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DENIS BEAU CONSIDERS THE CHALLENGES FOR A DIGITAL EURO

MISINFORMATION AND POLICYMAKING. CHRISTINE LAGARDE DISCUSSES THE CHANGES NEEDED

RENAUD FOUCART LOOKS AT THE IMPLICATIONS OF THE EU COURT'S GOOGLE DECISION

THE GLOBAL TRADE AND FINANCE PLATFORM

CONTENTS

CONTENTS

The task of separating truth from falsehood has plagued policymaking for centuries. During the Roman civil war following the death of Julius Caesar, Octavian famously prevailed over Mark Antony by spreading 'fake news' about his fitness for office. He did so via slogans forged on specially commissioned coins – an early version of a tweet[1].

Today, this task of distilling the truth is more urgent than ever. We have seen during the pandemic how quickly misinformation can spread – be it about possible treatments, such as drinking chlorine, or about the safety of vaccines. Indeed, falsehoods on Twitter are found to spread about 10 to 20 times faster than facts[2].

At the same time, the nature of the challenges we face are increasingly global, complex and fast-moving. This means that establishing the facts and understanding how they are interconnected is a precondition for charting a course through a shifting, uncertain world.

In this context, good policymaking has to rest on two foundations. First, policymakers have to be committed to searching for the truth, as best they can, through robust analysis and evidence-based policymaking. And because we can never have perfect knowledge, they must be prepared to adjust their views as the facts change.

Second, they need to explain their analysis to the public in a way that reduces complexity and unites people around the case for action. We will not solve the challenges of today, in a world of 'fake news', unless we can bring the public on board.

I would like to explain why today's challenges are different, why they can only be addressed by integrating scientific analysis deeply into policymaking, and why the public has to be mobilised in a new way to bring about change.

Ultimately, we need to be guided by Leonardo da Vinci words: *"learn how to see [and] realise that everything connects to everything else."*

The nature of today's global challenges

So what is it that makes the challenges we face now so difficult? Many of today's challenges are not new. Environmental threats such as smog and acid rain plagued the developed world in the 19th and 20th centuries. Pandemics have ravaged many parts of the world. And global economic crises have been a feature of the world economy for as long as globalisation has existed.

The benefits of science, policy and the public joining forces to realise our full potential are overwhelming. Only by working together in all areas can we draw on our strengths and build hope for a brighter future

But what makes the contemporary challenges unique is their sheer scale – and their potential to change the world profoundly. The challenges have intensified in at least three ways: their scope, their complexity and their potential to amplify.

First, the scope of today's challenges is genuinely global. A century ago, the Spanish flu spread like wildfire across the globe, infecting around a third of the world's population at the time[3]. But even in the highly globalised world that existed at that time, there were parts of the world the disease did not reach.

COVID-19, on the other hand, has been the first truly global pandemic. In less than six months, no region of the world was left untouched (save for a few Pacific islands) and virtually no aspect of our lives was unaffected. Unprecedented containment measures, in turn, triggered one of the most severe economic slumps since the Second World War[4].

Second, global challenges are now highly complex and require unprecedented levels of multilateral coordination. For example, when countries set out to close the hole in the ozone layer in the mid-1980s, the solution essentially required only a handful of the largest chemical companies to stop producing CFCs[5] and find alternatives. This in turn laid the ground for major economies to agree to the Montreal Protocol in 1987.

But addressing climate change is orders of magnitude more difficult. Not only do we have to contend with the multiple faces of climate change – more extreme weather patterns, rising sea levels, loss of ecosystems and biodiversity – but regions are also affected in different ways and at different speeds[6]. This makes devising timely and appropriate mitigation measures across countries exceptionally complex.

Third, global shocks tend to amplify in the face of a more integrated global economy. The OECD estimates that, in advanced economies, the contribution of global factors to changes in GDP growth has risen from around 35% in the 1980s to almost 70% today[7].

The internet also amplifies the spread of misinformation, which in certain situations can make global shocks worse. For instance, research suggests that in the first three months of 2020, nearly 6,000 people worldwide were hospitalised because of coronavirus misinformation[8].

At a minimum, the spread of 'fake news' leads to greater cynicism among the public about who is telling the truth and what sources to trust.

The upshot is that we are operating in a world of much higher uncertainty – about the nature of the shocks we are facing, how they will propagate, and what the public will believe about them. And policymakers have to change the way they approach problems and the way they communicate to adapt to this world.

Integrating science into policy

First of all, when faced with rising uncertainty policymakers have an even greater responsibility to commit themselves to a rigorous search for the truth.

To that end, their analysis has to be grounded in deep analysis, expert knowledge and the scientific method – which means constantly testing hypotheses and adjusting decisions in the light of new evidence. The public would be ill-served if policymakers mirrored what they believed to be the public mood and based their decisions purely on instinct rather than on objective reason.

We have had a striking demonstration of the need to integrate scientific analysis into policymaking during the pandemic. This has been a fast-moving crisis that could not be addressed through hunches or preconceived notions. The only way to fight it has been to act on the basis of the emerging evidence.

It is now clear that governments which chose to draw on the evolving science to inform the trade-offs lying before them have performed better – in terms of both protecting lives and shielding the economy – than those that did not[9].

And this has produced a virtuous circle of increasing demand for policy-relevant research. In the first half of 2020, publications on COVID-19 doubled every 20 days[10].

Yet the search for truth does not only apply to governments. In fact, for independent institutions such as central banks, the responsibility is even greater. We are entrusted with narrow mandates precisely to ensure that our decisions are based on facts rather than political influences. We therefore face an even stronger burden of proof to show that our decisions are guided by the weight of evidence alone.

This is a key reason why we invest so heavily in research and analysis. The ECB is ranked first among central banks worldwide for the quality of its research, it is ranked first in the field of monetary economics, and 15 of its economists are among the top 10% of authors globally[11]. That knowledge base – which involves constantly studying the effects of our own policies – gives us the foundation to act in the face of new challenges.

The benefits of that foundation were clearly visible in our own response to the pandemic. The shock to the economy was unprecedented, but we were able to draw on our past experience of financial disturbances in the

euro area; on our analyses of how self-fulfilling destabilising dynamics could emerge; and on our research into the effects of our previous asset purchase programmes, to deliver a rapid and effective response.

Indeed, our pandemic emergency purchase programme and long-term lending operations were able to rapidly remove tail risks in financial markets and avert a liquidity and credit crunch. Coupled with the actions of our banking supervision arm, our researchers estimate that these measures saved more than one million jobs[12].

Overall, the exceptional level of evidence-based policymaking in our societies during the pandemic has taken place because we have faced an existential threat, leading to the type of relentless focus on results that we usually only see in times of war.

It is simply remarkable that, within weeks, the genome of the coronavirus had been sequenced. Within a few months, tests for infection had been made available. And within a year, highly effective vaccines had been developed.

Having seen the incredible progress we can make when science and policy are united behind a common goal, in my view we should not now slide back into the pre-pandemic status quo. We must strive to continue this joined-up approach if we are to tackle the challenges we face today – and this applies perhaps most of all to climate change.

It is not by chance that the international architecture set up to tackle climate change has placed the science-policy nexus firmly at its core. Over the years, the Intergovernmental Panel on Climate Change has acted as an anchor for the understanding of climate science, helping ground policy agreements in knowledge and evidence[13].

Without this institutional anchoring, we would now be facing even more dangerous and irreversible levels of climate change. Absent global measures, the world would be at or over the 1.5°C warming threshold and heading towards a projected 4.4°C. That would translate into a 30% loss of global GDP by the end of this century[14].

But clearly the work is not yet done. The drawn-out negotiations at the COP26 summit illustrate the difficulties in reaching global political consensus, despite solid scientific evidence and the buy-in of large parts of the private sector. And an important reason for this is that, to achieve sustained progress, the public must be brought on board as well.

Engaging the public

Indeed, the job policymakers is not only to make decisions based on the best assessment of available evidence, but also to explain that assessment in a way that reduces complexity and underpins the case for action.

Today, faced with challenges that require far-reaching and unprecedented changes in all segments of society, the premium on effective communication has never been higher. To bring about change with the necessary speed and in line with democratic principles, we need a critical mass of people who are willing to overhaul many aspects of their daily lives.

Yet the barriers we face are high. In a world where 'fake news' can spread rapidly and people no longer know which sources they can trust, it is increasingly hard to centre public opinion around a broadly agreed course of action. However, it is not impossible.

The pandemic has proven that societies can be mobilised by scientific evidence to make profound changes, if that evidence is communicated in an effective way. People have accepted sweeping restrictions on their usual freedoms

in order to contribute to the common goal of saving lives and preventing an uncontrolled spread of the disease. So what are the elements that can help bring the public on board? To my mind, there are three: simplicity, framing and empathy.

Starting with simplicity, we should not underestimate the ability of the public to evaluate and absorb factual evidence – but it has to be presented in an accessible way[15].

We have seen this in the area of climate. In an experiment where US citizens who knew little about the scientific consensus on climate change were shown a simple pie chart illustrating the overwhelming consensus in favour of its man-made origins, their estimates of the climate consensus increased by nearly 20% – and that was with just one exposure[16].

We know that simplicity works for monetary policy communication, too. Research finds that providing households with simple statistics about inflation, such as the central bank's inflation target or forecast, has large and immediate effects on their inflation expectations. Providing more detailed statements and arguments, however, has no additional effect[17].

This is an important reason why one of the cornerstones of our strategy review was to make our inflation target clearer. Our new, symmetric 2% target is clear-cut and unambiguous.

But the challenge is not only to present the facts simply. It is also incumbent on policymakers to find ways of framing those facts so they resonate broadly with the values of the people they are speaking to. This is the second element.

It is well-known, for example, that framing climate change as a difficult trade-off between environmental benefits and economic costs tends to reduce support for mitigation measures, even for those who generally support action[18].

However, messages linked to healthier and more sustainable lifestyles – cleaner air, less waste – tend to meet with a positive response across a broad cross-section of the public[19].

Even the words we use matter. Studies from the United States find that conservatives are more likely to support preparing for environmental disasters when climate change is framed as extreme weather'[20]. And people across the political spectrum feel more negatively about natural gas as a source of energy when it is termed 'methane gas'[21].

Finally, we have to consider how the message is given and by whom. It has been clearly established that, when shaping people's perceptions of a crisis, empathy and compassion are critical elements of leadership communication[22].

For instance, there is some evidence that female leaders have performed better during the pandemic[23], in part because their communication approach has balanced science and empathy. Female leaders have often sought to share common experience, engage with the public and reach out and speak to vulnerable groups[24].

We also understand the importance of empathy at the ECB. Trust in the ECB is found to hinge not just on our competence in delivering our mandate, but also on whether we are perceived to care about citizens and act responsibly. So, communicating how responsible ECB policy benefits people's welfare can foster greater trust[25].

This is why, as ECB President, I have set out to overhaul our approach to communications. Among other initiatives, we have made our monetary policy communication more accessible and we now convey our decisions in a 'layered' way that makes them more relatable for people. The aim is to be simple – but not simplistic.

Conclusion

The challenges facing the world today are truly unprecedented. They have immense scale, complexity and potential to amplify through our extensive economic and digital links. This places extraordinary demands on humanity to solve them.

The coronavirus pandemic has demonstrated the speed with which risks can spread across the globe. And it may only be a dress rehearsal for the type of threat to our livelihoods that an overheating planet will pose to all its inhabitants.

But crucially, our joint response to the pandemic holds important lessons for the future. It can provide, perhaps, an emerging template for dealing with the complexity and uncertainty of the global challenges ahead.

In many ways, this response stands out for the considerable efforts made by all policy areas and the unprecedented policy measures taken. However, our ultimate success in tackling this crisis has stemmed from recognising that we have all had to act together.

Indeed, joint action from different policy areas has proved hugely beneficial in coping with the breadth of the shock. Intensive dialogue between scientists and policymakers has been fundamental in dealing with complexity and uncertainty. And broad coordination across countries has proved crucial in managing the pace with which the virus has spread.

Without this intensive cooperation, we would not have progressed nearly as fast with the economic recovery and the introduction of vaccines.

So, the fundamental lesson to be learnt here is that we cannot afford to operate with a setup that confines our work to distinct spheres. In a more interconnected global economy, intersectoral and multilateral cooperation is more important than ever to face complex challenges that transcend national borders.

As John Donne wrote, *"no man is an island entire of itself; every man is a piece of the continent, a part of the main."* This is the reality that we face in a world where our common challenges bind us closely together.

The benefits of science, policy and the public joining forces to realise our full potential are overwhelming. Only by working together in all areas can we draw on our strengths and build hope for a brighter future. ■

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Can climate change be tackled without ditching economic growth?

Klaas Lenaerts, Simone Tagliapietra and Guntram B Wolff explore whether decarbonisation and economic growth are compatible to reach net zero by 2050

Higher levels of economic activity tend to go hand-in-hand with additional energy use and consumption of natural resources. As fossil fuels still account for 80 percent of the global energy mix, energy consumption remains closely related to greenhouse gas emissions and hence to climate forcing.

This paper explores whether decarbonisation and economic growth are compatible or whether the world economy needs to grow less to be able to reduce greenhouse gas emissions fast enough to reach net zero in 2050. The literature provides profoundly different answers to this question, with scholars positioning along a spectrum that extends from the most optimist version of 'green growth' theories to sceptical 'degrowth' theories.

While globally, CO_2 emissions per unit of GDP are declining, the decoupling rate from 1995 to 2018 was only -1.8 percent annually. To achieve net zero by 2050, the rate would have to accelerate to -8.7 percent, assuming population and GDP growth projections as given, or by a factor of almost five.

To keep GDP growth and population at their projections and thus reject the proposition of degrowth, decoupling would have to accelerate massively. Two avenues are crucial: reducing the energy intensity of production and/or the emissions intensity of energy.

The huge fall in the price of renewable energy provides hope that decoupling can accelerate. Decoupling rates have accelerated in the last decade and decoupling is substantially faster in the European Union. In the EU, we estimate that decoupling only has to accelerate by a factor of 2.5.

We do not think degrowth propositions advanced in the literature will be pursued and therefore focus on the main challenges that must be tackled to achieve decoupling. Unprecedented efforts are required to achieve green growth. But hoping for humanity to sacrifice growth appears unrealistic.

1 Introduction

Climate change is one of the most pressing issues of our time. The science is clear: human activities have already caused approximately 1°C of global warming and at current rates will likely cause 1.5°C of global warming above pre-industrial levels between 2030 and 2050 (IPCC, 2018).

With the Paris Agreement, governments have committed to limiting the temperature increase to well below 2°C above pre-industrial levels and to pursuing efforts to limit it to 1.5°C (UNFCCC, 2015). Keeping global warming below this limit will require global greenhouse gas (GHG) emissions to quickly decline by at least 45 percent from 2010 levels by 2030, and to reach net-zero by 2050, with negative emissions thereafter (IPCC, 2018).

Economic growth has historically been the main driver of rising environmental damage and GHG emissions. To achieve such deep emission cuts, the world would have to either decouple global GHG emissions from gross domestic product (GDP) or face deep cuts to GDP.

The numbers we present in sections 2 and 3 are sobering: current projections of global population size and GDP per capita imply that the world must reduce the rate of CO_2 emissions per unit of real GDP by around 9 percent per year on average to reach the climate targets described above. Between 1990 and 2016, global emissions per unit of real GDP decreased only by 1.8 percent per year.

Confronted with these facts, scholars disagree about whether humanity can afford continued economic growth. The so-called 'green growth' literature is optimistic that suitable policies and technology will reduce emissions to sustainable levels while allowing for continued or even boosted economic growth.

This thinking is shared by several governments and institutions. For instance, the European Commission defines its European Green Deal as 'Europe's new growth strategy'. Degrowth scholars on the other hand dismiss this and argue that the global economy must be scaled down, and that systemic change and redistribution is necessary to accomplish this and address the *"fairy tales of eternal economic growth"*, as campaigner Greta Thunberg told world leaders in 2019[1].

On some level, this academic debate on extreme positions is largely theoretical. Developing countries will want to grow and will implement policies to that effect. The idea of deeper cuts to GDP in rich countries is also theoretical: economic growth is of central importance for welfare and issues such as debt sustainability, pensions and social security.

A shrinking or 'degrowing' economy could potentially also exacerbate the distributional implications of decarbonisation that will arise regardless (see for example Markkanen and Anger-Kraavi, 2019).

Yet, the sharp contrast in the theoretical positions of scholars is a way to conceptualise the magnitude of the challenge. Striving for green growth is an imperative, but no one can be certain ex ante that such a path is possible. What is certain is that it cannot happen without some key prerequisites.

It will require massive investment in existing green technologies and in the advancement of new breakthrough technologies, including for negative emissions. It will also require changed behaviour from everyone, and our economies will have to be adapted to deal with the consequences of climate change that can no longer be avoided.

The paper is structured as follows. Section 2 presents the numbers that make clear how significant the problem of decoupling is. Section 3 reviews the literature on degrowth and explains why degrowth proposals are not viable.

Section 4 summarises the literature on green growth. Section 5 discusses essential steps for the realisation of green growth. Section 6 concludes with recommendations for policymakers.

2 The challenge of decoupling: the hard numbers

Pursuing deep decarbonisation will be challenging. Annual global GHG emissions keep rising and show no sign of peaking. In 2019, they were 62 percent higher than in 1990, the year of the first Intergovernmental Panel on Climate Change report, and 4 percent higher than in 2015 when the Paris Agreement was signed (Friedlingstein **et al** 2020).

Even unprecedented circumstances such as the massive restrictions introduced to contain COVID-19 led only to a 6 percent drop in emissions in 2020, from which a quick rebound to pre-pandemic levels promptly followed (IEA, 2021a).

Historically, economic growth – by which we mean real GDP growth – has long been associated with increasing GHG emissions. Empirically, the causal chain is straightforward: higher levels of economic activity tend to go hand in hand with additional energy use and consumption of natural resources.

Fossil fuels still account for 80 percent of the global energy mix (IEA, 2020), and so energy consumption is closely related to GHG emissions and hence to climate forcing. Expansion of industrial processes, livestock rearing and other agriculture adds to emissions, while deforestation reduces carbon sinks.

A far-reaching transformation of the global economy is needed to reduce emissions. As 73 percent of global GHG emissions come from energy production (mostly as CO_2), most reductions will need to happen in that area[2]. An interesting way to look at this is by formulating the problem as a simple identity, as done by Kaya and Yokoburi (1998) on the basis of Holdren and Ehrlich (1974):

$$GHG\ emissions = population * \frac{GDP}{population} * \frac{energy\ demand}{GDP} * \frac{GHG\ emissions}{energy\ demand}$$

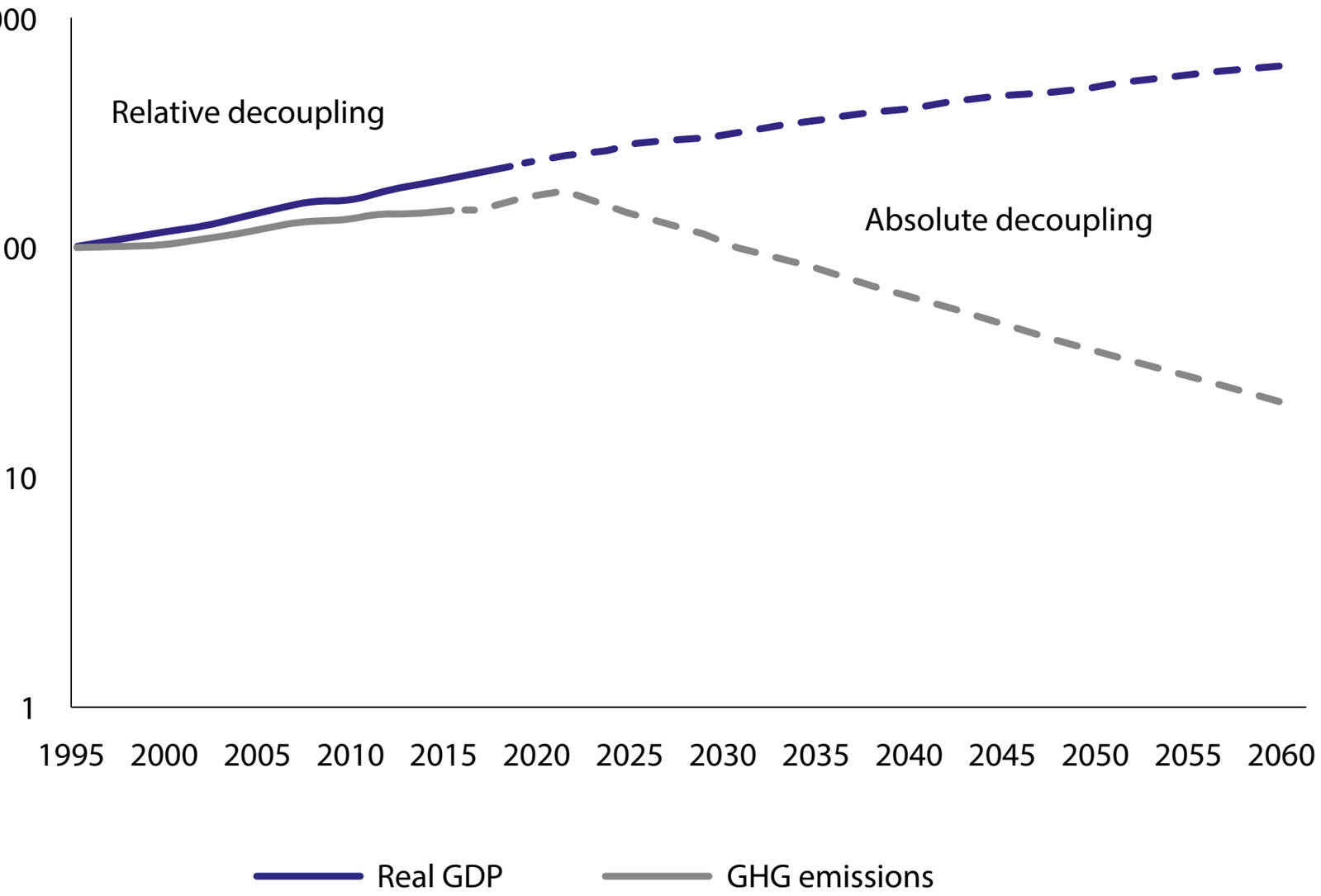
This identity permits GHG emissions (from energy production) to be decomposed into a product of the world's population size, GDP per capita, the energy intensity of GDP and the GHG emissions intensity of energy production[3].

Limiting population growth is one way to limit GHG emissions growth, but the debate on this topic goes far beyond the scope of our paper. We instead consider population growth as a given and base our analysis on OECD demographic forecasts. Cutting emissions would therefore need to happen by lowering some or all of the other factors.

Since lowering the second factor (GDP per capita) implies compromising economic and social welfare, the core question is whether the third and fourth factors (energy and emissions intensity) can decline at a sufficient speed to allow the first and the second to remain on their current paths.

This would imply an absolute decoupling of economic growth and GHG emissions (ie. a situation in which GHG emissions go down while real GDP continues to grow, see Figure 1) through a 'dematerialisation' of the economy (eg. through a shift from manufacturing to services), altered consumption behaviour, more efficient technology and the decarbonisation of the energy sector.

Figure 1. Global real GDP (2010 prices, PPP) and total GHG emissions



Note: 1995 =100. Logarithmic scale. Full lines are historical data, dots are OECD projections, dashes are a stylised representation of absolute decoupling.
Source: Bruegel, based on OECD, Economic Outlook No 103 – Long term baseline projections, accessed in July 2021 and on UNEP, World Environment Situation Room, accessed in July 2021.

Globally, there is no sign of absolute decoupling, but only of relative decoupling (ie. a situation in which total GHG emissions grow less than proportionately to real GDP).

Explained in terms of the Kaya identity, while energy related GHG emissions per unit of GDP are falling (the third and fourth factors combined), the fall is slower than the increase in real GDP (the first and second factors) so that overall emissions continue to rise.

In order to avoid global warming in excess of 1.5°C above pre-industrial levels, global GHG emissions must be rapidly reduced. Doing this without losses in economic prosperity will not be easy...

Figure 2 shows that in the last 100 years, annual CO_2 emissions from energy production have risen tenfold[4], even though emissions per unit of GDP have been slashed by almost two thirds (1.8 percent per year on average since 1990). This is simply because the global economy has grown at a much faster pace (2.8 percent per year on average since 1990).

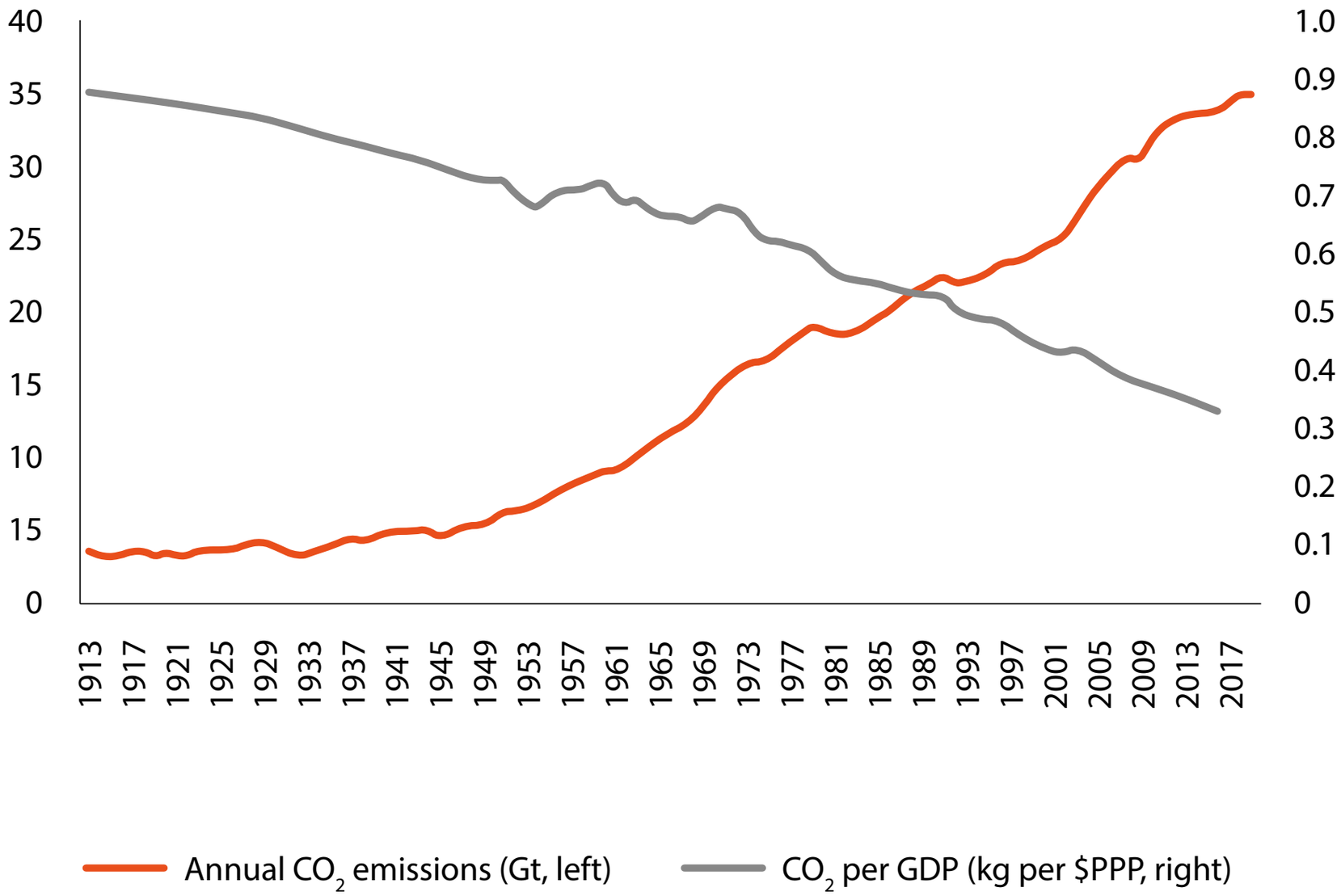
Thus, progress on decoupling GDP growth from CO_2 emissions has been achieved, but the continued expansion of the global economy has proven too fast to stop annual emissions from increasing, let alone to allow them to decrease, as is clear from Figure 2. A rough calculation (disregarding interactions between the factors of the Kaya identity) makes clear how far the world is still falling short:

- Gross emissions of CO_2 stood at around 35 billion Gt in 2018 (Our World in Data, OWID). This needs to decrease to approximately 5 Gt in 2050 according to a technologically conservative emissions pathway[5] of the IPCC (2018), or by 86 percent.

- The global population is projected to increase from 7.63 billion in 2018 to 9.77 billion people in 2050 (x1.28), and global real GDP per capita (2010 prices) is projected to increase from $19,896 to $41,099 or by 107 percent (OECD).

- CO_2 emissions per unit of GDP therefore have to decline by around 95 percent or approximately 9 percent per year on average from 2019 until 2050. Between 1990 and 2016, the world only achieved an average so-called 'decoupling rate' of 1.8 percent per year (based on OWID)[6]. Put differently, the average speed of decoupling during the next three decades will have to be almost five times greater. The later this acceleration happens, the greater it will have to be.

Figure 2. Global annual CO_2 emissions from burning of fossil fuels for energy production (in gigatonnes) and CO_2 emissions per unit of GDP (in kg per $PPP)



Source: Our World in Data (OWID) CO_2 Data Explorer (based on Global Carbon Project; BP; Maddison; UNWPP), accessed in July 2021; see https://ourworldindata.org/co2-emissions

Decoupling trends are not even fast enough in developed economies. Since 1990 the European Union's (EU) gross CO_2 emissions have decreased by 25 percent (OWID), while real GDP grew by 62 percent (European Commission, 2020a).

CO_2 emissions in the United States also started to decline more recently. This suggests that absolute decoupling is possible. But it is happening too slowly to match the globally required decoupling rate: the average EU decoupling rate was 3.4 percent per year between 1990 and 2016, while in the US it was 2.2 percent (OWID).

However, this is not the whole story. Developed economies such as the EU and the US import a lot of goods that are produced elsewhere, and thus GHG emissions attributable to consumption are somewhat higher than territorial emissions.

Fortunately, these broader emissions are also declining for the EU (Friedlingstein *et al* 2020). Once consumption-based territorial emissions are taken into account, the average decoupling rate for the EU is 2.3 percent per year since 1990 and 2.0 percent per year for the US (based on Friedlingstein *et al* 2020 and World Bank data), both lower than the rates based on territorial emissions.

3 Degrowth

Guided by past experience, the basic premise of degrowth theorists is that the world will not be able to sufficiently reduce GHG emissions while GDP grows.

In particular, they point to the fact that some of the technologies playing a relevant role in IPCC simulations, such as carbon capture and storage (CCS) applied to fossil power plants, or bioenergy with carbon capture and storage

(BECCS), do not yet exist and should not be relied on; their economic viability is unproven and they could even create new environmental problems (Keysser and Lenzen, 2021).

Such pessimistic views about our planet's capacity to sustain economic growth are not new. They have been around in some form at least since the *Essay on the Principle of Population* by Thomas Malthus (1789). He postulated that famines and economic collapse were inevitable unless birth rates decreased, based on the belief that population growth is exponential and growth of food production merely linear.

This argument was echoed throughout the twentieth century in environmentally inspired works by, for example, Osborn (1948) and Vogt (1948) and, most notably, in *The Population Bomb* by Paul Ehrlich (1968). Meadows *et al* (1972) predicted in *The Limits to Growth* (hereafter: LTG) that global population and economic activity would peak in the early twenty-first century, and advocated an economic and demographic 'equilibrium state' to avoid an uncontrolled collapse when humanity's need for resources finally exceeds the earth's capacity.

These authors all proved to be too pessimistic (at least so far) because they failed to predict the significant advances in agricultural yields, technological innovation and substitution, and declines in population growth rates.

Advances in resource efficiency have often been driven by market forces, such as for oil in the 1970s, when scarcity drove up prices, creating incentives for innovation.

However, technological progress is highly unpredictable, and since the atmosphere as a deposit for CO_2 is a rival but non-excludable good, purely market-driven innovation and substitution will not solve the problem of climate change (Eastin *et al* 2010).

Like LTG, modern degrowth theories subscribe to the idea that humanity must achieve a lower economic 'steady state' to avoid environmental catastrophe. The term 'degrowth' was probably first used in the writings of French philosopher André Gorz in 1972, and in the work of economist Georgescu-Roegen (1971, 1979), who wrote that economic activity in the long run is limited to a level supported by solar flows due to the laws of thermodynamics.

The term was popularised in the 1990s and 2000s by Serge Latouche (for example Latouche, 2009) who criticised economic development as a goal. In the early 2000s 'degrowth' was used as a slogan by social and environmental activists in France, Italy and Spain.

Finally, it emerged as an international research area in 2008 at the first Degrowth Conference in Paris (Demaria *et al* 2013; Kallis *et al* 2018), with many publications being produced, particularly in the first half of the 2010s, in the context of the global financial crisis and the sovereign debt crisis in Europe.

Authors including Giorgos Kallis (eg. Kallis, 2011), Jason Hickel (eg. Hickel, 2020), Tim Jackson (eg. Jackson, 2009) and Kate Raworth (eg. Raworth, 2017) are today at the forefront. Several variations of degrowth are advocated under different names, including 'wellbeing economics', 'steady-state economics', 'post-growth economics' and 'doughnut economics'.

There is no exact definition of what 'degrowth' stands for. Authors are not always clear on exactly what should 'degrow'. There are at least five different interpretations: degrowth of GDP, consumption, worktime, the economy's physical size, or 'radical' degrowth, referring to a wholesale transformation of the economic system (van den Bergh, 2011).

It is perhaps better to say that degrowth covers all these interpretations. Material and energy consumption and the economy's physical size need to degrow, out of a concern for resource depletion and more recently climate change.

Worktime degrowth is one tool to do so, GDP degrowth is an inevitable consequence (not an aim per se), and radical degrowth a necessary condition to make a post-growth economy socially sustainable (Kallis, 2011).

In terms of GDP and GHG emissions, degrowth scholars do not see a credible scenario in which the rate of decoupling of GDP and GHG emissions could be sufficiently high to avoid dangerous climate change (Jackson, 2009), and as such they arrive at the conclusion that global GDP must inevitably decline.

Realising the negative social consequences commonly associated with recessions, degrowth scholars set out to define a path to actively 'guide' GDP downward, rather than to passively let the world slip into a depression. Demaria *et al* (2013, p.209) therefore defined degrowth as a call for *"a democratically led redistributive downscaling of production and consumption in industrialised countries as a means to achieve environmental sustainability, social justice and well-being."*

As the definition suggests, the degrowth literature is not limited to the economy-environment nexus, but is also concerned with (international) redistribution, political participation, social fairness and 'beyond GDP' conceptions of welfare.

Antal and van den Bergh (2016) gathered a few economic arguments directed against the prospect of decoupling through green policies. The most common argument is the existence of a rebound effect from investment in efficiency and clean energy.

This means that as societies invest to reduce emissions, the increased income or savings resulting from those investments will at least partially offset the intended beneficial effects through increased consumption of non-renewable energy elsewhere. In addition, there is a risk that more stringent policies could see lower compliance because of what the authors call an 'environmental Laffer curve', with economic actors preferring to cheat rather than to respect regulations as the expected cost is lower.

A final objection is the possibility of burden-shifting: while not an issue for climate change, other environmental risks could be exacerbated indirectly by emission reduction efforts, for example soil pollution from mining for minerals.

Degrowth proponents advance a myriad of policies as part of a systemic change to make sure that the challenge of economic downscaling necessitated by ecological boundaries does not cause widespread human suffering. We will only touch on them superficially.

Perhaps the most important and common proposal is to limit the supply of production factors, most notably labour. Reductions in working hours are seen as a way to reduce consumption while increasing social welfare through more free time and achieving high levels of employment.

The latter must also be supported by shifting employment towards labour-intensive sectors and steering innovation to increase resource productivity rather than labour productivity, using green taxes and 'cap-and-share' schemes (Kallis, 2011; Kallis *et al* 2018).

Another element is to reduce aggregate investment by firms to net zero, which does not exclude that some (clean) sectors grow at the expense of other (dirty) sectors (Kallis *et al* 2018).

Other ideas found in the literature are the re-localisation of economies to shorten the distance between consumers and producers, and encouragement of the sharing economy (Paech, 2012), as well as new forms of (regional) money and limitations to property rights (Kallis *et al* 2012; van Griethuysen, 2012).

Some advocate for zero interest rates to avoid the growth imperative created by having to pay back interest (Binswanger, 2013), caps on savings to reduce wealth inequality and doing away with the logic of accumulation by firms and owners of capital. The aim is to arrive at a steady state in which the whole economy is consumed, which would end growth (Loehr, 2012).

Importantly, many of the proposed policies are considered by authors themselves to be incompatible with capitalism and unlikely to be implemented by liberal representative democracies.

Kallis *et al* (2018) therefore argued that in the absence of democratic degrowth policies a period of involuntary economic stagnation caused by climate change might usher in an authoritarian version of capitalism, unless more democratic alternatives are put forward.

Finally, it should be noted that degrowth proponents devote relatively little attention to limiting population growth, which would theoretically offer another – though contentious – way to reconcile GDP per capita growth and emission reductions.

Where it is discussed, most authors view it as undesirable, especially when non-voluntary, and point out that the large and growing populations of the Global South put relatively little stress on the environment (Cosme *et al* 2017).

On the whole the proponents of degrowth do point out the size and magnitude of the challenge confronting the world. However, we do not see any likelihood that either advanced or developing economies would accept and implement the radical propositions embedded in the degrowth literature.

We also do not think that it is in any way possible to manage degrowth without massive negative welfare effects. Overall this therefore points to green growth and the need to confront its current limitations.

4 Green growth

The calculations in section 2 illustrate the scale of the challenge. However, it is also important to note that the low decoupling rate up to now has occurred in a context in which there hasn't been a significant climate effort globally, and developed economies have put in place only modest policies. This pattern need not continue, and there are signs that it might not.

The EU has already managed to cut its territorial emissions of CO_2. This is of course partly due to lower population and GDP per capita growth than the global average. But data also shows that the decoupling rate (decline in CO_2/GDP) between 1990 and 2016 stood at -3.4 percent per year in the EU (based on OWID), more than the global average of -1.8 percent.

However, this is not at the required -9.4 percent for the EU's net-zero goal. When we break CO_2/GDP down into its two components from the Kaya identity, energy demand/real GDP and CO_2/energy demand, we see that the higher decoupling rate is mostly due to a decline in the latter: the energy sector has been decarbonised more in the EU than elsewhere.

Tables 1A and 1B show broadly similar evolutions for energy demand/real GDP globally and in the EU (the EU does slightly better), but while the carbon intensity of energy has remained largely stable worldwide, in the EU it has decreased by a yearly average of 0.7 percent since 1995.

Table 1A. Factors of the Kaya identity and CO_2/GDP, average yearly rates of change (%) at global level in historical reference periods and net-zero emission scenario

WORLD	Historical 1995-2018	Net zero scenario 2019-2050	Historical 2005-2018	Net zero scenario 2019-2050
CO_2	1.9	-5.9	1.6	-5.9
Population	1.2	0.8	1.2	0.8
Real GDP per capita	2.6	2.3	2.6	2.3
Energy demand/real GDP	-1.7	-1.7	-1.8	-1.8
CO_2/energy demand	0.0	-7.2	0.0	-7.0
CO_2/real GDP	-1.8	-8.7	-2.1	-8.7

Table 1B. Factors of the Kaya identity and CO_2/GDP, average yearly rates of change (%) at EU27 level in historical reference periods and net zero emission scenario

EU27	Historical 1995-2018	Net zero scenario 2019-2050	Historical 2005-2018	Net zero scenario 2019-2050
CO_2	-0.8	-8.1	-1.6	-8.1
Population	0.2	0.0	0.2	0.0
Real GDP per capita	1.2	1.4	0.8	1.4
Energy demand/real GDP	-1.8	-1.8	-2.1	-2.1
CO_2/energy demand	-0.7	-7.7	0.7	-7.4
CO_2/real GDP	-3.3	-9.4	-3.7	-9.4

Note: targeted gross CO_2 levels in 2050 are based on the LED/P1 pathway of the IPCC (2018) for the global estimates and on the 1.5 LIFE pathway of European Commission (2018) for EU27 estimates. Both pathways rely little on negative emission technologies. Our net zero scenario uses forecasted population and GDP per capita data by the OECD (EU GDPpc approximated by euro area data) and assumes (arbitrarily) that energy demand/real GDP will continue to decline at the same yearly rate as its average in the relevant reference period (1995-2018 or 2005-2018). Note that due to the different sources of the historical data, rates in the historical columns do not add up entirely as can be expected mathematically. We nevertheless made efforts to make the historical data as consistent as possible. Numbers should be interpreted as rough estimations.
Source: Bruegel, based on OWID for CO_2 emissions and CO_2/GDP, OECD (2018) for GDP per capita data, OECD (2021a) for population, OECD (2021b) for energy demand/real GDP, and IEA (2020b) for CO_2/energy demand.

A decline in energy demand/real GDP can be driven by improvements in energy efficiency from using better technologies for production, transport, isolation etc; by behavioural change towards less energy-intensive consumption (eg. increased use of public transport, a larger sharing economy and more re-use of durable goods); and by a changing economic structure towards a more 'immaterial' service-oriented economy.

A decline in CO_2/energy demand is mostly driven by the shift from fossil fuels to renewable energy sources. Changing behaviour also plays a role (choosing to travel by rail rather than by air for example).

So far, energy demand/real GDP has declined more since 1995 than CO_2/energy demand. Perhaps this is somewhat surprising as in the long run it seems more likely that energy would be almost completely decarbonised than that the global economy would be completely 'de-energised': goods still need to be produced somewhere and transport, heating and lighting will remain necessary.

In practice, both factors will have to decline simultaneously to sufficiently reduce gross CO_2 emissions. This is also visible in Tables 1A and 1B, which show that if energy demand/real GDP continues to decline at its current rate, a very steep drop in CO_2/energy demand will be necessary for both the world and the EU.

If energy demand/real GDP is also addressed more strongly, the 'burden' can be spread over both factors of the Kaya identity (see for example the different rates depending on which reference period is used for energy demand/real GDP).

The data presented here suggest that an absolute decoupling of CO_2 and GDP is possible, but that it is currently still too slow to reach net zero. Note that while the required decoupling rate is higher for the EU than for the world, the

EU is closer to its goal: while the overall decoupling rate must increase around five-fold for the whole world, the EU itself only needs less than a three-fold acceleration.

The historical decoupling rate against which to compare also increases if one takes a more recent reference period, as is visible in the table. Speeding-up will still take tremendous effort: if the energy intensity of GDP decreases at the same speed as in the last few decades, even the EU would need to speed up its decarbonisation of energy by a factor of around 11 to reach its required decoupling rate.

The drastic decline in prices of renewable energy technologies suggests that such an accelerated decarbonisation of energy may be feasible. Figure 3 shows that over the last decade, the cost of generating electricity with solar panels has decreased by 85 percent, while the cost of doing so with wind turbines has decreased by 68 percent.

The costs of energy from solar and wind have become lower than fossil fuel alternatives even without subsidies. Firms and governments all over the world would therefore have economic incentives to make the necessary investments to save money and at the same time reduce their emissions.

Investment decisions are of course not based solely on market prices but also on government policies and strategies. Money is still being invested in fossil fuels, but volumes are declining. Meanwhile global investments in renewable energy generation have been on the rise uninterruptedly since 2017, even during the pandemic in 2020.

Moreover, it takes time before lower costs are translated into larger investments, and other key investments must be made before renewable energy can be used at a massive scale, notably in energy storage capacity and more reliable distribution and transmission.

As investments in battery storage are surging while costs are declining and investments in grids are set to recover in 2021, we can expect that the upward trend in renewable energy investment will continue for the foreseeable future (IEA, 2021d).

Already in the earlier literature rejecting degrowth pessimism, the central role of technology was highlighted. Stiglitz (1974) and Kamien and Schwartz (1978) did not yet address GHG emissions, but rather whether continued consumption growth is possible in a world with exhaustible resources.

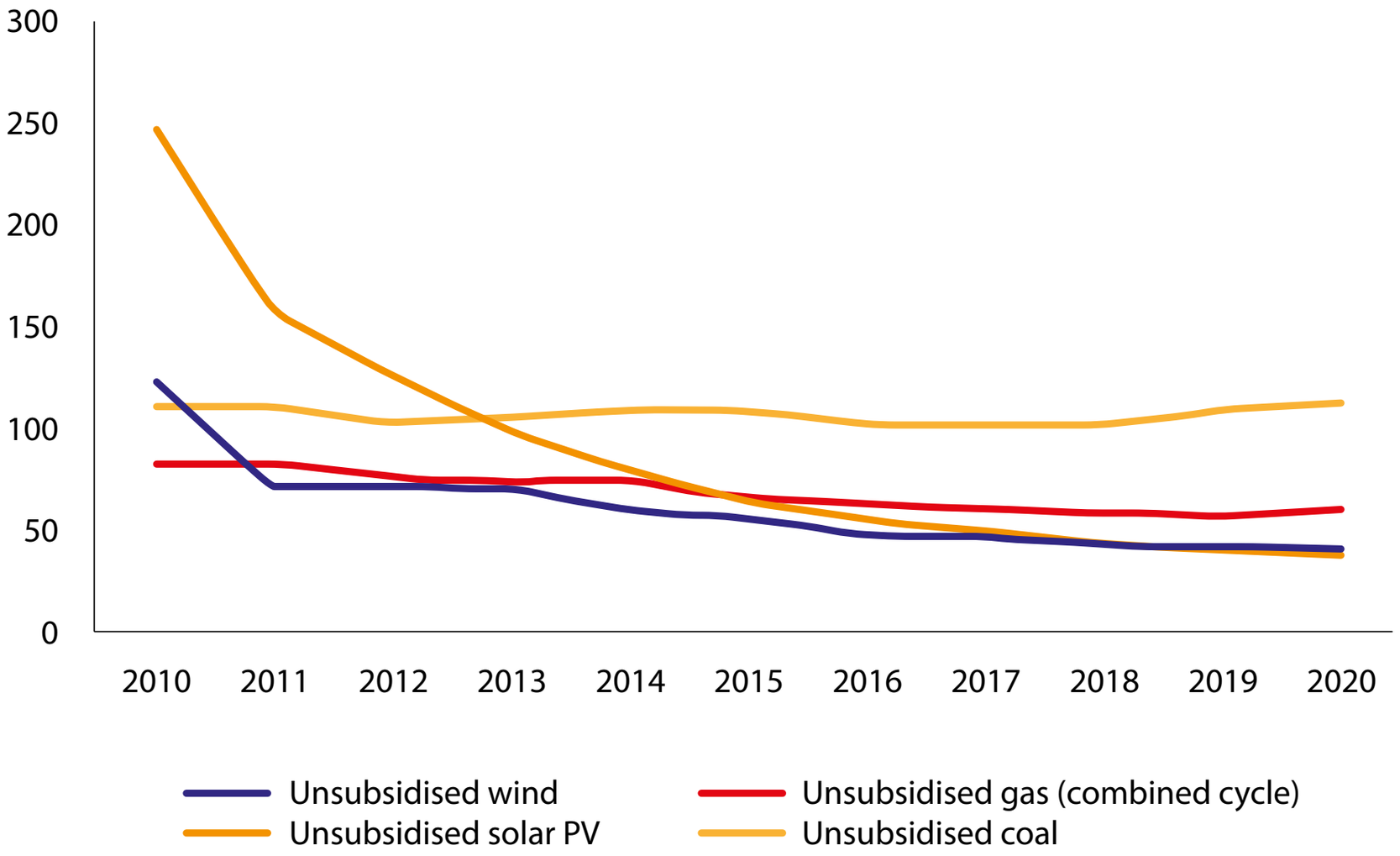
They found that technology-driven efficiency gains allow the limits set by nature to be pushed forward so that continued expansion is possible. Later papers, including Weitzman (1999), Acemoglu *et al* (2012) and Aghion *et al* (2016), discussed endogenous and directed technical change with more optimistic outlooks.

The 1987 Brundtland report *Our Common Future* is seen as a milestone for green growth with its definition[7] of 'sustainable development' (Jacob, 2012)[8]. The term 'green growth' only gained popularity in the wake of the global financial crisis of 2008 as an idea for short-term stimulus that incorporated environmental objectives (eg. OECD, 2009), and was adopted as a policy objective by international organisations in the subsequent years (Jacob, 2012).

Today it underpins the United Nations' Sustainable Development Goals[9], and to varying degrees different Green (New) Deal proposals (eg. European Commission, 2019; US House of Representatives, 2019).

No single definition has been developed of what is meant by 'green growth'. For example, the World Bank (2012), OECD (2011) and UNEP (2011) each define green objectives differently (Hickel and Kallis, 2020).

Figure 3. Levelised cost of energy (LCOE) from selected fossil fuels and renewable energy sources, in USD/MWh



Source: Lazard (2020).

Jacobs (2012) wrote that green GDP growth is understood as either: (1) higher growth than in a scenario without strong environmental or climate policies, both in the short and long run (dubbed the 'strong' version of green growth), or (2) lower in the short run and higher in the long run (the 'standard' version)[10].

Whatever the exact interpretation of green growth, publications from international organisations or governments predict both environmental benefits in the form of avoided climate damages and economic benefits resulting from increased investment and innovation[11].

This 'double dividend' forms the heart of the green-growth argument. The green-growth narrative rests on four pillars:

(1) subsidies for innovation and investments in renewable energy and energy efficiency that boost GDP;

(2) carbon pricing to further stimulate efficiency gains and renewables, and to avoid rebound effects, combined with recycling of tax revenues to cut corporate or labour taxes and boost employment;

(3) assumptions about innovation and negative emission technologies to accelerate the decoupling process; and

(4) compensation schemes for the poorest households, displaced workers or disadvantaged regions to make the transition politically feasible (see for example Table 2).

Table 2. Different green growth scenarios, showing targeted emission reductions, estimated GDP impact, key policies, and adversely affected groups (if no compensation)

	IMF (2020)	European Commission (2020b)[12]	IEA (2021b)
Emission reductions	Reduce gross global emissions by 80% by 2050	Reduce net EU emissions by 55% by 2030	Reduce global net CO_2 emissions to zero by 2050
GDP impact	Standard version: baseline GDP +0.7% first 15 years, -1% in 2050, +13% in 2100	Standard version: baseline GDP -0.27%/+0.50% by 2030	Strong version: baseline GDP +4% in 2030
Key policies	• green investment push • carbon pricing • compensatory transfers supportive macro policies	• green investment push • carbon pricing • tax recycling	• green investment push • carbon pricing
Adversely affected groups	• Low-income households, due to electricity prices and job status • Fossil fuel exporters	• Fossil fuel industry • Low-income households	• Fossil fuel exporters • Fossil fuel industry

Source: Bruegel.

Inclusion of such social elements puts current proposals a step beyond earlier incarnations of Green New Deals (Mastini *et al* 2021). In its most extreme form, green growth is believed to come as a result of free markets and does not even require public intervention other than carbon pricing (Gueret *et al* (2019) refer to this as 'green capitalism').

Overall, however, the empirical evidence for a double dividend looks mixed. In fact, some of the reports by official institutions state that a double dividend can be achieved only if very specific assumptions are made, while in many scenarios, strong climate action could at least in the short-term lower GDP growth.

5 Techno-optimism: important caveats

The numbers we have given show that the world needs to decouple gross GHG emissions and GDP growth much faster than currently. In the following, we set out the key actions necessary to achieve such a faster decoupling[13].

5.1 Need for massive investment in deployment of existing green technologies

To decouple GHG emissions and GDP growth, a huge expansion in green investment and a big shift in investment are needed. For instance, the IEA's (2021b) net-zero pathway estimates that global energy capital investments must increase from a current yearly average of about $2 trillion to $5 trillion (2019 prices) by 2030, after which they must stay at almost the same level until 2050.

As a fraction of global GDP, this would be an increase from 2.5 percent today to 4.5 percent in 2030, followed by a gradual decline back to 2.5 percent. Encouragingly, most of the technologies to be invested in up to 2030 (for 85 percent of emission reductions; see IEA, 2021b) are readily available.

Beyond 2030, that will be much less the case: only 54 percent of emission reductions will be accomplished with current technologies. Most of the investments up to 2050 (about 65 percent) would be directed to generating low-

carbon electricity, upgrading the electricity system for distribution and storage and electrifying new sectors of the economy (CO_2/energy demand), while a smaller though still significant share (about 15 percent) would be spent on efficiency improvements (energy demand/real GDP).

Governments will have to foot part of the bill, especially for large infrastructure projects or technologies still under development (IEA, 2021b). But the private sector will need to cover most of the investments.

It is therefore important that governments use policies to create incentives and facilitate investments, for example through carbon pricing, 'green' financial regulations and supervisory practises, or cooperation with the private sector through public financial institutions such as the European Investment Bank.

Clear and credible policy commitments also help by reducing the uncertainty that can keep firms from investing (Dechezlepretre *et al* 2021).

5.2 Need for breakthrough green technologies for decarbonisation

Most emission reduction scenarios that predict continued economic growth rely to varying degrees on the use of technologies that are not yet available. This is frequently used by degrowth proponents as an argument to question the feasibility of green growth.

The IEA net-zero pathway (2021b), for instance, relies to a great extent on future innovation: 15 percent of the emissions reductions by 2030 and 46 percent of the reductions between 2030 and 2050 are to be achieved with technologies that are currently in a demonstration or prototype phase, such as CCS, green hydrogen and advanced batteries.

The breakthroughs achieved in the current decade will therefore be crucial. Unfortunately, none of the technologies needed beyond 2030 are currently on track to being deployed in time (IEA, 2021c), as the road from concept to commercialisation is typically long and winding.

To accelerate the development of these innovative technologies, governments and the private sector both need to substantially increase their research and innovation funding. Fostering green innovation and bringing green technologies from the laboratory to the market requires government action, for example via pricing of emissions.

Public-private partnerships schemes, adequate risk-taking by public institutions and green industrial policy can further deliver breakthrough innovation (Tagliapietra and Veugelers, 2020). But, of course, there cannot be a guarantee that such breakthrough technologies will materialise in time.

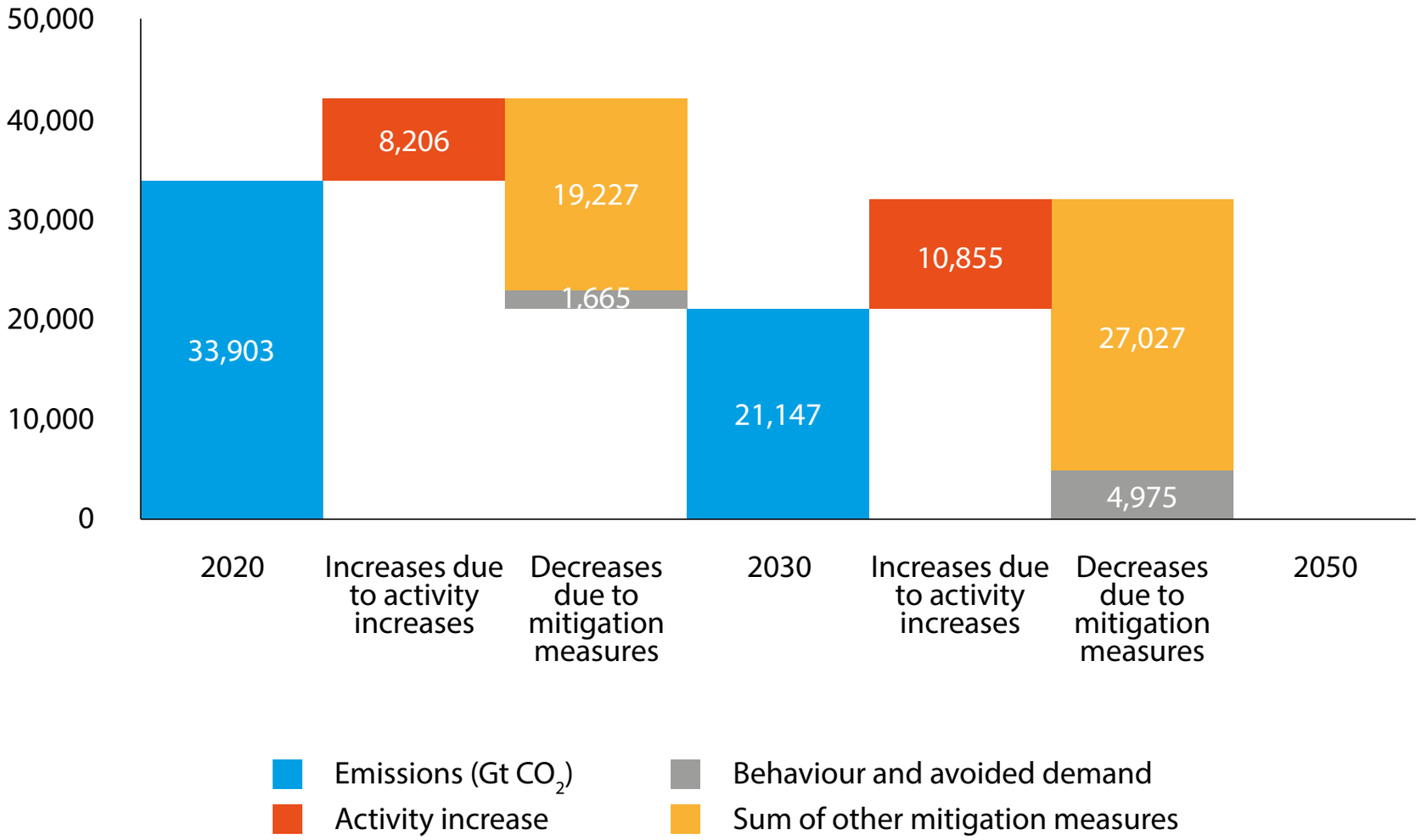
5.3 Need to foster behavioural change

In theory, emissions from energy production could be sufficiently reduced solely on the back of technology. However, we noted that both declines in energy demand/real GDP and CO_2/energy demand also depend on behavioural changes.

In practice, these will be needed to swiftly and affordably reduce emissions from sources that are more difficult to decarbonise, such as air travel. For instance, in the IEA (2021b) net-zero roadmap, behavioural change accounts for 12.5 percent of global CO_2 reductions between today and 2050 (Figure 4).

Behavioural change can also reduce the cost of the green transition. To appreciate this point, it is useful to compare the EU investment requirements to reach net zero by 2050 estimated by the European Commission under two

Figure 4. Impact of behavioural change in the IEA net-zero roadmap, emission reductions and increases from now to 2050 (megatonnes of CO_2)



Source: International Energy Agency (2021b).

different scenarios: one relying only on technology (1.5 TECH), and one relying on both technology and behavioural changes (1.5 LIFE).

Between 2031 and 2050, the 1.5 TECH scenario requires additional average annual investment of €289.5 billion compared to the baseline, while the 1.5 LIFE scenario requires only €175.7 billion (European Commission, 2018).

Furthermore, the energy sector is responsible for 73 percent of global GHG emissions[14]. This implies that even cutting energy-related emissions to zero would not be sufficient to achieve climate neutrality by mid-century, since the remaining emissions would still exceed the amounts permissible to limit global warming to 1.5°C (UNEP, 2020a).

Other sectors that primarily emit gasses including methane (CH_4) and nitrous oxide (N_2O) for other reasons than energy therefore also have an indispensable role to play in emission reductions. For much of these emissions however, particularly from agriculture and land use, which account for 18.4 percent of the total, technology is not likely to have much impact.

We have not made much progress in decoupling GHG emission from food production (1.0 percent per year since 1990, according to FAO data). As Turner (2020) put it, the technology 'cow' has indeed barely changed over the last millennia.

GHG emissions per kilo of meat from cattle have declined by a mere 0.4 percent per year on average since 1990. They account for 37 percent for all emissions from food production documented by the FAO[15] (FAOSTAT, 2021). A change in diet and the way we use land for producing other goods might thus become necessary.

Bearing this in mind, it is important to consider degrowthers' warnings of rebound effects. If policies to reduce emissions through investments in renewables and efficiency gains achieve positive income effects or too optimistic perceptions, a narrow focus on certain sectors could leave room for harmful effects from increased emissions elsewhere. This could offset at least part of the progress made in emission reductions from energy[16].

5.4 Need to develop and scale-up negative emission technologies

All IPCC emission pathways, including the one on which we based our calculations in sections 2 and 3, consider net CO_2 emissions, with reductions from agriculture, forests and other land use.

Reforestation, afforestation, habitat and soil management can be used to remove CO_2 from the atmosphere, provided that increased efforts are made in these areas. This is why gross emissions can remain small but positive in a net-zero situation.

Unlike the conservative pathway we used, most of the IPCC pathways (IPCC, 2018) also rely significantly on human-made negative emission technologies. They allow for greater remaining CO_2 emissions from activities that are hard to decarbonise when reaching climate neutrality by mid-century and beyond, as these are offset by more carbon removal.

This in turn means that the high required decoupling rate of around 9 percent becomes somewhat lower, which would make a difference in the feasibility of net-zero by mid-century.

This is controversial among climate scientists, however. Negative emission technologies are currently under development or in early small-scale implementation and are not on track to being ready in time (IEA, 2021c).

Furthermore, many scientists are sceptical about the feasibility and viability of certain technologies and are even worried that they may create numerous other serious environmental problems because of potentially high input requirements.

Governments should encourage the development of both natural and technological solutions but should be keenly aware that negative emission technologies cannot be a substitute for actual, immediate emission abatement.

5.5 Need to adapt our economies to unavoidable climate change

Global efforts to reduce GHG emissions are aimed at limiting global warming to 1.5°C, thus minimising dangerous climate change.

Unfortunately, with average temperatures already more than 1.0°C above pre-industrial levels (IPCC, 2018) climate change is already upon us. Natural disasters, most of which could be linked to climate change, reportedly caused $210 billion of damages worldwide in 2020[17] (Munich Re, 2021).

Structural change such as desertification and shifting seasonal patterns are already visible. Occasional and structural damages are bound to get worse and more frequent as temperatures rise to 1.5°C or 2°C in a mitigated scenario, let alone if we do nothing. For regions closer to the equator, climate change may become a matter of life and death, and political and other spillovers are to be expected.

It is therefore imperative that in parallel to mitigation efforts, investment in climate adaptation should accelerate. Coastal areas, often densely populated, will have to improve their flood defences, while many regions, in particular urban areas, simultaneously will have to save potable water for dry spells.

Buildings and cities need to be adapted to cope with sometimes much higher temperatures, while forests must be managed to minimise fire hazard. Rural areas will need to change their sources of income if certain crops become difficult to cultivate and tourist destinations lose their appeal.

Like mitigation, climate adaptation measures are good investments. For instance, in a scenario with 3°C of global warming or more, the PESETA IV study by the European Commission (2020c) estimated that installing reservoirs to reduce flood risks in Europe will save €40 billion per year by 2100, for a yearly investment of only €3.3 billion up to then.

Annual damages of up to €220 billion by 2100 can be avoided if we start investing less than €2 billion in the protection of our coastlines. The analysis suggests that such investments will still be worthwhile in a scenario with only 2°C of global warming.

It is important to realise the sizable returns to adaptation, as annual adaptation costs in the developing world alone are estimated to be between $140 billion and $300 billion in 2030, while those of developed countries are even higher (UNEP, 2020b).

6 Conclusions

In order to avoid global warming in excess of 1.5°C above pre-industrial levels, global GHG emissions must be rapidly reduced. Doing this without losses in economic prosperity will not be easy: so far, decoupling GHG emissions from GDP growth has been slow or absent.

This is seen as justification for degrowth scholars to propose a radical overhaul of our economic system. Yet this approach seems unrealistic. Asking for lower growth, let alone negative growth, would mean that large parts of the world could not develop, or only at the expense of even harsher degrowth in developed countries.

Low-income countries will obviously not follow this advice and the notion of redistributing income from rich to poor countries is also unrealistic.

The real question therefore becomes whether decarbonisation efforts can be accelerated. While global emissions have not declined, GHG emissions from developed economies such as the EU have, despite continued economic growth.

The data also shows that the speed of decoupling of emissions and growth has accelerated in the world. The efforts to reduce the carbon intensity of energy in many economies have contributed to a steep decline in the prices of renewable energy technology, which has improved the economic case for rapid decarbonisation worldwide.

Belief that further innovation and investment will enable the world to successfully reach climate neutrality by 2050 without reducing welfare underlies the green-growth narrative advocated by most governments and international organisations.

The direction and pace of technological progress are impossible to predict. Neither the degrowth hypothesis as the only approach to achieve climate neutrality by 2050, nor the green-growth hypothesis can therefore be credibly excluded ex ante. However, as we argued in the previous section, there are important actions governments can take to enhance the likelihood that green growth is achieved.

Ultimately, if stringent emission targets are taken as a given, the choice to pursue green growth, degrowth or something in between is a choice about how much one is willing to trust in technology and how much one wants to hedge against the adverse effects of declining GDP.

Both rely on untested ideas. The only certainty is that we should firmly commit to sticking to stringent targets no matter which path is chosen, and policy should evolve accordingly.

As the *Stern Review* (2007) put it, in the long run the benefits of strong climate action will outweigh the costs of climate action. ■

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Endnotes

1. See for example https://www.theguardian.com/environment/video/2019/sep/23/greta-thunberg-to-world-leaders-how-dare-you-you-have-stolen-my-dreams-and-my-childhood-video, accessed 15 July 2021.

2. The remaining emissions arise from agriculture (11.2 percent), land use (7.2 percent), industrial processes (5.2 percent) and waste (3.2 percent) (see https://www.climatewatchdata.org/ghg-emissions). While this paper focusses mostly on GHG emissions from energy, the more difficult part of emissions reduction and sustainability in general may in fact be making the necessary changes in how we use natural resources to feed and dress ourselves. More on this in section 5.

3. Energy production is what causes emissions, but the variable that must be impacted by policy is energy demand. We assume production is equal to demand and use IEA data on total primary energy supply to represent both. For IEA definitions see https://www.iea.org/commentaries/understanding-and-using-the-energy-balance

4. From here on we switch from showing data on total GHG emissions to data on CO_2 emissions for reasons of data availability and comparability to theoretical emission pathways. Since we focus on emissions mitigation in the energy sector, this is not an oversimplification: CO_2 represented 91 percent of global GHG emissions from energy in 2018 (CH4: 8.6

percent and N_2O: 0.8 percent), and the energy sector accounts for 93 percent of global CO_2 emissions (industry: 4.1 percent and LULUCF: 3.3 percent) (see https://www.climatewatchdata.org/ghg-emissions). LULUCF = land use, land-use change and forestry.

5. Loosely based on the LED/P1 pathway of the IPCC (2018), which uses neither carbon capture and storage technology (CCS) nor bioenergy with CCS (BECCS), technologies that are currently under development and that degrowth scholars deem unfit for climate change mitigation.

6. Decoupling is slowest in developing and emerging countries, where the carbon intensity of GDP is mostly higher than in Europe today. Between 1990 and 2016 the average yearly decoupling rate in India was -2.4 percent, in Africa -2.1 percent, in China -1.8 percent and in South America -1.1 (based on OWID data). It is important to note here that most of these countries had vastly lower levels of carbon intensity of GDP than developed countries throughout most of the previous century and have contributed much less to the current stock of CO_2 in the atmosphere. Nevertheless, as these economies increase their shares of world GDP, faster decoupling will become increasingly important. It is not for this paper to review the vast discussion on international climate justice and the degree to which different parts of the world, because they have increased the global stock of CO_2 in the atmosphere, should decouple more quickly.

7. "Development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (World Commission on Environment and Development 1987, p. 41).

8. It lay at the basis of global ecological policy thinking of the next few years, such as at the Earth Summit and in the Rio Declaration in 1992, which explicitly called for economic growth to address environmental problems.

9. The SDGs indeed also include 'Decent Work and Economic Growth' as SDG8.

10. Adding to the confusion is lack of clarity about the baseline against which growth is usually compared: is it a trajectory based on historical average growth rates or a no-action scenario that includes serious damage from climate change in the long run? This is not trivial, as in comparison to an economy wrecked by runaway climate change, an economy that avoids global warming by growing more slowly or even by shrinking could be on a higher growth path, but this is generally not a scenario considered as 'green growth'.

11. The environmental benefits are sometimes augmented by more short-term co-benefits, mostly through improved health; see Karlsson et al (2020) for an overview.
12. Includes JRC-GEM-E3, E3ME and E-QUEST model estimates.
13. Because of the nature of renewable energy, global supply chains, and the consequences of climate change, as well as the benefits to be had from cooperation in R&D, each of these points should be addressed with international cooperation in mind (see for example Leonard et al 2021).
14. See Climate Watch for historical GHG emissions.
15. See FAOSTAT, Agri-Environmental Indicators, accessed on 20 July 2021.
16. In the absence of a limit or prices on emissions, there can also be rebound effects within the energy sector, for example when people start using more energy because it is becoming cheaper or greener. This means increases in energy demand/real GDP offset decreases in CO_2/energy demand.
17. See 'Record hurricane season and major wildfires – The natural disaster figures for 2020', Munich RE, accessed 24 February 2021.

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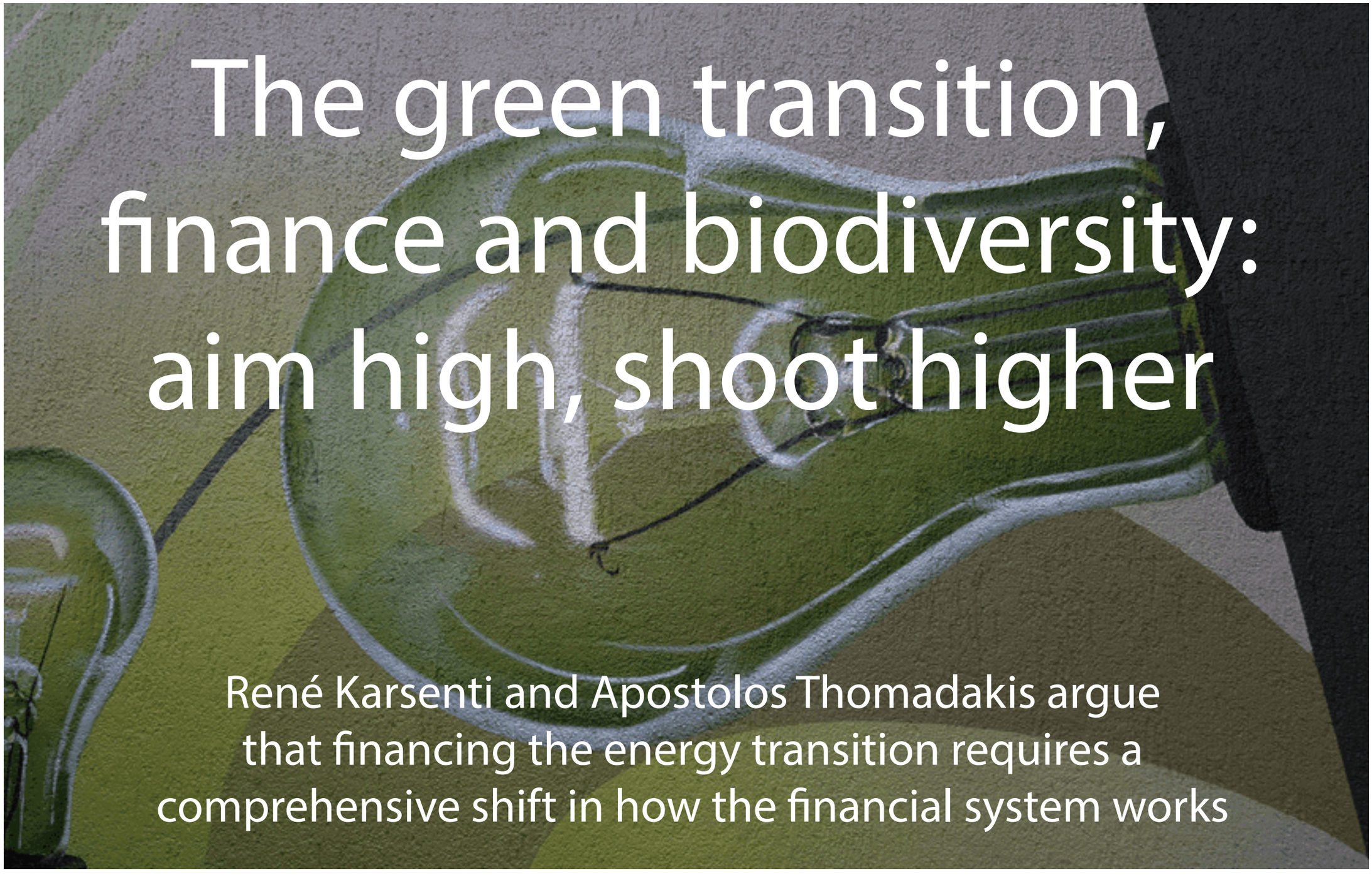
The green transition, finance and biodiversity: aim high, shoot higher



René Karsenti and Apostolos Thomadakis argue that financing the energy transition requires a comprehensive shift in how the financial system works

The urgency to succeed in financing the energy transition and reorienting private capital to sustainable investments requires a comprehensive shift in how the financial system works. The role of major market participants, investors, and policymakers in facilitating this shift is essential. To develop more green and sustainable economic growth, there is a need to:

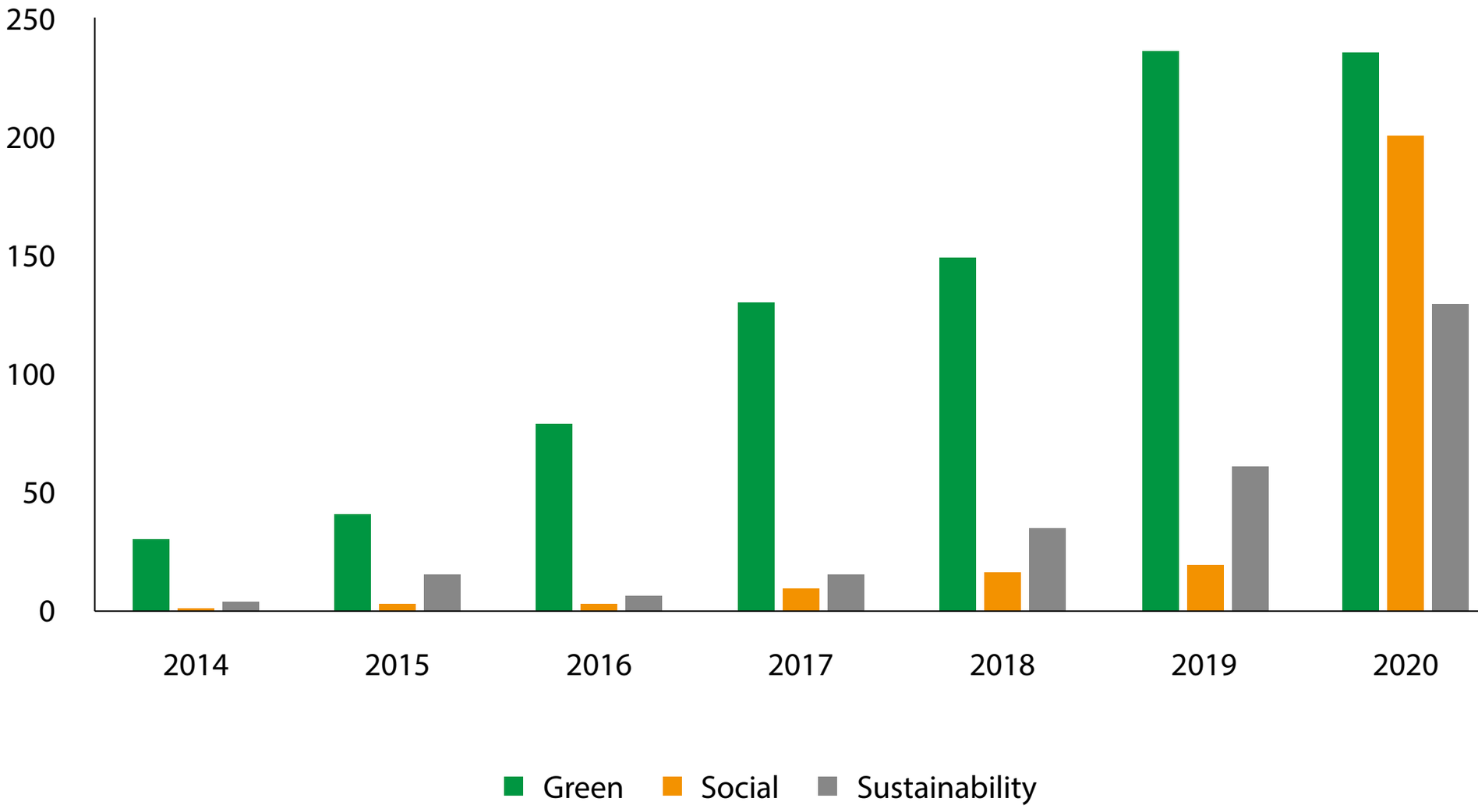
1. broaden access to the market through innovation and diversification;
2. further develop global standards and taxonomies;
3. enhance disclosure and reporting;
4. fully incorporate fintech and digitisation;
5. fully address biodiversity and nature-related risks

Beyond its quasi-moral obligation, mobilising finance for the energy transition is a historic opportunity, especially for the EU to act and lead as a true pioneer, that should not be missed.

Fifteen years ago, green, social and sustainability bonds (or sustainable bonds, collectively) were non-existent, while the green issuance volume was still a miniscule share of the bond market. Institutions such as the European Investment Bank (EIB), the World Bank Group (WBG), the International Capital Market Association (ICMA), and the International Finance Facility for Immunisation (IFFIm), have been trailblazers and put forward several significant initiatives.

As a result, building on such and other subsequent initiatives, the market has grown exponentially and moved from an aggregate issuance of €35 billion in 2014 to €568 billion in 2020 (see Figure 1). Today, the total value of outstanding sustainable bonds is at €1.6 trillion[1].

Figure 1. Global issuance of green, social and sustainability bonds (€ billion, 2014-2020)



Note: The process followed by the CBI to classify a green bond as eligible covers the following steps: i) identification of climate- themes and self-labelled debt; ii) screening sectors and green credentials to determine if the proceeds will finance eligible green expenses/assets/projects/activities; iii) evaluating the use of proceeds threshold. For more information on the Green Bond Database Screening Process, see here.
Source: Climate Bonds Initiative.

In the shadow of the pandemic

The COVID-19 pandemic has caused colossal damage since the beginning of 2020. It has been estimated that the cumulative cost to the global economy in 2020-21 would be over €10 trillion[2]. More importantly, it has pushed hundreds of millions of additional people into poverty across the world, while it has disrupted progress towards achieving the United Nations (UN) Sustainable Development Goals (SDGs)[3].

The decade ahead promises to be exciting, with new tools, participants, practices, and standards coming to the fore that will help us to navigate the climate transition

But, at the same time, it made clear the important role that capital markets play in intermediating capital to rebuild shattered economies. Indeed, the pandemic has served as an accelerant for growth in the sustainable bond markets. sustainable bond issuance totalled around €411 billion in the first half of 2021, nearly a 60% year-on-year growth from H1 2020[4].

In particular, social issues have gained momentum and emerged as a key instrument in financing a post-COVID 'sustainable recovery'. This segment represented 36% of the total sustainable bond issuance in 2020, up from 6% in 2019.

This is a remarkable development since the creation of the first IFFIm Vaccine Bond in 2006. Although many were concerned that the focus on social bonds would detract from progress in the green bond market, in fact the complete opposite has been the case.

Green and environmental considerations have been hard-wired into the countries' post-COVID programmes, both on the funding and disbursement side. What's also noticeable is that more than 95% of the sustainable bonds issued in 2020 reference ICMA's Green and Social Bond Principles[5].

Despite these positive developments, more needs to be done. Below we identify five key areas in which renewed focus should be given. For the remainder of this particular piece we will concentrate primarily on the fifth and final area.

- Broaden the market through innovation and the diversification of market participants and products in the green and sustainability space[6].

- Develop global standards further and ensure taxonomies are as harmonised as possible – in close consultations with market players – to avoid fragmentation.
- Enhance disclosure in reporting by issuers and investors, including on their climate transition strategy to generate even more confidence and robustness[7].
- Incorporate fintech and digitalisation as the main driving forces for the development of capital markets[8].
- Fully address biodiversity and nature-related risks, which has been identified as one of the top five risks in terms of likelihood and impact in the coming 10 years[9].

Assessing the risks

To effectively address biodiversity, it is important to first distinguish nature-related risks from climate change-specific risks, and then to find ways to properly measure them. Nature-related risks (encompassing biodiversity loss and ecosystem degradation) and climate-related risks, are both essential components for the accurate assessment of environmental risks.

Although they are highly interconnected, at the same time they are distinct from each other. Nature-related risks broadly refers to the risks to an organisation posed by the linkages between its activities and the natural world[10]. These can be shorter-term risks, as well as longer-term risks arising from its impact and dependency on nature.

On the other hand, climate change risks can be categorised into two broad categories, those risks related to the physical impacts of climate change (eg. acute risk, chronic risk), and risks related to the transition to a lower-carbon economy (eg. policy and legal risks, technological risks, market risks, reputational risk)[11].

However, some of these risks have been carried over into nature-related risks – namely physical (eg. the loss of mangrove swamps), transition (eg. the closure of soft drinks plants in India due to their impact on water

shortages), and litigation (eg. bond investors taking legal action against a Californian energy utility company for misrepresenting the risks of wildfires).

Moving into the measurement of such risks, Gross Domestic Product (GDP) has so far failed to clearly capture the depreciation of changes in biodiversity[12]. Nevertheless, according to the World Economic Forum (WEF), half of global GDP in 2019 was moderately or highly dependent on natural capital[13].

Although the depreciation and loss of natural capital has been a primary source of 'economic growth', it has not been taken into account in the calculations. Thus, there is need to capture the true value (or 'accounting prices')[14] of natural capital. This will allow for accurate measurements of the financial costs and risks and avoid further rapid destruction of our common biodiversity.

Developing comprehensive risk measures beyond the impact on GDP, are critical for market participants in their investment decisions. Banks and investors may be adversely affected by climate change risks, for example by holding the sovereign bonds of countries that are highly dependent on the over-exploitation of natural resources. In a case like this, the risk is under-priced by the market and needs to be clearly assessed and reported.

There is also need for a new set of international impact-weighted accounting standards, similar to the introduction of the international accounting standards after the 1929 Great Depression.

In essence, a standardised tool to measure the net impact that companies have on both the environment and people. More generally, although metrics that incorporate nature loss into risk models already exist[15], there is no single and widely accepted method for measuring biodiversity foot printing. Risks are far from negligible.

A 2018 assessment exercise found that 13 of the 18 sectors in the FTSE 100 (at that time having a total of approximately €1.4 trillion in net market capitalisation) have a high dependence on natural capital (including assets such as forests, water, fish stocks, minerals, biodiversity and land)[16].

This poses significant challenges to achieving the sustainable development objectives and poverty reduction.

Global commons – a radical proposition?

The long-term objective is to bring aggregate demand in line with aggregate supply; meaning that global demand must equal the biosphere's ability to meet the supply on a sustainable basis. This so-called 'impact equation' illustrates how the biosphere can heal itself over a set period[17].

But the current rate of depletion, driven by activity to create physical and human capital, threatens our fundamental life support system – the natural environment.

Perhaps a more visionary – and at the same time controversial – proposal for preserving natural capital, calls for the creation of a global Commons Fund (Dasgupta, 2021)[18]. Such an initiative would require an international organisation to monitor and manage forms of natural capital as global public goods.

This would be similar to the way the World Bank advances the cause of global economic development, and to the International Monetary Fund (IMF) when it comes to the rescue during instances of financial instability.

Global commons are like the Seven Seas – no one pays for their use as long as access to them is free. Such a rather controversial proposal might essentially entail the introduction of a new form of rent, to be collected through a

global organisation. The money raised would pay the compensation required to prevent further deterioration of the natural world.

However, this should not be perceived as an additional taxation to financial preservation, but instead as a way in which the global commons could (themselves) generate the funds needed to restore natural capital (ie. the air, water and land).

Conclusions

In 2015 Mark Carney – at that time Governor of the Bank of England – warned about "*the tragedy of the horizon*" and highlighted the important role of finance in accelerating short- and long-term climate change[19].

Progress in green and sustainable finance has been impressive since then, while the COVID-19 pandemic has proven its importance going forward.

The decade ahead promises to be exciting, with new tools, participants, practices, and standards coming to the fore that will help us to navigate the climate transition. The future of finance should be green and sustainable.

But to achieve this, it needs to be mindful of its environmental and social impacts, invest in the future, and also protect the ecosystem, and save lives. Let's not miss the opportunity to make a real and lasting impact. ■

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Endnotes

1. Based on data from the Environmental Finance Bond Database, accessed on September 9, 2021.

2. See IMF (2020), "World Economic Outlook Update: A Crisis Like No Other, An Uncertain Recovery", June, International Monetary Fund.

3. Latest estimates put the number of newly poor people as a consequence of COVID-19 in 2020 to rise to between 119 and 124 million. See WB (2021), "Global Economic Prospects", June, World Bank.

4. See the Climate Bonds Initiative's Sustainable Debt Market Summary for H1 2021.

5. See Green Bond Principles (GBP) and Social Bond Principles (SBP).

6. The last few months have proved to be a period of remarkable innovation, with the launch of the ICMA's Sustainability-Linked Bond Principles last June and the Climate Transition Finance Handbook in December.

7. There is a need for a new set of international Impact-weighted accounting standards, similar to the introduction of the international accounting standards after the 1929 Great Depression. This would be a standardised tool to measure the net impact that companies have on the environment and on the people.

8. A striking commonality between FinTech and sustainability is the need for common standards and harmonisation. FinTech could be used to develop common platforms, particularly in the sustainable finance sector for oversight, to facilitate comparability, and provide dynamic insights into environmental, social and governance (ESG) performance and reporting. For data providers, regular and more frequent ESG reporting is paramount to harness analytics and create greater transparency.

9. See WEF (2020), "The Global Risks Report", 15 January, Word Economic Forum. Moreover, it has also been advocated by market participants and investors through the United Nations' Principles for Responsible Investment (PRI), as well

as the international alliance Act4Nature, while it is one of the six environmental objectives under the EU Taxonomy which is central to the EU's Biodiversity Strategy 2030. Other important initiatives towards this direction include: the Natural Capital Financial Facility (NCFF), a partnership between the EIB and the European Commission which has already resulted in the EIB issuing a Sustainability Awareness Bond with a biodiversity theme in early January, the Taskforce on Nature-related Financial Disclosures (TNFD), the Finance for Biodiversity (F4B) which proposes a dedicated international Nature and Climate Sovereign Bond Facility, the Biodiversity Finance Initiative (BIOFIN), and the Sustainable Blue Economy Initiative. More recently, it was released in the UK as part of the Dasgupta Review on the Economics of Biodiversity, commissioned in 2019 by HM Treasury.

10. See the TNFD (2021), "Nature in Scope: A Summary of the Proposed Scope, Governance, Work Plan, Communication and Resourcing Plan of the TNFD", June, Taskforce on Nature-related Financial Disclosures.

11. See TCFD (2017), "Recommendation of the Task Force on Climate-related Financial Disclosures", June, Task Force on Climate-related Financial Disclosures.

12. See Dasgupta (2021), "Economics of Biodiversity: The Dasgupta Review", February, HM Treasury.

13. See WFE (2020), "Nature Risk Rising: Why the Crisis Engulfing Nature Matters for Business and the Economy", January, World Economic Forum.

14. A capital good's accounting price refers to the contribution an additional unit of it would make to the flow of social benefits.

15. Such as the Exploring Natural Capital Opportunities, Risks and Exposures (ENCORE) tool, developed by the Natural Capital Finance Alliance (NCFA), or the Integrated Biodiversity Assessment Tool (IBAT).

16. This is based on NCFA's ENCORE database.

17. See footnote 11.

18. Such a proposal might be carried by the UK to the 26th United Nations Climate Change Conference of the Parties (COP26) taking place later in November, and promoted more widely.

19. See "Breaking the Tragedy of the Horizon – Climate Change and Financial Stability", speech on 29 September 2015.

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The Global Gateway: a real step towards a stronger Europe in the world

Disappointment at the lack of fresh cash from EU global connectivity strategy is short-sighted. Simone Tagliapietra says Europe supports global development more than any other country in the world

On 1 December 2021, the European Union unveiled the Global Gateway, its plan to support infrastructure development around the world. This would mobilise €300 billion between 2021-2027 for connectivity projects, notably in the digital, climate and energy, transport, health, education and research sectors.

The rationale behind this initiative is clear: the world needs major infrastructure investments. The World Bank estimates that to achieve the goals of climate and environmental protection, universal access to energy, water and sanitation, greater mobility, and improved food security, the world must invest around €1.3 trillion per year in infrastructure.

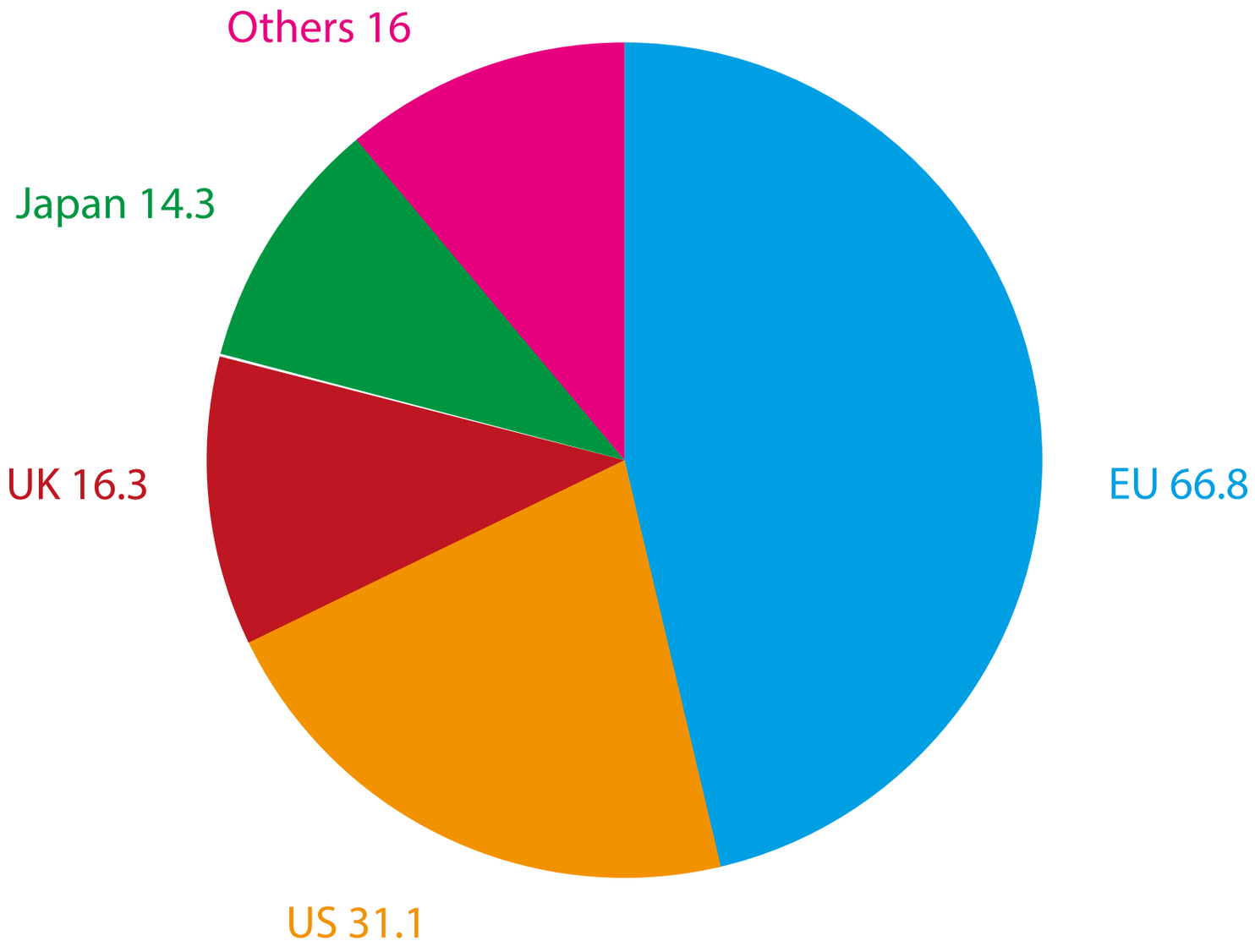
Alternatives to the Belt and Road Initiative

China understood the strategic importance of global infrastructure development when it launched the Belt and Road Initiative in 2013. To provide an alternative to the Chinese approach to global infrastructure development, some G7 leaders committed in June 2021 to *"a values-driven, high-standard, and transparent"* set of infrastructure partnerships: the US's Build Back Better World, the UK's Clean Green Initiative and the EU's Global Gateway.

The European Commission pitched the Global Gateway as *"a template for how Europe can build more resilient connections with the world"*, but critics quickly attacked the initiative, claiming it represents a repackaging of existing instruments rather than fresh EU cash.

However, this view misses the point. The EU and EU countries are already the world's leading providers of official development assistance (ODA). In grant equivalent (a methodology in which only the grant elements of loans are reported, instead of their full-face values), Europe disbursed €66.8 billion in 2020, 46% of world's total (Figure 1). What Europe really needs is not new resources, but to use existing ones more strategically.

Figure 1. Official Development Assistance (ODA) in grant equivalent in 2020 (in billions of euros)



Source: Bruegel from OECD.

To further put things into perspective, between 2014 and 2018 the EU and EU countries provided around €350 billion in ODA grant equivalent, while the Belt and Road Initiative (BRI) – against which the Global Gateway is being compared – provided around €200-€400 billion in loans, according to different estimates of the American Enterprise Institute and UNCTAD. Given that a grant represents a much bigger financial contribution than a loan, Europe's role as a donor is thus more significant than that of China or any other country.

In geopolitical terms, the Global Gateway can help the EU better position itself in the global infrastructure and connectivity race

Reducing fragmentation in EU global action

The problem is that EU action in the field is fragmented into countless initiatives, undertaken at both EU and national levels. As clearly outlined by the High-Level Group of Wise Persons on the European financial architecture for development, this has led to overlaps, gaps, inefficiencies and lack of geopolitical stance.

The EU has recently taken two steps to reduce this fragmentation and increase the coherence of its external action.

1. It has combined its funding for the neighbourhood and international development into a unique instrument, the Neighbourhood, Development and International Cooperation Instrument (NDICI), endowed with €79.5 billion for the period 2021-2027.

2. It has launched the 'Team Europe' package, which combines resources from the EU, EU countries, the European Investment Bank (EIB) and the European Bank for Reconstruction and Development (EBRD), to provide around €40 billion to partner countries to deal with the health and socio-economic consequences of the pandemic.

The Global Gateway, which will also be delivered via Team Europe initiatives, represents another important step in this process of consolidation of Europe's development finance, and an important one because of its focus on the strategic issue of infrastructure development and connectivity.

The real question will be how well strategic coordination between EU countries and EU institutions and financial institutions will work. The attempt to improve that coordination is positive, but whether it will succeed remains to be seen.

On the grants-versus-loans discussion, it is also important to flag that the loans provided in the framework of the BRI have often contributed to economic instability in the initiative's partner countries. There is evidence that BRI lending practices have increased indebtedness to alarming levels in some partner countries.

Even before COVID-19, the World Bank estimated that nearly a third of the initiative's partner nations were at high risk of debt distress. BRI doubtless represents one of several factors behind this debt pressure, but there are clear examples of its megaprojects having significantly worsened the macroeconomic situation of several countries, including Djibouti, Kyrgyzstan, Laos, Maldives, Mongolia, Montenegro, Pakistan and Tajikistan.

A working paper analysing the financing of 100 Chinese projects overseas highlighted that *"cancellation, acceleration, and stabilization clauses in Chinese contracts potentially allow the lenders to influence debtors' domestic and foreign policies."*

The Global Gateway in numbers

€300 billion: this is the overall investment that the initiative seeks to mobilise between 2021 and 2027. Lack of fresh EU funds aside, there is scepticism about the ability of EU guarantees to really crowd-in private investment. This represents a classical criticism of EU guarantee schemes, where the leverage effect is generally between 10-15.

For instance, the Juncker Plan sought to leverage €315 billion of private investments on the basis of €21 billion of EU guarantees (a factor of 15), while the investment framework of the recently launched NDICI seeks to leverage €500 billion of private investments on the basis of €53 billion of EU guarantees (a factor of 10). In comparison to these crowding-in factors, the expected leverage factor of the Global Gateway is a lot smaller: the EU component is foreseen to mobilise €135 billion of private investment on the basis of €40 billion of EU guarantees (a factor of 3.4) (Box 1).

Box 1. The financial structure of Global Gateway

Global Gateway aims to mobilise infrastructure development investments of up to €300 billion in the period 2021-2027. This sum is composed of:

- €135 billion in investment foreseen under the European Fund for Sustainable Development plus (EFSD+), where the EU provides €40 billion in guarantee capacity – of which €26.7 billion via EIB and €13 billion via a EFSD+ new window dedicated to Global Gateway, targeting national financing and development finance institutions.
- €18 billion in grants under other EU external assistance programmes.
- €145 billion in planned investments by EU countries' financial and development finance institutions.

Existing programmes such as the Pre-Accession Assistance (IPA) III, Interreg, InvestEU and Horizon Europe will also be used to mobilise resources under Global Gateway.

To add to this financial tool kit, the EU is exploring the option of creating a European Export Credit Facility to complement existing credit arrangements by EU countries and increase its overall firepower in this area.

Source: Bruegel from the European Commission.

This looks reasonable, as what private investors want before they invest in developing countries is just political risk insurance. After all, the World Bank and other development banks have always made an extensive use of guarantees to mobilise private-sector resources for development projects.

In this respect, the Global Gateway, with its focus on limiting risks of debt distress in partner countries, seems to provide a more reliable alternative for global infrastructure development.

First, as already mentioned, the EU funding model is a mix of grants, soft loans and guarantees aimed at crowding-in private sector investments, while the BRI exclusively focuses on loans.

Second, the EU requires partner countries to adhere to the rule of law, upholding high standards of human, social and workers' rights, as well as a respect for international norms and standards of intellectual property. This contrasts with China's lending practices, where contracts often include stabilisation clauses challenging human rights and sustainable development policies.

Lending contracts of both the China Development Bank and the China Eximbank include stabilisation clauses that *"create carve-outs within the rule of law, limit the borrower's self-governance, and potentially block state-of-the-art environmental, public health, labor, and other potentially vital and popular regulations."* This might also help explain why the BRI is perceived negatively in certain countries.

Beyond money: focusing on expertise and technical support

It is also important to underline that the Global Gateway has a strong focus on expertise, alongside financial assistance. This is important, because creating an enabling environment to attract investment in partner countries with support for reform of regulatory frameworks, or technical support for the development of infrastructure

projects, is important to ensure the scale and long-term durability of development actions, beyond individual infrastructure projects.

Global and domestic benefits

Infrastructure investments are the material way of turning sustainable development goals into practice. Climate action requires renewable energy plants, power grids and electric vehicle charging infrastructure, in the same way that health requires hospitals, education requires schools or connectivity requires ports. By promoting Europe's values in the world, the Global Gateway can thus also become the export arm of a new EU industrial policy.

It can help meet the EU's international pledges, such as on climate finance, by supporting partner countries in the implementation of their sustainable development agendas. It can enable EU industry to enter new growing markets, a win for EU industrial policy. On top of this, it can help economic development in the EU's partner countries, providing an invaluable foreign policy dividend for the EU.

In geopolitical terms, the Global Gateway can help the EU better position itself in the global infrastructure and connectivity race. Rule-based cooperation focused on a clear set of priorities represents an attractive alternative to the BRI in several partner countries, starting in Africa.

By scaling up cooperation on economic and social infrastructure projects, the EU thus has an opportunity to promote its values and vision of sustainability in a way that is tangible and long-lasting. The main challenge will be to align all European players to cooperate and share these strategic goals. ■

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Better sustainability data needed

To accelerate the low-carbon transition in capital markets investors need trustworthy sustainability data. Alexander Lehmann says regulators should remain alert to misconduct in capital markets

Capital reallocation towards sustainable investments is viewed as essential to Europe's low-carbon transition. The European Union has already developed global standards with its taxonomy of sustainable activities and disclosure rules applying to financial market firms.

But data on the environmental, social and governance (ESG) characteristics of companies, which are used extensively in asset management, remain a source of much frustration, and are increasingly in the regulators' spotlight.

ESG quality means many things to many investors

ESG-focused investment has been a key trend in capital markets over the past two years. Outside the United States, the share of ESG-dedicated retail funds has jumped to 13% of total assets under management (though this share is only 1.5% within the US).

While many existing funds have been simply re-labelled as sustainable by excluding certain industries, a big boost to this expansion came from EU requirements under the 2019 Sustainable Finance Disclosure Regulation (SFDR, (EU) 2019/2088) to label sustainable investment funds as either promoting positive environmental or social practices (so-called Art. 8 funds), or having such factors as their primary investment objective (Art. 9 funds).

Ratings and metrics that measure the ESG qualities of companies guide investor capital allocation and risk management. A metric for the environment pillar in an overall ESG score could for instance be based on carbon emissions, energy efficiency, other pollution or investment in low-carbon technologies.

Computation of such data is of course based on extensive subjective judgements about which metrics to include, how to weigh data and what amounts to acceptable or desirable benchmarks in individual industries.

Unlike for credit ratings, which is an opinion on a company's ability and willingness to pay, there is no well-defined ESG outcome that confirms the initial assessment. History is a poor guide to climate risks.

The ESG data industry is undergoing a rapid expansion and is changing as methodologies are improved. The product offering has broadened beyond ratings and rankings and now includes screening services, indices and benchmarks. Data inputs and raw company data are a major constraint, though the accounting bodies are rapidly developing sustainability standards.

The understanding of ESG performance and data to measure it will continue to evolve within an industry that is both competitive and innovative

For now, EU plans for more detailed and wider corporate sustainability disclosures, perhaps accessed through a centralised data platform, offer little immediate benefit to investors and data providers.

Technological innovations are rapidly evolving and may fill some of these gaps, also for smaller companies. New tools draw on earth observation data, automated analysis of company reports, and carbon footprint accounting based on payments data.

For financial markets to function efficiently, data should be of uniform quality, updated regularly and free from bias: eg. arising from company size, geography or industry. Current ESG data falls well short of this ideal.

Divergence between ratings from different providers can be attributed to the inclusion of different categories, different measurements and different weighting, and also to the rating provider's other unrelated assessments of the same company.

A portfolio of securities highly rated on issuers' ESG scores is not necessarily one with low carbon emissions. A high score in the 'E' pillar may not equate to low carbon emissions, as good intentions and forward-looking transition plans are often taken into account.

Will ESG data repeat the credit ratings debacle?

It all sounds similar to credit ratings, which played a major role in fuelling excessive investment in mortgage-backed securities ahead of the global financial crisis.

The current surge in sustainable investing could lead to a green bubble and erosion of the quality of investment advice and sales practices, which are familiar from earlier boom-bust cycles.

No doubt, the boom in sustainable investment products can give rise to new patterns of market misconduct, which is the traditional realm of securities markets supervisors, such as the European Securities and Markets Authority.

Misconduct could take the form of mis-selling (of products inappropriate for the end-investor's sustainability preferences) or misrepresentation (the deliberate distortion of true sustainability characteristics). Greenwashing securities is one form of the latter, in which marketing is used to portray an organisation's products, activities or policies as environmentally friendly when they are not.

Better ESG data that is transparent and explained clearly to end-investors could stem this practice, though in the first instance the capital market or intermediary (the asset manager or broker) is at fault.

The European Commission may be emboldened to examine ESG data and data providers given its experience of regulating credit ratings. It was the first major jurisdiction to do so after the global financial crisis, with comprehensive rules, designed to address conflicts of interest and inadequate credit rating methodologies, taking effect in 2013.

Yet, the parallels are more limited than they appear. ESG data does not have the same significance in financial regulation as credit ratings once did. There is also not the same degree of industry concentration, which could give rise to correlated rating actions.

Indeed, the ESG industry seems highly competitive as start-ups enter and new products are offered, though mergers of ESG data providers with established credit rating agencies should be watched.

The EU is particularly concerned by greenwashing in the context of its plan to expand green assets as a core component of its still nascent capital markets union. The confusion over ESG data could indeed deter institutional and retail investors (even if data is properly disclosed but poorly understood), or lead to capital misallocation in a green bubble (in which key risks are not reflected in the data).

In July 2021, the European Commission therefore set out to examine how ESG risks are reflected in existing credit ratings, which are already regulated, and also whether the ESG industry itself warrants regulation. Other market regulators are looking at the same issue; the International Organisation of Securities Commissions is developing guidance.

The Commission's approach

Two central tenets of capital market regulation are that the characteristics of financial instruments should be explained transparently, and that the preferences of end-investors must be taken into account in any sale. Retail investors traditionally benefit from additional protection and higher standards of disclosure.

In its efforts to strengthen the integrity of ESG investing, the EU should in the first instance hold brokers and asset managers accountable for any market misconduct, whether due to the poor use of ESG data or otherwise.

The European Securities and Markets Authority and national supervisors already have the legal basis for closer scrutiny, though may need to be better resourced in their enforcement actions.

This needs to be backed up by strong audit functions at national level, which should expose governance failures in capital market issuers.

ESG data is the new currency of sustainability-based investing and is indeed integral to this strategy. The underlying methodologies and the way data is integrated into the investment process will reflect the diversity of investor views. An ESG score may or may not impact credit quality but established rating agencies should demonstrate that they take such factors into account.

Providers of ESG data and sustainability ratings are legitimate targets for regulators where conflicts of interest, market dominance or poor disclosure of methodologies are concerned. The understanding of ESG performance and data to measure it will continue to evolve within an industry that is both competitive and innovative. Better products should be allowed to emerge in the marketplace, not defined in regulation. ■

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Monetary policy during an atypical recovery

The economy is back from the brink, but not completely out of the woods. Christine Lagarde says the euro area is going through a highly atypical recovery

The economy is back from the brink, but not completely out of the woods. After a highly unusual recession, the euro area is going through a highly atypical recovery. This atypical recovery is leading to rapid growth, but also to supply bottlenecks appearing unusually early in the economic cycle. It is also causing inflation to rebound quickly as the economy reopens. And it is helping to accelerate pre-existing trends and new structural changes brought about by the pandemic, which could have implications for future inflation dynamics.

But it is important today to take a step back. To understand how monetary policy should operate in this environment, we need to recognise where we have come from and where current trends suggest we are going. As John Maynard Keynes wrote, policymakers must always *"study the present in light of the past for the purposes of the future."*

We are coming from a decade of strong disinflationary forces that have depressed the whole inflation process. And while the robust recovery is supporting underlying inflation trends, what we are seeing now is mostly a phase of temporary inflation linked to reopening. Structural changes could create both upward and downward pressures on prices.

So, we still need an accommodative monetary policy stance to exit the pandemic safely and bring inflation sustainably back to 2%.

The inflation process before the pandemic

In the decade before the pandemic, inflation across advanced economies consistently surprised on the downside. The inflation process appeared to have slowed down along the transmission chain: from activity and employment to wages, and then from wages to prices. This was largely down to three factors.

First, gauging the true level of slack in the economy became harder[1]. Estimates of structural unemployment were consistently revised down as the economy strengthened[2]. And even as unemployment came down, many more people were drawn into the labour market, especially women and older people[3].

Second, structural changes in labour markets meant that receding slack fed more slowly into wage growth. Employment increased rapidly after 2013 but was mainly channelled into lower-paying jobs[4]. In parallel, global forces – such as globalisation and automation – reduced workers' bargaining power[5].

The pandemic has caused a recession like no other, and a recovery that has few parallels in history. The inflation response reflects the exceptional circumstances we are in. We expect that those effects will ultimately pass

Third, when wage growth did eventually pick up, firms were reluctant to pass on cost increases to consumers. Instead, we saw firms squeeze their profit margins[6]. This also reflected broader structural trends such as the digitalisation of services and the expansion of e-commerce[7].

Recession and reopening

Then, the pandemic hit, which led to a highly unusual recession followed by a highly atypical recovery.

In conventional business cycles, the depth of the slump normally determines the pace of the recovery. After exceptionally deep recessions, both demand and supply are often impaired for many years. From the onset of the great financial crisis, for example, it took seven years for euro area GDP to get back to its pre-crisis level. Growth never reconnected with the trend we thought possible before 2008.

But during the pandemic, though GDP saw its steepest collapse on record, the overall economy has reopened largely intact[8]. We now expect GDP to exceed its pre-pandemic level by the end of this year – three quarters earlier than we forecast last December – and it should come close to reconnecting with its pre-crisis trend in 2023. From its trough, the recovery in GDP is the steepest in the euro area since 1975.

This outcome is largely attributable to the combined response of monetary and fiscal policy, which has preserved both demand and supply. For instance, real labour income fell by 3.6% in 2020, but household real disposable income dropped by only 0.2%, because government transfers filled the gap. This is in stark contrast with the sovereign debt crisis, when disposable income fell by 2% year-on-year.

The atypical nature of the recovery is creating frictions in the economy, which can produce opposing effects on growth and inflation.

In certain sectors, supply shortages are holding back production, which is unusual so early in the business cycle. ECB analysis finds that exports of euro area goods would have been almost 7% higher in the first half of this year were it not for supply bottlenecks[9]. These risks to growth could mount if the pandemic continues to affect global shipping and cargo handling as well as key industries like semiconductors.

At the same time, the reopening is also pushing up inflation, which reached 3% in August and is expected to rise further over the coming months. Higher inflation today is largely the result of two exceptional effects.

First, inflation collapsed last year when lockdowns were imposed, which is creating strong base effects as activity recovers. Half of total inflation in the euro area today is due to energy prices, which are making up the lost ground from 2020. Base effects from last year's German VAT rate cut and the unusual timing of sales periods are also playing a role.

In fact, the low inflation rate last year and the high inflation rate this year equal, on average, the inflation rate observed in 2019 before the pandemic. So the price level now is roughly the same as if inflation had remained stable at its pre-pandemic level.

Second, imbalances between demand and supply in some sectors are pushing prices up.

Goods inflation rose to 2.6% in August, well above its historical average of 0.6% as – in addition to base effects – global supply chain disruptions met a sharp recovery in demand for durable goods[10]. Consumption of durables is already 1% above its pre-crisis trend[11], while shipping costs are around nine times higher today than in June last year.

Services inflation has also been rising – to 1.1% in August[12] – and it would have reached 2% using the consumption weights of last year, slightly above its historical average. This is also largely the result of demand returning to the sectors hardest hit by the lockdowns. Inflation in high-contact services accounts for virtually all of the rise we are seeing in services.

Once these pandemic-driven effects pass, we expect inflation to decline.

Base effects should drop out of the year-on-year calculation early next year, although we are seeing further increases in oil and gas prices.

It is harder to predict how long supply chain disruptions will last, but their ultimate impact on inflation will depend on how persistent they are and whether they feed through into higher than anticipated wage rises. Following the Japanese earthquake and nuclear disaster in 2011, production is estimated to have returned to normal after seven months for Japanese firms[13]. However, given the special nature of the pandemic and the recovery, it cannot be excluded that the resolution of supply-side bottlenecks may take longer now.

Monetary policy should normally 'look through' temporary supply-driven inflation, so long as inflation expectations remain anchored. Indeed, we are monitoring developments carefully but, for now, we see no signs that this increase in inflation is becoming broad-based across the economy. A 'trimmed mean'[14] of inflation – which removes the items with the highest and lowest inflation rates – stood at 2.1% in August. Furthermore, wage developments so far show no signs of significant second-round effects.

Inflation expectations also do not point to risks of a prolonged overshooting. Long-term market-based measures have risen by around 50 basis points since the start of the year – to around 1.75%[15] – and survey-based measures

have risen slightly to 1.8%[16]. This represents a move in the right direction. But it is still some distance away from our symmetric 2% target.

Inflation dynamics beyond the pandemic

In fact, looking beyond the pandemic, we expect inflation to only slowly converge towards 2%.

This is visible in the outlook for underlying inflation, which is a good indicator of where inflation will settle over the medium term. We currently project core inflation – which is one measure of underlying inflation – at 1.5% in 2023. Our survey of monetary analysts also points to a gradual convergence of inflation, which is expected to climb to 2% and stabilise at that level only five years from now[17].

This partly reflects the continuing pull of the structural factors that depressed inflation before the pandemic. But the pandemic has also created some new trends, which may have implications for the inflation outlook. Let me point to three.

The demand side

The first relates to changes on the demand side of the economy. Historically, core inflation in the euro area has mostly been driven by services inflation, which has contributed 1.1 percentage points to the long-term average of 1.3 percentage points. This is both because services have a higher weight in consumption[18], and because goods inflation has been held down by global forces of automation and competition.

Services inflation is closely linked to the strength of the domestic economy. It depends heavily on wage growth, as wages make up around 40% of the inputs for consumer services – double the share for goods. And robust domestic demand is crucial for a strong pass-through from wages to services prices[19].

So the key question today is whether the transition out of the pandemic could lift the outlook for domestic demand and thereby contribute to more dynamic services inflation. Here we see forces that point in different directions.

First, owing mainly to lockdowns, households are sitting on a large stock of savings that they have accumulated during the pandemic. Our new consumer expectations survey suggests that households are not currently planning to spend those savings. But this might change if the economy continues along a dynamic recovery path, causing people to adjust their risk assessment.

Indeed, research suggests that consumption is influenced by people's past experience of recessions, and the previous recessions in the euro area hit consumers especially hard[20]. From the onset of the great financial crisis and the sovereign debt crisis, it took seven years for consumption to get back to where it was at the start of 2008.

But by the end of 2022, we expect consumption to be almost 3% above its pre-pandemic level. And if that positive outlook is appropriately supported by the right policy mix, it could produce a virtuous circle, where people become more optimistic, upgrade their expectations of future income, and then spend more of the savings they have built up. This would help close the output gap from the demand side and put upward pressures on wages.

At the same time, there are forces that point to a slower pick-up in services inflation. As I said in my speech here last year[21], there are limits to how much services can be consumed, meaning they are unlikely to benefit from the same kind of pent-up demand as goods. At the end of the second quarter, services consumption was still about 15% below its pre-pandemic trend, even as restrictions were being eased.

The pandemic has also produced considerable slack in the labour market. Employment is now recovering quickly, but we have so far observed that labour force participation is rising even faster. This is good news for the economy,

but it also means that we expect unemployment to fall below its pre-crisis level only in the second quarter of 2023, and wages to grow only moderately.

The supply side

The second trend is related to changes on the supply side of the economy.

The pandemic has delivered a major shock to global supply chains and domestic labour markets. It has significantly accelerated the process of digitalisation – by seven years in Europe, according to one estimate[22]. And it may have distributional consequences that lead to changes in social contracts[23].

In the long run, some of these changes might dampen inflationary pressures.

For example, digitalisation could trigger a second wave of globalisation based on the virtualisation of services. It might lead to higher trend productivity, which could temper unit labour cost growth even as wage growth becomes stronger. And it could also shift activity more towards digital 'superstar' firms that have considerable market power and whose pricing is less sensitive to the business cycle[24].

But over the coming years, there is also a chance that prices will be pushed up.

For instance, today's supply shortages may induce firms to diversify their supply chains or re-shore some of their production. Previous pandemics like SARS were found to have had this effect[25]. That process could lead to higher cost structures that prioritise resilience over efficiency, which are then passed on to consumers. Geopolitics might also interfere in trade patterns and accelerate these shifts.

In parallel, faster digitalisation in Europe could initially create skill mismatches and scarcities, leading to wage increases even in the presence of persistent slack. The rate of job reallocations in major economies is estimated to double between 2019 and mid-2022[26]. This dynamic could also be reinforced by a renewed focus on inequality, which could lead to upward pressure on wages via rising minimum wages[27].

The green transition

The third trend – which is probably the most important yet least explored – is the green transition, the shift towards a low-carbon economy.

The pandemic has given the green transition a boost. It could lead to an accelerated increase in auction prices in the EU Emissions Trading System, the introduction of carbon prices covering a wider range of economic activities, and the adoption of a Carbon Border Adjustment Mechanism – all of which could have a direct inflationary impact.

The Network for Greening the Financial System estimates that implementing ambitious transition policies in Europe could gradually increase inflation relative to its previous trend by up to one percentage point over the transition period, before returning to that trend[28].

The green transition is also likely to make the pass-through of energy prices to consumer prices more complex. As energy supply shifts towards renewable sources, it will no longer be sufficient to look mainly at oil prices: we will also have to understand the energy mix and how the different sources are linked and can be substituted for each other.

Renewable energy in the euro area has increased from 5% of total available energy in 1990 to about 15% today. Similarly, the share of natural gas has increased from 17% to 24%. Oil, meanwhile, has dropped from 43% to 38%.

The ongoing rise in natural gas prices is testament to the complexity this creates, as that rise partly reflects unusually low wind energy production in Europe this summer and the need to fill the gap with conventional energy sources that can be mobilised quickly.

This, in turn, is having knock-on effects on other industries that rely on natural gas, like fertiliser manufacturing, and the industries that are dependent on by-products of fertiliser production, such as food packaging.

So we will need to understand these various transmission channels better. The impact of the green transition on inflation will ultimately hinge on the development of energy supply and the net effects of fiscal measures.

The increased use of natural gas to stabilise electricity production is only a bridge technology and will over time subside as new technologies for energy storage and distribution are more widely deployed. And the impact of carbon pricing will depend on whether the additional revenue is used to cut other consumption taxes, such as electricity taxes or VAT, directly support vulnerable groups or foster green investment.

If it is not, there is a risk that higher carbon pricing might reduce purchasing power and lead to relative price changes that push down underlying inflation. Research finds that introducing carbon taxes in euro area countries tends to raise headline inflation but lower core inflation[29].

Policy implications

So how should monetary policy behave in this environment? The key challenge is to ensure that we do not overreact to transitory supply shocks that have no bearing on the medium term, while also nurturing the positive demand forces that could durably lift inflation towards our 2% inflation target.

Our new forward guidance on interest rates is well-suited to manage supply-side risks. This guidance ensures that we will only react to improvements in headline inflation that we are confident are durable and reflected in underlying inflation dynamics. And the fact that inflation can move moderately above target for a transitory period allows us to be patient about tightening policy until we are certain that such improvement is sustained.

In terms of supporting demand, our monetary policy will continue to provide the conditions necessary to fuel the recovery. Indeed, our forward guidance has already led to a better alignment of rate expectations with our new inflation target, while helping to strengthen inflation expectations, which lowers real interest rates.

We expect to see further progress toward an even tighter alignment between the expected time of lift-off for our policy rates and the most likely inflation outlook as markets continue to absorb the rationale and key purpose of our forward guidance.

All this should provide a decisive boost to private spending once the uncertainty brought about by the pandemic fades, especially given the new investment needs created by the green and digital transition. The European Commission estimates that we need to see investment of around €330 billion every year by 2030 to achieve Europe's climate and energy targets[30], and around €125 billion every year to carry out the digital transformation[31].

Going forward, the contribution of fiscal policy, and therefore the appropriate policy mix, will remain important. Fiscal policy is likely to stay supportive, with the cyclically-adjusted primary balance expected to be -4.1% this year, -1.6% next year and -1.5% in 2023. But the scope of pandemic-related fiscal transfers will need to change from a blanket-based approach to a more targeted action plan.

Fiscal policy will need to be surgical, meaning focused on those who have suffered particular hardship. It will need to be productivity-enhancing, meaning that it facilitates structural changes in the economy and shifts activity towards future-oriented sectors, and delivers on the agreed reform programmes under the Recovery and Resilience Facility. And, taking a medium-term perspective, fiscal policy will need to follow a rules-based framework that underpins both debt sustainability and macroeconomic stabilisation.

For our part, monetary policy is committed to preserving favourable financing conditions for all sectors of the economy over the pandemic period. And once the pandemic emergency comes to an end – which is drawing closer – our forward guidance on rates as well as purchases under the asset purchase programme will ensure that monetary policy remains supportive of the timely attainment of our medium-term 2% target.

Conclusion

The pandemic has caused a recession like no other, and a recovery that has few parallels in history. The inflation response reflects the exceptional circumstances we are in. We expect that those effects will ultimately pass.

But the pandemic has also introduced new trends that could affect inflation dynamics in the years to come. Those trends could produce both upward and downward price pressures. So, monetary policy must remain focused on steering the economy safely out of the pandemic emergency and lifting inflation sustainably towards our 2% target. ■

Christine Lagarde is President of the European Central Bank

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The challenges of the digital euro

Denis Beau argues it is unlikely that banks will be erased from a future payments landscape in which stablecoins and central bank digital currency dominate

Over the past two years, most central banks around the world have been giving increasing thought to the idea of creating a digital form of their currency, a central bank digital currency (CBDC), to maintain the stabilising role of central bank money in a rapidly changing payments landscape: according to the BIS, about nine out of ten central banks have reported that they have launched studies.

To date, only two retail CBDCs have been introduced (in Caribbean archipelagos: the Sand Dollar in the Bahamas and DCash for the Organisation of Eastern Caribbean States), but over twenty pilot projects are underway around the world.

This observation naturally raises questions about the timing, form and role of central bank money in tomorrow's payments landscape and about the role of banks and commercial bank money in a world of stablecoins and central bank digital currencies.

From my point of view as a central banker responsible for ensuring that our payment system functions properly, it is difficult to answer these questions on the role of banks with anything other than caution yet confidence for two main reasons, on which I would like to focus my remarks at this point.

First, the stability of our payment system does not rest solely on our ability to make our central bank money available in digital form, and second, the effective introduction of such a digital currency raises complex problems that cannot be solved to the detriment of commercial banks in order to produce the expected effects.

1. The stability of our payment system does not rest solely on our ability to provide a CBDC

Changes in payment expectations and habits resulting from the digitalisation of our economies, the implementation of new technologies such as distributed ledgers, the emergence of new players such as fintechs

and big techs, and the development of the use of new settlement assets such as cryptoassets are likely to profoundly alter our euro payments ecosystem.

These innovations have the significant potential to improve the functioning of our payment system, in particular by making payment means simpler, easier and cheaper to use, and faster if not instantaneous.

My conviction is that, given the way in which investigations are being conducted into a digital euro [...] it is unlikely that banks will be erased from a future payments landscape in which stablecoins and central bank digital currency dominate

However, these innovations also carry risks for the smooth functioning of our payment system. In order to fully understand the scope of these risks, I believe it is important to recall the organisational principles of our payment system, which are at the root of its efficiency and stability.

a. The organisational principles of our payment system

The first is the dominance of currencies linked by a legally binding rule of convertibility at par: central bank or public money, and commercial or private money, issued by regulated financial sector players, first and foremost banks.

The second is that only central bank money is legal tender and must therefore be accepted by all.

The third is the complementary roles played by the dominant currencies: central bank money fulfils an integrating and anchoring function that guarantees the efficiency and stability of our payment system, while commercial money, and the services associated with it, which are traded on a highly competitive market, plays a key role in trade and the financing of the economy.

b. The risk of calling into question the foundations of the efficiency and stability of our payment system

However, these foundations are threatened by the diffusion of innovations across the payments field, which has been sped up by the health crisis and social distancing, if no measures are taken to preserve them.

Indeed, the reduction in the use of banknotes for transaction purposes and the prospect of the development, within the networks of the major global players in digital services, of cryptoassets as a means of payment, whose link with central bank money is complex and fragile, to say the least, if not non-existent for some, are likely to call into question the integrating and anchoring role that central bank money plays in our payment system.

These threats are reflected in a rise and a change in the dimension of the risks that any wave of innovation naturally carries, and which the health crisis has helped to amplify.

First of all, there are risks of a setback in terms of efficiency. Two risks are likely to change in scope:

- The risk of fragmentation of the payment system, both for everyday trading and between financial players due to a lack of secure and efficient structural interconnection, through convertibility at par between cryptoassets and central bank money, between old and new payment solutions.

- The risk of concentration, or even the emergence of monopolistic situations for the benefit of global digital giants and their private settlement assets, and therefore of Europe's increased dependence in terms of payment services vis-à-vis foreign players, with the associated issues of personal data protection and industrial and monetary sovereignty.

Then there are risks of a setback in terms of security. Prior to the health crisis, the risks of financial instability associated with the large-scale use, as a means of payment, of cryptoassets with unstable value, uncertain convertibility into central bank money, and without a responsible issuer and credible lender of last resort in the event of a destabilising shock, had been clearly identified.

With the crisis and the acceleration of the digital transformation, IT risk, and in particular cyber risk, has taken on a new dimension and added an operational dimension of systemic importance to the risk of financial instability, which also concerns cryptoassets.

c. Levers for action

For a central bank such as the Banque de France, which is responsible for ensuring the smooth functioning of our payment system, the objective is thus to make sure that innovations deliver the expected benefits for users in terms of speed, cost savings and ease of use, but without undermining the efficiency and stability of our overall payment system.

As a result, at the Banque de France, we are not ruling out that we might need to issue a digital form of our currency, to preserve the anchoring role of central bank money by providing it in a form that is better suited to the new, highly digitalised payments landscape.

This is why we have taken an ambitious experimental approach to a CBDC: we are currently in the process of finalising our programme of experiments on an 'interbank' or 'wholesale' CBDC, to test whether and how it could improve the performance, speed, transparency and security of transactions between major financial players, especially for cross- border payments.

In parallel, the Banque de Franceis closely involved in the investigation phase launched by the Eurosystem in July for the retail digital euro, which would be used by the general public in everyday payments.

However, a CBDC is not the only, or indeed the most urgent instrument we need to use.

We also regard regulation as a priority, because the smooth functioning of our payment system depends, first and foremost, on a regulatory framework that is clear, fair ('same activity, same risk, same rule') and balanced – in other words capable of encouraging innovation and at the same time maintaining the stability of our payment system.

This is why we have welcomed and are supporting the proposed Markets in Crypto-Assets (MiCA) regulation and the Digital Operational Resilience Act (DORA), presented in September 2020 – even though there is still room for progress on these texts in order to reconcile pragmatism and flexibility with the necessary requirements in terms of risk control and the prevention of regulatory arbitrage.

Moreover, other regulatory changes will have to be introduced which are also very important. I'm referring in particular to the supervision of the development of decentralised finance, where the usual regulatory frameworks are constrained by the fact that issuers and service providers are not easily identifiable in an environment where protocols are automatically executed without intermediaries, and there is no fixed jurisdiction for the services offered.

Lastly, in order to be effective, regulation must be multidimensional and coordinated at national and international level. At the Banque de France, we are very attached to coordination with other national and European regulators, which seems all the more essential given the increasingly cross-cutting nature of the issues.

This is also a priority for us, to limit regulatory arbitrage or indeed prevent it altogether. For this reason, we are closely involved in the work of multilateral fora (G7, G20, FSB, CPMI), especially on cryptoassets and the improvement of cross-border payments. Another action we see as a short-term priority is to facilitate and accompany initiatives by regulated players, which can help to foster a diverse and competitive market for efficient solutions, tailored to user needs.

Our institutions – such as the Banque de France's Lab, its Infrastructure, Innovation and Payments Directorate (DIIP), the ACPR's Fintech-Innovation Uni with its ACPR-AMF Fintech Forum – are fully mobilised to facilitate these initiatives and help them grow.

Among these initiatives, three in particular are worth highlighting. First, those in the field of instant payments, which open a new chapter in the payments industry. Second, the continuing development of open banking, thanks to the European financial sector's work on APIs. And last but not least, the European Payments Initiative (EPI).

Some major decisions on the effective launch of EPI are due to be taken in the next few weeks. But I would just like to remind you here that the Banque de France fully supports this initiative, as do the other Eurosystem national central banks and the European Commission, and currently seven EU member states, including France, that publicly announced their support for the initiative in a statement published on 9 November.

2. The introduction of a CBDC raises complex issues that need to be resolved without penalising banks in order to produce the desired effects

The second reason why we should take a cautious but confident approach to the role of banks in a world of stablecoins and CBDCs relates to the challenges that need to be met to ensure the digital euro contributes positively to the European financial system and payments landscape.

a. Avoiding disruptive effects for financial intermediaries

This implies making complex economic, financial, technical and organisational choices, to avoid generating disruptive effects for financial intermediaries that would conflict with our mandate to safeguard monetary and financial stability.

These disruptive effects could materialise in two ways:

- First, if the introduction of a CBDC were to lead, in normal periods and in periods of stress, to the conversion of a large share of bank deposits into assets held in CBDC.

A reduction of this size in deposits would have serious consequences. It could undermine banks' profitability and their ability to meet regulatory requirements, and ultimately affect their capacity to finance the real economy.

- The issuance of a CBDC could also reduce the role of banking intermediaries in client relationships, depending on the architecture chosen by the Eurosystem, which could restrict access to client information. To avoid these undesirable consequences, it is essential that commercial banks be involved. Their input is needed, for example, to set limits and/or remuneration disincentives for CBDC holdings.

In addition, choosing an intermediated architecture would allow us to exploit financial intermediaries' expertise in customer interface management, and thus preserve the essential role they play in this field.

b. Avoiding impediments to the conduct of monetary policy

Choices will also need to be made to avoid any adverse consequences for monetary policy conduct. The introduction of an unremunerated retail CBDC with no holding limit could make it difficult for central banks to pursue a negative interest rate policy, as market participants would prefer to hold the CBDC instead of assets remunerated at negative rates. This effect could be avoided by setting an appropriate level of remuneration for the CBDC.

c. Improving the efficiency and integration of payment solutions

Choices will also need to be made to ensure that the CBDC complements existing payment solutions, so that it can increase the efficiency and integration of certain market segments. This notably applies to cross-border payments. The work conducted under the aegis of the G20, in which the Banque de France played a leading role, has

confirmed that a CBDC can bring benefits in this area. However, to fully exploit this potential, central banks will need to coordinate their efforts to ensure that CBDCs in different jurisdictions are interoperable.

In its experiments on a wholesale CBDC, the Banque de France tested the main multiple-CBDC arrangements identified in the literature. As described in the report published by the Banque de France on 8 November, these experiments showed the different ways in which CBDCs can be made interoperable and highlighted the benefits of a CBDC in a cross-border setting (eg. more efficient correspondent banking, settlement security).

Lastly, choices will need to be made so that the CBDC interacts smoothly with private initiatives such as the EPI project, in order to strengthen the integration of the European payments market.

Conclusion

I would like to come back to a question that comes up regularly, about the future role of banks and commercial bank money in a world of stablecoins and central bank digital currencies and respond with one conviction and one wish. My conviction is that, given the way in which investigations are being conducted into a digital euro, which I have just summed up here, it is unlikely that banks will be erased from a future payments landscape in which stablecoins and central bank digital currency dominate.

My wish is that banks will assist the ECB and Eurosystem central banks in conducting these investigations, so that we are ready when needed to roll out a digital euro that can be a positive addition to the European payments landscape. ■

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The present and future of money in the digital age

The digital euro is an ambitious goal that can improve the efficiency of the financial system. Fabio Panetta says we must make it a driver of stability and inclusive progress

The topic of this article – the present and future of money in the digital age – has certain unique features. It is an age-old topic, because we have been talking about money for millennia, from the times of Ancient Greece and pre-Republican Rome. But at the same time it is a topical issue, because the digital revolution is transforming the role and the nature of money.

It is a subject for specialists: economists, lawyers, and technology experts. Yet it concerns each and every one of us. We all use money in one form or another – every day, and often several times a day. And we are all involved in the changes currently under way.

At the international level the digitalisation of money and payments is being examined by the G7 and the G20. In Europe, it is frequently discussed by Finance Ministers in the Eurogroup. It is on the agenda of the European Commission and the European Parliament. It was addressed by the heads of state or government at the Euro Summit last March. And it is of course central to the agenda of the European Central Bank (ECB).

This strong focus can be explained by the far-reaching changes that are under way. Digitalisation is changing the way we work, interact with each other and use our time. It is changing consumption habits, social relations, and our very culture. It is, in effect, changing the way we live.

Money and payments are also undergoing rapid change. Innovative tools are emerging. Not so long ago, cash was more or less the only way to make an immediate purchase. Today, however, we have grown accustomed to using forms of private digital money such as online bank transfers, payment cards and applications on our smart phones or watches. These are changes that directly affect the role of central banks.

In October the Eurosystem opened the investigation phase for the possible introduction of a digital euro: electronic money issued by the central bank.

If a digital euro were issued, it would have significant consequences. It would have not only economic and financial repercussions, for instance as regards the transmission of monetary policy, financial stability, and the operation of the international monetary system. It would also have wider relevance for global geopolitical equilibria and the fundamental rights of individuals, such as the right to privacy.

The digital euro project can be a success if we can ensure effective multi-level cooperation. Public authorities will have to work closely with private operators – consumers, intermediaries, firms and merchants – to understand their needs and how to meet them

I will illustrate the key characteristics and implications of this new money. And I will then discuss how we can maximise its benefits and reduce its risks.

The digital euro: what it is (and isn't)

The digital euro would be a form of sovereign money provided by the ECB in electronic format. It would be used by anyone – households, businesses, commercial outlets – to make or receive retail payments throughout the euro area. It would give citizens the same services they now obtain from paper banknotes: access to a secure payment instrument that is cost-free, easy to use and universally accepted within the euro area.

The digital euro would complement cash, not replace it. It would provide people with fuller and easier access to electronic payments, promoting financial inclusion. Unlike cash, it could be used not just for people to transfer money to each other or for purchases in commercial outlets, but also for online purchases. And as it would be a central bank liability, the digital euro would, like banknotes, be free of any risk, be it market risk, credit risk, or liquidity risk.

Cryptoassets and stablecoins[1]

The digital euro has nothing to do with cryptoassets such as Bitcoin. As it would be issued by the central bank, the value of the digital euro would be guaranteed by the State.

Cryptoassets, on the other hand, are not issued by any accountable entity: they are notional instruments with no intrinsic value, which do not generate income flows (such as coupons or dividends) or use-value for their owners. They are created using computing technology and their value cannot be ensured by any party or guarantee.

Cryptoassets are exchanged by operators whose sole objective is to sell them on at a higher price. They are, in effect, a bet, a speculative high-risk contract with no supporting fundamentals. That is why their value fluctuates wildly; hence cryptoassets are not fit to perform a currency's three functions: means of payment, store of value and unit of account.

The value of cryptoassets is growing rapidly and currently stands at over 2,500 billion dollars[2]. That is a significant figure with the potential to generate risks to financial stability that shouldn't be underestimated. For example, it exceeds the value of the securitised sub-prime mortgages that triggered the global financial crisis of 2007-2008.

In spite of the substantial sums involved, there is no sign that cryptoassets have performed, or are performing, socially or economically useful functions. They are not generally used for retail or wholesale payments, they do not fund consumption or investment, and they play no part in combating climate change.

In fact, there is clear evidence that they do the exact opposite: cryptoassets can cause huge amounts of pollution and damage to the environment[3]. And they are widely used for criminal and terrorist activities, or to hide income from the eyes of the tax authorities[4]. Moreover, they provide legitimate investors with no protection whatsoever against IT or cyber risks[5].

On the whole, it is difficult to see a justification for the existence of cryptoassets in the financial landscape.

The digital euro also differs from stablecoins.These are digital instruments whose value is linked to that of a portfolio of low-risk assets (reserve assets) such as currencies or securities. Without appropriate, rigorous regulation, stablecoins too are unfit to perform the functions of money: as they are low-risk but not risk-free, they are particularly vulnerable to possible runs in the event that holders experience a loss of faith[6].

Their dissemination could influence monetary policy implementation and undermine the efficiency of the securities markets[7]. For example, one of the most widespread stablecoins promises 'stability' by investing in low-risk assets such as commercial paper, and holds a large proportion of the stock of these instruments in circulation.

In a situation of stress, large-scale sales of assets in response to a sudden increase in redemptions could generate instability throughout the commercial paper market. This phenomenon could spread to other stablecoins and related sectors, eventually finding its way to the banks that hold the stablecoins' liquidity.

These risks could be amplified by a lack of transparency around the composition of reserve assets, by a lack of checks on conflicts of interest between issuers and holders of stablecoins[8], by cases of fraud[9] or mismanagement[10], and by the link between stablecoins and cryptoassets[11].

In sum, stablecoins are not therefore so 'stable', and that's why I have previously referred to them as 'unstable coins'[12]. In fact, a third of stablecoin initiatives launched on the market in recent years have not survived[13].

The risks posed by stablecoins would be reduced if reserve assets could be held entirely in the form of risk-free deposits at the central bank[14]. However, this would limit monetary sovereignty as one of the key tasks of the central bank – money creation – would in effect be delegated to private operators. They would perform that task with the aim of maximising profits, rather than fulfilling public interest objectives such as inflation control and the cyclical stabilisation of the economy.

Furthermore, the use of money would become expressly or implicitly onerous. This would affect access to a vitally important service which central banks have been providing to citizens for centuries on behalf of the State for free and in the general interest.

If they are kept within a framework of effective rules and checks, some privately issued digital finance instruments can increase the efficiency of payments, especially international payments. Europe is at the forefront of regulation, supervision and oversight of digital finance[15].

In countries outside Europe calls for stricter controls are becoming louder[16]. But the largely uncontrolled development of digital finance – in particular decentralised finance[17] – and cross-border interlinkages mean that further action at the global level would be desirable.

In the circumstances I have described, a digital euro would bring stability to the world of digital finance.

Why we need central bank digital money

For the ECB, the need to explore the introduction of a digital euro arises from the evolution of people's payment habits. The way we make our purchases has been changing, especially since the start of the pandemic[18]. Two trends are emerging.

The first is the tendency to use digital instruments[19]. Many of us regularly make payments using cards or apps on our mobile devices.

The second is online shopping. Consumers are buying goods and services – food, clothing, package holidays – not only in bricks and mortar local shops, but more and more on the internet[20].

Cash is increasingly used as a store of value and decreasingly as a means of payment[21]. The cash stock has continued to increase, driven by the precautionary demand for cash. However, only about 20% of the stock is now used for payment transactions, down from 35% 15 years ago.

Cash purchases are therefore decreasing. If this trend were to continue, banknotes would eventually lose their central role and become a marginal means of payment. Even central banks' efforts to continue to supply banknotes would not be enough to preserve that role in the face of insufficient demand for cash as a means of payment. Citizens could therefore lose a simple, safe and reliable means of payment that is provided for free by the State and universally accepted.

This would create a need to introduce a public digital currency.

But let me say, first, that not everyone agrees with this hypothesis. Some people feel that public digital currency would be redundant, given the vast supply of private electronic payment instruments available[22]. But this theory fails to recognise the central role of public money (that is, central bank money) in the economy[23].

Confidence in savings held as private money is largely determined by the strength of central bank money – the monetary anchor – and by the convertibility of private money into public money.

Central bank money is a safe form of money that is guaranteed by the State, by its strength, its credibility and its authority. Other forms of money consist of private operators' liabilities[24]; their value is based on the soundness of the issuer and is underpinned, in the last analysis, by the promise of one-to-one convertibility with risk-free central bank money[25].

This promise can prove to be ephemeral – for example when private issuers manage their capital or liquidity imprudently. It must therefore be repeatedly confirmed through the conversion of private to public money. For instance, our readiness to deposit our money with banks is underpinned by the knowledge that we can go to a branch or cash machine and withdraw cash from our deposits. This tells us that our money in the bank is safe.

It reassures us that we will be able to convert private money (deposits) into public money (cash) in the future too. Bank runs and financial crises start when confidence in the convertibility of private money disappears.

In practice, many people are unaware of the differences between public and private money. This is what economists call 'rational inattention'[26]. However, people know that banknotes protect them from the consequences of intermediaries potentially defaulting and they make their payment and savings choices accordingly.

This does not mean that the safeguards put in place to protect savings – legislation and banking supervision, deposit insurance schemes, capital markets supervision – are not important. On the contrary. They must, however, be flanked by convertibility to ensure the orderly conduct of payments, the stability of the financial system and the soundness of the currency.

Without the anchor of sovereign money, people would have to constantly monitor the safety of private money issuers in order to value each form of money. This would undermine the functioning of the payments system and confidence in savings.

History shows that access to public money is essential to instil confidence in private money, ensure the correct functioning of the payments system and safeguard financial stability. Periods in the past when various forms of private money co-existed in the absence of sovereign money – for example the free banking episodes of past centuries – were marked by recurrent crises[27].

Today, citizens hold central bank money in the form of banknotes. As I mentioned previously, in the future – in a digitalised world – cash could lose its central role. Central banks must therefore ensure that central bank money is fully usable and can retain its role as a payments anchor. That is the primary objective of the digital euro.

Benefits of the digital euro

The digital euro is therefore essential to the orderly conduct of payments in a digital world. But the decline in the use of cash is not the only factor that could transform the payments market. Other factors, also significant, have prompted the ECB to study the issuance of a digital euro[28].

Monetary, financial and political sovereignty

First, there is the need to assert our sovereignty in the monetary and financial fields, in keeping with the goal of safeguarding our strategic autonomy as established by the European Council[29]. The ability to make payments safely and efficiently, without external influence, is a fundamental need for the economy and for society as a whole, especially in a large jurisdiction like the euro area.

Two-thirds of digital retail payments in Europe are currently brokered by foreign operators[30]. Looking to the future, digital currencies issued and controlled outside the euro area – by private actors or foreign countries – could grow in importance, to the point of replacing existing means of payment.

The European financial system would thus be subject to decisions made by foreign actors and this in turn would place our legislative and regulatory powers at risk. A payments system based on technologies and practices designed, managed and supervised elsewhere would undermine the ability of the European authorities to exercise their supervisory control.

Such a system could be under-protected from external threats, including IT threats. It would expose people, businesses and states to the danger of the improper use of confidential information. It would make the information needed to combat unlawful activities harder to trace.

And the list could go on. But it is clear that a payments system and financial sector dominated by foreign operators would be unfit to support the single currency, and simply unimaginable in the world's second economy.

The 'colonisation' of the European payments system is not an imminent danger. But nor is it a remote one, given the speed at which digital finance is changing. Since early 2020 the value of stablecoins in circulation has risen from 5 to 120 billion dollars[31]. At the same time, the Big Tech[32] companies have expanded their financial business.

The convergence of these two tendencies – the growth of stablecoins and Big Tech's expansion in the finance sector – could have a drastic impact on the functioning of financial markets and supplant traditional intermediation and payment services. And that would give rise to the risks I described earlier[33].

To prevent these dangers we need to adjust the regulatory and supervisory framework. But that is not enough. The transformations under way should be governed by providing innovative and efficient financial services capable of meeting the emerging need for immediacy in our society, as well as the more general trend of digitalisation of the economy. The introduction of a digital euro would be a step in that direction.

Sovereignty and the international role of the euro

A digital euro accessible to foreign users would cut the cost of using our currency in cross-border payments and increase its suitability as a global invoicing currency. This would increase the international role of the euro, thereby strengthening Europe's strategic autonomy, lessening the global domination of the dollar and reducing global dependency on a single source of liquidity.

It would strengthen the 'Brussels effect': the influence exerted by the EU on the international stage by asserting and advancing its principles, decisions and institutional and legal practices[34].

ECB analyses show that the effects of this would be significant but less important than the fundamental drivers of the international role of a currency, such as the size of the underlying economy, its economic policies, the development of its capital markets, and the efficiency of its institutions[35].

Protecting confidentiality

Individuals have a fundamental right to privacy, which is enshrined in national and European regulations[36]. In the public consultation conducted by the ECB in 2020, 43% of respondents ranked privacy as the most important aspect of the digital euro, well ahead of other features[37].

Such a focus on privacy comes as no surprise. Misuse of confidential data that can be inferred from payments could lay bare private aspects of our lives such as our political leanings, sexual orientation or state of health.

This could impinge on personal liberties and interfere with the rights of individuals and with the rules that underpin the functioning of a modern liberal democracy.

The data contained in digital payments are frequently used by private companies for various purposes. Some payment companies are moving from a fee-based business model to a data-driven business model in which services are supplied free of charge in order to obtain detailed information on customers.

Digital payments therefore put privacy at risk and may give rise to misuse of confidential information. Data protection regulations aim to prevent abuses but cannot always keep pace with technological innovation, as was demonstrated by the case of Cambridge Analytica.

If it were offered by an independent public institution such as the central bank – which has no interest in exploiting payment data for any purpose – the digital euro would enhance confidentiality in electronic transactions by protecting against unwarranted intrusions.

Sound transparent governance that complies with the national and European regulations would ensure that information on users is only used for permitted purposes, such as combating illicit activities.

Confidentiality is distinct from anonymity[38]. Digital payments could ensure different levels of confidentiality[39], to be defined in line with general interest objectives. The technical experiments conducted by the Eurosystem confirm this possibility.

In any case, cash will remain available. Consumers will be able to continue to make anonymous payments with banknotes if they wish to do so.

Competition and efficiency

The European digital payments market is highly concentrated. Two US intermediaries handle two-thirds of card payments, while another US operator dominates online payments. Digital payments seem to be expensive for many users and are in fact mainly used by people with medium to high incomes.

The digital payments market could become more concentrated in the future owing to the expansion of the big tech firms, which have already shown a tendency to adopt anti-competitive behaviours[40]. Benefiting from their very large number of customers, network effects and economies of scale, these operators could obtain very large market shares[41].

This could cause traditional intermediaries to exit the market and damage competition, leading to an increase in fees and a deterioration in the quality of services with effects on other sectors such as insurance services and credit, and also on commerce itself[42].

In such a context, traditional anti-trust measures may prove to be ineffective given the length of time needed for the investigations and the speed at which the digital economy is advancing.

A digital euro would directly boost competition by making a free and easy to use digital means of payment available to everyone. But it would also have an indirect effect: the option to use the new form of money would allow European intermediaries – including small intermediaries which typically have less capacity for innovation – to offer products with a higher technological content at a competitive cost, making them better able to compete with global operators.

Effects on the monetary and financial system

The digital euro can bring about significant changes in the monetary and financial system which should be analysed in depth in order to assess how to design the new form of money in a way that harnesses its benefits and avoids undesired effects. I will now recall the main topics that are central to the Eurosystem's deliberations.

Monetary policy

Depending on its features, the digital euro could influence monetary policy. One important aspect is the possible application of interest rates. A digital euro earning no interest would replicate the characteristics of cash; with no limits on holdings[43] it would prevent the central bank from applying rates below zero, so savers – by holding digital euro – would avoid negative returns without bearing the risks and costs of owning huge quantities of banknotes.

Conversely, if interest was payable on the digital euro it could strengthen the transmission of monetary policy, but there would be a risk of diverting bank funds.

The impact on monetary policy would also depend on the reallocation of private financial wealth that the digital euro will bring about. Switching funds out of banknotes and into the new form of money would change the composition of central bank liabilities, without other significant effects.

On the other hand, if the digital euro attracted deposits (and the banks did not have the unencumbered reserves to cope with the outflow of funds), it could affect the cost and supply of credit and the transmission of monetary policy through bank balance sheets. The central bank could mitigate or eliminate these effects by increasing refinancing of banks or through asset purchases, thereby expanding its own balance sheet.

This list of possible effects could continue, analysing in greater detail different potential remuneration methods[44], possible compensatory measures and aspects such as the impact on the central bank's balance sheet and on seignorage.

But the main consideration is that the digital euro project does not aim to change how monetary policy is implemented. The changes that it will bring will depend on its features, which should be carefully studied and defined, but they would not interfere with the actions of the central bank.

The banking and financial system

The digital euro could affect banks' activities and the functioning of the financial system. In addition, if it is incorrectly designed, it could result in tensions and instability[45]. This could crowd out banks from the payments market.

In addition, in the absence of limits to its use, it could attract large volumes of deposits. This could make banks' funding unstable and more costly and have a negative impact on their profitability and credit offering. Ultimately, it could affect the real economy.

The risks would be greater in times of crisis. If there were doubts about the soundness of intermediaries, savers could transfer their funds out of bank deposits and to the central bank quickly and free of charge, including for large amounts. This could trigger a 'digital run' on bank branches. The possibility of this happening could encourage savers to reduce their bank deposits, even during normal times[46].

However, these risks would only materialise if the instruments put in place to protect financial stability – banking supervision, deposit insurance and the central bank as the lender of last resort – proved to be ineffective.

Above all, these risks can be kept in check by designing the digital euro in an appropriate manner in order to control its use as a form of investment. The debate on this issue focuses on two scenarios.

The first foresees the setting of a ceiling on the amount of digital euro that can be held by individual users[47], or on aggregate transactions, ie. on a weekly or monthly basis – to limit the outflow of bank deposits into the new form of money[48].

The second is based on a two-tier remuneration system which discourages holding digital euro in amounts above a certain threshold[49].

These constraints would make the digital euro an efficient means of payment available to everyone while ensuring that it would not be used excessively as a form of investment that would crowd out other financial instruments,

particularly bank deposits. Their introduction would remove the risk of instability, thus safeguarding financial intermediation. But in assessing the impact of the digital euro it would be wrong to assume that tomorrow's financial system will be like todays, because it will be different, even without the digital euro.

In the absence of government intervention, the system could be dominated by major global players, primarily big tech, who will be much less concerned than the central bank about the stability of the financial system. If properly designed, the digital euro will therefore avoid worse scenarios, thus conferring stability on the financial system[50].

To ensure the project's success, in order to avoid instability, the digital euro will be introduced in close cooperation with euro area intermediaries who will be authorised to handle the distribution and provision of services to the public, and it will be compatible with the additional services that they offer.

This will stimulate innovation: the new form of money will provide intermediaries with a regulatory infrastructure capable of connecting systems that are currently separate, such as retail payment schemes, the digital identity, the digital signature and electronic receipts.

This would make advanced payment methods available, such as programmable payments, online purchases subject to delivery of the product, payments based on the use of a certain good or service, or automatic cash transfers to and from the government.

Building on these payment innovations, the digital euro can act as a driver for modernising the financial and economic system as a whole and making it more efficient, extending the use of technology in dealings between households, firms, intermediaries and the government.

The international monetary and financial system

A digital euro that can be used without any constraints by non-residents could affect the structure and functioning of the international monetary and financial system through two channels[51]. First and foremost, it could increase the international transmission of shocks and exchange rate volatility, by influencing capital flows[52].

This would occur because its liquidity, low risk and potential rate of remuneration would make the digital euro attractive to international investors, reinforcing the relationship between exchange rates and interest rate differentials – the so-called uncovered interest rate parity – and amplifying portfolio adjustments triggered by monetary shocks.

The effects would be considerable for emerging economies that have strong trade or financial ties with the Single Market, as they would be more exposed to effects stemming from the euro area. These countries' central banks would be forced to take more decisive action in dealing with monetary or real shocks, suffering a loss of autonomy as a result.

Second, the digital euro could spread in third countries to the extent that it would crowd out local currencies, leading to a digital 'euro-isation', which could hamper the transmission of monetary policy and lead to financial instability.

The risks would be greater for emerging economies that have weak currencies and economic fundamentals, and close trade and financial ties[53] with the Single Market and which are integrated into global value chains[54].

Conclusion

The digital euro project can be a success if we can ensure effective multi-level cooperation. Public authorities will have to work closely with private operators – consumers, intermediaries, firms and merchants – to understand their needs and how to meet them.

Only then can we avoid two opposite risks: being 'too successful' and crowding out intermediaries and private financial instruments, or being 'not successful enough' and generating insufficient demand.

As regards ties with private operators, we engage with user discussion groups, with committees made up of banking and payments experts, and with technology experts. For the ECB, the aim of the project is not to enter the retail payments market but to offer an efficient, secure and low-cost form of digital money which intermediaries can use to satisfy citizens' needs.

Our task will be easier if there is genuine cooperation within the private sector itself, between intermediaries in all euro area countries, to launch pan-European payment initiatives capable of offering services across the entire euro area, of strengthening the ability to compete with the major international operators and of consolidating Europe's autonomy.

Cooperation within the public sector is crucial for defining the characteristics of the digital euro and for reconciling the conflicts arising from several objectives: the right of individuals to confidentiality versus the public interest in maintaining the level of transparency required to combat illicit activities; the benefits of allowing the digital euro to be widely used versus the need to safeguard financial intermediation; and the benefits from the widespread international distribution of the new form of money versus the need to avoid instability in other countries.

Some choices relate to monetary policy and the payments system and fall within the remit of the Governing Council of the ECB. Others relate to more general issues, such as the protection of privacy, which require the involvement of Europe's co-legislators. There is already intensive cooperation between the ECB, the European Parliament, the European Commission and the Eurogroup.

Lastly, there is a need for close cooperation at the global level. Around 80 countries are currently assessing the introduction of a digital currency. International cooperation is needed to define shared principles on economic and regulatory issues and to connect the various projects.

This type of approach will enable us to build an efficient system for international payments in the future by providing low-cost services to multiple sections of the world's population experiencing hardship, including migrants, thus promoting financial inclusion. The ECB is part of the initiatives launched by the G7, the G20 and the Bank for International Settlements.

The digital euro is an ambitious and complex goal that can improve the efficiency of the economic and financial system. We must make it a driver of stability and inclusive progress, capable of strengthening ties between economies and financial systems at the global level and of overcoming gaps and barriers between countries. ■

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Endnotes

1. The definition of cryptoassets can include assets that are not liabilities of any issuer, and stablecoins. The classification used in the text keeps these two categories separate.

2. See International Monetary Fund (2021), Global Financial Stability Report, "COVID-19, Crypto, and Climate. Navigating Challenging Transitions", October, and Panetta, F (2021), "Stay safe at the intersection: the confluence of big techs and global stablecoins", speech at the conference on "Safe Openness in Global Trade and Finance" organised by the UK G7 Presidency and hosted by the Bank of England, October.

3. For example, producing and trading Bitcoin alone wastes huge amounts of energy: the equivalent of the entire annual energy consumption of a country with millions of inhabitants like Switzerland.

4. It is estimated that the amounts of cryptoassets exchanged for criminal purposes are substantial, surpassing 2.8 billion dollars for Bitcoin alone in 2019 (see Chainalysis (2020), "The 2020 State of Crypto Crime", January). Other analyses in 2020 show that the volume of criminal activity exceeded 3.5 billion (see Ciphertrace (2021) "Cryptocurrency crime and anti-money laundering report", February). These studies are backed up by various operations carried out in recent years by Europol and Interpol to break up criminal organisations engaged in money laundering and selling weapons and drugs using cryptoassets.

5. There have been several cases of holders of cryptoassets losing all their savings after having lost their blockchain passwords.

6. Stablecoins can usually be converted to cash. Conversion mechanisms differ, however, from those of bank deposits or electronic money. In the case of bank deposits, one-to-one convertibility is based on deposit insurance schemes, financial legislation, and prudential supervision. The value of e-money holdings is protected by the fact that customers' funds must be deposited with third parties in cash format. The lack of such mechanisms could fuel runs on stablecoins if holders – who bear the risks of fluctuations in the value of reserve assets – expect a significant decrease in the redemption price or perceive the issuers as being incapable of absorbing losses.

7. See Panetta, F (2020), "The two sides of the (stable)coin", speech at Il Salone dei Pagamenti, November.

8. See the report prepared by the President's Working Group on Financial Markets, the Federal Deposit Insurance Corporation and the Office of the Comptroller of the Currency "Report on Stablecoins", November 2021.
9. See Mizrach, B (2021), "Stablecoins: Survivorship, Transactions Costs and Exchange Microstructure".
10. See Commodity Futures Trading Commission press release, "CFTC Orders Tether and Bitfinex to Pay Fines Totaling $42.5 Million".
11. In September 2021, approximately three quarters of exchanges of cryptoassets on trading platforms involved stablecoins. In that sense, stablecoins are also tainted by the illegal activities associated with cryptoassets.
12. See Panetta, F (2021), interview with Financial Times, conducted by Martin Arnold, 20 June.
13. See Mizrach, B (2021), op. cit.
14. See Panetta, F (2020), "From the payments revolution to the reinvention of money", speech at the conference organised by the Deutsche Bundesbank on "The Future of Payments in Europe", November.
15. The European Commission recently introduced a Proposal for a Regulation on Markets in Crypto-assets (MiCA). The ECB has updated its Payment Instruments, Schemes and Arrangements (PISA) supervisory model for electronic payment products to include digital payment tokens such as stablecoins.
16. With regard to the United States, see "Report on Stablecoins", (2021), op. cit., and the remarks of the Securities and Exchange Commission Chair, Gary Gensler, before the Aspen Security Forum, August 2021.
17. Decentralised finance (DeFi) is designed to provide financial services without intermediaries, using smart contracts on blockchain and stablecoins to facilitate the transfer of funds. See Bank for International Settlements (2021), "DeFi risks and the decentralisation illusion", BIS Quarterly Review, December.
18. See Panetta, F (2021), "Cash still king in times of COVID-19", keynote speech at the Deutsche Bundesbank's 5th International Cash Conference, Frankfurt am Main, June.
19. If given the choice, almost half of euro area consumers would prefer to pay with cashless means of payment, such as cards. See ECB (2020), "Study on the payment attitudes of consumers in the euro area (SPACE)", December.

20. Internet sales in the euro area have doubled since 2015. In August 2021 the Eurostat index of retail sales via internet or mail order houses (seasonally and calendar adjusted, index 2015=100) stood at 206.
21. See Zamora-Pérez, A (2021), "The paradox of banknotes: understanding the demand for cash beyond transactional use", Economic Bulletin, issue 2, ECB, Frankfurt am Main.
22. See Waller, CJ (2021), "CBDC: A Solution in Search of a Problem?", speech at the American Enterprise Institute, Washington, D.C., August.
23. For an analysis of the role of public money in the economy, see Panetta, F (2021), "Central bank digital currencies: a monetary anchor for digital innovation", speech at the Elcano Royal Institute, Madrid, November.
24. For example, deposits are a liability for banks.
25. One-to-one convertibility with the common monetary anchor is what makes these regulated forms of money convertible with each other at par and is why they are perceived as interchangeable when making payments.
26. See Sims, CA (2003): "Implications of rational inattention", Journal of Monetary Economics, 50(3), pp. 665-690.
27. See Eichengreen, B (2019), "From commodity to fiat and now to crypto: what does history tell us?", NBER Working Paper Series, No 25426, January; Rolnick, AJ and Weber, WE (1983), "New evidence on the free banking era", American Economic Review, Vol. 73, No 5, pp. 1080-1091.
28. This paragraph only covers the main benefits of a digital euro. For a full analysis see ECB (2020) "Report on a digital euro", October.
29. The heads of state or government espoused the principle of European strategic autonomy at the summit of 2 October 2020.
30. ECB (2019), Card payments in Europe, April.
31. See Panetta, F (2021), "Stay safe at the intersection: the confluence of big techs and global stablecoins", speech at the conference on "Safe Openness in Global Trade and Finance" organised by the UK G7 Presidency and hosted by the Bank of England, October.
32. The term Big Tech refers to technological giants such as Google, Amazon, Facebook and Apple (GAFA).

33. See Panetta, F (2020), "The two sides of the (stable)coin", speech at Il Salone dei Pagamenti, November; Panetta, F (2020), "From the payments revolution to the reinvention of money", speech at the Deutsche Bundesbank Conference on the "Future of Payments in Europe", Frankfurt am Main, November.
34. See Bradford, Anu (2012), "The Brussels effect", Northwestern Law Review.
35. See ECB (2021), "Central bank digital currency and global currencies", The international role of the euro, Frankfurt am Main, June.
36. The right to privacy is enshrined in the European Charter of Fundamental Rights.
37. The other features highlighted in the consultation were the security of payments and usability throughout the euro area, which were ranked first by 18% and 11% respectively.
38. See Panetta, F (2021), "A digital euro to meet the expectations of Europeans", introductory remarks at the ECON Committee of the European Parliament, April.
39. The degree of privacy could vary, for example, depending on the amount of the digital euro transaction or whether the payment takes place remotely or in person.
40. See "Into the danger zone. American tech giants ae making life tough for startups". The Economist, 2 June 2018.
41. See Panetta, F, (2020), "The two sides of the (stable)coin", op. cit.
42. For example, in November 2021 Amazon announced to customers in the United Kingdom that from 2022 it would cease to accept Visa credit cards issued in the United Kingdom and offered affected customers a discount of GBP 20 on their next purchase via an alternative payment method.
43. See the paragraph on the effects on the banking and financial system.
44. With a rate of return that is fixed or variable, only positive or even negative, the same as or different from the key ECB interest rates, etc.
45. The impact of the digital euro on the banking and financial system is explored in greater detail in Panetta, F (2021), "Evolution or revolution? The impact of a digital euro on the financial system", speech by Fabio Panetta at a Bruegel online seminar, February.

46. See Kumhof, M and Noone, C (2018), "Central bank digital currencies – design principles and balance sheet implications", Staff Working Paper, No 725, Bank of England, May.
47. See Panetta, F (2018), "21st century cash: central banking, technological innovation and digital currencies", in Gnan E. and Masciandaro, D (eds.), Do We Need Central Bank Digital Currency?, Conference Proceedings 2018/2, SUERF, pp. 23-32.
48. For example, individual users could be allowed to hold a maximum of €3,000, with a provision for amounts above this threshold to be transferred automatically to a bank account.
49. For example, a certain rate of return could be established for amounts up to €3,000, with penalising remuneration set for amounts above that figure. This proposal was put forward in Panetta, F (2018), "21st century cash: central banking, technological innovation and digital currency", in Gnan E e Masciandaro, D (eds.), Do We Need Central Bank Digital Currency?, Conference Proceedings 2018/2, SUERF, pp. 23-32; Bindseil, U (2020), "Tiered CBDC and the financial system", Working Paper Series, No 2351, ECB, Frankfurt am Main, January; and Bindseil, U. and Panetta, F (2020), "Central bank digital currency remuneration in a world with low or negative nominal interest rates", VoxEU, October. An in-depth analysis of how we could avoid the digital euro being used excessively as a form of investment is outlined in Bindseil, U, Panetta, F and Terol, I (2021), "Central Bank Digital Currency: functional scope, pricing and controls", Occasional Paper Series, No 286, European Central Bank, December.
50. At the same time, the digital euro could make it easier for the authorities to intervene in times of stress, for example by providing the central bank with real-time data on aggregate savings outflows.
51. The impact of the digital euro on the international monetary and financial system is explored in greater detail in Panetta, F (2021) ""Hic sunt leones" – open research questions on the international dimension of central bank digital currencies", speech at the ECB-CEBRA conference on international aspects of digital currencies and fintech, October.
52. See Ferrari, M, Mehl, A and Stracca, L (2020), "Central bank digital currency in an open economy", CEPR Discussion Paper Series, No 15335, October; and Committee on Payments and Market Infrastructures, BIS Innovation Hub, International Monetary Fund and World Bank (2021), "Central bank digital currencies for cross-border payments: Report to the G20", July.

53. See Aviat, A and Coeurdacier, N (2007), "The geography of trade in goods and asset holdings", Journal of International Economics, Vol. 71, No 1, pp. 22-51.
54. See Ikeda, D (2020), "Digital Money as a Unit of Account and Monetary Policy in Open Economies", Discussion Paper Series, No 20-E-15, Institute for Monetary and Economic Studies, Bank of Japan, December.

I would like to thank Federcasse for inviting me to speak at this edition of the Lectiones cooperativae. These lectures are an occasion to reflect on issues of broad significance and their implications for the application of the principles of cooperation. They offer us the opportunity to seek a deeper understanding of the changes taking place in the economy and in society. This article is based on a lecture delivered at the Federcasse Lectiones cooperativae in Rome, 10 December 2021

Biometric technologies at work: a proposed use-based taxonomy

Technology may not have a significant negative impact on the quantity of jobs, but it certainly transforms them. Mia Hoffmann and Mario Mariniello consider the implications for productivity and workers' quality of life

Executive summary

Biometric technologies have in principle the potential to significantly improve worker productivity, security and safety. However, they are also a source of new risks, including exposure to potential personal data abuse or the psychological distress caused by permanent monitoring. The European Union lacks a coherent regulatory framework on the mitigation of risks arising from the use of biometric technologies in the workplace.

We propose a taxonomy to underpin the use of artificial intelligence-powered biometric technologies in the workplace. Technologies can be classified into four broad categories based on their main function: (1) security, (2) recruitment, (3) monitoring, (4) safety and wellbeing. We identify the benefits and risks linked to each category.

To be more effective, EU regulation of artificial intelligence (AI) in the workplace should integrate more detail on technology use. It should also address the current scarcity of granular data by sourcing information from users of AI technologies, not only providers.

There is an untapped potential for technology to address workplace health hazards. Policymakers should design incentive mechanisms to encourage adoption of the technologies with the greatest potential to benefit workers.

Artificial intelligence users, in particular bigger companies, should be required to assess the effect of AI adoption on work processes, with the active participation of their workforces.

1 Introduction

Traditionally, the analysis of the impact of technology on labour markets has focused on measurement of the quantitative effects on aggregate employment. Researchers often ask whether technology will create more jobs than it will destroy, or which jobs are more exposed to the risk of disappearing because machines will replace humans.

But a parallel question is becoming increasingly pressing. Technology may not have a significant negative impact on the quantity of jobs available to humans, but it certainly transforms them, changing how jobs are performed, with implications for workers' quality of life and for productivity. Hence the focus shifts from a quantitative to a qualitative perspective.

Addressing this has become even more pressing in the wake of the COVID-19 pandemic, which has pushed companies to increase their adoption of digital technologies, with varying impacts on the wellbeing of workers (for example, during the pandemic investment by employers in monitoring and surveillance software has increased significantly; see Kropp, 2021; Mascellino, 2020).

Meanwhile, the disruptive potential of the pandemic has provided employers with an opportunity to introduce new work processes and redesign workplaces to address long-standing issues, such as workplace health hazards, that technology can help deal with.

We focus on artificial intelligence (AI)-powered biometric technology used in the workplace. Biometrics refers to the automated recognition of a person based on their physical and behavioural characteristics (Sabhanayagam *et al* 2018; Sundararajan and Woodard, 2018).

Identity recognition includes identification ('Who are you?') and verification ('Are you really who you say you are?'). But the use of AI-powered biometric technologies in the workplace can go well beyond recognising identity.

For the purposes of this Policy Contribution we define biometric technologies as AI technologies that rely on biometric data to derive inferences about the individual whose data is collected. Such inference can include individuals' moods, their level of concentration, their health or personality.

Even when the purpose of such soft biometrics is not to identify individuals, their deployment still has far-reaching implications for workers and workplaces, not least with respect to privacy (McStay, 2020).

Interest in using technology to monitor and control what workers do is booming; COVID-19 and the shift to remote work have exacerbated this

The global biometrics market is growing fast. Estimates from 2019 expected global revenues to almost double within the next four years, and reach $55.42 billion in 2027 (Figure 1). This data includes the use of biometrics across all domains, including law enforcement and in customer-centric applications.

Comprehensive data on the use of biometric technology in workplaces is scarce, a problem that should be addressed by policymakers. Because the adoption of new technologies in the workplace has significant potential to affect workers' wellbeing, a first key step is to improve the ability of public authorities to accurately monitor this phenomenon as it unfolds.

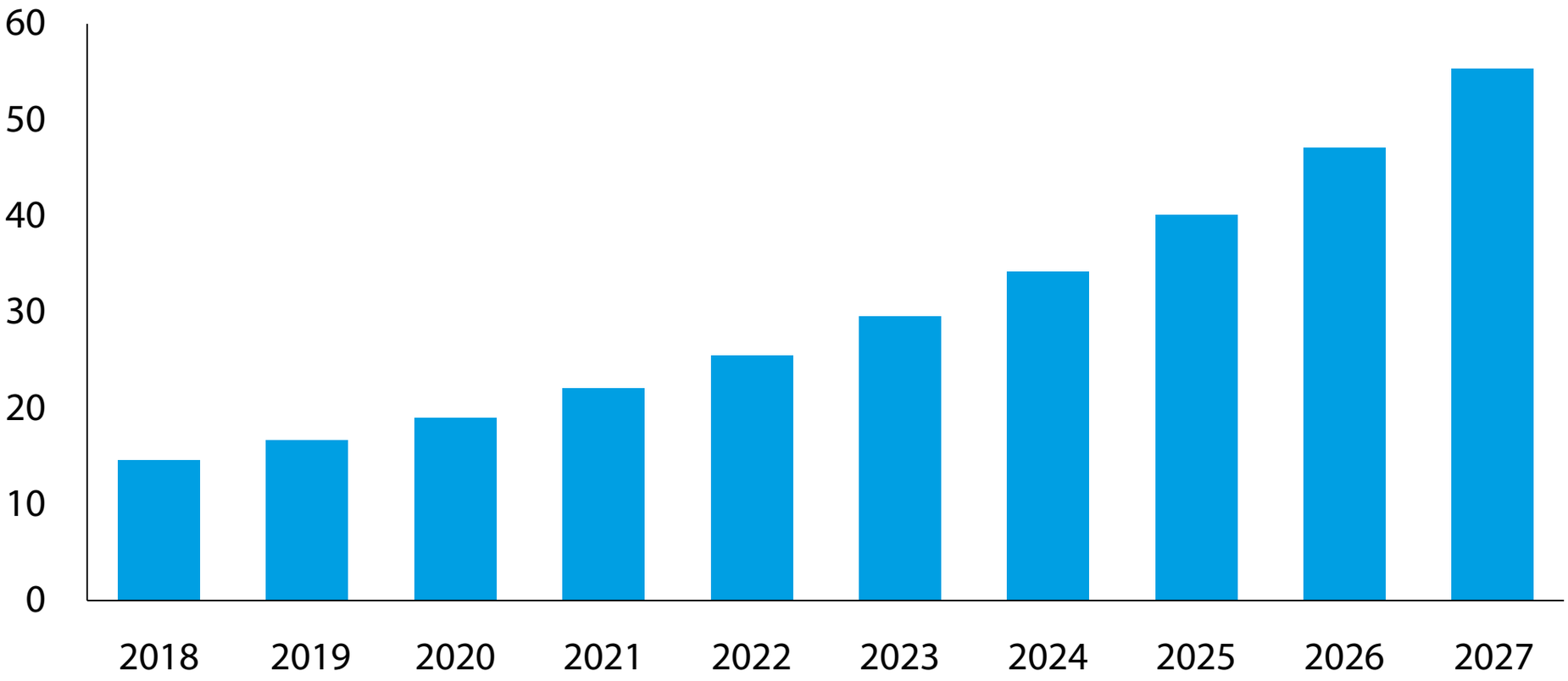
According to one survey (European Commission, 2020), 42 percent of enterprises in the EU use at least one kind of AI technology, but information is lacking about whether the AI technologies are applied to employees or customers, and no distinction is made between biometric and non-biometric systems[1].

Analysis by individual technology shows that those that can be classified as biometric technologies are among the less-utilised: natural-language processing (speech recognition, machine translation or chatbots) has been adopted by only one in ten firms, while 9 percent of enterprises use computer vision (visual diagnostics, face or image recognition), and the use of sentiment analysis (analysis of emotion and behaviour) is even rarer, at 3 percent[2].

A few sectors, including social work, education and real estate predominantly adopt AI systems related to biometrics, but overall adoption levels are very low. Skill shortages, both in the labour market and internally, represent major obstacles to the adoption of AI technologies in general.

However, for the adoption of sentiment analysis, reputational risks and lack of citizen's trust represent significant adoption barriers. These barriers are not considered very problematic for other technologies.

Figure 1. Global biometric technology market revenue in $ billions, 2018-2027



Note: Values from 2020 on are forecasts.
Source: Bruegel based on Statista, https://www.statista.com/statistics/1048705/worldwide-biometrics-market-revenue

The increasing interest of regulatory authority in these markets is therefore not coincidental. The European Union, for example, has been increasingly active in recent years in attempting to define a legal framework to mitigate the risks of abuse arising from advanced technology. The general data protection regulation (GDPR), which entered into force in 2018, is the bluntest example.

In April 2021, the European Commission proposed harmonised rules on artificial intelligence, commonly referred to as the 'AI Act' proposal (European Commission, 2021a). The main goals of the proposed AI Act are to create the conditions for ethical AI and the concrete enforcement of rules that mitigate AI risk, especially as experienced by the most vulnerable. For the workplace, the proposed AI Act specifically lists as high-risk:

- *"AI systems intended to be used for recruitment or selection of natural persons, notably for advertising vacancies, screening or filtering applications, evaluating candidates in the course of interviews or tests;*

- *"AI intended to be used for making decisions on promotion and termination of work-related contractual relationships, for task allocation and for monitoring and evaluating performance and behaviour of persons in such relationships"* (European Commission, 2021a).

The proposed AI Act, however, does not provide details about the identified sources of risk when artificial intelligence is used in the workplace. Nor does it explain through which mechanisms risk can arguably translate into harm for workers.

However, such explanations are needed to disentangle potentially harmful from potentially beneficial use of technology. Furthermore, the proposed AI Act would impose a number of requirements for providers and users of high-risk AI applications. These include risk management and assessment of potential current and future risks.

However, no specific guidelines are given on how that assessment should be done (for example, what should be considered a 'foreseeable risk' associated with the use of biometric technology in the workplace?).

We aim to fill the gap in the proposed AI Act by classifying technologies and explaining how technology in the workplace can harm workers. To our knowledge, this is the first attempt to propose a taxonomy of biometric technologies used in the workplace[3].

Our analysis furthermore suggests improvements that could be made to the AI Act draft text. In particular, the text should include a bigger emphasis on the role played by users of AI applications. As drafted by the European Commission, the proposed AI Act does not entail sourcing data on high-risk applications directly from, for example, companies that adopt them.

However, lack of granular use data can significantly hamper regulators' ability to understand how harm to workers can unfold at plant level. Moreover, the AI Act is geared to compelling providers of high-risk AI applications to improve their products.

However, AI applications may have significant redistributive effects when they are adopted, depending on the environment in which they are used. Such risks may not be entirely foreseeable by AI providers. It would thus be desirable that users should also engage in strategies that mitigate potential risks.

In particular, bigger companies could be required to assess the effects of high-risk AI applications on their workforces, with workers actively participating in such assessments.

2 Biometric technologies at work: a proposed use-based taxonomy

Biometric technologies can be categorised into three groups:

- Physical;
- Physiological;
- Behavioural.

Physical biometrics refers to data on static and unique bodily characteristics. Examples include DNA, fingerprints, iris and retina patterns and physiognomy, but thanks to technological progress, options now extend to include ear, palm and vein patterns and many more.

Raw biometric data is collected through a live scan or a digital image, which is then processed and translated into unique code. In facial recognition, for instance, this code reflects the size of the mouth, position and shape of the nose, the distance between the eyes, and so on (Sabhanayagam *et al* 2018).

Physiological biometrics is data on a person's physiological functioning, such as their heart rate, blood pressure, oxygen level and muscle use. While monitoring of this data is common in healthcare, physiological biometrics are increasingly moving into workplaces, especially for workplace health assessment (Mettler and Wulf, 2019).

Behavioural biometrics use patterns of human behaviour as the basis for analysis and are driven by deep-learning techniques. The underlying concept of the technology is to exploit distinct patterns of human behaviour as a means for authentication and identification, either in real-time or retrospectively (Liang *et al* 2020).

Behavioural biometrics extract information not from the outcome of an action, but from the way it is executed. For example, identity is verified by a worker's gait, while mood is evaluated from the pitch of their voice. A benefit is that data is collected without interrupting individuals in their ongoing activity in a way that an ID check or employee survey would. The ubiquity of smart devices, cameras and sensors contributes to the technology's growing importance in workplaces.

Regardless of the type of biometric technology, data analysis follows a similar, automated process. Raw biometric data is collected via sensors, cameras, microphones or other devices and pre-processed to remove noise and clean the data.

This is followed by feature extraction. Features are specific biometric data points or patterns considered to be indicative or predictive of the outcome of interest. For example, for identification, one of the features could be the distance between the eyes, or the pressure applied on certain keys while typing.

It could be the percentage of speaking time to assess personality, and the breathing rhythm to judge stress levels (Han *et al* 2017; Liang *et al* 2020; Sabhanayagam *et al* 2018; Vinciarelli and Mohammadi, 2014).

Depending on the type and amount of raw data, this step requires more or less computing power. Depending on the use case, the extracted features are fed into diverse AI models that determine the outcome of interest (such as classification, authentication or identification).

Biometric AI systems can serve a wide range of functions in the workplace. Providing security by verifying and identifying workers is one, but as we will illustrate in the next sections, there are many other purposes, including

those relying on physiological and behavioural biometric data. An important emerging field in this regard is affective computing (Yanushkevich *et al* 2020).

This refers to the computational analysis of data on human behaviour, such as facial expressions, gestures and language, or physiology, for its emotional information to derive conclusions about a person's affective state, including emotions (Balan *et al* 2020; Richardson, 2020), mood (Zenonos *et al* 2016), personality (Mehta *et al* 2020; Vinciarelli and Mohammadi, 2014) or stress levels (Khowaja *et al* 2021).

The analysis builds on several biometric technologies including facial expression recognition, tone analysis and natural language processing, and is typically based on the assumption that there are common and universal forms of emotional expression regardless of culture, gender, age or race (Barrett *et al* 2019; Richardson, 2020).

We propose to classify biometric technologies according to their use by employers. We identify the following four groups of use (Table 1)[4]:

- Security: security represents the classic use case for biometric technologies in workplaces. Allowing access to company resources to only authorised personnel is traditionally done using passwords, pin codes or key(card)s, but biometric authentication, such as face or fingerprint recognition, offers benefits in terms of accuracy, security and efficiency.

- Recruitment: the purpose of AI systems in recruitment, including biometrics, is to create objective, data-driven candidate evaluations, for example through automated interviews or psychometric assessments.

Table 1. A taxonomy for biometric AI systems in the workplace

Purpose	Technologies used	Use case	Real life example/brand
Security	Facial, fingerprint, gait, keystroke recognition	Access control, continuous authentication	BehavioSec, Innovatrics, FaceKey
Recruitment	Affective computing based on computer vision, voice and speech recognition and natural language processing (NLP)	AI-powered job interviews and personality assessments to evaluate candidates	Pymetrics, HireVue, Retorio
Monitoring	Affective computing based on voice recognition and NLP; wearable movement trackers; eye movement trackers; smart mouse	Worktime control, productivity and activity tracking, performance measurement	Cogito, WorkSmart, Geodis, Humanyze
Safety and wellbeing	Smart wearables; Computer vision	Accident prevention; physical and psychosocial health risk management	StrongArm Technologies, Fitbit, (many technologies in development)

Source: Bruegel.

- Monitoring: the digitalisation of work in many sectors has created new possibilities for uninterrupted and comprehensive worker surveillance. With biometric AI, employers can keep track of productivity, for example through keyboard logging or movement sensors, or measure performance using affective computing, concentration tracking or social metrics.

- Safety and wellbeing: one of the arguably most promising use cases for AI in workplaces is to improve worker health and safety. AI can help address a wide range of causes of morbidity by reducing the risk of accidents, burnout and musculoskeletal disorders. Most of the biometric systems we review rely on physiological data gathered through smart sensors and wearable devices that track muscle use, movement, fatigue or stress levels.

2.1 Security

Table 2. Biometric AI for security

Employees		Employers	
Risks	Benefits	Risks	Benefits
Privacy issues, surveillance, function creep	Contactless identification, simplification, no risk of losing keycards/forgetting passwords	Data protection liability	Higher security, reduced risks of insider fraud

Source: Bruegel.

Security represents the classic use case for biometric technology in workplaces. Companies have an interest in restricting access to their facilities, data and resources to authorised personnel only, which necessitates a process of identity verification.

Figure 2 shows the rate of use of biometric authentication methods in EU countries and in the United Kingdom, in 2019. One in ten of all EU companies rely on biometric authentication and verification in the workplace, with use rates ranging from as high as 24 percent in Malta to only 4 percent in Slovenia and Bulgaria.

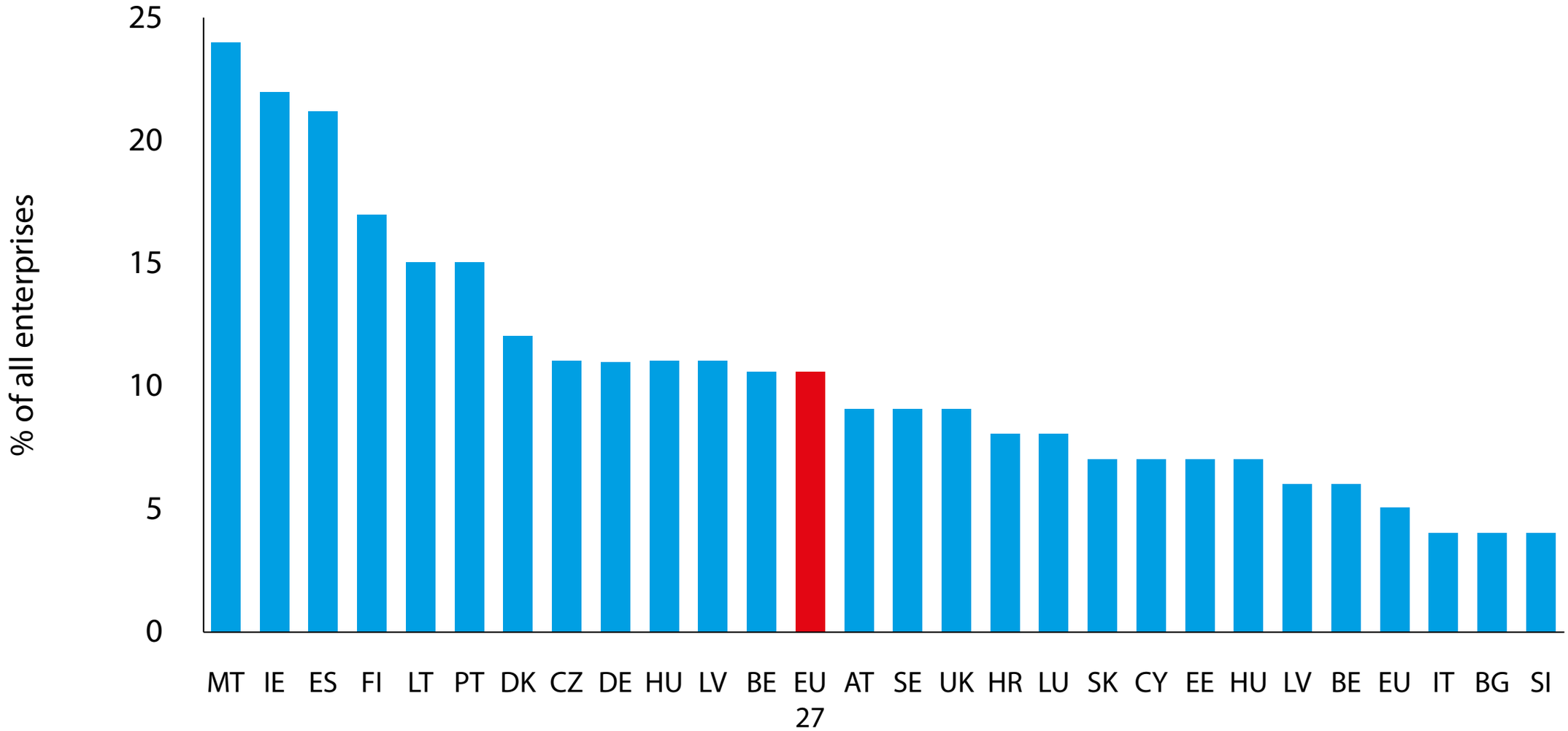
Fingerprint recognition is by far the most popular type of biometric authentication, followed by facial recognition, according to a survey of IT professionals[5].

There are several benefits to biometric authentication compared to conventional security systems. In contrast to knowledge-based (passwords, pin codes) or token-based (key cards) security systems, biometric authentication systems rely on characteristics inherent to someone's person. While passwords and key cards can be lost or stolen, biometric recognition guarantees that the individual in question is physically present.

Biometric authentication is also more time- and cost-efficient, since the automated process only takes seconds, if that, and no human identity check is needed. Moreover, biometric features cannot be forgotten and therefore time-consuming recovery or reset processes needed for forgotten passwords or key cards are avoided.

The passive nature of behavioural biometrics such as gait or keystroke recognition allows continuous authentication to ensure that the person accessing company data, accounts or other resources is indeed the one authorised to do so.

Figure 2. Use of biometric authentication in enterprises, 2019



Note: Data for the Netherlands is not available.
Source: Eurostat.

For these reasons, behavioural biometrics are increasingly used for fraud detection and insider threat management (Hu *et al* 2019; Liang *et al* 2020). Therefore, enhancing conventional security systems with biometric identity recognition is to date the most secure, effective and efficient way to secure access to company property (Sabhanayagam *et al* 2018)[6].

Reliance on employees' personal biometric characteristics for security has significant implications for workplaces and workers. Privacy is at the core of concerns about the collection, storage and processing of biometric data (Carpenter *et al* 2018; Holland and Tham, 2020).

Beyond being a unique feature of a person, biometric data can contain a wide range of additional, personal information, which can potentially be extracted. For example, the continuous recording of keystrokes for authentication will also capture the content that is typed, including potentially sensitive personal information.

Physical biometrics, such as fingerprints or hand geometry, may reveal private medical information. For example, Holland and Tham (2020) explained that fingerprints can be used to detect genetic disorders, and Carpenter *et al* (2018) argued that biometric samples allow the extraction of genetic markers that reveal potential health issues, such as hand swelling associated with sickle cell disease.

The mere possibility of extraction of this information from biometric data opens up new questions about privacy, and could lead to discrimination between workers.

The use of workers' biometric data for undisclosed purposes without their knowledge and consent is a central concern (Carpenter *et al* 2018; Holland and Tham, 2020). Beyond assessing medical risks, organisations could use

the data to conduct background checks or, as is being done in the US, cross-reference biometrics with immigration records to identify undocumented immigrants (Goldstein and Alonso-Bejarano, 2017).

Organisations could use the data to expand monitoring and surveillance, for instance by retracing employees' activities using historical authentication data. The GDPR prohibits function creep via the principles of data minimisation and purpose limitation.

Employers that want to expand the use of biometric data beyond previously agreed functions would need to obtain renewed employee consent. Critics point to the challenges of enabling meaningful and informed consent for data collection in an employer-employee relationship[7].

Finally, there are concerns about potential data breaches and third-party access to personal (biometric) data. One of the key benefits of biometric systems, the fact that they rely on inherent characteristics rather than on knowledge or tokens, also implies that biometric features are irreplaceable: in case of a compromise, biometric ID cannot be changed like a password.

2.2 Recruitment

Recruitment is an obvious application field for AI-driven analytics because hiring decisions are known to be riddled with human bias and discrimination (Bertrand and Mullainathan, 2004; Carlsson and Eriksson, 2019; Drydakis, 2009; Rooth, 2009; Tilcsik, 2011).

Hence, many AI-powered recruitment tools are developed and adopted specifically with the aim of eliminating this problem from the selection process by offering an objective, data-driven and comparable assessment of candidates (Sánchez-Monedero *et al* 2019).

Table 3. Biometric AI for recruitment

Employees		Employers	
Risks	Benefits	Risks	Benefits
Discrimination, spurious correlations, bias, lack of feedback	Potentially more objective interview	Liability, loss of talent due to spurious correlations	Cost reduction, potentially more equality in the hiring process

Source: Bruegel.

Virtually every Fortune 500 company is currently using some form of applicant-tracking system in their hiring processes[8]. However, to the best of our knowledge, representative, reliable data on the use of AI in recruitment, in particular interview systems or other biometrics, currently does not exist.

There is certainly potential for AI systems to enhance recruitment processes. Cowgill (2018) showed that AI can be better than a human counterfactual if certain conditions are met. He found that using a machine-learning algorithm to screen curriculum vitaes can do better than humans if the training data is sufficiently noisy.

The algorithm was built on text mining and natural language processing assessing factors including education and work experience, as well as soft skills. The algorithm led to selection of candidates who were more likely to pass the interview process, accept job offers and be more productive once hired[9]. The algorithm was more likely to select

candidates who graduated from non-elite colleges without job referrals or prior experience, but who had strong non-cognitive soft skills.

Biometric data is primarily collected during the interview process or through personality assessments, in which candidates' behaviour – including their facial expressions, pitch and choice of words – feed into an AI-driven assessment of competences and personality[10].

In order to assess a candidate's suitability for a vacancy, interview systems are trained using data on the company's existing staff. Their test scores are combined with corporate performance benchmarks to identify correlations between the AI's analysis and job success. The AI then compares candidates' scores with those of the existing staff and groups applicants according to their probability of job success.

Unilever, which relies on such an AI-enhanced recruitment tool for entry-level positions, claims the software has contributed to raising ethnic and socioeconomic diversity among new employees, in addition to saving 100,000 hours of interview time and $1 million in recruitment costs each year[11].

Drawing conclusions about emotional states or personality from video or tone recordings without human intervention is however challenging and potentially problematic, in particular when the automated evaluation is the basis for hiring decisions.

A key question that needs answering even before considering its potential usefulness in the workplace is whether or not AI is capable of doing what it claims. A review of the literature by Barrett *et al* (2019) emphasised that technology companies overestimate the scientific validity of their base assumption that there is universal emotional expression.

Instead, the authors found that emotional facial expression is highly context-specific, and that this variation is still understudied. They concluded that not only it is premature to use technology to draw conclusions about people's internal states, such analyses may completely lack validity if they fail to include the context of the individual (Barrett *et al* 2019).

Furthermore, there is a major transparency issue (Raghavan *et al*, 2019; Sánchez-Monedero *et al* 2019). It is currently not possible for researchers to evaluate the validity of the assessments. Developers of AI-powered hiring tools are reluctant to make their code or data available for independent audits, given their proprietary and sensitive natures.

They furthermore rely on their own definitions of unbiased or fair algorithmic assessment, as currently there are no regulations in force that provide a legal standard for these terms. Given that the tool is trained on the set of current staff for each vacancy, characteristics of performance vary from job to job.

Sánchez-Monedero *et al* (2019) concluded that even the most transparent providers fail to disclose how jobseekers can learn how their performance affected the system's evaluation. AI-backed systems are not geared to provide information on which factors (ie. facial expression, voice, pitch) and parameters influence their assessments.

In the case of the recruitment tools, this implies that neither candidates nor human resources managers can follow and retrace AI-based decision-making. The key risk, as a result, is spurious correlations. It is, for example, known that factors including lighting feature obstruction (such as covering part of the face with the hand), and expression intensity influence significantly the outcome and accuracy of computer-vision affective computing models (Patel *et al* 2020).

Finally, one of the most important discussions around AI is the prevalence of bias. Rhue (2018) found that a vision-based sentiment-analysis AI assigned more negative feelings to black faces. Similarly, racial bias has been found in algorithms for natural language processing because of lack of knowledge and understanding of the cultural determinants of linguistic emotional expression (Sap *et al* 2019).

Furthermore, affective computing and recruitment AI tools are 'ableist' by default, by assigning certain features of speech, body language and facial expression paramount importance for job performance, though they have little to do with actual suitability and are unattainable for people with disabilities (Whittaker *et al* 2019).

While some technology companies claim to undertake efforts to counter such bias by continuously auditing their algorithms, decision-making processes continue to lack transparency and traceability.

AI systems are known to frequently encode and perpetuate existing patterns of bias, and the rapid rollout of such tools without meaningful requirements or regulations imposed on them leads to the suspicion that they will exacerbate discrimination through their in-group and out-group classification systems (Crawford *et al* 2019).

2.3 Monitoring

Monitoring employees is not a new concept. Yet, in contrast to direct supervision by a physically present superior, the digitalisation of work and the internet of things (IoT) enables continuous and comprehensive tracking of all of workers' activities (Edwards *et al* 2018).

Interest in using technology to monitor and control what workers do is booming. The COVID-19 pandemic and the shift to remote work has exacerbated a trend already present before the crisis.

Table 4. Biometric AI for workplace monitoring

Employees		Employers	
Risks	Benefits	Risks	Benefits
Surveillance; loss of autonomy and control; mistrust between employee and employer, reduced job quality	Objective accounting of work efforts	Lower job quality could lead to higher employee turnover	Reduce time theft ('buddy-punching'); enhance productivity; improve performance

Source: Bruegel.

In 2018, Gartner found that more than half of large corporations had adopted non-traditional monitoring techniques, up from 30 percent in 2015 (Kropp, 2019)[12]. During the pandemic, demand for biometric-monitoring AI soared, and one out of four companies introduced technologies to track their employees' behaviour passively (Kropp, 2021; Mascellino, 2020).

Workplace applications centre on tracking attendance, activity or performance. The most frequent technological methods of workplace surveillance tend to be monitoring of work emails, browser histories and files, CCTV and

the recording and logging of phone calls (however, no granular data on use of monitoring technologies by EU companies is available).

Monitoring via wearable devices is more common in workplaces that require a lot of physical activity, such as warehouses or construction sites.

Many workplaces re-apply biometric security devices for the purpose of worker monitoring. For example, fingerprint-based attendance tracking systems are widely commercially available. Advocates of the technology claim that such systems make attendance tracking more efficient while preventing some workers from clocking-in for others, improving productivity for both management and workers.

However, these systems were ruled illegal in Germany in 2020, barring exceptional circumstances (Burt, 2020). Because the systems collect highly personal data, they run afoul of European GDPR laws.

When biometric data is combined with productivity-centred algorithms, the technology can be used to push efficiency and accuracy, potentially at the cost of surveillance and lower job quality (Gutelius and Theodore, 2019). Headlines about the deeply automated tracking processes in an Amazon warehouse offer an exemplary description of the risks of algorithmic monitoring and management.

According to one report[13], workers wear a type of tracker that monitors their location and movements as well as their work activity. Based on historic data, an algorithm establishes standardised productivity rates and benchmarks to be attained by each employee. The tracking device also measures time-off-task and sends automatic alerts to workers if the period between measured work activities becomes too long.

Reportedly, the AI system included an automated termination process: it would autonomously fire workers when quality or productivity benchmarks weren't maintained. Since thresholds were set to near-unattainable standards, workers were put under such significant time pressure that they would skip bathroom breaks in order to fulfil their artificially set benchmarks.

Discouraging and timing toilet breaks represents a questionable control over basic human needs and also raises issues around equality, illustrated by a number of reported instances in Europe where female employees (not of Amazon) were asked to wear specific clothing to signal when they were menstruating to receive permission to use the restrooms more often[14].

In office settings, a similarly comprehensive picture is painted by AI-driven sociometric devices: small, wearable badges capable of tracking individual and collective behaviours at work based on audio, movement, proximity and location data.

In combination with corporate metrics on output and performance, AI can link specific behaviours, such as talkativeness, or whether a worker dominates conversations, to productivity, identify (un-) productive processes and make suggestions to improve organisational efficiency (Eveleth, 2019; Ito-Masui *et al* 2021).

Although linking a badge to the wearer's identity requires consent according to the developers, critics argue that surveillance opportunities remain within reach, in particular in small or medium-sized entities (Moore, 2020).

Affective computing can also play a role in monitoring work performance. A US start-up called Cogito developed an AI system for call centres which assesses the mood of customers during phone calls and cues agents to adapt their way of speaking accordingly.

Using voice analysis and natural language processing, the technology detects over 200 indicators of emotional state of both the customer and the agent in real-time. When it identifies a certain emotional state in a customer – for example frustration – it alerts the agent to speak more slowly, or display more empathy.

Importantly, the AI serves not only as a tool to improve customer satisfaction, but also to monitor workers, as supervisors have *"the ability to proactively listen to live calls with no extra setup required [and] are automatically alerted to calls in which a customer is having a poor experience"*[15].

Automated monitoring may ensure that well-performing workers are identified and rewarded in a more consistent and objective manner. However, this comes at a cost of constant surveillance. The psychosocial risks associated with constant algorithmic monitoring are real and must be taken into account (Nurski, 2021).

2.4 Safety and wellbeing

Table 5. Biometric AI for health, safety and wellbeing

Employees		Employers	
Risks	Benefits	Risks	Benefits
Surveillance; collection of intimate health data; function creep; privacy	Prevention of accidents and adverse health outcomes	Liability for data protection	Reduction in incident costs

Source: Bruegel.

Workplaces can be dangerous. In 2018, 3,332 workers in the EU died in an accident at work[16]. In addition, there were over three million serious non-fatal accidents in European workplaces[17].

In the EU, most workplace accidents occur in a handful of sectors. Agriculture, manufacturing, construction and transport account for over 65 percent of all fatal accidents. The most prevalent causes of workplace accidents in industrial settings are, in decreasing order of frequency, falls from heights, strikes by moving or falling objects, machine contact, ie. when a worker is caught between parts of a machine, and being hit by moving vehicles (Svertoka *et al* 2021).

Non-fatal illnesses also burden workers. Musculoskeletal disorders, together with cancer and circulatory illnesses, are the leading causes of work-related morbidity in the EU (Elsler *et al* 2017). Workplace accidents, deaths and health problems generate massive costs that burden not only employers and employees but also public budgets and society as a whole.

The European Agency for Safety and Health at Work (EU-OSHA) estimated that the costs of work-related accidents and illnesses in the EU amount to at least €476 billion per year, equal to about 3.3 percent of EU GDP (Elsler *et al* 2017).

Technology may offer a solution to improve workplace safety. More and more smart technological solutions are available to address a wide range of work-related health issues. Instead of a reactive approach to accidents and health problems, these systems enable preventive action by detecting hazards and risks before they manifest themselves in accidents or illnesses (Pavón *et al* 2018).

Through sensors, these systems gather data from the workers and their surroundings aimed at environmental sensing, proximity detection and location tracking (Awolusi *et al* 2018; Svertoka *et al* 2021). Biometric AI systems typically combine data collected on workers from physiolytic equipment, with environmental data gathered from other sensors or cameras (Svertoka *et al* 2021).

Physiolytics are wearable devices that use measurements of body functions, such as heart rate, muscle use or blood oxygen level, in machine-learning models and data analytics, from which AI draws conclusions about the physical and sometimes psychosocial state of the wearer (Mettler and Wulf, 2019).

Wearables include fitness trackers, smart watches, patches and sensors attached to the body, smart clothing and personal protective equipment (PPE) (Svertoka *et al* 2021).

Biometrics can help through five broad channels: (1) increasing compliance with PPE requirements and preventing falls; (2) addressing hazard caused by fatigue; (3) reducing sedentary behaviour and physical inactivity; (4) limiting psychosocial stress; (5) reducing physical stress and musculoskeletal disorders[18].

1. *Increasing compliance with PPE and preventing falls*. Records from the US Bureau of Labor show that in most incidents resulting in severe injury, workers were not correctly wearing PPE, suggesting that the severity of the incident could have been reduced with full PPE compliance (Kritzler *et al* 2015). AI-driven solutions to PPE compliance are typically based on either computer vision or smart wearable technology.

   For example, a smart helmet can detect whether it is worn or not and determine the instant it is taken off using humidity sensors (Tan *et al* 2021). In other instances (eg. see Kritzler *et al* 2015), workers may wear a smartwatch that signals which PPE is required for the task and recognises whether it is worn at that point in time. When a

worker approaches a workstation, the machinery and industrial equipment will only activate if she wears the right gear, as determined by the watch.

Similarly, AI systems can help reduce the number of falls by identifying hazardous areas in workplaces using recordings of stumbling or loss of balance from smart sensors. Supervisors can use the data to detect hazardous locations on their worksites before an incident occurs, and address specific risks with targeted measures, without disrupting workers in their tasks.

2. *Addressing hazard caused by fatigue*. According to neuroscientific research, constant and long-term exposure to high-risk environments, such as construction sites, and the resulting familiarity with hazardous surroundings, lowers people's risk sensitivity and risk-judgement capabilities (Niv *et al* 2012).

   A range of wireless, wearable sensing devices has been developed to measure and assess the level of attention or situational awareness of workers in real-time using physiological biometrics such as eye-movement or brain signals. Amazon, for example, deploys AI-powered cameras in its delivery vehicles to improve safety following a number of serious car accidents[19].

   The vision system observes and records all drivers at all times and issues alerts for unsafe driving behaviour, such as speeding, fatigue or distracted driving. However, reports suggest that the technology sometimes unduly penalises drivers, negatively impacting their ability to earn income[20].

3. *Reducing sedentary behaviour and physical inactivity*. A number of health risks, including obesity, cardiovascular diseases and back pain, are associated with a lack of physical activity and extensive sedentary behaviour, typical of office environments. Workplace interventions to promote wellbeing and physical activity among employees

often involve providing workers with wearable fitness trackers, such as FitBits, to monitor and track their daily physical activities (Glance *et al* 2016; Nikayin *et al* 2014).

Large-scale collection and analysis of workers' data can provide the basis for specific health interventions to address emerging risks early on. However, whether this justifies constant monitoring of physical activity, in particular outside of working hours, should be judged by each individual worker.

4. *Limiting psychosocial stress*. A study by the World Health Organisation and International Labour Organisation identified a direct relationship between overwork and premature death (Pega *et al* 2021)[21]. Lasting psychosocial stress at work increases the risk of illness and death from heart disease and stroke.

   Moreover, chronic stress can lead to negative mental health outcomes. It is, for instance, a crucial cause of burnout (Salvagioni *et al* 2017). More than half of the European labour force reports commonly experiencing work-related stressors in their jobs (EU-OSHA, 2013).

   Recent technological advances in biometric technology have enabled the direct measurement of stress in the workplace. The benefits are straight-forward: early identification of chronic stress and its underlying causes can enable targeted, effective and timely preventive action by employers to mitigate the risk of adverse health outcomes in their organisations.

5. *Reducing physical stress and musculoskeletal disorders*. Physical stress can lead to musculoskeletal disorders (MSDs), one of the leading causes of occupational morbidity. Processes and environments in certain workplaces, like construction sites, assembly lines and warehouses, pose several risk factors for MSDs, including repetitive motions, force and awkward postures (Nath *et al* 2017).

However, ergonomic risks also emerge from tasks and occupations that do not require heavy labour but entail very repetitive motions, for example typing on a keyboard (Valero *et al* 2016) or scanning products at a supermarket check-out (Peppoloni *et al* 2016).

Biometric or biomechanical measurement tools, usually consisting or sensors worn on the worker's body, directly and accurately measure individual body movements over time and allow the identification of unsafe movements and detection of hazardous kinetic patterns (Nath *et al* 2017; Valero *et al* 2016).

Biometric technology used for safety purposes appears to have the greatest potential to benefit workers and employers alike. Nonetheless, its use is not risk-free. Workers may be concerned about their behaviour being constantly monitored. Workers' safety data may be accessed by their employers to assess their performance, undermining the primary goal of the adopted technology.

Physical and mental health information should not be used as a workforce management tool. Mood-recognition AI trained to associate biophysical states with stress levels and mood can allow employers to *"use this information to understand the general feeling of the work environment at any given time without explicitly asking any employees"* (Zenonos *et al* 2016), which would to many appear to be a strong encroachment on privacy, in particular since changes in mood are not necessarily related to work.

In addition to implications for data security, access by third-parties and function creep, the potential use of stress and mood-detection AI in workplaces raises the question of whether employers should come to know these things when their staff choose not to communicate them.

Box 1. Computers are everywhere except in workplace safety statistics

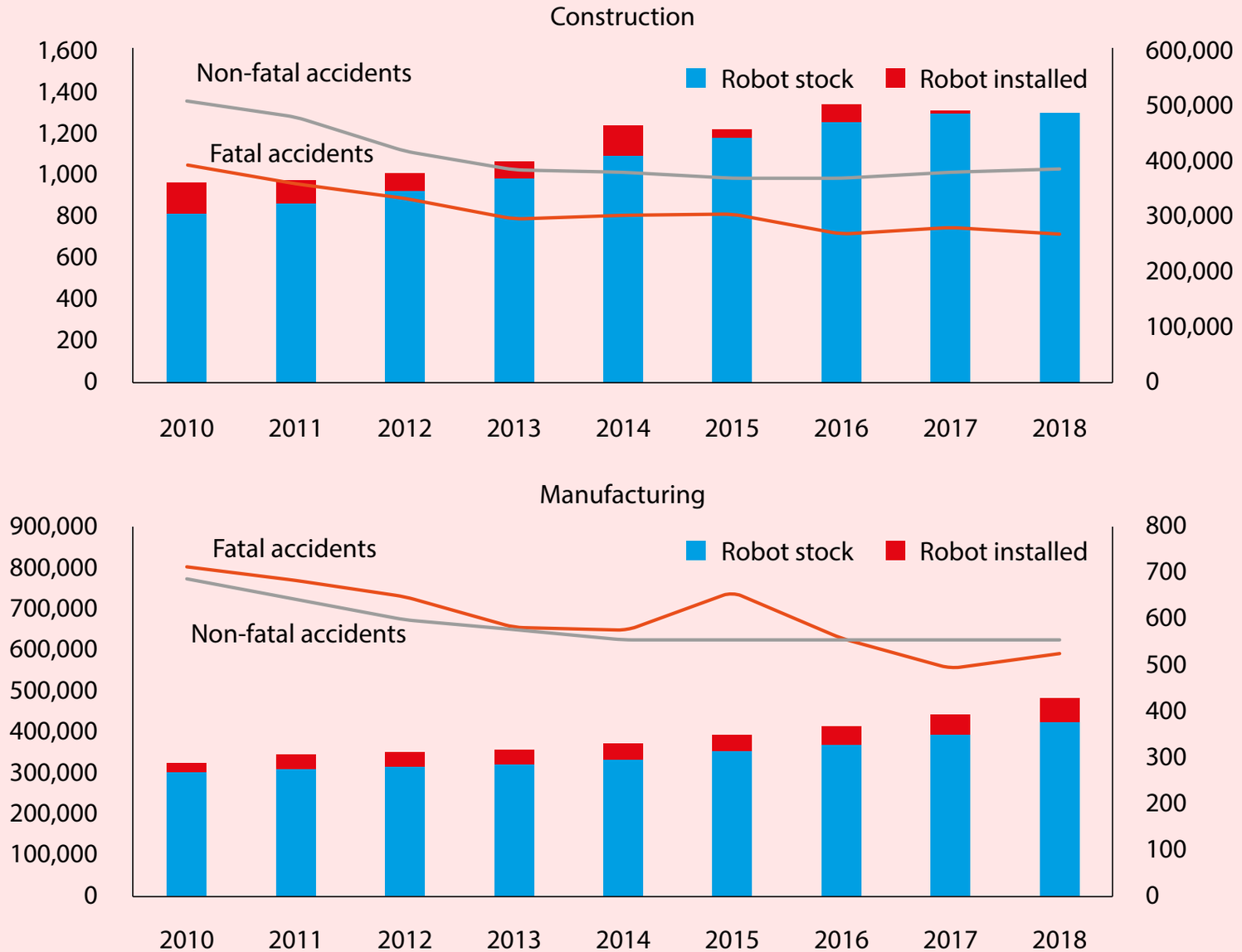
Biometric technologies have a great potential to increase safety at work. However, in sectors in which adoption of digital technologies has constantly increased in the past years, there has been no corresponding drop in injury rates.

Statistical information on the use of AI-powered biometric equipment in the EU is not yet available, but we can use proxies: it is reasonable to assume that sectors in which digitisation and robotisation are higher also tend to have a higher rate of adoption of biometric technologies.

Figure 3 compares the trend of robot adoption with workplace accidents in Europe. It might be expected that, as production processes become more automated, injuries would also become less frequent. However, that is not observed in the data: most of the growth in adoption of robotics took place after 2013/2014, but injury rates declined mostly before that.

While the insights from this analysis cannot be conclusive because of the lack of detailed data on the type of technology adopted by companies, they nevertheless suggest that worker safety does not seem yet a significant driver of companies' technological investment.

Figure 3. Workplace accidents and robotics adoption in industry, EU28



Note: number of fatal accidents in manufacturing and number of non-fatal accidents in construction expressed on the right axis.
Source: Eurostat and World Robotics.

3 From theory to practice to policy

The taxonomy of biometric technologies used in the workplace that we have described above has one primary purpose: to help make more concrete what the European Commission has only sketched in broad terms in its AI Act proposal.

The Commission is right to emphasise that using AI in the workplace can be very risky. But grasping the dynamics through which technology and actual harm are linked is an essential condition for effective regulation.

We note that there is a significant scarcity of data at granular level. This scarcity prevents observers from monitoring the implications of the adoption by employers of new technologies. While progress is being made in terms of data collection on technological adoption by European companies (for example, Eurostat has now indicators that monitor uptake of AI technology), statistics still lack detail on the type of biometric technology used.

The AI Act may help partially to address that issue, in that it imposes notification obligations to providers of high-risk applications. The European Commission plans to establish a system for registering standalone high-risk AI applications in a public EU-wide database, and this is a welcome development.

Yet, the database will be mostly driven by the information supplied by the AI application providers, which may not be able to accurately foresee all potential risks that can emerge at user level. It would be preferable to design coherent statistical systems for capturing information directly from EU employers about AI use.

The AI Act should also broaden the scope of what it considers 'biometric data': it currently relies on the definition adopted in the GDPR, which hinges on the application of the information collected to identify individuals.

However, as we have discussed, biometric technologies may have detrimental effects on workers even if not strictly used for personal identification (for example, data can be lawfully collected at personal level, but raw aggregate biometric data can be stored and used to control the workforce collectively).

For individual workers, biometric technologies in the workplace pose a variety of risks. There are privacy concerns: devices collect a myriad of detailed, sensitive data, with the risk that these may be accessed by (unauthorised) third parties or used by the employer without the employee's consent for purposes other than initially foreseen.

These risks are pervasive and represent a significant barrier. There is a potential loss of personal freedom or control over how employees organise their work. Knowing their employer has constant access to real-time metrics on their effort level can induce workers to change their behaviour and eventually leave them with less motivation and engagement.

There is a risk of over-reliance on the technology. This is particularly problematic when a technology's accuracy is overestimated. Not only can this leave workers unorganised in the case of a technology outage, it can also cause them to trust the device's recommendations more than their own feeling of wellbeing at the time.

From the perspective of workers, this also raises the question of whether it can be assumed that employers are capable of interpreting the output from AI correctly, or if they take the results as truth, though results are potentially biased.

Nevertheless, some technologies have huge potential to address long-standing issues. This in particular refers to safety and security in the workplace, which is a major, often underrated, problem in European labour markets.

It is thus important to ensure that any new regulatory requirement does not dissuade employers from adopting technologies that have a high potential to protect workers from injury or other health hazards.

Based on our taxonomy, it should be possible to design systems of incentives for providers to deploy innovative solution that maximise benefits while complying with the risk-mitigation rules, having in mind the final effect on workers.

Likewise, users could be steered to invest more in technologies that can help address workers' issues, rather than exacerbate them. For example, any discussion related to taxation of digital technologies (Christie, 2021) should be informed by that trade- off: 'robot taxes' do not necessarily need to focus on the quantity of jobs potentially destroyed by technology.

Rather they could be informed by the balance of risks and benefits which we have described in this paper. For example, it would be desirable to craft a taxation system that would reward employers that adopt technologies with high potential to increase safety at work while, if anything, penalising use of technology that can harm workers through intensive monitoring or automated emotional scrutiny.

The European Commission in June 2021 issued the *Strategic Framework on Health and Safety at Work 2021-2027*, which outlines actions to improve workers' health and safety in a changing world of work (European Commission, 2021b).

In this strategy, the Commission also recognises the potential of new technologies, including artificial intelligence, to improve occupational health, safety and wellbeing.

On a broader level, our analysis clearly indicates that no biometric technology can be considered intrinsically bad or good for workers. In other words, working hard to ensure that technology delivers accurate results, and that artificial intelligence systems are not conditioned by bias at any level of the value chain (development, data sourcing, distribution and use), do not guarantee no harm. Addressing bias is a necessary but not sufficient step to protect humans from harm.

Unbiased biometric monitoring of workers may deliver fairer assessments of worker performance, but it can still entail a worsening of their wellbeing, increasing their stress levels, for example.

That conclusion emphasises the role of risk management at local level by users of high-risk AI applications. Employers should not mindlessly adopt biometric technologies in their facilities or offices. Nor can they rely on providers' reassurances about the potential risks of the applications they develop (as it is currently suggested by the proposed AI Act).

Employers of significant size should rather be required to evaluate the impact of the implementation of high-risk technologies before adoption, possibly though the active involvement of their workforce. After adoption, employers should survey their workers' feelings and assess the effects on their wellbeing. ■

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Endnotes

1. European Commission (2020) is a survey of firms that provides useful general insights but does not enable conclusions to be drawn about specific use cases.

2. European Commission (2020), while aiming for representativeness, suffers from a low response rate of only 5 percent on average, which likely biases the adoption rate upwards. Therefore, the accuracy of the exact adoption rates may be limited. We believe, nonetheless, that in the absence of more reliable estimates the relative scarcity of biometric technologies compared to other technologies considered, is a realistic assessment.

3. An extended version of the taxonomy with more detail is available in Hoffmann and Mariniello (2022).

4. It should be noted that this classification is, to a certain extent, artificial: the boundaries between different uses of technologies are often blurred. So for example a technology used for security may also be used for monitoring. Nevertheless, we propose a classification which, in our view, best captures the differences between the applications that have been so far developed.

5. Peter Tsai, 'Data Snapshot: Biometrics in the Workplace Commonplace, but Are They Secure?', Spiceworks, 12 March 2018, available at https://community.spiceworks.com/security/articles/2952-data-snapshot-biometrics-in-the-workplace-commonplace-but-are-they-secure

6. An additional potential benefit is the potential of touchless biometric security to limit infectious disease transmission: US-based IT firm Hewlett Packard Enterprise adopted a facial recognition access system to reduce COVID-19 infection risk compared to, for example, machines requiring PIN code entry. See: https://www.hpe.com/us/en/newsroom/press-release/2020/06/hpe-to-deliver-five-new-return-to-work-solutions-to-help-organizations-accelerate-recovery-in-wake-of-covid-19.html, accessed 6 August 2021.

7. For a discussion of the complexity of meaningful consent to data collection within the employer-employee relationship, see Moore (2020).

8. Linda Qu, '99% of Fortune 500 Companies Use Applicant Tracking Systems', Jobscan, 7 November 2019, available at https://www.jobscan.co/blog/99-percent-fortune-500-ats/

9. The experiment was designed so that the algorithm's recommendation randomly overrode the choices of human recruiters about who to invite for interview. The effects measured were derived from candidates selected by the algorithm but not by the human recruiter.
10. Drew Harwell, 'A face-scanning algorithm increasingly decides whether you deserve the job', Washington Post, 6 November 2019, available at https://www.washingtonpost.com/technology/2019/10/22/ai-hiring-face-scanning-algorithm-increasingly-decides-whether-you-deserve-job
11. Minda Zetlin, 'AI Is Now Analyzing Candidates' Facial Expressions During Video Job Interviews', Inc., 28 February 2018, available at https://www.inc.com/minda-zetlin/ai-is-now-analyzing-candidates-facial-expressions-during-video-job-interviews.html
12. Gartner defines monitoring as "analysing the text of emails and social-media messages, scrutinising who's meeting with whom, gathering biometric data and understanding how employees are utilising their workspace."
13. Information in this paragraph is taken from Colin Lecher, 'How Amazon Automatically Tracks and Fires Warehouse Workers for "Productivity"', The Verge, 25 April 2019, available at https://www.theverge.com/2019/4/25/18516004/amazon-warehouse-fulfillment-centers-productivity-firing-terminations
14. See for example Kate Connolly, 'German supermarket chain Lidl accused of snooping on staff', The Guardian, 27 March 2008, available at https://www.theguardian.com/world/2008/mar/27/germany.supermarkets, and Ian Sparks, 'Boss orders female staff to wear red bracelets when they are on their periods', MailOnline, 30 November 2010, available at https://www.dailymail.co.uk/news/article-1334400/Female-staff-Norway-ordered-wear-red-bracelets-period.html
15. See https://cogitocorp.com/product/
16. Eurostat hsw_n2_02.
17. Eurostat hsw_n2_01. Serious is defined as causing at least four days absence from work.
18. A detailed analysis of each of the five channels is reported in Hoffmann and Mariniello (2022).
19. See Tyler Sonnemaker, 'Amazon Is Deploying AI Cameras to Surveil Delivery Drivers "100% of the Time"', Business

Insider, 3 February 2021, available at https://www.businessinsider.com/amazon-plans-ai-cameras-surveil-delivery-drivers-netradyne-2021-2

20. See Sarah Jackson, 'Amazon's AI-powered cameras punish its delivery drivers when they look at side mirrors or when other cars cut them off, report says', Business Insider, 20 September 2021, available at https://www.businessinsider.com/amazon-delivery-drivers-netradyne-ai-cameras-punished-when-cut-off-2021-9

21. Measured effect of 55+ working hours per week compared to regular (35-40) working hours.

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Big tech reset?

EU court dismisses Google appeal. Renaud Foucart believes the knock-on effects from this ruling could be enormous as tech giants consider their business models

Google is being fined €2.4 billion (£2.1 billion) for hindering competition in the EU after a 2017 decision has been upheld on appeal by the general court of the European Union. This is a saga dating back over 15 years, in which the European Commission has been accusing the tech giant of using its search results to give preferential treatment to its comparison shopping service over those of competitors.

The fine, of which a share will directly go to the UK by virtue of the EU withdrawal agreement, is also a vindication of the long fight against big tech by competition commissioner Margrethe Vestager. She suffered a crushing defeat in July 2020 when the same court overturned a €13 billion fine imposed on Apple for an elaborate – but legal – tax avoidance scheme.

But this time, the tide has turned and the message is clear: the regulators will not allow Google and its fellow tech giants to steer consumers towards their own products. They may now have to re-think their entire business models as a result. The internet as we know it – in which most services are free to use but consumers pay by giving away their private data – may come to an end.

The case against Google

Everything started in 2005 when a British couple, Adam and Shivaun Raff, developed Foundem, a new service for comparison shopping. Google had its own comparison service named Froogle (now Google Shopping), although by its own admission in 2006 in an internal document, it *"simply doesn't work."*

Foundem found itself demoted from Google's search results. Unless you specifically searched for it, it would only appear after several pages of browsing. Without consumers redirected from the dominant search engine, Foundem never really took off.

Having suspected that Google was restricting competition, Adam and Shivaun Raff attempted to convince the company to allow them some visibility. In 2009, they gave up and brought a complaint to the European Commission against Google for abuse of dominant position.

Over the years, several other comparison services such as Expedia and Yelp joined the complaint. They had also attempted to compete with Google, only to see their websites suddenly relegated to the bottom of the search results by the dominant search algorithm.

... the general court's verdict is likely to remain the guiding principle for the years to come, with major consequences for consumers

Then Google competitors in other markets started accusing the American company of anti-competitive practices. One complaint was about Google forcing the pre-installation of free Google software on Android phones, for example. Another was about Google forcing advertisers to use the company's services if they wanted to take out ads on YouTube. In all, Google is fighting a long series of similar cases on appeal against the commission.

This is where Google's fine over Froogle becomes really serious. It is far from being the largest imposed by the European Commission, but it may be the most consequential because the upcoming appeal cases are likely to use this one as a precedent.

Big tech and consumer rights

Internet companies like Facebook and Google get their revenue by monetising the data of their customers to show them search and display advertising that is relevant to them. They build an estate of companies – for example Google Search, Google Maps, Google Shopping and YouTube – and try to make sure that when consumers leave one service they stay in the estate.

The estate of Google is called Alphabet, and 80% of Alphabet's revenue comes from Google ads. The problem arises when a company like Google tries to keep consumers on their estate by hindering competitors.

Google and other tech giants know almost everything about us because they gather information from so many different sources. The logic of the current judgement is that those sources should work as separate entities.

In the future, your Google Maps or flight comparison experience may not use the information Google owns about you, or alternatively the company would have to share the data with competitors.

At the same time, Google may not be able to pre-install any of its services on Android phones, and may be forced to give consumers a fair choice of alternatives to Gmail, Maps or YouTube.

This case also confirms divergent approaches to competition policy in the EU and US. The main objective of competition policy, both in the US and Europe, is to protect consumers.

But in the US, the competition authorities concluded in a similar case in 2013 that the behaviour of tech giants does not hurt consumers. Their intuition was that what makes Google rich is what makes consumers happy, that consumers do not mind handing their personal data to this company as they get tailored advice in exchange.

Of course, it may seem that consumers do not care about giving away privacy simply because they are not aware of how much Google knows, and of how much money they make out of their data. For instance, when people started to notice that what is now called Meta, the estate of Facebook, was looking for ways to earn money from WhatsApp users, it caused quite a stir.

European regulators have taken a radically different approach. Their reasoning dates back two decades, since they first fined Microsoft for pre-installing Media Player and Internet Explorer with then-dominant operating system Windows 95.

The same essential objection has now been applied to Google. By blocking competitors from entering the market, consumers lose the benefit of potential innovations. With that logic, we enjoy the free services of Google simply because we have no idea how much better the alternatives could be if they got a chance to develop.

The general court of the European Union has vindicated the view of the European Commission that Google's behaviour is anti-competitive. Google may try to appeal to the European court of justice, but the general court's verdict is likely to remain the guiding principle for the years to come, with major consequences for consumers.

If tech giants cannot earn money from their current business model, they may have to find other sources of revenue, either charging directly consumers or by creating a more transparent system in which consumers are aware of the value of their data and sell it freely.

Whether the US will follow suit, and with whom the UK will choose to align if antitrust policies start to diverge radically across the Atlantic, are now the next big questions. ■

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