

# Innovation and Government Policies

## 创新与政府政策

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Lawrence J. Lau (劉遵義), Ph. D.

President and Ralph and Claire Landau Professor of Economics  
The Chinese University of Hong Kong  
and

Kwoh-Ting Li Professor in Economic Development, Emeritus, Stanford University

Pujiang Innovation Forum 2008  
Dongjiao State Guest Hotel  
Shanghai, May 18, 2008

Phone: (852) 2609-8600; Fax: (852) 2603-5230

Email: [LAWRENCELAU@CUHK.EDU.HK](mailto:LAWRENCELAU@CUHK.EDU.HK); WebPages: [HTTP://WWW.CUHK.EDU.HK/VC](http://www.cuhk.edu.hk/vc)

# Introduction

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- ◆ Innovation and Its Importance
- ◆ China's Advantages in Innovation
- ◆ The Role of Government in Promoting Innovation
- ◆ Concluding Remarks

# The Importance of Innovation

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- ◆ Why is innovation important? Innovation is important because it enables an economy to produce more output with the same inputs and/or the same output with less inputs.
- ◆ With innovation, output can grow even if inputs do not grow (e.g., land input cannot grow, and for millennia, agricultural output grows through increases in yield).
- ◆ Innovation increases productivity, and hence enables the growth of real output per capita.
- ◆ While the real output of an economy can grow on the basis of the growth in inputs, in the absence of innovation, such growth cannot be sustained in the long run, as diminishing marginal productivity will eventually and inevitably reduce the incremental output obtainable from the incremental inputs. Innovation is critical to ensuring long-term sustainability of the growth of real output per capita.
- ◆ There can also be innovation that generates non-pecuniary (non-monetary) benefits (e.g., in the areas of environment and public health).
- ◆ Innovation can be an important source of socioeconomic mobility.

# The Nature of Innovation

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- ◆ Innovation is not manna from heaven; it is the outcome of purposive investment activities—investment in human capital, investment in R&D, investment in information systems, investment in other forms of intangible capital, e.g., knowledge capital, goodwill (brand building), software, new business models and methods, etc.
- ◆ Continuous innovation requires continuous investment.
- ◆ As an investment, innovation is motivated by the rate of return, which in turn depends on the economic climate and environment, including the availability of infrastructure and incentives, tax treatment, exit possibilities and the security of intellectual property rights as well as the appropriability of the “rents” resulting from that particular innovation.

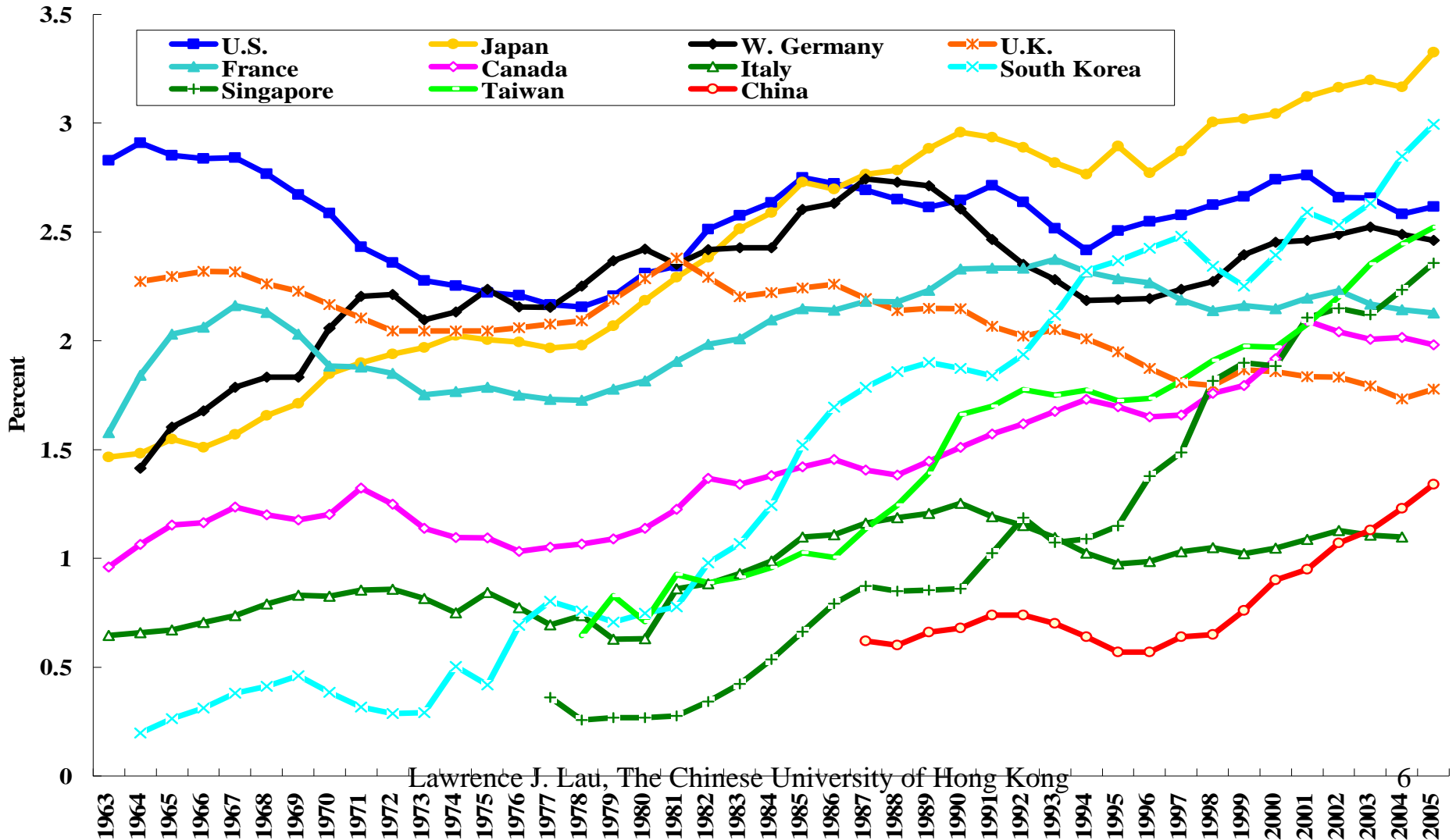
# The Characteristics of Innovation Activities

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- ◆ Innovation, e.g., the creation, initial application and commercialization of a patented product or process, often requires a high fixed cost, but the expanded application of such innovation, once created, has low marginal cost (e.g., introduction of existing drugs into a new market) and hence high marginal revenue and profit.
- ◆ A patent confers a legal monopoly, albeit one with a limited duration (typically 17 years in the U.S.), which in turn enables the successful innovator to make significant profits without fear of competition.
- ◆ To realize the profit potential, the legal monopoly must be protected and enforced by the Government.

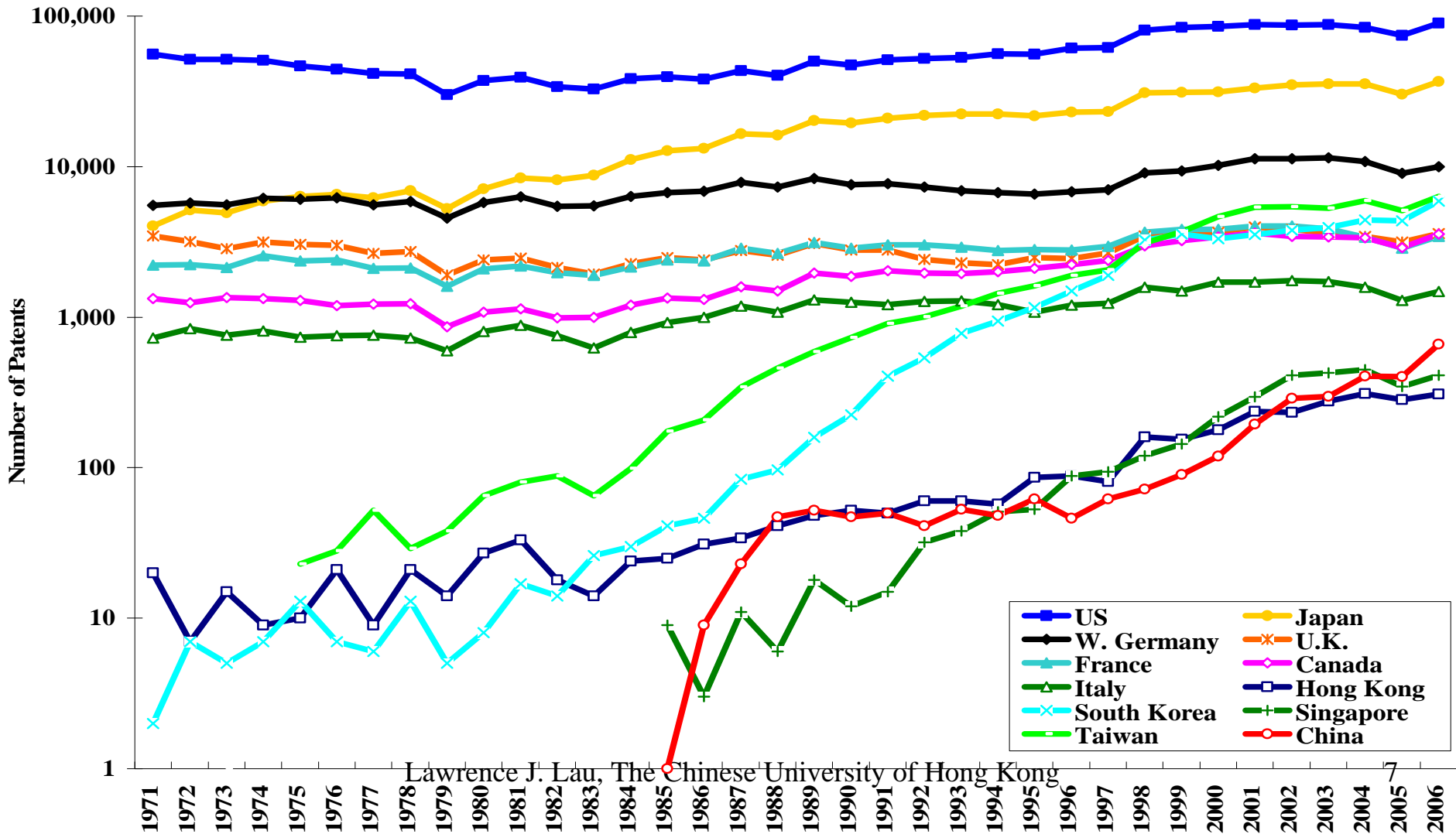
# R&D Expenditures as a Ratio of GDP: G-7 Countries, 3 East Asian NIES & China

Figure 8.1: R&D Expenditures as a Percentage of GDP: G-7 Countries, 3 East Asian NIEs and China



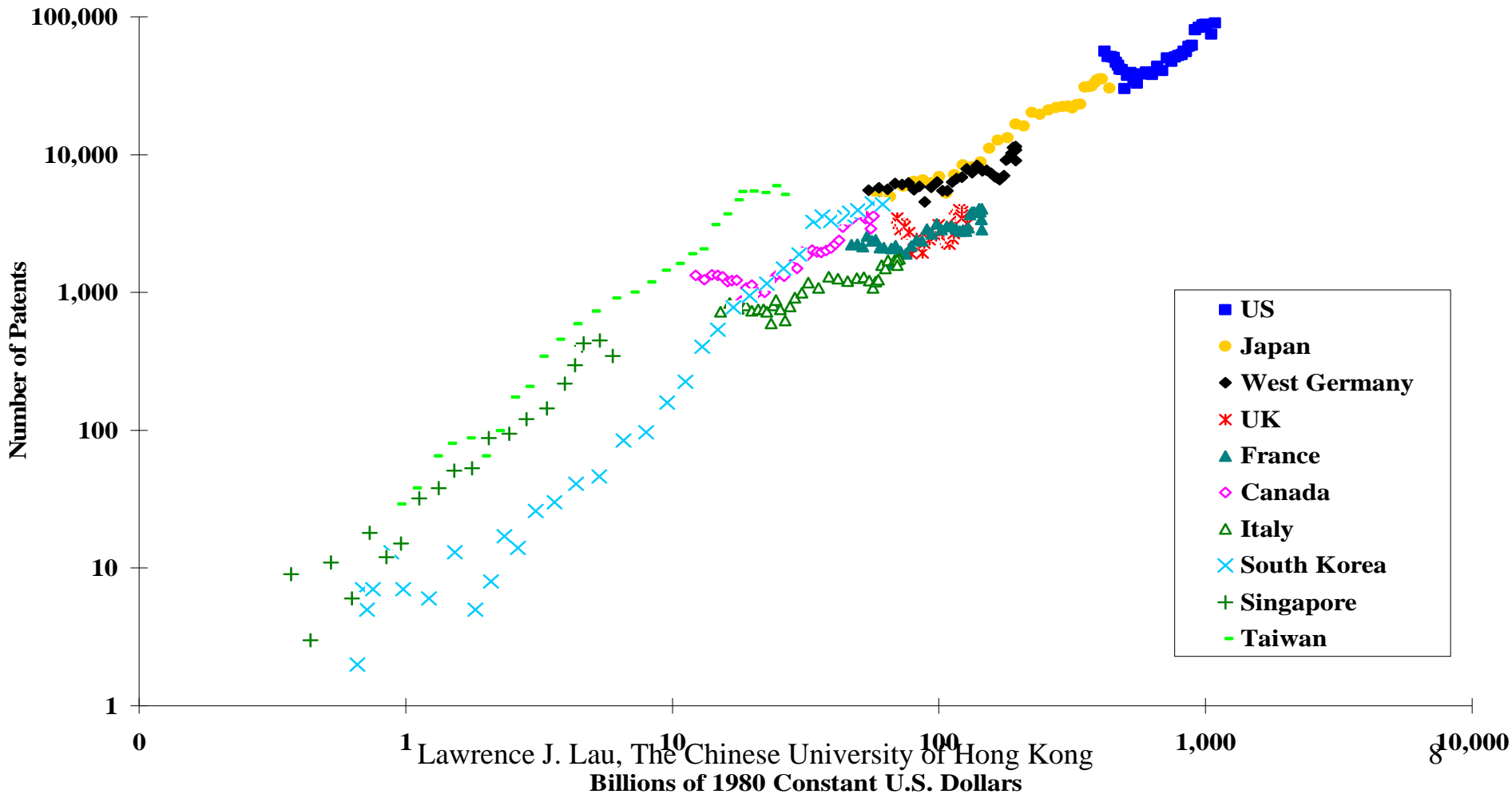
# Patents Granted in the United States: G-7 Countries, 4 East Asian NIEs & China

Figure 8.3: Patents Granted Annually in the United States: G7 Countries, 4 East Asian NIEs and China



# Patents Granted in the United States and R&D Capital Stocks, Selected Economies

Figure 8.4: The Number of U.S. Patents Granted Annually vs. R&D Capital Stocks



# The Process of Innovation

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- ◆ Basic Research—conducted in academic and research institutions such as universities and Chinese Academy of Sciences, typically supported by the government and foundations. No direct financial returns are expected.
- ◆ Applied Research—conducted in academic institutions as contract research sponsored by the government and enterprises and also in government-supported research institutions such as the system of National Laboratories and Sematech in the U.S. and the Industrial Technology Research Institute (ITRI) in Taiwan, and in laboratories in larger enterprises themselves. Little or no direct financial returns are expected except for applied research carried out at the enterprises.

# The Process of Innovation

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- ◆ Development—conducted in either existing enterprises or in start-up enterprises, typically supported by the internal funds of enterprises or by venture capital. The objective is a new product/process/service that may be patented or copyrighted. Financial returns are expected. Failure rates can be high, especially for stand-alone start-up enterprises but large enterprises normally have a number of parallel development projects.
- ◆ Commercialization--conducted at the level of the enterprises, including start-up enterprises
  - ◆ Pilot Project/Prototype
  - ◆ Incubation
  - ◆ Trial manufacturing/servicing
  - ◆ Efficient scale manufacturing (learning by doing), servicing or distribution
  - ◆ Success in commercialization is the key to translating innovation (patents, copyrights, know-how, trade secrets) into increases in real value-added or GDP.

# The Process of Innovation

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- ◆ Without development and commercialization activities at the level of the enterprises, including start-up enterprises, the benefits of innovation resulting from the government investment in basic and applied research cannot be fully realized. The results of the research must be translated into commercially viable activities.
- ◆ Military or national defence-related R&D are different because there the objective is not to make a profit and very often cost is not a consideration and one does not have to achieve efficient scale production. However, national defence-related R&D often has significant spillover to the civilian sector (e.g. the Arpanet became the internet).

# Adoption as Innovation

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- ◆ Adoption means the implementation of a concept already proven and executed elsewhere.
- ◆ Relative innovation, e.g., introduction of branded fast food outlets and restaurant chains; introduction of logistics management.
- ◆ Dissemination and diffusion of new ideas, concepts and business models.
- ◆ The possibility of leap-frogging for a relatively backward economy (telex machines and videotape players are virtually unknown in China; the high usage of mobile telephone service versus fixed-line telephone service).  
There can be “creation without destruction.”

# The Incentives for Innovation

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- ◆ The returns to innovation depends on the creation of a monopoly or quasi-monopoly (patents, copyrights, trade secrets, brand names and know-how). The ability to do so depends on the degree of protection of intellectual property rights.
- ◆ They also depend on the existing producers/suppliers. Can there be creation without destruction? Existing producers/suppliers with their sunk costs may prevent or retard the introduction, diffusion and adoption of innovation (e.g., VHS videotapes in the U.S. are still being used; fixed line telephone service).
- ◆ The degree of protection of intellectual property rights in turn depends on whether a country is a producer of intellectual property. With the growth of domestic production of intellectual property in China, the protection of intellectual property will be vastly enhanced and improved.

# The Advantages of the Chinese Economy: A Large Domestic Market

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- ◆ A large domestic market allows the realization of economies of scale.
- ◆ A large domestic market also allows the economy a significant influence on the development and setting of technological standards for products and services in the domestic as well as the world markets.
- ◆ A large domestic market also enhances the returns to R&D and other forms of intangible capital, including intellectual property and brand names. Economies of scale in the creation and utilization of intangible capital imply that the rate of return increases more than proportionally with the size of the market. The fixed development costs of innovative technologies and products or the promotion of a brand name can be more easily recovered from a large base of domestic demand.
- ◆ Reputation and reliability are particularly valued in the large markets.

# What Does It Take to Fully Exploit the Advantages of a Large Domestic Market?

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- ◆ Availability of infrastructure (transportation and communication, including the internet)
- ◆ Maintenance of a domestically open economy (the equivalent of the “interstate commerce” clause of the U.S. constitution)—no inter-provincial tariff or non-tariff barriers
- ◆ Maintenance of an internationally open economy--the role of the "open door" (WTO) and national treatment
- ◆ Affirmation of tangible and intangible property rights and the rule of law in the economic sphere--a national commercial and tax court empowered to settle and enforce all commercial and tax disputes, including intellectual property rights, on a nationwide basis

# The Advantages of the Chinese Economy: Backwardness

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- ◆ The ability to learn from the successes and failures of other economies;
- ◆ The ability to leap-frog stages of development (e.g., the telex machine, the VHS video players, the fixed landline phones); and
- ◆ The possibility of creation without destruction.

# The Advantages of the Chinese Economy: The Relative Abundance of Manpower

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- ◆ China is relatively abundant in scientific and technical manpower and the cost is a fraction of the cost in developed economies.

# The Role of Government in Promoting Innovation

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- ◆ Increasing government R&D expenditures eventually to 3 percent of GDP
- ◆ Investing directly in activities with high social rates of return but low rates of private returns—e.g., human capital, basic research, applied research, R&D in environmental control
- ◆ Investing and/or financing projects that are too large or have too long a gestation period for the non-government sector
- ◆ Coordination, standard setting and quality assurance
- ◆ Enhancing the incentives for non-government innovation by providing the necessary infrastructure, tax treatment, and access to capital markets
- ◆ Maintaining a level playing field—openness and competition

# The Role of Government

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- ◆ Support of basic and applied research (e.g., CERN at the European Union).
- ◆ Assuring the supply of an educated labor force; supporting higher education.
- ◆ Establishment of industrial research institutions if enterprises are not large enough in scale to support such research (e.g., Sematech in the U.S.; the Industrial Technology Research Institute (ITRI) in Taiwan).
- ◆ Provision of financing for major and highly capital-intensive research projects with long gestation periods, e.g., coal liquefaction, superconducting electricity transmission lines (Concorde by France and U.K.; Taiwan Semiconductor Manufacturing Corporation (TSMC) in Taiwan).
- ◆ Support and conduct of national defence-related R&D.
- ◆ Provision of a social safety net to accommodate the “destruction” that often accompanies “creation”.

# The Role of Government in Promoting Innovation

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- ◆ Developing and setting national standards and participation in the setting of international standards.
- ◆ Providing testing and quality assurance.

# Enhancing the Incentives for Non-Government Innovation

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- ◆ Maintaining the advantages of a large domestic market.
- ◆ Provision of infrastructure for information, communication, and transportation, as well as physical infrastructure such as science and technology industrial parks with low facility costs.
- ◆ Registration, protection and effective enforcement of intellectual property rights (e.g., patents and copyrights), with compulsory licensing when socially justified and necessary.
- ◆ Provision of tax benefits for R&D and other forms of innovative activities and for venture capital (e.g., the expensing of R&D expenditures; an R&D investment tax credit; the possibility of venture capital losses as a deduction against current income of individuals).
- ◆ Facilitating exits on stock exchanges by small and medium-sized enterprises (a Chinese Nasdaq?)—but in the Chinese environment it is best to require a track record of profits before initial public offering (IPO).

# The Protection of Intellectual Property Rights (IPR)

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- ◆ Without the vigorous protection and enforcement of intellectual property rights, venture capital is unlikely to take off in China.
- ◆ The protection and promotion of intellectual property rights should not be viewed as a purely legal enforcement problem. It is also an ethical and educational problem, with roots in long held traditions, customs and conventions, for example, the copying of paintings by older and established artists by aspiring artists (almost always with attribution). But it is above all an economic problem.

# The Issue of Copyright Durability

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- ◆ Current copyright laws in developed economies which extend the rights to 70 years beyond the life of the creator seem too long.
- ◆ It is a serious impediment to digital distribution of published material. For example, Google has basically digitized all of the books at Harvard University, and one can search the entire corpus on a keyword but downloads are not permitted.
- ◆ China should enact copyright laws that either provide for shorter durations for copyrights created in China in China itself or to mandate compulsory licensing in China.

# Maintaining a Level Playing Field— Promotion of Openness and Competition

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- ◆ National treatment for all enterprises, domestic and foreign (tax rates, benefits, government procurement)
- ◆ Encouragement and facilitation of imports of goods and services both to spur competition and innovation and to ensure that China does not fall behind technologically
- ◆ Anti-trust policy (aimed at both domestic and foreign enterprises) to promote competition and potential competition—the objective is to allow new technologies to emerge (e.g., The IBM case in the U.S.; the Microsoft case in the European Union).

# The Division of Labor between Government and Industry

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- ◆ Division of labor between the government and non-government enterprises. In general, the government should do (and only do) what the non-government enterprises cannot or will not do. These include:
  - ◆ Projects with very large capital requirements (e.g., the three gorges project)
  - ◆ Projects with long gestation periods (e.g., basic research)
  - ◆ Projects the benefits of which consist of mostly externalities and cannot be privately appropriated (e.g, environmental benefits, public health benefits)
  - ◆ Projects with very high risks of failure
  - ◆ Projects with national defense significance (e.g., the Moon-landing project)
  - ◆ Development-leading infrastructural projects
- ◆ The principle is that the government and the non-government sector should complement each other rather than compete with each other.

# Characteristics of Venture Capital Projects

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- ◆ Venture capital projects by their very nature are trying to innovate, to break new grounds, hence they have potentially very high failure rates—typically only one out of ten venture capital projects will become a commercial success; eight are likely to be outright failures; one out of ten may barely break even and survive.
- ◆ Information asymmetry—investors, even venture capitalist themselves, know much less about the prospects of the project than the inventors/operators of the project.
- ◆ Failures are apparent quite early (in not being able to meet milestones); successes take longer to realize.
- ◆ A venture capitalist must therefore be able to tolerate failure, have the capacity to lose money, be decisive enough to cut off funding to projects that fail to meet milestones, and to be patient about eventual payoff.

# The Role of Non-Government Enterprises

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- ◆ Non-government enterprises and entrepreneurs can tolerate higher failure rates than the Government. I cannot imagine a Minister reporting to the Premier that 8 of his or her projects have failed, one is struggling, and there is only one left that shows some promise.
- ◆ Moreover, the failures are known early, and the successes, if any, only become apparent rather late. This does not help Government officials who have to make regular reports.
- ◆ Non-government enterprises and entrepreneurs lose their own money and do not have to account to anyone else (yes, sometimes shareholders, but in the U.S., most venture capitalists invest in their own personal capacities.)
- ◆ Government officials are loath to cut off projects even though they do not meet milestones because they regard it as a sign of their failure so they are likely to continue failed projects much longer, wasting even more resources, whereas non-government enterprises and entrepreneurs cannot afford to continue to fund failed projects.

# The Role of Non-Government Enterprises

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- ◆ Because venture capitalists typically invest their own money, the possibility of moral hazard is reduced. They win or lose depending on whether the project succeeds or fails. Government officials typically invest the government's money and so they have no loss if the project fails but possible significant gains if the project succeeds. Thus, their interests and the government's interests may not be aligned. The possibility of hidden action may also lead to funding of projects that should not have been funded.
- ◆ Significant co-investment by the original inventor/operator is essential to reduce moral hazard.
- ◆ Sometimes inventors/operators do not succeed on their first try. Many succeed on their second or third try. There must be an environment that is also tolerant of failures so that inventors and operators of failed ventures will still have second and third chances.

# The Role of Government

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- ◆ Because of the high failure rates, the Government should not permit venture capital projects to raise funds publicly. In the United States, there are minimum net worth requirements for qualified investors and a limit to how many qualified investors can be approached. This is to protect the small investors by not allowing them to invest in venture capital because of its inherent riskiness.
- ◆ The Government can be helpful when a venture capital project reaches the commercialization stage—appropriate extension of credit can be critical to a project's eventual commercial success (e.g., Taiwan Semiconductor Manufacturing Corporation).

# Concluding Remarks

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- ◆ The complementarity of innovation and scale favours economies with large markets. The experiences of the United States and more recently China suggest that the size of the market can greatly increase returns to investment in innovation.
- ◆ That the United States has the highest rate of technical progress in the world, even though other economies may have invested similar percentages of their real GDPs in R&D, may be explained in part by its own large and open domestic market. Additionally, its own large and open domestic market raises the expected rate of return on investment in innovation to potential private investors (venture capitalists) and hence increase the private investment in innovation in the United States.

# Concluding Remarks

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- ◆ Globalization of world markets thus further enhances the returns to innovation for the world as a whole. Open markets spur both competition and innovation, and prevents a country from falling behind technologically.
- ◆ Ability and willingness for venture capitalists and entrepreneurs to take large risks and tolerance for failure are the two essential ingredients for the success of venture capital.
- ◆ Tax benefits in terms of write-offs against regular income, long-term capital gains treatment on gains and facilitation of exit are some of the measures that the Government can take to encourage and promote venture capital in China.

# Concluding Remarks

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- ◆ Protection of intellectual property rights is absolutely essential as an incentive for innovation (and for the success of venture capital). However, it requires not only enforcement but also education and promotion. The public should understand that without protection, the incentive to create intellectual property rights will greatly diminish, to the detriment of the nation.
- ◆ The best way to promote and protect intellectual property rights is to devise win-win solutions so as to create constituencies both domestically and overseas to sustain these solutions.

# Concluding Remarks

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- ◆ National security considerations may dictate certain particular investments, e.g., the development of an alternative operating system to Windows. However, ultimately, for the civilian sector, its success must be based on market acceptance, and not on a government sanctioned monopoly.