

substantially more important than patent protection. R&D executives placed greatest stress on product patent protection in the pharmaceutical industry, agricultural chemicals (for example, pesticides and herbicides, subject to analogous U.S. federal testing regulations), and industrial organic chemicals.

Mansfield²² asked the chief R&D executives of 100 U.S. firms what proportion of the inventions they developed during 1981 through 1983 would not have been developed had they been unable to obtain patent protection. The pharmaceutical industry group came out on top with 60 percent, followed by chemicals with 38 percent, petroleum with 25 percent, machinery with 17 percent, fabricated metal products and electrical equipment about 11 percent, while for groups such as primary metals, instruments, office equipment, motor vehicles, rubber products, and textiles the score was close to 0 percent. Earlier surveys yielding similar results for the United Kingdom²³, and for Germany²⁴. Thus, optimal patent policy can vary across industries.

In sum, a world without patents quite clearly would not be a world without innovation. Other incentives for innovation would fill most, but not all gaps. The influence of other factors on the propensity to innovate is presented in Annex B. Some inventions would, however, be lost, especially when the output of R&D is mostly information on whether the product works, with respect to which free riding is easy.

● *Is the Patent an Appropriate Protection System?*

Although devised to solve an important incentive problem, the patent system can be a crude and imperfect instrument. Patent protection is of the wrong kind when the project is complex and different firms hold patents on different parts of the entire innovation. Firm B may patent an improvement on firm A's invention, or firms C and D may each hold patents on diverse features, all of which a state-of-the art product should ideally incorporate. Each firm can block the other from using its patented part of the technology. Too long a patent term in this scenario would act as a disincentive to subsequent innovators. On the other hand, the holders of complementary patents often agree voluntarily to cross license each other. This enables all to achieve state-of-the-art

²² Edwin Mansfield, "Patents and Innovation: An Empirical Study", *Management Science*, 32, February 1986: 175.

²³ C.T. Taylor and Z.A. Silberston, *The Economic Impact of the Patent System*. Cambridge: Cambridge University Press, 1973.

²⁴ Klaus Grefermann, K.H. Openlaender, et al., *Patentwesen und technischer Fortschritt*. Teil I. Goettingen: Schwartz, 1974.