The Developing Economies, XXXIII-3 (September 1995)

BOOK REVIEWS

Induced Innovation Theory and International Agricultural Development: A Reassessment edited by Bruce Koppel, Baltimore, Johns Hopkins University Press, 1995, viii + 190 pp.

It may be said that the theory of "induced innovation" developed by Yujiro Hayami and Vernon Ruttan represents a major contribution to the economic study of agricultural development. Published in 1971, *Agricultural Development: An International Perspective* outlined a model of economic development based on the central idea of technological and institutional innovations as being endogenous to the economic system. A second edition came out in 1985, which elaborated on and extended the original model.

Before the arrival of this model, development in agricultural technology had been generally accepted as being exogenous to the economic system: i. e., as an exclusively product of scientific and technological advances. However, Hayami and Ruttan thought that the causal sequence leading to the inducement of technological innovations started with a change in relative factor scarcities, which in factor markets is reflected by a change in relative prices, which in turn defines the optimum technological bias from the farmer's standpoint. Farmers convey their wishes to scientists and engineers through their collective action. The latter group would respond by developing and making available new technical breakthroughs or new inputs that would enable farmers to substitute abundant factors for scarce ones to their advantage. It was in this way that optimum technological innovations were guaranteed for farmers. They also argued that institutional change was induced to capture all gains that new technology could produce.

This is why due credit should be given to the insight and imagination of these two authors, who conceptualized a new approach to the study of agricultural development by looking at technological and institutional innovations in agriculture as well as the economic system in the same perspective, using the supply-demand analogy and the individual maximization principle. During the two decades since their first book appeared, an immense volume of literature has proliferated for and against their theory.

The book under review here is based on a forum held at the 1988 annual meeting of the American Agricultural Economics Association in Knoxville, Tennessee. The forum was primarily designed to identify and assess the current relevance of the induced innovation theory to agricultural studies, as well as to offer suggestions for its possible reorientation and reorganization. The book is divided into four parts: "The Theory: Roots and Reassessment" (Part 1), "Critical Applications" (Part 2), "New Directions" (Part 3), and "Reassessment" (Part 4).

Part 1 opens with the editor's paper explaining the current need for a reassessment of the theory (Chapter 1), followed by Ruttan and Hayami's review of its development and applications (Chapter 2).

Part 2, which consists of four critical chapters, starts with Larry L. Burmeister's paper entitled "Induced Innovation and Agricultural Research in South Korea" (Chapter 3). He challenges the idea of political economy specification assumed by Ruttan and Hayami in their theory and suggests that a "directed" innovation model would be more useful to ex-

plain the development of agricultural technology in the Republic of Korea. Ruttan and Hayami contend that farmers assert and realize their preferences and interests through "political markets." Burmeister admits that this is true only of some state/society relationships, but affirms that there was no recognizable link of that nature in Korea during the 1970s. The Korean government simply realigned the prices of agricultural inputs and outputs in order to stimulate a rapid assimilation of HYV. Their political decision was aimed at reduced foreign currency expenditure on food imports and self-sufficiency in rice production. Thus, the technological shift in Korea was not induced by farmers, but rather orchestrated by the government. In response to his criticism, Ruttan and Hayami substitute an "ultra" induced innovation model, saying that the constraints on the working of the induced innovation mechanism were overcome by "political and bureaucratic entrepreneurship," which is induced by the changes in resource endowments. It is not quite clear, however, how political and bureaucratic power is induced in Korea. In the latter part of his paper, Burmeister addresses R&D activities in the 1980s and political liberalization in Korea, concluding that agricultural R&D responsiveness to pressing farmer concerns has failed to produce pronounced changes, as the induced innovation hypothesis might predict. We agree with Pranab Bardhan, who wonders how micro-level responses to market forces are translated into collective action that consciously guides activities of such institutions as agricultural R&D organizations.[1] This remains a black box in the induced innovation model. A more clear-cut specification of political-economic interaction might be required to enhance the validity and usefulness of this model.

In "Induced Innovation Theory, Agricultural Research, and Asia's Green Revolution" (Chapter 4), Koppel attempts to reassess the theory from three perspectives: the persuasiveness, the consistency, and the utilization of the induced innovation theory. The most impressive statement Koppel makes within the context of the first two perspectives is that "the interest of induced innovation theory in other [noneconomic] disciplines is (naturally) highly selective and structured. What induced innovation theory wants is supportive concepts and evidence, not alternative assumptions about what the basic issues are" (p. 59). Every time we come across such terms as "social ideology," "moral obligation," and "mutual help and insurance," we feel it is rather difficult to find supportive evidence of such concepts. In Koppel's paper the primary emphasis is laid on the utilization of the theory as an ideological tool. He points out the two ways in which this theory is utilized. First, it has been used to reassure international research institutions, such as IRRI and CGIAR (Consultative Group for International Agricultural Research), that "increasing documentation of problematic consequences of the green revolution were incorrect, biased, or, even if correct, were not the responsibility of the international centers but rather were the fault and responsibility of concerned national governments" (p. 63). Second, Koppel argues the theory constantly insists that "technological and institutional change in rural Asia was not a political issue (since the new technology offered constant returns to scale) but a matter of continuing and in a specific sense (appropriate factor bias) efficient economic adjustment" (p. 63). While accepting some of Koppel's criticism, Ruttan and Hayami assert that "our thinking has been more influenced by the research of the CGIAR institutes, particularly the International Rice Research Institute (IRRI), than influential on those organizations" (p. 172).

After a brief look at the induced innovation theory, Richard Grabowski takes up induced technical change and institutional change separately in his paper entitled "Induced Innova-

[1] Pranab Bardhan, "The New Institutional Economics and Development Theory: A Brief Critical Assessment," *World Development*, Vol. 17, No. 9 (September 1989).

tion: A Critical Perspective" (Chapter 5). As for the first type of change, he points out the existence of numerous groups of farmers, each facing different kinds of problems and needs, within any agricultural sector in a less developed economy. In such cases it would be rather difficult to decide which needs and wants should determine the allocation of research resources when developing new technology, for different groups have different needs (latent demand) with respect to the type of technology needed. "Latent demand is translated into actual demand via the functioning of the politico-bureaucratic system" (p. 79), of which the most important components are social structure and the legislative system: that is, the bias of innovation may be quite different from what is socially optimal. In virtual agreement with Grabowski, Ruttan and Hayami are willing to accept an "extension" of their theory. The second point Grabowski raises is connected with the "Lipton mystery," which states that after almost thirty years of developing and growing HYV, there does not seem to be a significant reduction in rural poverty.[2] One explanation of this problem (as Ruttan and Hayami argue elsewhere) is that rapid population growth offsets the positive benefits of the new technology adopted. Grabowski, however, points out that benefited farmers are likely to use their increased power to modify institutional environments, in order to capture a larger share of the benefits of technical innovations, which may be another factor responsible for continuing rural poverty. Following in the steps of Alexander Field,[3] Grabowski is skeptical of the induced theory of institutional innovation: " it is impossible to make all institutions endogenous within a model of individual choice based upon individual maximization" (p. 83) as is assumed by the induced innovation model. Ruttan and Hayami argue that all institutions, norms, or rules are not necessarily endogenous and that external factors, such as preexisting culture and ideology, may make institutional innovation more or less costly. Grabowski clearly shows that interpersonal relations are likely to be of the nature of a state prisoner's dilemma in the game theory: changes in rules (institutional innovations) are dependent upon the enforcement costs involved. These costs would depend on preexisting culture, ideology, and social structure. In this context, the key to innovation would lie in the nature of preexisting institutions rather than in exogenous economic variables. Ruttan and Hayami simply say that "a more rigorous approach to understanding the process of institutional innovation should rank high on the economic development research agenda" (p. 174).

In "Induced Innovation and Farm Mechanization" (Chapter 6), Yaov Kislev and Willis Peterson stress the need to address the problem of induced innovation in two different sectors separately: the manufacturing sector where new technology is initially developed, and the agricultural sector where it is used. They interpret the induced innovation theory as asserting that changes in relative price will induce technical innovations through two separate channels, "external" and "internal." If the new technology, such as new machine, is introduced as a result of technical progress in the manufacturing sector, and if quality change is not accurately recognized, there may be a shift in the estimated agricultural production function. They affirm that this is clearly illustrated by the mistake which Binswanger has made in his empirical analysis of technical progress in U.S. agriculture.[4] In response to this criticism, Ruttan and Hayami point out that interaction between agriculture

2 Michael Lipton, *New Seeds and Poor People* (Baltimore, Md.: Johns Hopkins University Press, 1989).

3 Alexander J. Field, "Microeconomics, Norms, and Rationality," *Economic Development and Cultural Change*, Vol. 32, No. 4 (July 1984).

4 Hans P. Binswanger, "Measured Biases of Technical Change: The United States," in *Induced Innovation: Technology, Institutions, and Development*, by H. P. Binswanger, V. W. Ruttan, and Others (Baltimore, Md.: Johns Hopkins University Press, 1978).

and manufacturing is incorporated into their theoretical framework. We may accept their theory, but there still remain some problems yet to be answered, not to mention the empirical evidence required to support and consolidate it.

Three chapters in Part 3 represent vigorous efforts to show new directions in which the induced innovation theory may develop. With respect to the development of the new institutional economics, the papers included cover a wide variety of topics, such as information and transaction costs, principal-agent relations, public choice, collective action, and the analysis of the mechanism and process by which changes in incentives are transferred into action by public and private agents, leading to technical and institutional innovations.

In "Predicting Institutional Change: What Building Block Does a Theory Need?" (Chapter 7), Hans P. Binswanger focuses on how environmental and technological features of agriculture generate risks and transaction costs and how certain forms of production organization and contracting for the transaction of land, labor, and credit are selected as the devices for coping with risk and transaction costs. After considering the general consequences of risk and information costs, he summarizes a number of material and risk characteristics of agriculture and derives his consequences for the existence or nonexistence of the two main intertemporal markets: the market for insuring crop yields and the market for credit. What is of crucial importance here is that crop insurance is infeasible without a government subsidy and that credit and capital markets must be quite limited where transport costs are high and the spatial transmission of information is costly. Then follows an analysis of the determinants of exchange and market possibilities for six primary factors of production: land, trees, animals, machines, workers, and management skill. The latter half of Binswanger's paper addresses many topics including labor costs and operational scale, draft animals and machines, management skills, and farm scale. Thus, we can get a comprehensive list of testable hypothesis with regard to the induced innovation theory.

In "Induced Institutional Change: A Neoclassical Synthesis" (Chapter 8), James A. Roumasset first demonstrates the lack of guidelines for applying the two theories of the induced innovation paradigm and New Economic History to explain a certain phenomenon. Then he points out a fatal trap into which many researchers may fall, saying "if one of the many possible efficiency explanations is constructed and appears to be consistent with a particular phenomenon, then that explanation will be chosen. If no efficiency explanation can be found, the researcher can reach into the residual tool kit of induced innovation and the New Economic History to explain the phenomenon in question. If the phenomenon still cannot be explained, then it will likely not be reported" (p. 139). To avoid this danger, Roumasset sets up three classes of models which can be distinguished within the neoclassical approach according to the degree of abstraction: "first best" (standard neoclassical theory), "second best" (plus transaction cost economics), and "third best" (former two plus political economy). The main point of his argument is that "the fundamentalism of the neoclassical paradigm can be preserved without sacrificing the reality to which bounded rationality is a response" (p. 147). Finally, he points out that the fatal drawback of the neoclassical paradigm is a lack of specified process that accounts for economic evolution.

Alain de Janvry, Marcel Fafchamps, and Elisabeth Sadoulet examine the effects of farm size distribution, transaction costs, and the state's objectives on the process of induced technical change in their paper entitled "Transaction Costs, Public Choice, and Induced Technological Innovations" (Chapter 9). In the opening section, they identify the basic two postulates of the induced technological innovation theory as the existence of perfect markets, in which "relative prices convey all relevant information to producers regarding the optimum bias of technology" (p. 151), and the responsiveness of the state to the demand of farmers. By applying the two concepts of transaction costs and the state's autonomy, they

obtain the ranking of technological biases that depend on the farm size distribution and the degree of the state's own objectives. They have succeeded in adding new determinants of technological bias, such as the structure of transaction costs across farmers, the rules of access to credit in terms of collateral, the state's own objectives, the ability of lobbies to generate pressure, and the constitutional rules through which influence affects decision making by the state. Their final comment has it that "the grand scheme of market forces introduced by Hayami and Ruttan needs to be enriched by the specificity and the complexity of the structural, institutional, and political contexts where technological biases are determined" (p. 164). This conclusion, which sums up most of the difficulties and objections raised against the induced innovation theory in the preceding part of this book, points to something of crucial importance that the theory in question has left out for further improvement and refinement.

We agree with Hayami and Ruttan that market forces, in particular relative prices that reflect factor scarcities, are one of the important factors that determine the direction and degree of technological bias in agriculture. Their theoretical model, however, is too simplistic and contains some vague concepts. The most problematic of them involves the political economy specification, in which interaction between the farmers' demand and researchers' supply is revealed. We agree with the contributors to this book who suggest that the induced technological innovation theory is valid in some specific situations: where there is a large number of scientific organizations, where farmers are educated and intelligent enough to acknowledge the potential advantages of new technology, where private companies and financial institutions as well as farmers have enough financial resources to invest, and/or where research organizations are responsive enough to farmers' demand regarding the desired technological bias. Hayami and Ruttan admit that "the interesting questions center on cases in which it appears that the processes of technical and institutional innovation produce results that are not consistent with the 'pure' theory of induced innovation" (p. 179). Thus the right political economy specification, both in theory and in practice, still remains an imperative item on the research agenda, and, if we established and well documented, will lead the induced innovation theory in the desirable direction. In this connection we must remind ourselves that we have many economic concepts and tools on hand to help us in our efforts to develop this theory, such as game theory, the principal-agent relationship, transaction cost economics, risk and information economics. We should try to make the best use of them. This does not mean that we should deny the importance of interaction between economics and other social sciences, rather, if economists rely too heavily on noneconomic concepts "selectively" in an attempt to explain some economic phenomenon, they may be misguided and led astray away from achieving their goals; that is, arriving at the correct explanation of same phenomenon or improving and refining some economic theory.

In reviewing the Koppel-edited volume, I took the time to read Hayami and Ruttan's book (the revised edition of 1985)[5] again and came up with three questions I was unable to solve when I first read it. The first one is related to the difference between the "innovation possibility curve" (IPC) and the "isoquant." In their book, the induced innovation hypothesis is illustrated by using the IPC (see Figure 4-2 on Hayami and Ruttan, p. 91). The IPC is defined as an envelope of unit isoquants corresponding to the alternative technologies that can be developed for a given research budget and a given state of the art. An isoquant

5 Yujiro Hayami and Vernon W. Ruttan, *Agricultural Development: An International Perspective*, rev. ed. (Baltimore, Md.: Johns Hopkins University Press, 1985).

is a set of efficient points that can be attainable by technologies actually available. Thus, they are two different concepts. However, some, including Hayami and Ruttan, explain induced technical innovation as a biased shift of the IPC, while others called it a biased shift of the isoquant. Even in volume under review, both ideas are used to describe the same theory. This is bewildering and confusing. I am quite sure that a biased shift of either the IPC or isoquant should explain the induced innovation theory. I would like to go further and say that the induced innovation hypothesis should dispense with the IPC. The IPC is a very vague concept in itself, especially because the term is not clear-cut enough in its frame of the area covered: when actually applied to technological potential, it may describe one curve for all the countries in the world, another for some particular region, and still another for some country. That is why one cannot help feeling that Hayami and Ruttan's use of the IPC in explaining their model is similar to the use of the "putty-clay" by the neoclassical school. The same could be said of their use of the "meta-production function." Another dubious point about Figure 4-2 is that the connection between land and machinery in the context of technological development is taken for granted. This complementary relationship is not necessarily true of agricultural technology. A second question should be raised about the econometric method used in Chapter 6 (see equation 3 on Hayami and Ruttan, p. 150), where intercountry productivity differences are accounted for by estimating their labor productivity functions. The residual term, however, is obviously dependent on the unit of measurement used, which means productivity differences are not adequately measured. The third question is more crucial than the first two. In Chapter 11 of *Agricultural Development*, Hayami and Ruttan point to the changes in factor share as evidence of the income-equalizing effects of new technology (see Figures 11-7 and 11-8 on Hayami and Ruttan, pp. 350–51). In other words, they suggest that the decline in the relative share of land and the rise in the relative share to labor imply that the income position of marginal farmers, tenants, and agricultural laborers rises relative to that of landlords and large owner farmers. They explain that "growing poverty and inequality are almost certain to result if the efforts to generate technological progress are insufficient to overcome the decreasing return to labor resulting from the growing population pressure on land" (Hayami and Ruttan, p. 352). Contrary to their argument, even in the technologically progressed area, the north village case in their book, the number of marginal farmers, tenants, and agricultural laborers increases relative to that of landlords and large farmers. In such a case, the changes in factor shares do not necessarily guarantee an improved income distribution in the area concerned. We should add that a fatal flaw in their argument is that factor share of income is not an adequate tool to analyze income distribution. Furthermore, if we analyze the income distribution of a rural area, we have to take nonfarm income into account, which Hayami and Ruttan have unfortunately failed to do. We hope these shortcomings will be redressed in a third edition.

Finally, what is the chief benefit we get from reading the Koppel volume? Its best service lies in the way it helps to make our understanding of the induced innovation theory clearer. Moreover, all the critiques and suggestions ("new directions") offered provide strong stimuli to further (much needed) creative research into the induced innovation theory. The book is a must for those engaged in development economics, agricultural economics, and, perhaps, other social sciences as well. We are looking forward to a more elaborate and refined third edition of *Agricultural Development: An International Perspective* in the near future, in response to this volume. (Norio Usui)