"Technology acquisition and exploitation strategies for growth and diversification in large enterprises"

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"Technology acquisition and exploitation strategies for growth and diversification in large enterprises"

The purpose of this presentation is to present technology and innovation policies and strategies at different levels:

Macro levels as background

- Global
- National

Micro levels as main focus

- Corporate
- Business
- Technology

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Macro Levels

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Some Macro Techno-Economic Trends

1. New technologies and innovations are main drivers of economic growth and development and increasingly so
2. Increasing international economic and technological interdependencies
3. Increasing globalization and convergence
4. Expansion of intellectual capitalism, much enabled by ICTs and large and small technology firms
5. Increasing scale, complexity and speed of new technologies.
6. Increasing technological diversity in nations, companies and products/services
7. Increasing supply of and demand for technologies in various technology markets
8. Increasing external technology acquisition and exploitation (leading to ’open innovation’)

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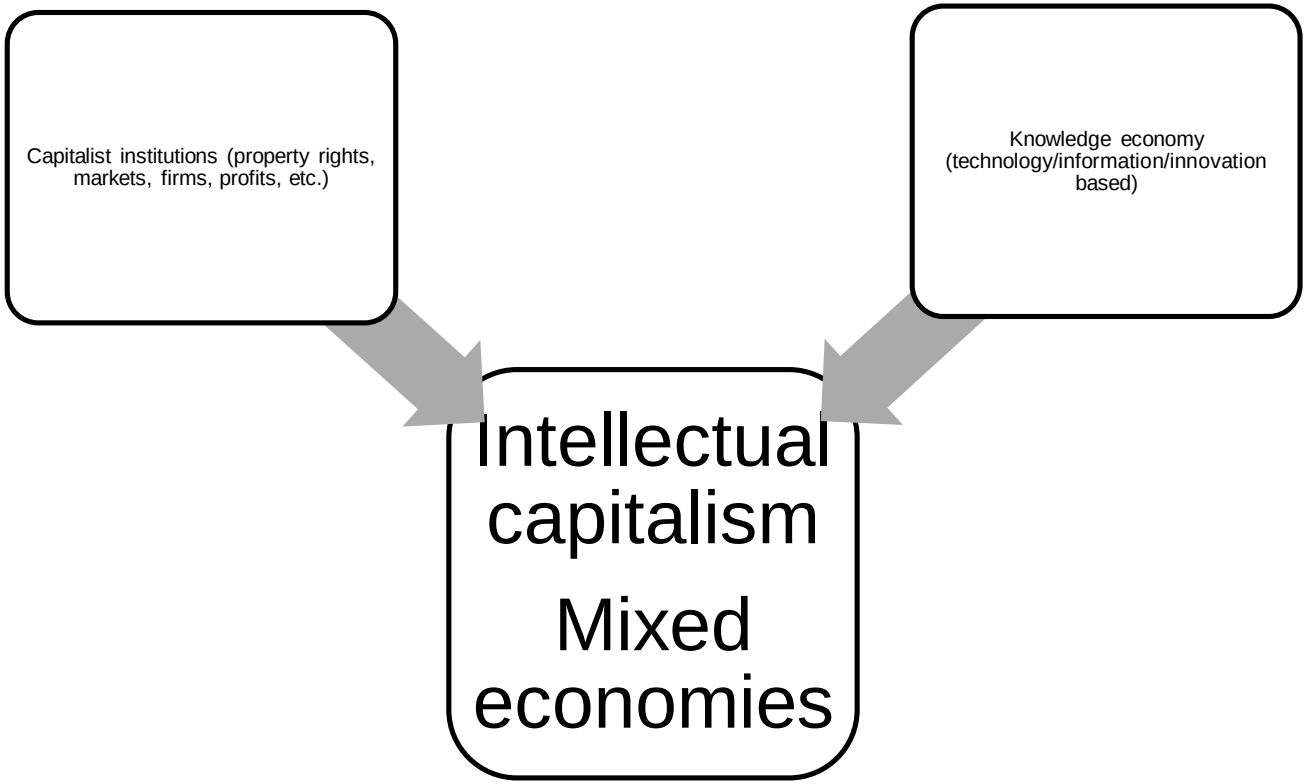
Overall convergence:



Mainly driven by ICTs and MNCs

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Nota Bene:

The pace of technological change
is slower today
than it ever will be

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Fundamental relations between innovation and economic development

The Innovation Spiral –

– Start-up knowledge…

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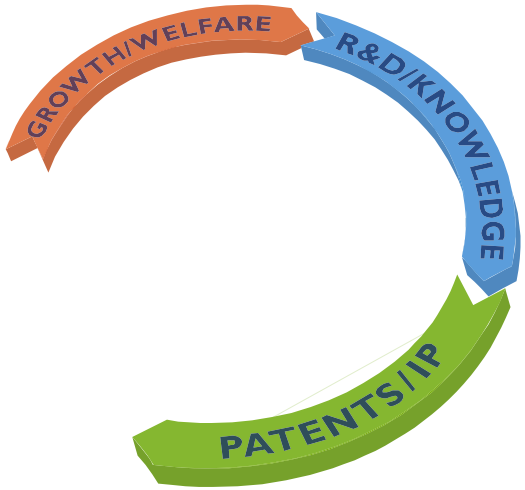
The Innovation Spiral

…creates intellectual property (IP) and is fed by resources…



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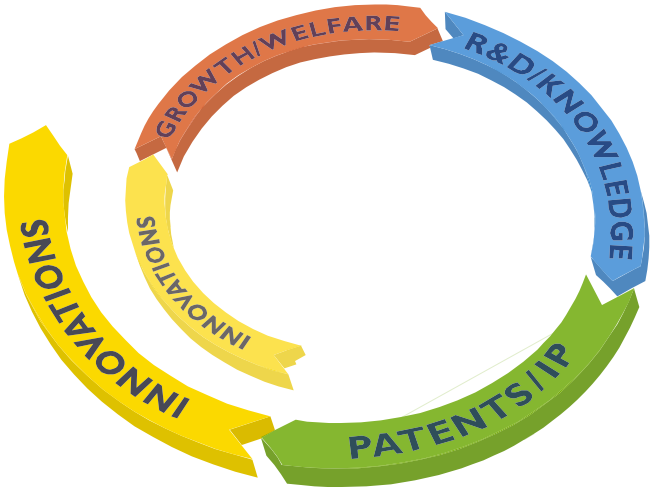
The Innovation Spiral

…fostering and fostered by innovations…



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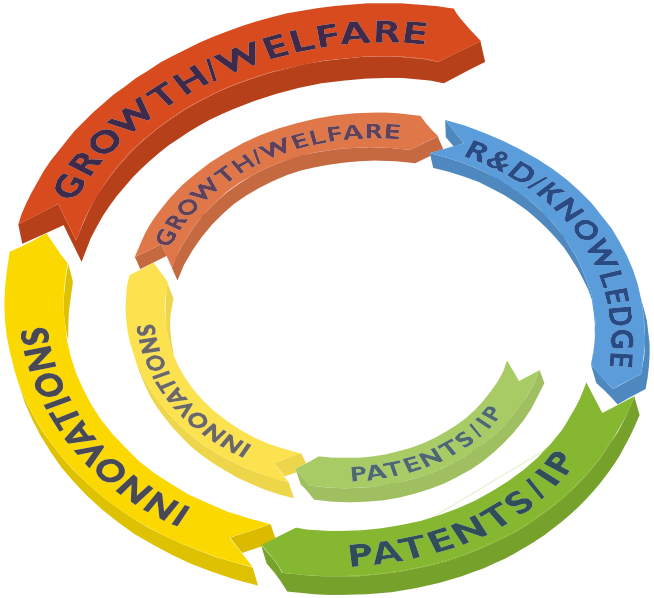
The Innovation Spiral

…fostering economic growth and welfare and fostered by patents and IP…



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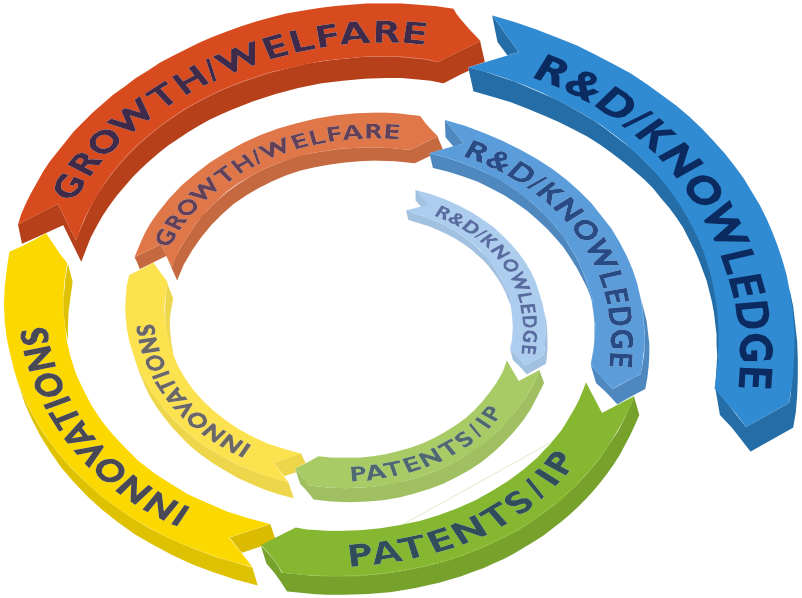
The Innovation Spiral

…feeding into more R&D and knowledge…



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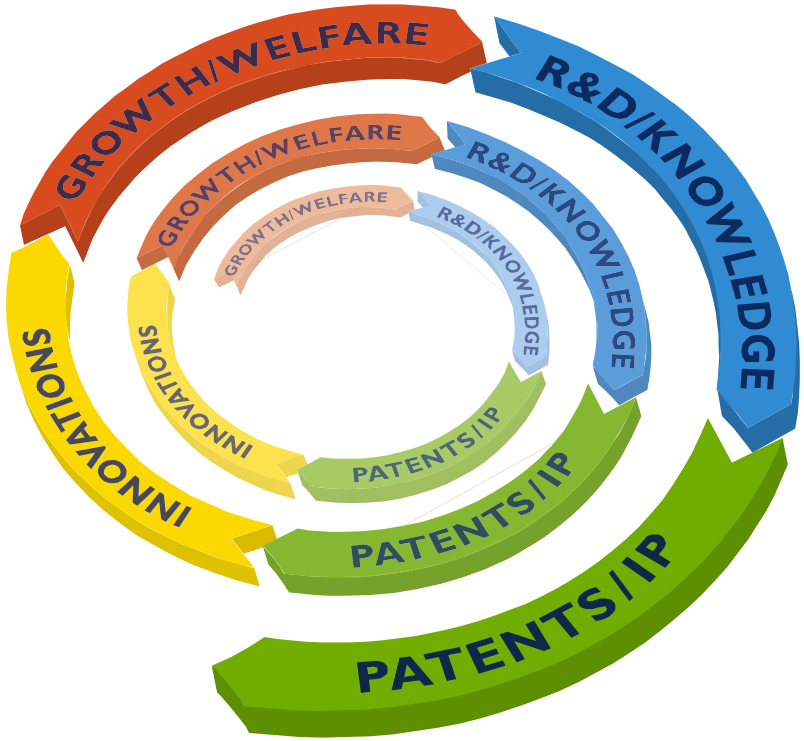
The Innovation Spiral

…etc., leading to…



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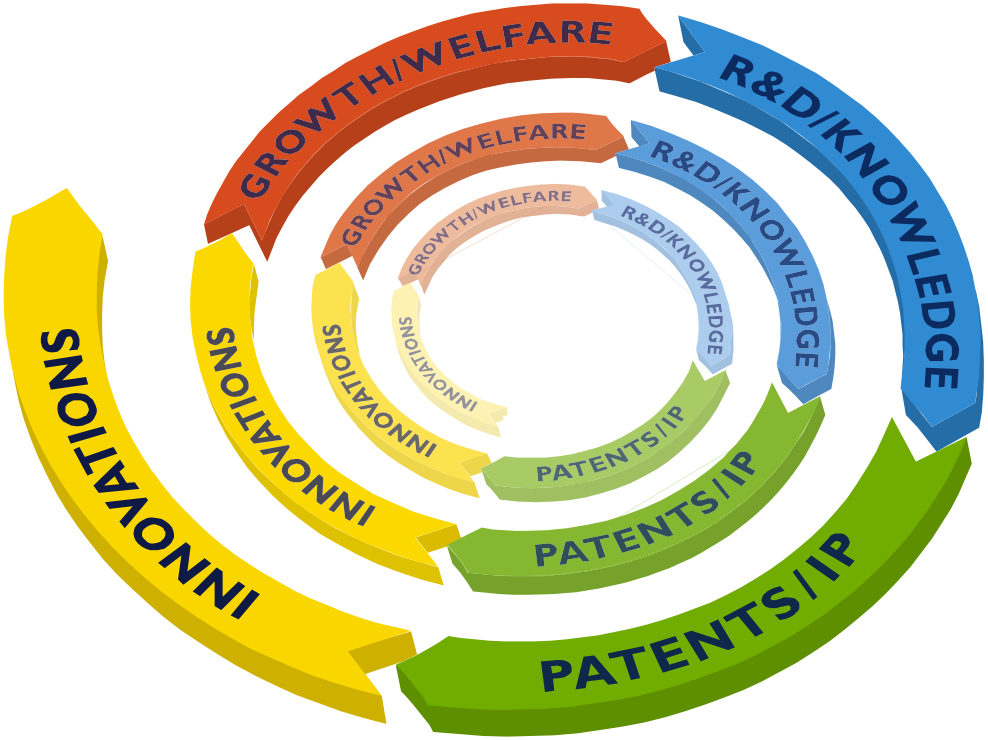
The Innovation Spiral

…a case of positive feedback



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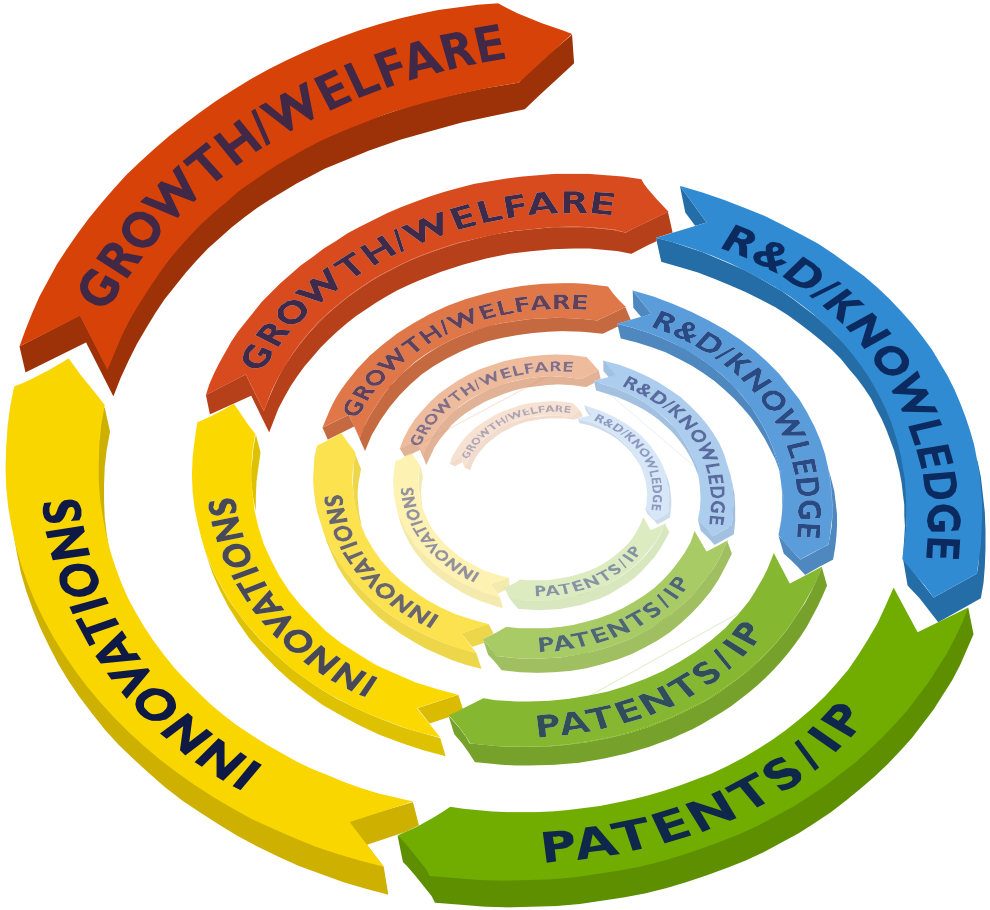
In other words

R&D and Innovations drives Growth and Welfare



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Innovation Spirals at Macro and Micro Level

Planned economy

Economic system

Market economy

Economic system

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Neither system is perfect due to

Government failures/inefficiencies

Market failures/inefficiencies

Management failures/inefficiencies

Hence, skills in innovation economics and technology management are vitally important

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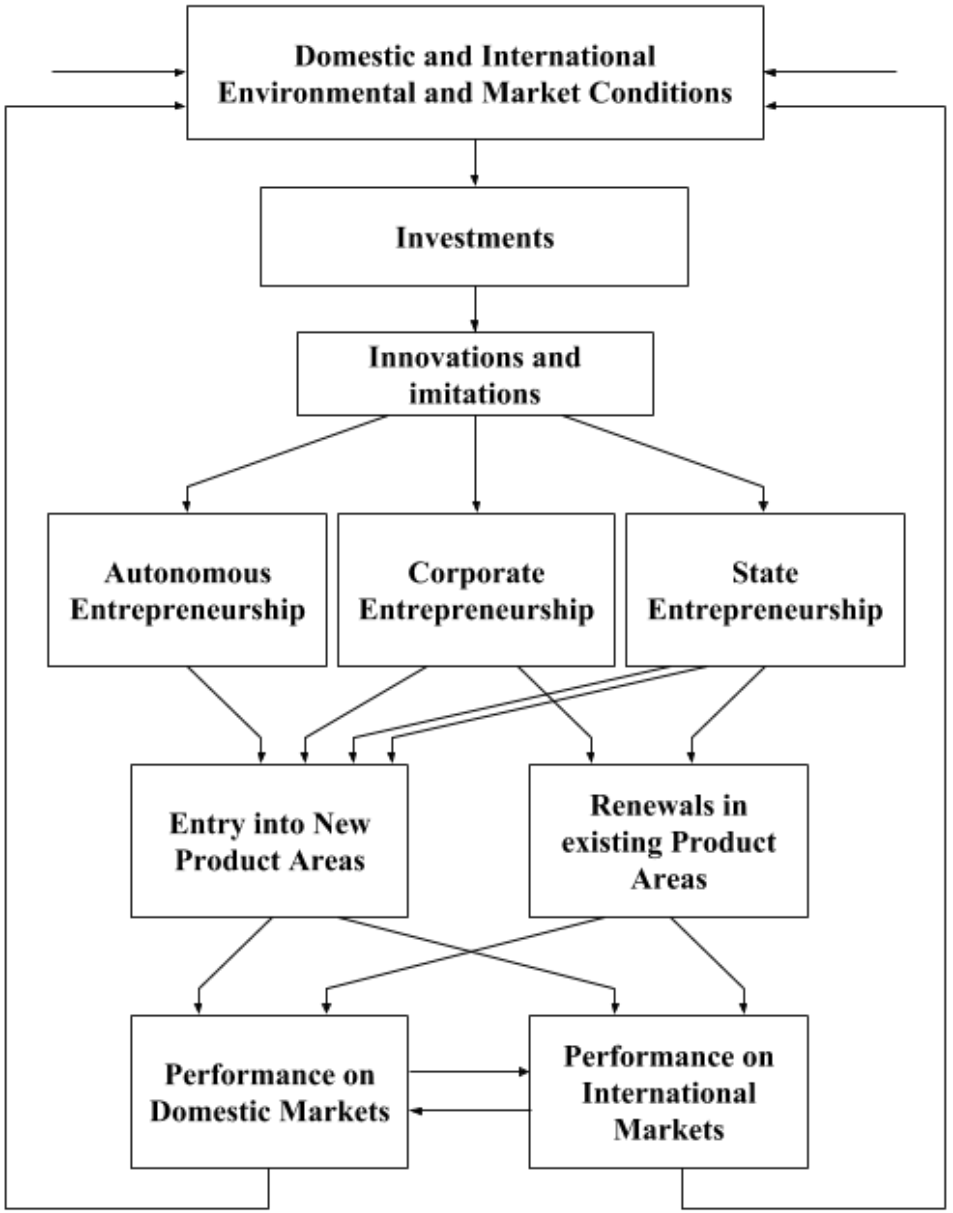
A National Innovation System Model*)



*) University entrepreneurship (private and public) is included in corporate and state entrepreneurship. Military entrepreneurship is included in state entrepreneurship

Source: Granstrand, O. and Alänge, S. (1995)

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A National Innovation System Model*)

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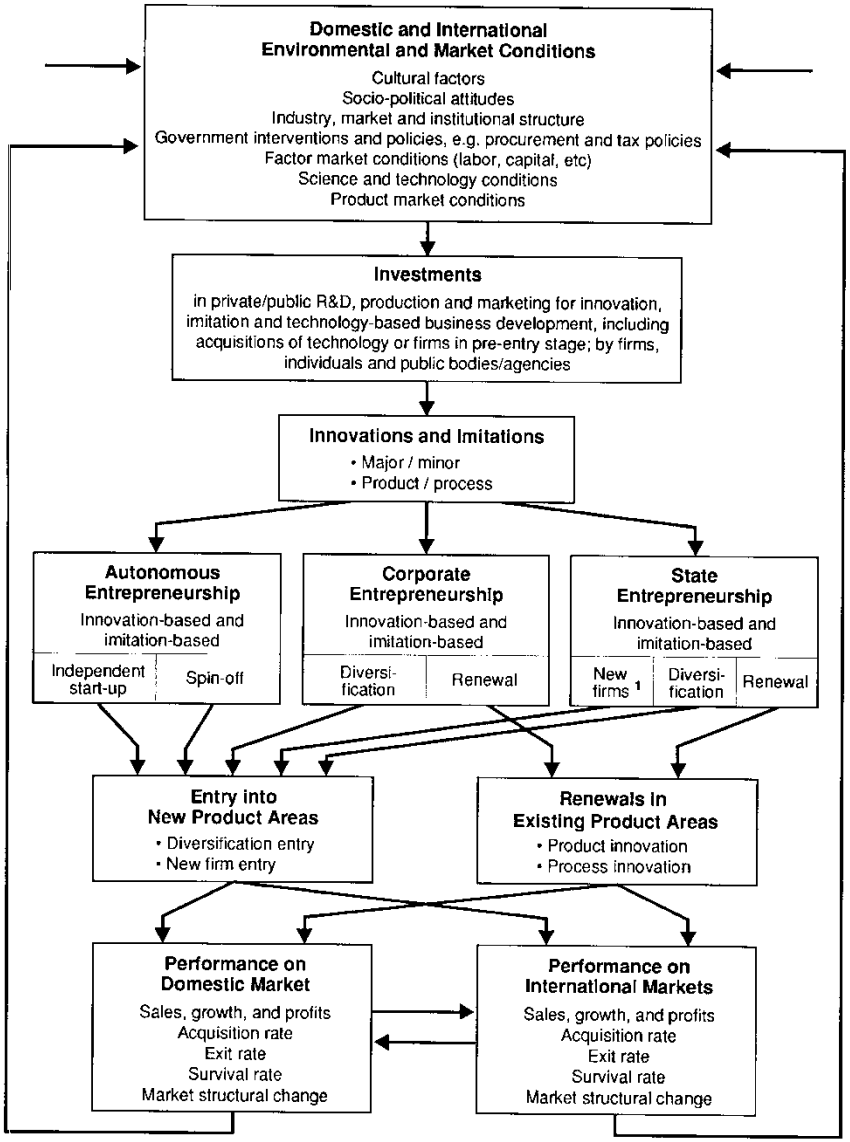

1) This category of state entrepreneurship refers to cases where the state directly performs entrepreneurial events during the early phases of a new firm start up process (e.g. by selecting product, market and technology). When the new firm reaches the stage of a going concern, an independent entrepreneur may take over full responsibility.

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R&D and Innovations for Growth and Welfare

Some general recommendations for an emerging economy:

1. Change the roles of and the interplay between state, academia and industry to adapt to a more technology based globalized economy
2. Build up a national culture for technology based business development / entrepreneurship
3. Strengthen the education system, especially for engineers, and foster their careers also in policy, management and entrepreneurship.
4. Strengthen the national innovation and entrepreneur system
5. Safeguard the national growth appropriation
6. Strengthen the regional cooperation in business development
7. Promote English as an international language in parallel with national language
8. Transform the Patent and Trademark Office (PTO) offensively towards internationalization, diversification and rationalization
9. Create an interministerial Strategy Council for technology and innovation policies at the highest political level
10. Foster the design and implementation of technology and innovation policies/strategies at macro-and micro levels

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R&D and Innovations for Growth and Welfare

Strengthen the innovation and entrepreneur system by

1. Strengthening state (public) entrepreneurship, especially within the technology-based service sector, and in particular
   - the university and college sector (university entrepreneurship)
   - the telecom and energy sector
   - the financial sector
   - the defense and security sector
   - the medical and health sector
2. Strengthening the innovation-based entrepreneurship in small and medium-sized firms (SMFs), with adaptation to the conditions for
   - SMFs outside the seats of universities and colleges
   - SMFs connected with universities and colleges
3. Strengthening the corporate innovation systems and safeguarding the large companies' will and ability to create new business areas in addition to renewing the existing ones
4. Strengthening the collaboration between innovation efforts in large and small companies
5. Strengthening the regional entrepreneurship
6. Raising the economic competence in the entrepreneur system and refining its financial support institutions

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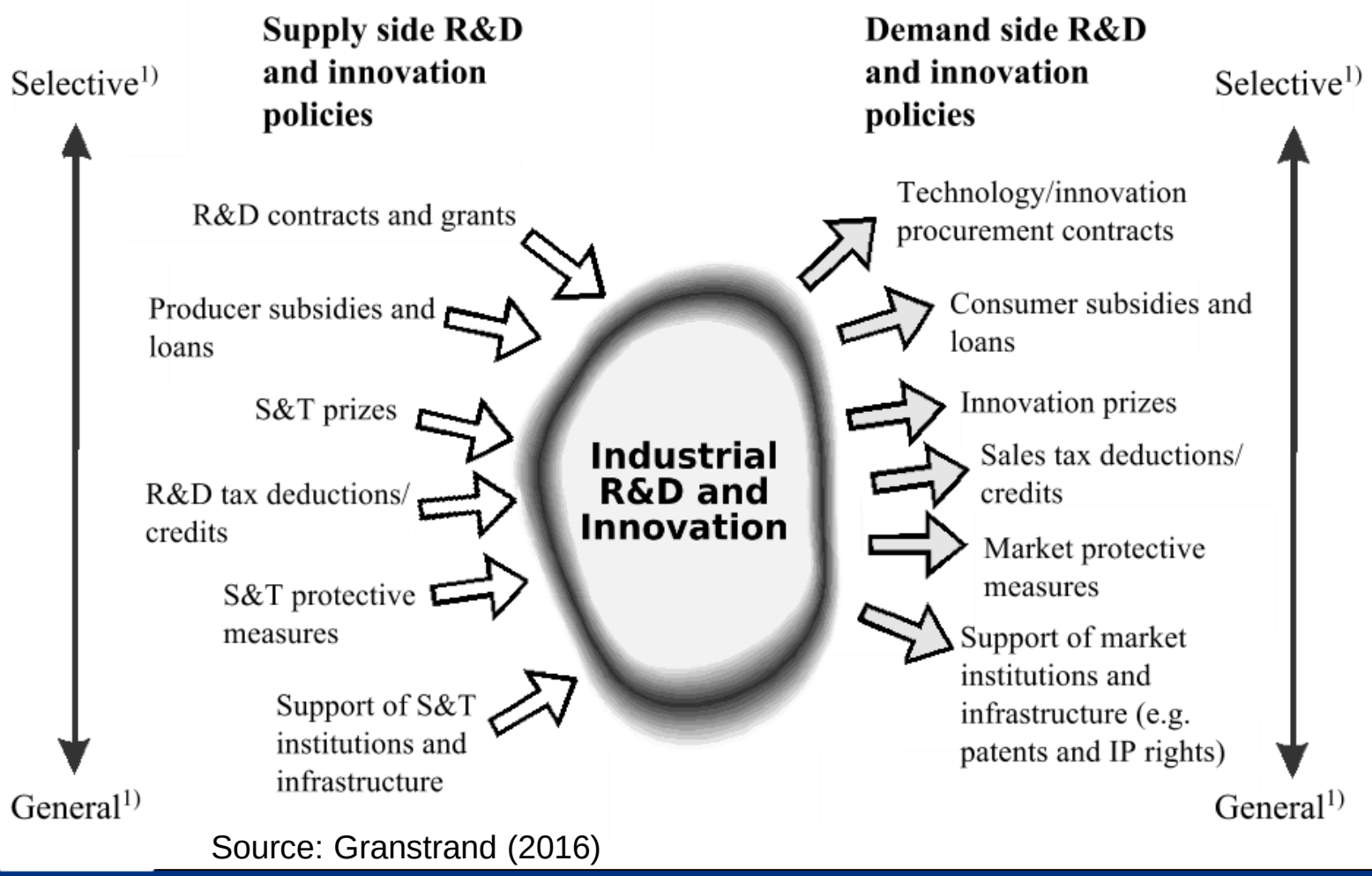
Supply and Demand Side R&D and Innovation Policies



Source: Granstrand (2016)

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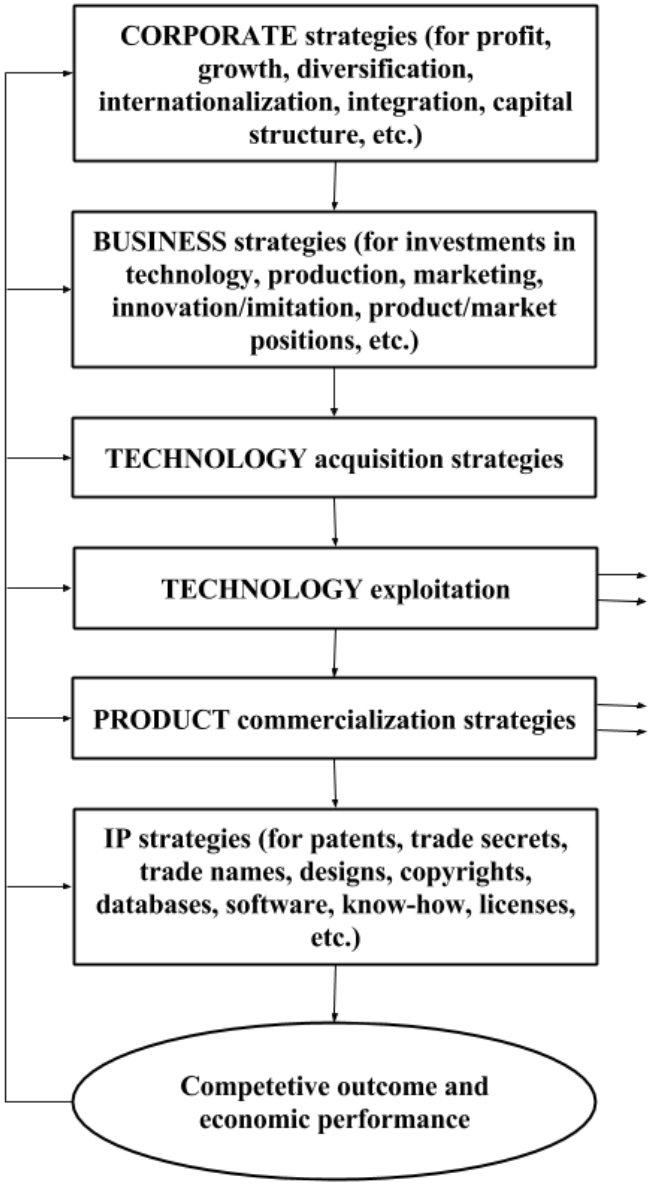
Micro Levels

Different levels of management strategies for the technology based firm:

"The Corporate Strategy Ladder"



Source: Granstrand (1999)

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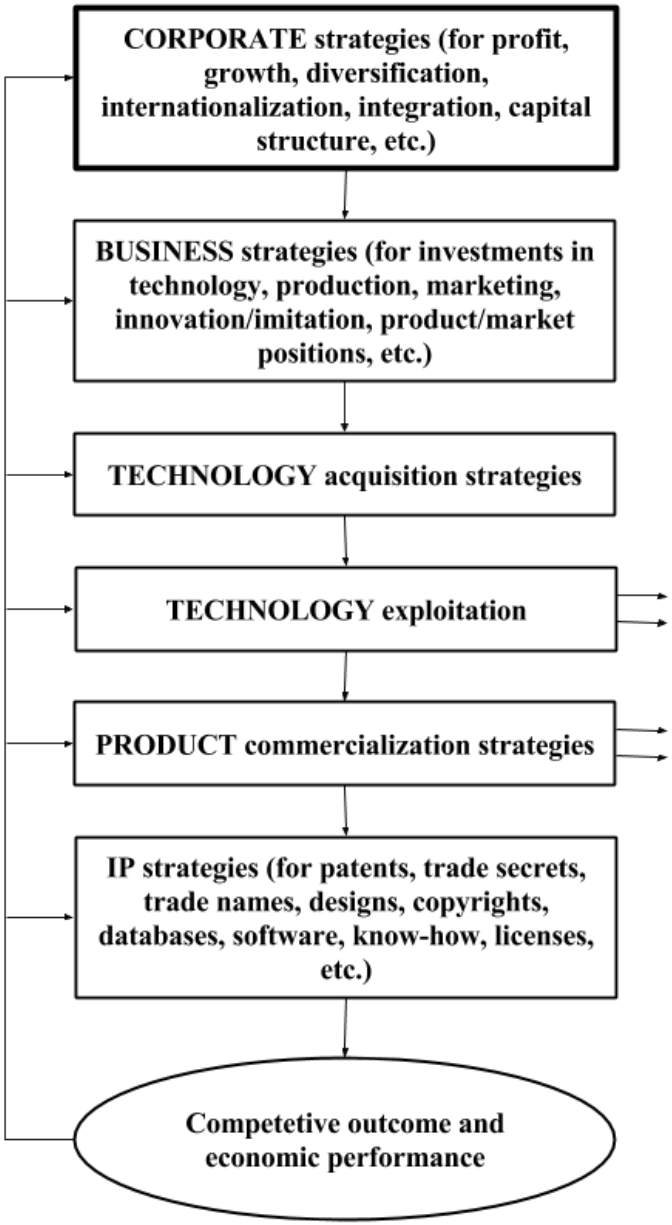
Corporate strategy level



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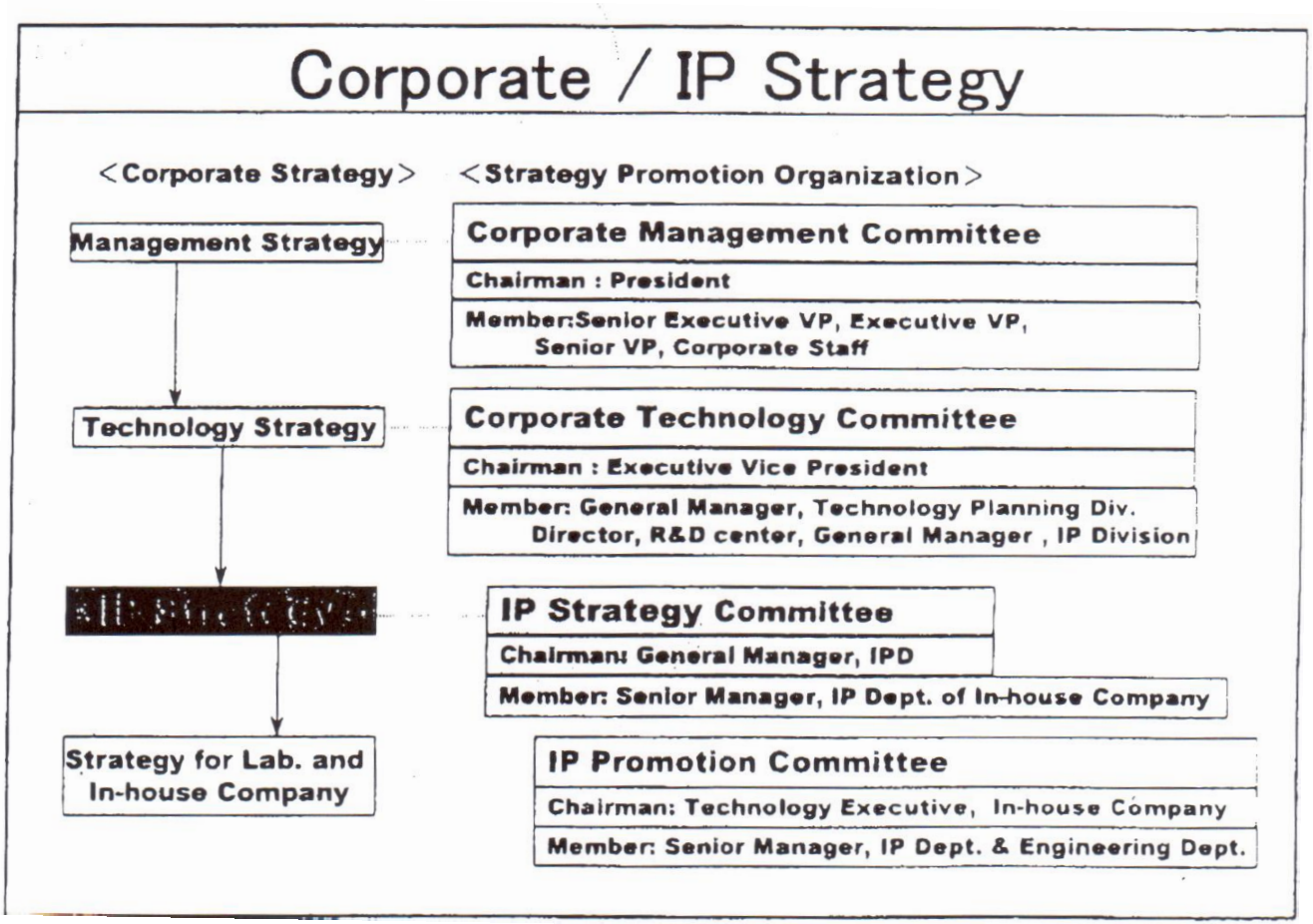
Micro Level: Strategies for TBF

Example: Toshiba



Source: Toshiba internal document as of 2002.

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Main corporate objectives

Profits

Growth

- Internationalization
- Diversification

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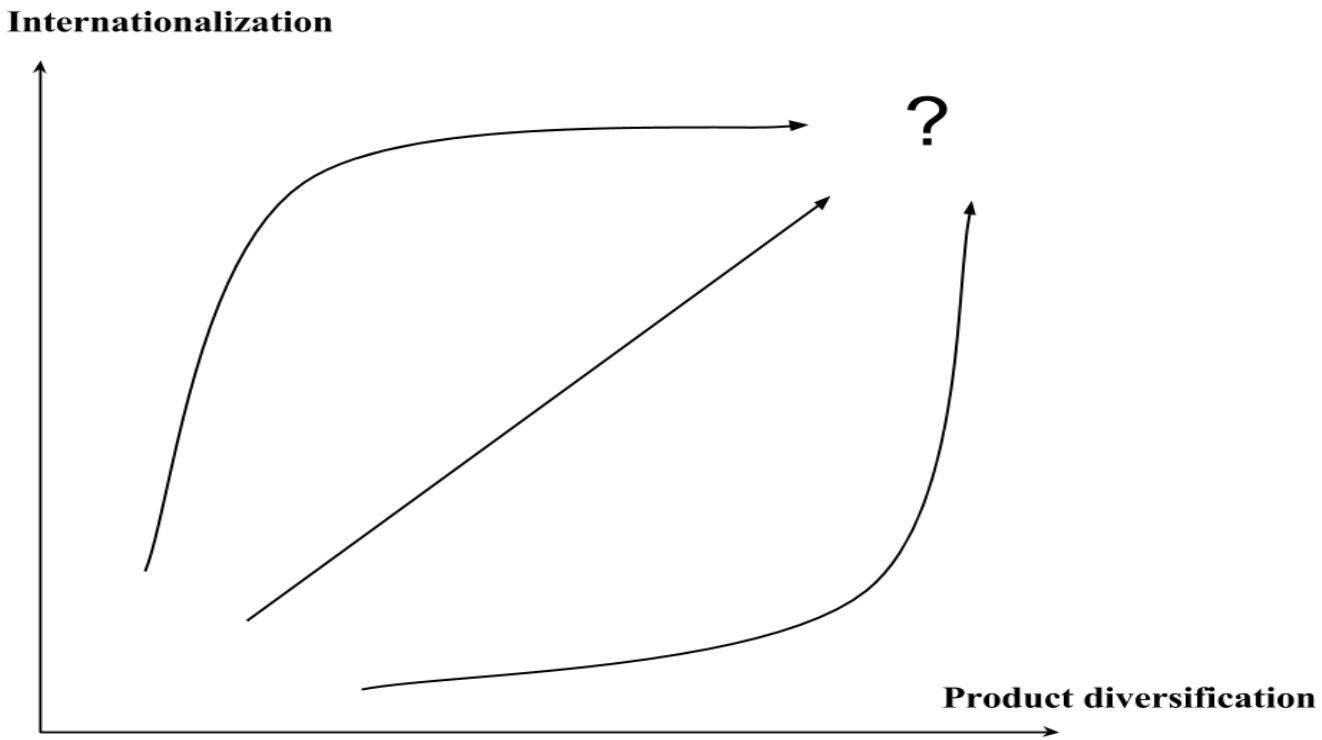
Corporate Strategy Sequences over Time



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Studies show:

1. Product diversification creates more value in emerging economies than in developed ones (McKinsey)
2. Technological diversification and technology related product diversification generates strong corporate growth (”mul-tech” rather than ”hi-tech”) but also growth of R&D (Chalmers and others)
3. Product related technology diversification in tandem with technology-related product diversification is conducive to innovation (Chalmers)
4. Technological diversification necessitates external technology acquisition and open innovation (Chalmers)
5. In small countries innovation based firms internationalize first, then perhaps diversify, while natural resource based firms diversify first, then perhaps internationalize

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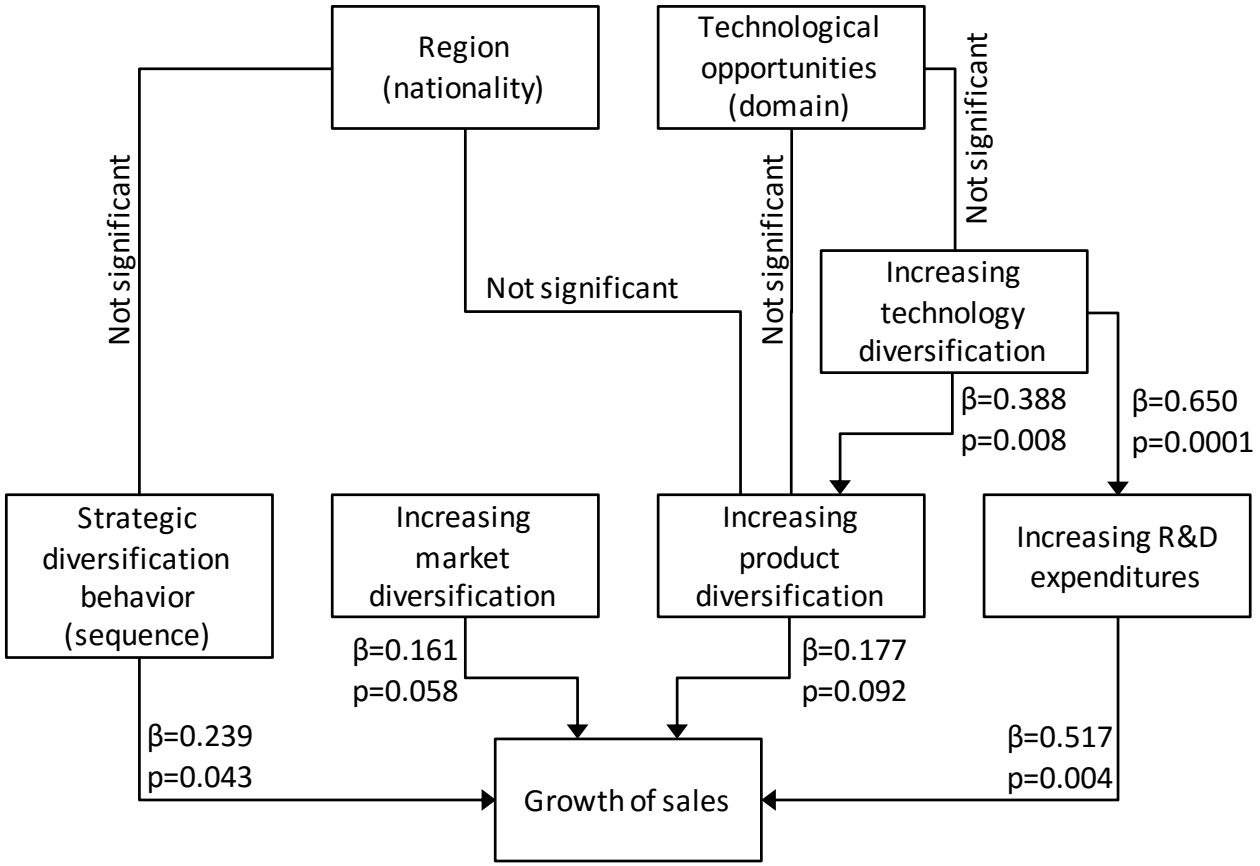
Corporate growth and diversification of technology and product sales



Model R^2 = 0.597
Model p = 0.0001

"Not significant" = Not significant at 10% level
β = Standardized partial correlation coefficients

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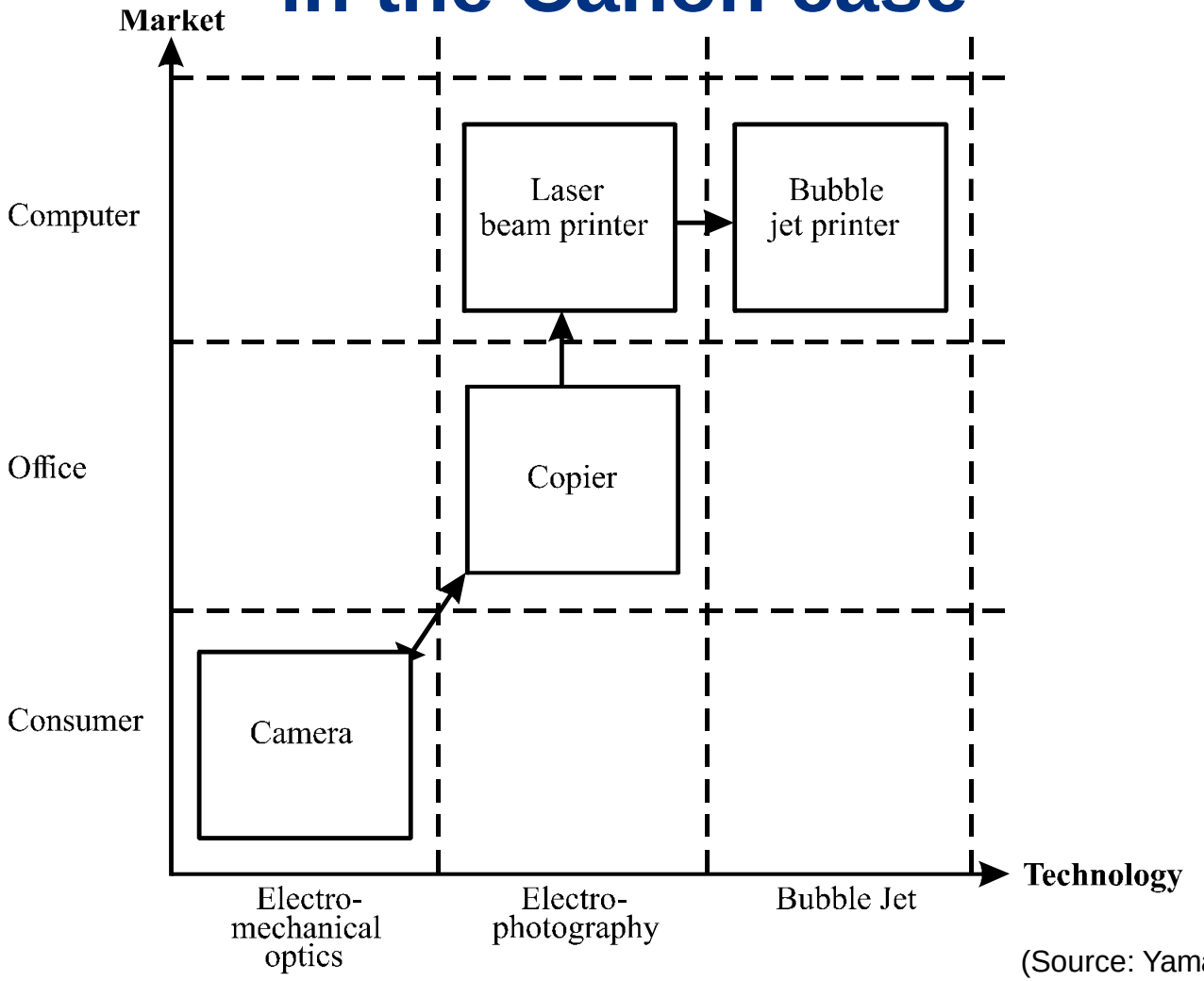
Case of Canon

Canon's five major corporate strategies (as of 1992)

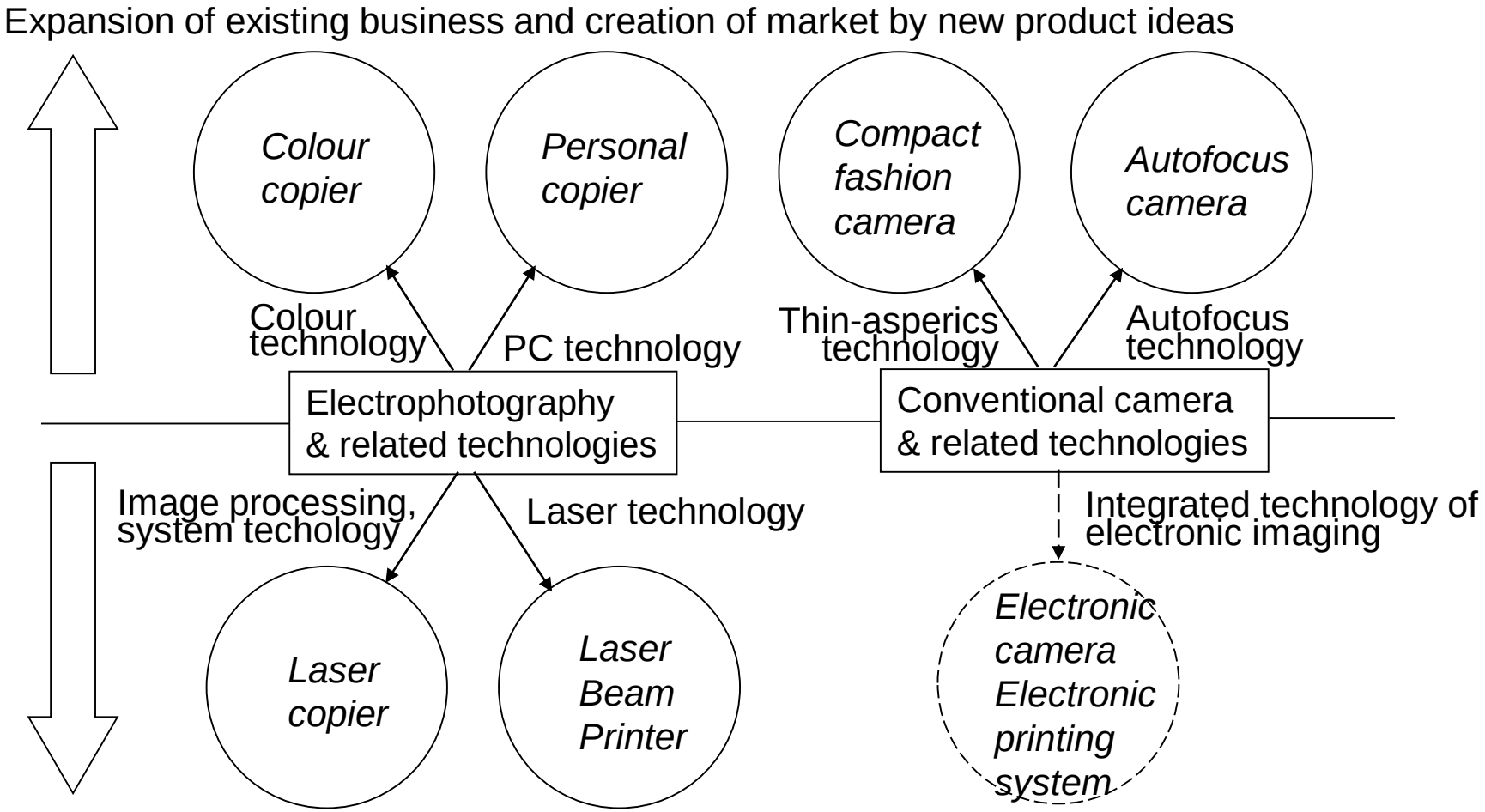
1. New corporate philosophy of mutual prosperity ("kyosei")
2. Strengthening of R&D
3. Diversification (which must be "synergetic")
4. Globalization
5. New organization

Technology-related product diversification in the Canon case



(Source: Yamaji 1994)

Synergetic product development



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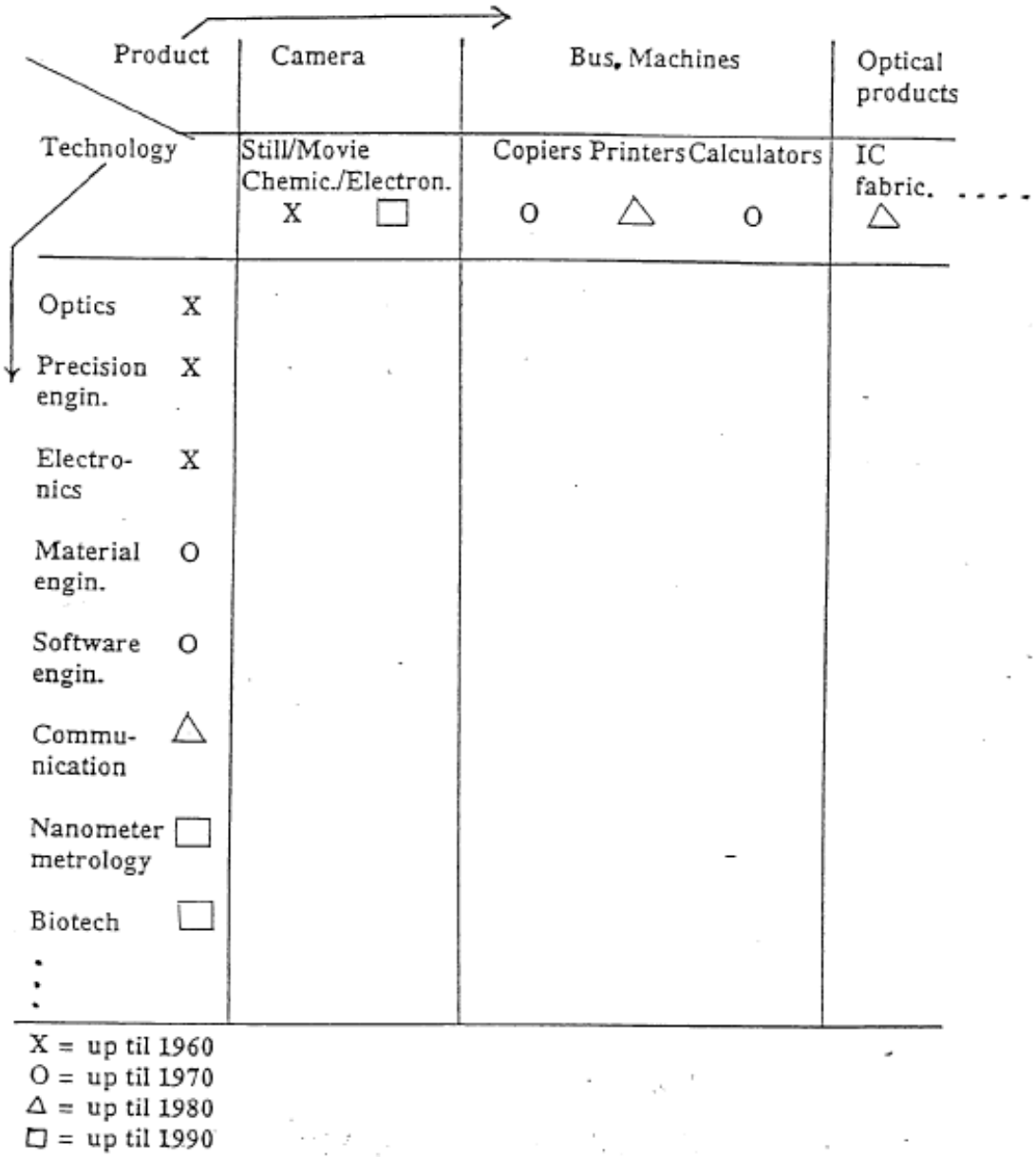
Overview of Canon's Technology/Product Diversification



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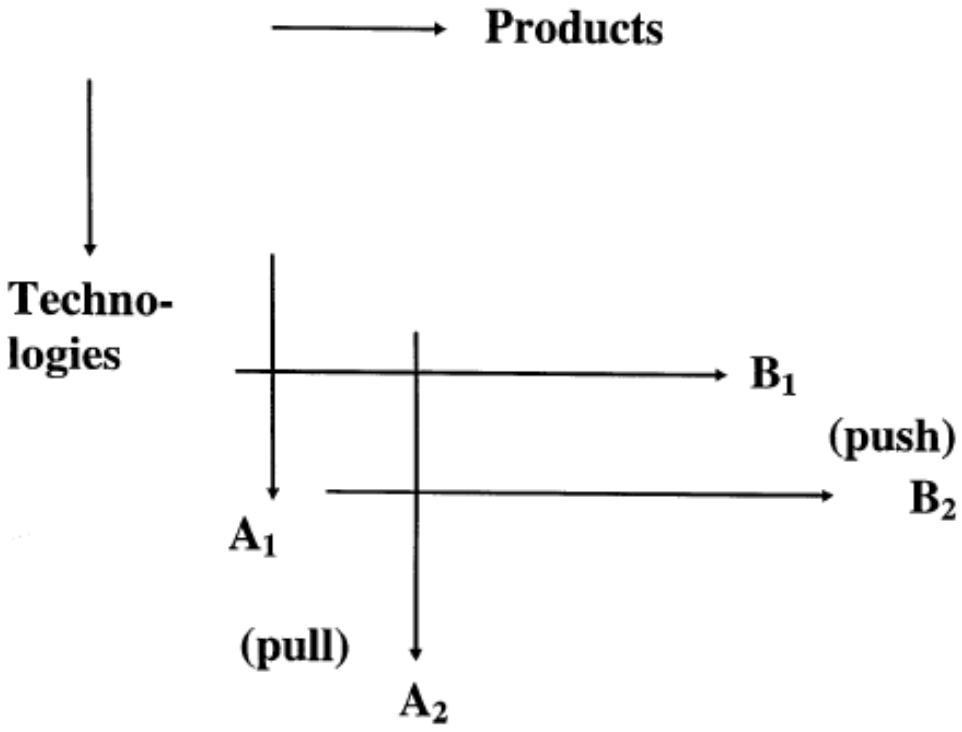

JAPAN – A + B moves

SWEDEN – A moves

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- ″We give annual cash awards to the employee who has applied for the most patents that year and to those who have developed patents or software of an outstanding nature.″

- ″I encourage our researchers to read publications about patents rather than academic theses. I also tell them to experiment with the results of theoretical research, to try to develop patents so the practical benefits can be ascertained.″

- ″We try to encourage the view that the company′s value to society lies in a developing new technology. We also try to provide a corporate environment where thought and originality are rewarded.″

Keizo Yamaji
CEO, Canon Group

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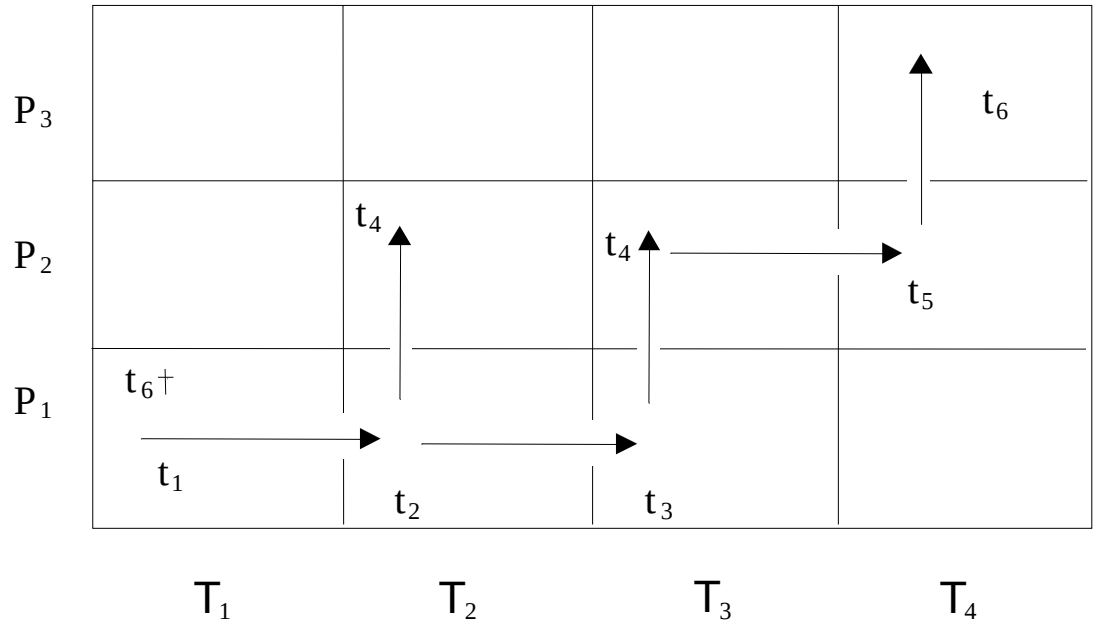
Dynamics of product and technology diversification

Product business



Legend

T = technology

P = product business

t = time

† = discontinuance (exit)

Source: Granstrand (1998)

Technology and product diversification

Technology diversification leads **to growth in the technology-based firm**, while at the same time leading to **growth in the firm's R&D expenditures, increased external technology acquisition and openness in the innovation process**.

Theoretically, in the process of taking advantage of technological opportunities, **technology diversification at the corporate level** may lead to **increased sales in five different** and partly **complementary ways**:

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Technology and product diversification

Static economies of scale

- The same, or close to the same, technologies could be used in several different products with minor adaption costs

Dynamic economies of scale

- Knowledge is improved by the learning process when applied repeatedly

Economies of scope (cross-fertilization)

- Combining different technologies yielding new inventions, new functionalities and increased product and/or process performance

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Technology and product diversification

Economies of speed

•Combining technologies most often require some technology transfer, and intrafirm technology transfer is, under certain conditions, faster and more effective than interfirm.

Economies of space

•Gaining advantages by locating operations in regions with a concentration and high diversity of technologies that yield spill-overs.

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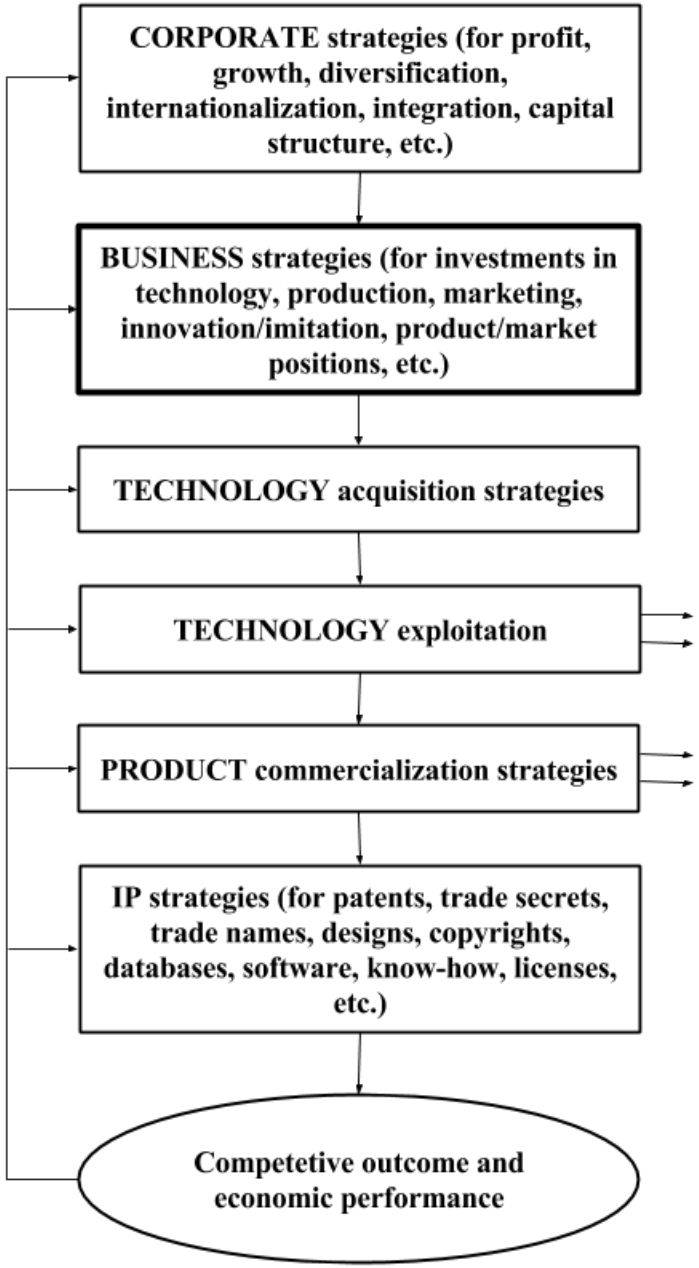
Business strategy level



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Some Innovation/Imitation Strategies

- Focus on early/late mover advantages/disadvantages

Some examples:

- Focus on major/minor product/process innovations/imitations for cost and quality leadership, possibly in sequence

- Focus on joint product/process technologies for price/performance leadership

- Persistent leader/lagger
- Intermittent leader/lagger
- Partial leader/lagger
- Fast second
- ”Me-too-plus”
- Trickle-up vs tricke down the quality ladder
- Technology fusion/combination/convergence (e.g. Mechatronics)

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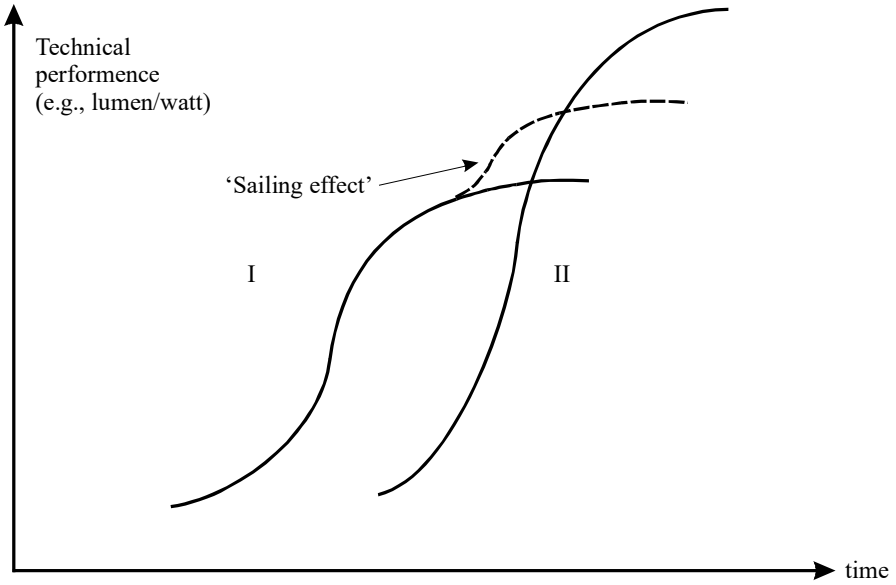
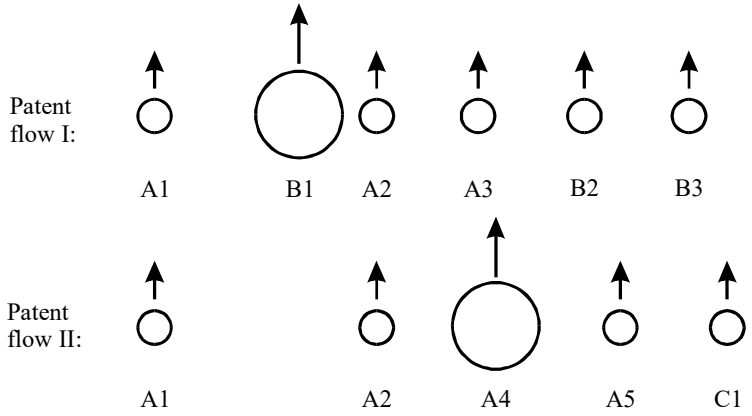
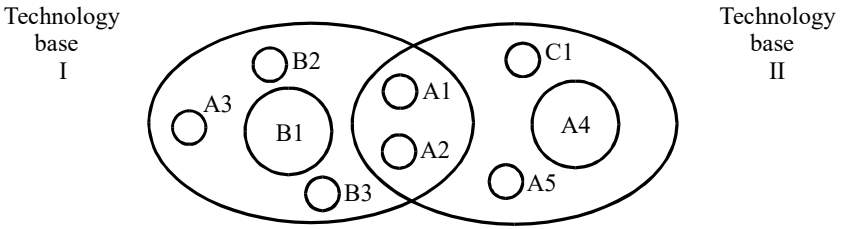
Patenting strategies in the case of competing technologies







Legend:
- A1, B2 etc = Company A's first patent in the area, Company B's second patent in the area etc.
- I, II = Two technical performance curves, corresponding to technology base I and II, represented by two overlapping sets of technologies, being partly protected in technology space by two patent flows over time. The <sailing effect= refers to improvements in old technical performance in response to threats from new technologies.
- Circles denote scope of patents
- Arrows denote patent granting dates

Source: Granstrand (1999)

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General Investment Strategies When a New Technology Emerges is:

a) to invest in improvements of the old technology (cf. “the sailing effect”)

b) to invest in improvements of some version of the new technology

c) to invest in a hybrid version, based in parts on both the old and new technology

d) to introduce the new technology in an evolutionary manner in the existing (e.g. piece-meal replacement of analog components with digital)

e) to skip the emerging technology and jump to the next-next major new technology (leap-frogging)

or finally

f) do nothing (wait and see)

When and how to introduce the new technology (if at all) and when and how to exit the old technology are thus crucial timing decisions for technology management.

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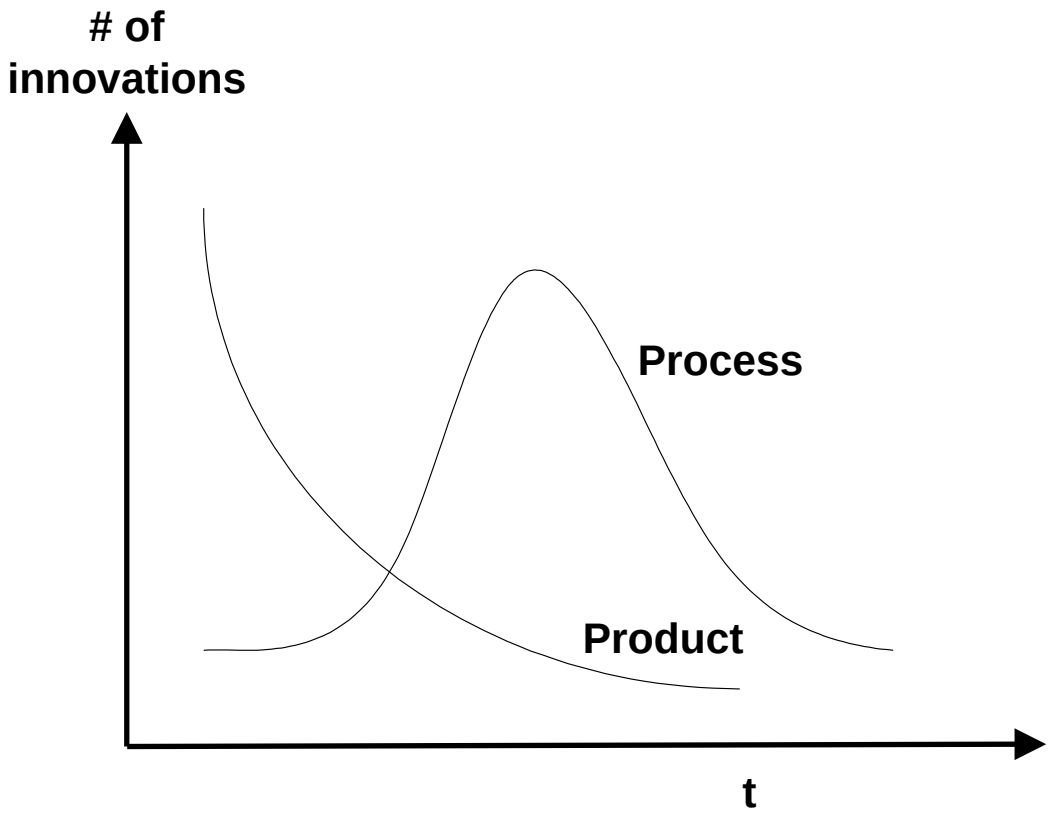
Rate of subsequent product and process innovations in a product area



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Advantages and disadvantages of early and late movers on markets

Early mover

Advantages

- Economies of scale and learning and increasing returns in general
- Firstcomers have first crack at emerging technologies and markets and the opportunity to establish unchallenged, dominant market share
- Possibility to use pre-emptive and foreclosing strategies or otherwise build up barriers to entry
- Reputational advantages
- Possibility to build up exclusive IP positions
- Possibility to set standards

Disadvantages

- Build-up of physical and intellectual capital which becomes obsolete
- Build-up of inertia, rigidities and hubris
- Build-up of the NIH syndrome and the success breeds failure syndrome

Advantages and disadvantages of early and late movers on markets

Late mover

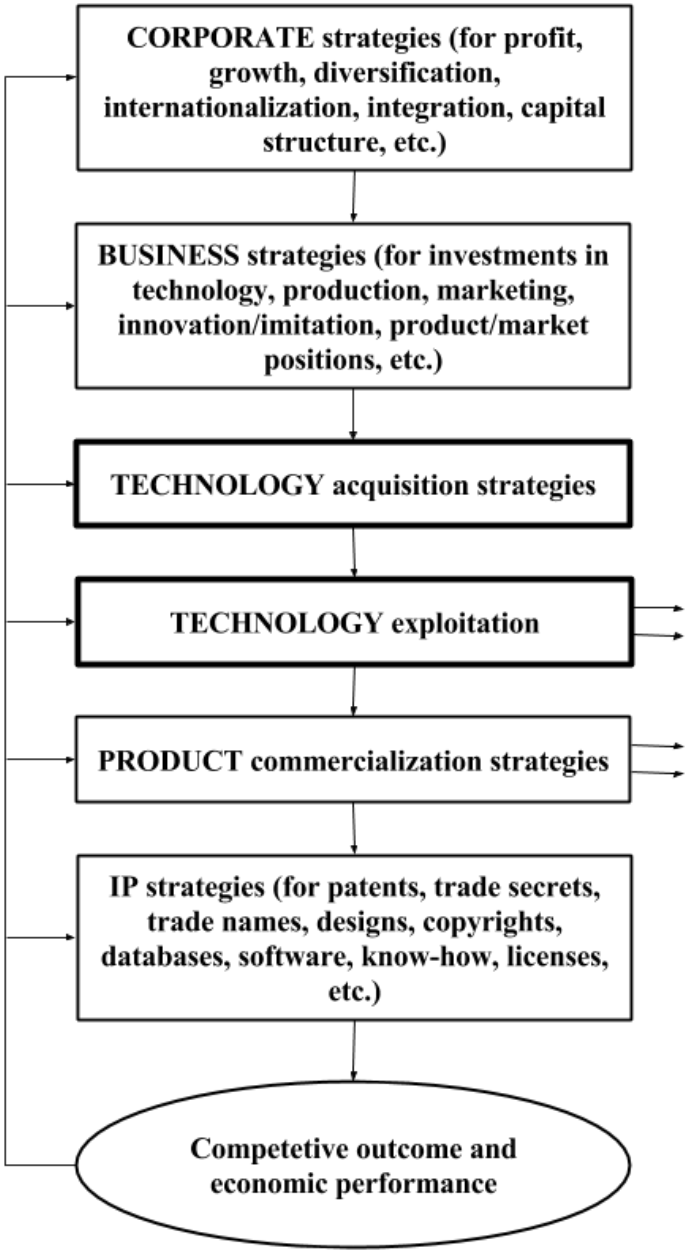
Advantages

- Economies of speed and timing
- Reduction of basic R&D costs compared to firstcomers
- Lower initial start-up costs
- Reduction of aimless groping
- Technological leapfrogging is possible
- Learning from early movers
- Reduction of NIH effects
- Aggregate growth rates tend to be faster
- Cumulation of catch-up competencies

Disadvantages

- Lag in technology
- Resource scarcity due to early mover preemption
- Forced to concentrate on low value-added products
- Lacking economies of scale in production
- Threat by foreign imports from firstcomers
- Competition from foreign subsidiaries operating in home markets
- Threat of being overwhelmed (the FIB- foreign is better syndrome)
- Lack of large companies which can invest in product improvements, appropriate innovations and pursue second-to-market strategies
- Tendency towards unbalanced growth and a polarized economy

Technology strategy level



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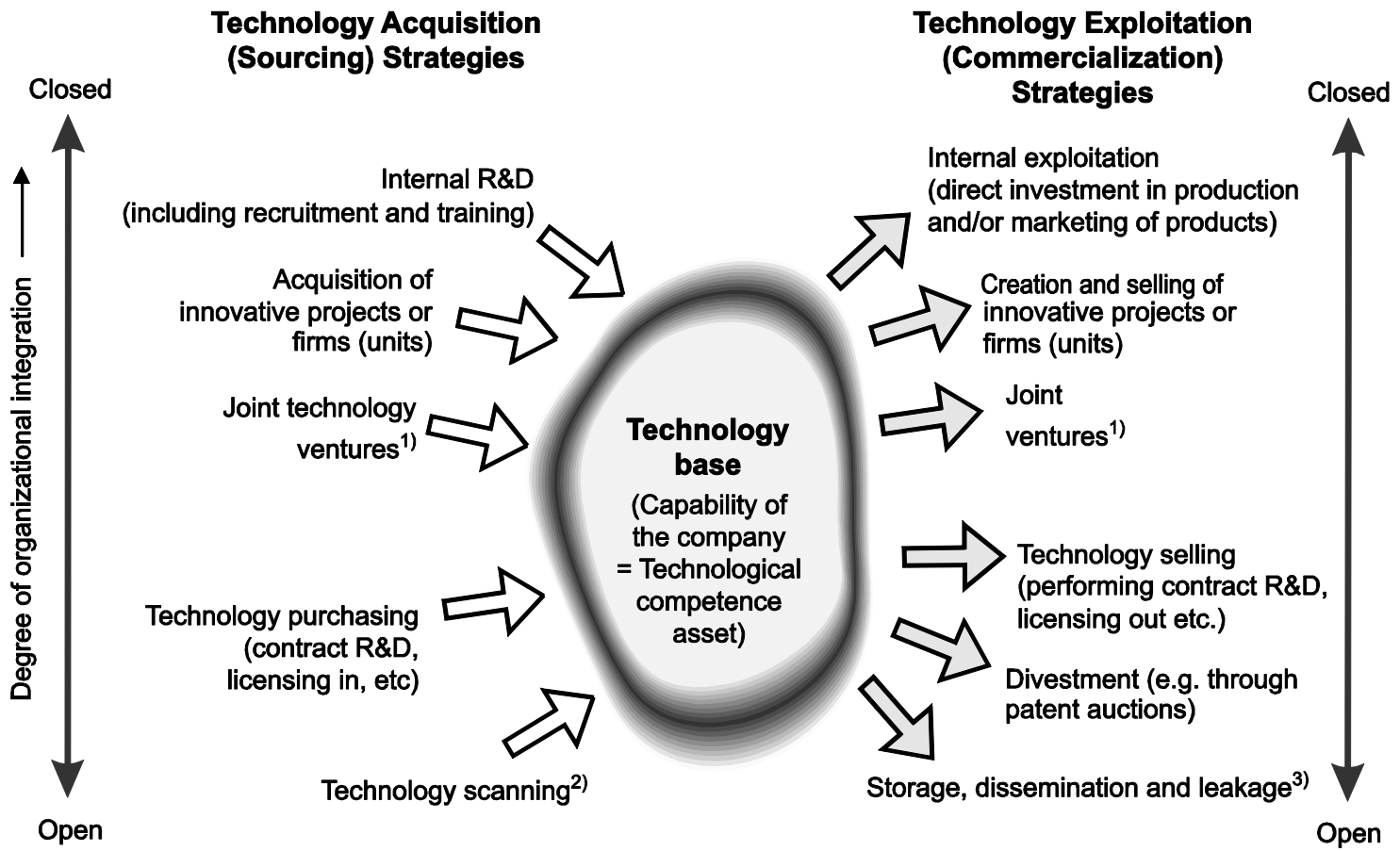
Open and Closed Strategies for Sourcing and Exploitation of Technology



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Case of Japan

Common features of technology exploitation in Japan's catch-up

1. **Synergetic product/technology diversification (reaping economies of scale, scope and speed) through:**
   - Internal development (Japanese companies)
   - Mergers and acquisition (US companies)

2. **"Speed to market" through:**
   - Exploratory R&D
   - Incremental development and learning
   - Concurrent engineering, coordination and communication
   - Sense of urgency (stimulated by domestic competition)
   - Global marketing

Common features of technology exploitation in Japan's catch-up

3. **"Speed to technology" through:**
   - Technology scanning
   - Will to explore and experiment (often early on and with patience)
   - Technology acquisition (e.g. from Western firms and universities and through internal and external technology supply and licensing networks)
   - Large central R&D
   - Technology transfer and communication internally and externally
4. **Dynamic application orientation and user cooperation**
   - Weak science and research culture
   - Application visions
   - Broad market orientation
   - User cooperation
5. **IP protection, licensing and monitoring**

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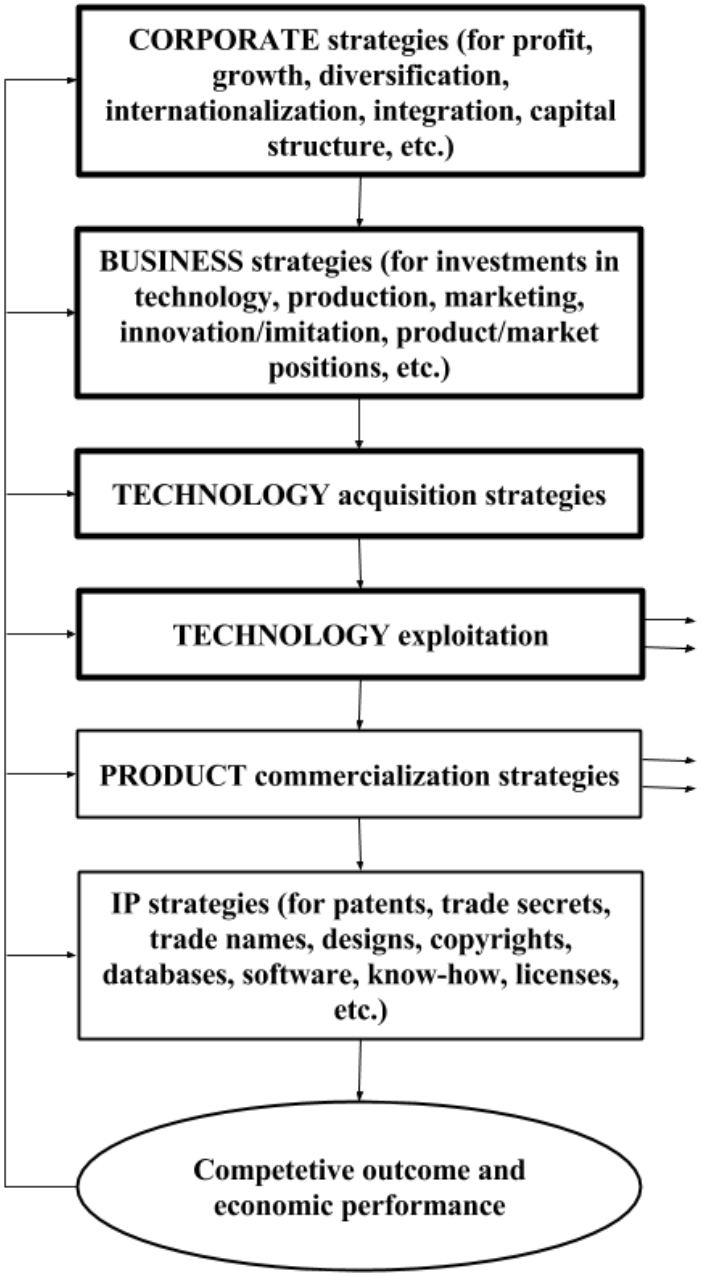
Summary of Strategies



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Structures of corporate innovation systems- Some examples

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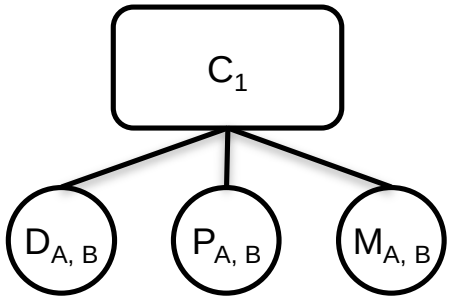
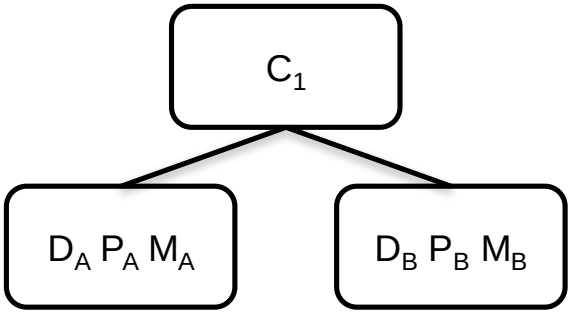
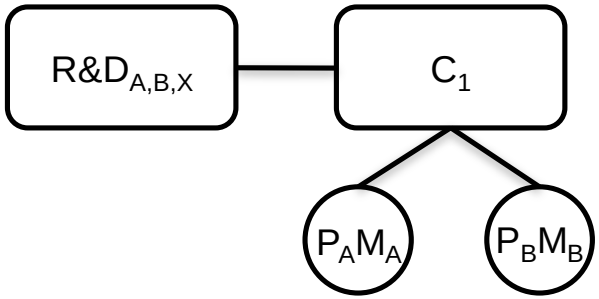
Organizational Structures for R&D and Innovation



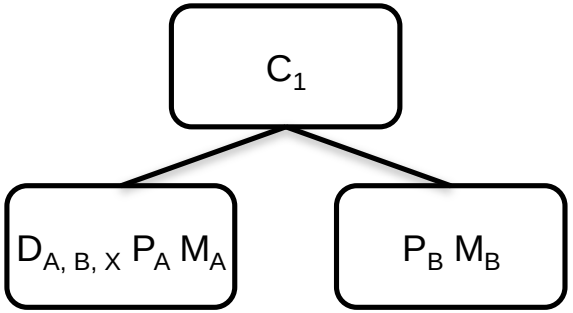
Functional organization(U-form)



Divisional organization(M-form)



R&D centralized



R&D intensive division

Source: Granstrand (1982)
Notation:
C1, C2 … denote companies. A, B denote existing product areas and X, Y, Z new product areas.
Functions are D for R&D, P for production, M for marketing.

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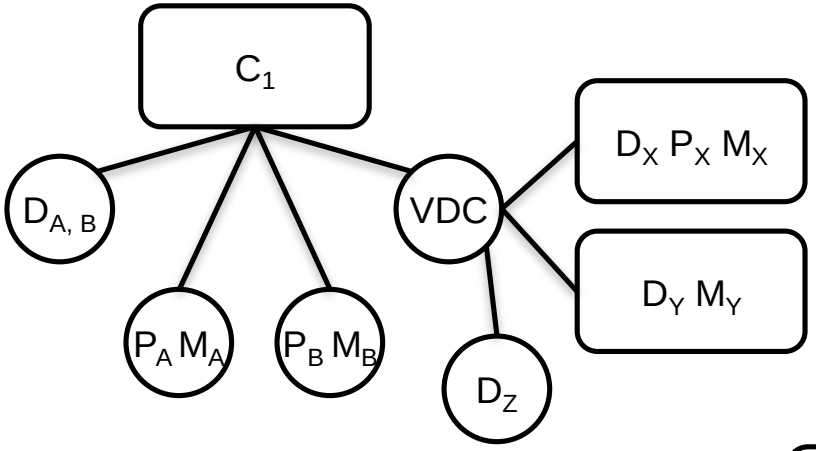
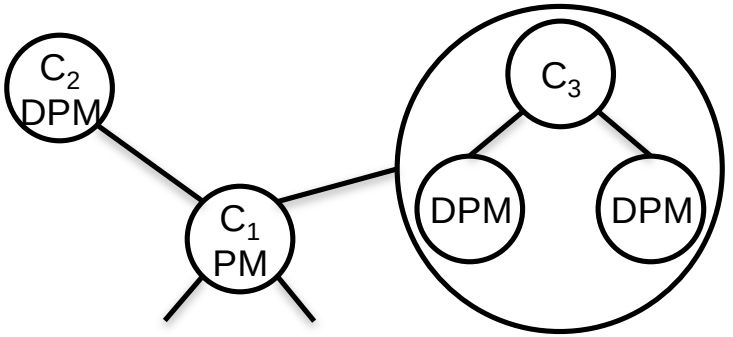
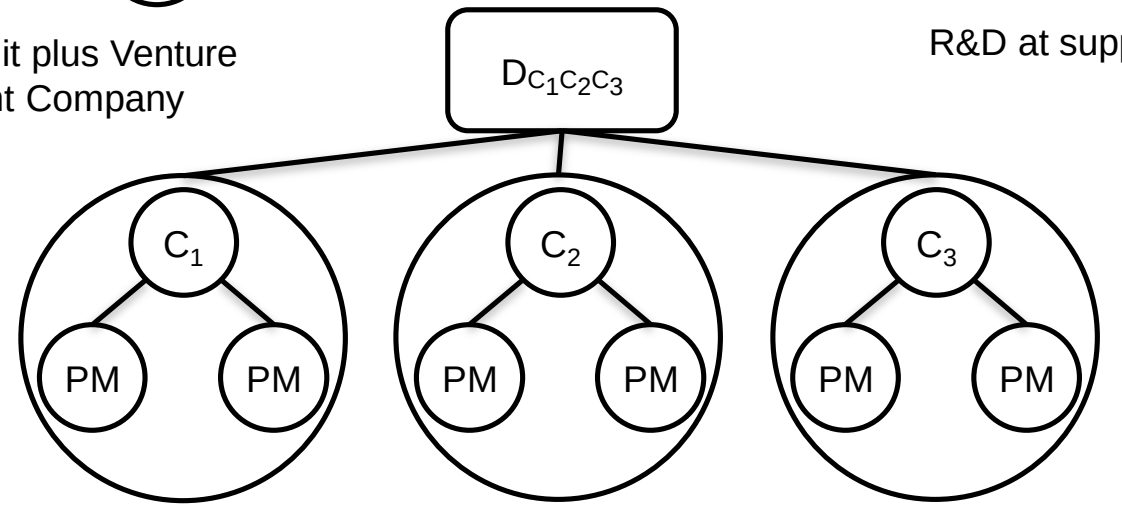
Organizational Structures for R&D and Innovation



Central R&D unit plus Venture Development Company



R&D at suppliers



Collective R&D

Source: Granstrand (1982)

Notation:

C1, C2 … denote companies. A, B denote existing product areas and X, Y, Z new product areas.

Functions are D for R&D, P for production, M for marketing.

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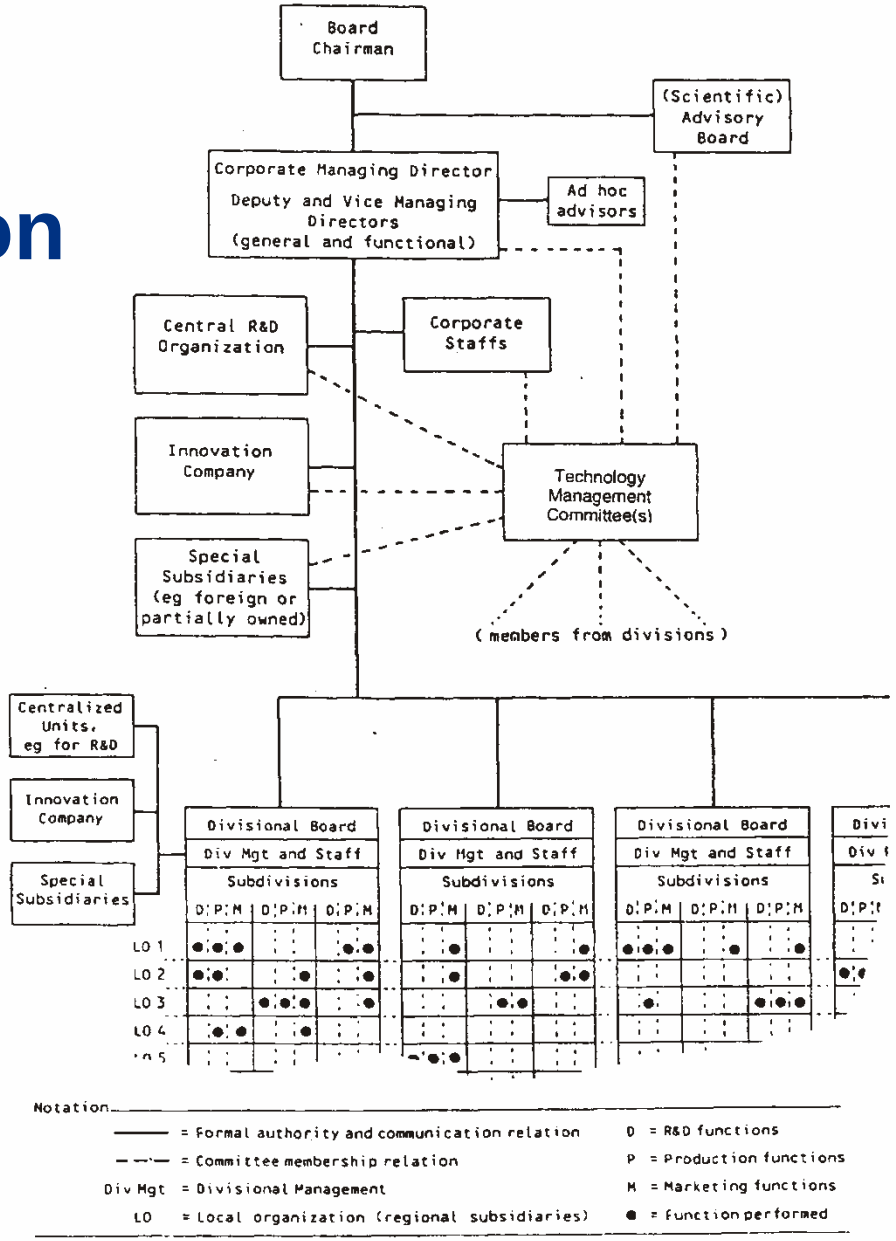
Example of a Divisionalized Corporate Organization Structure – (M-form)



Summary and Conclusions

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Nota Bene:

The pace of technological change
is slower today
than it ever will be

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Reference Material

Granstrand, O. (2016), *Patents and Innovation for Growth and Welfare*, Edward Elgar Publ. (Forthcoming).

Granstrand, O., and Holgersson, M. (2014), 'Multinational technology and intellectual property management – Is there global convergence and/or specialization?' , *International Journal of Technology Management*, Vol. 64, Nos. 2/3/4, pp. 117-147, 2014.

Cantwell, J., Gambardella, A., and Granstrand, O. (eds) (2004): *The Economics and Management of Technological Diversification*. Routledge, London.

Granstrand, O. (1999), *The Economics and Management of Intellectual Property – Towards Intellectual Capitalism*. Edward Elgar Publ., London.

Granstrand, O. (1998), 'Towards a Theory of the Technology Based Firm', *Research Policy*, Vol. 28., No. 2-3, pp. 275-302.

Granstrand, O., Patel, P., and Pavitt, K. (1997), 'Multi-Technology Corporations: Why They Have 'Distributed' Rather than 'Distinctive Core' Competencies.', *California Management Review*, Vol. 39, No. 9.

Granstrand, O., and Alänge, S. (1995), 'The Evolution of Corporate Entrepreneurship in Swedish Industry – was Schumpeter wrong?', *Journal of Evolutionary Economics*, No. 5, pp. 133-156.

Granstrand, O., and Oskarsson, C. (1994), ′Technology Diversification in ′Mul-Tech′ Corporations′, *IEEE Transactions on Engineering Management*, Vol. 41, No. 4.

Granstrand, O., Sjölander, S., and Håkansson, L. (1993), 'Internationalization of R&D – A Survey of Some Recent Research', *Research Policy*, Vol. 22, No. 5-6m pp. 413-430.

Granstrand, O., Bohlin, E., Oskarsson, C., and Sjöberg, N. (1992), ′External Technology Acquisition in Large Multi-Technology Corporations′, *R&D Management*, Vol. 22, No. 2, pp. 111-133.

Granstrand, O., Håkansson, L., and Sjölander (eds) (1992), *Technology Management and International Business*, Wiley.

Granstrand, O. (1982), *Technology Management and Markets*. Pinter Publ., London.

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Thank you for your attention!

Questions?

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