Setting the Stage
The “Old” New Era

It has become common to argue that technological advance is the most important source of long term economic growth.

Economists and policy analysts have paid increasing attention to high technology activities, associating them with higher value added output and higher incomes.
The “Old” New Era

The traditional perception of high technology has been research and development (R&D) intensive manufacturing industries.

The importance of technology-based economic activities has been associated with the share of high technology manufacturing industries in the gross domestic product (GDP) of a country.
### Table 1. Manufacturing industries classified according their global technological intensity (ISIC Revision 2)

<table>
<thead>
<tr>
<th>High-technology</th>
<th>CITI Revision 2</th>
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</thead>
<tbody>
<tr>
<td>1. Aerospace</td>
<td>3845</td>
</tr>
<tr>
<td>2. Computers, office machinery</td>
<td>3825</td>
</tr>
<tr>
<td>3. Electronics-communications</td>
<td>3832</td>
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<tr>
<td>4. Pharmaceuticals</td>
<td>3522</td>
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<tr>
<td><strong>Medium-high-technology</strong></td>
<td></td>
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<tr>
<td>5. Scientific instruments</td>
<td>385</td>
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<tr>
<td>6. Motor vehicles</td>
<td>3843</td>
</tr>
<tr>
<td>7. Electrical machinery</td>
<td>383-3832</td>
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<tr>
<td>8. Chemicals</td>
<td>351+352+3522</td>
</tr>
<tr>
<td>9. Other transport equipment</td>
<td>3842+3844+3849</td>
</tr>
<tr>
<td>10. Non-electrical machinery</td>
<td>382-3825</td>
</tr>
<tr>
<td><strong>Medium-low-technology</strong></td>
<td></td>
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<tr>
<td>11. Rubber and plastic products</td>
<td>355+356</td>
</tr>
<tr>
<td>12. Shipbuilding</td>
<td>3841</td>
</tr>
<tr>
<td>13. Other manufacturing</td>
<td>39</td>
</tr>
<tr>
<td>14. Non-ferrous metals</td>
<td>372</td>
</tr>
<tr>
<td>15. Non-metallic mineral products</td>
<td>36</td>
</tr>
<tr>
<td>16. Fabricated metal products</td>
<td>381</td>
</tr>
<tr>
<td>17. Petroleum refining</td>
<td>351+354</td>
</tr>
<tr>
<td>18. Ferrous metals</td>
<td>371</td>
</tr>
<tr>
<td><strong>Low-technology</strong></td>
<td></td>
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<tr>
<td>19. Paper printing</td>
<td>34</td>
</tr>
<tr>
<td>20. Textile and clothing</td>
<td>32</td>
</tr>
<tr>
<td>21. Food, beverages, and tobacco</td>
<td>31</td>
</tr>
<tr>
<td>22. Wood and furniture</td>
<td>33</td>
</tr>
</tbody>
</table>
The “New” New Era

The penetration of “infrastructural” technologies (ICTs, biotech, advanced materials) throughout the economy has, however, dramatically altered the basic meaning of high technology during the past decade.

Rather than referring to the output of R&D-intensive industries, high tech now refers to a style of work applicable to just about any business.

Leading business analysts have argued that we no longer have high and low tech industries, only high and low tech firms.
An era of knowledge-based development and growth?

Knowledge-Based Economy

Materials technologies revolution

Biotech revolution

Communications revolution

Infotech revolution

Globalization

International trade

Finance

Investment
Knowledge-Based Economy

The term “knowledge-based economy” reflects an increasing recognition of the role of knowledge in economic growth.

“A knowledge-driven economy is one in which the generation and exploitation of knowledge play the predominant part in the creation of wealth”.

Knowledge-based Economy

Compared to natural resources, physical capital, and low-skilled labor, the role of knowledge has taken on greater importance. The OECD economies are more dependent than previously on the production, distribution and use of knowledge. They experience faster expansion of output and employment in high-tech industry segments both in manufacturing such as computers, electronics, and aerospace and in services such as software, banking and finance, and telecommunications.
Patterns of Economic Growth

- OECD economies are increasingly based on knowledge. They also are increasingly integrated into the world economy, through international flows of goods and services, investment, people and ideas.

- The role of MNCs in the international economy high, rising, but different across countries.

- Over the past decade, the high-technology share of OECD manufacturing production and exports has more than doubled to reach 20-25%.

- While still lower, trade in high-tech services among OECD member nations is increasing as well.
Manufacturing-Services Convergence

Moreover, the penetration of ICTs has gradually shifted the locus of high tech production from exclusively manufacturing to a combination of manufacturing and services.

Technology is transforming the nature of the products of both sectors.

1) Manufacturing is becoming more like services:
- customer service is becoming more important;
- products are increasingly being tailored to the needs of individual customers.

It is estimated that over three quarters of the value of a typical manufactured product is already contributed by service activities such as design, sales, and advertising.
Manufacturing-Services Convergence

(2) Technology is also changing production and consumption patterns in some of the most valuable and fastest growing service sectors (e.g. business services).

The codification of knowledge in such services makes direct contact between producer and consumer unnecessary allowing such services to be held as inventories and be traded internationally (e.g., expert computer systems).

The introduction of ICT is making services more capital intensive and more productive. This process will also make services more susceptible to competition and to the economic cycle - like manufacturing goods.
Manufacturing-Services Convergence

The convergence of high tech manufacturing and services has

- Exposed the under-appreciated role of the latter as consumers of high technology products.
- Unleashed strong innovative forces in service sectors.

Service sectors are rapidly increasing their direct participation in the R&D efforts of those economies. This is done both independent of and in association with manufacturing.
Growth and Innovation

These developments have profound implications for both policy and strategy.

- The ability to create, distribute and exploit knowledge and information seems ever more important and is often regarded the single most important factor underlying economic growth and improvements in the quality of life.

- The competitiveness of firms depends crucially on how well they make use of their own intangible assets, such as skills and creativity, and gain access to new ones by cooperating with other for-profit and nonprofit organizations.
Growth and Innovation

- Innovation has become:
  - more market-driven;
  - more rapid and intense;
  - more closely linked to scientific progress;
  - more widely spread throughout the economy.

The ways in which organizations interact in an economy have been affected, with networking, cooperation, and the fluid flow of knowledge within and across national borders gaining in importance.
Growth and Innovation

In reaction to (a) increasing costs and risks of innovation and (b) intensifying international competition, many firms have opted for more focus and specialization.

At the same time, as the range of technologies required for innovation in many industries has expanded and technologies have become more complex, companies can no longer cover all relevant disciplines and the required wide range of scientific and commercial knowledge.

The need for cooperation has thus become greater than ever before. The number of strategic partnerships has exploded the last couple of decades.
Growth and Innovation

Firms must learn to link changes in their intellectual capital and the worth of their business and balance sheets. But, this is not really new. A firm’s intellectual capital (intangible assets) - including both the stock of knowledge and the ability to enhance it - has always been a source of competitive advantage.

What is new is mounting evidence that for an increasing number of firms in high technology manufacturing and service sectors the intangible component of value far outweighs the value of their tangible assets.

Fifteen years ago, Fumio Kodama noticed that several large manufacturing firms in Japan were spending more on building their intangible assets through R&D than on building their tangible assets through investment in traditional capital. He argued that these firms were turning into “thinking organizations”. Since then, this process has intensified in manufacturing and has spread widely in knowledge-intensive service sectors.
A New Era for Policy
A New Era for Policy

Technology policy will need to adopt the broader notion of innovation and not just technology. Likewise, innovation policy will need to become much more user-centered and demand-based. Innovation policy must also be better integrated with:

- General economic policies that affect incentives to innovate;
- Policies that shape the regulatory and institutional environment in which innovation takes place; and,
- Policies providing safety nets for parts of the population that fail to follow the ever increasing pace of change.
OECD Policy Recommendations

In its (now dated) report “The New Economy: Beyond the Hype” (2001) the OECD listed a number of detailed recommendations.

They should be viewed together as part of a policy mix. None of the five broad areas can be taken in isolation, but as part of a mutually reinforcing package of measures for growth.

The five broad policy areas are:
OECD Policy Recommendations

Ensure that economic and social fundamentals are in place:

- Preserve macroeconomic stability;
- Encourage openness;
- Make financial systems more supportive of innovation;
- Mobilize labor resources;
- Address the redistributive implications of structural change.
OECD Policy Recommendations

Facilitate the diffusion of ICTs:

- Focus policy efforts on increasing the use of new technology;
- Increase competition and continue with regulatory reform in the telecommunications industry to enhance the uptake of ICT;
- Ensure sufficient competition in hardware and software to lower costs;
- Build confidence in the use of ICT for business and consumers;
- Make e-government a priority.
OECD Policy Recommendations

Foster innovative environment:

- Give greater priority to basic research: future innovation will be jeopardized without it;
- Improve the effectiveness of government funding for innovation;
- Make greater use of competitive funding and evaluation in supporting public research;
- Tackle new challenges in intellectual property regimes;
- Remove barriers and regulations that limit effective interaction between universities, firms and public laboratories.
OECD Policy Recommendations

Enhance human capital:

- Invest in high-quality early education and child care;
- Raise completion of basic and vocational education and improve the quality of the system;
- Improve school-to-work transition;
- Strengthen the links between higher education and the job market;
- Provide wider training opportunities;
- Reduce obstacles to workplace changes and give workers a greater voice.
OECD Policy Recommendations

Stimulate firm creation / entrepreneurship:

- Promote access to financing;
- Facilitate firm entry and exit;
- Review and access the relevance and effectiveness of government support systems;
- Encourage an entrepreneurial spirit in society.
Another Approach to Policy
Three dimensions of policy must be addressed in order to create growth in the knowledge-based economy:

1. Policies that affect the pressure for change (or how to create the appropriate incentives to economic agents to innovate).

2. Policies that affect the ability to absorb change (or how to increase the ability to innovate).

3. Policies that assist the losers from change (or how to partly redistribute the wealth from the winners to the losers in order to make change socially acceptable).
Policies that affect the pressure for change:

(a) general economic policy, macroeconomic policy more specifically, and sector level policies that affect relative prices, thus affecting relative expected rewards to investors

(b) trade policy which affects competition levels

(c) competition policy which affects domestic competition

(d) intellectual property rights policy, which affects competition levels, incentives to invent, rates of technology diffusion
Policies that affect the ability to absorb change:

(a) science and technology policy, which affects the ability to create and disseminate scientific and technological knowledge

(b) innovation policy, which focuses on the introduction of new technologies and, more than S&T policy, addresses the demand side of the technology equation (technology user)

(c) human resource policies (including education, training etc.), which create the ability to create and deploy effectively the most important resource in the knowledge-based economy

(d) deregulation, restructuring of the financial system
Policies that assist the losers from change:

(a) Social policies for income redistribution, unemployment compensation, pension financing for failing industries, etc.

(b) Regional policies assisting structural change in regions locked into the “wrong” industries and technologies.
The United States has:

- a good record in the first set of policies
- a good, but idiosyncratic, record in the second set of policies
- a relatively poor record in the third set of policies

Looking into the US experience, other countries can certainly benefit from the first set of policies, selectively benefit from the second set, and benefit little from the third set of policies. [States will have a better record with respect to the third set.]
The Debate Today
Public Policy to Support Innovation

Developed countries seem to agree on five broad policy areas to ease constraints on the incentives of private firms to innovate:

- Direct public fiscal policies to stimulate innovation, whether through grants or the tax system;
- The funding of public research organizations and measures to improve linkages with the private sector;
- The regulation of intellectual property;
- The availability of finance for innovation expenditures;
- The availability of human resources for science and technology.
Public Policy to Support Innovation

**Market failure** has been the long-standing favorite rationale of economists to justify government support for STI. It has been expressed largely in terms of the argument that social returns to R&D investment exceed private returns. As a result, the private sector would be expected to underinvest in R&D.

In addition to imperfect appropriability, however, market failure may be the result of:
- factor indivisibilities
- information asymmetries among stakeholders
- uncertainty
Public Policy to Support Innovation

This traditional economic rationale for public support for STI has, more recently, been supplemented by newer approaches that have focused on system failure due to technological and more generic system complexity involved in scientific and technological advance and innovation. E.g.:

- “Lock-in” of early technological trajectory;
- Institutional constraints on the diffusion and utilization of knowledge;
- Technological complexity;
- Timing of R&D investments relative to the technology life cycle;
- Technical infrastructure and standards;
- Investing within the life cycle versus investing to transition between technology life cycles.
Public Policy to Support Innovation

It is currently unclear what the appropriate government role is in counteracting systemic failures. It is also unclear at what level of government there is place for intervention. The discussion here has focused on systems of innovation, be they national, regional, or sectoral.

It has also focused on the re-examination of more mainstream subjects of STI policy, now under new lenses, such as:

- Firm Characteristics, Market Structure
- Technological Opportunity, Appropriability, Firm Strategy
- The Diffusion (Dissemination) of New Technology
- Globalization/Internationalization of R&D
- Linkages to External Sources of S&T Knowledge
- Intellectual Property Protection
- Small Firms - Technology-Based Entrepreneurship
- Science Parks, Technology Incubators, Venture Capital
- Innovation in Services