EUROPEAN SCIENCE FOUNDATION

STOA

The Science of Innovation

ESF-STOA policy brief

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More information about the conference:
www.esf.org/innovation

Contents

Foreword 3
1. Innovation policy: 'uncommon sense' needed 4
2. The 'science of innovation' 4
3. Policy myths and rituals 5
4. Blind spots in innovation policy 6
5. Creative destruction, or destructive creation? 6
6. Cognitive lock-in 7
7. The ERA and academic disparities 8
8. Evidence-based innovation policy: limits and challenges 8
9. Sharing risks and returns: toward a new model of knowledge governance 9
10. Innovation aimed at public value 10
Conclusions 10

Foreword

In the context of global competition and of daunting collective challenges in terms of the environmental, demographic, social and economic sustainability of our societies, Europe needs to urgently improve its innovative potential. For this, Europe must stimulate a culture of innovation that enables and inspires all individuals, research institutions, firms, public sector organisations and others actors of our society to actively foster innovation. Innovation is not just the topic of the moment; the future of our societies and economies depend on it.

Innovations have transformed our world, allowing our ancestors to escape from hunger and poverty. As innovation has become one of the centre-pieces of European policy, a sound understanding of the nature and dynamics of such a powerful driver of the economy has become crucial, and will have huge consequences in shaping current and future policies.

Innovation is the answer; but it is no easy answer. Indeed, important questions remain, for instance whether stimulating innovation might lead to increasing inequalities, as the costs and benefits may be unevenly distributed among social and age groups and among countries inside EU, especially between the North and South. We need to talk not only about the positive but also about the potential negative impact of innovation, and about the ways to evaluate the different forms of impact of research and innovation policy in order to adequately redirect resources and adjust policy instruments. We must create policy measures tailored to the European context, which is a challenge in its own right, as the European scale and diversity adds an important dimension of complexity.

An incomplete understanding of the complex, nonlinear innovative process might result in failure of public policies to fulfil the needs and hopes of the European citizens. New and effective policies require close interaction with innovation research. In this policy brief, the results of the ESF / STOA conference 'The Science of Innovation', which took place in Brussels on 28 February 2012, are summarised in the form of 10 thought-provoking issues that the science of innovation presents to policy-makers. It should be understood as a 'sample' of insights that this research domain has to offer. We hope it will help to deepen the discussion on innovation, and to strengthen the link between innovation research and innovation policy.

António Correia de Campos
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1. Innovation policy: 'uncommon sense' needed

The Horizon 2020 programme represents a huge investment and carries a lot of hopes, promising that science and technology will lead to a "smarter, more sustainable and more inclusive society". The key mechanism through which this should be achieved is innovation, which is understood as the application of new knowledge in the form of new products and processes. In fact, innovation is not only a central part of European research policy, but has become an important centrepiece of European policy in many domains. Often innovation is seen as a panacea, a cure for all problems. However, innovation is complex, especially when taking indirect and systemic effects into account; and is not easy to understand and steer. Many policy-makers seem to work with a limited number of rather schematic ideas about innovation; ideas that have been repeated so often that they have started to feel like common sense. But in fact, 'uncommon sense' is needed to understand and use this powerful mechanism of shaping economies and societies. Innovation is not always benign, its effects are often not clear-cut, and more innovation is not automatically better. Innovation in financial products and services for example are seen by many as an important source of the current crisis. Moreover, over time the meaning of the term 'innovation' has been broadened and stretched, and it is now used for a much wider range of activities than in the past. Insights derived from an era that had a narrower concept of innovation are not always necessarily appropriate. While promoting more innovation in our economy, it is crucial to better understand how to optimally (rather than maximally) stimulate innovation, and how to prevent unintended consequences and increase the probability that innovation will lead to actual progress. Social sciences research on innovation has a lot to offer in this respect, and the 'science of innovation' should be considered as an essential tool in devising and improving policy.

Innovation is not always good, and more innovation is not always better

2. The 'science of innovation'

Originally, economic theories on innovation and technology assumed that these simply occurred, as some sort of 'exogenous force', which did not need to be explained but merely exploited. However, more recent theories have placed innovation within the system, and see it as endogenous to the growth process. Innovation is now recognised as both an important cause and consequence of economic growth, as surplus enables the further development of different forms of knowledge, which in turn leads to further economic growth. This is however not a simple mechanism, and it has proven remarkably difficult to really explain why and how important innovations occurred and how to capture their impact.

The 'science of innovation' – often referred to as science, technology and innovation (STI) studies – is founded on decades of research from economists, sociologists, historians – amongst others – and has grown into a significant field of study involving several thousands of researchers. Yet, as the world is

Much of our knowledge has been gathered in the context of innovation in industry, while in fact more than 80% of our economies consist of the service sector, and services are arguably the major drivers of our economies.

changing rapidly, and as the meaning of the term innovation is stretched to cover almost any process of renewal – from a new gadget to a new system of micro-credit which will fundamentally alter social and economic structures in a society – it is clear that we need to know more and understand better. For example, much of the knowledge on innovation is based on research in industry, which is only of limited relevance for innovation in the service sector. Not only do we need to know more, we also, and crucially, need to use this knowledge better. Policy-makers tend to be selective in what they choose to take from existing evidence and what they choose to ignore. This has implications for policy design, as quite a lot of our investments may not have the impact we wish they had.

3. Policy myths and rituals

As the term 'innovation' has proceeded to enter virtually all policy discussions at the European level, its meaning has become stretched and diluted. This poses a challenge for innovation policy-making, because at the same time, the ideas on what drives innovation have not (yet) evolved along with the notion of what innovation is. For example, the United States is still in many ways the dominant frame of reference for thinking about innovation and how to achieve it. This has led to copying perceived characteristics and structures of the US innovation system. The key 'ritual structures' are increased R&D expenditures; an emphasis on commercialisation of science through university based spin-off and licensing routes in high technology producing sectors; the promotion of entrepreneurship and new business entry; support for risk taking in venture capital; and the development of the SME sector more generally.

Much policy-learning is in fact policy-copying. But what works in one context may not work in another; the differences really make a difference.

There are many 'myths' in the innovation policy world; for example about the role of SMEs, universities and the state.

While all these elements of course do matter, they have been greatly exaggerated, to the neglect of other key factors of the innovation system as a whole. Features that work in the US may not work as well in Europe, and in fact many of the ideas that Europe has about what works in the US are incomplete or distorted. For example, in the US, it is in fact in existing, large firms (rather than small new start-up SMEs) and in *non*-R&D intensive sectors (rather than R&D-intensive sectors) where the main productivity gains are being realised. The real importance of universities in the innovation system is not the direct commercialisation of research-derived knowledge. It is rather a range of other highly influential effects, notably the 'production' of an educated workforce able to generate and/

or absorb innovations, and of educated consumers able to use innovative products, both necessary for realising the value of innovation. Also, contrary to the ruling perception of many European policy-makers, active intervention by the state is key to innovation in the US. Innovation policy has to beware of myths and rituals, and needs to be highly context-specific (national, regional). Given the diversity of Europe, this presents a big challenge for those who want to develop European level innovation policy.

Every bit of the i-phone actually had huge amount of state support, and the actual algorithm at the basis of Google was funded by an NSF research grant. Innovation is not simply a matter of getting more "Steve Jobses".

4. Blind spots in innovation policy

Due to the adoption of the idea of the 'knowledge society', in which knowledge is the main driver of economic development, higher education and research are now conceptualised as central engines of economic growth and national competitiveness. In this process, higher education and research have been reclassified from the status of public good to that of a globally-traded service. This has had profound impact on the way higher education institutions operate, what they do, how they do it and why they do it. Universities now have a new role:

Universities have been redefined as 'engines of economic growth'. This has profoundly changed the (self-) understanding and rationale of universities, and the effects of narrowing their mission is not necessarily positive, not even in economic terms.

to take responsibility for contributing to economic development via the production, diffusion and commercialisation of research results.

The focus on innovation as an output of research and higher education has led to a policy interest in a more active steering of research funding, towards areas seen as strategically important for improving national competitiveness. Impact, excellence, critical mass and international collaboration have become key criteria for funding decisions. Policies directed toward an increased contribution from the university to economic growth, via technology transfer and academic entrepreneurship, have contributed to a rather specific, narrow 'grand narrative' of the university. Other forms of knowledge transfer from the university, and knowledge transfer from other sectors than the university, have been largely omitted from the discourse – to the detriment of innovation policy, which has developed serious blind spots. There are a number of trade-offs which are not recognised sufficiently. For example, there has been a large shift of funding from secondary to tertiary education. Effectively this has reduced the quality of the output of secondary education, and it has reduced the quality of the input into tertiary education. The net result of the shift in funding in the education system, inspired by the wish for more innovation, is not necessarily positive – not even in terms of increasing innovation.

5. Creative destruction, or destructive creation?

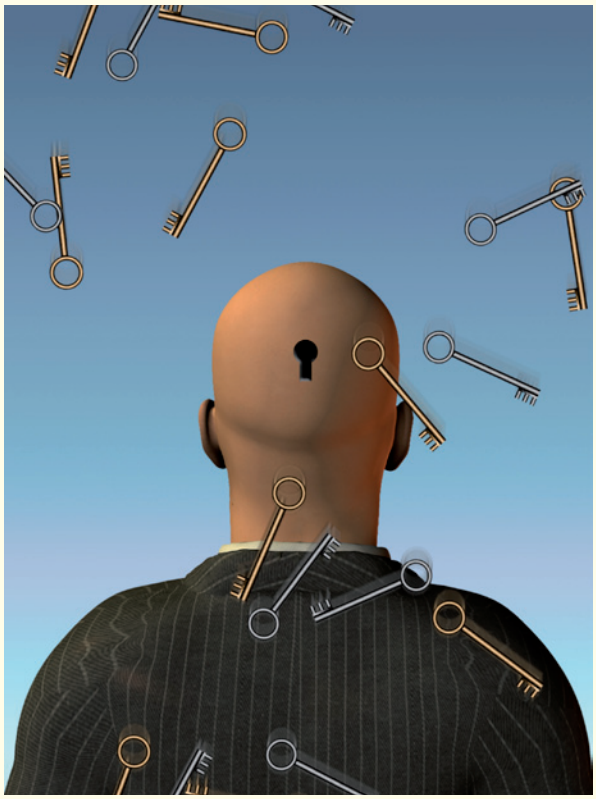
In principle, innovation is characterised by a Schumpeterian process of 'creative destruction' renewing economic activity and society's dynamics and hence leading to higher levels of development and welfare. In this process a few incumbents are destroyed to the benefit of many newcomers. However, innovation can also present the opposite pattern: a process of 'destructive creation', to the benefit of a few rather than of many. In the case of destructive creation, new products and services may diminish or destroy the usage value of existing ones before it is optimal to do so, whilst in addition incurring costs (e.g. environmental, health) that are not taken into account. In fact, it is thinkable that there can be 'too much innovation', and in the current period of 'crises' examples seem to abound: unsustainable fossil-fuel-based economic growth and financial innovation are only the most

The core of the innovation process consists of 'creative destruction'. Most policymakers focus on the creation part rather than on the destruction, for obvious reasons. But you can't have all 'creative' and no 'destruction'. In fact, sometimes innovation is much more like 'destructive creation', in terms of its net effect.

obvious ones. The STI community, especially its economists, seems not to have been sufficiently forthcoming in highlighting the limits of innovation in sectors where forms of destructive creation appear much more common than the usual forms of creative destruction, and policymakers may not be sufficiently aware of underlying trade-offs involved. As stimulating innovation is at the core of European policy, this is worth some in-depth reflection.

6. Cognitive lock-in

In principle, a strong link between innovation research and innovation policy should improve the quality of innovation policy by making it more evidence-based. But strengthening the link between innovation research and innovation policy is not automatically improving the quality of policy; it matters in what way it is strengthened. Rather than innovation policy-makers being passive consumers of scientific knowledge, they often commission and even cooperate with scientists to produce knowledge. However the policy process possesses its own cognitive frames. Through a direct commissioning of research therefore, knowledge is increasingly framed in a fashion that allows it to be easily integrated into the cognitive frames in policy, thereby legitimating existing views. The increased proximity between innovation policy and innovation research may therefore have the effect of limiting the horizon of both policy-makers and researchers. If our research funding mechanisms are too tightly coupled to pre-conceived notions of what is relevant, it can result in excluding important research questions and reducing the options for effective innovation policy. Thus, while policymakers should actively draw on the 'science of innovation', at the same time it should ensure its independence in order to increase its value.



7. The ERA and academic disparities

The policy for the European Research Area (ERA), and the increased (self-)perception of universities as economic actors, providing economically relevant products and services for which they should seek new markets, are important forces creating a European market for higher education. One of the effects of this is a sharpening of the differences between the universities and researchers that have a good 'market position' and those that do not (e.g. in Eastern Europe). Universities and, at the individual level, researchers have to be very well networked in order to be able to secure European funding for their research. This is a challenge for those areas where resources are scarce, infrastructure is underdeveloped, and teaching loads do not allow extensive time for travel and network maintenance. Thus, the effect of the ERA policy may be uneven, as the opportunities it presents are unevenly distributed.

8. Evidence-based innovation policy: limits and challenges

Governments have implemented a wide range of policies to encourage innovation with a view to stimulating economic growth and social progress. These range from local interventions (such as the establishment of science parks designed to build local innovative clusters) to system-wide policies (such as R&D tax credits, public venture capital investment or innovation procurement programmes). In order to maximise the effects of such policies policy-makers need evidence of efficiency, effectiveness and legitimacy. However, evidence on the effects of innovation policy is generally limited, widely dispersed and exists in many different forms – from academic research to internally-commissioned programme evaluations. The quality of the studies available is variable and is often lowered by de-contextualisation and by a quantification bias.

Policy makers want numbers, and work with numbers in setting their policy objectives (e.g. the objective of 3% of GDP in research and innovation). But clearly there often is no simple match between a

Innovation policy is often not really evidence-based, or based on distorted evidence. Available evidence from innovation research is fragmented, of variable quality, and hard to interpret; and it is often used in inappropriately.

policy instrument and an objective. A policy instrument may serve several objectives and vice versa. Instruments are also interdependent and affect each other's effects, sometimes mutually strengthening each other but sometimes also cancelling each other out to some extent, or combining into having unintended consequences.

The value of evidence crucially depends on the context in which it has been collected, and interpretation requires great care; it does not make that much sense for instance to affirm that one tax regime works better than another one without the context in which it is implemented. We need a much broader understanding of what evidence is, and of the role of evidence production in the whole policy cycle. A European Compendium project (similar to the 'Compendium of Evidence on Innovation Policy' project currently undertaken in the UK), systematically collecting evidence and using this to 'test' policy assumptions and hypotheses before they are turned into actual policy, could be of great value.

9. Sharing risks and returns: toward a new model of knowledge governance

Because innovation can be very uncertain, financing innovation implies taking risks; scientists can have 90% failure rates in R&D projects. Hence, if we want more innovation, we need to be speculative and engage in risk taking. Innovation is collective; the process results from the work of several different actors. The innovation process is the result of real division of labour among many actors including firms, banks, venture capital but also universities and states (national and local). In addition, innovation is also very cumulative; many of the actors mentioned come in late, after the state has made risky investments and get a lot out of the process. The state and private investments do not operate on the same landscape in terms of risk and capital intensity.

Nevertheless, innovation – although it has become increasingly collective (eco-systems) – returns on investments are becoming increasingly privatised. Despite coming late in the innovation process, after important risky investments, private actors receive a lot in returns. In finance, it is quite common to think that there is a relationship between risks and returns; therefore it is important to make sure that the collective risk-taking maps into a collective reward system, and to identify different risk-takers (innovation actors) and the level of risk each actor takes on.

SITRA, the Finnish government's public innovation fund, provided the early stage funding for Nokia; it later reaped a significant return on this investment – a fact accepted by the Finnish business community and politicians.

Public investments receive part of the return through taxation. The issue is therefore to evaluate whether this return is proportionate to the risk taken by public investment in innovation and research. If not, a new knowledge governance model could be considered, with new tools to give returns proportional to the very active risk-taking role of state in investing in radical innovation. Public venture capital, as well as national and European investment banks, could be considered as possible tools of this new knowledge governance.

Perhaps a new knowledge governance model should be considered, with innovative financial tools to give returns proportional to the very active high risk-taking role of state in investing in innovation.

10. Innovation aimed at public value

There is near-universal acceptance of the assumption that innovation is one of the most important, perhaps even the most important, means of achieving the fundamental collective goals of societies, including economic growth, national security, health, and life itself. However, much of the discussion on the impact of innovation focuses much more narrowly on the economic impact. This does not capture the other important effects such as better health or life satisfaction, which are only to a limited extent related to economic growth.

R&D Expenditures:
US ranks 1st
(301 billion euro in 2011)

Patents:
US ranks 1st
(283 per million in 2011)

World Health Care:
US ranks 37th
(Slovenia is 38th)

Infant Mortality:
US ranks 34th
(Malta is 35th)

Corruption Index:
US ranks 24th
(Uruguay is 25th)

Academics are trying to build alternative conceptual frameworks to the traditional economic understanding of innovation and to complement market-based criteria for evaluating the public value of innovation. In public value innovation, innovation is seen as beneficial to the extent that it enhances public values (e.g. education, human rights, health) and equitable and positive social outcomes. One of its general principles is to work for fairness and equity in distribution of social costs and benefits of innovation.

The concept of public value innovation aim at questioning paradoxes such as the increasing funds allocated to enormously expensive medical technology innovations – useful for the well insured – versus minimal research and innovation devoted to 'diseases of the poor'. It has the advantage of offering a very different perspective, focusing on ends rather than means, on measuring what we are trying to achieve rather than on what we are trying to achieve rather than our ability to measure what we can achieve.

Innovation is important, but not enough, and no guarantee for progress. Bad things can happen in society even with a great deal of investment in R&D and innovation.

Theories of public value innovation try to create a new typology of innovations based on their social impact. This new typology could lead policy-makers to privilege certain types of innovation rather than others; it will complement and enhance the means to evaluate policies in terms of their expected impact, including innovation policies. It is then possible to consider public value success and failure along with market success and failure, and observe that they are not automatically aligned. This can help policy-makers to optimise investments in innovation in terms of their broader outcomes.

Conclusions

We are in a historically unprecedented time, in that never before has innovation been so systematically stimulated, at such scale and intensity, with so many resources actively and explicitly devoted to it. Innovation is, in the end, only part of the answer to deal with the issues of our time; and it is an issue in itself, as many of our current problems are in fact to some extent or in some way related to the consequences of innovations in the past. The 'science of innovation' can bring fresh insights, and the 'sample' of insights in this policy brief will hopefully encourage all stakeholders of the innovation ecosystem to engage in a fruitful debate and to work together toward the fostering of an enlightened culture of innovation.

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