New Technology-Based Firms in the 1990s *edited by Ray Oakey* (Paul Chapman Publishing, London, 1994), pp. vi + 218, £ 39.95. ISBN 1-85396-274-0; **High-Technology New Firms: Variable Barriers to Growth** *by Ray Oakey* (Paul Chapman Publishing, London, 1995), pp. ix + 134, £ 25.95. ISBN 1-85396-239- 2.

Technological development is often considered to be a key determinant of profitable firms and prosperous economies. Accordingly, considerable attention has been given to capturing the ingredients of successful innovation in economic, management and policy literature. Two recent books by Ray Oakey suggest that the common factors determining success are elusive and unresolved by recent empirical studies of new technology-based firms. Indeed, the evidence is sometimes conflicting and contradictory, reinforcing the view that innovation is a random process.

The problems associated with developing a coherent and consistent understanding of innovation and technology within firms are most evident *in New Technology-based Firms in the 1990s*. This is an edited book which deals with four aspects of technology and the firm: entrepreneurship and innovation management; finance; intellectual property; and policy. Here, the advice provided is sometimes conflicting and the empirical support for the conclusions presented is sometimes unsubstantial and unconvincing.

For example, several chapters of this book deal with the issue of networking and new technology-based firms (NTBFs). Rothwell argues that the innovation process has moved towards a 'systems integration and networking' model in which networking with leading-edge users, suppliers and sources of technological development are crucial. Stockport and Kakabadse's contribution is less certain regarding the centrality of networks in their analysis of NTBFs. These authors argue that there are different types of interorganisational networks which may also change over time. Importantly, Stockport and Kakabadse provide conditions and circumstances under which the forces driving firms towards interorganisational networks are countervailed by negative consequences of these associations. This implies that collaborative arrangements will not always be beneficial for NTBFs, and need to be assessed according to a range of variables.

The difficulties associated with networks and interorganisational collaboration are also noted in Caird's contribution to this book which examines sources of innovation. Her limited survey of 24 winners of the U.K. Government, "Small Firms Merit Award for Research and Technology" indicates that whilst only 13% of these firms believed that innovation was assisted by collaboration with other companies, 17% identified relationships of this nature as an obstacle to innovation (p. 63). However, this paper also highlights the centrality of end user and producer relationships to the innovation process and the development of innovative ideas, with 71% of firms participating in this research having indicated that innovation was problem-driven (p. 61).

Another chapter of this book examines the role of small technology firms as an instrument of bringing technology to the market. Bower and Whittaker suggest that these firms provide an important linkage between university-based science and conventional companies. The implication of this analysis is that networking is important, not only for the commercial success of firms, but for the innovation process. Thus, innovation requires the development of networks which include mediators and 'interpreters' such as small technology based firms.

Whilst Bower and Whittaker identify the value of associations between small and large firms to the innovation process, Garnsey and Wilkinson argue that there are problems with these relationships for both firms and broader technology development objectives. These authors provide evidence that in some circumstances "a global network can give rise to rigidities and diseconomies of scope which can vitiate the prospects for a new technology" (p. 132). This case study of a UK semiconductor firm, Anamartic and its global alliances with US, Japanese and German firms identifies substantial inherent technological and commercial difficulties when NTBFs lose control over their intellectual property, and the uncoupling of R&D from production processes.

Thus, these chapters present a divergence of views on networking, strategic alliances and collaborative arrangements. These associations appear to have variable outcomes, provide mixed benefits for the participants in these arrangements, and may vary over time. This implies the absence of any clear and consistent 'macro' principles of collaboration which can be applied to innovation theory, suggesting that a more sophisticated analysis of a wide range of variables and influences might be required.

Other chapters of this book suggest that similar problems appear to exist with respect to analysis of entrepreneurship and management within NTBFs. Indeed, Oakey concludes that this analysis implies that the nature of the innovation process within many NTBFs is rather anarchistic, and genuinely eclectic (p. 6). For example, Augsdorfer identifies 'bootlegging' as important source of less certain, bottom-up ideas within firms. Bootlegging is scientific experimentation undertaken in secrecy or in the absence of formal management approval within firms. These authors argue that bootlegging is a response to the random and unpredictable nature of innovation and experimentation.

Whilst Caird demonstrates some commonality in the sources of innovative ideas, the factors affecting the choice of innovative projects are more diverse. For example, her research suggests that innovative ideas were mostly problem-driven, or emerged from discussions with clients and colleagues but the factor affecting the progress of innovative projects include technical viability, finance, market acceptance, human resources, business influences and collaboration with other firms. This implies that the development of technological ideas depends on a wide range of factors, reinforcing Oakely's observation that these new industry sectors are characterised by chaos and uncertainty.

Similarly, few conclusions can be drawn from other issues addressed in this book. Much of the analysis of financing NTBFs tends to compare the extent to which national financial institutions support the development of new technology enterprises. Lumme, Kauranen and Autio provide evidence that the financial markets in the United Kingdom are more supportive of NTBFs than in Finland whilst Deakins and Philpott indicate that Germany and Holland provide a more conducive business environment for these firms than the United Kingdom.

A common criticism of these chapters is the inability of banks in the United Kingdom to assess and interpret the value of intellectual property and technical assets of firms; an observation which might also be applied to many other liberal democracies including Australia. Indeed, the role of banks are pivotal to the analysis of financial support for NTBFs in these chapters. Philpott uses bank risk assessment processes as the basis for his judgement that "banks seem to have little appreciation of the nature of technology-based businesses" (p. 78) whilst the paper by Deakin and Philpott use similar analytical techniques to demonstrate that "UK bank financial instruments that are actually taken up by (new technology entrepreneurs) are more short term than in Holland or Germany" (p. 102).

Again, the conclusions from this analysis are uncertain. Whilst this analysis provides a clear indictment of banking institutions in the United Kingdom which might easily be translated to other parts of the globe, although the implications of this analysis are less clear. Philpott suggests that banks should encourage the employment of specialists with the capacity to understand new technology business whilst chapters by Lumme *et al.* Deakin and Philpott, and Mason and Harrison all identify alternative funding sources to banks.

This book provides an important insight into current research on NTBFs, and a broad range of perpsectives on issues affecting the sector. It is based on papers presented at a Manchester Business School conference and tends to suffer from a lack of coherence and consistency both in the content and quality of the papers. For example, the section dealing with policy issues is not only internally fragmented but also covers subject matter which has few relationships with earlier chapters.

However, these chapters do make an important contribution to broader knowledge and understanding of technology-based enterprises and the innovation process. In particular, it highlights the dynamic, uncertain and complex nature of innovation which implies that policy, likewise, needs to be continually under review, flexible and adaptable. Indeed, Keeble's contribution is important in this respect, by highlighting the wide range of policies and influences (mostly non-technical) which affect the development of NTBFs in national and regional economies. Oakey's own contribution to recent analysis of innovation and the commercial development of technology is documented *in High-Technology New Firms: Variable Barriers to Growth*. This book is a more consistent and systematic evaluation of several key factors affecting the growth of new technology firms in three emerging industry sectors; biotechnology, electronics and software. Furthermore, Oakey's contribution provides some substantial and defensible conclusions on NTBFs. This book is significant in terms of both its empirical analysis and theoretical contribution.

The empirical investigation of this book relates to five factors influencing the development and growth of NTBFs. The first proposition tested by Oakey is whether the progress of NTBFs is deterministically influenced by the experiences, education and background of a firm's founder. Here, he concludes that previous experience and expertise developed over years prior to formation has a strong deterministic influence on the activities of firms.

Second, Oakey provides evidence that there are significant sectoral differences in the growth and capacity of firms to raise development capital. In particular, long product development cycles and high R&D costs were found to be disincentives to investment in biotechnology firms, although problems with raising capital were evident in all sectors throughout the early development of firms.

Third, Oakey's research indicates that there are also differences in the R&D intensity of firms between sectors with biotechnology firms having extremely high levels of R&D, and "the weakest level of R&D activity in the software enterprises" (p. 80). The implication of this analysis is that investors in NTBFs need to apply distinctive risk and pay-back assessment criteria to different high-technology industry sectors.

Fourth, this book provides evidence of very complex and sophisticated geographical and organisational input and output linkages between NTBFs and their suppliers and customers, with an unusually high concentration of single customer industries being an unusual characteristic of Oakey's survey sample. However, cross-sectoral differences again prove to be significant with software firms having the only strong pattern of local purchasing and biotechnology firms demonstrating particularly strong international linkages with both suppliers and customers.

Finally, Oakey addresses the issue of acquisition. He argues that the loss of independence and internal cohesion often resulting from the NTBF being acquired by larger corporations may often "severely damage the very success that made the firm an acquisition target from the outset" (p. 112). However, the evidence he provides suggests that the requirement for capital to finance expansion and growth mostly takes precedence over this loss of independence, especially in conditions where financial markets are unsympathetic to NTBFs.

This analysis enables Oakey to propose two significant positions with respect to both theory and policy applied to NTBFs. The first conclusion is that any understanding of NTBFs requires disaggregation of high-technology industries beyond simple characterisations based on R&D inputs. He argues that there are significant theoretical and practical differences between industry sectors with the generic category of 'high- technology' industries. These differences include the stage at which firms are launched, R&D requirements, pre-production risk, post-production uncertainty, entry barriers and competition. According to Oakey previous conceptualisation of 'high-technology' industries has assumed a "spurious level of homogeneity" (p. 2). This implies a second conclusion. Public policy needs to account for variances between industry sectors. For example, the long lead times, high entry barriers and radical nature of innovations associated with biotechnology firms imply different policy instruments and levels of assistance than for software industries where entry barriers are low but competition is strong.

High-Technology New Firms: Variable Barriers to Growth make a significant contribution to both the broader understanding of the theoretical and conceptual differences between high technology industry sectors, and a detailed understanding of the three sectors examined in this book: biotechnology; electronics; and software. Oakey's is based on qualitative and quantitative analysis which is both plausible and convincing. Throughout the author provides consistent and appropriate linkages between his empirical analysis and theory, providing welcome linkages to the implications for both corporate strategy and public policy.

The message for policymakers is understandable, forceful and important. High-technology industries make an important contribution to employment growth and the competitive position of 'mature' industry sectors. Accordingly, there is considerable strategic benefits in governments assisting the development of these sectors. However, the public and policymakers should have realistic expectations regarding the failure rate of firms in these emerging industries and the contribution of individual firms to economic growth (flow-on benefits are probably more important). Previous policy instruments need to re-evaluated to account for significant differences between industry sectors broadly classified as 'high- technology' industries. Although this book is based on experiences in the United Kingdom, its message might easily be translated into other liberal democracies which have an aversion to government intervention and targeting. This book provides policymakers with both a rationale for intervention in the new technology sector, and the analytical tools to begin the process of determining the policy instruments which are most appropriate.

Both of the books reviewed here provide an insight into recent research and knowledge of NTBFs, and are recommended for reading. However, *New Technology-Based Firms in the 1990s* is inconsistent in quality and unclear in its direction and messages. Its strength is its coverage of a wide range of important issues affecting both technology strategy within firms and policymaking for new technology industries, and its insight into the random and indiscriminate nature of innovation. *High-Technology New Firms: Variable Barriers to Growth* provides a more rigorous analysis of NTBFs and makes a more significant contribution to the development of future policy and corporate strategy. Whilst not denying that the innovation *process* is often arbitrary, Oakey's analysis is able to draw together some important commonalities and messages to the reader. This book is coherent and accessible, and should be read by academics, policymakers and business managers in the field.

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