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Introduction

This volume is the second publication of the National Bureau of Economic Research (NBER) Innovation Policy and the Economy (IPE) group. The appreciation of the importance of innovation to the economy has increased over the past decade. At the same time, there is an active debate regarding the implications of rapid technological change for economic policy, and the appropriate policies and programs regarding research, innovation, and the commercialization of new technology. This debate has only intensified with the rapid rise and fall in the valuations of technology stocks.

The IPE group seeks to provide an accessible forum to bring the work of leading academic researchers to an audience of policymakers and those interested in the interaction between public policy and innovation. Our goals are:

- to provide an ongoing forum for the presentation of research on the impact of public policy on the innovative process;
- to stimulate such research by exposing potentially interested researchers to the issues that policymakers consider important;
- to increase the awareness of policymakers (and the public policy community more generally) concerning contemporary research in economics and the other social sciences that usefully informs the evaluation of current or prospective proposals relating to innovation policy.

This volume contains the papers presented in the group's meeting in Washington DC in April 2001.

The first two sessions seek to define appropriate government policies in high-technology industries. David S. Evans and Richard

Schmalensee analyze the implications for antitrust analysis of the dynamic winner-take-all competition characterizing many markets where technological change is rapid and drastic innovation frequent. As emphasized by Joseph Schumpeter over 50 years ago, the nature of competition in such markets is that successful innovators achieve only *temporary* market power. Indeed, it is the acquisition of such temporary market power that provides the incentive for innovative investment. Successful firms are subject to loss of their market position to subsequent innovators, however, so the use of temporary market power may not be a cause for policy concern.

Evans and Schmalensee show how the possibility that current market leaders may be displaced in the next round of innovation can lead to new conclusions about the appropriate scope of antitrust analysis. For example, conventional tests for predatory behavior and tying can lead to misleading conclusions. Practices labeled as monopolistic under traditional analysis are an inherent part of the competitive process in Schumpeterian industries. Evans and Schmalensee conclude that appropriate competition policy in Schumpeterian industries requires the development of new models and analytical tools that address when consumers will benefit (or not) from antitrust policy intervention.

The second paper considers intellectual property policy. For many decades, economic theorists assumed that the relationship between intellectual property rights and innovation was straightforward: stronger property rights would generate more innovations. In the past decade, the literature on *sequential innovation* has raised important questions about this reasoning. In many cases, generations of innovations are linked to one another: one discovery builds on another, which in turn relies on earlier work. When innovation is a cumulative process, too broad an award to one innovator may discourage innovation by followers.

In their paper, two of the leading contributors to this literature, Nancy Gallini and Suzanne Scotchmer, discuss these recent works. They review the recent writing on this topic, and highlight the implications of the sequential innovation models. They also explore the question of whether radically redesigning the nature of the awards given to innovators might boost innovation.

In the third paper, Manuel Trajtenberg considers more direct interventions: when government does not just set the "rules of the game," but directly funds research and development. He uses the science and

technology policy of Israel as a case study to explore several core issues related to such policies.

For several decades, Israel has had a systematic and well-funded policy designed to foster commercial R&D. This policy was founded on technological *neutrality*, i.e. the government did not attempt to choose what technologies to support, but rather provided a subsidy to any firm proposing a commercial R&D project that met certain basic qualification criteria. Trajtenberg describes the experience with this program, and the evidence regarding its effect on overall R&D and innovation. He also discusses the tensions that have arisen in recent years as the government's desire to impose a budget constraint have come into conflict with the principle of neutrality. He concludes that Israeli policy appears to have been generally quite successful in being flexible and responsive to changing circumstances. At the same time, the Israeli high-tech sector has enjoyed a remarkable boom, though it is unclear how large a role the public policies played in this success story.

This paper shows that ideological aversion to government support of commercial technology and ideological commitment to solving market failures through government technology programs are both equally unhelpful. Needed are a careful analysis of what works and what doesn't and a quantification of the economic effects of different policies. Trajtenberg shows that in Israel, at least, flexible, technology-neutral support of commercial R&D appears to foster high-tech growth, though we are far from being able to determine whether the social returns to this growth justify the investments made.

The last two papers in the volume address the character and policy consequences of the "New Economy." Timothy Bresnahan offers a synthetic framework for evaluating the consequences of information technology for economy-wide productivity growth. Motivated by recent theoretical and empirical advances, Bresnahan argues that traditional conceptualizations of the value arising from innovation are flawed. First, the value arising from information technology is sometimes due to network effects, and so consumer welfare increases with the extent of usage across the population. Second, in an even larger number of contexts, the benefits from information technology are only realized if there is *co-invention*—complementary innovation by *users* of information technology. Bresnahan argues that these two factors account for a very important portion of the total returns to IT, with implications for long-term growth and economic policy. When co-invention is impor-

tant, the economy-wide benefits from information technology accumulate slowly and unevenly. As a result, the rate of productivity growth at a given time critically depends on prior innovation levels and on the ability of co-inventors to extract the value from these prior inventions. While most policies related to innovation—from intellectual property policy to tax credits to antitrust—focus almost exclusively on providing appropriate incentives to initial innovators, Bresnahan's analysis suggests that equal attention must be paid to the incentives and resources available to co-inventors. For example, it may be appropriate to substantially broaden the definition of activities that are covered under the R&D tax credit in order to induce a higher rate of investment in the downstream activities so critical to realizing the benefits from information technology advances.

The final paper builds on these themes, assessing whether the microeconomic evidence "adds up." Brad DeLong links the diffusion of telecommunications and information technology to the most striking changes in the economy as a whole over the last decade. Recognizing that macroeconomic volatility is still an ever-present threat, DeLong evaluates whether the circumstances associated with distinct drivers of macroeconomic fluctuation can themselves be tied to technological change.

He makes three key arguments. First, DeLong argues that the five-year-old resurgence in the productivity growth rate can indeed be tied to technological advance and is likely to be sustained. Recent empirical studies highlight a key reason for optimism: information technology now accounts for a large enough fraction of total capital services to contribute to aggregate productivity growth. Second, this boost in productivity growth may have helped to both lower the natural rate of unemployment and increase the sensitivity of inventories to changes in aggregate demand. While the evidence is not conclusive, higher productivity growth and lower search costs may have therefore provided policymakers with increased flexibility in monetary and fiscal policy. Finally, on a more speculative note, recent patterns of technological change may have increased the volatility of financial markets. Consequently, though the New Economy seems to have offered increased macroeconomic stability up to this point, policymakers must address themselves to the new policy challenges resulting from these structural shifts in the economy.

As with last year's volume, we end on an optimistic note. While the issues involved are undoubtedly difficult, the essays highlight the role

that economic theory and empirical analysis can nonetheless play in evaluating key policies impacting innovation. They suggest that contemporary research in economics can usefully inform the evaluation of current and prospective innovation policy alternatives.

Adam B. Jaffe, Josh Lerner, and Scott Stern