ΠΑΝΕΠΙΣΤΗΜΙΟ ΠΑΤΡΩΝ
UNIVERSITY OF PATRAS

# LECTURE 12. *BUSINESS STRATEGY-INNOVATION AND R&D (ROLE OF R&D IN COMPETITION, INCENTIVES FOR R&D AND INNOVATION)*


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# What and Why Innovation?

- An **innovation** is the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organisational method in business practices, workplace organisation or external relations.
- Innovation – key to the growth of output and productivity (Fagerberg, 1988)
- The relationship between innovation and economic development is widely acknowledged.
- Innovation policy should be evidence-based.
- Innovation data – to better understand innovation and its relation to economic growth; to provide indicators for benchmarking national performance.
- Why R&D (Cohen and Levinthal, 1989;1990)

# What is the 'economics of innovation'?

**Microeconomics** – understanding processes, including how incentives affect firms. Role of technical change (3- stages).

**Macroeconomics** – 'innovation' drives economic growth, and economic growth drives living standards, environmental, political e.t.c.

**Economic Policy** – are there market failures in the innovation process and what, if anything, should the government do?

**Business Strategy** – this is not a course on advising firms how to innovate, but does include some insight into this.

https://data.worldbank.org/indicator/IP.PAT.RESD

# Definition of innovation

Basic definition

Introduction of new ideas that add 'value' to a firm's activities

OECD *The Oslo Manual (1997, 2005)*

- introduction of a new product or a qualitative change in an existing product
- process innovation new to an industry
- the opening of a new market
- development of new sources of supply for raw materials or other inputs
- changes in industrial organisation

# Innovation and busines

Some students may benefit from a brief comment on why innovation is so important to business

Some example of quotes

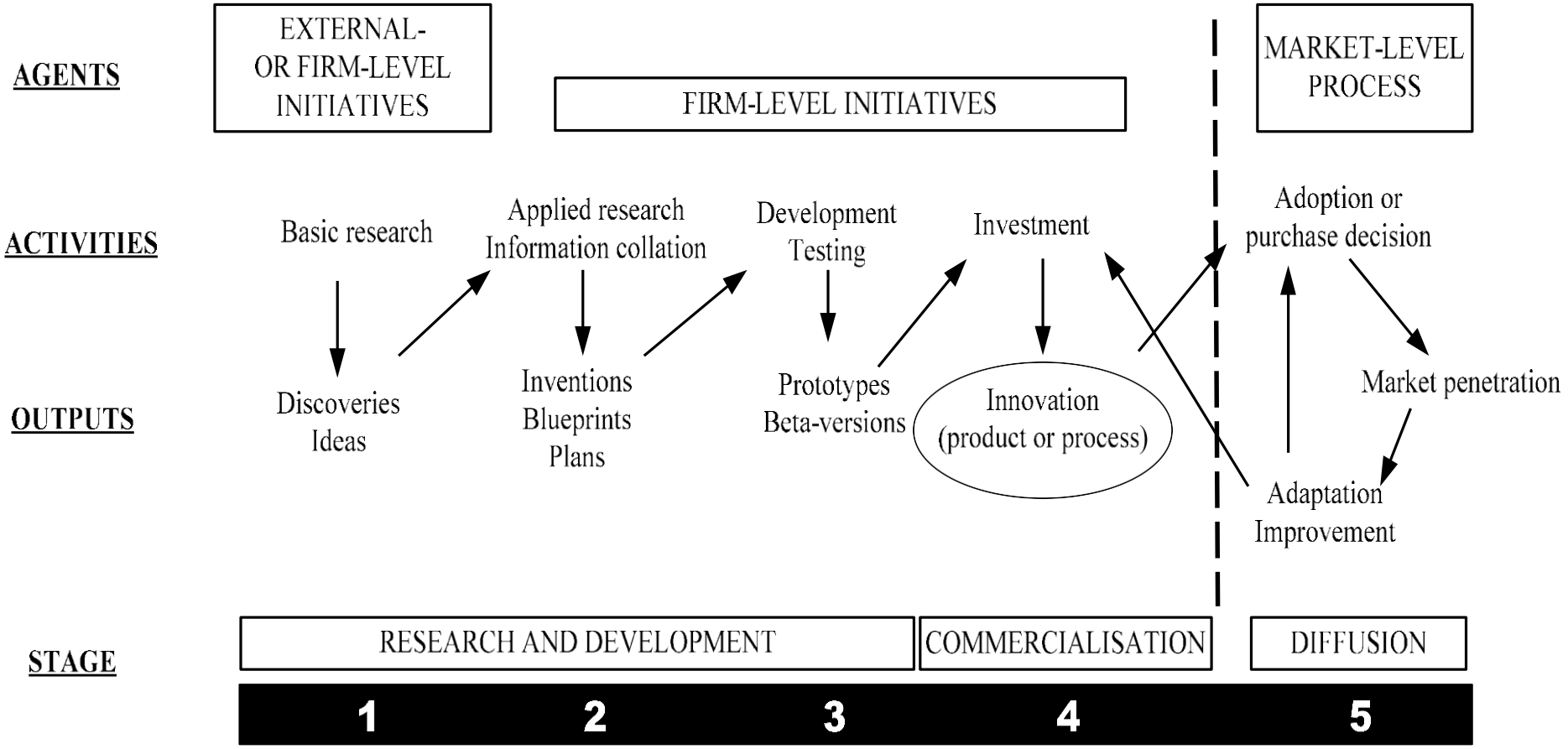
- "Business has only two functions, *innovation* and marketing." Peter F Drucker
- "Creativity is thinking up new things. *Innovation* is doing new things."
  Theodore Levitt (management guru)
- *Innovation* distinguishes between a leader and a follower." Steve Jobs

# Invention, Innovation, Diffusion(Schumpeterian 1932;1939;1942 trilogy)

- **Invention**: creation of an idea to do or make something (profitability not yet verified)
- **Innovation**: new product/ process commercially valuable i.e. successfully developed inventions.
- **Diffusion**: the spread of a new invention/innovation throughout society or at least throughout the relevant part of society.
  - Without this cannot gain full benefits
  - Some of this represents 'spillovers' or 'positive externalities'

Two activities in inventing and innovative activity are patenting (output of inventive) and R&D (output of inventing-innovative).

# The innovation proces

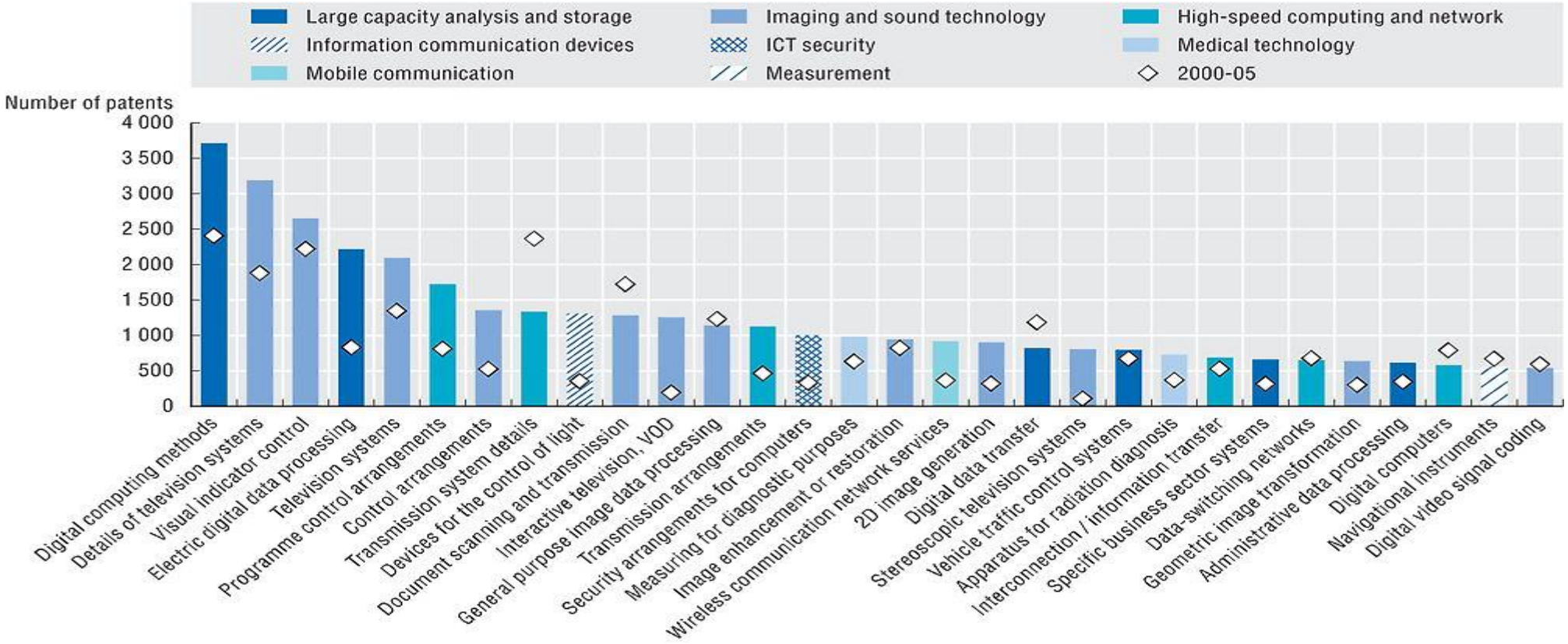


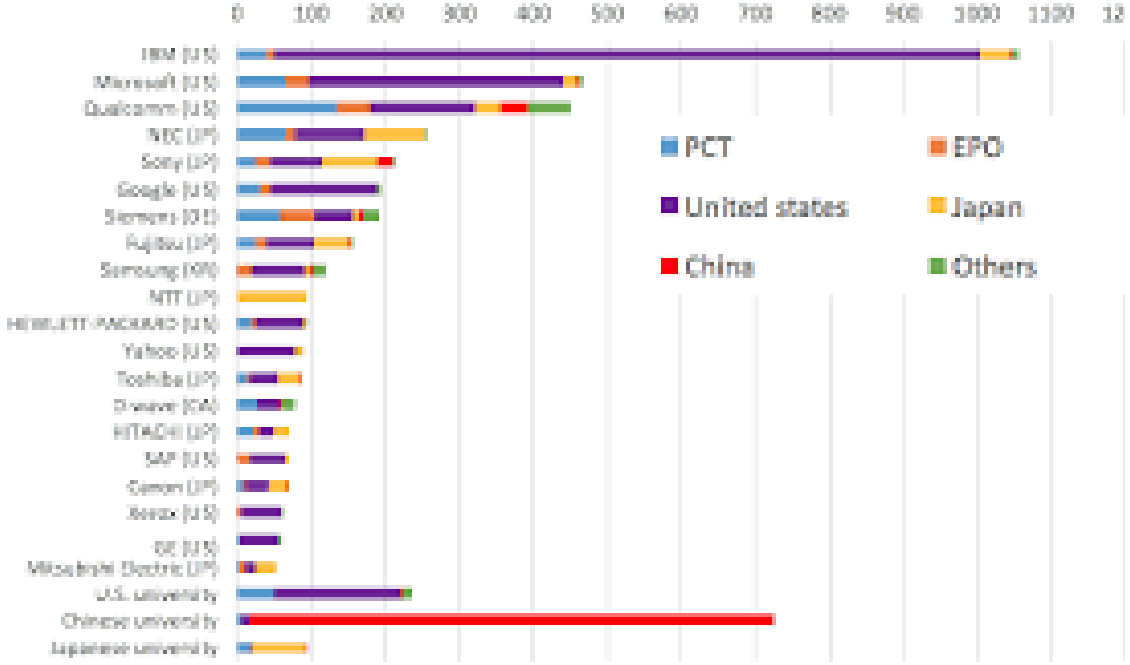

Source: Greenhalgh and Rogers (2010)

# Some Important concepts

1)Innovation is discontinuous and lumpy
2) Innovation is a wider concept
3) Entrepreneur is not the narrow profit maximizer.

1) Intrinsic uncertainty (Stoneman, 1983)
2) Any firm engaged in inventive activity will contemplate the appropriability of the results of its activity
3) Timing is crucial (time-cost trade-off or patents race)




## Top 50 countries for patent applications 2020

TOP 50

| | | 2020 | Change |
|---|---|---|---|
| 1 | United States | 44 220 | -4.1% |
| 2 | Germany | 33 934 | -3.0% |
| 3 | Japan | 31 841 | -1.1% |
| 4 | P.R. China | 13 432 | +9.9% |
| 5 | France | 10 356 | +3.1% |
| 6 | R. Korea | 8 126 | +9.2% |
| 7 | Switzerland | 8 112 | -1.6% |
| 8 | Netherlands | 6 376 | -8.2% |
| 9 | United Kingdom | 6 116 | -6.6% |
| 10 | Italy | 4 600 | +2.9% |
| 11 | Sweden | 4 425 | +6.6% |
| 12 | Denmark | 3 404 | -6.5% |
| 13 | Belgium | 3 400 | -6.9% |
| 14 | Austria | 3 300 | -1.6% |
| 15 | Finland | 1 895 | +11.1% |
| 16 | Spain | 1 751 | -5.0% |
| 17 | Canada | 1 750 | -4.4% |
| 18 | Israel | 1 681 | +6.8% |
| 19 | Chinese Taipei | 1 344 | +15.9% |
| 20 | Ireland | 970 | +10.8% |
| 21 | Australia | 938 | -3.9% |
| 22 | India | 698 | +6.7% |
| 23 | Norway | 646 | 0.0% |
| 24 | Turkey | 594 | +26.1% |
| 25 | Singapore | 577 | +14.3% |
| 26 | Saudi Arabia | 488 | +36.1% |
| 27 | Poland | 483 | +4.3% |
| 28 | Cayman Islands | 458 | -9.7% |
| 29 | Liechtenstein | 436 | -9.2% |
| 30 | Luxembourg | 394 | -5.1% |
| 31 | Puerto Rico | 390 | -1.7% |
| 32 | Russian Federation | 384 | +8.2% |
| 33 | Barbados | 380 | +8.7% |
| 34 | Portugal | 348 | -8.3% |
| 35 | Czech Republic | 305 | +1.3% |
| 36 | New Zealand | 300 | +11.1% |
| 37 | Slovenia | 168 | +38.2% |
| 38 | Brazil | 161 | -16.1% |
| 39 | Hong Kong SAR (China) | 138 | +26.8% |
| 40 | Greece | 136 | -3.5% |
| 41 | Hungary | 127 | +10.3% |
| 42 | Antigua and Barbuda | 97 | +142.5% |
| 43 | South Africa | 88 | +1.1% |
| 44 | United Arab Emirates | 71 | +65.1% |
| 45 | Malta | 65 | +12.1% |
| 46 | Cyprus | 54 | +10.2% |
| 47 | Thailand | 50 | -25.8% |
| 48 | British Virgin Islands | 50 | +5.1% |
| 49 | Estonia | 37 | +19.8% |
| 50 | Slovakia | 36 | +31.3% |

European Patent Office (EPO)

# Scientists, Knowledge and Technology

**Scientists**

- Discover knowledge by research
- Disseminate knowledge (open science?)
- Knowledge is public good(non-rival in use), hence created externalities
- Universities, government labs, some large firms
- It may represent the basis for technological advances
- This distinction is based on motivation (Dasgupta and David, 1991)

**Technology**

- Application of knowledge to 'production'
- Firms driven by profit incentive
- Private good: investment (R&D) projects, appropriate, use of intellectual property

# Product and proces innovations Blaug (1963)

Product innovations

- product used by consumers
  - Microwaves, computers, mobile phones, etc
  - Products use by firms
  - Shipping containers, computers, robots, etc

Process innovations

- Used by consumers
  - Fast food, air travel
- Used by firms
  - Assembly lines, software

**Product innovation**: introduction of a good or se rvice that is new or significantly improved with respect to its characteristics or intended uses. This includes significant improvements in technical specifications, components and materials , incorporated software, user friendliness or other functional characteristics.
**Process innovation**: implementation of a new or significantly improved production or delivery met hod. This includes significant changes in techniques, equipment and/or software.
**Marketing innovation**: implementation of a new marketing method involving significant changes in product design or packaging, product placement, product promotion or pricing.
**Organisational innovation**: implementation of a new organisational method in the firm's business practices, workplace organisation or external relati ons.

# Innovation activities

Innovation activities are all scientific, technological, organisational, financial and commercial steps which actually, or are intended to, lead to the implementation of innovations. Some innovation activities are themselves innovative, others are not novel activities but are necessary for the implementation of innovations.

Innovation activities also include R&D that is not directly related to the development of a specific innovation.

# Innovation activities for product and process innovations

- ***Intramural (in-house) R&D:*** This comprises all R&D conducted by the enterprise, including basic research.
- ***Acquisition of R&D (extramural R&D):*** R&D purchased from public or private research organisations or from other enterprises (including other enterprises within the group).
- ***Acquisition of other external knowledge:*** Acquisition of rights to use patents and non-patented inventions, trademarks, know-how and other types of knowledge from other enterprises and institutions such as universities and government research institutions, other than R&D.
- ***Acquisition of machinery, equipment and other capital goods:*** Acquisitions of advanced machinery, equipment, computer hardware or software, and land and buildings (including major improvements, modifications and repairs), that are required to implement product or process innovations.
- ***Other preparations for product and process innovations:*** Other activities related to the development and implementation of product and process innovations, such as design, planning and testing for new products (goods and services), production processes, and delivery methods that are **not** already included in R&D.
- ***Market preparations for product innovations:*** Activities aimed at the market introduction of new or significantly improved goods or services.
- ***Training:*** Training (including external training) linked to the development of product or process innovations and their implementation.

# Innovation activities for marketing and organizational innovations

- ***Preparations for marketing innovations:*** Activities related to the development and implementation of new marketing methods. Includes acquisitions of other external knowledge and other capital goods that are specifically related to marketing innovations.
- ***Preparations for organisational innovations:*** Activities undertaken for the planning and implementation of new organisation methods. Includes acquisitions of other external knowledge and other capital goods that are specifically related to organisational innovations.

# Innovations and Market Failure

- Innovation as a public good
  - Non-rival and non-excludable
- Externalities from innovative activity
  - R&D spillovers
- Indivisibilities, uncertainty, and capital markets
  - Fixed costs, uncertainties
  - Do capital markets cope with these?
- Patent races and duplication

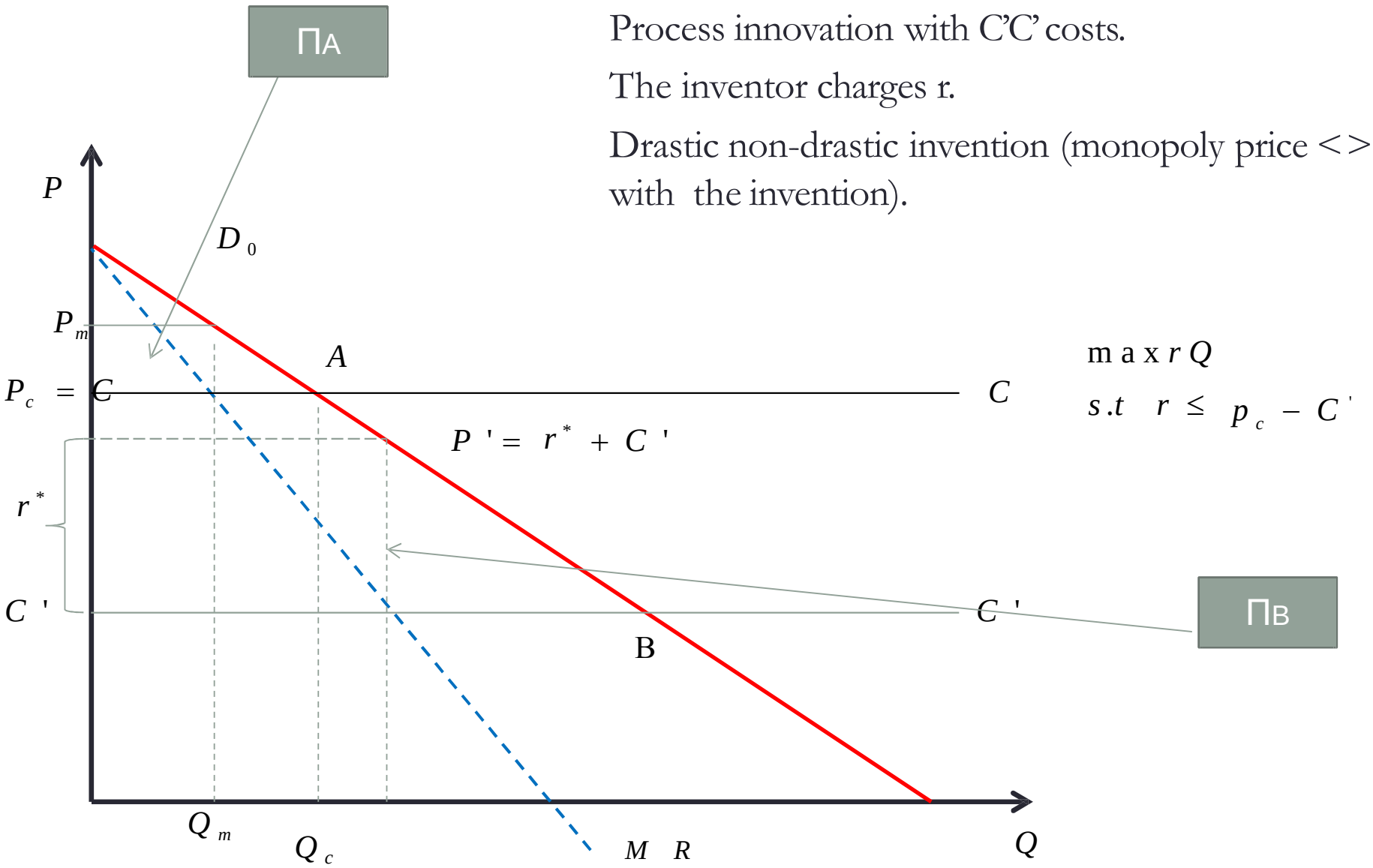
# The incentive to invest (Drasticinvention)- Arrow (1962)

Differences between monopoly and competitive market.

Process innovation with C'C' costs.

The inventor charges r.

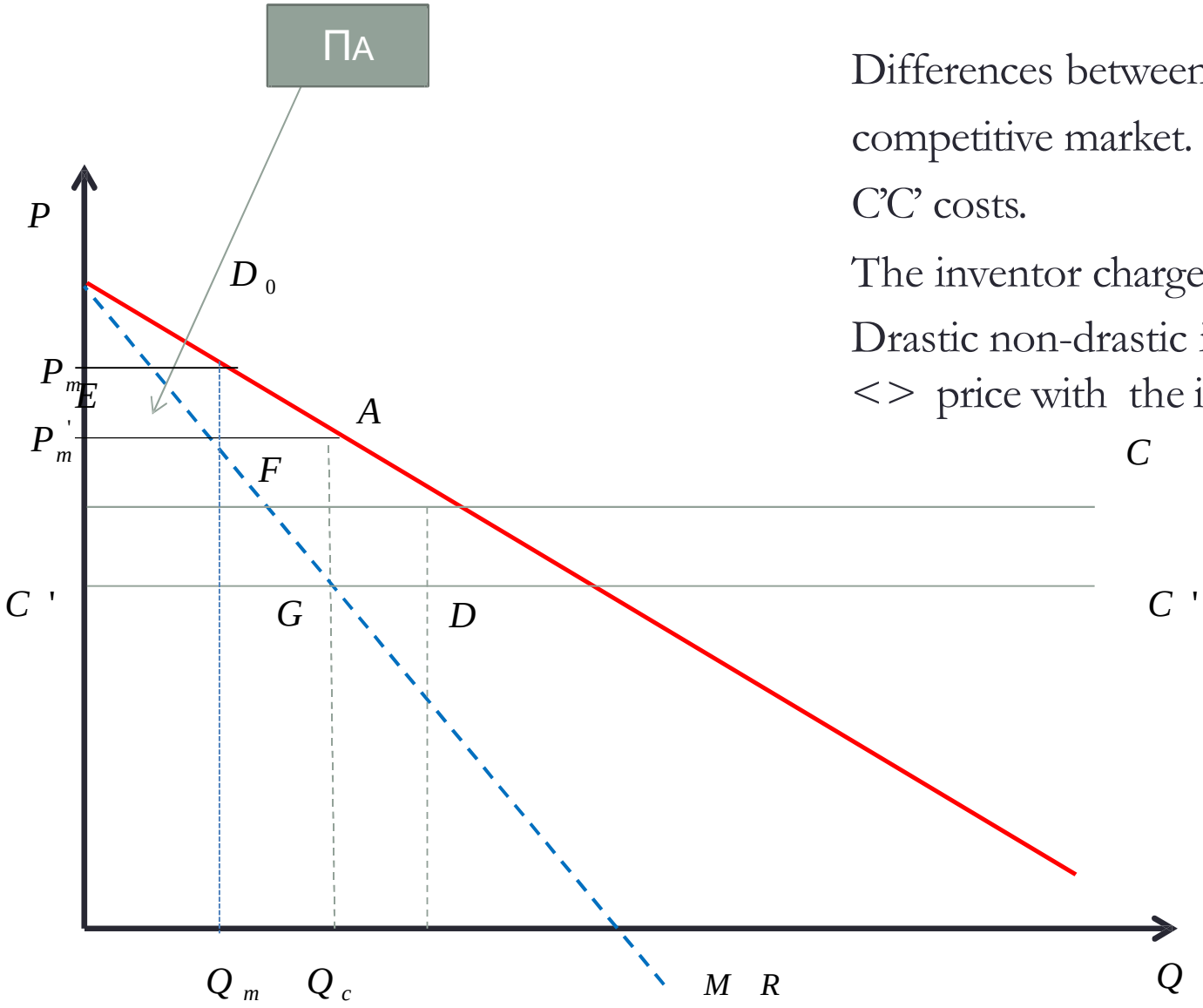
Drastic non-drastic invention (monopoly price <> price with the invention).




$$\max r\,Q$$

$$s.t \quad r \le p_c - C'$$

# The incentive to invest (Non-drasticinvention)-Arrow (1962)




Differences between monopoly and competitive market. Process innovation with C'C' costs.

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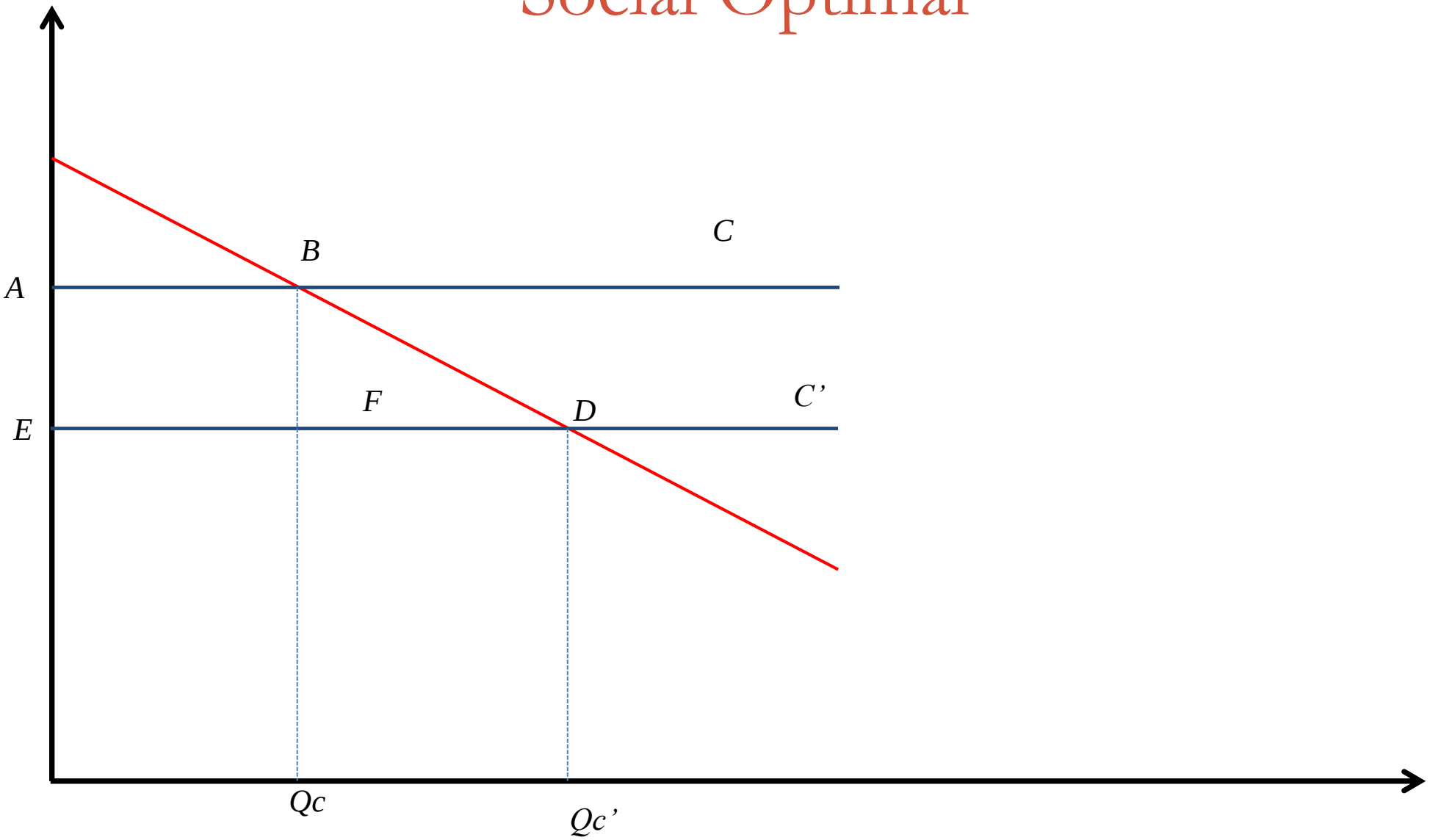
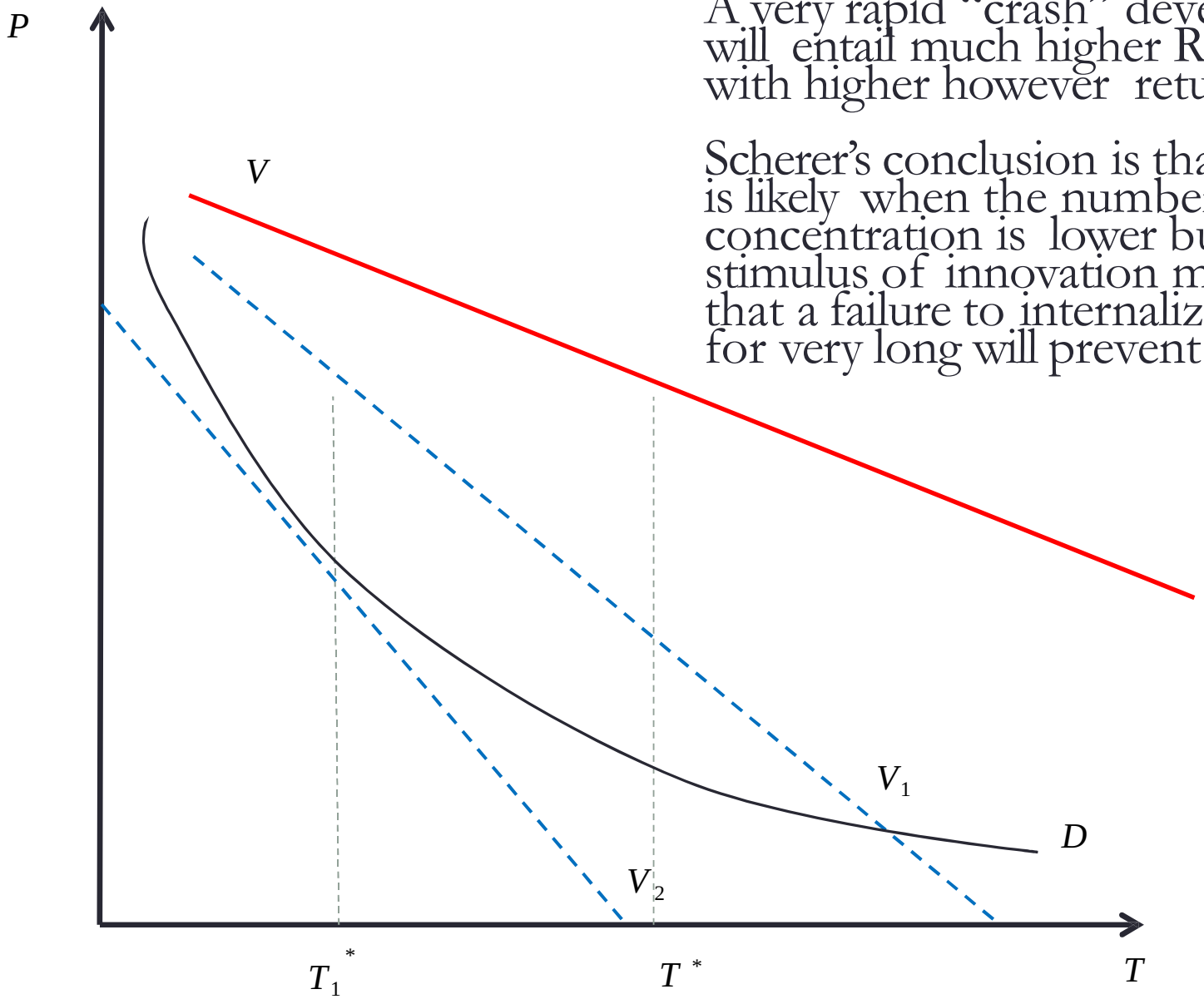
# Social Optimal



# Criticisms concern Arrow model

1. There is no competition in the inventive process.
2. Diffusion of the innovation is assumed to be instantaneous in the competitive case.
3. The new process is taken as given.
4. Only a single discrete invention is considered.

# Pace of Development and the timing of innovation (Scherer, 1967;1970)




A very rapid "crash" development programme will entail much higher R&D (Mansfiled, 1971) with higher however returns.

Scherer's conclusion is that more rapid innovation is likely when the number of sellers is greater and concentration is lower but beyond a level the stimulus of innovation maybe killed off by fears that a failure to internalize the innovation returns for very long will prevent development costs.

# Innovation and R&D as a continuous activity

$$Q = f(p, RD), Q_p < 0, Q_D > 0$$

$$TC = TC(Q) + RD$$

$$\frac{RD}{pQ} = \frac{\varepsilon_{RD}}{\varepsilon_p}$$

Needham 1975

$$Q = f(p, RD, \overline{RD}), Q_p < 0, Q_D > 0$$

$$TC = TC(Q) + RD$$

$$\frac{RD}{pQ} = \frac{\varepsilon_{RD} + k\varepsilon_{\overline{RD}}}{\varepsilon_p}, \varepsilon_{\overline{RD}} < 0, k > 0$$

Hay and Morris, 1980

$$\frac{RD}{pQ} = \frac{\varepsilon_{RD} - \varepsilon_{CD}(\varepsilon_p - 1)}{\varepsilon_p}, \varepsilon_{CD} < 0$$

$$\Pi_i = pQ_i - TC_iQ_i - RD_iTC$$

$$\frac{RD_i}{pQ_i} = \frac{-\varepsilon_{CRD}\left(\varepsilon_p - \frac{Q_i}{Q}\right)}{\varepsilon_p}, \text{and}$$

Dasgupta and Stiglitz 1980

$$pQ_i - TC_iQ_i = \frac{Q_i}{Q}\frac{p}{\varepsilon_p}$$

# Innovation and R&D as a continuous activity

Dasgupta and Stiglitz 1980

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$$pQ_i - TC_iQ_i = \frac{Q_i}{Q}\frac{p}{\varepsilon_p}$$

Free entry

Barriers to entry

Number of firms is exogenously fixed. The relationship between stems from previous equations. Less concentrated industries do more R&D than the more concentrated ones but the amount per firm falls.

$$(p - TC)Q = RD$$

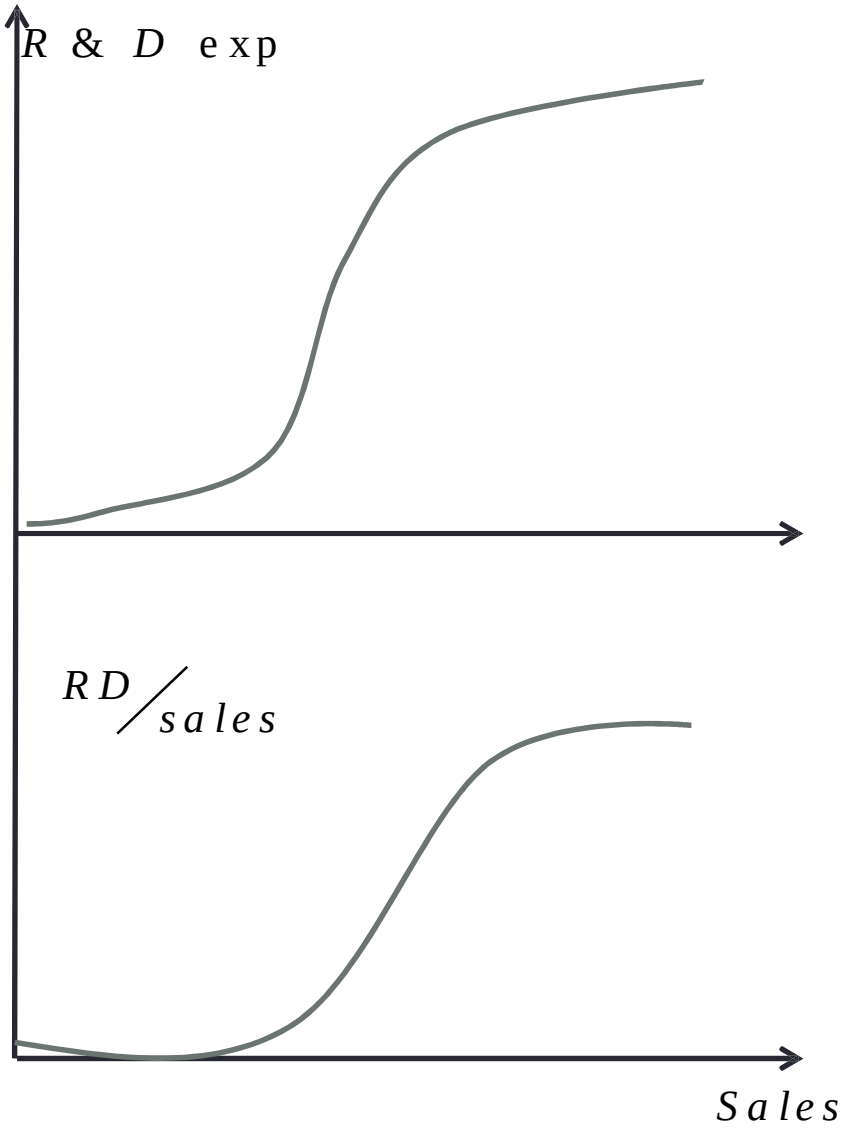
$$\frac{RD}{pQ} = \frac{p - TC}{p} = \frac{1}{n\varepsilon_p}$$

1) Market structure and R&D will be jointly determined in many cases
2) The market as opposed to socially managed economy, may well involve excessive duplication.

# Measuring and R&D intensity (Weis , 1971)

In measuring inventive and innovative activity researchers have employed three main alternative

1. Head-counts of the number of patents issued
2. Expenditure or employment of personnel on R&D
3. Head-counts of the number of innovations, sometimes confined to significant innovations as defined by the researcher or/and the industry experts.



# Restoring incentives to invent and innovate

- Public provision of a public good
- Club provision of a local public good
- Pigovian subsidies
- Definition of property rights
- The trade-off between incentives and monopoly power

# Questions for discussion

1. How would you distinguish between an invention and an innovation?
2. What are the key characteristics of a public good? Is all new knowledge a public good?
3. What is a positive externality? How does this differ from a public good?
4. How does innovation create positive externalities? Why are they a problem?
5. What are the key market failures surrounding investment in innovation?
6. Does the creation of intellectual property rights help or hinder the markets for innovative goods and processes?

# Classifying firms by degree of innovativeness

- The **innovative firm** is one that has introduced an innovation during the period under review. The innovations need not have been a commercial success – many innovations fail.
- An **innovation active firm** is one that has had innovation activities during the period under review, including those with ongoing and abandoned activities. In other words, firms that have had innovation activities during the period under review, regardless of whether the activity resulted in the implementation of an innovation, are innovation active.
- A **potentially innovative firm** is one type of "innovation active firm", that has made innovation efforts but **not achieved results**. This is a key element in innovation policies: to help them **overcome the obstacles that prevent them from being innovative** (converting efforts into innovations) – Annex for developing countries.

# Factors influencing innovation

- **Objectives**: Identifying enterprises' motives for innovating and measuring their importance
- **Hampering factors**: reasons for not starting innovation activities at all, or factors that slow innovation activity or have a negative effect on expected results. These include economic factors, such as high costs or lack of demand, enterprise factors such as lack of skilled personnel or knowledge, and legal factors such as regulations or tax rules. The ability of enterprises to appropriate the gains from their innovation activities is also a factor affecting innovation.

Source:www.uis.unesco.org

# Objectives and effects of innovation

- **Competition, demand and markets**
- Replace products being phased out
- Increase range of goods and services
- Develop environment-friendly products
- Increase or maintain market share
- Enter new markets
- Increase visibility or exposure for products
- Reduced time to respond to customer needs
- **Production and delivery**
- Improve quality of goods and services
- Improve flexibility of production or service provision
- Increase capacity of production or service provision
- Reduce unit labour costs
- Reduce consumption of materials and energy
- Reduce product design costs
- Achieve industry technical standards
- Reduce production lead times
- Reduce operating costs for service provision
- Increase efficiency or speed of supplying and/or delivering goods or services
- Improve IT capabilities
- **Workplace organisation**
- Improve communication and interaction among different business activities
- Increase sharing or transferring of knowledge with other organisations
- Increase the ability to adapt to different client demands
- Develop stronger relationships with customers
- Improve working conditions
- **Other**
- Reduce environmental impacts or improve health and safety
- Meet regulatory requirements

Source:www.uis.unesco.org

# Factors hampering innovation activities

- **Knowledge factors:**
- Innovation potential (R&D, design, etc.) insufficient
- Lack of qualified personnel: Within the enterprise / In the labour market
- Lack of information on technology / markets
- Deficiencies in the availability of external services
- Difficulty in finding co-operation partners for: Product or process development / Marketing partnerships
- Organisational rigidities within the enterprise: Attitude of personnel/ managers towards change, Managerial structure of enterprise
- Inability to devote staff to innovation activity due to production requirements
- **Institutional factors:**
- Lack of infrastructure
- Weakness of property rights
- Legislation, regulations, standards, taxation
- **Cost factors:**
- Excessive perceived risks
- Cost too high
- Lack of funds within the enterprise
- Lack of finance from sources outside the enterprise: Venture capital / Public sources of funding
- **Market factors:**
- Uncertain demand for innovative goods or services
- Potential market dominated by established enterprises
- **Other reasons for not innovating:**
- No need to innovate due to earlier innovations
- No need because of lack of demand for innovations

Source:www.uis.unesco.org

# Impacts and outcomes

- Impacts of innovations on firm performance range from effects on sales and market share to changes in productivity and efficiency. Important impacts at industry and national levels are changes in international competitiveness and in total factor productivity, knowledge spillovers of firm-level innovations, and an increase in the amount of knowledge flowing through networks.
- The outcomes of product innovations can be measured by the percentage of sales derived from new or improved products.

Source:www.uis.unesco.org

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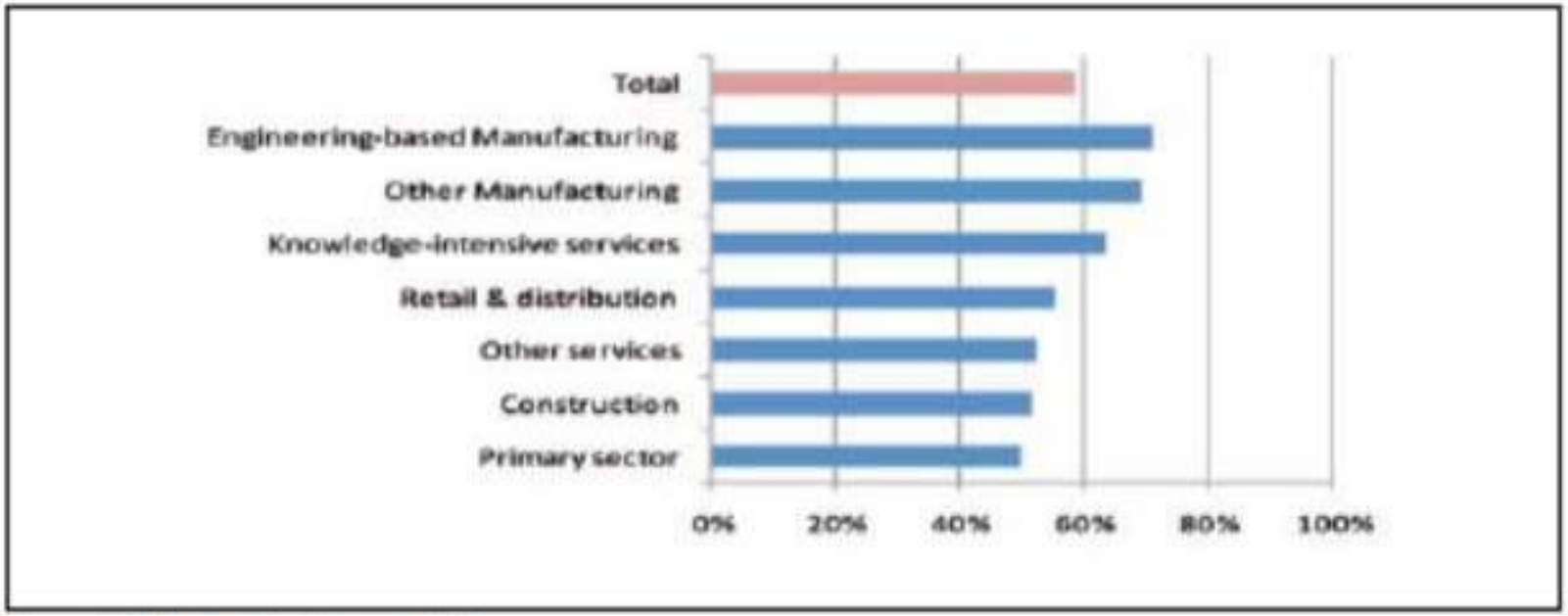
# Appendix- Innovation and Research Strategy for Growth

- Launched 8th December 2011
- Supported by BIS Economics Paper – provides analysis to underpin the policy document


Lesson 1: Innovation is pervasive. UK data shows high levels of innovation and l ow variance across industries. Highly innovative firms are found in all industries and regions.

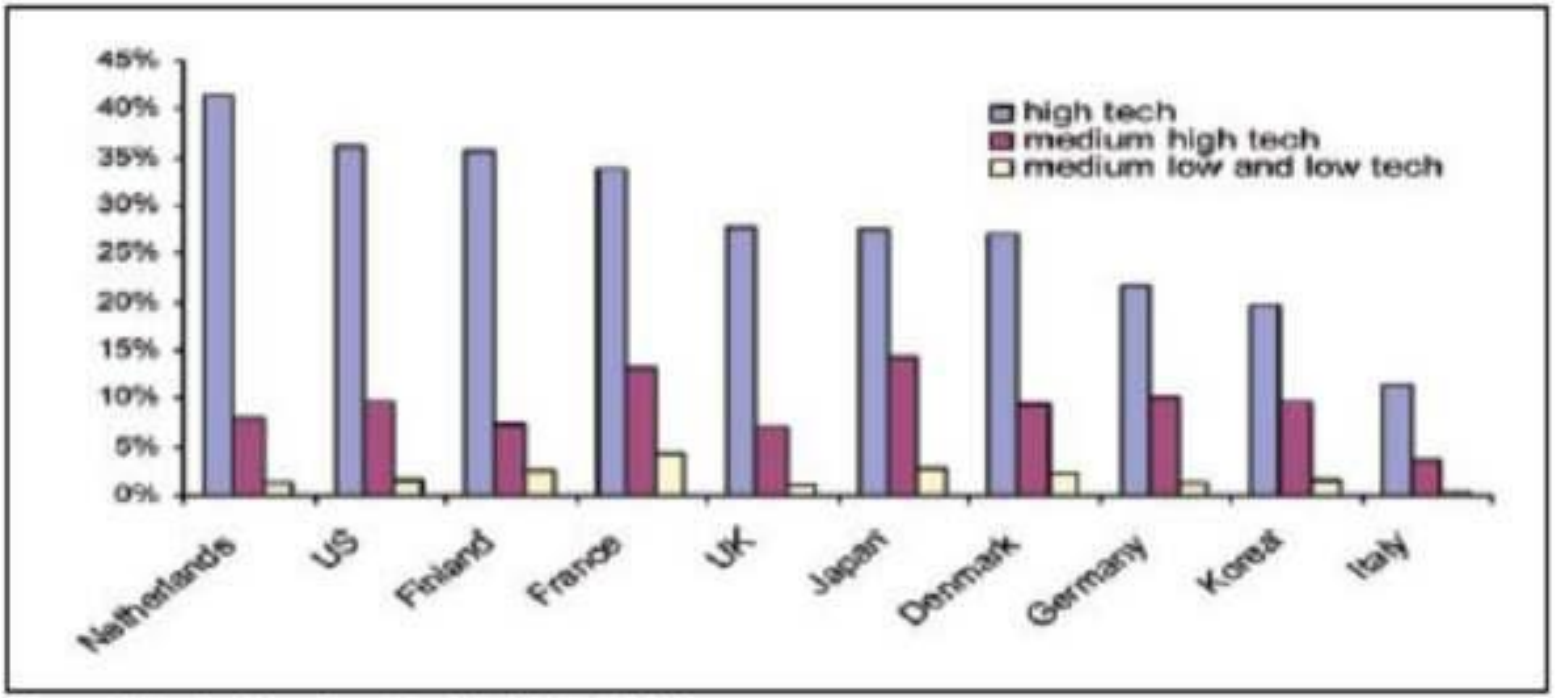
*Proportion of innovation active enterprises in the UK, by sector (2006 – 2008)*




*Source: UK Innovation Survey, 2009*

Lesson 2: UK R&D performance is uneven. In terms of R&D, the UK performs relatively strongly in small high tech sectors, and relatively poorly in large low tech sectors.

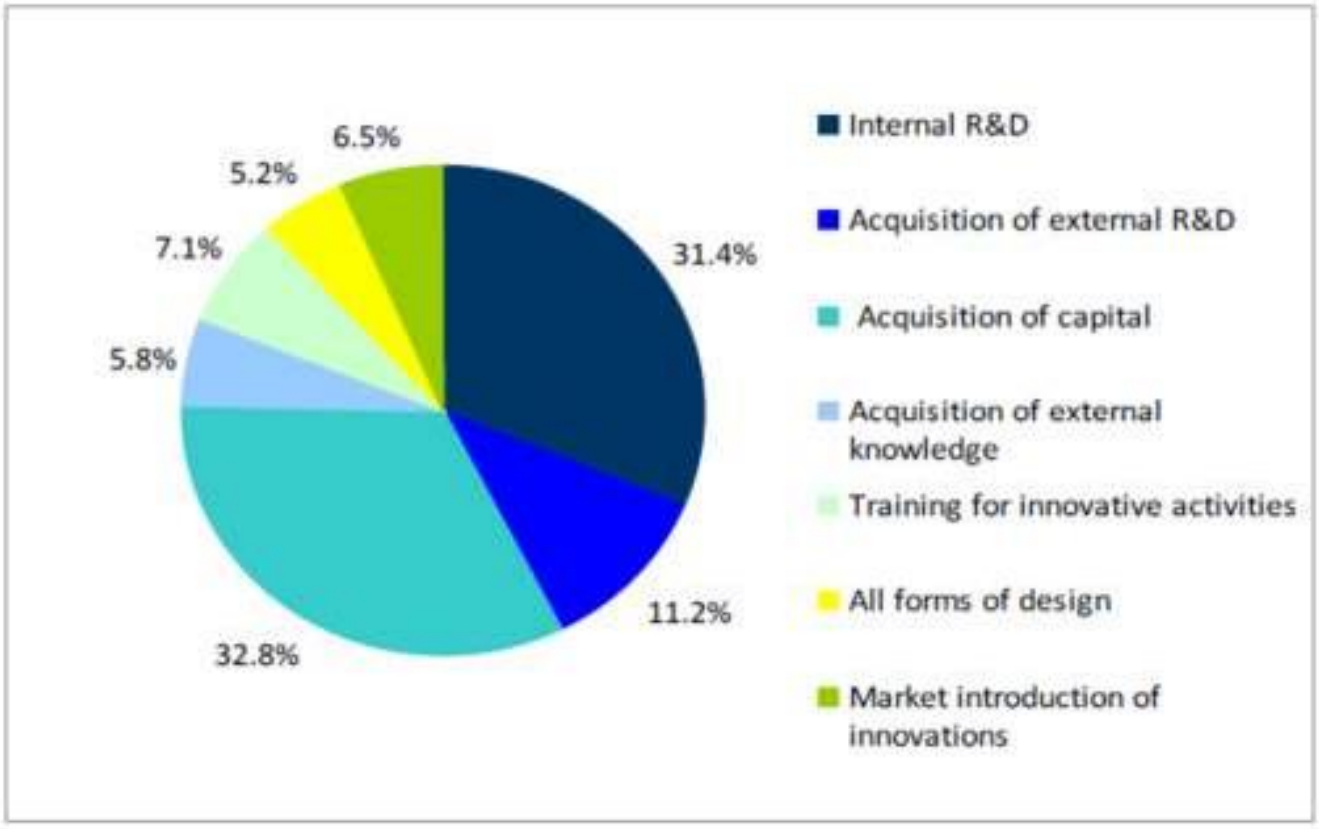
*R&D expenditure in businesses as % of gross value added, annual average (2003 – 2006)*




*Source: BIS calculations based on OECD data (2011)*

Lesson 3: Non-R&D inputs are large, growing and central to innovation. Non-R&D inputs are larger than R&D across all industries. More than half of innovating firms do no R&D at all.

*Innovation expenditure in 2008*
*(proportions of total expenditure)*



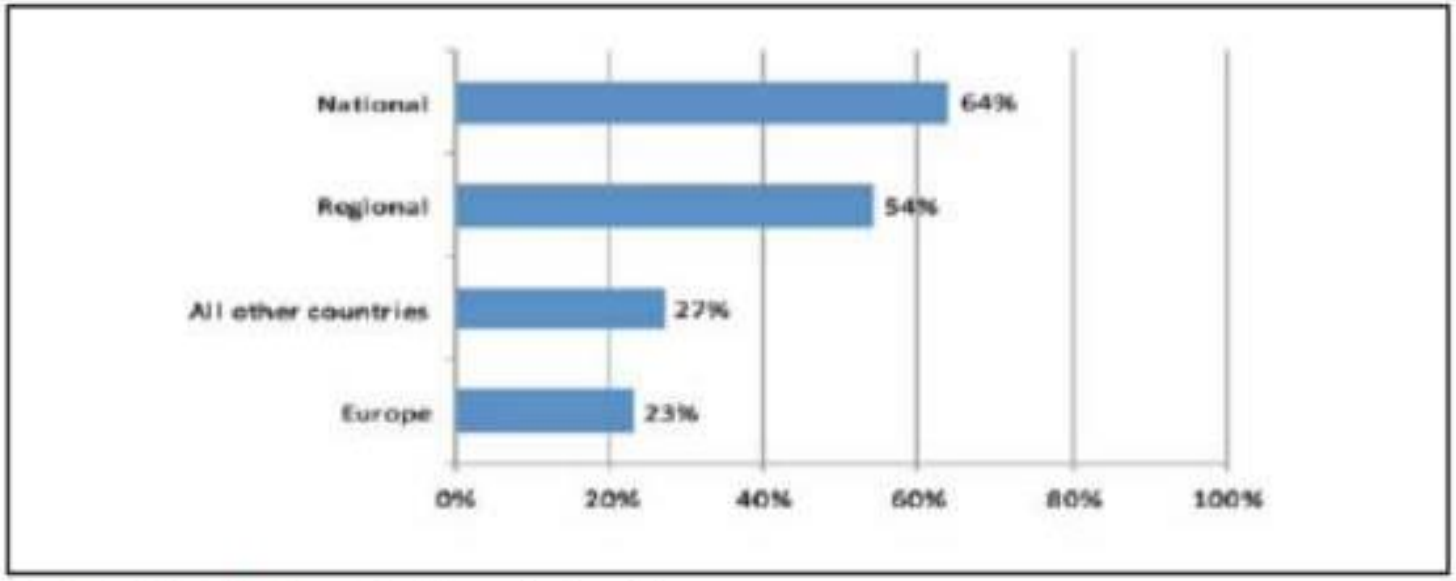
Lesson 4: Universities and the innovation infrastructure interact well with industry. Evid ence suggests close and productive links between the knowledge infrastructure, as a whole, and business. Take-up issues may be more on the side of business.

*Degree of academic-business engagement across types of interaction in the UK*

| Type of Interaction | Cambridge survey (At least once) | IGPC survey (At least once) |
|---|---|---|
| Attendance at conference with industry and university participation | 87% | 78% |
| Attendance at industry-sponsored meetings | n/a | 59% |
| A new contract research agreement (original research done by university alone) | 37% | 54% |
| A new joint research agreement (original research undertaken by both partners) | 42% | 53% |
| A new consultancy agreement (provision of advice that requires no original research) | 43% | 44% |
| Postgraduate training with a company | 33% | 44% |
| Training of company employees (through course enrolment or through temporary personnel exchange) | 33% | 27% |
| Creation of new physical facilities with industry funding (e.g. new laboratory of buildings on campus) | 9% | 15% |

Lesson 5: Cross-border value chains are increasingly important. Many product s derive from cross-border collaborations. Shocks to production have major tra de impacts. Innovation capability seems important to participation in global val ue chains.

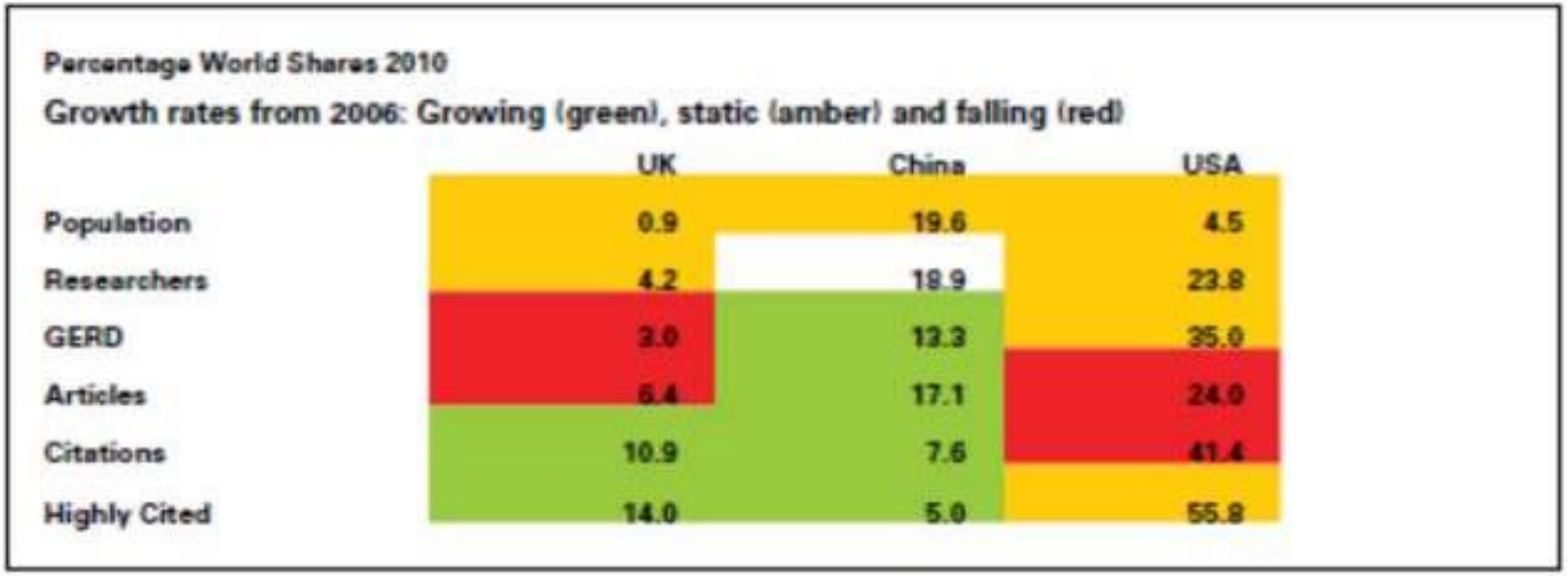
*Location of cooperation partners*
*(% of UK innovative enterprises with cooperation agreements)*




Source: BIS (2009) UK Innovation Survey, London: BIS.

Lesson 6: UK's science performance is strong. UK research quality is growing and the UK research base achieves the best value for money among the large economies, leading on all counts of papers, citations and highly cited papers per pound spent on R&D.

*Scienitific publication pattern*




*Source: BIS (2011), International Comparative Performance of the UK Research Base, Elsevier report to BIS*

Lesson 7: The public sector has a significant role in innovation performance. The public sector shapes the environment, generates technologies, innovates in services and procur es products on a large scale. A strategic approach to procurement could target whole ma rket areas that are important for the economy and ripe for innovation.

*Government as a purchaser, by sector*

| Sector | Government demand as a share of total demand, 2008 |
|---|---|
| Education, including training | 60.8 |
| Pharmaceuticals | 35.2 |
| Medical and precision instruments | 29.1 |
| Legal activities | 16.4 |
| Market research and management consultancy | 16.4 |
| Aircraft and spacecraft | 13.2 |
| Pulp, paper, paper products, printing and publishing | 10.7 |
| Owning and dealing in own real estate | 10.5 |
| Computer services | 10.0 |
| Post and telecoms | 9.2 |
| Architectural activities and technical consultancy | 6.8 |
| Advertising | 6.8 |
| Accountancy services | 5.5 |
| **Whole Economy** | **15.6** |

*Source: ONS (2010)*