seven Middle East nations.

The objective of the first study was to examine the structure and connectivity of the transport network in Syria and its relationship to the transport demands of the country. An additional goal was to examine the utility of mathematical tools in a detailed analysis of the transport network of a developing country.

The analysis shows how the development of transport facilities in certain important regions of the country has lagged behind demand. This was especially the case in the newly developed agricultural areas of the northeast, where a large increase in agricultural production has taken place in recent years, especially in the two important export items of cotton and wheat. The completion of a number of irrigation projects in this area within the next few years will increase this production even further. Since the agricultural products of Syria mature at an earlier time than most of those of its competitors, they command a high price

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\* In process

in world markets, and it is of special importance to be able to move these products to the port of export as fast as possible. The railway that is under construction in this area will help, but the road network in the area will have to be improved in order to supplement the railway.

The second study explores the transport aspects of economic integration for Iraq, Syria, Lebanon, Jordan, Saudi Arabia, Kuwait and Egypt, all of which have taken definite steps toward economic cooperation. The framework of a transport network to facilitate the economic integration of this area is already available, since original construction took place prior to partitioning of the region. But transport costs remain high. One reason is the delays encountered at the borders which disrupt passenger transport and cause heavy damage to perishables. Goods moving by rail from Beirut to Bagdad should take from four to five days under normal conditions, but due to numerous delays at international borders it is customary to allow between 20 and 25 days for delivery. High costs also result from the absence of control on truck overloading, with resulting deterioration of the highways and extraordinary requirements for road maintenance. An effective transport system to accommodate estimated future trade calls for the removal of these abuses, the coordination of highway planning on an international basis, and the establishment of common carrier trucking service for the entire region.

#### Transport and Plant Location in Latin America\*

David Kendrick

A linear programming model of the production and transportation of flat steel products in Brazil in 1965 has been constructed, and about twenty-five production runs have been made with the model to study its properties. These production runs have involved changes in the location of demand in the system; in the capacities of various production units in the plants; in the cost of transportation for final products; in the cost of various inputs at some of the plants; and in the transportation of intermediate products between plants. The model consists of three plants (with six production units in each plant), three market areas, and four products.

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\* In process

The linear model is to serve as the core of a non-linear programming model which will be used to study the problem of when and where to add to capacity in existing facilities or to build new facilities when there is a growing demand for the products and when the production process is characterized by economies of scale. The non-linear model will be constructed first for only the Brazilian system. Then it will be expanded to cover the dozen or so plants that are major producers of flat steel products in Latin America, and finally, it will be applied to the enlarged problem.

In the Brazilian case, the linear model has proved to hold great promise as an analytical tool for studying product flows in a transportation system under changes in the regional structure of demand, increases in total demand, or changes in some of the cost elements of the system.

#### Transport and Growth: The Soviet Record\*

Holland Hunter

This study will examine several transportation and regional aspects of Soviet industrial expansion since 1928. The Soviet record provides substantial statistical evidence with which to test a number of hypotheses concerning spatial efficiency in economic development, with important lessons for developing economies.

One portion of the work will reconstruct railroad freight traffic flows for coal, iron ore, and steel products in the early plan era. Between 1928 and 1934, Soviet planners laid the foundations for massive industrial expansion through building "the second iron and steel base" of the USSR. Ample data permit evaluation of Soviet policy, with the benefit of hindsight, using linear programming and other analytic tools not available thirty years ago.

Another part of the study will examine postwar transportation developments in the USSR and review the technological and economic factors that underlie Soviet policy toward choice of railroad motive power, competition between road and rail carriers, and treatment of urban passenger transportation. The results of intensive use of railroad plant and equipment, combined with government repression of the passenger automobile, are evaluated in policy terms.

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\* In process

### Relating Transport to Other Sectors

Case studies of the economic impact of transportation projects have made it clear that transport policy decisions need to be derived from the goals that transport improvements are meant to serve. Where the target is increasing agricultural productivity, for example, transport needs to be viewed as one of the many inputs that are necessary, and assigned whatever priority is appropriate to the total package. This approach helps to avoid overemphasis on any one element, and reveals new ways of achieving the ultimate goal.

A series of papers is in process which explores the relation between problems and potentials in various sectors of the economy and the designing of transport policies that will effectively resolve problems or exploit potentials. Included in the series is:

Transport and Energy in Economic Development: With  
Special Reference to India, by Edward S. Mason\*

The capital requirements and, for most less developed countries, the foreign exchange requirements for transport and energy are large. In the early stages of development, consumption of these services tends to increase substantially faster than the growth of national income or GNP. In contrast, inputs of energy and transport services per dollar of GNP may be relatively stable or even decline in later stages of development. Moreover, there are strong interdependencies and possibilities of substitution in the development of these two sectors.

Less developed countries in economizing transport and energy investment should pay particular attention to three important considerations: (1) whether investment in transport and energy facilities should be provided well ahead of demand or limited to breaking up bottlenecks; (2) whether policy should aim at complementarity or competition among various transport modes and among various sources of energy; and (3) what effect existing and prospective relative factor prices might have.

Applying these criteria to India, it is concluded that this country's policy has been correct in not "building ahead of demand" in these sectors and in minimizing the creation of excess transport capacity. This does not mean that road transport and the use of oil should not be

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\* Completed

encouraged to compete with existing rail facilities and coal production, for these should yield high returns in the future. A study of the Indian transport and energy sectors also shows that a change in price policy-- in the screening rates used to justify investment--and in the degree of preference given to domestic production, plus greater use of market tests have much to contribute to the efficient coordination and allocation of transport and energy investment.

Other papers in preparation are: "Urbanization," by Benjamin Chinitz; "Rural Development," by Wilfred Owen; "Communications," by Ithiel de Sola Pool and associates; and "Public Administration," by Edwin T. Haefele.

### Country Studies of Transport: India

Wilfred Owen

The work of the Transport Research Program has been extended through staff participation in the World Bank's economic mission to India. In addition to Brookings responsibility for the transport policy aspects of the Indian survey, work has been done at AID request to assist in analyzing the transport aspects of the India Long Range Assistance Strategy.

In each of India's first three Five-Year Plans, transport has accounted for 26 percent of all public investment outlays. As a result, rail and port capacities have more than doubled, road transport has quadrupled, and important gains have been made in air and pipeline transport. Yet for the world's second most populous country, the coverage of the transport system and the quality of the service are grossly inadequate. Much of rural India is isolated. The number of commercial motor vehicles in relation to area or population is far lower than for any major nation. The railways, despite their achievements, nearly always operate close to beyond their limits. Under these circumstances the ambitious Fourth Plan targets for industry, agriculture, and other sectors appear highly impractical without radical changes in transport policy.

The report on Indian transport policy emphasizes such aspects as the relation of transport inadequacies to the food shortage, to problems of rural development, and to trends in urbanization and industrialization. Special importance is attached to improved organizational arrangements

in the transport field, to the elimination of artificial barriers to transport, and to a reallocation of resources among transport methods.

Work in India has made it possible to apply the results of Brookings research quickly to problems in the field, and it has provided valuable feedback to help guide the research program itself. Memoranda on the Indian transport problem have been prepared for the Indian Planning Commission, the AID Administrator, and the World Bank.

An additional country study, "Transportation in Colombia," is being prepared by Richard Weisskoff under the direction of John Meyer. This report will incorporate the field studies previously made in Colombia by Weisskoff, Joseph Hartley, and William Paul McGreevey.

#### Highway Improvement in Malaysia\*

William B. Hughes

This project augments the case study program in Latin America by providing evaluations of the developmental impact of four highways in Malaysia.

Among the major areas of inquiry have been: (a) cost reductions achieved because of the new or improved highways, including reduction in transport cost, retail and wholesale price reductions, changes in inventory and storage costs, and reductions in spoilage; (b) income benefits arising from new or improved highways, including increased receipts of growers, land areas under cultivation, improvements to land through reclamation and irrigation, and establishment of new industries; (c) other impacts, including the effect on employment, labor mobility, school attendance, quality of education, and changes in social and cultural activities.

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\* To be completed September 1965

Financing Transport in Developing Countries\*

Alan R. Prest

A substantial proportion of resources in developing economies is devoted to transportation. In the public sector it is common to find 20 to 30 percent or more of investment funds allocated to railways, highways, ports, shipping, and air transport facilities. Large expenditures are also made in the private sector, for motor vehicles and other equipment. The basic issue is how the transport capacity needed to achieve development goals can be financed, and how financial policies can be avoided that will create unnecessary obstacles to growth.

This monograph will examine the key issues relating to railway pricing policy, user charges for highways and other tax-supported facilities, the role of the public and private sectors, the financial responsibilities of various levels of government, and the possibilities of innovations in finance to obtain needed support.

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\* In process

### The Harvard Transport Research Program

The purpose of the Harvard Transport Research Program is to devise analytical techniques for improving the quality of transport planning decisions in developing countries. The program has three primary tasks: (1) to derive in a more rigorous fashion the implications of modern economic theory, engineering, and operations research for transport planning; (2) to formulate models to simulate or otherwise infer the relationships between transport investments and the broader national goals of economic development; and (3) to apply these techniques to determine which transport technologies, new and old, might best serve the economic goals of developing countries under varying geographic, industrial, and population circumstances.

This program is under the direction of Professor John R. Meyer of Harvard University with the support of Brookings staff members, Martin Wohl and Brian V. Martin. During the summer of 1965 the Harvard program staff will include twelve full-time and six part-time professional staff members--nine or ten of them senior analysts. Funds approximately equal to the AID-Brookings support have been made available from other sources.

The transport research seminar at Harvard has included approximately sixty graduate students over a three-year period. Thus far fifteen discussion papers have been prepared, and eight Ph.D. theses are in process. Enrollment has been about equally divided between U.S. and foreign participants.

Doctoral theses are now in final stages of preparation on the following subjects:

#### Structure of Highway Trucking Costs in Underdeveloped Countries, by Armando Lago

This study is concerned with interrelated problems of truck design and performance characteristics, road design and maintenance, and truck operation. Given the fact that developing countries rely on equipment suited primarily to conditions in more developed economies and confronted by universally poor road maintenance, this study is designed to provide public policy guidance with respect to highway and truck transport practices.

Efficiency in the International Airlines Industry,  
by Mahlon Straszheim

The purpose has been to define what is meant by a rational international airline industry, to examine to what extent the present industry conforms to such a standard, and to prescribe policies to improve industry performance in terms of these objectives. The motivation comes from generally poor performance to date--high prices, excess capacity, insufficient profits--and from restrictions in the market which could contribute to such a situation--entry and capacity restrictions, price fixing, pooling, and government commitment to subsidy.

A fundamental feature of the industry is that the benefits are both direct and external. Therefore private decision-making based on the market may not lead to an optimum, and many governments have responded by making their carriers chosen instruments. They have supported them in politically oriented services, and often at a considerable loss. In the case of underdeveloped countries in particular, governments have supported inefficient carriers on the basis of external effects which appear to be largely exaggerated. Most of the benefits of service could accrue to a nation served by another country's carrier. While regional operations are always justifiable, the entry into long-haul jet markets can be a very expensive one in terms of subsidy loss and balance of payments.

Elasticity of Demand for Freight and Passenger Transportation  
in Underdeveloped Countries, by Gerald Kraft

The purpose of the study is to develop estimating equations to determine future volumes of freight traffic, and to determine aggregate levels of passenger transport. The demand study will permit estimation of interregional freight and passenger flows for alternative transport configuration. In particular, it will be possible to account explicitly for the interactions between transport prices, commodity prices, and passenger and freight volumes.

The Cost Implications of Urban Land-Use Layouts  
by Robert Jones

The total annual cost of housing, urban transportation, and urban utilities is a large percentage of annual income in Latin American cities, and probably in the cities of all poor countries. This study describes the relationships between these costs and a large number of variables, and estimates the costs for several cases selected to show the effect of differences in the most important variables.

This thesis shows how the costs of a neighborhood depend on its design variables--particularly the type of building, the lot frontage, and the type of utility services--and how the costs of city-wide transportation and utilities depend on the population, land area, and land-use layout. For the particular problem of providing low-cost neighborhoods for the many low-income families migrating to urban areas in Latin America, the tentative conclusion is that the lowest annual cost per dwelling unit of a given size--including the costs of transportation and utilities--is obtained with single-story self-help houses on small lots with a piped sewage system. (In a city with very little unbuilt land available nearby, four- or five-story walkup apartments would be the cheapest solution.)

The practical value of the city-wide cost analysis is to know the incremental cost of serving new industries and neighborhoods in cities of various types and sizes. With this knowledge, new industries can choose locations that are socially efficient, whether led by the price system or pushed by government controls. The hypothesis is that with control over the intra-urban location of major employment areas, the total population and area of the city can grow substantially without increasing the cost per capita for a given standard of utility and transportation services.

Transportation Planning and Capital Budgeting Under  
Conditions of Uncertainty, by Leon M. Cole

This research attempts to develop a computer approach to exploring alternative pricing or rate policies for proposed investment projects in underdeveloped countries. The purpose is to clarify the effects of alternative rate policies on choices among different design standards for any proposed capital project on the basis of both financial soundness and national economic profitability criteria.

Administrative factors are considered and in every instance that rate scheme is preferred which, all else being equal, is more nearly feasible and simplest to administer. Normally, schemes which tend to minimize price discrimination among users are preferred, but where a given project is found not to be financially self-supporting, even for optimal design standards, the computer program automatically determines the best rate discrimination program, among users over time, for the given circumstances.

Other theses in process are "A Programming Approach to Capital Budgeting for Transportation," by Hrishikesh Vinod; "Port Development in Developing Countries," by Donald Shoup; and "Compatibility of Regional Income Equalization with Other Economic Objectives," by Koichi Mera.

Titles of discussion papers prepared in connection with the Harvard program are as follows:

1. A Model for the Evaluation of Transport Alternatives,  
by Brian V. Martin
2. The Use of Index Bonds in Underdeveloped Countries,  
by Benjamin I. Cohen
3. Road and Rail in India: An Institutional and Economic Study,  
by Donald N. McCloskey
4. Transportation Pricing in Underdeveloped Countries: A  
Welfare Analysis, by Robert Mnookin
5. Transportation in Colombia: A Case Study in the Economics  
and Politics of Resource Allocation, by Richard Weisskoff
6. Implementation of the Model to Evaluate Transportation  
Programs in Developing Countries, by Brian V. Martin
7. Transportation Planning in Developing Countries, by  
Brian V. Martin and Charles B. Warden
8. The Elements of Transportation Planning, by Brian V. Martin

9. Introduction to Transport Technology, by Brian V. Martin
10. Power Requirements in Transportation, by Brian V. Martin
11. The Economics of Transportation, by John R. Meyer
12. The Short-Run Congestion Cost and Pricing Dilemma, by Martin Wohl
13. Short-Run Congestion Costs as a Basis for Allocating Long-Run Roadway Costs and Determining Differential Prices, by Martin Wohl
14. Planning for Optimal Capacity under Uncertainty with Application to Highway Transportation Systems, by Leon Cole
15. A Model for the Evaluation of Transport Alternatives: Initial Outline of Computer Program. Part I. The Macro-Economic Model, by Brian Martin

Drawing on materials developed in these theses and discussion papers, it is planned that three major volumes will be produced:

- I. Transport Technologies in Underdeveloped Countries  
and
- II. Models for Transport Systems Analyses in Underdeveloped Countries, by Brian Martin, Richard Soberman, P. O. Roberts, and David Kresge
- III. Principles of Transport Planning for Underdeveloped Countries, by John Meyer and Martin Wohl

The purpose of these books will be to develop procedures for planning and evaluating transportation investments in underdeveloped countries. The major difficulty is that such investments can be properly assessed only in the light of a fairly comprehensive plan of overall economic development. But a good plan, in turn, requires as one of its inputs a thorough knowledge of transportation possibilities or at least of the probable availability of transportation facilities. In short, important interactions exist between design of an efficient transportation system and design of a comprehensive development plan. Accordingly, an attempt to develop better analytical and empirical procedures to take these interactions into account is a primary objective.

The goal of the technology aspects of the project is to provide a basis for selecting technologies appropriate to the tasks to be performed, the resources available, and the peculiar environments encountered in developing economies. The initial step was to classify the various technological possibilities for moving freight and passengers, both existing and potential, and to specify the conditions under which alternative methods are most feasible. This involves analysis of ways in which cost and performance are affected by the physical environment as well as the effects of various economic, social, and political factors on the use of particular technologies.

To develop the cost, demand, and investment functions for a particular situation, two hypothetical "developing country" cases were selected: (1) A predominantly rural population with high population density, almost exclusively agricultural, with low tropical plain topography, dominated by river systems; and (2) low population density, and high urban concentrations with a range of geography consisting of highlands, plains and lowlands.

This research makes use of advanced analytical techniques. Simulation models, for example, are used to examine the consequences of various economic, demographic, or geographic factors, and more importantly, technological possibilities. With regard to the latter, the full range of old and new technological possibilities are included. For example, it may be more effective in underdeveloped countries to turn to transport devices of less performance capability or less sophisticated design than is now being used in more advanced countries--that is, to move back a generation as well as forward. The systems to be examined will also include wider use of air cargo and containerized-integrated road-rail systems.

System simulation will involve as a first factor the determination of a suitable representation of a multi-mode network, for modeling of truck, rail freight, barge and air freight operations under the seasonal peaking type of demand which is typical of developing countries. Demand and supply requirements for each commodity are set by the economic portion of the model.

The transport sector of the model will attempt to account for the collection of commodities and their distribution to line haul facilities from outlying districts, as well as transfer between modes, loading, unloading, and warehousing. Also important will be back haul and vehicle utilization factors.

The final volume of the series will present guiding principles for transport planning and will cover the following major areas: (1) transport costs and costing; technological and operating characteristics; (2) pricing; (3) capital budgeting; (4) regulation and regulatory institutions; (5) systems analysis and evaluation.

The Program at Syracuse University:

Transport Administration in Developing Countries:

John Lindeman and associates

The initial purpose of the project was to appraise expert advice to developing countries on the administration of transportation systems. The study was to be based on certain hypotheses, which were to be tested. Chief among them were these:

Expert advice is often inconsistent as among countries, and this inconsistency is based not so much on objective differences among countries as it is on personal opinions and biases of the experts as to the "right" kind of administration.

Within a single country conflicting advice is often given for much the same reason.

There is a kind of expert parochialism which may lead to expert advice on railroad management, for instance, which conflicts with and perhaps (if accepted) could vitiate other experts' advice on, for example, highway policy.

It is very seldom that expert advice on transportation administration is concerned with more than the "efficient" management of an existing facility, taken by itself as an economic unit. That is to say, very little attention has been paid, by advisers, to the problems of organizing and administering a transportation system which furthers basic development aspirations in a rapidly changing social and economic context.

Testing of the hypotheses on the basis of published material and interviews tends to confirm that the major need, after assessing the expert advice that has been given, is to provide guidelines to the kind

of advice that is needed. Thus the purpose of the project has been to define the administrator's role at various levels of the transportation complex, and in order to avoid operating in a vacuum, to define these roles with reference to actual administrative and organizational patterns in several underdeveloped countries.

The Program at Northwestern University:  
African City-Hinterland Development

Leon Moses and Ralph Beals

Rapid urbanization has accompanied economic growth in many developing nations. The causes of this urbanization through migration have not been well understood. However, social problems and the social overhead capital costs associated with growth of cities have been matters of great concern to some development planners. In particular, it has been suggested that urban migration is too rapid, that economic growth is thereby retarded, and that direct action should be taken in hinterland areas to slow migration.

In order to assess the claim of overrapid urban migration and to provide a basis for judging the responsiveness of migrants to economic opportunities, study has been made of the interregional pattern of migration in Ghana. There is no evidence that migration to the principal and capital city, Accra, is unduly rapid. High incomes in Accra attract migrants, but so do high incomes in other regions. A very high proportion of educated persons go to urban areas, but the available evidence indicates that this is a consequence of the high demand for educated people rather than some irrational dissatisfaction with village life. In short, the conclusion is that there is no unavoidable flow of migrants to cities. People migrate because incomes are high in cities.

Among the possible causes of rapid urbanization is uncertainty about the profitability or feasibility of hinterland development. The major part of the study focuses on agricultural development in Ghana and on the role of transport investment in this development. The direct impact of reduction in transport costs was on the rate of migration, chiefly seasonal labor migration.

The role of migration in development and the effects of transport investment on the movement of people has been almost entirely neglected

in benefit-cost studies designed to assess transport projects. In this study the great importance of migration for Ghanaian development is analyzed in a series of regional production and allocation models. It is clear that Ghanaians are quite responsive to economic opportunities whether urban or rural, and that transport investment will thus be effective for development whenever it makes higher incomes available.

### Conferences and Other Activities

Brookings staff members have presented papers and participated in transport research conferences and seminars in many countries. They also assisted in the transport research activities of universities and other organizations.

Seminars have been conducted at the Economic Development Institute in Washington, the Asian Institute of Economic Development in Bangkok, the Economic Commission for Asia and the Far East, the National Council of Applied Economic Research in New Delhi, at Harvard, Yale, Syracuse, Northwestern and American Universities, and at the University of Los Andes in Bogota. Meetings have been chaired at the United Nations Conference on Science and Technology in Geneva, the National Research Council in Washington, and the Society for International Development. Papers have been presented to the Pan American Highway Congress, the United Nations Special Fund, the Engineering Foundation Conferences in New Hampshire, the World Meeting and Pacific regional meeting of the International Road Federation in Madrid and Tokyo, the Flight Forum in Hartford, and the Canadian Good Roads Association in Montreal.

Discussion of specific aspects of the program have taken place with staff members of the Harvard Advisory Group in Dacca and Karachi, the Ford Foundation in Kuala Lumpur and New Delhi, the Economic Commission for Africa in Addis Ababa, the Economic Commission for Latin America in Santiago, the Development Center of the Organization for Economic Cooperation and Development in Paris, the University of the Panjab in Chandigarh, and the transport and economic planning agencies of Greece, India, Pakistan, Thailand, Japan, Egypt, and Malaysia.

Other meetings have been held with the National Development Council in Buenos Aires, the Latin American Free Trade Association in Montevideo, the University Institute of Economic Research in Sao Paulo,

and the University Regional and Urban Planning Institute in Rosario, Argentina. Many discussions have taken place with AID representatives abroad, including missions in Pakistan, Thailand, India, Kenya, Bolivia, and Brazil.

More direct participation in work abroad has been provided by assistance to ECAFE in the preparation of a transport survey manual; staff help for the National Council of Applied Economic Research in its regional transport study of Madras; and aid to the Government of India in the review of its Report on Transport Policy and Fourth Plan preparations. A number of participants in the Brookings program have taken advisory posts abroad, in the Chile-California program, in Turkey, Malaysia, India and Paraguay for the World Bank, and in Somalia, Kenya, and Nicaragua for AID. Help to AID and the World Bank in locating staff for transport missions has been a continuing function.

An important objective is to bring the results of completed research to the attention of policymakers and other research workers as quickly as possible. All draft reports have been circulated widely for comment and criticism. A total of more than 2,400 complimentary copies of books have been distributed throughout the world. The East-West Center at the University of Hawaii is publishing a paperback edition of Strategy for Mobility in English, for distribution in Asia, Africa, and Latin America. A paperback edition in Arabic is being published by the U. S. Information Service.

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