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The "Black Box" of Technical Change and Innovation

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The members of this panel are to be congratulated for their pioneering efforts to look into the black box, marked by technical change which most of their colleagues prefer to assume constant as an exogenous variable. The concern of the paper by Zoltan Acu is to evaluate changes in the content of the box, say as represented by property rights, e.g., patents on technical information that has the potential to support innovation. The concern of the joint paper by Professors Diwan and Chakraborty is to examine the R&D components of technical change. Both are contributions to the rapidly growing body of literature sparked by Schumpeter's path breaking insights that are leading us out of the static competitive partials models of the mainstream. Whatever their shortcomings at the present stage, they are welcome steps in the right direction.

Both papers are empirical, as is increasingly the case with studies seeking to enlighten us about "black box" type questions. From the standpoint of technique, I think it is safe to say that the present studies are in the hands of able practitioners. My contribution to facilitating their ongoing work is thus to try to focus more specifically on highlighting the nature of the theoretical model or models that must necessarily underlie their empiricism.

Since the economic analysis of technical progress is not a straightforward matter, it is best to go back to the basics that Schumpeter taught us (1934). It is to him that we owe the threefold distinction between invention, innovation, and the diffusion of innovation, for these concepts are now accepted convention in the analysis of technical change. Invention is generally defined as a novel idea, method or model for a new and improved product, process or system. The role of a patent is to institutionalize an invention as a private property right and, like an invention, the creation of a patent right does not necessarily imply empirical feasibility or prototype experience, though as Jewkes (1958) suggests, it does convey the presumption that it will, in fact, work.

Thus Schumpeter distinguished between invention and innovation—using the term innovation to connote the first introduction of a new product, process, method, or system into the economy, including the military sector. These distinctions are relevant for putting the papers under consideration into perspective. Many inventions are patented but most patents are never used commercially. This fact is important in relation to what Schumpeter called the "diffusion of innovation" which is critical to the achievement of productivity gains and successful competitive performance. The Chakrabory-Diwan paper, on the other hand, is concerned with the linkage between technical change and R&D, which is a strategy by a firm to change its knowledge base and articulate new products and processes. Its orientation is, in this sense, broader than the Acu paper.

The Schumpeterian framework for the analysis of technical change has been very useful conceptually. But it has also encouraged a somewhat fragmented approach in which the
interdependence and feedback that is inherent between the stages of technical change has sometimes been lost sight of. Indeed, it is only when I study the two papers side by side that I become aware that when I view technical changes within context of interdependence and feedback that I was able to categorize what I think of as critical "black box" type questions.

1. By what process is technological variety generated?
2. By what processes do technological changes, i.e. innovations, acquire economic weight by becoming diffused?
3. By what mechanisms does the process of acquiring economic weight shape the development of technological variety, i.e. cause still other technological changes?
4. By what mechanism does the process of acquiring economic weight shape the development of the economy?

I've formulated these "black box" questions to highlight my sense that when we are discussing technical changes it is basic to recognize that they are working themselves out within the structure of input-output relations which are becoming changed. A framework which treats the black box as a receptacle into which the technical changes become operative i.e. exerts an economic weight via changes in the production and cost functions. I am fascinated by Zeller's seemingly unrelated regression method—about which I am totally ignorant. I must also confess that, as someone who spent much time and energy trying to understand the famous capital controversy of a decade or two ago—that I am distraught of aggregate production functions—so I really feel the need for a much more intuitive argument about the way in which, the R&D variable is used to analyze the cost changes caused by R&D or technical changes. The argument that technical changes should involve a reduction in cost that it should be embodied in capital goods is intuitively obvious and satisfies my requirement to examine the mechanism through which technological changes come to have economic weight. But I am puzzled why, at the end of your paper the analysis proceeds in terms of the marginal cost of capital rather than the rate of profit of a profit real wage ratio? The marginal cost of capital can only mean the cost of funds to finance R&D and/or capital expansion and are linked to the market and are therefore exogenous to the model. The profit rate, however, is (or could be) endogenous to the model and would close it in the tradition of the Post-Keynes and Post-Sraffa growth theorists.

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