

Innovation and Growth: Concepts and Policy Implications

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Research for new economic policies

The fodder for long-run growth

- Stories of economic growth and human history are stories of technological change and changing beliefs and ideas.
 - New ideas and technologies are the fodder for economic growth
 - Diminishing returns to capital and labour make it impossible to sustain economic growth in the absence of productivity improvements.

- Learning by doing raises the marginal productivity of capital over time
- Inexhaustibility of knowledge generates increasing returns to scale
 - *the cost of acquiring knowledge is independent of the scale on which it is used, yet the benefit obtained very much depends on the scale at which it is used*
- **The cost of knowledge is the main determinant of the rate of technological change**
 - *Influencing the cost of finding new ideas is the key to economic growth*

Characteristics of knowledge

Characteristic	Description	Implication
Non-rivalrous	One person's use does not prevent a second person from using	Positive externalities in the form of technology spillovers
Inexhaustible	Can be used repeatedly – once obtained has almost zero marginal cost	Increasing returns to scale
Only partially excludable	Knowledge 'producer' cannot fully internalise benefits	Market underproduction relative to optimal rate from a societal perspective
Uncertainty in production	Outcome of investment is unknown – no guarantee of a return	Market underproduction relative to optimal rate from a societal perspective
Combinatorial	Knowledge bases and ideas can be combined to create new ideas	Importance of networks/human capital/proximity to other people/t&c technologies

Models of innovation and growth

- **New growth models:** knowledge production as endogenous
 - Growth process driven by purposive accumulation of human and physical capital together with the production of new knowledge, often created through R&D activities, and the diffusion of that knowledge.
 - Inability of knowledge producers to fully internalise the benefits of investing in R&D, as well as uncertainty of production, reduces incentive to undertake such activity.
 - *Policy - provides rationale for activist technology policy (R&D subsidies/tax breaks/education spending/fiscal and other supports for enabling technologies, knowledge infrastructure and technology diffusion)*

- **Evolutionary models:** economic change as historically grounded path-dependent process
 - Innovation is blind (stochastic process).
 - Individuals and organisations with bounded rationality learn and search experimentally in uncertain and permanently changing environments and with uncertain outcomes.
 - *Policy - role of government is to create an environment and set of incentives that encourages innovation, removes blockages or barriers, and that supports the diffusion of innovations at the individual, organisational and economic system levels*

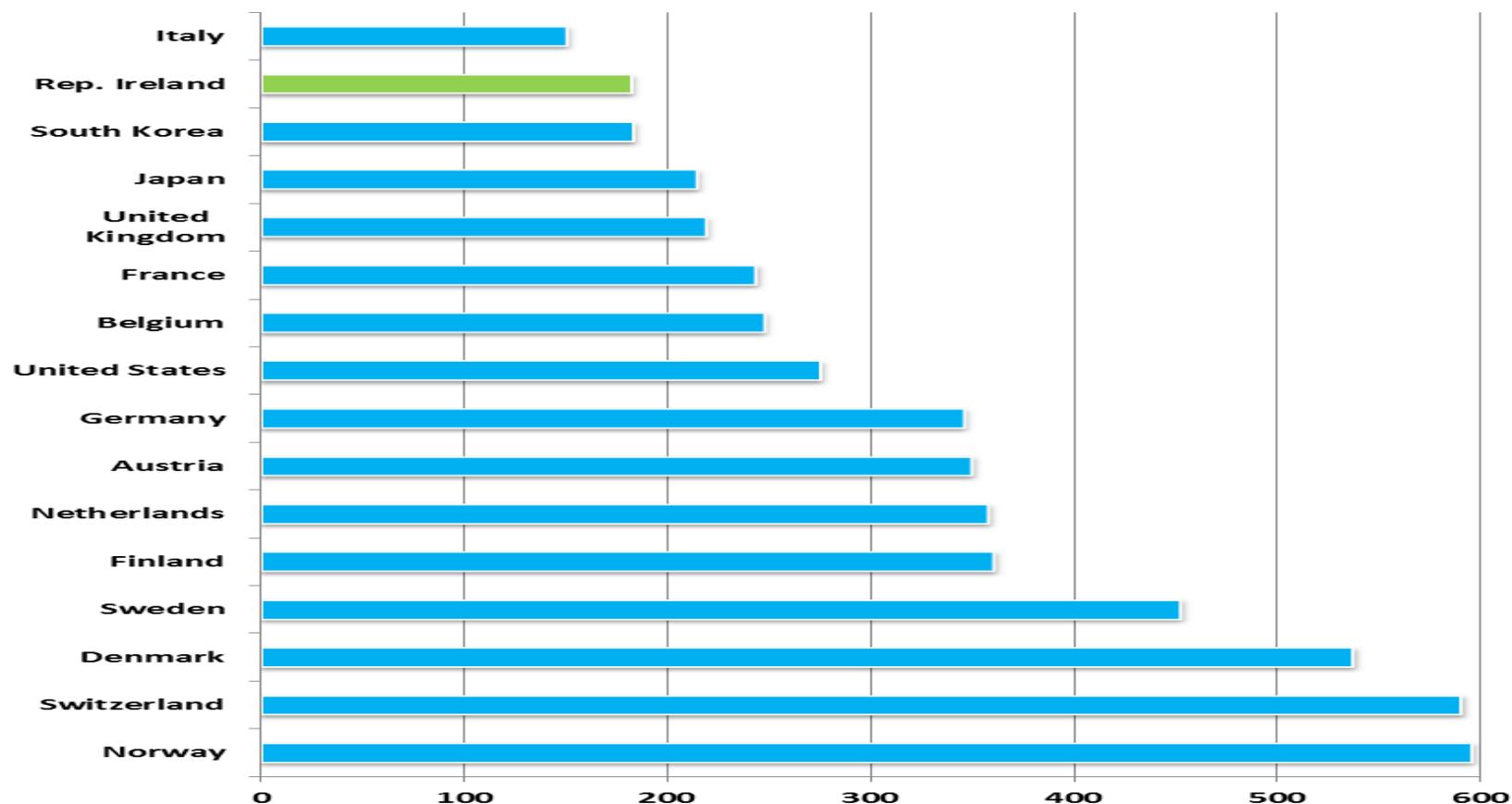
Models of innovation and growth

- **Complexity based models:** economic change through exploitation of increasing returns from new innovations
 - Economy is a complex adaptive system with emergent properties.
 - Optimal outcomes cannot be guaranteed; new possibilities continuously emerging as part of a dynamic process within the system
 - *Policy - innovation is enhanced by having an open society with the rate of innovation a function of the prevailing socio-economic environment, including beliefs, types of knowledge flows, sets of incentives, and legal, political and cultural rules of the game – points to the importance of the innovation system*

- **Neo Schumpeterian models:** elements of the new growth framework; technological change as path-dependent process and economy as complex system.
 - Competition between innovations, rather than between firms, is central force propelling economic growth.
 - Process of economic upheaval and change seen as perpetual.
 - *Policy - tries to reconcile the other schools – stresses the importance of innovation inputs – main inputs to innovation are public and private expenditures and the publicly available stock of innovations*

Per capita spend on public sector R&D, 2015 selected high income economies, (€)

(Eurostat)



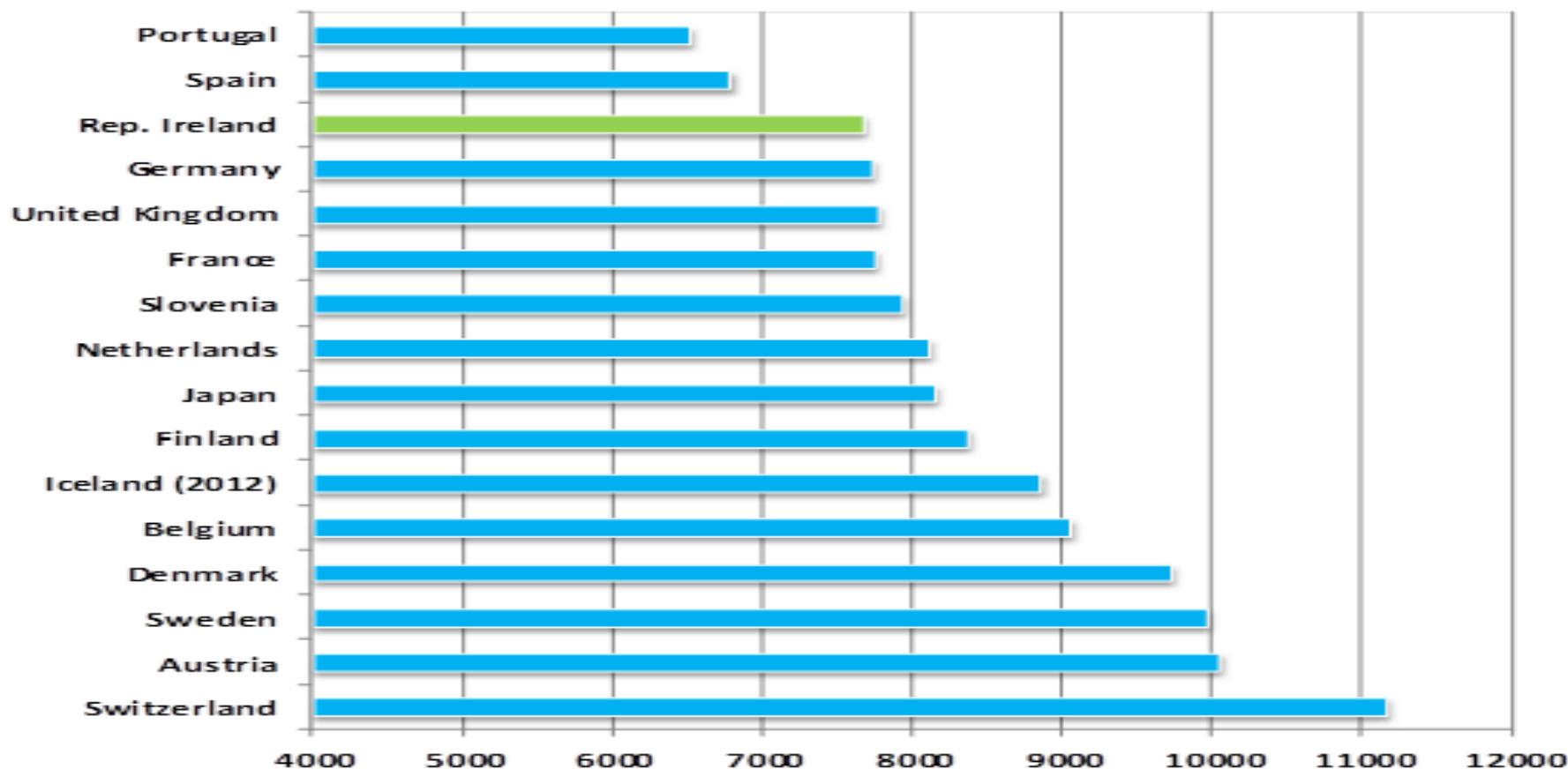
Figures shown are the combined totals for government and higher education R&D expenditure.

Definition differs for Germany, Netherland and the United States.

Data is 2014 for Japan, South Korea and Switzerland and 2013 for the United States.

Public spending on education institutions per pupil (FTE) in 2013, selected countries (PPS)

(Eurostat)



National Innovative Capacity

- The ability to generate original ideas and communicate and assimilate existing innovations.
 - A function of education levels, compatible institutions, knowledge flows, the quality of capital markets and government policies that support R&D (the innovation system).

- The production and diffusion of innovations can be incentivised through measures to increase the productivity of R&D and other knowledge production activities.
 - E.g. reducing the cost of innovation inputs (subsidies/tax breaks) or improving the quality and efficiency of those inputs (education)

- Increasing the productivity of knowledge production:
 - Invest in human capital. This is because human capital is a complement to the production and exploitation of ideas
 - Support and invest in technologies which themselves reduce the cost of knowledge search and the diffusion of useful ideas (e.g. broadband)

National Systems of Innovation (NSI)

- A system of innovation comprises:
 1. The institutions engaged in innovation related activities (STI Actors)
 2. The environment in which these institutions operate and
 3. The linkages between these institutions including collaborations
- NSI supporting institutions include the public administration apparatus; the financial system; the legal and regulatory framework; cultural attitudes and the education system
- The presence of compatible and well-functioning institutions merely *permits* the development of a successful NSI
- Ultimately, it is the actions of the STI actors that will propel innovation

STI Actors

STI Actor Role	Examples	Sample Contributions
Policy Maker	Governments, Government Departments, International Organisations	Strategic Direction, Funding
Policy Enactor	Public Agencies	Coordination, Regulation, Programme Funding
Technology Producer	Enterprises, Academia, Research Institutes	Knowledge, Skills, Products
Technology User	Enterprises, Industries, Foreign and domestic markets	Demand, Spillover, Feedback
Technology Lobbyist	Academia, Industry Groups, Business and Consumer Groups	Analysis, Information, Demand

Technology Diffusion

Understanding the diffusion path of innovations

- Factors influencing or related to:
 - the perceived benefits
 - the perceived costs
 - the industrial and social environment
 - Uncertainty and information problems

Relevant technology characteristics

- Relevant advantage over other technologies
- Compatibility with existing norms and practices
- Complexity
- Trialability
- Observability

Technology Diffusion

Models of diffusion:

- Epidemic model (based on awareness);
- Discrete choice model (based on expected net benefit);
- Complex Network Models (based on network relations);
- Percolation Models (based on network relations – emphasises regional variation)

Enablers at the macro level (these overlap)

- Transport and communication technologies
 - Connectivity, access to knowledge
- Effective population size and density
 - Proximity and spillover, super-linear scaling
- Education and human capital
 - Competence, creativity, openness to new ideas
- Institutions or ‘the rules of the game’
 - Financial system, regulatory system, legal system, cultural norms, quality of governance
- Cost of knowledge, returns to innovation
 - Fiscal policy (subsidies/tax system), property rights

Innovative and absorptive capacity of firms and consumers.....

Technology Adoption 'tests'

Category	Question	Factors
A	Is the potential adopter 'aware' of the technology?	Education, Experience, Physical Location, Contact with existing users
B	Does the potential adopter have the 'opportunity' to acquire the technology?	Technological constraints, infrastructure constraints, market constraints, legal constraints, physical location
C	Does the potential adopter have the 'capacity' to acquire the technology?	Cash flow, income, wealth, access to finance, education and skill-set, social contacts
D	What is the potential adopter's anticipated level of 'utility' from the technology	Personal preferences, perceived relative advantage, familiarity with similar technologies, market opportunities

Policy levers

- We can enhance awareness of new technologies and innovations through a public information campaign, or by improving the knowledge flows between economic actors
- Opportunity to acquire technologies may be an issue of infrastructural or legal constraints. Policymakers have some control over these areas. Broadband is a contemporary example of a technology whose diffusion is limited in many countries due to lack of opportunity, particularly in rural areas
- Capacity to acquire the technology, sometimes called absorptive capacity, may relate to financial constraints or human capital constraints. This suggests a rationale for directly subsidizing technology adoption by small firms, and for subsidizing training and up-skilling for workers and managers.
- Finally, we can increase the perceived utility of the technology through public information campaigns and demonstration effects and through complementary investments in human capital

Recapping

1. Sustainable growth is dependent on continuous productivity gains arising from innovation
2. Innovation is itself a function of the production, diffusion and application of economically useful new ideas
3. The characteristics of knowledge mean that the self-regulating market under-produces relative to the social optimal level of innovations
4. Increasing innovation 'outputs' is not simply a matter of increasing innovation 'inputs'
 - a. The institutional environment and innovation system matter
5. No matter how useful an innovation is, its impact will ultimately depend on its level of diffusion and its pervasiveness in the economy
6. Successful technology diffusion requires a positive adoption decision. The adoption decision depends on the perception of the utility and opportunity cost of the technology

Potential Reforms

1. Increase spending on basic and applied research as a percentage of economic output, as well as seed funding for high potential start-ups.
2. Increase per pupil spending on education. In particular, increase spending at early years and in disadvantaged areas
3. Incentivise (subsidise) take-up of science, technology, engineering and mathematics (STEM) courses at undergraduate and postgraduate levels and support attractive career paths for STEM workers.
4. Establish a state investment bank to raise affordable and patient funding for innovating enterprise (equity stakes) – the ‘entrepreneurial state’.
5. Greater focus on enhancing absorptive capacity – may relate to financial constraints or human capital constraints. Explore potential for grants to SMEs for adoption of new technology.
6. Increase support for horizontal linkages between the state, higher level institutes and industry – coordinate networks of firms and institutes through government schemes
7. Address market failures in the provision of high speed broadband to rural areas
8. Have independent and regular evaluation of innovation policy tools.
9. Provide for multi-year funding envelopes and consolidate funding and actions into a small number of agencies.