# THREE ESSAYS ON INTER-TEMPORAL ECONOMIC DEVELOPMENT

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ABSTRACT

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This dissertation is concerned with social preferences, accumulation of physical and human resources, and technology in inter-temporal development planning. Continuity of preferences defined over time paths of consumption imposes behavioral restrictions such as impatience or myopia. The first essay extends the different notions of myopia due to Brown and Lewis, and their characterization of the Mackey topology in terms of myopia, from $\ell_\infty$ to $L_\infty$. This characterization is then used to extend Araujo's theorem on the necessity of impatience for the existence of competitive equilibrium from $\ell_\infty$ to $L_\infty$.

In the second essay, an overlapping generations macro model of population growth and capital accumulation that generates the decisions of rich and poor families regarding number of children and savings is used to study the interactions among population growth, capital accumulation, skill composition of labor, and income distribution. Tax transfer policies that can be used to affect these variables are also analyzed. The model provides an alternative to the Beckerian models for explaining the inverse household income-child quantity relationship observed in most developing countries.

The third essay develops a decision theoretic model of R & D behavior incorporating time and uncertainty in the process of knowledge creation within an optimal stochastic control framework. The sources of knowledge are taken to be purchase of technology and know-how abroad and domestically as well as in-house R & D investment. The model is estimated with data from three groups of Indian manufacturing industries (light, petro-chemical, and heavy).

In all three industries the bigger firms tend to substitute domestic for foreign purchase of technology and technical know-how, and in heavy industry they also do more in-house R & D. Monopoly power has no significant impact on light industry R & D activities. In the other two, it reduces firms' purchase of technology without changing significantly their other R & D activities. In the case of the petro-chemical industry this reduction is offset partially by an increase in in-house R & D efforts. Patenting stimulates further in-house research only in the light and petro-chemical industries. While the petro-chemical and light industries conduct more basic research, heavy industry does only minor adaptive research in in-house laboratories.

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To my mother

# PREFACE

The three essays of this dissertation have been written under Professors Donald J. Brown, T. N. Srinivasan, and Robert E. Evenson respectively, and Professor T. N. Srinivasan coordinated all the three essays. The main financial support for this study came from a Yale Fellowship, and part of the support for the third essay came from a NSF grant, specifically for collecting data used in the essay. I benefited from presentation of my second and third essays at Trade and Development Workshops at Yale, at seminars at the Indian Statistical Institute, and at George Washington University. Professor H. Scarf introduced me to mathematical economics in his lucid graduate course. While I was a junior research fellow at the Indian Statistical Institute, I benefited from working with Professors V.K. Chetty and T. Parthasarathy. During that time, I learned the mathematics used in my first essay from an excellent measure theory course given by Professor K.R. Parthasarathy.

Many people helped me in preparing this manuscript. In the early stages, I benefited from conversations with T. Bewley, W. Hildenbrand, J. Geanakoplos, and N. Wildberger on my first essay; with T.P. Schultz, N. Birdsall, J. Heckman, S. Bose, Zvi Eckstein, and K. Wolpin on my second essay; and with C. Dahlman in my third essay. I am grateful to all of them. I am also grateful to my colleagues for their readiness to assist me, especially to Emily Lawrance and Julie Anderson who provided editorial assistance for the second and third essays, and to James Rauch who provided an overall editorial assistance.

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Words cannot express how highly I value my mother's judicious and brave decision to send me away to a good school in the city, and as a consequence to endure a lot of hardship. Indeed, her noble endeavor and her precious influence on me created the background for my second essay. It is with this great indebtedness in mind that I dedicate my dissertation, especially my second essay, to my mother and to my brothers and sisters.

I, however, retain all the responsibilities for any remaining errors.

New Haven, Connecticut

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# INTRODUCTION

Development economics is concerned with economic and social development of the poor nations where abject mass poverty, unemployment, and low household savings are most commonly observed. Since markets either do not exist or fail to function in these countries, public policy plays a crucial role in development planning. The fundamental problem of development planning is the allocation of the resources of a nation among different activities over time and under uncertainty so as to maximize social welfare. The availability of natural and human resources together with the exogenously given technology at different points of time determine the set of feasible programs. A social preference ordering is assumed to exist over the space of feasible programs. The optimal program is a maximal element in the feasible set with respect to this ordering. The first essay deals with the social preference ordering, the second one with human resources, and the third essay deals with technology.

Whether a social preference ordering should exhibit impatience or myopia has long been debated. For the existence of an optimal program all that is needed is in fact continuity of the social preference ordering and compactness of the feasible set. Both continuity and compactness are, however, dependent on some notion of topology on the program space. Continuity of preferences has been known to impose behavioral restrictions such as impatience or myopia. A unified treatment of both time and uncertainty calls for a

more general state space, e.g., $L_\infty$. In my first essay, I generalize different notions of myopia due to Brown and Lewis and their characterization of the Mackey topology in terms of myopia from $\ell_\infty$ to $L_\infty$. Then this characterization of the Mackey topology on $L_\infty$ is used to extend Araujo's theorem on the necessity of impatience for the existence of competitive equilibrium from $\ell_\infty$ to $L_\infty$.

Population growth of a nation affects its economic development in a number of ways, interacting for instance with capital accumulation, household income distribution, quality composition of the labor force, etc. In the growth literature, the population growth rate is either exogenously given or is a function of national income, and the individual incentives for having children, especially by the poor parents, have no role. The New Home Economics frames the problem in a static micro-economic framework and cannot shed light on the interactions of population growth with macro variables such as income distribution and capital accumulation. The empirical literature has been mostly inconclusive on the direction and strength of these relationships. In my second essay, I examine the theoretical linkages among population growth, capital accumulation, quality composition of the labor force, and household income in an overlapping generations general equilibrium model aggregating the household decisions about fertility and savings. In the absence of a well developed capital market and an old age security scheme in developing countries, children provide old age security for their parents. I employ a temporary general equilibrium framework to study the short run as

well as long run nature of the relationship between fertility and other variables. These relationships also suggest public policies that can affect the rate of population growth.

In growth models, technological change is assumed to be exogenous. It is now well recognized that technological change is not only a major source of growth but it is also an endogenous economic activity. The policy makers in developing countries have begun to emphasize rapid indigenous technological change as an answer to their development problems. The literature on technological change in developed countries presumes in-house R & D effort as the only source of technology change; it studies relationships between in-house R & D expenditure and firm size, monopoly power, productivity gain, and variations in stock prices -- both theoretically and empirically. But developing countries also have other important sources for acquiring technological knowledge such as purchase of technology and technical know-how from abroad. The LDC technology literature has focused mostly on the choice of technique within a static production function framework, and on the political aspects of technology transfer. In my third essay, I develop a decision theoretic model incorporating dynamics and uncertainty in the process of knowledge creation within an optimal stochastic control framework. For the case of a single source for knowledge, I derive comparative results on how the pace of in-house R & D effort will change with changes in market concentration, firm size, and profitability of the current line of production. Then I allow for more than one source in specifying a

model for empirical estimation. I apply the latter model to data from Indian private firms. The factors, which are presumed to affect a firm's R & D activities, and which are measurable either directly or using some instrumental variables, are taken to be the firm's own stock of technological knowledge, firm size, and market concentration or monopoly power. The empirical analysis throws light on the effectiveness of public policies relating to MRTP(monopoly and restrictive trade practices) legislation, different licensing schemes, import substitution vis-a-vis export promotion, and patent protection in stimulating indigenous technological development in India.