

Contents

<i>List of figures</i>	vii
<i>List of tables</i>	viii
<i>Preface</i>	x
1 Introduction	1
A word about theory	8
Plan of the book	13
2 Cooperative research as an institution	17
The characteristics of research and development	18
Availability and use of research and development resources	27
Definitions	41
The rationale for cooperative research	46
Conclusion	56
3 Cooperative research experience	61
National cooperative research organizations	62
International cooperative research organizations	82
Examples of multi-party cooperation in R&D	94

Semiconductor Manufacturing and Technology Institute (Sematech)	94
The Very Large Scale Integration Circuit (VLSI) Research Association	107
The Alvey Programme for Advanced Information Technology	112
Highlights of the evidence	115
Conclusion	119
 4 A theoretical approach to research cooperation in industry	 127
Empirical findings on the relationship between R&D inputs and R&D outputs	129
Model appraisal	136
General formulation of the model	139
Parametric model	143
Cooperative versus noncooperative industrial setup	153
Cooperative research within different market and research environments	161
Secretariat research joint ventures	166
Operating entity research joint ventures	174
Reprise	202
Appendix	210
 5 Synthesis	 213
Stages of technological evolution	216
Cooperative research and industrial evolution	222
 6 Concluding remarks	 234
 <i>Bibliography</i>	 246
<i>Author Index</i>	265
<i>Subject Index</i>	268

List of figures

1.1	The linear model of innovation	10
3.1	Time distribution of ERA launching	73
3.2	Integrated circuit complexity trends	104
4.1	Distribution of probabilities for better cooperative industry performance	159
4.2	Cooperation versus noncooperation: I	164
4.3	Cooperation versus noncooperation: II	180
4.4	Cooperation versus noncooperation: III	186
4.5	Cooperation versus noncooperation: IV	188
4.6	Cooperation versus noncooperation: V	190
4.7	Cooperation versus noncooperation: VI	192
4.8	Cooperation versus noncooperation: VII	194
4.9	Cooperation versus noncooperation: VIII	196
4.10	Cooperation versus noncooperation: IX	198
4.11	Cooperation versus noncooperation: X	200
5.1	Stages in the technological evolution of an industry: I	217
5.2	Stages in the technological evolution of an industry: II	220
5.3	Cooperative research across stages of technological evolution	231

List of tables

2.1	National R&D expenditures of selected countries	28
2.2	Estimated nondefense R&D expenditures as a percentage of gross national product by country	29
2.3	U.S. research and development expenditures by sector	30
2.4	Scientists and engineers engaged in R&D	32
2.5	National R&D expenditures financed by industry	33
2.6	Sectoral percentage shares in the U.S. R&D effort by source and performer	34
2.7	R&D expenditure and performance by sector and category in the United States: 1990	37
2.8	Modes of technical cooperative agreements	42
2.9	Cooperative R&D and joint technology development	44
2.10	Time trend of inter-firm agreement formation by mode of cooperation	55
3.1	U.S. cooperative research organizations sorted by decade of establishment	65
3.2	The third Framework Program (1990-94)	84
3.3	Capital expenditures for semiconductor manufacturing and product prices	101

3.4	Semiconductor device densities	103
4.1	Relative noncooperative and cooperative performance for varying spillover rates	155
4.2	Examples of b and $\theta(D=0)$ pairs for given a ($\theta = \theta^c < 1$)	168
4.3	Effect of increases in b , a , a_0 , δ , δ_0 , and θ on the levels of firm R&D, output, profits and social welfare [secretariat RJV]	170
4.4	Values for a , b , and θ for $N < 0$ ($\theta < \theta^c = 1$)	177
4.5	Combination of b , $2/3b$, and dQ/dP for higher noncooperative development research effort ($\theta < \theta^c = 1$)	177
4.6	Lower limits of δ -values for $N < 0$ ($\theta < \theta^c = 1$)	178
4.7	Effect of increases in b , a , a_0 , δ , δ_0 , and θ on the levels of firm R&D, output, profits and social welfare [operating entity RJV]	183
5.1	Model of post-war industrial evolution	226
5.2	Examples of selected industries classified by stage of technological evolution	228