**Course Content**

1. Introduction: Basic Concepts on Innovation (OHEI, chapter 1)
2. Measuring Innovation (OHEI, chapter 6, author Smith)
3. The Economics of Patents (EI, chapter 7, author: Rockett)
4. Technological Change and Industrial Dynamics (EI, chapter 3, authors: Dosi and Nelson)
5. Technological Innovation and the Theory of the Firm (OHEI, chapter 2, author: Lazonick  EI, chapter 16, author: Teece)
6. Sectoral Systems of Innovation (OHEI, chapter 14, author: Malerba)
7. Innovation and Employment (OHEI, chapter 21, author: Pianta)

*The acronyms of the following textbooks are in parentheses*

1) OXFORD HANDBOOK OF INNOVATION (OHEI), 2005, Edited by Jan Fagerberg and David C. Mowery,

2) ECONOMICS OF INNOVATION (EI), 2010, Volume 1, Edited by Hall, B.H., and Rosemberg, N.
Teaching materials: selected chapters from these textbooks

The Oxford Handbook of Innovation

Edited by Jan Fagerberg, David C. Mowery, and Richard R. Nelson

Oxford Handbooks
- Comprehensive overview of innovation which serves as both an introduction and point of reference to the subject
- Collects in a single volume contributions covering different aspects of innovation, written from various disciplinary perspectives

Slides and chapters of these books will be delivered on the course website, at unistudium https://www.unistudium.unipg.it/unistudium/login/index/index.php, or in alternative, you can visit teacher personal home page http://dec.ec.unipg.it/~fabrizio.pompei/Economics%20of%20Innovation.htm
Teaching and Assessment

- You will attend lectures, seminars, and laboratory sessions, the latter means working on data processing and setting up empirical analyses.
- You will be assessed through a written exam and a homework that basically relies on data processing and empirical report mentioned above.
- To sum up, exams are made up of:
  1) Written exam in classroom: there will be 7 multiple-choice questions (3 scores each correct answer); duration: 1 hour
  2) Homework: short essay (max two pages) focused on commenting 2 tables that report data you processed with a statistical package (STATA); the grading scale ranges in this case from 0 to 10.

The maximum exam score will be $21 + 10 = 30$ cum laude

Please, note that classroom exam (multiple choice questions) cannot be tried again more than 3 consecutive sessions. After three attempts students must skip the next exam session. An increasing difficulty level is also demanded for students that want to try again the short essay.
**Student Timetables**

- **Teaching:**
  Monday, 14.30 : 16.30 (Aula 2)
  Tuesday, 10.30 : 12.30 (Aula 6)
  Friday, 10.30 : 12.30 (Aula Magna)

  *from March 16, every Friday Laboratory Sessions will take place*

- **Exams:**
  June 4, h. 10.30
  June 29, h. 9.30
  July 13, h. 9.30
  September 7, h. 9.30

- **Office hour:** Thursday, 9.30 : 10.30
1. What is Innovation

2. Innovation in the History of Economic Thought

3. Basic Concepts and Taxonomy of Innovation

4. Questions for Lecture 1

*The materials for this lecture have been partially drawn by The Oxford Handbook of Innovation (2005) Chapter 1
Innovation is not a new phenomenon, we can say it is old as the mankind itself.

Tendency to think about new and better ways doing things is inherently 'human'.

Research on the role of innovation in economic and social change has proliferated in last the thirty years with an inclination towards cross-disciplinarity

Thus, to get a comprehensive overview, it is necessary to combine insights from several disciplines.
**Innovation as a ’Black Box’**

- Traditionally economics has dealt with the allocations of resources to innovation (in competition with other ends)....
- ...while the innovation process itself has been more or less treated as a ’black box’.
- A lot of what happens has to do with learning occurring in organized settings (groups, teams, firms, networks)....
- ...therefore **sociology, organizational science and management** are important disciplines to study innovation.
- Learning process tend to be linked to specific geographical contexts and change over time...
- ...therefore **economic geography** and **economic history** are also important.
Smith and Ricardo

- **Adam Smith (1723-1790)** the founding father of economics, paid great attention to invention and technological change as determinants of the 'wealth of nations'
- According to Smith inventions and innovations follow the **division of labour**, thus the main driver of innovation and 'wealth of nations' is the division of labour
- **David Ricardo (1772-1823)** paid attention to the effects of new machinery on labour and wages
- Capitalists tend to introduce new machinery to save labour when it becomes expensive due to increasing skills and specialization
- In Ricardo’s view, it is a choice between the potential for detrimental effects on labor from the use of new machinery versus even worse effects if the machinery is not used at all
- If a capital is not allowed to get the greatest net revenue that the use of machinery will afford here, it will be carried abroad, and this must be a much more serious discouragement to the demand for labour,
Mill, Marx and Marshall

- **John Stuart Mill (1806-1873)** also saw the centrality of invention in the wealth creation, even if he was one of the first to write of the paradox that invention did not obviously lead to an improvement of all ordinary people.

- **Karl Marx (1818-1883)** recognised the absolute centrality of innovation within the economic development 'the bourgeoisie cannot exist without constantly revolutionising the instruments of production'. According to Rosenberg, Karl Marx was very important for his influential method of studying technology as the result of interrelated social processes, especially highlighting the mutual interaction between technology and the economy.

- **Alfred Marshall (1842-1924)** was one of the first to emphasize that consumer can be an innovator, so innovation is not just the prerogative of the producer but can be an action on the part of the consumer.
Joseph Schumpeter (1883-1950) developed an original approach focusing on the role of innovation in economic and social change.

Economic development in his view has to be seen as a process of qualitative change, driven by innovation, taking place in historical time.

He defined innovation as new combination of existing resources.

This combinatory activity he labeled 'the entrepreneurial function' to which he attached a lot of importance.

The entrepreneur has to fight against inertia and 'resistance to new ways' he finds in the society.
An important distinction is normally made between invention and innovation.

Invention is the first occurrence of an idea for a new product or process...

...while innovation is the first attempt to carry it out into practice.

In many cases there is a considerable time lag between invention and innovation.

Such lags reflect the different requirements for working out ideas and implementing them.
Basic concepts and taxonomy of innovation

INVENTION AND INNOVATION (II)

- Very often there are lags between invention and innovation
- Some conditions for the development of an idea and commercialization of prototype may be lacking
- For instance, some vital inputs or complementary factors could be not yet available....
- Let’s think for example to the Leonardo da Vinci’s advanced ideas for flying machines

- The realization of these ideas was impossible at that times and had to wait for the invention and subsequent commercialization of the internal combustion engines
Innovation as continuing process

- Every good that originally was an innovative product is radically improved compared to the first commercial model.
- For instance, a car as we know it today is completely different from first models...
- ...due to the incorporation of a very large number of different inventions/innovations.
- What we think of a single innovation is often the result of a lengthy process involving many interrelated innovations.
- Therefore, many scholars of technological innovation find it natural to apply a systems perspective rather than to focus exclusively on individual innovations.
Types of innovations

Schumpeter distinguished between these different types of innovation:

1. Process innovation
2. Product innovation
3. Exploitation of new markets
4. Organizational innovation
Process Innovations

Very often a new and improved process will lead to incidental improvements in the product.

However, it is helpful to understand the simple economics of the ‘pure’ process innovation.

If we take into account the cost curves we can distinguish three types of process innovations:

1. A reduction in fixed costs, with no change in marginal costs
2. A reduction in marginal costs, with no change in fixed costs
3. A reduction in marginal costs accompanied by an increase in fixed costs
**Process Innovations: reduced fixed costs**

To put it simply, we can plot linear marginal costs and u-shaped average costs:

A reduction in fixed costs affects average costs.

The average cost curve (curve 1) is pushed downwards.

This process innovation reduces the minimum efficient scale and hence reduces the economies of scale.

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**The minimum efficient scale** is the quantity of product a firm makes efficiently (minimum average cost).
Process Innovations: reduced marginal costs

Innovation that reduces marginal costs while leaving fixed costs unchanged:

Both marginal costs (1) and average costs (1) are pushed downwards.

Thus, we have lower marginal and average costs ...

... accompanied by higher production levels.

Process innovation driven by reduced marginal costs increases economies of scale.
Capital Intensive Process: reduced marginal costs, increased fixed costs

Very often firms can substitute labour-intensive production processes with the capital-intensive ones:

The labour-intensive process has a low intercept (zero fixed costs) and a steep slope (high marginal costs).

The capital intensive process has a high intercept (high fixed costs) and a shallow slope (low marginal cost).

At high scale of production, the capital-intensive process can produce the required scale of output at lower costs...the opposite occurs at low scale of production.

The labour-intensive process has constant returns to scale, while the capital-intensive one shows increasing returns.
During the twentieth century, rapid technological change has changed the production methods and costs of a wide range of industries. One influential tradition of economic analysis has argued that technological change does indeed tend on average to increase the economies of scale. Hence, innovation leads to increases in industrial concentration. This was particularly important in industries such as steel, aircraft manufacture, chemicals and petroleum.

Another tradition of economic thought highlights that while technological change until 1950 was mostly concentrating, change since then has frequently reduced economies of scale and has been de-concentrating. This was the case for replacement of specialised machines by computer controlled general purpose machines, or the gradual displacement of water and rail transport by road transport.
A pure product innovation creates a new or improved product for sale without any change in the production process...

...except that more inputs (labour, machine, time, materials) may be required.

In practice a new product will often require some innovations in the production process.

Nevertheless the conceptual distinction is an important one.

Very often to analyze question of product choice and product innovation we use the characteristics approach.

The characteristics approach treats the product as a collection of characteristics or features.
According to the characteristics approach we can show the quality of products by means of a graphic.

Let's think to a personal computer (pc) where quality is described by two characteristics: cheapness and performance.

Imagine that 2 different groups of users feature the market: small users and big firms.

Once a pc reaches the minimum level of cheapness/performance to be accepted by consumer it can be sold in the market.

Of course for small users we have cheaper pc with small performance, whereas hi-performance and less cheap pc will be bought by big firms.
According to Schumpeter, a firm can be called innovator if it introduces an existent innovation in a new context.

Actually there is still debate around calling these enterprises as innovators or imitators.

Indeed if the innovative character only concerns the new market some scholars highlighted that this innovation includes a larger dose of imitative behaviour.

However this not excludes the possibility that imitation may lead to new innovations.

Introducing something in a new context often implies considerable adaptation (and, hence, incremental innovation).
Organizational innovations are new ways to organize production processes and work within firms.

For example, you can produce at lower costs by simply re-organizing the production and maintaining at the same time the same machinery and equipments.

Organizational innovations also include arrangements across firms such as the organization of entire industries.

Organizational innovations are gaining ground in the last years.

According to European Commission, the proportion of firms that concentrate on organizational innovations is larger in Knowledge Intensive Services (KIS) than in Manufacturing.
For knowledge-intensive services (KIS), knowledge is the main production factor and the 'good' they offer.

Knowledge-intensive business services (KIBS) build a subcategory of KIS that includes:

i) cumulative learning, arising from in-depth interaction between supplier and user;

ii) Activity of consulting, i.e. 'process of problem solving in which KIBS adapt their expertise and expert knowledge to the need of the client'
Most technological innovations are in manufacturing, while most non-technological innovations (market and organisational innovations) dominate in services.
Incremental and Radical Innovations

- Radical innovation is a process or product completely new with respect to that we had in the past.
- Incremental innovation refers to continuous improvements of existing processes or products.
- Schumpeter very often focused on 'technological revolutions', that is a cluster of innovations that together may have a very far-reaching impact.
- Recently, many scholars also acknowledged that the cumulative impact of incremental innovations could be as great as the radical ones.
- Especially in the long run we cannot neglect the cumulative impact of marginal innovations in some fields.
MULTIPLE CHOICE QUESTIONS FOR LECTURE 1

1. Joseph Schumpeter gave the most important contribution in:
   a) Demonstrating relationships between innovation and division of labour; b) demonstrating that innovation could be also a new combination of existing resources; c) demonstrating relationships between innovations and new machinery; d) demonstrating links between the inventor and the users.

2. A process innovation reducing fixed costs without changing marginal costs:
   a) Decreases the productivity; b) Increases capital intensive processes; c) reduces the economies of scale; d) increases the economies of scale.

3. A process innovation that reduces marginal costs and increases fixed costs at the same time:
   a) Increases hiring of new workers; b) causes more competition in the market; c) reduces the economies of scale; d) leads to market concentration by increasing the economies of scale.

4. Product innovation can be studied by means of:
   a) Cost curves; b) characteristics approach; c) economies of scale approach; d) productivity approach.