

**PATENTS, CITATIONS AND INNOVATIONS: A  
WINDOW ON THE KNOWLEDGE ECONOMY**

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Foreword by Paul Romer

The study of economic growth is constrained by a shortage of data. Economists have known for decades (and suspected for centuries) that such intangibles as ideas, knowledge, technology, scientific discoveries—call them whatever you want—drive the process of growth. We have learned that it is relatively easy to build theoretical models that capture this dynamic. The difficulty comes in finding empirical counterparts for the variables that stand for the intangibles.

When Robert Solow wrote his pioneering papers on growth in the 1950s, he could build on decades of work on the empirical foundations of macroeconomics. Its system of national accounts and its summary measures of output, capital, labor, and factor shares in income made sense of a bewildering array of information about the tangible inputs and outputs of economic activity. This empirical foundation turned a model that might otherwise have been a one-trick pony into a powerful workhorse.

Adam Jaffe and Manuel Trajtenberg have built a comparable base that a new generation of theorists can use when they are ready to put their models to work. They have carried to completion a program outlined by Simon Kuznets and set into motion by Zvi Griliches—using patents to create systematic measures of the intangibles that drive economic growth. In the process, they have turned the massive body of data collected by the U.S. Patent Office into a resource that any economist can use. Together with their coauthors, they have organized

the raw data; created new measures of the importance, generality and originality of patents; checked the validity of these measures; and addressed the subtle econometric problems that arise along the way. In a series of applications, they have also demonstrated how to use these data to answer important economic questions. Best of all, Jaffe and Trajtenberg have packaged everything up in a user-friendly form. An economist working anywhere in the world will be able to study how two experts formulated and attacked important economic questions, then read about the mechanics of using the data, insert the CD-ROM, and get to work.

As a thesis advisor, my most difficult challenge has been to help students connect formal abstractions about ideas, knowledge, technology, or science to concrete questions that they might have some hope of answering. Next time I face this problem, I know what I'll do: have them study this book.