Notes on the Program in Technology Adaptation at MIT

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These notes describe briefly a recently-instituted technology adaptation program at MIT. Then, the problem of technology adaptation is outlined from the standpoint of the production function, and two examples of work at MIT in connection with the new program are given.

The MIT program is supported by a "211d" grant from the Agency for International Development. These grants are for the purpose of strengthening US institutions in areas related to international development. The grant to MIT has as its purpose the strengthening of MIT as a center for teaching and research in the adaptation of technology to less developed countries (ldc's). The program, now in the second of a projected five years, is governed at MIT by a faculty committee chaired by Professor J. Ruina of the Department of Electrical Engineering.

The focus of the program during the first year was on a faculty seminar. At each meeting of the seminar an MIT faculty member or visitor with experience in relating technology to a less developed country presented observations on the program in question and the reasons for the success or lack of it of the program. The purpose of the seminars was to provide a background in technology adaptation for MIT participants.

The seminar continues to meet this year. However, the focus of the program has shifted to ten projects in various technical fields to which the program has provided seed money or other support. These projects range from those in fields of "hard" technology--materials science, for example--to projects in decision-making and planning for nutrition and water resources. The criteria used to choose the programs to which seed money has been given include relevance to technology adaptation, importance to the enhancement of teaching and research capability at MIT, and potential for generating self-supporting research. The latter criterion is to insure insofar as possible that MIT will remain strong in technology adaptation beyond the period of the AID grant.

A useful way of approaching technology adaptation is in terms of what economists call the production function, the transformation relationship between inputs and the output of a good or service. The approach can be illustrated by an example using one output and two inputs. In Figure 1, the inputs are A and B, represented along the vertical and horizontal axes respectively, and output levels are given by the curves labelled EP1, EP2, etc. These are equal product curves. Each represents the different combinations of inputs that can be used to produce a given level of output. This part of the figure is the production function. In addition, the figure includes what are called equal outlay lines. Each of these gives the boundary of the set of combinations of inputs that can be bought with a given budget. Equal outlay lines, labelled EO1, EO2, etc. in the figure, can be calculated for each level of expenditure on inputs given the prices of inputs. The tangency of an equal outlay line with an equal product curve, given the shapes shown in the figure, represents the most

output that can be produced with a given budget. The combination of inputs represented by the tangent point is the optimal combination of inputs for the production of the output represented by the equal product curve. The line connecting all such points of tangency is called the expansion path, and it gives the combinations of inputs that are optimal for each level of production. (Note that in Figure 1 the correct amount of output is not shown--this depends on output prices in the system.) This analysis can be found, together with special cases, in intermediate texts in microeconomic theory.

From the standpoint of the production function the technology adaptation problem is to estimate input prices in the country to which technology is to be adapted and then to develop the technology of the production function in the region indicated by the input prices. Neither of these tasks is necessarily straightforward. The estimation of input prices, for example, requires the estimation not only of market prices for inputs but of the adjustments to these prices that are required to compensate for market imperfections, including unemployment, foreign exchange rate distortions, and others. The development of production function relationships in the region suggested by input prices will sometimes require substantial engineering effort.

This approach suggests the hypothesis that in the past many US and other developed nations have engaged not in technology adaptation but rather in technology transfer. This means, for example, assessing the size of a generating plant needed to meet projected energy demands and then constructing that plant according to optimal (or at least usual) US or other developed area input combinations. The appropriate procedure

is to design the plant according to the input combinations given by the expansion path for the ldc. Figure 2 shows a production function with one output and two inputs, and two sets of factor prices. Assuming that input A is relatively abundant in the less developed area being studied, and that input B is relatively more abundant in the developed area, the proper expansion path for the less developed country is EPldc, and for the developed country, EPdc

Two areas of research currently being supported by the technology adaptation program at MIT can be described to illustrate this approach.

The first is in the area of materials. Here, the possibilities for utilizing ferro-concrete in the construction of machine and facilities parts are being studied. Ferro-concrete is a form of concrete reinforced with small, closely spaced wires. It can be made in a variety of shapes and it is relatively labor-intensive compared to the cast parts that it would replace. In addition, the basic materials apart from the reinforcing wires can be obtained domestically in most ldc's, thus avoiding the foreign exchange expenditures required by the importation of cast pieces. However, for industrial applications the use of the material remains relatively unexplored, and the purpose of the research is to examine actual applications of ferro-concrete for machine and facilities parts. At present two sample uses of the material are being studied, a housing for a pump and a housing for a heat exchanger in a generating plant. While detailed factor price estimates for ldc's have not been employed in this work it reflects the approach suggested here: to study an area of the production function where the ldc expansion path is likely to lie.

The second area of research is water resources planning. Here, an attempt is being made to assess the appropriate combinations of planning techniques and models under each of several alternative sets of circumstances that might hold in ldc's. The output of a water resources planning process for a river or other hydrologic entity can be defined as plans of increasing quality; and inputs include technical personnel with modelling skills, data collection inputs, computational services, and the like. Some possible situations for the production function for water resources planning are given in Figure 3. The two inputs shown are modelling abilities and data collection. The curvature of the equal product lines reflects the assumption that the two inputs can be substituted one for the other to maintain a given level of plan quality.

The production function approach outlined here is not used explicitly for all of the projects associated with the technology adaptation program; it represents the writer's view of a useful conceptual framework for the technology adaptation problem.

An ideal output from the MIT program would be a set of general principles for technology adaptation and guidelines for implementing them. These are not in sight yet, and might never be. And it is too early in general to assess the successes or failures of the MIT program. But as far as one participant has been able to observe, the program has already had substantial success in sensitizing the participants to the importance of and the key issues involved in technology adaptation.

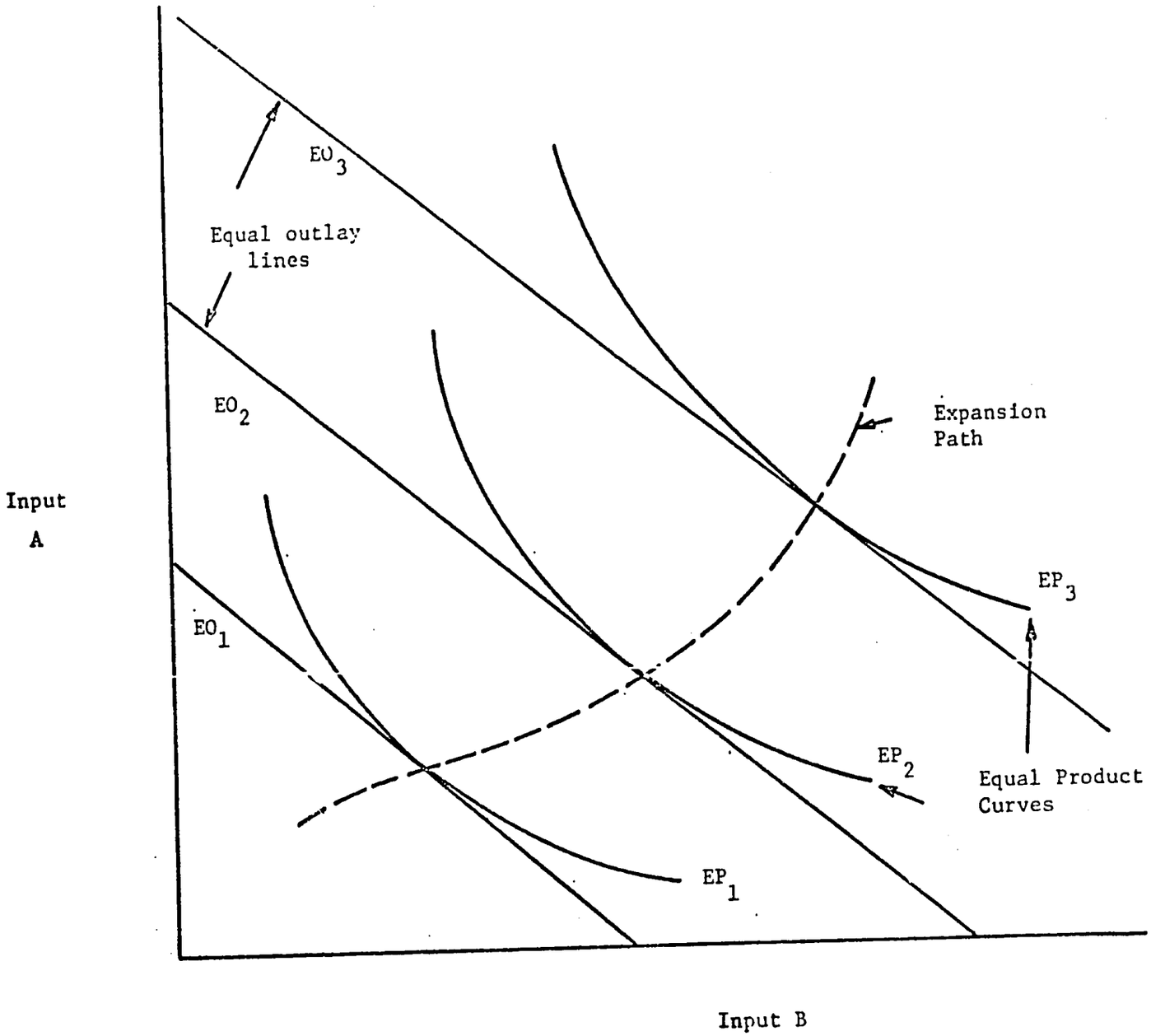

EO3
Equal outlay lines
EO2
EO1
Expansion Path
EP3
EP2
EP1
Equal Product Curves
Input A
Input B

Figure 1

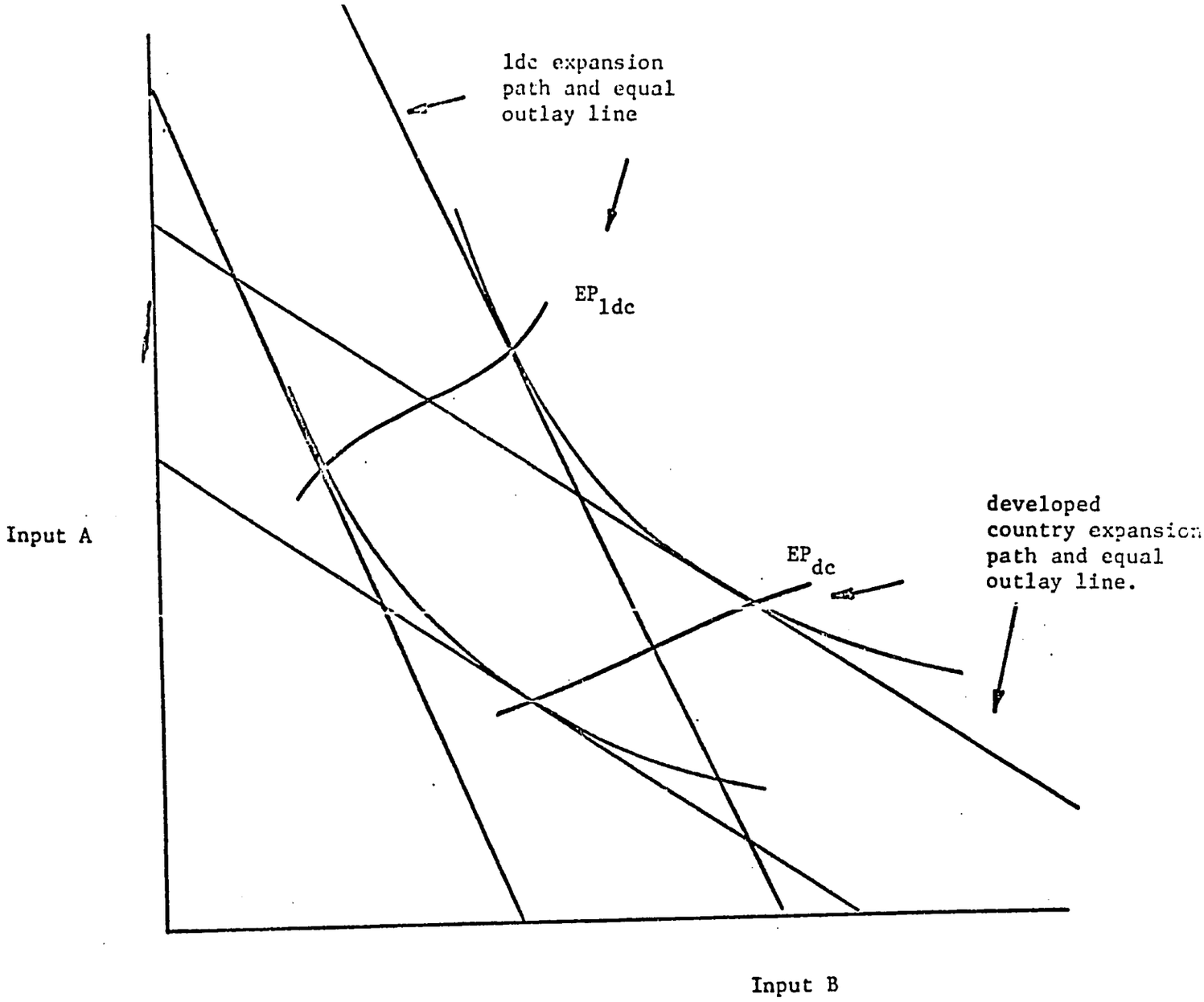
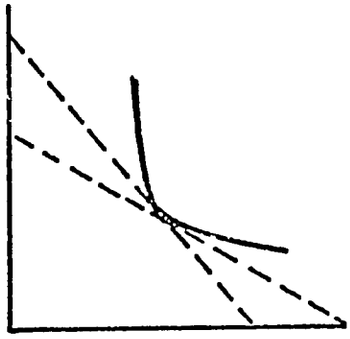
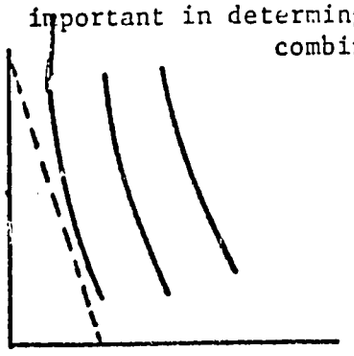

ldc expansion
path and equal
outlay line
EP_{ldc}
Input A
developed
country expansion
path and equal
outlay line.
EP_{dc}
Input B

Figure 2

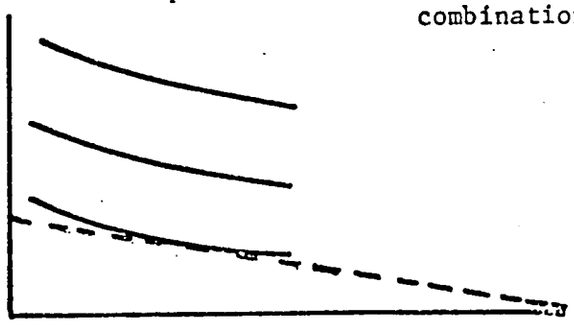
3a. Relative input prices important in determing input combinations.



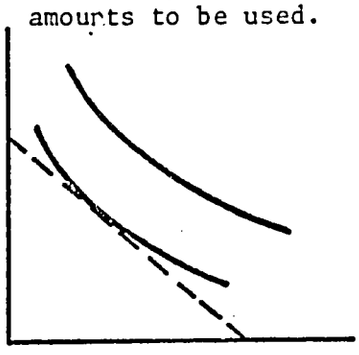
3b. Relative input prices unimportant in determining input combinations.



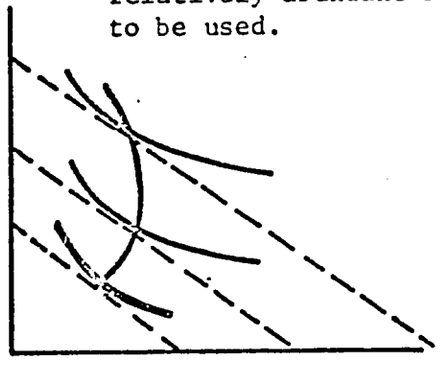
3c. Modelling abilities must be relatively abundant for large amounts to be used.



3d. Data collection services must be relatively abundant for large amounts to be used.



3e. Budget limit represented by equal outlay line shown sets upper limit of quality of plan attainable.



3f. Optimal input combinations change as quality of plan increases.

Figure 3

In each figure 3a-3f, modelling abilities are on the vertical axis and data collection services are on the horizontal axis.

Each equal product curve represents a plan of a given quality, increasing with increasing inputs.