Introduction

The relationship between academic research and innovation rarely stands still. For instance, a variety of indicators of science and technology have shown that in the 1990s the link developed between academic research and industrial innovation became stronger. For example, Narin et al. (1997) found there was a threefold increase in the number of academic citations in industrial patents in the US through the mid-1990s. Much of this research leads one to question commonly held assumptions that academic research is separated from industrial practice. In fact, in recent years, it is becoming increasingly common to highlight the sheer complexity and multiplicity of social interactions that link academic research and industrial practice. The patterns of interactions that bind research to practice are diverse, often subtle and influenced by a wide mixture of social and economic factors.

Central players in reshaping understanding about the links between research and innovation are a number of new, path-breaking empirical studies of university and industry interactions (see Mansfield 1991; Klevorick et al. 1995). Chapter 4 builds on these past empirical studies, updating some of the results from the highly influential Yale survey. The original Yale survey showed that academic research was useful to industrial research and development (R&D) managers, detailing the interactions between disciplines and industries. It demonstrated that there is considerable variety across different industries in the way research influences industrial practice. In some sectors, for instance pharmaceuticals, the link between research and practice is tight, whereas in others the link is more indirect. An essential part of this analysis was the distinction between research that was directly useful and research that provided background knowledge for the firms' scientific and technological activities. Using this distinction, the study was able to document the importance of traditional disciplines, such as physics and mathematics, for a number of sectors (Klevorick et al. 1995).

Chapter 4 is not just a replication of the earlier Yale study; it is an extension and further elaboration of the Yale approach. It attempts to characterize the relationships between research and innovation in more detail. The chapter demonstrates that publicly funded research remains extremely useful for industrial firms in the US. This is an important finding and challenges the common contention that academic research is 'useless'. The

chapter also explores the key channels of exchange between industry and academic research. It contradicts the conventional view that publicly funded research primarily generates new ideas for industrial R&D, finding instead that it contributes to *finishing* existing R&D projects.

Chapter 5 focuses on changes in the national system of research funding in France. It explores the unexpected consequences of changes in France's policies towards universities and research. Like many OECD countries in the 1990s, France developed a new policy environment to support the commercialization of publicly funded research conducted at universities. The new French strategy draws heavily on ideas that Steinmueller (see Commentary) characterizes as 'managerial' which contend that greater efforts are necessary to support the commercialization of university research. France's efforts to create new sources of funding that run alongside traditional support mechanisms for research and teaching as well as a series of measures are designed to encourage interaction between researchers and industry.

Despite the enthusiasm within OECD policy communities for commercialization of research, there is an ongoing and unresolved debate among science policy researchers about the merits of such policies (see Florida 1999). These efforts to support commercialization of university research have often been based on a desire to copy the perceived success of the US system. Pavitt (2001) argues that too often European and other OECD countries have drawn the wrong lessons from the US system. It is not the ability to commercialize technology that sets the US apart from Europe, it is the high levels of public support for basic research and the multiplicity of entrepreneurial funding agencies that target highly profitably new lines of inquiry, a point that Stephan reinforces (see Commentary). Like Pavitt, in Chapter 5 Llerena, Matt and Schaeffer are sceptical about new French policies. They directly challenge two main principles of the French policy reform – the first focused on the maintenance of the lack of university autonomy in managing staff and facilities and the other suggesting that entrepreneurial researchers will be able to derive considerable financial benefit from their research. They suggest that the new French reforms have only had a marginal impact on the state of university autonomy in France. They have not provided the universities with the freedom that was intended by the reform programme. Moreover, the authors suggest that the idea of the entrepreneurial researcher is largely a myth. They suggest a more radical agenda of reform, involving greater university autonomy and greater personal discretion for researchers to raise income from their research activities. For them, the current set of reforms still carries with it many of the limitations of past generations of French innovation policy, an overly bureaucratic and state-directed system of control.

Chapter 6 focuses on interactions between universities and firms in the life sciences in Europe and the US. The chapter brings together new evidence on collaborative R&D projects to explore the patterns of relations between public and private actors in the life sciences. It finds that the sets of network relations in the US are concentrated in regional clusters that span a number of drug development stages, a diverse range of organizations and numerous different disciplines. In comparison, European networks are less dense, more specialized and display greater geographic dispersal. In other words, the US networks are institutionally thick, involving considerable interaction across organizations and disciplines, whereas the European networks are institutionally thin, involving smaller numbers of actors in highly specialized communities. The authors suggest that the characteristics of the European networks limit universities' participation in commercially oriented R&D, undermining the economic potential of these university centres. However, the authors suggest that the US and European networks are profoundly influenced by the distinct cultural and institutional contexts in which they are located. Given these differences between Europe and the US, they argue that European research policy should not attempt to copy American policies. Rather, they suggest that European policy should be focused on developing a new set of network interactions between basic research and development, and among small firms and universities within Europe.

Chapter 7 is located in the tradition of the New Economics of Science. It seeks to characterize a science system through the methods and approaches of economic analysis. It deals with the tricky issue of evaluating research funding programmes. Previous research has found programme evaluation difficult because: (a) it is often hard to measure research performance; (b) many of the benefits of the funding are long term in nature; and (c) there is a strong selectivity bias, arising from the fact that *ex post* evaluations are usually conducted on research groups that have previously received research funds and therefore have been able to improve their qualifications for further funding. Cesaroni and Gambardella confront these challenges of evaluation in Chapter 7 by using several new combinations of economic techniques and new data. Their study is based on a comprehensive data set drawn from the Italian Research Council's programme for biotechnology and bioinstrumentation, which ran from 1989 to 1993.

In their approach, they assess the impact of funding on a research team's performance and the impact of several structural features of the team, such as size, location and so on, in shaping research performance. They find that the past performance of the principal investigator and collaborations with foreign research institutions play a key role in shaping the research performance of the project. However, they also find that research funding produces

constant rather than increasing returns to scale, suggesting that incumbent advantage is limited, at the current scale of Italian research funding. It is therefore not possible to adopt a strategy of picking 'winners' as these researchers are located well away from the marginal project selected. The result of funding a greater diversity of projects and researchers may, however, be serving to preserve diversity and prevent the accumulation of advantages of incumbency.

REFERENCES

- Florida, R. (1999), 'The role of the university: Leveraging talent, not technology', *Issues in Science and Technology*, **15**(4), 67–73.
- Klevorick, A.K., R.C. Levin, R.R. Nelson and S.G. Winter (1995), 'On the sources and significance of interindustry differences in technological opportunities', *Research Policy*, **24**(2), 185–205.
- Mansfield, E. (1991), 'Academic research and industrial innovation', *Research Policy*, **20**(1), 1–12.
- Narin, F., K.S. Hamilton and D. Olivastro (1997), 'The increasing linkage between US technology and public science', *Research Policy*, **26**(3), 317–30.
- Pavitt, K. (2001), 'Public policies to support basic research: What can the rest of the world learn from US theory and practice? (and what they should not learn)', *Industrial and Corporate Change*, **10**(3), 761–79.