Publicly Funded Research & Innovation in the EU

Unlocking its public value, in the EU and beyond

Every year the EU commits an amount of around €12 billion to fund so-called framework programmes (Fps), which aim at supporting research and innovation (R&I) activities in the EU. The first question is: Do we really need this investment? My answer is a firm yes and I will shortly only argue on the rationale of publicly funded research and innovation. A second question is whether this investment yields the maximum return and, if not, what may be needed to optimise it. Answering this question is the principal aim of this book.

Nikos D. Sakkas
Author

Nikos Sakkas: I carry out energy & ICT related research as a professor at the Hellenic Med University, Greece & the Un. Of Hull, UK. I also participate in innovative global ventures (wirelessthings.biz, leiminte.com, hellohoreca.com) as an advisor or a partner. Often these businesses have been spin-offs from EU funded research and innovation and have by themselves greatly inspired this book. In my free time, in lounges and aeroplanes, I have found a strange pleasure in writing; fiction and non-fiction alike. Two years ago, I published the book "Democracy again! The EU megapolis and the democratic challenge" that was another source of inspiration for the current endeavour. Unconnected as they may seem at first sight, it is the passion for a progressive and self-challenging EU that underlies both these topics. This book, in particular, was written with consultation, direct contribution and inspiration by my good friend Serafim, a person of a rare quality whose friendship I have enjoyed in recent years and whom I greatly thank for this collaborative experience. I remain hopeful that this is just the first of a series of joint ventures to follow. All my books are available at Amazon and www.artdrop.net.

Serafim A. Kotrotsos
Contributor

Serafim Kotrotsos: Swinging between academia and business, start-ups and incumbents, entrepreneurship and social services, research and management, execution and coaching, the key common factor in all three decades of my career so far has been innovation. This is the main energy source throughout my endeavours across sectors, including e-Business, Teaching, Software engineering, Management Consultancy, Telecommunications & Utilities, Artificial Intelligence & Big Data, Social networks etc. With the background of a tech start-up founder and a leading role in the B2B operations of a leading ICT provider group in the Middle East, innovation has been more of an everyday practice rather than an exception. In parallel, when an inner voice can no longer be suppressed, I resort to documenting and publishing some of my views about critical concerns of my home country Greece and our larger home Europe. This book is the intersection of all these, along with my friendship at first sight for Nikos.

by Nikos D. Sakkas

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DEMOS
balanced thinking

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In loving memory of my father

My gratitude to the RadioArt Internet radio, for the inspiration and the company

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Preface

I am a fan of innovation. It has played an important part in my life and I have had ample empirical exposure to it, allowing me to reflect on it on numerous occasions and in various contexts and roles.

I see innovation in a broad sense. As a game-rule changing concept and not just in its technological dimension. Innovation in art, lifestyles, perceptions, besides innovation in technology.

Innovation is not some side activity of our society; it is its beating heart, what makes the difference. And it is, of course, not only linked to technological innovation, although this is indeed a great part thereof. Great art almost always represents a new approach to things. There is a considerable distance between the neoclassicism of the 18th century and the post-impressionism school of the early 20th century, with many fascinating and disruptive turning points. Truman Capote became famous because he established a new writing category, that of a non-fiction novel. Bauhaus, the Beatles, Picasso: all became famous because they broke the rules, because they were innovative.

Taking a fresh look at our world is a rare capability and the very first step to discovering new things; a fundamental aspect of our well being and prosperity, throughout all threads of our lives. Such a disruptive and status-quo challenging outlook cannot be programmed nor framed in tight business schedules or within some 10-year business plan. Besides, this is how the

World Wide Web emerged; by the endeavours of Tim Berners-Lee, in the course of a largely unplanned and pretty accidental trip.

The "Think Different" campaign, launched by Apple Computer, Inc. at the turn of the century, mainstreamed, perhaps for the first time, this broad perspective of innovation. In that rare and inspiring initiative, Bob Dylan, Martin Luther King Jr., Richard Branson, John Lennon and many more featured next to the likes of Albert Einstein, masterfully portraying the frontier-less nature of innovation.

I find it important to say all this, so the reader understands the true perspective of the author and why he may sound passionate about this idea of innovation. Yet, in case someone already wonders: no, I won't point, after this point, anymore in this broad direction. Of course, there are some common behavioural and cognitive traits along all threads of innovation and in all its successful practitioners. However, in this treatise, I will rather narrow the focus on technological innovation. And, in particular, I'll look into the public EU instruments for fostering and financially supporting innovation. Approximately every six years one new such instrument comes out. They are typically called framework programmes (FPs) for research and development; the latest one is better known as Horizon 2020, running till 2020. Horizon was supported financially with the amount of €80 billion, for a period of six to seven years and the successor instrument, Horizon Europe, will receive about €100 billion.

A call for creative destruction

Either history is really governed by laws, and in that case, a truly human-activity is impossible, except perhaps in a technical sense; or human beings really make their own history, and then the task of theory will not be directed to discovering "laws", but to the elucidation of the conditions within which human activity unfolds.

Cornelius Castoriadis

Every inception, such as this book, comes with a long background of experiences, thoughts and emotions that accumulate over time. Inceptions may start as somewhat fluid, with no clear direction. In time, the more interest and concern a person has in a particular topic, the more he consults with and cross fertilises his experiences with his peers and seeks to validate them in the light of the dominant theories, the clearer will be the pattern that will emerge. It is at the confluence and the interplay of experiences gained and theoretical abstractions attempted that clarity and a feeling of confidence will eventually result.

Indeed, experience is not the only way that opinion and knowledge is generated. The second, equally important tier is that of a theory creation; meaning by this the identification of causal relationships that are rationally robust and acceptable, and validated in a number of circumstances. Though validation will always be necessary, a theory stands out mostly for its solid causal, deductive or inductive, inference. A theory is more about insight and causality than it is about data correlation.

However, the usefulness of a theory lies also in its ability to point in a direction and support predictions. Trivial as this may sound, theories have been paramount in shaping the world we live in. When we enter an aeroplane to fly over the ocean we

are at the mercy of these theories and their causal predictions. They underpin every single moment of our flight. If one of the numerous predictions made by the theory of the flight failed, our aeroplane would with no doubt come down.

Yet, the aeroplanes fly and, therefore, the theory truly exists; it is no fancy. Aeroplanes very rarely come down and even then it is not because our predictions betrayed us but because of some other mechanical failure; some technical incompetence to manage an otherwise safe and trustworthy prediction.

However, it took a long period from the flight of Icarus to our modern flight fare. A long period with many failures in-between and significant human loss. In time, however, our flight theory became more and more perfect, could account for extremely rare conditions and cope with them efficiently. The science of the air flight could provide us with the most accurate predictions. And its technology peer, developed in parallel, could fully and successfully manage these predictions and take us safely across lands and oceans.

Innovation has a large legacy, similar to that of air flights. In fact, Archimedes who came out of his bathroom shouting "Eureka, eureka!" was a keen and a major innovator and, incidentally, the inventor of the basic laws of the air flight. However, it took a very long period for them to emerge into a practical innovation, and this happened only after a great number of in-between contributions from many other researchers.

Innovation, however, is also linked to social issues and not just natural phenomena like the air flight. In the realm of society, we have proven, as humankind, much less capable of developing theories, delivering predictions that are trusted by all. This is why we have, throughout history, an abundance of socio-economic schools of thought, whose views may often be

separated by a deep gulf. On the contrary, we have only one theory for the air flight; and it is respected by all sane people.

And then came Einstein. And one of the many big things that Einstein did was that he shattered our cherished theories and our safe predictions stemming from them. He demonstrated, beyond any doubt, that even these natural laws that we place so much trust in have their limitations. Outside a given context they simply crash. Maybe our plane will never endeavour out of this context and so we can still board it with easy minds. Yet, the theory that we so much loved to consider as an absolute value is not really such.

Einstein's main social contribution, besides his grandiose and breathtaking scientific theories of relativity, was that he demonstrated how relative things truly are. How we still do not have any perfect theory that we can safely rely upon. How our much-cherished laws are trapped in a specific context and that if we venture out of it very strange things may happen.

A main point in this treatise is that the era that is unfolding, that of the Fourth Industrial Revolution, is again challenging our theories and the current status quo. We are entering a period that has characteristics which for Joseph Schumpeter would have perhaps signalled a clear and bold mandate for creative destruction.

Elucidating these conditions of our era may require us to overhaul even some long established theories and practices stemming out of them.

It may require us to make our own history.

Inspirations and aspirations

I have had ample opportunity to get to know the EU research and innovation (R&I) context. I would say, for the last 20 years

it has been a part of my professional life. Just a part, however; one that I have deliberately tried and succeeded to keep in specific boundaries. Because I enjoy the whole life-cycle of innovation; not only its development but all the way down to the moment when one interacts at some trade fair with ordinary people, presenting and debating on the real thing. Besides, this latter kind of activity led me to a major discovery; the unique knowledge of the customer, and, therefore, also of the citizen. A discovery whose paramount relevance and repercussions will pop up time and again in the following pages.

This controlled engagement unfolded along the three following distinct pathways.

First, I have personally directly benefitted from this engagement; being a contractor myself several times I contributed to pushing research into the real world and real-life products. I have been contracted by the European Commission for the evaluation of applicants' proposals for more than 20 years and have been invited several times to carry out the evaluation of other funded projects of the framework programmes (FPs). Last, I have been an elected member of the steering committee of the EEB (Energy efficiency in buildings) public–private partnership, in the period 2011–2012, enjoying a rare learning experience and the opportunity to see from a close distance and from the inside how the R&I FPs were designed and set up. Statistically, however, all this experience has limited significance and I need to be frank about it. It represents no more than just a very limited viewpoint on the EU R&I FPs.

Second, I came to meet interesting people, some of whom turned into current day collaborators, friends or both. Others just remained short term, yet unique and impressive acquaintances whose company was a learning experience that I en-

joyed in full during the typically weekly evaluation mandates in Brussels. Taking into account that my definition of life quality is largely related to the quality of people that surround me, I would not be at all exaggerating in saying that the EU research & innovation has impacted upon my quality of life.

Third, I have been offered an opportunity to contemplate European Research. To develop my theory. This theory was not built only on EU innovation funding. It is supported by many other experiences and engagements with innovation as well as inspiring reading that I will reference wherever appropriate. It is underlined by a deep appreciation of the unique potential of innovation for social well being. In addition, this theory has not been just a mental exercise. Often it came with moments of enthusiasm and moments of frustration and weariness, especially when this large potential was not fulfilled. In short, with a range of strong feelings and not just thoughts of the intellect.

It is this third dimension that mostly helped put in place the theoretic substrate of my treatise here. With all the natural boundaries and limitations I referred to above, which any science worker needs to strongly observe and acknowledge.

Indeed, in the following I will avoid risky generalisations based on personal experiences. I may, indeed, in some cases make some reference to things that I have repeatedly and consistently sensed, some common patterns that make me think that even if I am wrong, I cannot be totally wrong. Besides, as a matter of principle, my arguments below do not point to a narrow band of something being totally right or wrong or even being right or wrong at some precise percentage. I do not attempt any such resolution. I raise some issues, I register some persistent patterns and, just because of this persistence, I think these patterns cannot be wholly wrong. There must be some

element of truth in them and from this perspective, I lay them, patterns and conclusions, in front of the reader.

However, my main approach will not be driven by data but by theory. It will attempt the elaboration of a theory for the EU public R&I, perhaps more suitable for the current condition of the fourth phase of the Industrial Revolution (IR). Or, to be more precise, it will rather be a critical review and a proposal for amendment and adaptation of an existing theory; the one currently already in place and deeply embedded in the EU FPs.

Thus, the critique and adaptation of the current dominant theory of the EU R&I policy is at the heart of my methodology. In full acknowledgement of the limitations inherent to all theories. Limitations that not only do not subvert the usefulness of a theory, but rather add to its beauty. Besides, perhaps, being unique challenges for the creation of a new theory.

I will, therefore, not be too data-centred, primarily because of my limited experience-based data. However, besides acknowledging my lack of access to statistically significant data, I will also emphasise below the lack of such data in general. I will expand on this, as one of the key points of my critique is what I will call a "low transparency exercise".

This has nothing to do with human intention. It is more a matter of inertia, an attitude that is a remnant of the pre-Fourth IR era, and, thus, falls short of what is currently a completely feasible and absolutely essential transparency. Something that is not just a noble goal but that can be tangibly aimed at.

Overall, the FP programmes are a key brick in a vital infrastructure that we need to seriously revisit, drastically improve and partially, at least, redesign. Perhaps, with a sense of urgency.

I am aware that this concern is taking shape and emerging

now and then in diverse contexts. It is my aspiration to highlight the significance and perhaps add some insight to this ongoing discussion and exchange.

Why this book?

I have said it already above: I am passionate about the idea of innovation. I mostly want to talk about this passionate idea of mine. Incidentally, it is broadly acknowledged that technological innovation is a fundamental key for wealth generation. Literature and media abound with stories of tigers like Korea and Singapore, or more individual ones such as that of Ibrahim Mo who, against all odds, in the mid 90s set up a telecom business in the middle of nowhere in Central Africa, only to completely change the way of life in that part of the planet 10 years later.

This wealth generation is also a prerequisite and a most promising and stable track for pulling in a good deal of important things: employment, social cohesion, happiness and the like. In this sense, I am confident that my passion is not radiating into some vacuum; it reflects also on such massive change-for-the-good patterns.

I think there are some things to be carefully preserved and another strand of practices that need to change, sometimes radically, in order to make the most out of the EU R&I FPs. I do not underestimate the former, but I do confess I am here far more interested in the latter; in addressing what I see as an innovation deficit in the EU and how it can be overcome.

It is not accidental that the EU has an innovation shortage when compared to the Far East and the USA. This well-documented fact is not just a matter of the publicly funded FPs; it applies more generally. It is our whole culture of innovation that we need to adapt if we are to bridge this gap. Even more

so in our era, when the unfolding fourth phase of the Industrial Revolution (IR) is challenging stereotypes and creating massive opportunity, waiting to be harnessed.

In Part 1, I propose some guidelines for such a strategic re-orientation of R&I in the EU. I believe that publicly funded innovation should prioritise the areas of innovation that maximise social value; this should be its strategic positioning. Obvious as this may seem, I doubt that it has been accounted for in the implementation roll out. Of course, I fully endorse the idea that business value generated by innovation has also a great positive social impact. Yet, if we remain at this level of analysis, no priorities for a publicly funded innovation scheme can ever emerge; everything will turn out to hold about the same potential, to be about equally important.

One needs to take a closer look at what social value is really about and which R&I activities, in particular, are those that may maximise it. If one carries out this prioritisation exercise, then the "equally important" activities will now start to stratify while those of a higher social value will start surfacing at the top.

I will argue that these strategies are where the EU publicly funded research should be directed.

I would, however, strongly caution against any idea that such socially prioritised strategies would come with any intrinsically higher value, compared to those driven by more clear business interests. This is by no means the case, nor is it my intent to examine this. It is not a matter of being superior in some sense; it is only about maximising social value.

Such society-targeting strategies would still generate business value and thus maintain their high importance also for the private sector. Besides, most of the evidence I will call upon in the main text and in support of these strategies will derive

from the private sector. Clearly, there is no risk that such a prioritisation could possibly curb the interest and compromise the participation gear of the private sector. The very contrary! It is about a win-win and not a zero-sum game.

This prioritisation exercise is what I mostly carry out in Part 1. And at the end of it I will point in three distinct directions: market generating innovations, collaboration and peering, and co-creation or social innovation.

Part 2 takes a more operational look into the EU R&I FPs. Though it perhaps highlights some current deficiencies, this is not the main approach or intention. Operations are there to serve strategies. Thus, if one suggests a strategic reorientation, as I do in Part 1, operations will, in general, also be affected. Optimising operations without a close consideration of the strategy they are supposed to serve may be a very confusing and wasteful practice indeed.

This also extends over and applies to impact assessment; one more key operation. Impact assessment should again be defined in the light of the overarching strategies. It serves decisions and decisions are taken in the light of strategies. The more clear and consistent this line is, the more effective the assessment operation will be. Otherwise, assessment will seem difficult; frequently it is then bypassed as mission impossible. In essence, however, this may only be a matter of not knowing what decision is really there to be supported.

I focus on assessment because we direly need to measure our EU R&I performance and to do so in a tangible way. In the era of big data it is not enough to resort to dubious, as I will show, macroeconomic impact indicators. We need micro level, data driven measurement and impact assessment strategies.

And we need these for one more reason. In the light of the

new, revamped strategic approach, measurement and assessment will now be essential for true society-wide transparency. With society as a key stakeholder, papers, patents and macroeconomic projections will not secure true transparency; they will be of little relevance. Other things will matter more.

For the greater part of Part 2, I propose an approach for securing transparency; one founded on the principle of impact communication and not general information dissemination, which is already adequately practised. I will argue that such a true, micro level impact can indeed be measured. It ought to be measured. And it can serve a multifold purpose, extending well beyond transparency. It can help rationalise and optimise the FP evaluation exercise. And, in this way, it can deliver massive insight and assist fact-based decision making at all levels.

Who is this book for?

For sure, this is not a book for people that would like to inform themselves about the EU R&I workings and opportunities, perhaps thinking of taking advantage of them, on behalf of their organisations. There is no intention at all to offer any such "how to" guidelines; I would have to strongly caution against any such misplaced expectation.

That said, the book is for everyone that has even a broad interest in innovation. The more this interest approaches the publicly funded EU instruments for innovation, the greater the relevance will naturally be.

Traditional innovation stakeholders, such as academia and business as well as related policy makers, will naturally pop up as protagonists throughout the text. However, a key premise, in the following, is that the unfolding fourth era of the Industrial Revolution provides ample space for society itself to innovate.

And to really harness this we need to sincerely reach out to society, build new collaborative models, readdress and actualise new intellectual property approaches, etc. Although perhaps the more difficult part will ultimately be to transcend stereotypes, change mindsets and challenge the status quo.

In this sense, the book does not address only those who have the traditional capacities of a researcher or an innovator: strong analytical skills and deep formal and thematic knowledge. All these undoubtedly remain pillars of innovation; yet, our era allows them now to be complemented and drastically leveraged and empowered by the formal as well as informal and empirical knowledge that society carries. This novel co-creation paradigm defines a radically new role for society in innovation; it receives an important and strategic placement in the discussion below.

Einstein himself quoted that "*the only source of knowledge is experience*". Perhaps his intent was not to fully downplay formal knowledge but rather to highlight the systematically undervalued, experience-based knowledge. The point, however, remains and is in our era clearer than ever: there is massive talent out there, awaiting to be harnessed and linked to the innovation effort. And this is one of the major opportunities and challenges ahead.

The EU is justly proud of its superior and globally attractive social model. Yet in innovation it scores well below the USA and SE Asia. Can this advanced EU social model fuel an innovation advantage? Would this not be a most natural expectation? This is a central point of my investigation below. Indeed, I think it is worth a try.

In the book I also try to explore one more, somehow unexpected connection. Something that reaches out of many cur-

rent definitions and perceptions of innovation, although, as I will show, this is something that is more and more revisited and challenged.

Can innovation provide an instrument to transform and leverage the EU support to the developing world for its battle against poverty?

My answer is yes. And though this idea may initially appear to be somehow out of context, I will discuss below the related literature and show how innovation can be key in creating new markets and how new markets can be instrumental in eradicating poverty. I believe there is here an important and rather unharnessed opportunity to link with other important EU Aid policies. Perhaps we need to pay far more attention to this link; it will result in unique, multifold and mutual benefits, and also alleviate undue and needless immigration pressures.

In this way, the strategic view of innovation proposed here takes a more broad perspective, one encompassing also other hot issues currently on the EU agenda. Whether this holds the promise of empowerment or brings the risk of diluting the message is for the reader to say.

For this reason, I suspect that, deeper in mind, this book may have also been written for a broader audience: all those who embrace, wholeheartedly, the unfolding EU project and adventure.

Acknowledgements

In all my multifold engagement with innovation, there have been several people that have played a role and provided important inspiration and stimulation. The list is long and it would perhaps be futile to attempt to reconstruct it in full. However, I would like to single out a few of the most relevant performers

that have had a great impact upon me and have influenced significantly the ideas laid out in this book.

Hans Eder, an Austrian businessman who early in my professional life passed over to me, in a relaxing way, some powerful advice on what innovation is about. I would continue with my mentor, Themis Lekkas, whose multifold, rare and laterally developing professional track has for many decades been a source of learning and inspiration. Also, my old and dear friend George Chamilothoris for the multifaceted exchanges we have had on the many matters underlying innovation, from the early days of our friendship and, luckily, also over a long period of professional cooperation in a great diversity of business and academic contexts. Another old friend, Christos Housiadas, for his unique creative suspicion when talking about innovation matters over a long period of time, in his capacity of a most accomplished scientist and successful manager, of a rare and genuinely multidisciplinary breed. Last, Harvard Professor Clayton Christensen, whom I do not know in person but whom I have been following for some time now, ever since his inspiring jobs theory and up to recent days and his market generating innovation concept, in his breathtaking "The Prosperity Paradox" (2019), a book whose influence will be traceable throughout this treatise.

Introduction

In 2017 public and private sector R&I expenditure in the EU amounted to €320 billion[1]; this represents an R&I expenditure as a percentage of GDP at 2.06%. In the same year Korea spent twice as much (4.55%), while the US (2.78%) and Japan (3.2%) stood also significantly higher than the EU. The EU scored even slightly below China, whose related expenditure was, in this period, as high as 2.13% of its GDP. In the same year the majority of R&D expenditure in the EU was in the business sector, this being 1.36% of the GDP or roughly 2/3 of the overall expenditure. Business here refers to the private sector; in the EU, the important public enterprise spending in R&I is accounted for in the government spending. Overall, the sources of funding (2016) are as follows:

56.6% of the total expenditure within the EU-28 was funded by EU enterprises, 30.9% was funded by the government[2], and a further 10.0% by foreign business. Funding by the higher education and private non-profit sectors was relatively small: 0.9%

1 Eurostat, Statistics explained, 2019, https://ec.europa.eu/eurostat/statistics-explained/index.php/R_%26_D_expenditure

2 It is perhaps worth noting that the public sector is an important player and funding agent of innovation throughout the world, even in the USA where the military and the US National Institutes of Health are two among the many, very active R&I supporting agents (https://www.newscientist.com/article/mg21929310-200-state-of-innovation-busting-the-private-sector-myth/).

and 1.6% of the total respectively[3].

In addition, the EU produces three times fewer quality patent applications[4] than Japan, while the venture capital available in the EU is at least five times lower than in the US, as also is the number of fast-growing start-ups: so-called unicorns.

In line with the above figures, it is also noteworthy[5] that foreign-owned firms account for 20% to 25% of total business R&I expenditure in France, Germany and Spain; a percentage that may rise to 30% and 50% in other countries, the UK included.

The EU framework programmes for R&I are publicly funded schemes that have allocated, in recent years, about €11–12 billion on a yearly basis for the support of R&I in the EU. This figure amounts to approximately 3.5% of the related total EU expenditure (€320 billion, 2017) or, equivalently, 10–11% of the public domain expenditure. This figure refers to the Horizon 2020 FP, covering the seven-year period 2014–2020. It is expected to increase by more than 10% in its sequel Horizon Europe. The exact figure is unknown at the time of writing.

Overall, the above snapshot illustrates a clear deficit of R&D in the EU. Also, the EU lags behind the strategic goal for a 3% investment in R&D by the year 2020, as laid down in the Europe 2020 strategy.

Why public research?

Recently, I deviated from my everyday norm; instead of using

3 Eurostat, Statistics explained, 2019, https://ec.europa.eu/eurostat/statistics-explained/index.php/_%26_D_expenditure#R_.26_D_expenditure_by_source_of_funds

4 Patent Cooperation Treaty, http://www.wipo.int/pct

5 Internationalisation of business investments in R&D and analysis of their economic impact, EC, 2012.

my car to go to one of my usual destinations, I took my bike. It was a feasible distance, just some 10km away. I then found myself utterly delighted by a new discovery! A wonderful track, just 50 metres away from the highway I had been driving on for years. A track through nice, quiet streets, through freshly bloomed lemon trees. It literally made my day. And it was just weird to contemplate how this accidental path of mine had gone by unattended for so many years. We enjoy end goals but we also enjoy paths. There must be hardly any modern country that does not have some poem to cherish the journey, the accidental journey, and the many delights it often comes with. Indeed, our life is built around journeys as it is built around pursuit of goals. And it is often fulfilled more from the unexpected than from the planned.

Of course, market forces could have discovered my delightful track; in fact I see them already working in this direction. Cafés and parks and other amenities will gradually show up on the sidewalks. Of course, there can be a promising business model around a pleasant, picturesque city route. But this obvious fact is not where I really wish to point my argument. The important thing is that path values are not as easily identified by markets in the same efficient way that they can cater for end goals. Let us see some examples to understand what I consider as a very notable limitation of the market mechanisms. Accidental journeys are not only about uncapping beauty; they are also the principal way that much of our current wealth and civilisation has been developed. Science is perhaps the area where this is most profoundly true.

Archimedes accidentally came across the law of lift, which today carries our boats and planes. Maxwell's discovery of the electromagnetic waves was more conscious and not as acci-

dental as Archimedes' "eureka!". Yet it never crossed Maxwell's mind, nor the mind of any of his contemporaries, what he had really discovered. Edison, Marconi and so many other people that would follow would decipher the true value of Maxwell's achievements. Even today, we cannot be certain we have fully reaped it.

A better known story is that of how the Internet and, in particular, the World Wide Web developed; nobody in the mid-80s had the faintest vision about something that 20 years later would be used by eight year olds. Key business executives of the times consistently played down the hype around computers and cautioned against what they saw as a massively exaggerated potential. It was a completely different mandate and context (CERN, Switzerland) that, again accidentally, set the foundations of the World Wide Web. We have to face this reality of "accidents" that may generate massive and unique value, even if we might have preferred an infallible law about the universal ability of market forces to optimally predict and moderate all economic and social value.

Indeed, markets would have been reluctant to fund Archimedes' and Maxwell's wonder journeys. And they laughed at any notion about something like the Internet, even as recently as the 80s. Because this type of value, the journey value, resulting from such essentially objective-less investigations, is largely unknown to the markets. As an impact it only manifests in the long term, often in the very long term. And the markets are pretty indifferent to this.

Why do we analyse our business plans in a time frame that typically and with only very limited exceptions spans over five, 10 or maximum 15 years? Because this is how far we can see, maybe because this is how far we wish to see. If wishing, in this

context, really represents something different to seeing and is not a restatement of essentially the same thing, as I tend to believe. If an off-track journey was about beauty alone, as with my recent bicycle ride, we need not be so much concerned. Markets understand and reward beauty. But science is much more long term than beauty. And markets cannot tackle long term phenomena; they are too hectic for that, too uninterested and low motivated. There is too much risk for any to bear. If we really wish to harness this value, the value of the accidental discovery, we should not consider markets as the enabling mediator. There is ample empirical evidence for this.

Such accidental innovation, as I will call it, is a distinguishing trait of humans, as pertinent to our present time as it has ever been in the past. This inquisitorial spirit is commonly also referred to as research, or even basic research. Research may work in a planned way towards a goal but often this goal may not even be initially perceived and may be reached all of a sudden, as a by-product of other investigations. In this latter case it occurs rather accidentally. And if it also succeeds in delivering tangible use value then it also qualifies as innovation. Indeed, I will use throughout this text the term innovation to denote anything that carries novel and tangible added use value when considered with regard to the labour, materials and knowledge it has required for its generation.

Accidental innovation is the most obvious but far from the only or even the most sound reason for public research. As I will show below, there are several types of innovation and though they typically generate value for both the private/market and the public/society side, the balance of this value is not always the same. There are cases, I will later denote them as "market generating innovations", where the social value is potentially

largely in excess of the market value. Though the term may be encountered here and there, I have personally borrowed it from a book[6] that has very much influenced me, enlightened I could say, in general and with regard to this book undertaking.

Such innovations are, therefore, reasonable to attract the interest of the public sector as it appears now to be the main stakeholder and key beneficiary. This is not to suggest that the public should withdraw from the other innovation arenas. Only that it should prioritise those areas where the public benefit will be higher.

Accidental innovation and, especially, market generating innovation should, in my view, be the spearheads of publicly funded R&I. The former I have introduced just above. I will refrain from expanding on the latter here as it will be discussed in detail below, when addressing the categorisation of innovation.

The private–public innovation frontier

A highly interesting point is the relationship between public and private operators with regard to the development of innovation. This book is based on two key premises. First, that innovation is not a zero-sum game and is, potentially, greatly beneficial to investors, practitioners and society alike. And second, that the various types of innovation may not necessarily have the same impact across these many beneficiaries. To this extent, I will argue in the following that there are types of innovation that hold a larger potential for society, although they will typically also carry benefits for the rest of the innovation stakeholders. And there will be other types of innovation where the

6 Clayton Christensen, Efosa Ojomo and Karen Dillon,"The ProsperityParadox: How Innovation Can Lift Nations Out of Poverty", Amazon, 2019.

benefit leans excessively towards private operators with society now left with a less tangible and rather indirect impact.

If this is truly the case and given that in the book I address EU publicly funded research and innovation, then it is a central issue of the book to suggest how one can trace the line across innovation strategies, in such a way that the society benefit is maximised. Indeed, this is one of the key issues discussed below, something reflected also in the subtitle of this book. In this sense, the broad debate on the relationship between private and public innovation is also very much pertinent to my investigation here.

Mariana Mazzucato, a Professor at University College London (UCL), has extensively researched the public–private frontier as regards innovation. Her position is that public research must be credited for several major innovations of our time, to which private entrepreneurs shifted their attention only much later and only after the difficult and risky early phases were successfully completed. Here is a passage from one of her works, highlighting the underestimated importance of publicly funded research[7].

State funded organisations (mainly decentralised ones such as DARPA, SBIR and so on) have been fundamentally involved in generating radically new products and processes, which have changed the way that businesses operate and citizens live — transforming economies for ever from the internet revolution to the biotech revolution to what (it is hoped) will be the greentech revolution.

Similar approaches to those of Mazzucato often show up in the press.[8]

7 Mariana Mazzucato, "The Entrepreneurial State", Demos Editions, 2011, page 115.

8 Tyler Cowen, "The Lack of Major Wars May Be Hurting Economic

Fundamental innovations such as nuclear power, the computer and the modern aircraft were all pushed along by an American government eager to defeat the Axis powers or, later, to win the Cold War. The Internet was initially designed to help this country withstand a nuclear exchange, and Silicon Valley had its origins with military contracting, not today's entrepreneurial social media start-ups. The Soviet launch of the Sputnik satellite spurred American interest in science and technology, to the benefit of later economic growth.

Indeed, wars and other mega projects have been instrumental for publicly funded innovation as they have exceeded the financial capabilities of private side operators. Many innovations would not have occurred without the critical intervention of the state.

I agree in full with the approaches of the writers above; I find that they are built on solid and unquestionable facts. Indeed, innovative private entrepreneurs have benefitted from massive and publicly funded research which they have tapped into in a timely fashion and have largely capitalised upon, for their own innovative and proprietary agendas and without having to share the typically huge upstream costs. Additionally, if not even more importantly, private entrepreneurs have also benefitted from huge previous knowledge assets generated over the centuries, by "being able to see while standing on the shoulders of giants", as Newton humbly put it. But it is society that is the inheritor and, therefore, the shareholder of these knowledge assets; it is only logical and ethical that it should demand a return on them.

Does this then mean that the private sector has enjoyed a disproportionate benefit with regard to the risk it has taken in the process, and has even in some cases extracted more val-

Growth", The New York Times, 13 June, 2014.

ue than it has generated, as Mariana Mazzucato vehemently suggests? I personally find it difficult to respond in a conclusive and fact based manner. As underlined above, a part of the value generated by innovation must reach society, as a return for the massive knowledge resources, owned by society, that have over the years overflowed to private entrepreneurs, for them to harness and create their disruptive innovations. Yet, how much is this value that has been, in this way, transferred to the private sector? And why has it not already been returned via taxation and other resulting social benefits? For example, could anybody 25 years ago have imagined having something like Google Maps being made freely available to her? I doubt it.

The idea that markets have benefitted hugely from state infrastructure and investment is, of course, accurate but does not reflect the full truth. Because markets have been pivotal in pulling in significant infrastructure (see the rail and road infrastructure built in the USA in the 19th and early 20th century to take advantage of the breakthrough innovations of the time, especially the commoditisation of the automobile by H. Ford, or the case of Toyota in postwar Japan and the pressing need to develop road infrastructure) and in some cases have taken this responsibility upon themselves (there are several such examples in the third world, where infrastructure vital for business could not be provided by the state).

This relationship between infrastructure and innovation is something important and I will come to it again later, especially in the context of the emerging economies. Because innovation, if well-targeted, has the potential to be a great enabler of added value infrastructure. And infrastructure investment can assist innovation as well. But infrastructure *without* innovation that generates market activity may not always be sustainable

and can easily turn into a liability. If China runs today with an infrastructure investment amounting to 8% of its GDP this is only because there are rising, significant market and innovation-driven forces to sustain it. Infrastructure may in some cases, indeed, be a vital and an unconditional priority; for example, water and sewage treatment plants in the developing world. Yet, infrastructure can often be just a facilitator and may have no intrinsic value on its own. It is there to allow value to flow and has no real use if there *is* no adequate value. It may easily evolve into a value trap. For example, an extensive road network that cannot even be sustained, because of poor economic activity.

In our time especially, this private–public coexistence in innovation raises several important technical and legal issues. Is the intellectual property rights system fair and rational and up to the challenges of the modern age? Do corporations, such as Facebook, respect privacy and competition legislation? As important as it is to constantly revisit such issues, I doubt this will be sufficient for us to come up with an innovation value distribution concept that will keep everybody happy. The evolution of innovation in our societies and this subtle frontier between private and public opens a bigger and broader discussion: the inexhaustible topic of wealth redistribution. Of course, along with the reasoning of the previous paragraph, I can personally only be in favour of the idea of wealth redistribution. But, so would the vast majority of people on Earth. Even Milton Friedman, often considered one of the toughest free-market oriented ideologues, acknowledges the need for redistribution and proposes an implementation instrument called in the literature "negative taxation". The tough issues are, therefore, not the "Yes" or "No", but the "How much?" and also the "To whom?".

Realistically, we can only expect a vast diversity of respons-

es on these thorny and most controversial issues. My personal outlook is to consider this diversity as natural, if not even welcome. In the end, the whole controversy might just be a matter of the preferences of people and their collectives (societies). Instead of aiming at some unanimously accepted calculation methodology for redistribution we might just need to moderate and live on with our many, unavoidably different preferences and perspectives. To this purpose, we have a most efficient tool, one that I think we may be making a rather limited use of: democracy. A revamped democracy, perceived in a decentralised manner, would allow these many preferences to take distinct shapes and lay out their preferred agendas[9].

In short, I fully realise the importance of value distribution of innovation endeavours, with which both the public and the private operators engage, such as the EU FPs for R&I. In fact, I am eager, in the pages below, to make some practical recommendations in exactly this direction. To question, in particular, to what extent the current setup of EU R&I really maximises the public part of this value, as it ought. And to suggest some strategic reorientation in that direction.

This is as far as I will go. I have no data and no method to take any more general and all-encompassing approach on the matter and suggest a clear line passing between value points A, B and C. I hinted above that such a thing may not even exist for our overarching issue at stake here: wealth redistribution. I am a strong believer in the power of measurement, and this will

9 I am, however, already reaching beyond the borders of the effective area that I want to address in this treatise. I will, therefore, not expand further on the issue, referring the interested reader to a previous book of mine on the matter: "Democracy Again!: The EU megapolis and the democratic challenge", that can be downloaded from www.artdrop.net or bought at Amazon.

show up now and again in the following. But to measure, you need to have a clear mandate and a well formulated decision you wish to make. In wealth redistribution this is not the case; there are an array of opinions available, for treating and deciding upon the issue. In consequence, there is simply no way to define how wealth should be redistributed. There are a great number of ideological and philosophical standpoints on the issue and it is not my intention to challenge or side with any of them.

I will, however, make an exception for some ideas that are clearly extremist and out of tune with reality. Luckily, we have not much left from the Marxist legacy that downplayed the importance of individual and private side action and considered it as synonymous to exploitation. Perhaps, with the interesting anomaly of modern day China, that in the name of a questionable Marxism follows its own reverse and aggressively pro-market path. But we have a new wave of a reverse kind of extremism that now considers that the private side by definition acts in the interest of the common good and that the public side, driven by a web of self interests, is only setting up traps for its noble goals.

It is no surprise that this dogmatic approach also extends to the domain of innovation.

The sceptics of public research

I am myself aware of many cases where I think we would be better off with the public sector completely stepping aside and leaving the markets to work. In principle, I do not contest exploring the potential this idea may have, in some given contexts. However, this book does not target the general balance between public and private operators in our societies; it explic-

itly targets innovation. And I have shown above and will continue to demonstrate later on that the quest for innovation cannot be optimally served with the public side stepping out of it.

Yet, this is not something unanimously accepted. As an example, here is how Peter G. Klein from the renowned Mises Institute puts it[10]:

The reality is far more complicated than the myths repeated by those who claim that many of the technologies and innovations we now value were produced single-handedly by the government. Yet, the historical reality does not diminish the ease with which Obama and other fans of government spending can point to innovations like the internet and the interstate highways and say "you didn't build that." We can only speculate on what might have been produced had the market been allowed to function. Likewise, we can still see the pyramids today and marvel at the innovation that went into their construction, but unfortunately, the wealth and labour stolen from ordinary Egyptians to build them has now been long forgotten.

I do value markets and give them the huge credit they deserve, but I love truth and rational reasoning more than I value markets. So the kind of argument, "If the public had not got involved we would have done it faster and better", as raised by Klein above, is a rather poor argument. What would it have meant to not to have Pharaohs in ancient Egypt? What would the Egyptians have had instead and why would this have necessarily been better? Besides, if the Pharaohs and their extravagances were a bad thing three millennia ago, how would the Mises Institute comment on the slave markets in the 16– 18th centuries, just three centuries ago? These were a pure, 100% market institution: no state, church or other institution was really involved there as a protagonist.

10 Peter Klein, "Government Spending on 'Innovation': The True Cost Is Higher Than You Think", Mises Daily Articles, 15 June, 2015.

In the end, I feel justified to argue that had the Internet not evolved primarily in the public domain, it would have taken us quite some time to move it out of the towers and the labyrinths of intellectual rights, erected by proprietary endeavours. A similar perspective is taken by other people, some of whom are credible authors in top business journals. For example[11]:

The early internet was noncommercial, developed initially through defense funding and used primarily to connect research institutions and universities. It wasn't designed to make money, but rather to develop the most robust and effective way to build a network. This initial lack of commercial players and interests was critical—it allowed the formation of a network architecture that shared resources in a way that would not have occurred in a market-driven system.

Klein's mindset enters us into an imaginary, a pure, black and white realm. He obviously considers that the state must be unconditionally bad and wasteful. Facts contradicting his infallible principle are of a secondary importance; they only blur the big idea and can be overlooked.

No, I don't think you can ever trick reality and get an advantage over it just by proposing some "better" imaginary scenario. This simply is not rational thinking. I am only eager to hear about step by step change; about evolution and not revolutionary jumps into nowhere.

State and market have played their roles in the quest for prosperity. Likewise, both have committed ugly deeds, but this is no reason to opt for some purist, Platonic idea and forcefully select one over the other. The only rational question here, that I find worthwhile considering, is: how do you trace the line in innovation, between public and private, and, in particular, how does the public side define its priorities? Indeed, making the

11 Joichi Ito et al., "The Blockchain Will Do to the Financial System What the Internet Did to Media", Harvard Business Review, 8 March, 2017.

case for public research is no difficult thing. Commenting on the exact approach pursued in the EU and questioning whether this effectively maximises the public value is another. It is the latter subject that will occupy me in the following pages.