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**Working Paper Series**

**#2019-001**

**From "destructive creation" to "creative destruction": Rethinking  
Science, Technology and innovation in a global context**

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**UNU-MERIT Working Papers**

**ISSN 1871-9872**

**Maastricht Economic and social Research Institute on Innovation and Technology**

**UNU-MERIT**

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# From “destructive creation” to “creative destruction”: Rethinking Science, Technology and innovation in a global context<sup>1</sup>

*Luc Soete*

## **Abstract**

There is general agreement amongst economists today that Science, Technology and Innovation (STI)<sup>2</sup> have dramatically contributed to individual countries’ economic growth and welfare. Another, 21st Century way of looking at the old Solow residual discussion is to observe that STI has been the core factor behind the intrinsic characteristic of capitalism to accumulate indefinitely. Doing so STI has also created the seeds of the current pattern of unsustainable global development. Once the major driving forces of countries’ international, technological competitiveness are taken into account, “smart”, innovation-led growth and “sustainable”, green growth appear in contradiction with each other. The paper makes the case for “smart” no longer be leading in STI policy but rather “sustainability”. Four priority “directions” are suggested: radical improvements in eco-productivity reducing the energy and emissions intensity of production, distribution and consumption; biomimicry as sustainable product innovation guiding principle; the use of AI and big data as “sustainable purpose technologies” assisting and complementing growth in eco-productivity and green product development and design; and finally regulatory and taxing policies addressing over-consumption, including advertising. In so far as sustainability and inclusiveness are also in contradiction with each other, there is also need for specific proactive, integrated “eco-social” STI policies. Global sustainable development will only be successful if it supported by all classes in society. While for high income classes priority can be given to increased taxation, for low income classes there is a need for a more comprehensive green new deal that should include house retrofitting and social energy tariffs making the energy transition cheap. Finally the research community itself should put full priority to exploit fully the digital substitution advantages of research networking, rather than air travel.

**Keywords:** Science, Technology and Innovation; smart growth; sustainable development; inclusiveness.

**JEL Codes:** F6, M48, O30, O33, O38, P48

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<sup>1</sup> Cooper Memorial Lecture held in Maastricht on November 21<sup>st</sup>, 2018.

<sup>2</sup> STI refers here to both activities covered by Research and Development (R&D) expenditures whether carried out in public or private sectors of the economy as defined in the OECD Frascati Manual as well as Innovation activities as defined in the OECD Oslo Manual.

## Introduction

There is general agreement amongst economists today that Science, Technology and Innovation (STI)<sup>3</sup> have dramatically contributed to individual countries' economic growth and welfare. In the developed world by continuously expanding the quality and range of goods and services while increasing at the same time productivity; in the developing world indirectly by sketching out the path to rapid development through technology transfer and technological catching up<sup>4</sup>. Doing so STI has at the same time created the seeds of the pattern of **global** unsustainable development we witness today.

Another 21st Century way of looking at the old Solow residual discussion is to observe that STI has been the core factor behind the intrinsic characteristic of capitalism as "economic system" to **accumulate indefinitely** with an inbuilt tendency **to continuously expand** the supply and demand for new wants. As the British investor Jeremy Grantham put it recently: "*Capitalism, by ignoring finite resources and by neglecting the long-term well-being of the planet and its potentially crucial biodiversity, threatens our existence*"<sup>5</sup>.

The fundamental challenge before us today is how and under which conditions STI can contribute to solve this global unsustainable development. What counts now from a policy perspective is quite suddenly not so much the rate but the way we can influence the **direction** of technical change. Over the last year there have been lots of proposals on how to implement new "mission oriented research and innovation" policies at national and European level, closely in line with national industrial policy<sup>6</sup>.

At the global level this represents though a much more formidable challenge.

Over the last twenty years or so, we have witnessed a **dramatic growth in STI funding** at global level not just at OECD country level. Available figures, such as the global Figure presented in the UNESCO Science Report 2015<sup>7</sup>, refer only to the R&D part of individual countries' STI activities.

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<sup>3</sup> STI refers here to both activities covered by Research and Development (R&D) expenditures whether carried out in public or private sectors of the economy as defined in the OECD Frascati Manual as well as Innovation activities as defined in the OECD Oslo Manual.

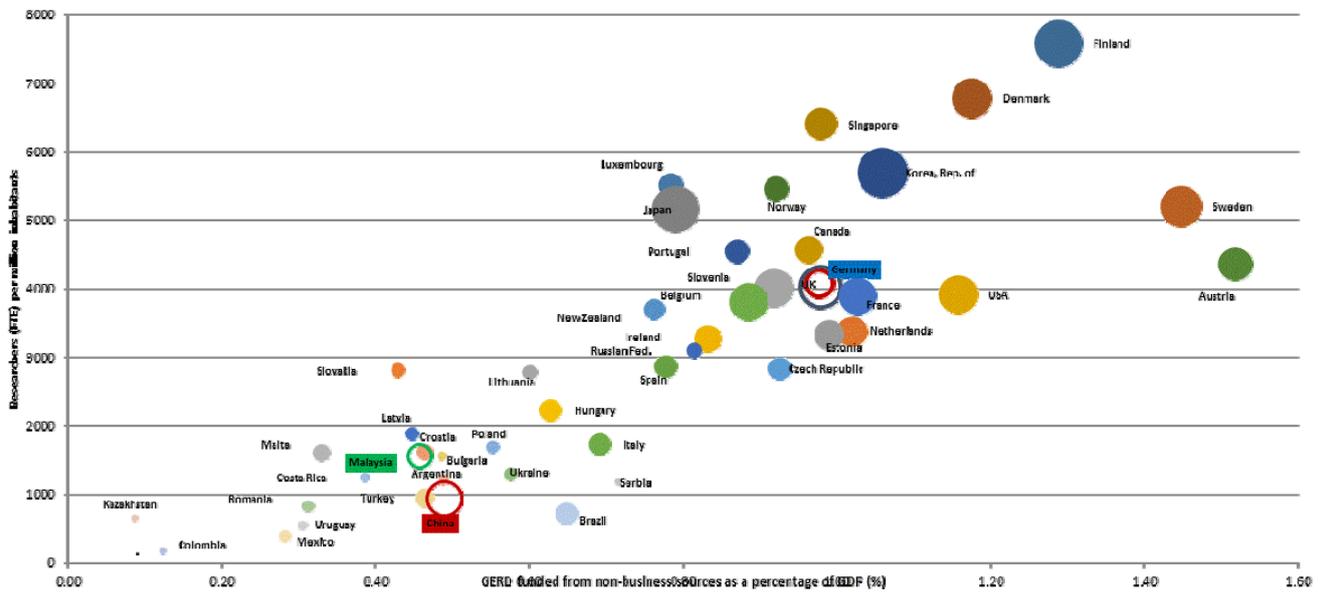
<sup>4</sup> As Charles Cooper has highlighted in much of his writings of the seventies and eighties. See e.g. Cooper, C. (1973), *Science, Technology and Development*, London: Routledge.

<sup>5</sup> In Klein, N. (2015), *This Changes Everything: Capitalism vs the Climate*, New York: Simon&Schuster, p. 233.

<sup>6</sup> See amongst others Mariana Mazzucato (2018), *Mission-oriented Research and Innovation in the European Union, A problem-solving approach to fuel innovation-led growth*, Brussels: EC ([https://ec.europa.eu/info/sites/info/files/mazzucato\\_report\\_2018.pdf](https://ec.europa.eu/info/sites/info/files/mazzucato_report_2018.pdf)) and the two reports from the Economic and Social Impact of Research (ESIR) expert group for the EC which I chaired: ESIR Memorandum I (2017), *Towards a Mission-Oriented Research and Innovation Policy in the European Union. An ESIR Memorandum*, Brussels: EC ([https://ec.europa.eu/info/sites/info/files/an\\_esir\\_memorandum-towards\\_a\\_mission-oriented\\_research-and-innovation\\_policy\\_in\\_the\\_european\\_union-executive\\_summary.pdf](https://ec.europa.eu/info/sites/info/files/an_esir_memorandum-towards_a_mission-oriented_research-and-innovation_policy_in_the_european_union-executive_summary.pdf)) and ESIR Memorandum II (2018), *Implementing EU Missions*, Brussels: EC (<https://publications.europa.eu/en/web/eu-law-and-publications/publication-detail/-/publication/4177ae56-2284-11e8-ac73-01aa75ed71a1>)

<sup>7</sup> See UNESCO Science Report, Executive Summary written by Soete, L., S. Schneegans, D. Eröcal, B. Angathevar and R. Rasiyah (2015), "A world in search of an effective growth strategy", Paris: UNESCO, p. 15. (<http://unesdoc.unesco.org/images/0023/002354/235407e.pdf>)

**Figure 1: 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 (%)**



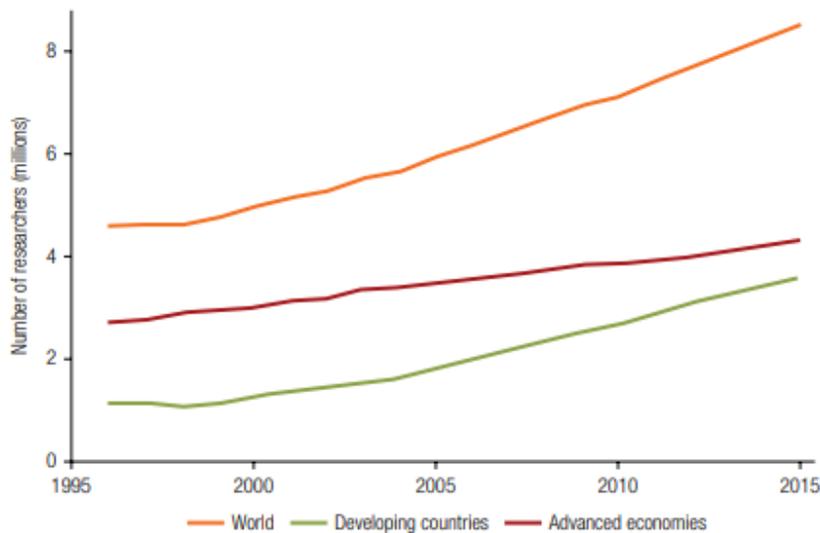
As was noted in that report: “With public budgets under pressure especially in advanced economies since the 2008 financial crisis, there is a temptation to divert public STI budgets towards the R&D and commercialisation end of the innovation cycle.”

Over the last ten years and since 2008 though, public but in particular *private R&D expenditures* have been growing rapidly as highlighted in a recent Nature article<sup>8</sup>. Total private R&D spending amounted to nearly \$800 billion, total public R&D spending to nearly \$350 billion. The latter data refer though only to the R&D expenditures spent in OECD countries. At the global world level, the growth in research activities has been particularly significant, as illustrated in Figure 2. There are now twice as many researchers in the world as twenty years ago, with about half of them located in the developing world.

**Figure 2: The Number of Global Researchers Has Doubled since 1995, with Most Growth in the Developing World<sup>9</sup>**

<sup>8</sup> Nature, 13 september 2018, <https://www.nature.com/articles/d41586-018-06634-4>

<sup>9</sup> See Cusolito, Ana Paula, and William F. Maloney. 2018. Productivity Revisited: Shifting Paradigms in Analysis and Policy. Washington, DC: World Bank. doi:10.1596/978-1-4648-1334-4.



Source: Elaborations using UNESCO data.

The rapid growth in R&D has been driven by a national policy focus on increasing national R&D spending as **competitive tool**: a national, or in the case of the EC, a European focus on the **rate of technical change**. Doing so the focus is first and foremost on the **supply side** of the STI system with the allocation of public research funds increasingly based on individual or institutional performance based primarily or solely on **excellence**, and private R&D being primarily carried out by large multinational corporations with their “Research” being increasingly anchored physically near some of the world-leading public research organisations such as universities and other public research institutions and the “Development” part becoming increasingly footloose, following in the slipstream of foreign investment, and closely related to design and other sales related R&D activities which need to be carried out near the main sales markets, assisting in the further development of new products and services.

Ten years ago in a paper<sup>10</sup>, part of a foresight exercise about “The World in 2025” at the request of the European Commission, Directorate for Science, Economy and Society in close collaboration with the Bureau of Economic Policy Advisors, I argued that it was the extreme geographical inequality in world GDP in the 60’s and early 70’s which formed the basis for the sheer unilateral focus of social scientists and policy makers on strengthening **domestic** competitiveness as the essential feature for a country’s future economic growth. As Ulrich Beck, discussing the phenomenon of globalisation, put it in 2002: *“The consequences of this for society (and sociology) have been spelt out most clearly in the English-speaking countries, but above all Britain, where it has been forcefully argued that conventional social and political science remains caught up in a national-territorial concept of society. Critics of ‘methodological nationalism’ have attacked its explicit or implicit premise that the national state is the*

<sup>10</sup> Soete, L. (2008), Malthus’ Revenge, UNU-MERIT Working Papers series #2009-030.

*'container' of social processes and that the national framework is still the one best suited to measure and analyse major social, economic and political changes.*"<sup>11</sup>

This national-territorial obsession of social scientists was particularly reflected in policy makers desire in both developed **and** developing countries alike, to be technologically independent, to create national technology support policies aimed at strengthening the country's technological competitiveness. As a matter of fact, in the 70's the notion of technological independence was quite popular in the development literature<sup>12</sup>.

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<sup>11</sup> Beck, U (2002), *The Cosmopolitan Society and Its Enemies*, *Theory, Culture and Society*, Volume: 19 issue: 1-2, page(s): 17-44.

<sup>12</sup> See my critique of that concept in Soete, L. (1981), "Technological dependence: a critical view" In: Seers, D. (Ed.) *Dependence theory: a critical reassessment*, London: Frances Pinter.

## 1. Innovation-led consumption-based growth: how creative destruction became destructive creation.

My first claim is that the dramatic rise in fossil-based energy use and more broadly in global emissions since WWII has been fundamentally driven by the inherent drive across first the OECD world and later on – the last three decades – the emerging economies towards US consumption patterns.

Combined with the dramatic growth in digital information and communication technologies over the last thirty years, these high income consumption aspirations have rapidly diffused across the globe triggered by similarly rapidly growing advertising expenditures. As I put it, in the “Malthus’ revenge” 2008 paper: “Once the word “*population*” in the famous Malthus quote that: “*the power of population is so superior to the power of the earth to produce subsistence for man, that premature death must in some shape or other visit the human race*” is replaced by consumption, both present, real consumption and future, global consumption aspirations, the Malthus’ quote takes on a new, more intriguing 21<sup>st</sup> Century meaning... Such replacement appears justified following the global diffusion of new digital information and communication technologies over the last thirty years with the uptake of those technologies across the world at a historically unprecedented speed.”

The spreading internationally of what I will refer to here as “consumerism” has as a result blossomed along the lines of STI being focused on new innovation products replacing each time the existing capital stock of the previous generation of old-fashioned consumer goods. In short, consumer variety as the driving engine for economic growth. This innovation-led consumption-based growth path has been based on what I have called and described in the Marie Jahoda lecture at SPRU in 2011 as a process of “destructive creation”<sup>13</sup>.

It is also worthwhile noting that this process has been accompanied over the last decades by a significant decline in public investment (including maintenance) in most OECD countries.

### A brief revisit of the Jahoda lecture...

“***Innovation is good for you***” became a common feature of most STI studies and policies over the last decades.

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

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<sup>13</sup> The Marie Jahoda lecture was also the core of the Tans lecture given a couple of weeks later at Maastricht University (November 2011). Both lectures were written up in Soete, L. (2012), “Maastricht reflections on innovation”, *UNU-MERIT Working Paper 2012-001*.

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 argued in the Marie Jahoda lecture, 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.

Since the Marie Jahoda lecture I have elaborated some of those ideas further and considered in more detail other possible examples<sup>14</sup> of “*destructive creation*” patterns which I will not elaborate upon here. My focus here will be on the trend towards an ecologically unsustainable, innovation-led consumerism growth path. It remains surprising how these economic rationales have so far been rarely part of discussions in our STI research community, as opposed to the STS community<sup>15</sup>.

Let me briefly summarise here how innovation in consumer goods might have led our societies to a conspicuous consumption path of an innovation led “*destructive creation*” growth path. 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 2006/7<sup>16</sup>. Calvano’s formal analysis shows how *destructive creation* will unambiguously lead to higher profits whatever the innovation costs. On second thought this shouldn’t come as a surprise. “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, 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 and has more recently been very much induced by the emergence of new ICT consumer goods. Easy and cheap ways in which existing usage value can be destroyed is through e.g. product design and restrictive aftermarket practices, and in the extreme case through so-called “*planned obsolescence*” limiting on purpose the life span of particular consumer goods.

It is actually surprising in how many areas processes of “*destructive creation*” exist that hinder prolonged usage and induce customers to migrate continuously to newer models. The most extreme and widespread case would be new product design in e.g. fashion clothing or shoes destroying existing output, but there are of course many other forms and sorts of restrictive aftermarket practices which can be found in many 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

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<sup>14</sup> Such as the addictive impact of social media.

<sup>15</sup> See also my recent attempt at bringing both STI and STS research tradition together in Soete, L. (forthcoming), Science, technology and innovation studies at a crossroad: SPRU as case study, *Research Policy*, in press.

<sup>16</sup> Calvano, E. (2006), "Destructive Creation", SSE/EFI Working Paper Series in Economics and Finance 653, Stockholm School of Economics, revised 30 Dec 2007.

products (smart phones, mobiles, iPods, iPads). See the legal case brought against Apple in 2003 with respect to the planned obsolescence of the battery life of the batteries in the iPod. Paul David termed this, the innovation fetish Imelda Marco syndrome “*in memory of a famous instance of the uncontrollable, obsessive accumulation of more and more pairs of women’ shoes (another, richly documented fetish object).*”

This “*conspicuous innovation*” consumption growth path which in its environmental impact and ecological footprint is not only unsustainable in the developed world, is increasingly so at the global level, where international communication induces consumers to “long” for such new goods. Traditionally consumer product innovation has been driven by *professional use* demand directed towards the tip of the income pyramid: the long tail of product quality, professional use improvements. While this has offered growth expansion opportunities to firms thanks to rising income inequality in developed and emerging economies, it is economically unsustainable. Compare it e.g. to the search on the part of the business community in the absence of Keynesian global redistribution policies for long tails elsewhere such as in the case of the Ford’s T-model in early 20<sup>th</sup> Century, or innovations focusing on low income consumers, bottom of the pyramid innovations as Prahalad named this process or local grassroots innovation as Anil Gupta likes to mention.

## 2. Global self-defeating “smart” growth goals

One of the most interesting trade models, much in line with Charles Cooper’s thoughts and reflections on the particular role of technology transfer for development, was Paul Krugman’s 1979 North-South technology trade model<sup>17</sup>. One of Krugman’s most interesting analyses, focusing on the particular role of technology accumulation under the form of new products in the North and the subsequent technology transfer to the South for North-South wage levels, highlighted the way the North would ultimately be condemned to continuous product innovation to maintain its higher wages and income level in the long term. As he concluded: “The crucial point... is that the incomes of Northern residents depend in parts on the rents from their monopoly of newly developed products. This monopoly is continuously eroded by technological borrowing and must be maintained by constant innovation in new products. Like Alice and the Red Queen, the developed region must keep running to stay in the same place”<sup>18</sup>. In many ways, the need for a process of continuous technological accumulation is what is behind the notion of “smart” growth, as put forward in the Lisbon 2010 and the current Europe 2020 strategy with the complaints about private firms failing to invest sufficiently in Europe in R&D and innovation.

But let us focus on what this implies at the global level for the South. Which other direction of technical change to pursue if not the Northern one? Here too, it seems as if “the South must keep running and running to never catch-up”. Combined this North and South “running” behind innovation to maintain or increase high income consumption levels is likely to lead to a dramatic increase in the ecological footprint of humanity and behind the rapid movement of our planet towards the Anthropocene<sup>19</sup>, following the Holocene.

As a side issue it is interesting to observe that addressing the challenges emerging with the Anthropocene, will require contrary to the previously described North-South technology trade model, **open** research collaboration as illustrated by some of the success stories of research addressing global public goods: space once it moved beyond the “old” national mission goals (such as “man on the moon”), epidemics and global health (Ebola treatment and partly vaccination), food and transport security (including the emergence of an international insurance market), weather and climate change observation (the signing of the Paris convention) , etc.

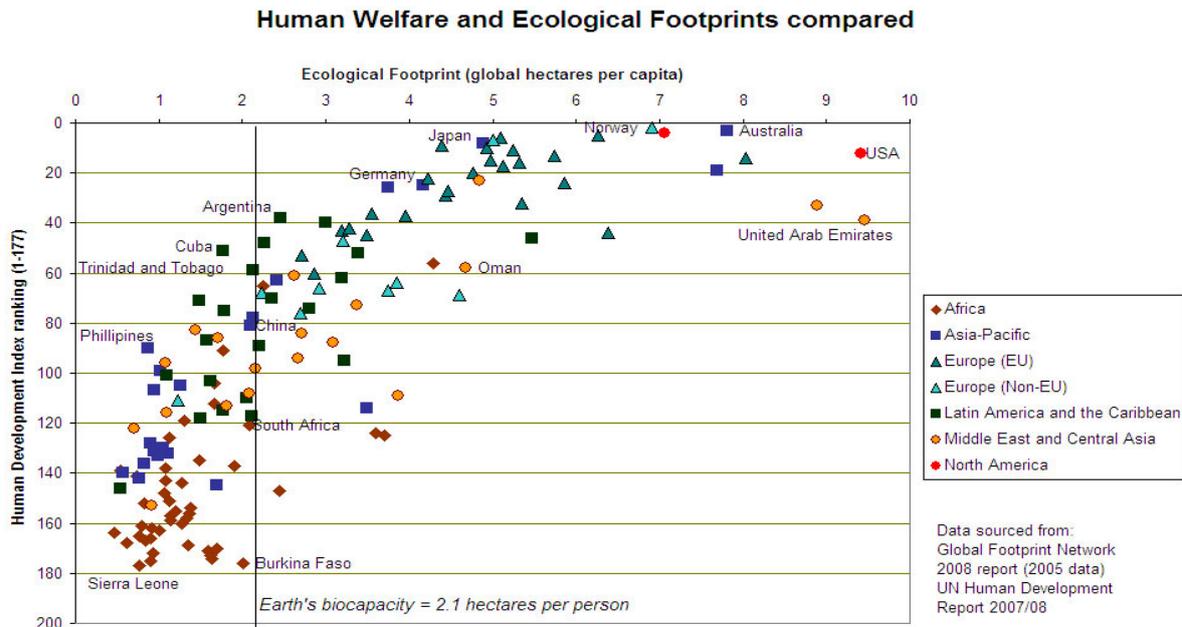
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<sup>17</sup> Krugman, P. (1979), A Model of Innovation, Technology Transfer, and the World Distribution of Income, *Journal of Political Economy*, Vol. 87, No. 2 (Apr., 1979), pp. 253-266.

<sup>18</sup> Krugman, P. (1994), *Rethinking International Trade*, MIT Press, p. 147.

<sup>19</sup> The **Anthropocene** defines Earth’s most recent geologic time period as being human-influenced, or anthropogenic, based on overwhelming global evidence that atmospheric, geologic, hydrologic, biospheric and other earth system processes are now altered by humans. The word combines the root “anthropo”, meaning “human” with the root “-cene”, the standard suffix for “epoch” in geologic time. The term was widely popularised in 2000 by Dutch Nobel prize winner Paul J. Crutzen who considered the influence of human behavior on Earth’s atmosphere in recent centuries as so significant as to constitute a new geological epoch. As he explained: “I was at a conference where someone said something about the Holocene. I suddenly thought this was wrong. The world has changed too much. So I said: ‘No, we are in the Anthropocene.’ I just made up the word on the spur of the moment. Everyone was shocked. But it seems to have stuck.” Paul Crutzen received a Doctor Honoris Causa from Maastricht University in 2013.

The overall impact of the “technological competitiveness” and catching-up process as described by Krugman and further elaborated upon in some of my earlier work with Giovanni Dosi and Keith Pavitt, is that the ecological footprints of most developed and emerging countries in the world are well above the Earth’s biocapacity as illustrated in Figure 3.



### Smart and sustainable development

The first conclusion, one could draw from this analysis is that “smart”, innovation-led consumer-based growth and “sustainable”, green growth are, once the driving forces of international, technological competitiveness are taken into account, in contradiction with each other.

This can be neatly illustrated through carbon emission accounting, a more sophisticated way than identifying the Earth’s biocapacity as was done in Figure 3. Such accounting attributes carbon emissions to the final demand of a country and is based on the US System of National Accounts. They will include private consumption by households; government consumption through the public expenditure on final goods and services; and investment (private and public) in construction, equipment, infrastructure and so on. The first one, consumption by households accounts for about 64% of global emissions. In short it is the intrinsic expansionary growth of household consumption which is behind the dramatic growth in carbon emissions. At the same time, the global integration in trade and global value changes has of course altered the balance of emissions and widened the gap between territorial (production) and consumption emissions of both North and South. A country such as Sweden can claim<sup>20</sup> that it has achieved carbon neutrality in production, its household consumption will remain carbon emission

<sup>20</sup> See Soete, L. and J. Stierna (2018), “What matters in research and innovation? Reflections inspired from a “Tour d’Europe”, October, mimeo.

dependent. This becomes even more visible once looking at agriculture with its more protected production structure such as in the EU.

So what should be the road for STI given its global unsustainability impact? Let us propose a list of new directions to STI which should become the framework within which research activities should be carried out.

First, STI should focus more than ever on improvements in productivity, in particular eco-productivity reducing the energy and emissions intensity of production, distribution and consumption. It remains, and despite the many measurement debates and issues, surprising that (total factor) productivity has been declining both in the North and South<sup>21</sup> over the last ten years. One of the reasons I would advance here, is that the research focus has been too much on product as opposed to process innovation.

Second, with respect to product innovation, there is a need for a new, alternative and overarching directional framework for STI. I would suggest that this could be found in biomimicry. Biomimicry is not a new idea – I first read Janine Benyus 1997 book *Biomimicry: Innovation Inspired by Nature* in 2002 – but it has received a lot of new attention as providing an overall directionality to research, innovation and design focusing on how nature, including all living organisms have continuously “invented”, adjusted and adapted themselves to environmental challenges. More recently, Idriss Aberkane provides a more updated and broader approach in his book: *L’age de la connaissance*<sup>22</sup> which goes beyond the traditional design focus of biomimicry and offers lots of research opportunities covering the full spectrum of STI.

Third, many of the rapid STI developments in other areas, often of a general purpose type such as those in the field of AI and big data, should be used in a complementary way to achieving rapid growth in eco-productivity and green product development and design. One may think of the use of blockchain to identify the ecological footprint of goods and services and their international exchange; the way AI could reduce rates of global energy consumption; big data and digital platforms provide the delivery of public services to citizens substituting for (rather than complementing) traffic congestion; etc.

Fourth, one should consider in a number of areas reducing private consumption, regulating advertising and developing various incentives and nudging schemes focusing on changing consumer behaviour. As Ian Gough put it: “reducing the sphere of private consumption would reduce opportunities to compare one’s consumption with other and richer groups, which is one of the drivers towards hyper-consumption”<sup>23</sup>. To proclaim that this cannot be done, because consumer choices are the taken-for-granted foundation of policy is to assume that the current factors and forces shaping preferences are either optimal or unchangeable. By contrast, given the fact that public services are more eco-efficient than private consumption, one should at the same time incentivise various “commoning” movements broadening public services to include e.g. also energy and water. Think e.g. at the local level, if a

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<sup>21</sup> See in particular the recent World Bank report of Ana Paula Cusolito and William F. Maloney (2018). Productivity Revisited: Shifting Paradigms in Analysis and Policy. Washington, DC: World Bank, quoted above.

<sup>22</sup> See in particular the recent book of Idriss Aberkane, *L’age de la connaissance*, Robert Laffond, 2018.

<sup>23</sup> Gough, I. (2017), *Heat, Greed and Human Need, Climate Change, Capitalism and Sustainable Wellbeing*, Cheltenham: Edward Elgar.

provincial energy company aimed at transition towards sustainable energy production should not be developed in Limburg.

In short “smart” should not be leading in STI but “sustainability”. At first sight this might seem a too simple framework for the global “direction” for STI when contrasted with the variety of SDG challenges before us, but it is one which brings sustainability as the central variable in the process of research and innovation and more generally STI activities.

### **Sustainable and inclusive development**

Sustainable and inclusive growth appear also in contradiction with each other...

“Necessities” (energy, water, transport) have often higher carbon emissions than many luxuries goods suggesting, following Ian Gough, that traditional redistributive social policies will raise, rather than lower emissions. Simply increasing prices to take into account emissions, will raise major distributional issues, as illustrated in the current revolt in France and Wallonia of the “*gilets jaunes*”, despite the fact that petrol prices in both countries are still well below price levels in The Netherlands. In lesser densely populated areas such as France and Wallonia with only few urban settlements, such price increases affect much more the poorer, already “excluded” non-urban (“*la France profonde*”) sections of the population.

There is hence a need for specific proactive, integrated “eco-social” policies. E.g. a comprehensive green new deal such as house retrofitting and social energy tariffs. In a certain sense, the notion of basic income should be applied to eco-social needs: e.g. providing a minimum “basic” energy support, while taxing heavily energy overconsumption. At the same time and as pointed out by Gough, tax financed social consumption such as health services, social care and education is inherently redistributive. It is based on allocation according to need, risk or citizenship not on market demand and automatically serves redistributive social goals. As Gough points out in the UK “Public services are 76% of post-tax income of the poorest groups and 14% of the richest groups”.

Some of the old notions of Charles Cooper and Raphie Kaplinsky on appropriate technologies and Prahalad and Anil Gupta on Base of the Pyramid and frugal innovation fit well within this eco-social framework. Sustainable development will only be successful if it supported by all classes in society. For the well-off, the priority given to increased taxation will probably represent the most straightforward incentive to change behaviour and reduce hyper-consumption as mentioned above. For the less well-off, both in the South and the North, there is now a new, clear “direction” for STI. To provide sustainable goods and services at the base of the innovation pyramid.

As in the case of biomimicry they raise some of the most motivating research/innovation challenges. Let me list those which I identified ten years ago within the context of developing countries<sup>24</sup>: autonomy, not always being wired to high quality infrastructure (energy, water, roads, terrestrial communication);

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<sup>24</sup> Soete, L. (2009), 'International research partnerships *on the move*', in H. Molenaar, L. Box and R. Engelhard (eds.) *Knowledge on the move: emerging agendas for Development-oriented Research*, Leiden: International Development Publications.

low education levels hence an intrinsic necessity of simplicity in use; little to no maintenance/repair facilities, so an intrinsic need for long term sustainability; strong needs in urban slums and poor rural villages, but barely without any current purchasing power; high living risks, so a low willingness to invest or borrow money in the long term. Many of these features appear today from an inclusion perspective also of particular value to poor and less well-off citizens in the North.

## Conclusions: Addressing global unsustainability

The temptation to prophesy in global policy advice fuels, as the French sociologist Francis Chateauraynaud has pointed out<sup>25</sup>, writings on “*collapsology*” like the book by Pablo Servigne and Raphaël Stevens, *How Everything Might Collapse*, 2015 or even Bruno Latour’s *Face à Gaïa*, 2015. I agree with Chateauraynaud that while most of the data and arguments used are not in dispute, the way in which these arguments, visions and data have been assembled into an ***end-of-the-world narrative*** is problematic. E.g. these experts appear to speak on behalf of all humanity using systematically the pronoun “we”. To attribute phenomena to humanity as a whole is to forget the fact that many people, who are living in poverty, play almost no part in the advent of the Anthropocene.

As Chateauraynaud points out opposite to such a predetermined, “closed” view, scientists and researchers should be involved in the search for a multiplicity of “counter-Anthropocenes” – possible worlds that are “forged in the interstices”. While they often appear as forms of “resistance”, they generate other modes of acting and of the perception of the world. What is the role of social scientists in here? To announce the inevitability of catastrophe or to tackle problems at different levels of action?

This represents, if I may say so, a formidable challenge for UNU-MERIT. First and foremost as global academic think-tank, UN-MERIT will have to become more outspoken, leaving the security of disciplinary excellence and/or policy recognition. Radical ideas are today needed to promote more inclusive and sustainable growth. Doing so, one will have as a first step to be much more critical with respect to the many, more “***window dressing***” initiatives from businesses, financial institutions, or even universities...

Let me in conclusion give three examples to illustrate my point and highlight the need for more radical reflections.

First, let me quote Benoît Cœuré, a Member of the Executive Board of the ECB. He made this intervention at a recent conference on “Scaling up Green Finance: The Role of Central Banks”, November 8<sup>th</sup>, 2018: *“I will argue that climate change can be expected to affect monetary policy one way or the other. That is, if left unchecked, it may further complicate the correct identification of shocks relevant for the medium-term inflation outlook, it may increase the likelihood of extreme events and hence erode central banks’ conventional policy space more often, and it may raise the number of occasions on which central banks face a trade-off forcing them to prioritise stable prices over output.... In the more desirable scenario in which humankind rises to the climate change challenge, the implications for monetary policy could be equally far-reaching, in particular if the associated shift in the energy mix changes relative prices to an extent that risks destabilising medium-term inflation expectations.”* Is this the central, relevant challenge for central banks confronted with unsustainable development?

Second, the progress made so far in developing a functioning European Union Emissions Trading System<sup>26</sup>. The ETS is based on a cap and trade principle and provides permits for major emitters of

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<sup>25</sup> See <https://en.unesco.org/courier/2018-2/stop-catastrophist-discourse>

<sup>26</sup> “The EU ETS works on the ‘cap and trade’ principle. A **cap** is set on the total amount of certain greenhouse gases that can be emitted by installations covered by the system. The cap is reduced over time so that **total emissions fall**. Within the cap, companies receive or buy **emission allowances** which they can trade with one another as

carbon dioxide, most of them without a charge (even in 2020 this will still be 30% of manufacturing and 82% in the aviation sector). The price of emissions allowances has been hovering since it was introduced ten years ago around €10 per tonne (see Figure 4). Yet as the IEA stated recently, *“limiting the global mean temperature rise to below 2°C with a probability of 66% would require an energy transition of exceptional scope, depth and speed. Energy-related CO<sub>2</sub> emissions would need to peak before 2020 and fall by more than 70% from today’s levels by 2050... [it] would require an unparalleled ramp up of all low-carbon technologies in all countries. An ambitious set of policy measures, including the rapid phase-out of fossil fuel subsidies, extensive energy market reforms, and stringent low-carbon and energy efficiency mandates would .... need to be introduced immediately and comprehensively across all countries ..., with CO<sub>2</sub> prices reaching up to US \$190 per tonne of CO<sub>2</sub>. .... ( pp.7-8)”*.

As the director of the IEA, Fatil Birol points out, *“in Our Common Future (1987), Gro Brundtland warned about fossil fuels and the need to search for alternative energy sources. Fossil fuels represented then 81% of all energy sources. Today fossil fuels represent... 81%.”* (Fatil Birol, IEA, NRC 17-11-2018).

Third, international transport pricing. The latter has been dominated just like the international trade in goods and services by the international agreements on how to preserve an international level playing field (IATA, WTO) reducing (tariff) costs. It is urgently time to hold those international organisations responsible for the dramatic growth in emissions as a result of the reductions in the cost of transport. With such low transport prices, sustainable alternatives are unlikely to get beyond the pilot phase. The aviation industry could e.g. dramatically cut its carbon footprint using existing technologies, yet it will only do so if the cost of flying significantly increases. Synthetic fuels produced using green electricity could provide e.g. carbon neutral energy to Europe’s fleet, but only if the cost of a plane ticket is increased by around 60%, or by 23% if policymakers applied fiscal measures on kerosene use equivalent to a €150 per ton of CO<sub>2</sub> carbon tax. *“It’s unlikely that, even with carbon pricing, electrofuels will reach cost parity with kerosene. As a result, policies will need to be put in place to ensure the uptake of electrofuels.”* (Andrew Murphy, aviation manager at Transport and Energy, from *“Cheap flights hamper climate action”*, Simon Pickstone, 22 Oct 2018). And to remind us all, aviation is set to use up by 2050 around a quarter of the world’s carbon budget for the Paris goal of limiting warming to 1.5 degrees.

Let me therefore make a concrete proposal, in line with the need to reduce consumption and directly resulting from our activities as global researchers. I will propose to the European Commission that in the coming Horizon Europe programme, researchers one would no longer get the travel costs covered. One can no longer ignore the fact that the impact of the European Framework Programmes on the international air travel of researchers has been significant. At the same time, the digital technologies and future virtual reality representations in research have barely taken off. For sure we have opened our research meetings through wireless communication to the outside world, as in the case of MOOCs

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needed. They can also buy limited amounts of international credits from emission-saving projects around the world. The limit on the total number of allowances available ensures that they have a value.”

“the EU ETS has delivered emission reductions of 2.9% from participating installations, marking a decreasing trend in emissions since the start of phase 3 in 2013, while the surplus of allowances in the carbon market fell to 1.69 billion allowances, its lowest level since this start.” See:

[https://ec.europa.eu/clima/news/carbon-market-report-ets-surplus-falling-lowest-level-2013\\_en](https://ec.europa.eu/clima/news/carbon-market-report-ets-surplus-falling-lowest-level-2013_en)

with respect to education. One could consider this as a complementary additional positive feature enlarging our research audience and of course we have paid a lot of attention to communication and impact. But the substitution opportunities for travel in our research networking did not develop because air travel became continuously cheaper and the time spent in travelling appeared increasingly "luxury time": being served, watching movies, sleeping, reading, working while not being interrupted, etc.

It is time to put priority to exploit more fully the digital substitution advantages of research networking. Think e.g. of the opportunities to have three-dimensional representations as some French politicians (Melanchon) or pop stars frequently do. Why have we as STI researchers not been much more involved in developing such technological communication methods and why have those methods not been used and diffused much more in our own research community?

Time to take responsibility for our own unsustainable behaviour.

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