Innovation and the productivity paradox: why we do not seem to learn from innovation studies

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Introduction

- Some 35 years ago, I participated with Christopher Freeman in the debate which was raging at the time in both the US and Europe about the so-called productivity paradox: “everywhere around us we see computers except in the productivity statistics” (Bob Solow).
- Today there appears in many ways a similar debate going on. Where are the productivity gains associated with the digitalisation of our societies, with the digital connectivity, the social media? The lack of productivity growth evidence seems to hold for the US and Europe, also for Japan.
- These trends seem to raise at first sight similar questions as to the ***radical*** nature and “general purpose” productivity impact of those, by now old “microelectronics technologies” in the 80’s and the current digital transformation of the 21st Century (see e.g. Bob Gordon).
- Hence the title of my talk: it seems as if we, as research community of science, technology and innovation studies scholars, do not learn from the past. Of course we are confronted again and again with new technologies which are in their nature and impact on society very different, but why is it that we seem to have to take so much time to harness the productivity gains of those technologies.
- My talk will consist of two parts: first some more macro-economic observations; second some more micro-economic observations.

1. The macro-economic challenge: productivity measurement and new value creation

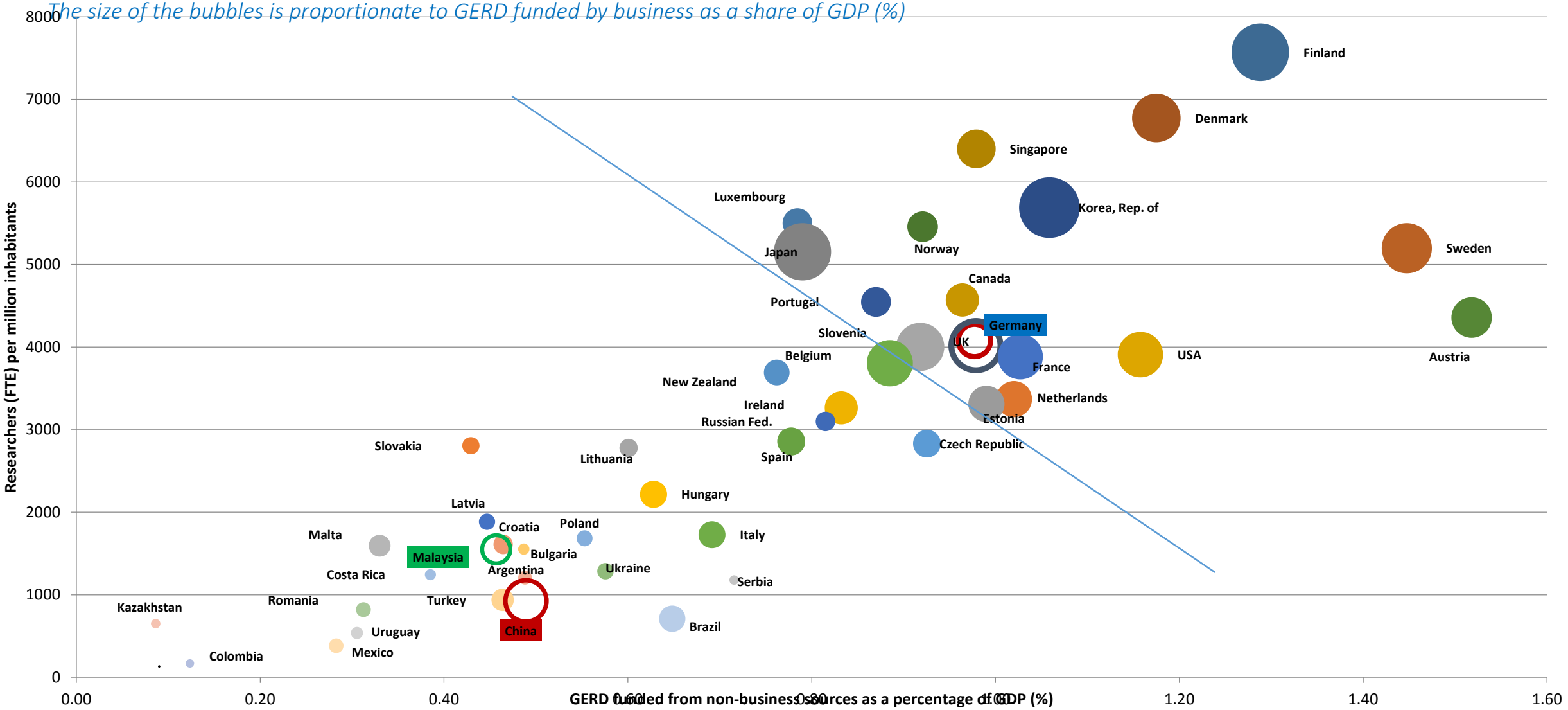
- There has always been a strong belief in the positive relationships between investments in science and technology, as measured through Research and Development (R&D) expenditures and economic growth, in particular (total factor) productivity growth.
- The growth models of the 1990s (Romer, Aghion, etc.) show how in a competitive environment profit-driven firms will invest in R&D. Such R&D-flows and the accompanying positive externalities are an important part of the supposed effect on productivity.
- The economic effect of the public R&D depends hence by and large on its interaction with the private sector: firms create value based on knowledge generated by public science (see Figures below).
- However, the links between R&D and productivity seem to become increasingly tenuous, a country's high R&D intensity is not a guarantee for future growth or productivity growth.
- Reasons:
  - Global value chains undermine any direct link between national R&D intensity and domestic value extraction;
  - There has been a significant world-wide increase in R&D, with more than a doubling in the number of scientists and engineers over the last fifteen years with different components of R&D distributed world-wide;
  - There is the impact of digitalisation on research collaboration.

Public and private R&D are complementary, not substitutes

(USR, 2015)

Mutually reinforcing effect of strong government investment in R&D and researchers, 2010–2011

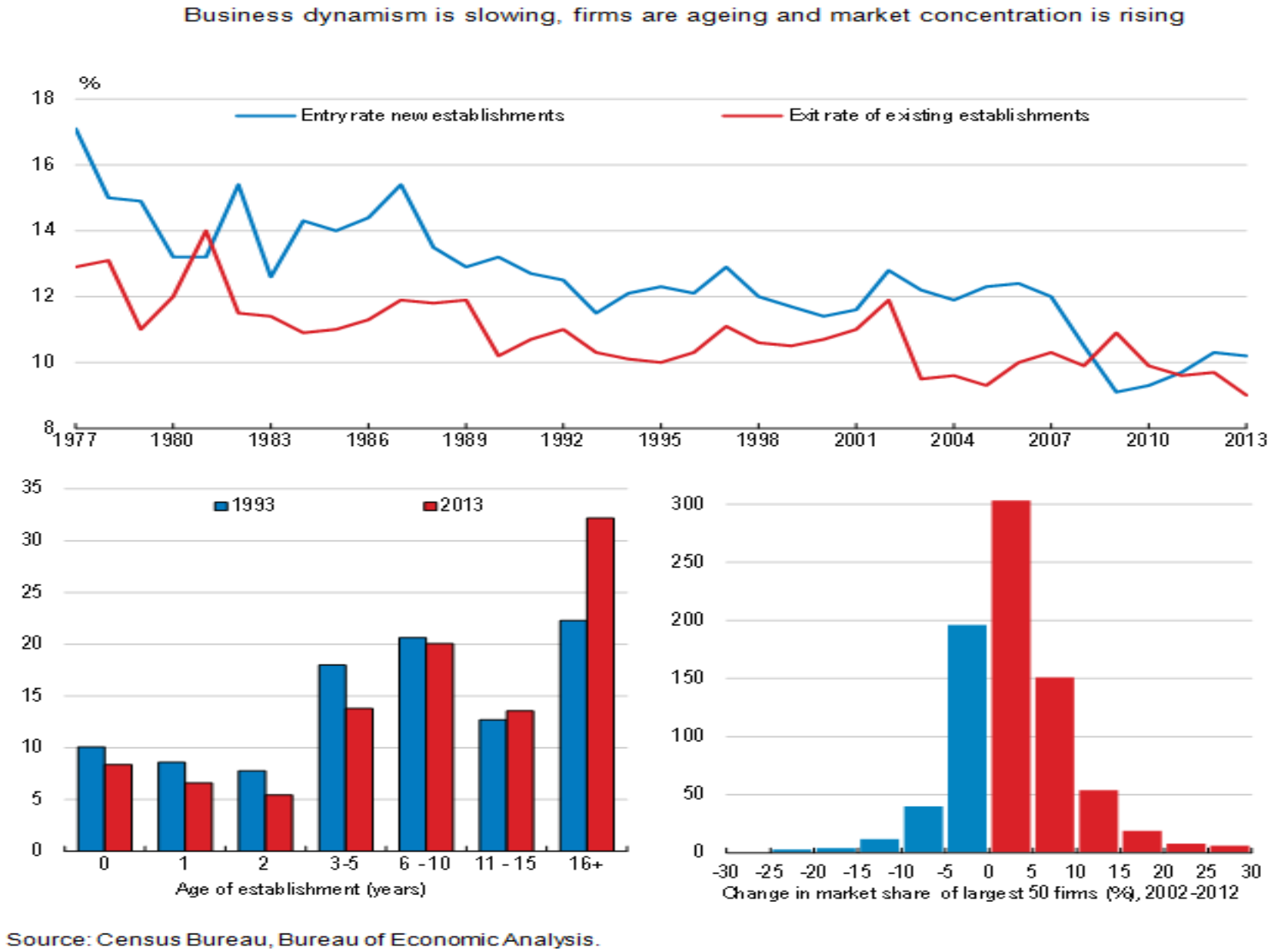
The size of the bubbles is proportionate to GERD funded by business as a share of GDP (%)



The invisible productivity impact of research

- A recent Dutch CPB study concluded, failing to find any significant evidence, that public R&D had a zero impact on TFP growth. It goes without saying that is rather difficult to convince Ministers of Finance, or the Treasury about the importance of investment in R&D under those circumstances…
- Explanations:
  - R&D is a core part of innovation, but innovation is much broader than just R&D. At the same time productivity growth is crucially dependent on diffusion, on the dynamics of old firms' exit and new firms entry and scaling up (see US picture below).
  - In the 2008 System of National Accounts R&D became a capital expenditure for the first time rather than an expense as it was considered in the beginning of national accounting. This is having a significant influence not only on indicators of science and technology but also on re-estimation of GDP.
  - Welfare implications of digital technologies are poorly translated into GDP (Freeman and Soete, 1994). Value of Google, Amazon, Facebook, Twitter…
- One needs to take a systems approach measuring local value creation in global value chains: a systems approach will have to deal with the actors (agents) in the system wherever they are, what they do (activities), how they interact (linkages) and what is the result in the short term (outcomes) and in the longer term (impacts).

"Competitive markets see a lot of firm entry and exit. However, this dynamism has declined: new firms are not being created as frequently as in the past (See figure, top panel) and the most productive of these firms are not growing as fast as they once did. This matters because advances in productivity typically result from the rapid growth of young dynamic firms. Instead, start-ups appear to be failing more often and the remaining firms are getting older with larger firms increasingly dominating markets (See figure, bottom panels)." Douglas Sutherland, OECD, 2016



https://oecdecoscope.wordpress.com/2016/12/06/unleashing-private-sector-productivity-in-the-united-states-2/

Innovation and invisible value creation

- Measurement of innovation when it is reflected in a new product or service is intrinsically difficult: there will be an intrinsic “positive” Schumpeterian bias towards innovation (see further).
- Second innovation can happen everywhere: in rich or poor countries; in government departments and research institutes; in hospitals, universities and museums; in households and more broadly consumers and users (von Hippel); in cities and local environments; and of course in the business sector for which most measures exist: patents, share of new products or services, innovation surveys, etc.
- Third, there are, and certainly once the systemic perspective is taken into account, two sets of innovation indicators not well represented: those dealing with linkages; and those related to framework conditions.
  - For a product like the iPod, its design, production and marketing take place in different countries and involve different elements of the innovation system (actors, activities, linkages and outcomes). The challenge is how to identify and record each transaction in the value chain including its geographical location.
  - Framework conditions vary with jurisdiction and include history, education and culture of participants in the system. These are difficult to change in the short term. However, terms of trade, standards, and the terms of labour contracts can be changed in the shorter term by governments as can e.g. taxes related to value creation.

Jobs and employment creation fears

- The current debates on robotics and artificial intelligence as the new challenge for employment, raising the specter of mass unemployment, sound from a historical perspective not very convincing. Historically the evidence of disappearing skills as a result of new technologies has not really been at the core of the emergence of mass unemployment.
- Rather existing social welfare systems in Europe have been incapable of addressing the issue because they became stuck in providing social security for full-time blue or white collar workers.
- What's new?
  - Disruptive innovations with incumbents being undercut by regulatory "free riders", with volatile employment conditions;
  - Global distributional issues with General Purpose Platforms rather than the old GPT enabling network monopolists to attract global network rents based on absolute size (economic) and political advantages;
  - Newly created consumer surplus neither valued nor taxed, hence major difficulties for public authorities to redistribute rents.
  - Deflationary effects of combination of new technologies and globalisation having become rather clear.
- In general, we tend to lack the necessary imagination to anticipate the new types of jobs that will be created by digitalisation.

2. The micro-economic challenge: technology and *"innovation is good for you"* positivism

- *"Innovation is good for you"* became a common feature of most science, technology and innovation studies and policies over the last decades.
- In many ways this is surprising given the fact that innovation ***failure*** rather than innovation ***success*** appears the most common feature in most early micro innovation studies (see e.g. the so-called SAPPHO study at SPRU in the 70's and the Yale study in the 80's).
- Following in particular historical analogies in line with the contribution of Joseph Schumpeter, one identified "innovation" at the societal level as a positive factor in bringing about structural change. Representing, in Schumpeter's terminology a process of "***creative destruction***".
- The introduction of new technologies and the organisational changes accompanying its introduction challenges the economic structure with new firms emerging challenging existing firms and organisations who have to adjust or will disappear. It is this process of creative destruction which renews society's dynamics and leads ultimately society to higher levels of economic development and welfare – destroying a few incumbents to the benefit of many newcomers;
- As I have argued elsewhere though, there is no reason why now and then there could be an exact opposite pattern being dominant: a process of "***destructive creation***" – innovation benefiting a few at the expense of many.

Characteristics of "*destructive creation*"

- A common feature of "destructive creation" appears its dependency on networks whereby the regulatory framework governing the network provides sometimes the major source for innovation.
- Why such patterns of "destructive creation" appear to have blossomed more recently is, I would argue, closely related to the advent of the new, digital information and communication technologies (ICT).
- ICT has allowed for a dramatic growth in opportunities what has become known as the long tail of product and service delivery differentiation.
- This has had major growth effects allowing for satisfaction of consumers' wants along the demand curve. New "versions" have emerged and have been behind the rapid growth of many new varieties of services.
- However the emergence of such service differentiation has also led to opportunities for cherry picking: for selecting profitable segments of demand which were essential though for the "full" service delivery.
- As a result, features of "universal service" delivery associated with the previous network service delivery came under pressure. Their quality of delivery became of lower quality or in the worst case discontinued. In network services it has increasingly become expensive to be poor.
- At the same time, network regulators were neither well-prepared nor informed about the many new digital opportunities. Deregulation led to new products or service delivery, inspired by change in regulation, exploiting fully the new digital opportunities of product differentiation with in some cases negative societal externalities.

Some examples of "*destructive creation*" innovation

- Two well established examples of patterns of "***destructive creation***", and one more speculative linked to current lack of productivity growth in the US and EU:
  - First, within the old framework of industrial innovation: the trend towards an ecologically unsustainable, innovation-led consumerism growth path;
  - Second, within the new network ICT-led innovation framework: the emergence of financial innovations following liberalisation and ICT based globalisation.
  - Third, the addictive impact of social media.
- In each of these cases the solution will have to be found in strengthening society's capacity to develop innovations of the opposite welfare enhancing "***creative destructive***" type.
- This raises some fundamental policy challenges about regulation with respect to environmental waste and sustainability both at local and global level as in the first case; the restrictions, control and quality of policy governance as in the second case; and the behavioural and public health limits to individual freedom as in the third case.
- It remains surprising how these economic rationales have so far been rarely part of discussions in our community. Colleagues in the STS community did have a well documented framework in which one also looked at some of the possible negative externalities of technical inventions, generally referred to as "Technology Assessment". The question therefore remains: what about innovation assessment?

Case 1: Innovation and planned obsolescence

- A closer look at the way innovation in consumer goods might have led our societies to a conspicuous consumption path of innovation led “destructive creation” growth.
- In most modern growth models, the decision to invest in research and development is driven by the prospect of monopoly profits on the incremental value that new vintages provide. In short, innovation goes hand-in-hand with value creation. Yet one can also imagine an opposite pattern: a process in which innovation actually destroys the usage value of the existing stock of durable goods and as a result induces consumers to have to repeat their purchase.
- Example: Emilio Calvano’s model of 2007. Calvano’s formal analysis shows that destructive creation unambiguously leads to higher profits whatever the innovation costs. On second thought this shouldn’t come as a surprise. It is “the power to “wreck” the value of old versions of a product ends up serving restoring profits.”
- Of course, this destruction of others’ monopolies may happen to the destructive creator later on, but the point is that there is no mechanism to take into account the optimal timing of innovations in regard to the destruction costs of all sorts of affected capital.
- The analysis presented by Calvano highlights the fact that the phenomenon of “destructive creation” is rather widespread. Easy and cheap ways in which existing usage value can be destroyed through product design, restrictive aftermarket practices, and in the extreme case planned obsolescence limiting on purpose the life span of particular consumer goods.

A rather pervasive process

- It is actually surprising in how many areas such processes of "*destructive creation*" exist that hinder prolonged usage and induce customers to migrate continuously to newer models.
- There are many forms and sorts of restrictive aftermarket practices which can be found in ICT related sectors such as software writers limiting backward compatibility, or electronic goods manufacturers ceasing to supply essential after-sales services or spare parts for older products (smart phones, mobiles, i-Pods, i-Pads). See the various legal cases brought against Apple with respect to the planned obsolescence of the battery lifes.
- Such a "*conspicuous innovation"* consumption growth path which in its environmental impact and ecological footprint is no longer limited to the developed world, but is now increasingly also present in emerging countries.
- It warrants a shift in the process of technology development and innovation: traditionally consumer product innovation has been driven by *professional use* demand directed towards the tip of the income pyramid: focusing innovation on the long tail of product quality, professional use improvements. While this has offered continuous growth expansion opportunities to global firms thanks to rising income in emerging economies, it is at the global level unsustainable
- Search on the part of the business community for long tails elsewhere (remember Ford's T-model): e.g. at low income level: bottom of the pyramid (BoP) innovations (Prahalad), local grassroots innovation (Anil Gupta).

Case 2: Financial innovations and systemic failure

- Financial innovations have actually been described as innovation of the “destructive creation” type and have by now been well studied.
- I would disagree with economists claiming that the financial product innovations of the last ten to twenty years, like Credit Default Swaps (CDS) or securitization were just “wind-making” innovations or illustrations of the lack of knowledge of risk management with financial experts. These new financial products were at the time they were introduced truly innovations in the real sense of the term.
- Again there is a clear link with ICT and the way these digital technologies, opened up new product/service opportunities. Let me just quote Greenspan back in 2005: “*recent regulatory reform, coupled with innovative technologies, has stimulated the development of financial products, such as asset-backed securities, collateral loan obligations, and credit default swaps that facilitate the dispersion of risk… These increasingly complex financial instruments have contributed to the development of a far more flexible, efficient, and hence resilient financial system than the one that existed just a quarter-century ago.*”
- However, the systemic impact of these new innovations on the rest of the system was insufficiently thought over. Regulators did not pay attention or were unaware of the new innovative opportunities: society missed dramatically an appropriate innovation assessment tool.

Innovation and positive incentives

- What then is the solution to financial innovations? The answers were actually known by financial specialists: forbidding destabilizing naked short sales; banning information hiding off-balance-sheets constructs; responsibility of the selling agent for the information given; dropping sales provisions not in favour of pricing of advice but rather payment of agents in proportion to the stock of contract values. Clear personal responsibility for the screening of bought packages; etc… However, all these involved processes of "creative destruction" within the sector itself and hence solutions could not be implemented by the sector itself.
- Both cases: unsustainable consumption and finance point to the negative societal externalities accompanying innovation not having been addressed by regulators.
- "Game design" in inducing sustainable behaviour by various actors through the design of games in regulation and control might well be a fruitful research line, such as mechanism design developing architecture whereby positive incentives are developed (see e.g. the 2007 Nobel prize for Leonid Hurwicz, Eric Maskin and Robert Myerson) bringing about the sought after behavioural outcomes.
- Such an architecture can be simple: it starts from the way citizens act, respecting their individual freedom, whereby the mechanism design is so that human coordination mechanisms achieve higher valuations from citizens than if left at the mercy of the uncoordinated expression of their actions.
- To put in more popular terms: parents who give their two children a cake and leave the distribution to the freedom of the kids will create conflict. Avoiding conflict without universal orders and prohibitions, a simple stimulus 'A divides the cake and B chooses' will do. In society, it is no different.

Case 3: social media and attention addiction

- The third case is more open for discussion but is one that is currently hotly debated in the US following the election of president-elect Donald Trump, but is clearly of relevance to our discussion of the productivity paradox: the role of social media in undermining productivity.
- Traditional private media companies are governed by a set of journalistic rules and regulations with respect to information provision and the transparency of (in-)dependence of news reporting, next to the more profit oriented commercial tasks of attempting to attract the attention of the reader, watcher or listener and operate as an advertising tool for commercial goods and services.
- Within the digital world though, the new "social" media platforms have only one central purpose: to "harvest" as much time as possible from the reader, watcher or listener and translate such time in revenue. What has become known as the "attention economy" purpose: investing massively resources in making their services as addictive as possible with the aim of making people return to such services throughout more or less all waking hours.
- There are of course many positive "creative destruction" features to the mergence of "social" media through global digital access, networking and connectivity. Furthermore traditional media have been forced to renew and reinvent their business model, renewing the whole way in which citizens communicate with each other.
- However, social media seem also to be accompanied by significant "destructive creation" features.

Social media and productivity

- In our increasingly complicated societies, the ability to concentrate without distraction on hard tasks – what Calvin Newport describes as “Deep Work” – is becoming increasingly valuable.
- By contrast, social media appear to weaken these skills because of their addictive engineering features, comparable in many ways to the phenomenon of planned obsolescence with respect to material consumption, as discussed in the first case of destructive creation.
- The more one uses social media, the more one’s brain learns to crave for a stimulus at any hint of boredom. Compare for instance the regulatory difficulties in imposing restrictions on the use of mobile communications in traffic or if I may say this in these surroundings, while teaching. It is actually no surprise that it is a company like Google who is most interested and keen in developing autonomous driving!
- In short, there is a point at which the use of Internet impedes one’s productivity. Something which is likely to be individually defined and which can be enhanced and learned through more consciousness and time awareness training.
- There appears, however, also a macro-economic (public health) issue in terms of an “attentional crisis”, society might be facing.

Conclusions

- Fourty years ago, the debate in our technology and innovation community about the productivity paradox was very much dominated by the organisational and skill challenges, the new technologies required in order to achieve the expected productivity gains. With Chris Freeman and Carlota Perez, I wrote many articles and books with historical comparisons on previous technological transformation such as the introduction of electricity and the innovation of unit electric drive as radical, new organisational paradigm.
- Today, it is tempting to compare the present productivity paradox with the previously studied one. However, and as I tried to illustrate here, the impact of the digitalisation and democratization of innovation, the emergence of global, general purpose platforms and local innovations apps, implies that we are confronted with new global systemic features of technology and innovation, whereby the latter is much more widely distributed than R&D, less dependent on the professional R&D lab, more involving trial and error, with a more crucial role of users.
- The central issue policy makers face today appear to some extent rather similar:
  - If there is only scant evidence of a productivity impact of new technologies, how can one justify on economic grounds public investments or support for private investment in research and innovation?
  - How does one cope with the “destructive creation” features of new technologies and innovation, and ultimately transforms those into a regulatory framework within which creative destruction can flourish.

Conclusions (Cntd)

- The three examples highlight three different directions for finding solutions to re-orient those “destructive creation” tendencies towards positive “creative destruction” structural changes:
  - The first one goes typically in the direction of pushing for innovation and structural change in the direction of circular economy principles. If firms in their profit seeking survival can only operate by continuously “wrecking” the value stock of existing products with consumers, circular economy principles such as the re-engineering of those old products, the recapturing of the old stock through different ownership relationships or taking directly responsibility for the waste, might go along way in the direction of a more sustainable innovation processes;
  - The second, one points to the care which must be taken in liberalizing particular network services in which there are some systemic network externalities. This puts a heavy burden on regulatory agencies to sometimes limit the search for new growth opportunities within some parts of the network. Experimentation along so-called “innovation deals” might provide a solution here. Allow for some time for a regulatory sandbox within which experiments can take place and systemic risk become more clearly identified;
  - The third one, the most speculative example, is probably also the most difficult one to address. For starters one might do well to rename the sector from “social media” to “social entertainment”. There are no media principles operating in this area of harnessing attention. Second, while human enhancement and self-discipline can be learned, firms providing such services might well see growth opportunities here. Third, there might well be a role here for education, focusing more on attention human enhancement.

Thank you for your attention

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