Lecture 13
Patent is a monopoly right to exploit an invention commercially for a maximum of 20 years, subject payment regularly renewal feeds.
Patent is a unique source of technical information, that help you innovate and in the creation of your market strategy, however 80% of technical information contained in the documents are not published, because the publication may compromise the patentability of an innovation either formally or substantially.

Prior art search can reveal possible solution for your problem, or may acquire the rights of a patent that offers a solution for your problem at lower cost than your invention or if the licensing is not possible, it helps you find an alternative solution without infringe the existence patent

The patent can also help you in your market strategy, because helps to analyze innovative strength and technological trends, avoid duplication of R&D activity and avoid waste of human and capital resources, it brings together inventors and inventions, helps to maintain the market position and find new business partners, and to monitor competitors

Patent document

The patent document is composed by the date of publication, the date of filing, that is the date when the document is delivered to the appropriate authority, and the date of priority, is the most important date, and it's followed by a code, where are included some information about the nationality of patent and it's the date to take into account to understand the date of application of a patent, so you can compare with other patents

IPC is a technological classification system, that provides a hierarchical system of language independent symbol for the classification of patent and utility model according to the different areas of technology to which they pertain

In a patent family, every document has the same priority or combination of priority

EPO includes a broader range of prior art, with a focus on international and non-patent literature, and present a detailed search report
Moreover, the EPO citation process is more exhaustive, especially in the context of opposition procedures, while USPTO is more streamlined and focused on US patent
So USPTO is more focused on national patents and documents and doesn't give much importance to international and non-patent literature.

Search report

Defining if documents and patents are considered novelty or involve an inventive step.
The category "X" means particularly relevant documents when taken alone, so they cannot be considered novelty or to involve an inventive step.
The category "Y" means particularly relevant documents if combines with other documents of the same category.

The category “A” means documents defining the state of art, and the category “D” means documents already cited in the application.

Lecture 14

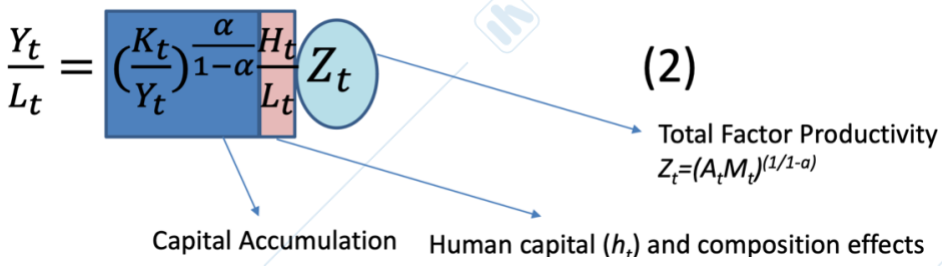
Neoclassic growth model is a model growth of GDP per workers via capital accumulation, it considers the production function, where GDP depends on capital labor and technology, and the capital accumulation equation, where change in net capital stock equals gross investment less depreciation.

According to Solow, the production function assumes diminishing returns to capital or labor and constant returns to scale.
The production function is $y = Ak^a$, where A is the technological capital, k is the capital and a is a constant, this function is put in relation with the capital accumulation equation, that is $dk/dt = sY - \delta K$, where s is the portion of gdp saved, Y is the gdp, δ is the depreciation of capital and K is the capital.
So, the capital accumulation equation represents the portion of GDP saved and remain in the economic system less the depreciation of capital due to consume.
Y and K are endogenous variables while s, δ and a are exogenous variable
If we assume L and K as a constant, the Solow’s curve represents a concave slope, that reflects a diminishing marginal product of capital

The Solow’s results are:
Investment in capital cannot drive a long run growth in GDP per workers
Need technological change to avoid diminishing returns to capital
And don’t advise poor countries to invest without due regard for technology and incentives

Neoclassic model results:
in the neoclassic model, countries tend to converge to a steady state gdp per workers, if there is no technology growth, if countries are in the same steady state, poor countries grow fast and converge, this is called as classical converge.
Change in saving rate ration produces level effects and not long run growth effects
If increase technology, there is more saving and marginal product of capital, that includes an increasement of investment and capital accumulation.
The long run growth is explained by the growth of the exogenous productivity factor (A), the ¾ of the growth is due to A, but nobody is able to explain what A is.

Growth accounting:



The gdp per workers (Yt/Lt) is influenced by the capital accumulation, Human capital, that depends on the level of education of workers and other social aspects, and Total Factor Productivity, that is the measure of an economy's efficiency in using its inputs.

Endogenous growth models, that try to consider the endogenous variables as the driving forces of growth.

Romer model
Romer demonstrated how knowledge can be the driver of long-term economic growth and how economic forces govern the willingness of firms to produce new ideas and innovations.
Romer explain that the creation of new knowledge assumes to have a positive effect to productivity opportunities of other firms, because knowledge cannot be patented or kept secret, this effect increases the productivity without payment.
So, if an investment has positive external effect, it's generated an increase in aggregate productivity, that is strictly related to aggregate increased of A by K.
According to Romer, spillovers and learning prevent the decline of the marginal productivity of capital, so the function is represented by a constant slope.
In conclusion of the process, we have 2 effects, decreasing returns to scale at firm level and increasing returns to scale at economic level.
Romer explained that the market/competitive growth is sub-optimal, due the presence of externalities/spillovers, the shocks and policies produce permanent effect, contrary to Solow model, and large countries grow fast, the level of capital output in different countries doesn't converge, growth may be persistently slower in less developed countries and may fail to take place at all.

Lucas model
For Lucas the main driver of the economic growth is the human capital, he assumes it with a formula: $y = Ak^{a}(uhN)h_{a}^{\gamma}$, where h_{a}^{γ} is the average human capital, that allows for the external effects of human capital that can also influence other firms.
the main driver is h, it grows the effect is to scale up the input of workers, so increasing y and the marginal product of capital k.
in Lucas model, A is a constant, so it's not influent in the growth
Moreover, the human capital drives the knowledge externalities and learning by doing, so it's the driver of the productivity growth.

Many endogenous models assume profit seeking firms invest in R&D, the incentives are the expected monopoly profits of new product or process, that depends on the probability in inventing and, if successful, expected length of monopoly; while the cost is the expected labor cost, that depends on productivity

The market in these models is the monopolist competitive, so the competition is related to the creation of new product or service, there is free entry in R&D, zero profit if the fixed costs are up to the maximum potential monopoly profit

Schumpeterian model
The Schumpeterian model analyzes the possible market failure.
the first possible market failure is due to the appropriability effect, through incentives of the monopoly, a new innovation generates new consumer surplus, that involves to too little R&D activity and too few products.

The second possible market failure is due to creative destruction, the creation of a new technology/innovation can destroy the competition on the market and the profit of the other firms. So, it involves to too much R&D activity and too many products on the market.
The last possible market failure is due to the knowledge spillover externalities, each firms R&D activity helps reduce cost of the other innovation, positive externalities.
It involves to too little R&D activity and too few products on the market.
According to Schumpeterian, the entry of new firms or entrepreneurship are crucial to stimulating the competition and innovation.
He also explains that the incumbent's attitude is really important, because can bring the market in a saturated state, where the new entries are destroyed by the large firms in the market, as called 'killer acquisition' and he suggests a larger role of anti-trust authority in the market, to maintain the equal competition.

Lissoni 1

Diffusion
Intra firms' diffusion is the % of sales/outputs due to a new product or process
Inter firms' diffusion is the % of firms using a new process or producing a new product
Inter industry diffusion is the % sales/outputs of industry due to a new product or process

The diffusion is slower than it's expected, it has the behavior of a sigmoid curve, it takes off slowly, at prime moment it's increased speedy and after that it goes down.
It's also depended on innovation and market.

Information-based models explain two models:
The first is the internal diffusion model (epidemic model), where the information are distribute by users, so it's an exchange of feedback about the new technology, the information diffusion has the behavior of a Sigmoid curve, so started slowly, it's necessary to reach a critical size of adopters to accelerate the diffusion, after reaching this critical size, the curves takes off rapidly and after that goes down, when the technology is almost used by the totally of users.
The external diffusion model, it's related to the diffusion of information by external factors, as governments, policies or advertising, this process starts more rapidly than the internal model, because it's not necessary the reaching of critical size and the behavior of the curve is a concave slope, so starts to take off rapidly and after that goes down.

The information-based models have some problems, the first is that simplifying the process, there are only two actors, and they don't change over the time, if there isn't innovation the price don't change, and the individual characteristic of possible adopters remains the same as their numbers.
The second one is the economic elements in the model don't have microeconomic foundation, the economic values of innovation are assumed, and they are not proved by microeconomic models, and the lag of diffusion is not derived from individual adoption lag, as a function of adoption profitability.
Moreover, there are some elements that can influence the diffusion of a technology, that are called peer effects in adoption choice.
They are friends and consumers choice, that can influence the choice of other possible adopters, and geographical cluster, some studies reveal that the percentages to adoption are different according to the different part of a country or city.

Another important element for the diffusion of a technology is the network; the network theory of influence explains that finding the most central actor of a network, is possible to increase the diffusion of a technology, that type of actor is called influential adopter.
However, a fundamental element in this theory is the distance between the actors, a dense network has shorter distance, so it'll be quicker the diffusion, whereas less centralized network has longer distance, so slower diffusion, and often there aren't central actors, but there is less exposure to manipulation and less risk of information clogging.
The key assumption of this theory is:
Information on innovation is not a big issue, but maintaining status is the key issue.

Lissoni 2
The threshold model has less emphasis on the information problem, the late diffusion of an innovation isn't totally due to an information problem, but also to an economic problem, they don't understand the profitability of the introduction of this innovation and if the new technology is superior to the old ones.
the model takes into account also the characteristic of new technology and the adoption environment, that can influence the choice of possible adopters.
A new technology will be adopted if their economic benefits outweigh their costs of adoption, that is assumed by a formula, $w\Delta aS \geq rp$, where w is the wage rate, that represents the cost of labor saved by the innovation, Δa is the labor saving per unit area or output, S is the firm size, while r is the interest rate for the adoption of a new technology and p is the fixed cost of adoption.
It's possible to estimate a S_{cr} that represents the critical size, where firms with size bigger than it have more advantage to adopt new technology, firms with a smaller size have to wait for the adoption, until the critical size decreased.
The heterogeneity source distribution is a bell shaped.

The threshold model has influenced either exogenous forces or endogenous forces.
The exogenous forces are the macroeconomic variables, wage rate w and interest rate r, that drive the model externally; while the endogenous forces are the learning by doing and the economics of scale that reduce fixed costs p and improve the performance Δa overtime.
Often technologies have large fixed costs that cannot be divided or shared, that represents the problem of indivisibility, this problem creates entry barrier for the small firms, so the model emphasis on the importance of firms size.

Lissoni 3

The introduction of a new technology looks like a race, one possibility to compete in the market is the standardization, there are some possibilities, the first is one version of a new technology prevails over the others, it represents the de facto standardization, the second is firms selling different versions coordinate set a common standard and or conversion standard and the last is the government to set a standard in the market.
However, it's possible to occur to market failure, when the fixed standard is socially lower the dominant technology or when the standard is proprietary, and the owner acts monopolistically; another type of market failure is due to the lack of standardization, the strong network effects, that permits the dominant technology to emerge, is mitigated by the heterogeneity in early adopters' choices and lack of coordination.

The standardization process is irreversible, the less popular technologies lose value more than the most popular technology, it can cause the first market failure.

There are two different type of network effects, direct is typical of communication network, the immediate value of a technology depends upon the numbers of its users, it's typical of physical network and the positive feedback is immediate.
Indirect is typical of complex technologies, usually is related to two or more components, for example hardware and software, where the availability of the second depends upon the number of users of the first component.

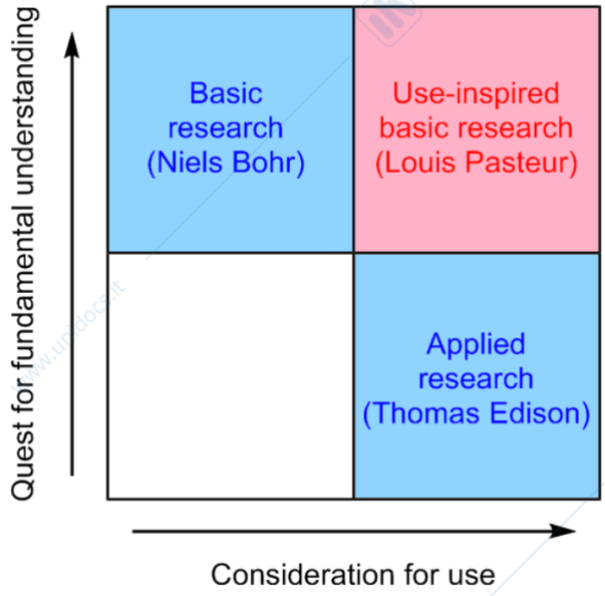
Arthur's model:
This model explains how two technologies will share the market depends on the stochastic process underlying the adopters' choice.
The model shows the extremely uneven patterns are most likely than 50%-50% pattern and nothing ensures that dominant standard will be the optimal one (ex-post adoption benefits do explain ex-ante choices)
Arthur's model explores the dynamics of competition between two technologies entering a market, particularly focusing on:

1. **Path Dependence**: Early advantages or random initial conditions can strongly influence which technology dominates.
2. **Network Effects**: As more users adopt a technology, its value increases for both existing and potential users, leading to a positive feedback loop.
3. **Lock-In**: Once a technology gains a dominant position, switching to the alternative becomes increasingly difficult for users due to compatibility, costs, or entrenched standards.

According to Arthur's model, the Government intervention against lock-in is needed, because the coordinating users' choose the superior standard on the market, or the Government can avoid to establish the lock in process, maintaining technology variety, until the moment when there'll be an optimal technology on the market, but the maintaining for too long technological alternatives can be suboptimal, there is a lot of waste of resources.
Nelson's model

Lissoni 4
The assumption of Nelson's theory:
The marginal benefits of basic research depend upon the number of innovations this will help introducing higher benefits than applied research, but UNCERTAINTY conditions firms' attitude towards innovation activities, it cannot be reduced to risk, firms simply avoid it
The last assumption is for sake of simplicity: marginal cost of research is constant (=1).
The theory explains that the large firms have more vantages to invest on R&D activities than small firms, more marginal profit.
The result of his research is that Anti-trust policies should be lenient towards R&D-intensive large companies and public funding of basic research is necessary, due to market failure, because private expenditure will fall short of social optimum, even when the economy host several large R&D companies.
The «market failure» motive isn't only related to an appropriability problem, but also due to the uncertainty of researcher and the lack of imitation.
So, it's showed that scientific results are not, by default, a public good.

Nelson explains that Public funding of basic research will deliver the expected results (wideapplications) only if produced as a public good, through Freely accessible, codified and published in journals, and the resulting from unconstrained enquiry.
Nelson, contrary to the definition of basic research, defined an use-inspired basic research that combines the quest for fundamental understanding with the desire of practical application, so he assumes a coexistence between basic research and applied research.



Bohr's Quadrant (Top-Left):
Pure basic research with no immediate practical use.
Example: Niels Bohr's work on quantum mechanics.

Edison's Quadrant (Bottom-Right):
Pure applied research focused on practical outcomes with little emphasis on fundamental understanding.
Example: Thomas Edison's work on electrical devices like the light bulb.

Pasteur's Position (Top-Right Quadrant):
Pasteur's research epitomizes the dual goals of advancing scientific understanding and addressing urgent societal needs.

Bottom-Left Quadrant:
Neither practical nor foundational, often not a focus in structured research funding.

Pasteur's placement demonstrates that:

- Research does not need to sacrifice practical impact for scientific rigor or vice versa.
- Integrative research efforts can simultaneously address theoretical and societal objectives.
- His work serves as a model for use-inspired research, guiding policymakers to support similar initiatives that balance these dual goals.

Connections Between Papers and Patents
Papers can cite other papers, and patents can cite other patents, creating citation networks.
Patent-to-Paper Citations:

- Patents often cite academic papers to acknowledge their scientific foundations, demonstrating the influence of basic research on innovation.
- Citation pathways are used to measure the influence of scientific knowledge on technological development.

Distance measures how closely a patent aligns with the foundational science described in academic papers.
Distance = 1: Indicates that the patent is directly on the technological frontier, closely tied to recent scientific discoveries.
Greater distances suggest indirect or derivative relationships between the science and technology.
"Home Runs":

- Highly cited papers and patents (top 5% of citations in their field/year) are considered impactful.
- Such "home runs" often lie closer to the frontier, reflecting their combined scientific and technological relevance.

Distribution and Patterns

- Discipline-Specific Variations:
  - Some scientific fields contribute more directly to patents (e.g., biotechnology or materials science), while others remain more abstract.
  - Distribution charts show how fields differ in their distance to the frontier, emphasizing where innovation is more science-driven.

There is no strict trade-off between a paper's scientific relevance and its proximity to the frontier. Highly cited, impactful papers often bridge both goals, disproving the traditional linear model of innovation.

Lecture 22

The economic growth is related to the process of knowledge creation and its diffusion, where opportunities and development are embodied into specific technology, so we need to take into account the role of general-purpose technologies in this process, moreover, it's also related to the presence of some forms of knowledge spillover externalities.
The human capital has an important role in the economic growth because of its interaction with some significant elements as cultural and social capital.

The role of government, the government should engage in the new projects to support and align the market, because, on its own, it wouldn't be able to achieve balance.
Thus, it should aim to become an entrepreneurial state, that through visionary and strategic public investments distributed across innovation chain, it can inspire animal spirits in private businesses.

Another important element is the geographical cluster, that is the geographical location where many resources are accumulated and give more advantage to businesses in a given economic branch.

The *endogenous growth model* of Ackgit and Ates
Throughout the years, the market concentration has increased, the market concentration is the firm's ability to make profit, market power, and it's related to the firm's performance.
Also, the markups have increased, the markup is the deference between profit and marginal cost.
So, the profit share of GDP has increased, but the labor rate of gdp has decreased, so we can understand the negative association between market concentration and labor share.
It implies the decline in the share of knowledge diffusion
Because if the market is saturated and very concentrated, it's impossible for new firms or companies to enter in the market, so there are less job opportunities and in front of high profit of these firms, the incomes of workers are the same, so the labor rate has been decreased over year.

Moreover, the labor gap between frontier and laggard has widened, so for the small companies are not able to catch up the large firms, so the rate of new \entry and young firms have decreased, and the overall productivity growth has fallen.

4 reason why knowledge diffusion are less:
The first is due to the increasingly data dependent nature of productivity, the tacit knowledge and the big proprietary data play an important role in production, so there is a tendence to keep this data and knowledge secret.
The second is due to the regulation that favor established firms, that reduce job mobility and increase lobbying and political rent.
The third is due to the increasing of offshoring, many firms move their production activity to other countries where the cost of production and the regulation are more profitable.
The fourth is due to the abuse of the intellectual property, the race of patent's creation brings to the creation of patent thickets and trolls, that reduce the competition in the innovation.

GPT
GPTs, General purpose technologies are technologies that can affect the entire economy, so they have the potential to drastically alter society through their impact on pre-existing economic and social structures
GPTs are characterized by widespread use, they can use as input for a wide range of sectors, it has the potential for continuous innovation, and when GPTs increase, even the productivity of innovative activities in user sectors improves.

GPT performs some generic function that is vital to the functioning of many products or production systems, as continuous rotatory motion by the steam engine.
GPTs impact the economy through the massive reorganization and relocation of economic activities, concomitant gains in efficiency.
Sum up, GPTs are pervasive application across many sectors, they spawn further innovation in application sectors and itself is rapidly improving.

Invention of a method of inventing (IMI) has a great potential as research tool in problems of classification and prediction

According to the endogenous growth models both GPTs and IMIs are big influential driver of long term technological progress

How to overcome the disparity between social and private optimum?

the first solution is the proactive development of institutions and policies that encourage competition, data sharing and openness, so have an important role the government, military and key consumers.
The second solution is contracting and coordination between key players to break away from limitations of arms-length market transitions.
So it's necessary cooperation among institutions and firms, because the smaller the quality of GenPTs, the more difficult it's the app sectors to anticipate the future quality of the GenPTs