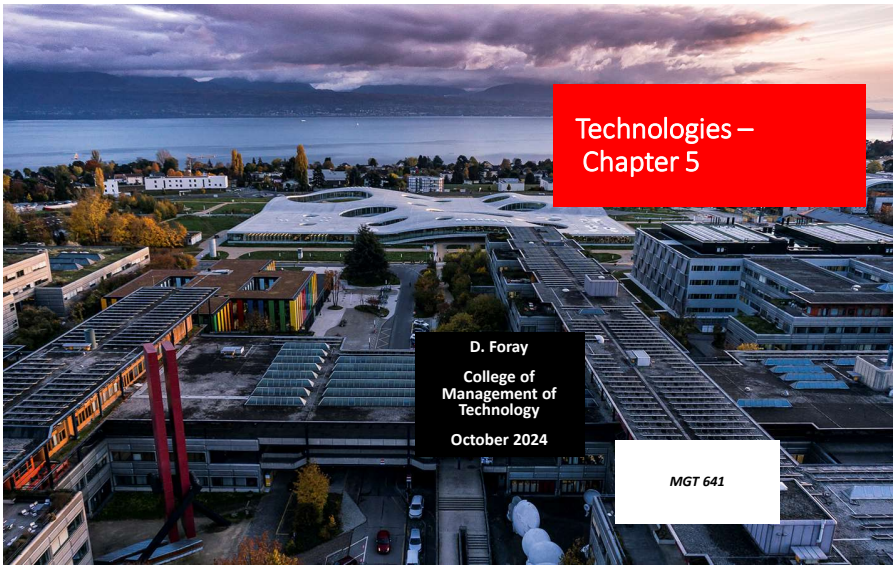

Technologies – Chapter 5

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How to accelerate the development of critical technologies

Narratives – problem/solution context as framing consumer's, investor's, firm's decisions

Firms undertake ''spontaneous'' corrections because they care on their *corporate social responsibility*

Market's regulation *measure the costs negative externalities, translate it into a tax - the hope is that firms will correct the negative effects through innovation *establish norms, standards, obligations, etc..

Financial engineering

Policy process

Technological innovation – policy to accelerate R&D and diffusion

Social norms – policy to influence large scale behavioal tipping

- Grant, prize, public procurement?
- How to accelerate?

The toolbox for influencing directly business innovations

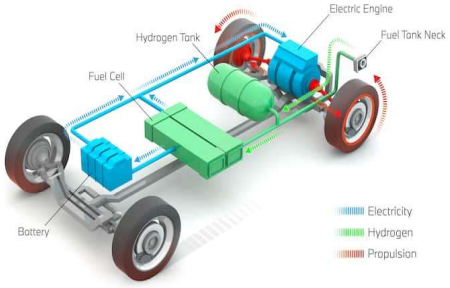
- Narratives, repairing markets and new business models can influence firm's strategies, investors' decisions and consumers' preferences and thereby they influence innovation in an indirect way
- We have also tools to promote a specific technology: some tools can target – not firms or consumers – but specific technologies which are needed to solve a ''problem''
- These tools can address costs – because innovation is expensive
  - R&D subsidies – push logic
- These tools can address expected revenues – because rewards are poor on some markets
  - Prizes, advance market commitment – pull logic

A Government is seeking for a **specific innovation**: hydrogen fuel tech (car); new drugs (obesity)

Push – to lower cost of innovation	Pull – to create rewards
R&D grants	Prize, AMC

Push and pull
Public procurement

A grant or a prize?
A grant is provided ex ante (based on a proposal which is selected)
A prize is given ex post (based on the achievement of the task)

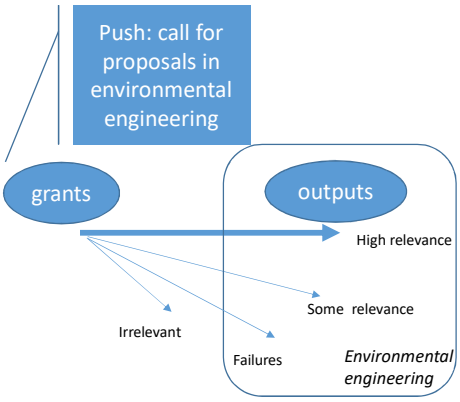


A grant or a prize? The principal-agent problem

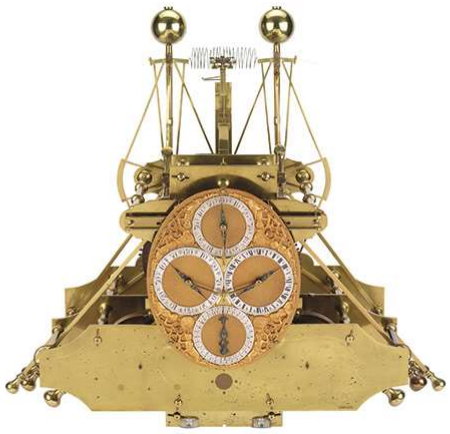
- Principal pays & agent executes
- Under a push logic, the principal pays for inputs with no certainty whether a 'useful' output will be discovered/invented – this is the principle of research grants
  - The whole risk is taken by the funder
  - Research is characterized by strong information asymetry (the agent has more information about his/her actions than the principal then the agent may have an incentive to minimize effort) – it is difficult to monitor that the agent devotes full resources and efforts to this research.
- Under a pull logic, the principal pays for the output – that mitigates greatly information asymetry problems but increases risk for participants
  - The distribution of risk is different whether this is pull (risk for innovator if she does not succeed) or push (risk for government who will pay for failure)

Government research grants (push logic)

- With a R&D granting system based on a competitive process – call for proposals, evaluation, selection – it is possible to target some thematic areas where more R&D is needed
- Variety of government programs to encourage innovation by providing grants to academic researchers or private firms
- Principal-agent issue – the principal has difficulty to monitor and control the effort of the agent (above)
  - Solution – instead of one single funding decision at the start, multiple check points opening the option to discontinue projects which are not working well – but difficult to do
- Example Small Business Innovation and Research Act in the US
- The Swiss mechanism
  - Subsidies go to the university lab to support a partnership with a firm – no direct subsidies to companies



Ex ante grand prize for product development



Ex ante technical specification

Reward – access reconciled
Needs public funding (the reward is no longer based on monopoly rents)

In a *push logic* – probably only mathematicians and astronomers would have received subsidies – based on their track record
A pull logic opens the competition to any "out of the box' initiatives

In 1707, English navigators on a feet of five ships misjudged longitude and ran aground about 20 miles from the English shore. Many similar tragedies
To attempt to find a solution to this 'longitude problem', the British Government offered a prize of £20 000 for 'a method of determining longitude within a half of a degree'
The Board of longitude monitored the competition and the solution was developed – not by astronomers or mathematicians – but by a clockmaker named John Harrison – it took 12 years to prove the worth of the chronometer and reward the inventor. J.H got his prize and gave his invention to the public domain

A prize sponsored by a foundation (pull logic)

- Can determine direction in a very detailed way – e.g. *development of manufacturable,fast and affordable cars that exceeds 100MPGe (miles per gallon energy equivalent)*
- Mitigates principal-agent problems (it pays for the output)
  - Money change hands only if successful products are developed – so sponsors need not worry to invest millions in a project that may ultimately fail (very different situation than in a push mechanism where the millions can be burned in unsuccessful projects)
  - Minimize monitoring costs
- Has a positive effect on diffusion: Prize is given for a **public good** – and possibility to link the amount of the prize with the magnitude of the diffusion
- Create a large pool of contributors (spanning field/discipline boundaries) (unlike R&D grants whose selection process is partly based on reputation implying that some potential inventors censor themselves)
- Need to find a good balance between too detailed *ex ante* specification (anti-competitive effect) and too vague/broad specification (no directionality)

An important design feature: Metrics of *ex post* use or impact

- One issue with *prize* is that products may be developed – they meet strictly the specifications - but for some reasons they are not desirable to consumers or clients (they don't become innovations!)
- Important to try to link reward to value
- Useful to base reward payments on some measure of *ex post* valuation of the product by consumer

XPRIZE Overview

What is XPRIZE? **An XPRIZE is a highly leveraged, incentivized prize competition** that pushes the limits of what's possible to change the world for the better. It captures the world's imagination and inspires others to reach for similar goals, spurring innovation and accelerating the rate of positive change.

* The $2 Million Northrop Grumman Lunar Lander X CHALLENGE: Designed to build an industry of American companies capable of routinely and safely flying vertical take-off and landing rocket vehicles useful both for lunar exploration and for other applications.
  - Created as part of NASA's Centennial Challenges
  - 12 teams spent > $20 million
  - Earned contracts with government agencies and private customers
* The $1.4 Million Wendy Schmidt Oil Cleanup X CHALLENGE: To inspire a new generation of innovative solutions that will speed the pace of cleaning up seawater surface oil resulting from spillage from ocean platforms, tankers, and other sources.
  - 38 teams from 4 nations
  - Teams required to more than double the industry's previous best oil recovery rate
  - Winning team nearly quadrupled the industry's previous best rate; and now has improved to six times the rate
  - Winning technology was rated No. 2 on National Geographic's "Most Hopeful Energy Developments of 2011" and by the Washington Post as the No. 13 best moments in innovations in 2011

Ex ante grand prize for demonstration

In 1919, a New York hotel owner offered an aviation prize for the first person to fly across the Atlantic, nonstop Paris – New York. 25 year old Charles Lindbergh designed and supervised the construction of the 'Spirit of St Louis', complete with huge fuel tanks, longer wings, and a new location for the seat. He made his famous first solo flight across the Atlantic in 1927

Ex ante 'technical' specification to encourage demonstration projects (rather than spurring the development of a commercially viable product)

Louis Daguerre invented the Daguerreotype process of photography in 1837. The invention was patented but Daguerre – an old man – was not able to commercialize his invention. He just did not use it. His friend Arago – a famous academician – persuaded thr French Government to buy the patent. Subsequently, the Government made the technique freely available in the public domain. Following this patent buyout, Daguerreotype photography was adopted worldwide rapidly and the technology was greatly improved by other inventors.

Ex post: Patent buy out

Ex post pull mechanism

A patent buy out mechanism corrects the access problem (no monopoly pricing) while rewarding the inventor. The Government can choose what are the inventions which should be treated under this mechanism – within what domain of priority?
Problem – what is the correct price for the patent? Equivalent to the social value of the invention – Kremer proposes a mechanism for patent buyouts in which the value of patents is determined using an auction

In the city of Lyon – capital of the silk industry - a fund was officially established to reward inventors who agreed to disclose their knowledge and actively participate in the diffusion of the technology (teaching). Thus secrecy and patent were actively opposed and each inventor was encouraged to be a dynamic actor of innovation diffusion Jacquard's loom was a major invention.The invention became the property of the city and quickly spread. Jacquard received a reward in exchange for the diffusion of the invention and his work to teach and train .
But later, Jacquard started to complain that he was not treated well – considering the importance of the invention.
He left Lyon to go to Paris where he wanted to patent his invention.
The police of Lyon were urged to take him back!

Ex post* reward – including a metrics of *ex post use

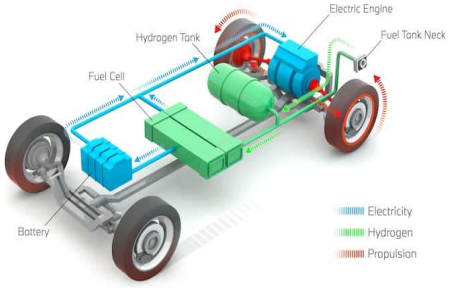
Ex post pull reward involving a mechanism which tied the reward to actual adoption and training to the new technology

Very similar to patent buy out – No *ex ante* specification. The *ex post* prize corrects the access problem (no monopoly pricing), while rewarding the inventor.
Problem – what is the correct price for the invention? Jacquard was not happy!

A Government is seeking for a **specific innovation**: hydrogen fuel tech (car); new drugs (obesity)

Grant: Best fit to advance research and knowledge broadly – because in research even a failure is an information

Prize: Best fit to support a specific product development and diffusion



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Public procurement for innovation

- Governments as lead customers use purchasing rules to promote innovation for specific Grand Challenges
  - Generates intitial momentum (learning effects, production costs, improvements in technology and process)
- Example of US Green Building Council LEED Standard for sustainable building practices – (*Leadership in Energy and Environmental Design*)
- Public agencies place orders for building meets LEED standard
- The Governmt may be a major customer – then PPI can influence the behaviors of other stakeholders
- Spillover effects – private sector LEED adoption is 80% greater in cities with a green building procurement policy (as well as in « neighbor cities »)
- Mechanisms
  - Increasing local awareness of the benefits of green practices (demonstration role)
  - Jump-starting the development of a dynamic specialized input market (suppliers, architects) lowering prices of green-building expertise and materials
- Governement PPI can break down important barriers to LEED adoption

- Grant, prize, public procurement
- How to accelerate?

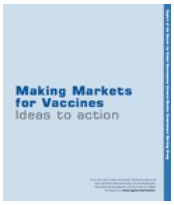
Acceleration – extreme case

- Can we make a business case for a drug to prevent or cure diseases concentrated in poor countries – in many cases there is simply no market?
- Rich countries Governments or Charities could engineer a market where non yet exist – advanced market commitment (AMC)
  - Evidence shows that markets work (to incentivize pharmaceutical companies)
- Difference with the prize system – AMC creates a market
- Under AMCs, donors make a legally binding commitment to buy at a high guaranteed price a vaccine if and when one is invented
- If credible, such promise creates an incentive for for-profit companies to fund, test and make the targeted vaccine
- The higher guaranteed price provides an economic return for innovators and developers, and in exchange the innovators agree to a cap in the long run price that they charge for the product.
  - How to set the guaranteed price? – Should correspond to the value society would put on a vaccine
- The product is distributed at price = cost during the AMCs – If no suitable product is developed, no AMC payments would be made

Michael Kremer, an influential Harvard economist, first suggested the idea in 2000

Center for Global Development

An extensive consultation process was organized by an American think tank (2004-2005)



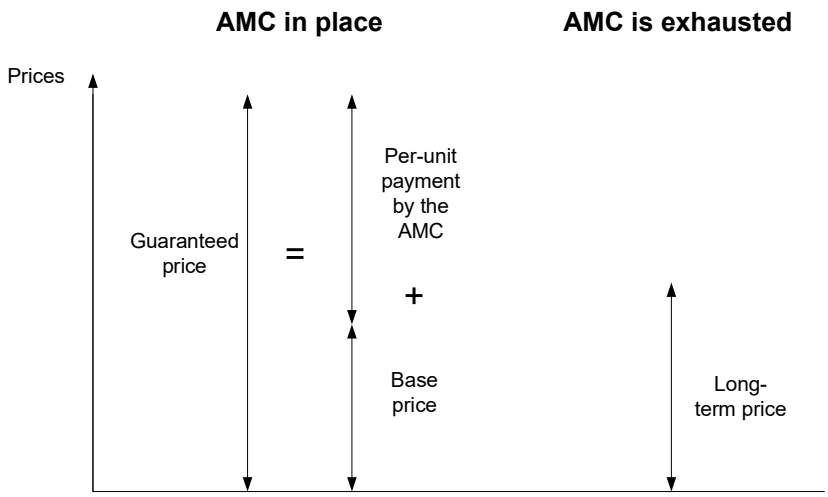
The report of the think tank was followed by work from the World Bank and the Italian government

G8 leaders agrees to launch a pilot AMC in July 2006 at the St Petersburg Summit

AMC ADVANCE MARKET COMMITMENTS for vaccines

GAVI ALLIANCE

In February 2007 the pilot AMC (on pneumococcal vaccine) was launched http://www.vaccineamc.org/



Country X ministry decides to buy the new vaccine – it will co-pay for $1 per dose and the company will receive a top up payment of $ 14 from the donor

Devil in the details

*No such thing *as A malaria vaccine*
The first vaccine may not be the best possible
*The donor will have to set out the traits of a vaccine it would be willing to buy
*The donor's pledge will at best motivate firms to hit this mark, not surpass it. Because:
*Firms are competing for a limited pot of money ($3 billions?) and a company that comes to market second, with a later but better vaccine may find the pot already emptied by its swifter rivals.
*If companies anticipate this danger, they will lower their sights, setting for a vaccine that just reachs the bar set by the donor.
Responses
Speed matters
The final customers will decide

21

From vaccines to climate

- Apply an AMC scheme to deal with the problem of developing new carbon removal solutions: the global world will need to remove huge amounts of C02 from the atmosphere (5 to 10 billions of tons per year by 2050) and the world is not on track to do this.
- Current solutions to capture carbon are not permanent and hard to manage and measure.
- We need ''a gigaton-scale portfolio of permanent carbon removal solutions''. These technologies don't yet exist and will be very expensive to develop and scale up.
- The financial solution may be to involve companies and governments with net-zero pledges which will fund the AMC by formalizing their financial commitment to buy carbon removal over a certain time period. When tons of CO2 get removed, the AMC will pay suppliers of new technologies and issue credits back to buyers.
- Such an approach will send strong market signal – stronger than fragmented companies making net-zero commitments while potential innovators are facing great uncertainties about what kind of solutions will be selected by the market.
- Another great advantage is that this market signal can be sent NOW – in spite of the fact the technologies are not yet ready.

Wrapping up – the toolbox to direct innovation

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	Science advancement	Product development , demonstration & adoption	Diffusion
Push instruments: address costs	Grants & subsidies	Subsidies	Adoption subsidies
Pull instruments: address revenue	Ex ante prize (in math)	Ex ante prize Advanced market commitment	Metric of ex post use Patent buy out
Push x pull		Public procurement	Spillovers to private markets

Recommended reading – Kremer and Williams

EPFL

Merci

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