5 ALTERNATIVE MODELS OF TECHNOLOGICAL CHANGE

The production function model of technological change set forth in Chapter 4 has guided for over one-half of a century much of the empirical research in economics related to the relationship between R&D and technological change. Simply put, its underlying conceptual framework is:

R&D → Knowledge → Innovation → Technological Advancement → Economic Growth

Thus, conceptually, there is a positive relationship between investments in R&D and technological change as measured by growth over time in TFP, and statistically the correlation is also positive.[1]

However, the production function approach that has dominated the empirical economics of this topic is void of any statement about the role of innovation in the R&D-to-TFP relationship, thus a rethinking of technological change, as well as the idea that many factors may be causally related is warranted.

TECHNOLOGY AND TECHNOLOGICAL CHANGE[2]

Researchers have used the concept of technology in a variety of ways. In a narrow sense, technology refers to specific physical or tangible tools, but in a broader sense technology describes whole social processes. In the broader sense, technology refers to intangible tools. Although there are analytical advantages to both the narrow and the more encompassing

[1] This literature is reviewed in Link (1987) and Link and Siegel (2003).

[2] This section draws, in part, from Bozeman and Link (1983), Link (1987), Hébert and Link (1988), and Link and Siegel (2003).

views, the different uses of the concept of technology invariably promote confusion at both the theoretical, empirical, and policy levels.

By focusing on physical or tangible technology, questions arise such as: How can technologies be differentiated? What aspects of technology are of interest? For the most part, economists have attempted to answer such questions by dealing with the indirectly perceivable aspects of physical technology or tangible tools. Namely, the focus turns from attributes to the knowledge embodied within the technology. And, the knowledge base of technology is not only a theme in this chapter, but also it is a critically important starting point for the development of science and technology policy.

Conceptualizing technology as the physical representation of knowledge provides a useful foundation for understanding technological change and its determinants. Any useful device is, in part, proof of the knowledge-based or informational assumptions that resulted in its creation. The information embodied in a technology varies accordingly to its source, its type, and its application. For example, one source of information is science, although scientific knowledge is rarely sufficient for the more particular needs entailed in constructing, literally, a technological device. Having said that, it would be useful in this regard to think of science as focusing on the understanding of knowledge and technology as focusing on the application of knowledge.

Other sources of knowledge include information from controlled and random experimentation, information that philosophers refer to as ordinary knowledge, and finally, information of the kind that falls under the rubrics of creativity, perceptiveness, and inspiration.

Regarding perceptiveness, Machlup (1980, p. 179) argued that formal education is only one form of knowledge. He asserted that knowledge is also gained experientially and is gathered and processed at different rates by each individual. The following statement reflects Machlup's notion of perception quite clearly:

> Some alert and quick-minded persons, by keeping their eyes and ears open for new facts and theories, discoveries and opportunities, perceive what normal people of lesser alertness and perceptiveness, would fail to notice. Hence new knowledge is available at little or no cost to those who are on the lookout, full of curiosity, and bright enough not to miss their chances.