RICHARD T. ELY LECTURE

THE ECONOMICS OF PRODUCTION

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For the last twenty years or so I have singled myself out among my fellow econometricians for arguing with all the means at my disposal that not every element of the economic process can be related to a number and, consequently, that this process cannot be represented in its entirety by an arithmomorphic model. At the same time, I have insisted that in our haste to mathematize economics we have often been carried away by mathematical formalism to the point of disregarding a basic requirement of science; namely, to have as clear an idea as possible about what corresponds in actuality to every piece of our symbolism. Curiously, in the home of quantity, in the natural sciences, this position does not constitute a singularity. On the contrary, essentially the same words of caution have come from many a high authority in physics—such as Max Planck or Percy William Bridgman, for example.[1] But even some engineers have raised their voices against blind symbolism. The recent remarks by a well-known British engineer are worth quoting at length:

> Contrary to common belief it is sometimes easier to talk in mathematics than to talk in English; this is the reason why many scientific papers contain more mathematics than is either necessary or desirable. Contrary to common belief it is also often less precise to do so. For mathematical symbols have a tendency to conceal the physical meaning that they are intended to represent; they sometimes serve as a substitute for the arduous task of deciding what is and what is not relevant; . . . . It is true that mathematics cannot lie. But it can mislead.
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> However, the dangers of over-indulgence in formula spinning are avoided if mathematics is treated, wherever possible, as a language into which *thoughts may only be translated after they have first been* [*clearly*] *expressed in the language of words*. The use of mathematics in this way is indeed disciplinary, helpful, and sometimes indispensable.[2]

The topic of this lecture—the economics of production—presents, I believe, sufficient interest by itself. But in choosing it, I have been guided also by the fact that it may serve as a substantial illustration of the harm caused by the blind symbolism that generally characterizes a hasty mathematization.

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What has come to be known as "the production function" is quite an old item in the economist's analytical paraphernalia. As we may recall, it was introduced in 1894 by Wicksteed with one simple remark: "*the product being a function of the factors of production we have* $P=f(a, b, c, \ldots)$."[3] This paradigm of imprecision apparently sufficed to make us accept Wicksteed's simple symbolism as an adequate analytical representation of any production process and use it indiscriminately in every kind of situation. And as the usage of the vapid terms "input" and "output" became widespread, popular manuals came to treat the subject in an even more cavalier manner than Wicksteed's. A typical presentation is that the production function expresses symbolically the fact that "the output of the firm depends on its inputs."

But even consummate economists have accepted Wicksteed's formula without any ado. They only felt that the meaning of the variables involved ought to be explained. The greater number of such authors adopt the position that the formula shows the quantities of inputs (or of factors) necessary to produce a certain quantity of output (or of product). Accordingly, all symbols in a production function,

$$Q = F(X, Y, Z, \cdots), \tag{1}$$

stand for quantities.[4] Others conceive the same function as a relation between the inputs per unit

[1] Max Planck, *The New Science* (New York, 1959), pp. 43, 158–59; P. W. Bridgman, *The Logic of Modern Physics* (New York, 1949), p. 50.

[2] Reginald O. Kapp, *Towards a Unified Cosmology* (New York, 1960), p. 111. My italics.

[3] Philip H. Wicksteed, *The Co-ordination of the Laws of Distribution* (London, 1894), p. 4.

[4] For a small yet representative sample, see A. L. Bowley, *The Mathematical Groundwork of Economics* (Oxford, 1924), pp. 28–29; J. R. Hicks, *The Theory of Wages* (London, 1932), p. 237; E. Schneider, *Theorie der Produktion* (Vienna, 1934), p. 1; A. C. Pigou, *The Economics of Stationary States* (London, 1935), p. 142; P. A. Samuelson, *Foundations of Economic Analysis* (Cambridge, Mass., 1948), pp. 57–58; K. E. Boulding, *Economic Analysis* (3rd ed., New York, 1955), p. 585; Sune Carlson, *A Study on the Pure Theory of Production* (New York, 1956), p. 12; Ragnar Frisch, *Theory of Production* (Chicago, 1965), p. 41.