# ON-LINE SUPPLEMENT TO: TECHNOLOGICAL INNOVATION, PRODUCT DEVELOPMENT, AND ENTREPRENEURSHIP IN *MANAGEMENT SCIENCE*

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Following are tables with short summaries of the work reviewed in the body of the article.

The final column of the tables indicates the methodological approach of the work, employing the following legend:

E≡ empirical; Q≡ qualitative empirical; C≡ conceptual; T≡ theoretical model.

**The Role of the Individual**

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| 1964 | Holt and Feber | The psychological transition from management scientist to manager | Using a psychodynamic perspective, provides a longitudinal examination of how one person overcomes the conflicts and problems of transitioning from a technical position to a management position | Q |
| 1976 | Aram and Morgan | The role of project team collaboration in R&D performance | Uses survey of professional employees of an R&D center at an industrial company to show that perceptions of collaboration increase chances for employees to meet their needs which enhances technical performance | E |
| 1977 | Rubenstein and Schroder | Managerial differences in assessing probabilities of technical success for R&D projects | Examined factors that influenced the assessment of success probabilities by people working on different projects at one company and found that individual, organizational and situational factors all mattered | E |
| 1988 | Leonard Barton and Deschamps | Managerial influence in the introduction of new technology | Surveyed people working at one company to understand the adoption of an innovation and found that individual characteristics of end users mediated the effect of managerial authority on adoption | E |
| 2002 | Barker and Mueller | CEO characteristics and firm R&D spending | Used sample of Business Week 1000 firms to show that firms with CEOs with legal or production education or experience had lower R&D spending than those with marketing and engineering experience and education. | E |

**Organization Design – *Organizational Structure***

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| 1964 | Rubenstein | Decision making in large decentralized companies | Uses data from five industries to show the variation in the distribution of decentralized, centralized and combination organizational forms across industries and the problems created by each | E |
| 1980 | Feller | Managerial response to technological innovation in public sector organizations | Explored the effect of technological change on productivity improvement in government agencies, arguing that the adoption of productivity enhancing innovations in government agencies is inhibited by managerial preferences | C |
| 1983 | Miller | The correlates of entrepreneurship in three types of firms | Examined the factors that influenced innovation and risk taking across firms to show that the innovativeness of centralized firms was explained by management characteristics | E |
| 1983 | Kim and Utterback | The evolution of organizational structure and technology in a developing country | Examined Korean manufacturers and found that younger firms are more mechanistic, have more adaptable technology, less internal technical capability, less innovation and are smaller scale. | E |
| 1984 | Ettlie et al | Organizational strategy and structural differences for radical versus incremental innovation | Using food processors, showed that aggressive strategies and organizational concentration of technologists enhance radical innovation, but growth strategies and decentralization enhance incremental innovation. | E |
| 1994 | Zenger | Explaining organizational diseconomies of scale in R&D: Agency problems and the allocation of engineering talent, ideas, and effort by firm size | Used data on technical employees at two companies to show that small firms overcome agency problems and have greater &D performance because they can award employment contracts that reward employees for high performance, thereby enabling them to attract and keep high quality technical employees | E |
| 1996 | Damanpour | Organizational complexity and innovation: Developing and testing multiple contingency models. | Meta analysis on organizational innovation which shows that organization structure-innovation relationship is contingent on environmental uncertainty, organization and innovation type, and implementation, and organization size-innovation relationship is contingent on environmental uncertainty, and organization and innovation type. | E |

**Organization Design – *Communication***

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| 1972 | Baker and Freeland | Structuring information flow to enhance innovation | Provide a model and empirical test to show that flow of information influences both quality and quantity of ideas submitted by individuals to their organizations | E |
| 1975 | Gruber and Niles | The science-technology utilization relationship in management | Argued that science and technology are developed by different groups of people, necessitating management of technology personnel who tie the two groups together | C |
| 1980 | Tushman and Katz | External communication and project performance: An investigation into the role of gate keepers | Compared project teams at one organization and found that external gate keepers enhanced locally oriented tasks and facilitated external communication | E |

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| 1980 | Ettlie | Manpower flows and the innovation process | Used several case studies and existing literature to develop a conceptual model of the effects of movements of personnel across organizations on innovation | C |
| 1982 | Lee and Allen | Integrating new technical staff: implications for acquiring new technology | Examined technical employees of one organization to show that new employees were less connected than established employees, which hinders product development, but not research | E |
| 1984 | Ebadi and Utterback | The effects of communication on technological innovation | Showed that communication frequency, centrality, and diversity enhanced, and formality inhibited, individual success at innovation; whereas centrality, diversity and cohesiveness enhanced project success at innovation. | E |
| 1985 | Brown and Utterback | Uncertainty and technical communication patterns | Used data in several companies across three industries to show that competitive uncertainty increased the amount of external communication by technical personnel. | E |
| 1986 | Ebadi and Dilts | The relation between research and development project performance and technical communication in developing country Afghanistan | Examined a variety of R&D projects and found that mid- and high-performing groups that have more frequent communication perform better, and that low-performing groups that have communication centrality perform worse. | E |
| 1996 | Moenart and Souder | Context and antecedents of information utility and the R&D/marketing interface | Used a path model to show that information was perceived as more valuable if it was more relevant, credible, understandable, and novel and was provided by someone more senior and experienced. | E |
| 1998 | Xie et al | Interfunctional conflict, conflict resolution styles , and new product success: A four culture comparison | Used data on marketing managers from Japan, Great Britain, Hong Kong and United States to show a curvilinear relationship between innovation performance and conflict between organizational units and that national culture was the best mechanism for overcoming conflict. | E |
| 1998 | Van den Bulte and Moenart | The effects of R&D team co-location on communication patterns among R&D, marketing, and manufacturing | Used longitudinal data on networks of R&D personnel at a telecommunications company to show that collocation increased communication within R&D but not between R&D and marketing | E |
| **Organization Design – *Decision Making*** | | | | |
| 1973 | Moskowitz | An experimental investigation of decision making in a simulated research and development environment | Put MBA students and R&D managers through an R&D decision game involving technical uncertainty to show that the groups played the game differently but that both displayed suboptimal behavior. | E |
| 1973 | Souder | Analytical effectiveness of mathematical models for R&D project selection | Developed four models for selecting R&D projects and compared them to actual data to show that the models are effective, but that effectiveness depends on selecting the right stage in the life cycle and management goals | C |
| 1974 | Truemper and Dean | The OPRAD research and development management game | Evaluated the OPRAD game, a simulation to train people to manage R&D and showed that results from the game were consistent with the results of a questionnaire about R&D decision making. | C |
| 1977 | Souder | Effectiveness of nominal and interacting group decision processes for integrating R&D and marketing. | Used data on project teams from R&D and marketing to show that nominal interacting approach generated the most consensus and integration in the teams. | E |
| 1978 | Dailey | The role of team and task characteristics in R&D team collaborative problem solving and productivity. | Examined research and development problem solving in project teams and found that team cohesiveness had a positive effect on problem solving and that task certainty had a negative effect | E |
| 1986 | Van de Ven | Central problems in the management of innovation | Provides a framework for how researchers should conduct longitudinal studies of innovation based on four factors: ideas, people, transactions and context. | C |
| 1991 | Oliva | Information and profitability estimates: Modeling the firm's decision to adopt a new technology | Used catastrophe theory to develop a model of the adoption of new technology for new firms and tested the model on simulated data on innovation projects | T |

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| 1994 | Von Hippel | “Sticky information” and the locus of problem solving: implications for innovation | Argued that when information lies in a particular location, that location tends to be where problems are solved and when information is in multiple locations, the problem solving shifts across locations | C |
| 1995 | Nair | Modeling strategic investment decisions under sequential technological change | Developed a formal model of the strategic decision to invest in new equipment when any number of new technologies may appear in the future and the characteristics of those technologies are uncertain | T |
| 1999 | Childs and Triantis | Dynamic R&D investment policies | Developed a formal model of the optimal approach to R&D investment R&D over time and showed that it is often optimal to develop back-up projects even if they have lesser expected value than the main project | T |
| **Basic Research and Advanced Development** | | | | |
| 1963 | Martin and Ackoff | The dissemination and use of recorded scientific information | Presents two field studies on how physicists and chemists spend their time, especially the amount and kind of communication in which they engage. | E |
| 1964 | Dean | Allocation of Research and Development Resources in US and Israel Industry | Considers allocation of national technological resources to different sectors of the economy. A comparison is made of the sources and consumers of R and D funds in the U.S. and Israel. | E |
| 1972 | Gaver and Srinivasan | Allocating resources between research and development: A macro analysis | Presents a queuing model to coordinate the research potential and the development capability of an organization. Use of Monte-Carlo methods is illustrated. | T |
| 1977 | Zimmerman | Decision models for individual scientists involved in basic research | Develops, compares and analyzes; the relative applicability and usefulness of models of the decision process of individual scientists. | Q |
| 1982 | Lee | A nonsequential R&D search model | Develops a research and development search model based on current technology level, the length of the decision horizon and basic research. Existence of a reservation technology level is used to find a stopping rule. | T |
| 1982 | North, Warner; Stengel | Decision Analysis of Program Choices in Magnetic Fusion Energy Development | Describes a methodology based on decision analysis for addressing major program decisions in the development of magnetic fusion energy. | T |
| 1985 | Lee | On the joint decisions of R&D and technology adoption | Develops and analyzes a decision theoretic model of the joint decisions of R and D and technology adoption of a firm. Increases in the cost of R and D or technology adoption, lead to a decrease in the phenomenon. | T |
| 1986 | Joglekar and Hamburg | An industry model of resource allocation to basic research and its policy implications | Investigate the effect of relevant factors upon a homogenous industry’s allocation of resources to basic research. Findings advise allocation of government support for basic research. | E |
| 1987 | Hopp | A sequential model of R&D investment over an unbounded time horizon | A Markov model of sequential research and development investment, where successful firms are assumed to have an advantage in follow-on research and development; and a solution approach are developed. | T |
| 1987 | Guerard, Bean, and Andrews | R&D management and corporate financial policy | Determinants of research and development, dividend investment and financing decisions of 140 firms are investigated econometrically. | E |
| 1987 | Mansfield | Price indices for R and D inputs, 1969-198 | Presents R and D price indices based on actual prices and expenditures reported by firms. The GNP deflator is shown to underestimate the rate of inflation in R and D. | E |
| 1989 | Joglekar and Hamburg | Industry concentration and allocation of resources to basic research | Finds that comparable heterogeneous and homogenous industries fall equally short of their Pareto optimal investment in basic research. Policy implications are discussed. | E |
| 1994 | Helfat | Evolutionary trajectories in petroleum firm R&D | Tests the persistency of differences in efforts devoted to research and development using data from the petroleum industry. Finds support for evolutionary theory. | E |
| 1996 | Harhoff | Strategic spillovers and incentives for research and development | Develops a model in which a monopolistic supplier can contribute to downstream product improvements by creating knowledge spillovers which downstream firms use as a substitute for their own R and D efforts. | T |

**Technology Strategy – *Economic Studies***

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| 1977 | Teece | Time-cost tradeoffs: Elasticity estimates and determinants for international technology transfer projects | Used data on projects to establish US manufacturing operations overseas to show that costs were higher when technology had not been commercialized before, when projects were larger and when larger organizations undertook the projects | E |
| 1984 | Lee | On reswitching and convergence properties of research and development rivalries | Provides a formal model which shows that a technological leader will stop doing R&D until a competitor begins to catch up so the follower will be the only party engaging in R&D | T |
| 1986 | Mansfield | Patents and innovation: An empirical study | Used data from a sample of manufacturing firms to show cross-industry variation in the willingness is innovation and the use of patents is a function of patent strength | E |
| 1987 | Park | Dynamic patent races with risky choices | Provides a formal model of R&D strategies in which innovators invest more than followers but followers choose riskier strategies | T |
| 1990 | Graboski and Vernon | A new look at the returns and risks to pharmaceutical R&D | Examined the financial returns to research and development investments in a sample of drugs and found that the returns were equal to the cost of capital in the industry but that the returns were skewed | E |
| 1991 | Conner and Rumelt | Software piracy: An analysis of protection strategies | Provided a formal model to show that not deterring piracy is the best strategy when there are network externalities because piracy increases the user base | T |
| 1991 | Sinha and Cusumano | Complementary resources and cooperative research | Model of joint ventures. Key variable is complementarity of skills and resources. | T |
| 1992 | Erickson and Jacobson | Gaining comparative advantage through discretionary expenditures: The returns to R&D and advertising | Used Compustat data to show that R&D and advertising did not generate long term competitive advantage or high returns to R&D once firm specific factors and feedback effects had been captured | E |
| 1992 | Moorthy and Png | Market segmentation, cannibalization and the timing of product introductions | Provided a formal model of new product introductions which showed that sequential introduction is best if customers are impatient and cannibalization would occur unless the seller cannot commit to future price or quality | T |
| 1993 | Roller and Tombak | Competition and investment in flexible technologies | Provided an formal model and empirical test to show that flexible manufacturing is more likely to be adopted in more concentrated markets, and is more likely to be continued larger and more differentiated markets | T<br>E |
| 1994 | Cohen and Levinthal | Fortune favors the prepared firm | Provided a formal model to show that a firm which has invested in absorptive capacity is more likely to bring in outside knowledge and to predict technical advance in the firm | T |
| 1997 | Khanna and Iansiti | Firm asymmetries and sequential R&D: Theory and evidence from the mainframe computer industry | Provided a formal model and empirical test to show that firms with greater market share and more resources have more aggressive targets for investment stages when R&D is staged and strategic considerations matter | T<br>E |

**Technology Strategy – *Behavioral Studies***

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| 1983 | Hambrick et al | Business unit strategy and changes in the product R&D budget | Used the PIMS database to show that for growing businesses, R&D intensity was affected by strategy, competitors and budgetary flows within the organization, but that for mature businesses R&D intensity is stable | E |
| 1984 | Thietart and Vivas | An empirical investigation of success strategies for businesses along the product life cycle | Used the PIMS database to show that the most effective strategy for firms to achieve market share and cash flow depends on the time horizon of firm goals, the stage of the product life cycle and the industry environment | E |
| 1985 | Kim and Kim | Innovation in a newly industrializing country: A multiple discriminant analysis | Examined innovative firms in Korea to show that those initiated by local benefit more from close interaction with local customers and those initiated by innovators benefit more from interaction with foreign suppliers | E |
| 1986 | Miller and Toulouse | Chief executive personality and corporate strategy and structure in small firms. | Used a sample of small firms to show that CEO flexibility, need for achievement, and locus of control influenced firm strategy. | E |
| 1987 | Horwitch and Thietart | The effect of business interdependencies on product R&D-intensive business performance | Used the PIMS database to show that market share and return on investment depends on the nature of the business and the environment, strategic objectives, and number of markets in which firm is found | E |

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| 1989 | Pavitt et al | Technological accumulation, diversification and organization in UK companies, 1945-1983 | Used data on UK companies to show that in science-based companies, technological opportunities come from users and related markets, but in scale intensive industries come from upstream suppliers | E |
| 1990 | Robinson | Product innovation and startup business market share performance | Examined a sample of large firms and showed that superiority over competitive products was the most important factor affecting market share and compatibility with customer preferences did not matter | E |
| 1991 | Zajac et al, | New organization forms for enhancing innovation: the case of internal corporate joint ventures | Used data hospitals- physician joint ventures to show that innovation outcomes ere better if organization members are close in age, the parent organization is positively disposed and activities are linked to sponsor | E |
| 1992 | Brockhoff | R&D cooperation between firms – A perceived transaction cost perspective | Showed that perceptions of high transaction costs, which occur when technology is new, firms have limited cooperative experience, and firms use formal contracts to govern relationships, lower perceived success | E |
| 1992 | Capon et al | Profiles of product innovators among large U.S. manufacturers | Examined a sample of Fortune 500 firms to show that effective strategy, structure and environmental fit explain both innovation and firm performance | E |
| 1992 | Auster | The relationship of industry evolution to patterns of technological linkages, joint ventures, and direct investment between the US and Japan | Examined the investments of Japanese companies in the US and showed that Japanese firms tend to create technological investments in new industries, create joint ventures in rapidly growing industries, and make direct investments in older industries | E |
| 1996 | McGrath et al | Innovation, competitive advantage and rent: A model and test | Showed four necessary conditions to appropriate the returns to innovation: a capable team, the creation and exploitation of new capabilities, the establishment of competitive advantage, and causal understanding | E |
| 1997 | Lefebvre et al | Technology policy and its organizational impacts | Used data on CEOs of small metal manufacturers in Quebec to show that CEO perceptions of the environment influenced the effect of technology strategy on innovative outcomes | E |
| 1998 | Christianse n et al | Strategies for survival in fast changing industries | Examined the survival of firms in the computer disk drive industry and showed that a strategy of targeting new market segments with architectural innovations is survival enhancing | E |
| 1999 | Silverman | Technological resources and the direction of corporate diversification | Showed that the resource base of an organization affects the choices of industries into which firms diversify and that there are conditions under which firms can use contracting to exploit specific resources | E |
| 2001 | Randall and Ulrich | Product variety, supply chain structure and firm performance: the U.S. bicycle industry. | Used historical data on the American bicycle industry to show that there is an optimal match between the structure of a firm's supply chain and its product offerings | E |
| 2002 | Zucker et al | Commercializing knowledge: University science, knowledge capture, and firm performance in biotechnology | Examined US biotechnology firms and showed that firms with more articles coauthored with start scientists perform better at generating new products, new patents and employment | E |
| 2003 | Nerkar | Old is gold? The value of temporal exploration in the creation of new knowledge | Used data on pharmaceutical firms over time to show that previously developed knowledge is an important component in the creation of new knowledge in firms | E |
| **Technology Strategy – *Strategy Process*** | | | | |
| 1983 | Burgelman | Corporate entrepreneurship and strategic management: Insights from a process study | Provided a conceptual model of the process of internal corporate venturing in large organizations that shows that success requires diversity of activities, top management direction setting, and correct organization structure | C |
| 1988 | Bourgeois and Eisenhardt | Strategic decision processes in high velocity environments: Four cases in the microcomputer industry | Offered detailed case studies of four computer firms to show how executives made decisions in industries that face a high rate of technological change. | Q<br>E |
| 1989 | Weiss and Birnbaum | Technological infrastructure and the implementation of technological strategies | Provided an essay explaining how firms implement technology strategy, arguing that successful implementation requires an understanding of both the external environment and firm capability | C |
| 2000 | Iansiti | How the incumbent can win: Managing technological | Used quantitative and qualitative data from the semiconductor industry to show that research experience is central to performance at revolutionary | E |

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| | | transitions in the semiconductor industry | projects and project experience is central to performance at evolutionary projects | |
| 2003 | Lee | Innovation and strategic divergence: An empirical study of the U.S. pharmaceutical industry from 1920 to 1960. | Looked at the history of the U.S. pharmaceutical industry and showed that the choices made about antibiotics in the 1940s led to the creation of two groups of firms – innovators and imitators | E |
| **Knowledge Transfer –*Learning*** | | | | |
| 1968 | Barr and Knight | Technological change and learning in the computer industry | Examined the rate of change in the computer industry and found evidence of firm and industry learning and the inappopriability of knowledge developed from firm level learning | E |
| 1980 | Gerstenfeld and Berger | An analysis of utilization differences for scientific and technical information | Used a survey of technical employees at several large companies top examine individual level learning | E |
| 1990 | Adler | Shared learning | Used a field study of an electronics firm to show that the manufacturing learning curve depends on shared learning across manufacturing and R&D and between older and newer plants on a continuous basis | E |
| 1991 | Adler and Clark | Behind the learning curve: A sketch of the learning process | Examined the effect of cumulative learning, training, and changes in engineering on changes in productivity at two departments of an electronics company | E |
| 1998 | Hatch and Mowery | Process innovation and learning by doing in semiconductor manufacturing | Examined learning by doing and found that dedicated facilities, the proximity of manufacturing and development and joint equipment improved semiconductor process yields. | E |
| 2003 | Schilling et al | Learning by doing something: Variation, relatedness and the learning curve | Examine whether organizational learning is enhanced by specialization and found that the same level of learning was achieved through unrelated variation as through specialization | E |
| **Knowledge Transfer – *Knowledge Spillovers and Technology Transfer*** | | | | |
| 1999 | Almeida and Kogut | Localization of knowledge and the mobility of engineers in regional networks | Examined the movement of engineers and found that knowledge spillovers across regions because of the degree of movement of engineers across firms in different locales. | E |
| 2000 | Morrison et al | Determinants of user innovation and innovation sharing in a local market | Examined a sample of Australian libraries to show that users with in house technical capability were more likely to modify innovations and that users share information if they belong to a user group, do not think their firms needs are unique and think the modification has commercial value | E |
| 2002 | Agrawal and Henderson | Putting patents in context Exploring knowledge transfer from MIT | Explored knowledge transfer from two MIT departments and found that publications are a different transfer mechanism from patents | E |
| 2002 | Colvyas et al | How do university inventions get into practice | Examined 11 case studies of university inventions to understand the importance of intellectual property rights in ensuring that the inventions were commercialized | E |
| 2003 | Song et al | Learning by hiring: When is mobility more likely to facilitate interfirm knowledge transfer | Examined the effect of hiring on knowledge transfer and found that transfer is greater if new employees have more distant knowledge, work on non-core areas of employer and if employer is less path dependent. | E |
| 2003 | Sine et al | Halo effect and technology licensing | Empirical study of technology transfer from universities, with institutional prestige and explanatory variable. | E |
| 2003 | Gittleman and Kogut | Does good science lead to valuable knowledge? Biotechnology firms and the evolutionary logic of citation patterns | Used data on publications and patents of a sample of biotechnology firms to show that important papers are negatively related to high impact innovations, suggesting that the selection processes are different for the two research outputs. | E |
| **Product Planning and Portfolios** | | | | |
| 1967 | Hartmann and Moglewer | Allocation of Resources to Research Proposals | Presents a game-theoretic model for allocation of company resources to research proposals focusing on the uncertainties of contract funding and their effect on company policy. | T |

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| 1967 | Petersen | Computational experience of the Balas Algorithm applied to the selection of R&D projects | Formulates the resource allocation to R and D projects problem as an integer programming problem. Accommodates R and D projects extending over several budget periods and carryover of unspent funds. | T |
| 1969 | Moore and Baker | Computational Analysis of Scoring Models for R and D Project Selection | Evaluates the performance of Scoring models for R and D project selection. Finds that performance of scoring models is highly sensitive to modeling decisions and parameters. | T |
| 1972 | Lockett and Gear | Programme selection in research and development | Discusses the difficulties associated with the application of mathematical programming problems as an aid to R and D project portfolio selection. Describes procedures for handling these problems. | C |
| 1973 | Pyle et al | Scientific Manpower Allocation to New Drug Screening Programs | Develops a dynamic programming based model to assist R and D management in the crucial task of allocating manpower resources to a set of competing pharmaceutical research programs. | T |
| 1973 | Souder | Analytical Effectiveness of Mathematical Models for R&D Project Selection | Evaluates the performance of mathematical programming models for R and D project selection and funding by benchmarking the results with an ex-pots optimum allocation. | T |
| 1973 | Souder | Utility and Perceived Acceptability of R & D Project Selection Models | Assesses the analytical utility and managerial acceptability of three expected value maximizing project selection models within five different R and D organizations. | T |
| 1974 | Maher and Rubenstein | Factors Affecting Adoption of a Quantitative Method for R&D Project Selection | Reports on the results of an attempt to develop, test, and evaluate systematically; an R and D project selection technique - the modified risk analysis technique; in an operating R and D organization. | Q |
| 1975 | Souder | Achieving Organizational Consensus with Respect to R&D Project Selection Criteria | Reports the results of the use of the Impact method for achieving organizational consensus in R and D project selection criteria in four different organizations. The method involves repeated paired comparisons. | Q |
| 1975 | Aldrich and Morton | Optimal funding paths for a class of risky R&D projects | Extends the optimal control problem of financing risky R and D projects over time to allow the possibility for time-dependent returns. Demonstrates convergence to a unique, autonomous solution for optimal spending rate. | T |
| 1975 | Baker and Freeland | Recent Advances in R and D Benefit Measurement and Project Selection Methods | Provides an assessment of the literature addressed to quantitative models of R and D project selection and resource allocation decisions. Divides literature into benefit measurement and resource allocation methods. | C |
| 1975 | Robinson and Lakhani | Dynamic Price Models for New-Product Planning | Establishes that dynamic pricing models are more appropriate for pricing in rapidly evolving businesses. Experience curve phenomenon and market-penetration models are used to illustrate the nature of dynamic feedback. | T |
| 1976 | Baker et al. | A Budget Allocation Model for Large Hierarchical R&D Organizations | Develops a model which allocates an available budget to research alternatives subject to budgetary constraints on both organizational and technical entities. The solution is based on a network flow algorithm. | T |
| 1977 | Moore and Taylor | Multiteam, multiproject research and development planning with Gert | Presents a simulation study of multiple R and D projects that are worked on concurrently and sequentially by more than one research team. The GERT (Graphical Evaluation and Review Technique) is employed. | T |
| 1977 | Rubenstein and Schroder | Managerial Differences in Assessing Probabilities of Success for R & D Projects | Identifies three types of variables as accounting for individual differences in probability assessments. An assessor's relation to the project and rank explain individual differences in probability assessments. | E |
| 1977 | Schwartz and Vertinsky | Multi-attribute investment decisions: A study of R&D project selection | Identifies differences in tradeoffs between resources, risks and payoffs made by a cross-section of managers from different industries. Work environments and personal characteristics are found to be significant. | E |
| 1981 | Blanning | Variable base budgeting for R&D | Presents risk-return models addressing the allocation of resources between selection and implementation of R and D projects. A budget is allocated between selection which reduces risk and the budgeted activities | T |
| 1981 | Silverman | Project appraisal methodology: A multidimensional R&D benefit/cost assessment tool | Introduces a multi-dimensional, easy to use tool for assessing the relative merits of research and development projects, called Project Appraisal Methodology (PAM). | T |
| 1981 | Winkofsky Baker, Sweeney | A decision process model of R&D resource allocation in hierarchical organizations | A goal programming based model is developed for decentralized R and D resource allocation. The model represents allocation process involving a number of subunits at three hierarchical levels. | T |

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| 1982 | Taylor, Moore, and Clayton | R&D project selection and manpower allocation with integer nonlinear goal programming | Develops an integer goal program for resource allocation and project selection subject to non-linear constraints for relations between allocated resources and return; and linear constraints for budget and other resources | T |
| 1983 | Silverman | Project Appraisal Methodology: Market Penetration Elements | Describes a multiple competing technologies market penetration model which incorporates multiple attributes rather than strictly price into the market share allocation function. | T |
| 1984 | Fox, Baker, and Bryant | Economic models for R&D project selection in the presence of project interactions | A present value interactions approach is presented for economic selection of R and D projects. An approach for assessing these present value interactions is presented. | T |
| 1985 | Bard | Parallel funding of R&D tasks with probabilistic outcomes | The problem of funding redundant R and D tasks across several stages or components of a project is formulated as a probabilistic network and solved by means of a heuristic comprising simulation and dynamic programming. | T |
| 1985 | Fox, Baker, Norman | Project Selection Decision Making Linked to a Dynamic Environment | Simulation model that attempts to include simplified market and production characteristics of a hypothetical firm and a specific project selection decision mechanism is constructed. | T |
| 1985 | Mandakovic and Souder | An Interactive Decomposable Heuristic for Project Selection | Reviews decomposable systems, decomposition and 0-1 integer programming techniques relative to selection problems. A heuristic procedure is a suitable way to handle such problems. | T |
| 1986 | Kalish and Lilien | A market entry timing model for new technologies | Develops a market diffusion model that incorporates negative word-of-mouth associated with failure resulting from premature introduction, to advise optimal timing/entry decision | T |
| 1987 | Lippman and McCardle | Does cheaper, faster or better imply sooner in the timing of innovation decisions | Finds that innovation decisions are made; later when information is cheaper, and earlier when information is more accurate. With faster arrival of information, the change in timing of information does not matter. | T |
| 1991 | Granot and Zucker | Optimal sequencing and resource allocation in research and development projects | Constructs a suitable R and D model to facilitate the analysis of activity sequencing and resource allocation in R and D projects. The technological specifications and the stopping time are endogenized. | T |
| 1991 | Oral, Kettani, Lang | A Methodology for Collective Evaluation and Selection of Industrial R&D Projects | Proposes a methodology for evaluating and selecting R&D projects in a collective decision setting, especially useful at sectoral and national levels. | T |
| 1993 | Ali, Kalwani, Kovenock | Selecting product development projects: Pioneering versus incremental innovation strategies | Investigates project selection of duopolists facing a choice between developing a highly innovative product or an incremental innovation. Effects of differential efficiencies and degree of substitutability are investigated. | T |
| 1996 | Bhoovaragh avan, Vasudevan, Chandran | Resolving the Process vs. Product Innovation Dilemma | Proposes a consumer based approach to distinguish between process and product innovation. Argues need for integrated process and product innovation to meet consumer wants. | T |
| 1996 | Schmidt | A Stochastic Optimization Model to Improve Production Planning and R&D Resource Allocation | Presents a Markov decision process model that links biological and engineering parameters to optimize operations performance and R and D resource allocation. | T |
| 2002 | Ding and Eliashberg | Structuring the new product development pipeline | Presents a normative model for structuring the new product development pipelines so as to choose the optimal number of approaches to be funded at each stage. | T |
| **Development Process Management** | | | | |
| 1969 | Abernathy and Rosenbloom | Parallel Strategies in Development Projects | Addresses a project manager's problem of deciding when to use or continue a parallel strategy. Identifies the informational requirements for a sound choice between parallel and sequential strategies. | C |
| 1971 | Lucas | Optimal Management of A Research and Development Project | Develops a model to aid in evaluation and control of an individual R and D project, with stochastic costs per unit time and an uncertain time to completion. | T |
| 1973 | Lockett and Gear | Representation and analysis of multi-stage problems in R&D | Describes a method of representing and analyzing the multi-stage dynamic nature of R and D projects using decision trees, mathematical programming and simulation in combination. | T |

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| 1980 | Taylor and Moore | R & D Project Planning with Q-Gert Network Modeling and Simulation | A simulation study of two cases of R&D planning. The first case is for a series of projects analyzed sequentially by a single team; the second is for a series of projects analyzed sequentially and concurrently by two teams. | T |
| 1989 | Clark | Project Scope and Project Performance – Parts Strategy and Product Development | Using data from the product development in the auto industry, presents evidence on the impact of project scope on lead time and engineering productivity. | E |
| 1990 | Zirger and Maidique | A Model of New Product Development – An Empirical Test | An empirical test of a product development model in the electronics industry. Various factors internal and external to the organization are identified as determinants of product success. | E |
| 1990 | Cusumano and Kemerer | A Quantitative Analysis of U.S. and Japanese Software Development | A comparative analysis of software development in the United States and Japan. Analyses indicate that Japanese software development project performs at least as well as their US counterparts. | E |
| 1992 | Griffin and Hauser | Patterns of Communication among Marketing, Engineering and Manufacturing | Examines communication patterns for two matched product development teams where the key difference is that one used a phase-review development process and the other used quality function deployment. | Q |
| 1992 | Whang | Contracting for Software Development | Develops a game-theoretic model for incentive and information issues associated with software contracting. Constructs a contract that aligns incentives and produces the same outcome as in-house development. | T |
| 1995 | Adler et al. | From project to process management: A framework for analyzing development time | Develops an empirical framework for analyzing development time where organizations must manage concurrent projects that place competing demands on shared human and technical resources. | C |
| 1995 | Ettlie | Product-Process Development Integration in Manufacturing | A survey based study of success in new product launches that finds significant correlation between the extent to product design and process design are integrated in new program launches. | E |
| 1995 | Ha and Porteus | Optimal Timing of Reviews in Concurrent Design for Manufacturability | Derives an optimal review policy when a concurrent design for manufacturability approach is followed. Policy is based on the trade-off between review costs and; quality control and development time concerns. | T |
| 1996 | Cohen, Eliashberg, and Ho | New product development: The performance and time-to-market tradeoff | Develops a multi-stage model of new product development that captures the trade-off between the conflicting goals of reducing product development time and improving product performance. | T |
| 1997 | Smith and Eppinger | Identifying the controlling features of engineering design iteration | Extends the design structure matrix used in identifying iterations in development problems with coupled problems. The “work transformation matrix” is proposed which identifies the most demanding coupled tasks. | T |
| 1997 | Datar et al. | New Product Development Structures and Time-to-Market | Analyzes new product development by three international manufacturers that dominate a segment of the electronic component industry. The objective is to examine two distinct strategies and structures. | E |
| 1997 | Krishnan, Eppinger, Whitney | A Model-Based Framework to Overlap Product Development Activities | Presents a model that identifies condition under which various types of overlapping activities are appropriate for a pair of coupled activities. Illustrations from industrial applications are provided. | T |
| 1998 | Thomke | Managing experimentation in the design of new products | A study of the differences in experimentation strategies. Shows that users may find it optimal to conduct an experiment in different modes. | T |
| 1998 | Von Hippel | Economics of product development by users: The impact of "sticky" information | Argues that agency costs and information transfer costs favor problem solving by those who directly benefit from the solution and have difficult to transfer local information . | T |
| 1998 | Hauser | Research, Development, and Engineering Metrics | Seeks to understand how the use of Research, Development, and Engineering (R,D&E) metrics can lead to more effective management of R,D&E. | T |
| 1999 | Terwiesch and Loch | Measuring the effectiveness of overlapping development activities | Statistically measures the effectiveness of overlapping development activities in reducing project completion time. This effectiveness differs with the organizations capability to resolve uncertainty early in the process. | E |
| 1999 | Bollen | Real Options and Product Life Cycles | Develops an option valuation framework that explicitly incorporates a product life cycle. Uses the framework to value the real option to change a project's capacity. | T |

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| 2000 | Harter and Slaughter | Effects of process maturity on quality, cycle time, and effort in software product development | Empirically investigates the relationship between process maturity, quality, cycle time, and effort for the development of software products. Finds that higher levels of process maturity accompany higher quality and effort. | E |
| 2001 | Tatikonda and Montoya-Weiss | Integration operations and marketing perspectives of product innovation | Empirical study of factors leading to product development performance in 120 projects. | E |
| 2000 | Atuahene-Gima and Evangelista | Cross functional influence in new product development | Examines the effects of the marketing and R and D functions' influence and participation on new product performance. Finds that self –reported influence and that reported by the other plays an important role. | E |
| 2001 | Maccormac k, Verganti, and Iansiti | Developing products on Internet time: The anatomy of a flexible product development process | Adaptive development processes required for dynamic environments. Empirical study of internet software development projects. | E |
| 2001 | Thomke and Bell | Sequential testing in product development | Develops a model that treats testing as an activity that generates information about technical and customer need related problems. Finds a closed form for the optimal testing frequency. | T |
| 2001 | Joglekar et al. | Performance of coupled product development activities with a deadline | Proposes the performance generation model to develop insights about optimal strategies to manage coupled design activities that share a fixed amount of resources; subject to performance and deadline constraints. | T |
| 2001 | Krishnan and Ulrich | Product development decisions: A review of the literature | A broad review of product development literature encompassing work in the fields of marketing, operations management, and engineering design. Conveys the shape of the entire research landscape. | C |
| 2001 | Natter et al. | The effect of incentive schemes and organizational arrangements on product development process | Studies the impact of incentive schemes on the new product development process for different types of organizations. Sequential organizations are compared to different types of team-based organizations. | T |
| 2002 | Von Hippel, and Katz | Shifting innovation to users via toolkits | Documents the Toolkit approach, where manufacturers abandon the attempts to understand user needs in favor of transferring need-related aspects to users. | C |
| 2002 | Gerwin and Barrowman | An evaluation of research on integrated product development | Critiques and provide recommendations for problems in the Integrated product development literature. Charts an agenda for future research in the area. | C |
| **Product Design** | | | | |
| 1987 | Kohli and Krishnamurti | A heuristic approach to product design | A dynamic programming heuristic is described to find approximate solutions to the problem of identifying a new, multi-attribute product profile associated with highest share of choices in a competitive market. | T |
| 1993 | Ulrich et al. | Including the Value of Time in Design-for-Manufacturing Decision Making | Presents an economic model that makes explicit the trade-off between lower unit costs and longer product development time. This model is applied in a field study of the application of DFM to Polaroid cameras. | E |
| 1995 | Liberatore, Stylianou | Expert Support Systems for New Product Development Decision Making | Presents a modeling framework that merges knowledge-based expert systems and decision support systems with management science methods for project evaluation. | T |
| 1996 | Balakrishnan and Jacob | Genetic algorithms for product design | The research proposes the use of and evaluates the performance of genetic algorithms as a procedure for generating close to optimal solutions to the product design using conjoint analysis problem. | T |
| 1998 | Ulrich and Pearson | Assessing the importance of design through product archeology | Asses the importance of design in determining product costs by measuring the variation in design performance among a set of competing design efforts for a set of functionally similar products in a single product category. | E |
| 1999 | Fisher, Ramdas, Ulrich | Component Sharing in the Management of Product Variety | Analytical model and empirical study of brake rotor sharing in the automobile industry. | E |
| 1999 | Ulrich and Ellison | Holistic customer requirements and the design-select decision | Develops a theory for the trade-off between designing components unique to a new product application and using existing off the shelf components. The theory is tested in a cross sectional analysis of 225 products. | E |

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| 2001 | Chen | Design for the Environment: A quality-based model for green product development | Develop a quality based model for analyzing the strategic and policy issues concerning the development of products with conflicting traditional and environmental attributes. | T |
| 2001 | Krishnan and Gupta | Appropriateness and Impact of Platform-based product development | Uses an industrial example to illustrate the costs and benefits of platform-based product development. Shows that platform based development is inappropriate for high market diversity and low scale economies. | T |
| 2001 | Desai et al. | Product differentiation and commonality in design: Balancing revenue and cost drivers | Examines the trade-off in using design configurations with commonality which lower the manufacturing cost, but hinder the ability to extract price premiums through product differentiation. | T |
| 2002 | Gjerde, Slotnick, and Sobel | New product innovation with multiple features and technology constraints | Develops a model that advises a firm's decision to innovate to the technology frontier as a function of the internal and external environment in which a firm operates. | T |
| 2002 | Kim and Chhajed | Product Design with multiple quality-type attributes | Attribute-based model of product design. Analytical results based on differentiation, cannibalization. | T |
| Concept Development | | | | |
| 1974 | Shocker and Srinivasan | Consumer-Based Methodology for Identification of New Product Ideas | Suggests a procedure which analytically ties a model to predict users' predispositions to purchase different brands in a product market together with a search process to identify optimal new product ideas. | T |
| 1979 | Dillon, Calantone, Worthing | The new product problem: An approach for investigating product failures | Applies a variable selection procedure based on discrete data components to the new product selection problem. The applied method compares favorably with the linear discriminate approach. | T |
| 1986 | Von Hippel | Lead Users: A Source of Novel Product Concepts | Explores how lead users can be systematically identified, and how lead user perceptions and preferences can be incorporated into industrial and consumer marketing research analyses. | C |
| 1988 | Urban and Von Hippel | Lead user analyses for the development of new industrial products | Documents a test of the lead user methodology. New concepts generated on the basis of lead user data are found to be strongly preferred by a sample of users. | E |
| 1997 | Burchill and Fine | Time versus Market Orientation in Product Concept Development | Develops a normative model of the product concept decision process, supported with tools and techniques, and codified as a decision support process for product development teams. | Q |
| 1998 | Bhattacharya, Krishnan, and Mahajan | Managing New Product Definition in Highly Dynamic Environments | Presents a model of real-time definition, where a firm adapts its product definition process to the market and competitive environment. Uncertainty is resolved through frequent repeated interactions with customers. | T |
| 2000 | Morrison, Roberts, Von Hippel | Determinants of User Innovation and Innovation Sharing in a Local Market | Explores the characteristics of innovation, innovators, and innovation sharing by users of information search systems. Finds distinguishing factors for users who modify and share the innovations and those who do not. | E |
| 2001 | Dahan and Mendelson | An extreme value model of concept testing | Employs extreme-value theory to investigate the trade-off between benefits and costs of parallel concept testing. Develops closed form solutions, when profits follow certain distributions. | T |
| 2001 | Goldenberg, Lehmann, Mazursky | The idea itself as predictors of new product success | Proposes a framework for early analysis of new product innovations based on the success potential embodied in the product-idea itself and the circumstance of its emergence. | E |
| 2002 | Krishnan and Bhattacharya | Technology selection and commitment in new product development | Addresses the problem of technology selection and commitment under uncertainty to advanced technologies. Argues against outright rejection of prospective technologies when pressure to differentiate is enormous. | T |
| 2002 | Lilien et al. | Performance assessment of the lead user idea-generation process | Reports on a natural experiment conducted within the 3M company on the effect of lead user idea generation process relative to more traditional methods. | E |
| **Adoption and Diffusion of Innovation** | | | | |
| 1964 | Haines | A Theory of Market Behavior after Innovation | A report on the study of innovation of consumer non-durable products. Hypotheses are built on short-run rational individual behavior and | E |

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| | | | aggregation of the same. Aggregated hypotheses are then tested with data. | |
| 1966 | Allen | Factors Influencing Market Penetration | Advises the selection of a technological business area to exploit, using a mathematical model. Model takes into account company capability, time, market competition, and the economic gain over time. | T |
| 1969 | Bass | New Product Growth for Model Consumer Durables | A growth model for timing of the initial purchase of a product is developed under an assumption relating purchase timing to the number of previous buyers. The model is motivated by imitative and innovative behavior. | E |
| 1972 | Bernhardt and Mackenzie | Some Problems in Using Diffusion Models for New Products | Analyzes some of the problems in using diffusion models to formulate marketing strategies for introducing new products. Six models which remove some of the theoretical and methodological restrictions are presented. | T |
| 1978 | Mahajan and Peterson | Innovation diffusion in a dynamic potential adopter population | Develops a single-adoption diffusion model where the potential adopter population is dynamic i.e. there is no constant ceiling. Data from two innovations are analyzed. | E |
| 1978 | Dodson and Muller | Models of new product diffusion through advertising and word of mouth | A diffusion model recognizing the interaction between adopters and non-adopters is developed. Influence of external information sources (advertising) and repeat purchasing is also incorporated. | T |
| 1979 | Ettlie and Vellenga | The adoption time period for some transportation innovations | Exploratory study of the factors influencing time lag between adoption decision and implementation. Cost, complexity of the innovation, organizational risk climate, and union reaction are key factors. | E |
| 1980 | Teece | The diffusion of an administrative innovation | Examines diffusion of the M-form (multidivisional administrative structure) in two classes of large industrial firms. A simple deterministic diffusion model from technological innovation gives commendable results. | T |
| 1980 | Heeler and Hustad | Problems in Predicting New Product Growth for Consumer Durables | A popular new product diffusion model is applied in an international setting Instability with limited data, environmental differences, and systematic under-reporting peak sales time, are identified as limitations. | E |
| 1982 | Zmud | Diffusion of Modern Software Practices – Influence of Centralization and Formalization | Examines the influence of centralization and formalization on organizational innovation. The effect of structural overlays such as the existence of a formal mechanism and experts in project teams is examined. | E |
| 1983 | Randles | On the diffusion of computer terminals in a n established engineering environment | A mathematical model to advise the rate of acquisition of computer terminals based on their adoption rate is developed. The model is applied to the aerospace division of a large company. | T |
| 1984 | Mahajan, Muller and Kerin | Introduction strategy for new products with positive and negative word of mouth | Examines a diffusion model for products where negative information plays a dominant role and discusses its implications for optimal advertising timing policy. | T |
| 1985 | Kalish | A New Product Adoption Model with Price, Advertising, and Uncertainty | Product adoption is characterized as a two step process- awareness and adoption. An epidemic model is used for awareness. Adoption is modeled for a heterogeneous risk-averse population. Optimal control is investigated. | T |
| 1985 | McCardle | Information acquisition and the adoption of new technology | A model to advise the optimal collection of information about the profitability of a new product is developed. A firm continues to collect information when the Bayesian estimate of profitability is in a specified interval. | T |
| 1986 | Dewar and Dutton | The Adoption of Radical and Incremental Innovations – an Empirical Analysis | Proposes and empirically tests different models to predict adoption of radical and incremental innovations. Finds investment in human capital to be a major facilitator of technical process innovation adoption. | E |
| 1987 | Mamer and McCardle | Uncertainty, competition, and the adoption of new technology | Models sequential gathering of information about economic value of an innovation in the presence of competition from a substitute or complementary good. Existence of Nash equilibria is established. | T |
| 1987 | Norton and Bass | A Diffusion Theory Model for Successive Generations of High-Technology Products | Deals with the dynamic sales behavior of successive generations of high-technology products. Builds on the Bass (1969) diffusion model. | E |
| 1987 | Simon and Sebastian | Diffusion and Advertising: The German Telephone Campaign | Investigates the influence of advertising on the diffusion of new telephones in West Germany. A cumulative measure of the total advertising effect is suggested and quantified. | T |
| 1988 | Jensen | Information cost and innovation adoption policies | Models the optimal acquisition policy for information about the economic value of an innovation; in a setting where both costly and costless sources | T |

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| | | | of information are available. | |
| 1989 | Davis, Bagozzi, and Warshaw | User Acceptance of Computer Technology: A Comparison of Two Theoretical Models | An empirical study of the ability to predict people's computer acceptance from a measure of their intentions. Perceptions about usefulness and ease of use have a strong effect. | E |
| 1990 | Chatterjee and Eliashberg | The innovation diffusion process in a heterogeneous population: A micro-modeling approach | An innovation diffusion model is developed based on the determinants of individual level adoption. Incorporates a population heterogeneous in initial perceptions, preference characteristics and information responsiveness. | T |
| 1990 | Nilakanta and Scamell | The Effect of Information Sources and Communication Channels on the Diffusion of Innovation | Examines the extent to which information sources facilitate the diffusion of data base design tools and techniques. Organizational resources are found to influence only certain classes of these innovations. | T |
| 1993 | Mansfield | The diffusion of flexible manufacturing systems in Japan, Europe and the United States | An empirical study on the diffusion of flexible manufacturing systems in Japan, Western Europe and the United States. | E |
| 1993 | Bayus | High-Definition Television: Assessing Demand Forecasts for a Next Generation Durable | Presents an approach that links product segmentation (on the basis of historical demand parameters, and other marketing and manufacturing variables) and demand forecasting for new products. | T |
| 1996 | Szajna | Empirical Evaluation of the Revised Technology Acceptance Model | Provides confirmatory evidence of the Technology Acceptance Model of Davis et al. (1989)—why users sometimes accept and sometimes reject information systems. | E |
| 1998 | Meade and Islam | Technological forecasting - Model selection, model stability and combining models | Identifies and categorizes models from extant literature. Analyzes forecasting performance of the models on simulated datasets. Shows that it is easier to identify a class of appropriate models rather than one model. | C |
| 1998 | Bayus | An analysis of product lifetimes in a technologically dynamic industry | Conducts statistical analyses of computer models introduced at various market levels between 1974 and 1992. Finds that technology lifetimes have not accelerated and manufacturers have not reduced life cycles. | E |
| 1999 | Loch and Huberman | A punctuated equilibrium model of technology diffusion | Presents two stable usage equilibria in a model of technology diffusion when improving old and new technologies with externalities are available. Sudden shifts between equilibria determine patterns of technology diffusion. | T |
| 2000 | Cananio, Dibble, and Amir-Atefi | The importance of organizational structure for the adoption of innovations | Develops a model of the diffusion of a profitable innovation through a firm. Uses numerical simulations to calculate the relative importance of direct and structural adjustment components of changes in profitability. | T |
| 2001 | Adner and Levinthal | Demand heterogeneity and technology evolution | Presents a demand based view of technology evolution that is focused on the interaction between technology development and the demand environment in which the technology is evaluated. | T |
| 2001 | Pisano, Bohmer, and Edmondson | Organizational differences in rates of learning: adoption of minimally invasive cardiac surgery | Proposes and tests the hypothesis that learning curves may vary across organizations engaged in the same learning task due to organizational learning effects. Data from the health care setting is used. | E |
| 2002 | Agarwal and Bayus | The market evolution and sales take off of product innovations | Explores the relationship between takeoff times, price decreases, and firm entry for a sample of consumer and product innovations. Finds that new firm entry dominates other factors in explaining observed sales take-off times. | E |
| **Public Policy – *The Effect of Innovation on Economic Growth*** | | | | |
| 1964 | Gold | Economic effects of technological innovations | Examined the economic impact of technological innovation in the US from 1899 to 1939 and found no evidence of the substitution of capital for labor that economic theory would suggest should occur from innovation | E |
| 1965 | Weiss | Some growth considerations of research and development and the national economy | Showed a positive relationship between investment in R&D and GNP growth | E |
| 1973 | Simon | Technology and environment | Provided an essay on the relationship between technology and environment which argued that technology is the solution to most societal problems | C |

**Public Policy – *Factors that Account for the Rate of Innovation***

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| 1966 | Horowitz | Some aspects of the effects of the regional distribution of scientific talent on regional economic activity | Used data on the distribution of scientific talent across US states to show that the presence of technically trained people increases the rate of innovation in that locale | E |
| 1969 | Libik | The economic assessment of research and development | Examined differences in perceptions of R&D in Eastern and Western Europe and showed the effects that these have on R&D evaluation | E |
| 1983 | Landis and Svestka | The demand for engineers – projections through 1987 | Examined rate of patenting across 7 countries in 41 industries over 20 years and found that other countries improved their rate of invention relative to the US | E |
| 1988 | Mansfield | The speed and cost of industrial innovation in Japan and the United States: External vs. internal technology | Found that Japanese firms have an advantage over US firms in innovating based on technologies sourced from outside the organization | E |
| 1988 | Glismann and Horn | Comparative invention performance of major industrial companies | Compares invention (patenting) performance of the United States, Japan and Europe. Relative decline of U.S. output explained by “catch up” by others, not government policy. | E |

**Public Policy – *Tools Used by Policy Makers***

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| 1981 | Cummings et al | Policy analyses for an infant technology: Hot dry rock geothermal resources | Illustrated the value of policy analyses to make choices about technology by looking at the case of dry rock geothermal energy. | C |
| 1981 | Oral et al | Formulating technology policy and planning industrial R&D activities | Discussed how the government of Turkey used a simulation, an industrial survey, and an R&D plan to create a national R&D policy. | C |

**Public Policy – *The Impact of Specific Government Policies***

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| 1983 | Hertzner et al | Manufacturing technology in the 1980s: A survey of federal programs and practices | Found that federal programs to create and transfer manufacturing policies to industry tend to have short term goals and are impact only a few users. | E |
| 1983 | Joklekar and Hamburg | An evaluation of federal policy instruments to stimulate basic research in industry | Provided a formal model to show that government provision of seed money and matching subsidies are ineffective in remedying the problem of suboptimal private investment in R&D. | T |
| 1984 | Mansfield and Switzer | Effects of federal support on company financed R&D: The case of energy | Showed that federal funding of R&D enhances private firm R&D. | E |
| 1988 | Wyckoff and Tornatzky | State level efforts to transfer manufacturing technology: A survey of programs and practices | Examined university-based state programs to transfer technologies and found that the programs experienced problems with the academic environment, maintaining staff, remaining technologically current and balancing needs of customers. | Q<br>E |
| 2002 | Cohen et al | Links and impacts: The influence of public research on industrial R&D | Surveyed R&D activity in US manufacturing and found that public sector research is important across a wide range of industries and is critical in a few, most notably, pharmaceuticals. | E |
| 2002 | Owen-Smith et al | A comparison of U.S. and European university-industry relations in the life sciences | Mapped the network structure of organizations conducting research in the biological sciences and showed that large pharmaceutical firms are more important in Europe than in the US. | E |
| 2002 | Mowery et al | Learning to patent: Institutional experience, learning, and the characteristics of U.S. university patents after the Bayh-Dole Act, 1981-1992 | Used university patents made by research universities to show that experience with patenting, development of technology transfer offices and relationships with the Research Corporation all fail to explain improvement in patent importance among new entrants | E |
| 2002 | Thursby and | Who is selling the ivory tower? Sources of growth in university | Estimated the total factor productivity growth in invention disclosures, patent applications and licenses across universities and showed that the increases | E |

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| | Thursby | licensing | were best explained by an increase in interest in licensing. | |
| 2002 | Feldman et al | Equity and technology transfer strategies of American research universities | Reported results from a survey of universities which showed that university experience affected licensing activity | E |
| **Entrepreneurship –*Decision Making*** | | | | |
| 1971 | Hakansson | Optimal entrepreneurial decisions in a completely stochastic environment | Formal model of entrepreneurial decision making in which the entrepreneur's preferences, return on investment, time horizon, and cost of capital influence the entrepreneur's optimal allocation of resources. | T |
| 2001 | Azoulay and Shane | Entrepreneurs, contracts, and the failure of young firms | New franchisors design their organizations on the basis of different information about efficient contracting, but that those firms designed efficiently are more likely than other firms to survive over time. | E |
| 2001 | Shane | Technological opportunities and new firm creation | More important, broader scope, and more radical inventions are more likely than other inventions to be exploited through new firm formation. | E |
| 2001 | Shane | Technology regimes and new firm formation | Age of technical field, lack of market segmentation, importance of marketing and distribution complementary assets and ineffectiveness of patents all reduce the likelihood that new firms will be formed to exploit inventions. | E |
| 2002 | Shane | Selling university technology: Patterns from MIT | When patents are effective, university inventions are more likely to be licensed. When patents are effective, those patents licensed to non-inventors are more likely to be commercialized and generate more royalties. | E |
| **Entrepreneurship –*Strategy and Performance*** | | | | |
| 1986 | Meyer and Roberts | New product strategy in small technology-based firms: A pilot study | Examined the effect of novelty in the product portfolio of 10 small firms and found that firm growth is enhanced by strategic focus and limited product novelty. | E |
| 1990 | Keeley and Roure | Management, strategy, and industry structure as influences on the success of new firms | Ventures whose founding teams have greater experience choose more favorable industries to enter and entering more favorable industries had a positive impact on performance. | E |
| 1994 | Dowling and McGee | Business and technology strategies and new venture performance | Examined the sales growth of 52 post-IPO firms in the telecommunications equipment industry and found that firms that adopted a low cost strategy and had a higher investment R&D had greater sales growth. | E |
| 1999 | Shane and Foo | New firm survival: Institutional explanations for new franchisor mortality | Used data on the failure rate of new franchise systems to demonstrate that efforts to generate legitimacy reduce the failure rate of new franchise systems below that explained by economic factors alone. | E |
| 2002 | Shane and Stuart | Organizational endowments and the performance of university start-ups | Found that new firms whose founders had direct and indirect social ties with investors in new firms prior to the establishment of their firms were more likely to receive venture capital and less likely to go out of business. | E |
| **Entrepreneurship –*Organization Design*** | | | | |
| 1987 | Roberts and Hauptman | The financing threshold effect on success and failure of biomedical and pharmaceutical start-ups | Technological expertise of the firm is correlated with the risk to adopters of its products, but receipt of financial capital mediates this risk, creating a threshold for adequate financing of these firms. | E |
| 1989 | Kazanjian and Drazin | An empirical test of a stage of growth progression model | Using a sample of 71 new computer and electronics firms, showed that new technology firms progress through four growth stages – conception, commercialization, growth, and stability. | E |
| 1989 | Khan and Manopichet wattana | Innovative and noninnovative small firms: Types and characteristics | Examined 50 manufacturing firms in Texas and found more innovative firms tended to engage in more environmental scanning and perceived the environment as more dynamic, less hostile, and more resource abundant. | E |
| 2002 | Archibald et al | Should start-up companies be cautious? Inventory policies which maximise survival probabilities | Provide a formal model to show that new firms should be more conservative in purchasing than established firms, but that too conservative a strategy is not survival enhancing. | T |
| **Entrepreneurship – *Financing*** | | | | |
| 1984 | Tyebjee and Bruno | A model of venture capitalist investment activity | Venture capital investments have five characteristics: management skills, exit potential, resistance to external threats, differentiation, and market | E |

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| | | | desirability. | |
| 1990 | Amit et al | Entepreneurial ability, venture investments, and risk sharing | If entrepreneurs differ in ability, the less able entrepreneurs will be more likely than the more able ones to seek venture capital financing because of the potential for adverse selection. | T |
| 1999 | Shepherd | Venture capitalists' assessment of new venture survival | Venture capitalists key decision criteria are, in order of importance: industry expertise, education, entry timing, degree of competition, stability of success factors, and lead time. | E |
| 2002 | Shane and Cable | Network ties, reputation, and the financing of new ventures | Using data from 202 investments and interviews with stakeholders, found that investors use social ties to gather information about entrepreneurs as a way to overcome information asymmetry in venture finance. | E |

E≡ empirical; Q≡ qualitative empirical; C≡ conceptual; T≡ theoretical model.

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