THE END OF THE COMMONS[1]

Thoughts on sustainability
A position paper

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Abstract

In this position paper on climate protection and economic and social sustainability, economic theory dealing with ownership rights and internalised and externalised costs is set in relation to the dramatic decrease in information and transaction costs brought about by the technological innovations of the past 50 years. In this particular constellation, it is probable that the extraction of carbon, its consumption and its removal from the atmosphere will give rise to a new market with stakeholders on both sides. For those involved in carbon removal, new ownership rights will arise. As a result, the atmosphere will be treated less as a commons, leading to ownership losses for carbon consumers.

In a visionary "net-zero" world of compensation, the authors stipulate the use of CO_2 certificates issued using secure, forgery-proof technology as well as the compensation of CO_2 potential at the source as key means to preventing a wave of all-pervasive controls. As such, this position paper has a clear political dimension.

1 We thank Dr Ivan Adamovich, Dr Paul Gilgen and Dr Gerhard Schwarz for their critical and supportive comments on the first draft of this paper.

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A Introduction

Is it still possible to make a relevant contribution to a topic as widely discussed as sustainability and the climate? Does an attempt to clarify our thoughts even make sense when the positions seem firmly staked out and all we need do is hold faith with one side or the other – the climate activists or climate deniers? Is there still scope for novel and creative ideas, or has all the terrain been claimed?

Indeed, some outside pressure was needed for the authors to tackle an issue of such magnitude as the climate problem. One catalyst was the rational response of corporations to the foreseeable slew of new environmental and climate protection regulations, the need to gain a clear perspective on the sense – or non-sense – of so-called "green investments" on the capital markets another, not to mention the integration of ESG criteria (Environment, Social and Governance) in the investment recommendations of banks and institutional investors.[2]

Yet all this would not have been motivation enough for us to pen this piece. Rather, it was our first-hand observation of change around us: the depletion of Switzerland's mighty Aletsch and Morteratsch glaciers makes it clear that simply shrugging our shoulders and disengaging on climate issues is not a viable option. At the same time, we remain sceptical enough to not simply swallow the climate hype. The quickness of governments and politicians – not to mention trend-savvy institutions such as the World Economic Forum – to leap on the green bandwagon is cause enough for pause. As ever, our stance remains: "We take nothing at face value and we would put nothing past anyone." In other words, we believe anyone and everyone capable of anything and everything. And that applies equally – if not more so – to the topic at hand.

Economic theory can contribute greatly to a better understanding of the real issues at hand and deliver key indicators – perhaps even actual recommendations – on how to best shape the future. Therein lies the aim of this paper. After a presentation of the basic issues and key facts (section B), section C describes the economic effects of some key technological innovations on the social and economic structures of our world. The fourth part (section D), outlines in somewhat visionary fashion where these changes may lead. Without giving away the conclusions here, it is fair to state that the world should steel itself for extensive and radical change. The fifth section (E) describes the path ahead to a fundamentally new world order. A path that is rocky and potentially dangerous as, among other challenges, it will largely involve a re-allocation

2 According to a Swiss market study on sustainable investments conducted by Swiss Sustainable Finance in collaboration with the University of Zurich, the market for sustainable investments has, for some years now, been growing at double-figure rates (2020 +31%) and was worth around CHF 1,500 billion in 2020, with ESG-compliant investments making up the largest share.

of ownership rights and significant changes in the value of existing property. Furthermore, in the wake of the above-mentioned hype, there is already evidence of market distortions, poor policy choices and malinvestment. The closing section (F) addresses potential courses of action that will be of fundamental significance and lasting consequence for society.

B The unknown commons

In 1494, Franciscan monk and mathematics professor Luca Pacioli (1455 to 1514/1517) published his summary of the mathematical knowledge of his time, the "Summa de Arithmetica, Geometria, Proportioni et Proportionalità", in which he described the "Venetian method" of commercial bookkeeping, thus launching double-entry bookkeeping on its path to success; his work was translated into several languages and repeatedly reissued. Double-entry bookkeeping made it possible for the first time to understand economic processes and to move from a purely static view of a business's financial situation to an appreciation of its cashflows. Indeed, in its significance, double-entry bookkeeping can be mentioned in the same breath as the advent of the printing press, which evolved at a similar time. Without the latter, there would have been no Renaissance, Reformation or Enlightenment; without the former, no stupendous surge in economic prosperity as seen in the Modern era. Managing a company without information on its dynamic components is simply unfathomable.

Double-entry bookkeeping revealed once and for all how much money was being spent and on what – and also where the potential for maximising residual equity capital lies. This most likely helped the House of Medici to its fortune, and cost control remains a key element of company management to this day. Indeed, maximising equity capital was equated by Adam Smith with optimising owner utility, a notion that underpins his theory of market economics and later led to the establishment of (ever-more state) institutions to secure property rights. Adam Smith further outlined a moral incentive for economic activity by illustrating how trade and commerce under free market principles ultimately benefit the prosperity of all – the famous "invisible hand".

However, as fundamentally important and correct as Pacioli's double-entry bookkeeping proved for subsequent economic developments, so too was it incomplete. Because it captures only the identifiable, visible *internal* costs of an economic activity, but not the indirect, invisible *external* costs it transfers to unknown third parties. Although the contamination of waterways by the booming textile industry should long have prompted systematic reflection, and although air pollution, especially near coalmines, reached dramatic levels, it was not until the 20th century that economist Arthur C. Pigou first introduced the notion of external costs into

economic theory, and that at the macro-economic level. Indeed, awareness of external effects (both negative and positive) generated by business activity was slow to dawn.

No doubt it was "The Problem of Social Cost", the seminal article by Ronald Coase (1910 to 2013) published in the *Journal of Law and Economics* in 1960, that paved the way for consideration of the external effects of commercial activities. In his famous theorem, Coase describes the interaction of two neighbouring economic agents – a railway operator using spark-emitting engines and the owner of a wheat field – and demonstrates that their utility maximisation is the same, regardless of which party is liable for damages from the perspective of property rights. The one absorbs, so to speak, the external effects of the other: the external costs are internalised. The condition being, of course, that the information and transaction costs of the parties are low or negligible. As a rule, however, this is not the case, which is why sub-optimal situations arise that call for a regulator. It is also termed a market failure.

The matter of information and transaction costs is particularly problematic when, rather than involving two neighbouring market players, there is an undefined community on one side of the equation. In other words, an unknown number of unknown people, who, perhaps without noticing, are already suffering in some small way from the external effects of an economic activity, but for whom it does not pay to lift a finger – let alone do more – to address the situation: the cost of collective action is prohibitively high, and the potential benefit to the individual is too low.[3]

Garrett Hardin, in his famous 1968 essay "The Tragedy of the Commons" (published in the journal *Science*), describes precisely this situation – and terms it a tragedy. Commons are over-exploited because no one acts in their defence. What applies to the oceans' fishing grounds applies equally to pastureland, free parking spots, and public toilets: human beings, regardless of how cultivated they style themselves, tend to abuse public goods. In his paper, Hardin describes the conditions under which a commons dilemma can be identified, addressed, and possibly even resolved – namely when the situation becomes tangible, disadvantageous or painful. Already in 1968, Hardin identified human overpopulation as a future challenge, one for which he saw few satisfactory solutions: most involve strict regulation and oversight and are born of a political process that, depending on the circumstances, can prove particularly painful.

Every car exhaust pipe, every smokestack is an instrument for abusing the common good of air. Similarly, the old practice of draining industrial wastewater in rivers, lakes and the oceans – and household sewage in the nearest cesspool – is nothing more than a generally accepted practice of shifting external costs onto society, here an undefined community downriver. After

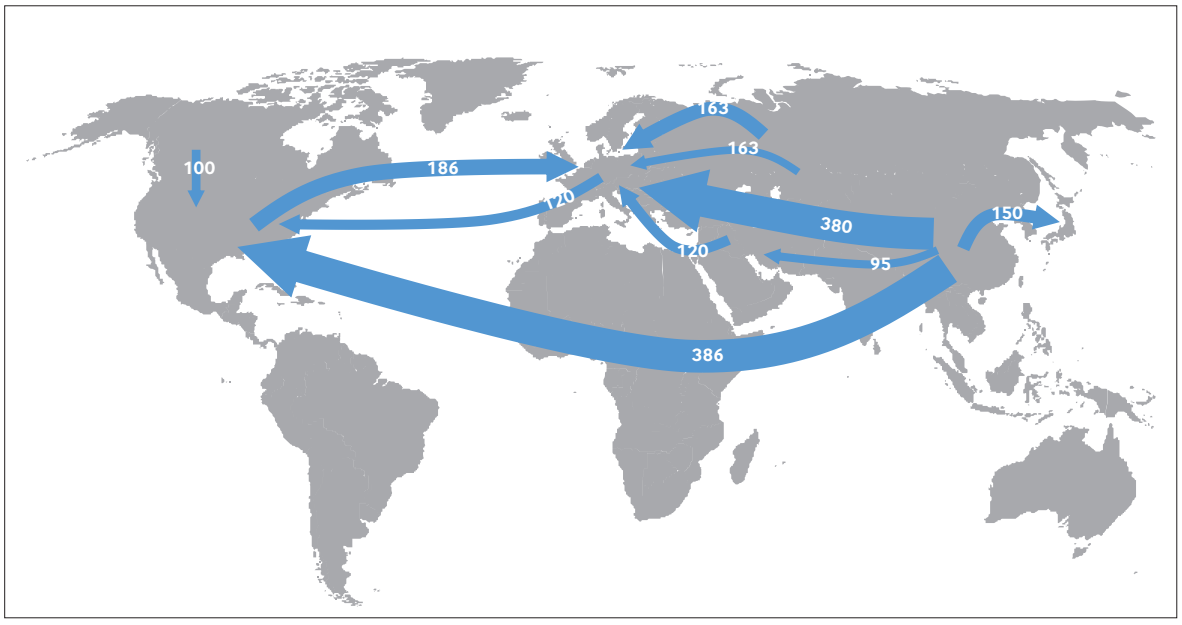
3 The underlying theory is found in "The Logic of Collective Action" by Mancur Olson, 1965.

World War II, many countries in the Western world set about cleaning their waterways. Likewise, air pollution, at least at a local level, was reduced via smokestack filtration and prohibitions on burning certain fuels, such as coal, in private homes. In other developments, the lead in combustion-motor fuel was replaced, for instance, with methyl tert-butyl ether; and in diesel motors, the emission of nitrogen dioxide and particulate matter was reduced to a point that performance was compromised under normal driving conditions, such that one company felt induced to establish a separate operating mode for exhaust emissions testing – a fraud exposed by the Dieselgate scandal. Common to all these clean-up efforts, however, is this: they took place where the effects of pollution were more or less visible, recognisable – and felt: the degree of suffering was high enough for the collective to exert political pressure.

The fact that it took a relatively long time to understand that "pollution" was not the environmental issue per se but only a relatively small part of the overall problem, was probably related to the reorganisation of the global economy. Indeed, in the course of globalisation, the production and consumption of goods have become geographically decoupled. In other words, the dirty work of production has been moved far from the place of consumption – and there it remains. The following figure illustrates the magnitude of this discrepancy: emissions are generated on one side of the world to facilitate consumption on the other. Without wanting to question the merits of globalisation – the polluter pays principle is hardly furthered by this arrangement.

Out of sight, out of mind

Net transfer of mega tonnes of CO_2 from place of origin to place of consumption. The ten largest transfers are shown; here Europe is treated as one region.



Source: Global Carbon Project, Global Carbon Budget 2021; own illustration

For these reasons, signs of global warming were needed to draw humankind's attention to a greater externality problem, namely that of the largely undefined commons of the atmosphere. To be sure, warning signals had been sounded some years earlier about the "irresponsible" consumption of oil and gas resources, albeit not due to concerns about global warming but the depletion of resources. That is how it was clearly propagated by the *Club of Rome* in the 1970s, and later too, around the new millennium, by the prophets of peak oil. The fact that coal, crude oil and natural gas – aggregated bacteria, plankton and plant substances fossilised over millions of years – belong to the most valuable resources that the earth's crust has to offer, and that these resources are literally being burned up within just a few hundred years, was of course protested by scientists and far-sighted ecological thinkers. Yet still the issue did not gain traction with the public or in politics.

With all our reservations about the shrill tone of much climate activism, we must concede that the movement has greatly contributed to raising public awareness. Even if the apocalyptic visions and dogged one-sided focus of climate activists meet with consternation in pluralistic societies, the zeitgeist has never had an interest in respecting the status quo – and it was always capable of toppling conventions and institutions. Regardless of how we have reached this point, however, global warming has become the overriding issue in all spheres of society and politics, and it has been displaced only momentarily by the more immediate problems of the pandemic and the Russo-Ukrainian conflict. Furthermore, a certain consensus has emerged on the issue: yes, climate change is a fact and (probably primarily) caused by the proliferation, lifestyle and behaviour of the human species. And yes, we must act to slow, halt or even reverse these developments. How quickly and by what method and at what cost – these are matters of lesser agreement. That young people demand faster action is, in view of the intertemporal problematic ("today's pleasure is tomorrow's pain"), simply explained from an economic perspective.[4]

The atmosphere as a commons: that will work for as long as the earth's CO_2 resorption capacity remains uncompromised and the chemical composition of the atmosphere remains more or less stable. Yet research over the last 20 to 30 years has shown that emissions, including those caused by human activities are changing this composition to the extent that global warming could have perilous consequences within a relatively short period of time.[5] The data currently

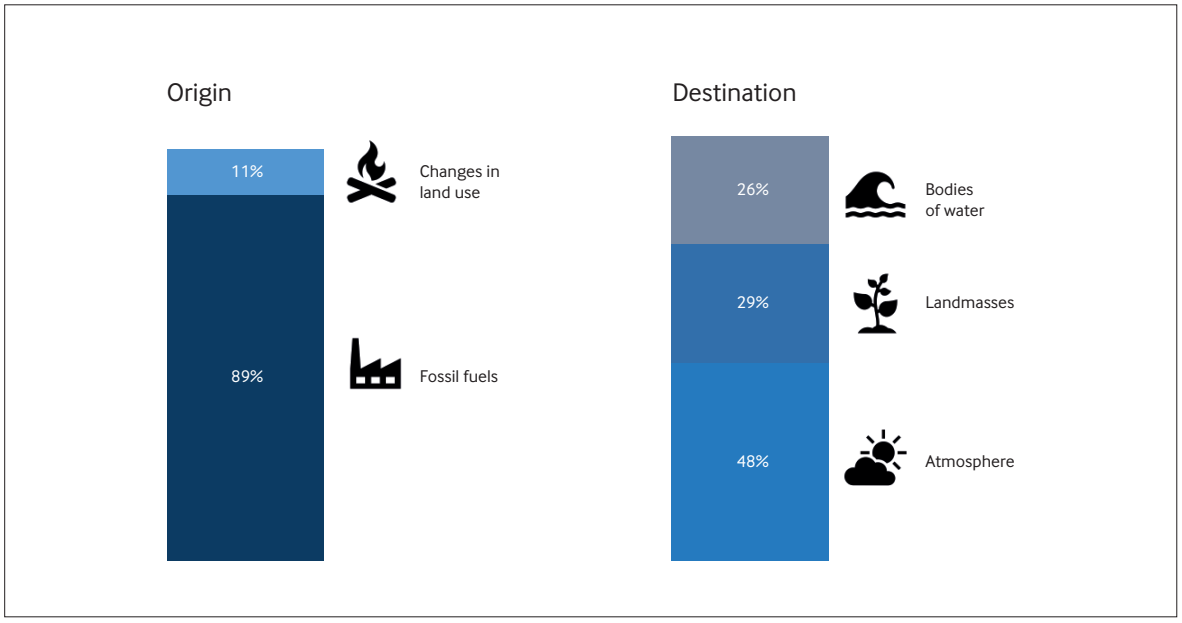
4 In the interest of completeness and to present a balanced view, it should be mentioned here that a minority group see the increase in atmospheric CO_2 concentration not as a negative but a positive factor, and that CO_2 emissions thus represent a positive externality. The thinking is that CO_2 promotes plant growth and would enable land that is currently non or only partly arable (such as in the highlands of South America) to be used for agricultural purposes. At the same time, it must be noted that due to the complexity of the models involved, the extent of human influence on global warming is disputed, thus converting an object of science into an object of faith.

5 Changes in the composition of the earth's atmosphere were not unusual in the history of our planet, triggered by non-human causes such as volcanic eruptions and strikes by comets and asteroids, and also by endogenous events such as the excessive proliferation of certain species (cf. Konstantin Sakka's guest opinion piece in the NZZ newspaper dated 31 December 2021).

available suggest that we continue to release approximately 50 percent more CO_2 into the atmosphere than our oceans and land biosphere can resorb. The following figure depicts the current estimates.

Emissions and where they go

Global representation of CO_2 emissions and where they are absorbed. The discrepancy of three percent between their origin and destination results from estimation and calculation difficulties.



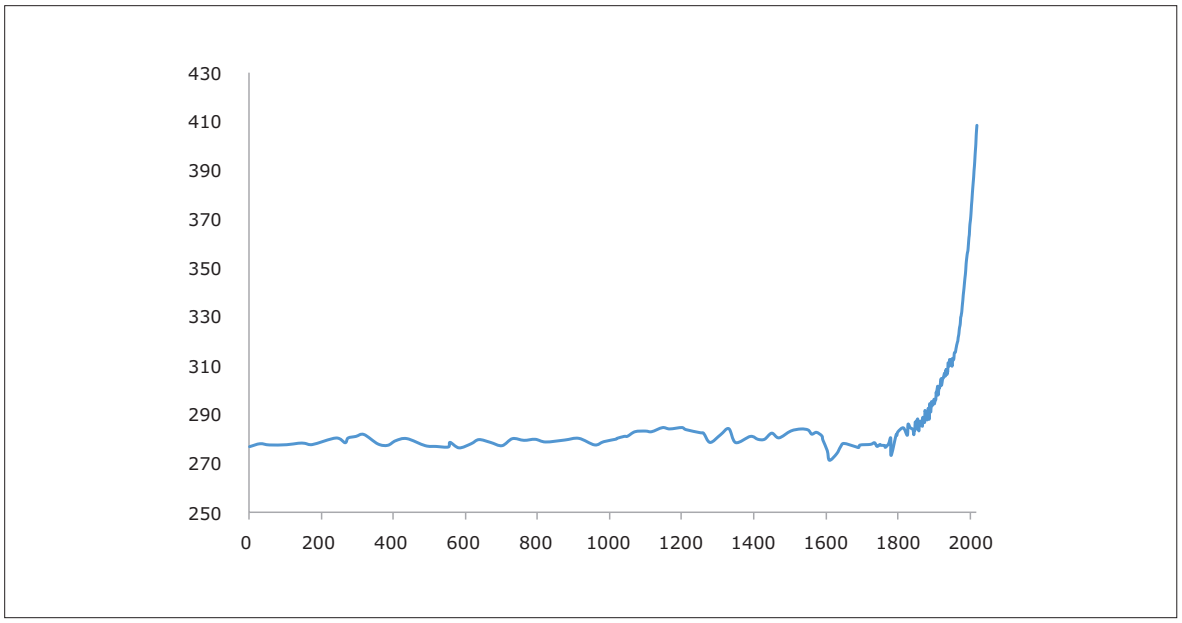
Source: Global Carbon Project, Global Carbon Budget 2021; own graph

There are good reasons to doubt this model and others too, and it is certainly welcome and important that scientific discourse on the matter takes place and critical voices are not simply decried as "climate deniers". When in the following chapters we nonetheless adopt the view that both a real climate problem and a visible externality problem exist, then for the following reasons:

1. The rapid depletion of aggregated carbon and its historically rapid consumption are fact. Indeed, it would be surprising were such activities to have no effect on the atmosphere and oceans.
2. Overall, the world economy is highly "carbonised", i.e., dependent on the consumption of carbon. If this consumption grows, the related problems will grow, not diminish.
3. The global population will further increase in the foreseeable future. And these additional human beings – who will likely enjoy longer lives than their predecessors – will also emit CO_2.

CO_2: an undeniable increase

Atmospheric CO_2 concentration in parts per million (ppm) for the period 0001 to 2018



Source: Our World in Data; own graph

That said, we do not wish to determine here how urgently the solutions are needed. Indeed, this line of argument is not essential to our further deliberations, as we assume that developments to overcome the externality problem will take place regardless. In fact, there is already empirical evidence of this occurring. For instance, the Swiss firm Climeworks[6] has succeeded in convincing companies to pay a current price of approximately USD 550 per tonne for underground sequestration of carbon dioxide via facilities in Iceland (a land of abundant geothermal energy) that extract CO_2 from the air and convert it into solid carbon. The Restor Foundation[7], by contrast, makes the most of the natural potential of sunlight and photosynthesis: it provides companies and private individuals with opportunities to offset their ecological footprint through suitable restoration and conservation projects.

One thing, however, seems clear: the greater the need, the faster the transformation – regardless of whether the side effects of the process prove even more consequential.

6 www.climeworks.com
7 https://restor.eco

C Technology-based structural change on the horizon

Over the past 50 years, developments in information and communication technologies have radically altered economic circumstances – indeed, the very way humans live. It is superfluous to detail the technological side of this extraordinary story here. Rather, our work is to correctly present the economic reality and implications of these changes.[8]

For the sake of clarity, we begin not after World War II, when electronic data processing gained a foothold and communication technologies made a giant leap, but with the Babylonians and their prodigious use of clay tablets.

As data storage devices, clay tablets were essentially one thing: heavy. Not to mention highly limited in capacity. Moreover, the information stored thereon was easy to change or erase. Information processing, as required to administer an extensive empire, for instance, was by necessity decentralised and no doubt entailed immense human resources. The invention of paper, printing presses, filing card systems, photocopiers, faxes, and early and next-generation computers increasingly improved the situation, but on a fundamental level, nothing really changed: until relatively recently, data handling has always entailed high collection, processing and storage costs and was constrained by the limits of possibility.

In many respects, modern information technology has resolved the issue of high costs and other constraints, because they now *no longer exist*. This starts where information is created, in other words where one state of knowledge is transformed into another. For instance, when we walk through an airport body scanner. Our name and photo, not to mention perhaps our naked body scan, amount of toothpaste in the tube, brand of deodorant, mobile phone data complete with all contacts and messages, laptop content – all such data can, or could theoretically, be collected. When we write an email, not only keywords but entire texts can be captured. When we are active on social media, our user behaviour is analysed to generate accessible personality profiles. Through access to bank account information, either illegally via data CDs, or legally through the now authorised automatic exchange of information, the same applies to our personal financial profile. All our physical and online activities create a *trail of data* that can be *collected at practically no cost*. Vestiges of information, from small to microscopic, which are generally – when taken individually – completely irrelevant.

8 This position paper draws in this regard on the "Bergsicht" publication by M1 AG entitled "Total Data" (issue 4, December 2013) available at www.bergsicht.ch.

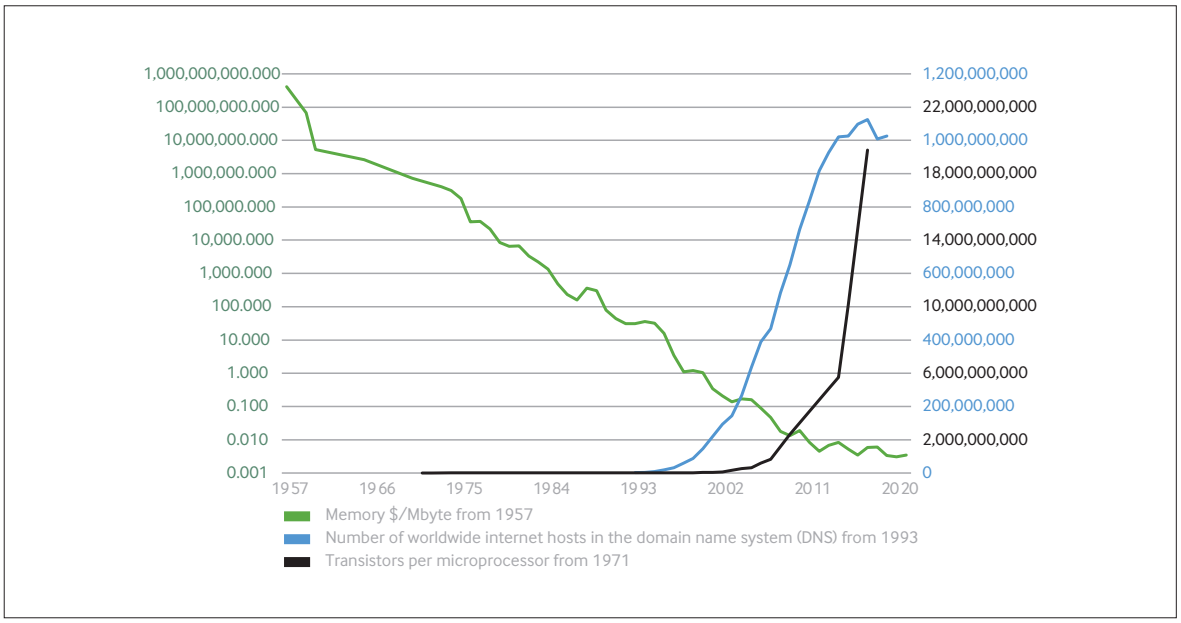
But that is not where it ends. Aside from quasi no-cost data collection, *unlimited processing* is now possible – also at exceptionally low cost. Those who access information, regardless of what and how, can have their merry way with it: generate a personal profile, segment information, aggregate information. Just use the words "holidays", "beach" and "palm trees" in a few emails, and lo and behold, advertising banners for Mauritius, the Maldives and Miami abound. Whether that, from a higher perspective, is a good or bad thing is another matter. Our point is that this – and much more besides – is both possible and actually occurring. Whether we use a search engine, an email server or an online newspaper, the data we generate is continually collected, processed and "refined" for other purposes.

And that is still not where it ends. More importantly, the *storage* of information collected and processed in this way is also possible at *exceptionally low cost*. Modern storage media, be it physically at home on a personal computer or virtually in the cloud – a curiously invisible megabyte cumulonimbus – can easily archive a whole library, enabling it to be retrieved on command. And the programmes for relocating information are becoming ever better and more user-friendly. Indeed, we now have nothing short of time machines at our disposal that are capable of presenting complete data sets for any given point in the past. In other words, modern information technology, having overcome the hurdles of distance and data volume, has now overcome many roadblocks posed by the aspect of time. In principle, nothing is ever lost, everything can be recovered. Memory, on both an individual and collective level, has become infinite.

Somewhere in the internet, with unknown possibilities for access by authorised (as well as less authorised and totally unauthorised) entities, lie a multitude of more or less complete mosaics. These mosaics create an image of us, describe us, and give indicators as to our probable behaviours and preferences. In contrast to physical mosaics, however, such as those in Ravenna and the Hagia Sophia, these are not static images, but films, dynamic coming-of-age novels. And they are either linked to the internet protocol address of our electronic devices or (thanks to credit card payments, electronic banking, and smartphone contact details and photos) our names and home address. Moreover, these digital mosaics have not only a third, temporal dimension – they also map out our personal networks and can be linked to generate overarching mosaics of relationship clusters. Today's computers have the ready capacity to model smaller and larger aspects of a society.

Sky-high capacity, rock-bottom prices

Indicators of technological development over the past 60 years



Source: John C. McCullum; Our World in Data; Statista; own graph

Taken together, this is what we call big data – an adequately self-descriptive term. From an economic perspective, big data has dramatically reduced information and transaction costs and will continue to do so. From lugging around clay tablets to shopping on Amazon: that would be drastic enough in itself. But where modern technology really takes on *secular potency* is in the algorithmic recombination of enormously simple and cost-effective data collection, equally cheap data processing and the possibilities of data retrieval at practically no cost. This is where artificial intelligence (AI) comes into play. Using AI, not only can the proverbial needle in the haystack be found, but also the reason why it is there, the patterns according to which needles disappear in haystacks, and the provisions required to prevent them from getting lost in haystacks in the first place. The step from full traceability to normative process design is logical and obvious. What can be understood, can be influenced. Both on a large scale (harvesting and storing hay) and a small scale (sifting out needles). And the costs are tending towards zero, allowing for a fine-meshed filter indeed.

The unprecedented rate at which measurement, information and transaction costs have decreased and the opportunities this presents to easily influence the course of events – in other words, cheaply and effectively – must now be set in relation to the economic theory outlined in section B. According to Coase, an efficient cost and return allocation between two interacting economic agents can be established regardless of the property rights situation,

but only if information and transactions costs between the two parties are *non-existent*. In practice, this has never been the case, thus institutions were required to define and secure property rights and obligations in order to regulate the externalities – at least where these could be identified and quantified.

The tragedy of the commons, as presented by Hardin, results directly from high information and transaction costs: the costs of measurement and collective action (which are effectively information and transaction costs) to exercise property rights are so prohibitive that no one sees themselves called upon to defend the larger community interest – the commons.

Having observed how technology has enabled information and transaction costs to approach zero, all that remains is to extrapolate the logical outcome of these developments: the more information and transaction costs cease to exist, the more likely a Coase situation will occur – in other words, a *self-regulating property regime* – and the more likely the commons, as described by Hardin, will disappear. The reason is that in every case and at every point in time, it is easy (that means cheap and effective) to take collective action and exercise property rights. Or put differently: thanks to the dramatic decrease in information and transaction costs, which are frequently near zero, the allocation and regulation of *property rights* worldwide will be restructured – and in many places come into being for the first time – and the significance of the *commons* will decrease, with *elimination* as the trend.

When we combine this theoretically derived insight with the potential of AI and the explosion in information and its simple retrieval, and we then exponentiate this by the increasingly noticeable damage to the various commons of the world caused by economic and population growth, then it is no baseless exaggeration to predict *massive structural change* in the years and decades ahead. Essentially, this will involve the transition from an incomplete to a more complete form of bookkeeping, one that increasingly excludes damage to the commons and integrates the costs of repair. The practice of bolstering capitalistic business equity capital at the cost of the greater, common residual capital will come to an end – because the commons will cease to exist. The explosive power of this insight cannot be overstated.

D A world of compensation

How could a new world order – an ideal-typical order and hence a visionary, utopian and certainly somewhat illusory one – without an "atmosphere as commons" look and function?

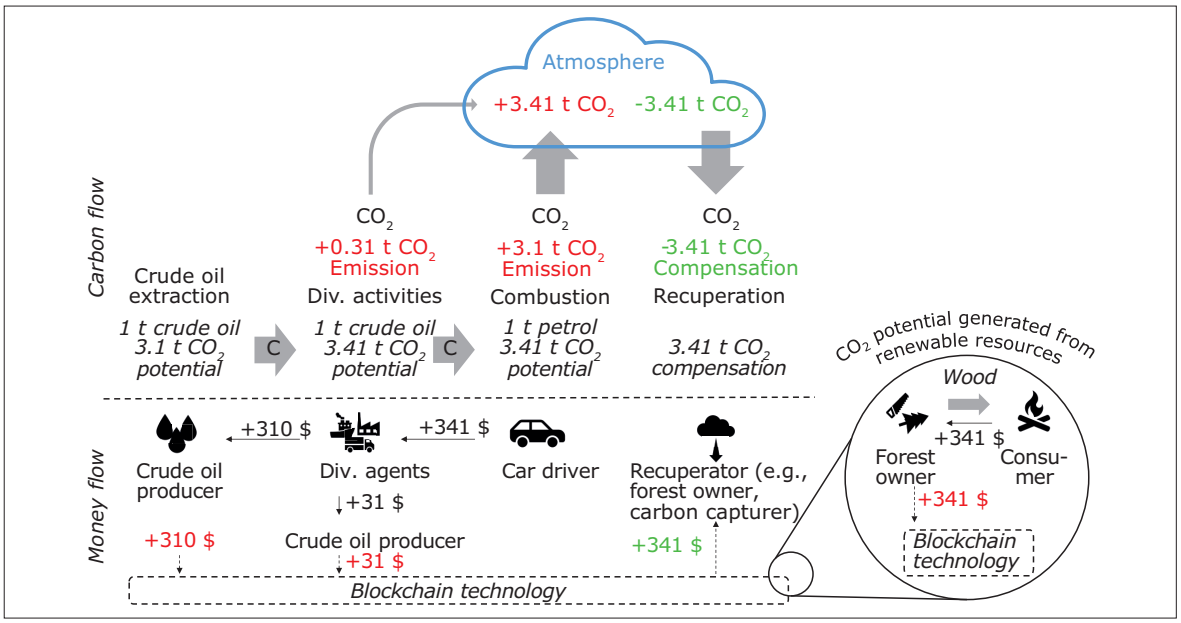
We begin with the side of CO_2 generation.[9] Wherever CO_2 *emissions potential* is created, literally *at the source*, the exact amounts would be registered. This would continue along the entire value chain – right through to the smallest offshoots – of goods manufactured in complex and specialised procedures: wherever carbon is processed such that it could potentially pollute the atmosphere either as CO_2 or in an equivalent chemical form, such emissions potential would be registered. Of course, it must be possible to measure these processes precisely, but with today's high-precision geodetic measurements and satellite surveillance, this is unlikely to pose a technical problem. The registered data then form the basic framework for financial compensation – because pay we must. A certain amount of dollars per tonne of CO_2 potential. For the sake of simplicity, we assume a cost of one hundred US dollars per tonne.

This price can be passed further along the product chain, somewhat like *accrued value added tax*. A few examples: black coal is mined in Germany, and the mine pays $240 per tonne of coal (namely 2.4 * $100.00 = $240.00 for CO_2 potential of 2.4 tonnes of black coal). The coal is then used to generate electricity in an adjacent facility. The cost of a kilowatt hour of electricity then increases by $0.03 due to the energy potential of coal. Another example: oil mining in Saudi Arabia, which produces 3.1 tonnes of CO_2 potential per tonne of oil, and for which $310 is paid at the source. Refining the oil then consumes an estimated 10 percent of the mined oil, thus increasing the price of the refined product to $341 per tonne. A third example: a farmer plants a sunflower crop that produces 0.8 tonnes of sunflower oil per hectare (by contrast, palm oil crops produce 5.6t per hectare). Some of the oil is used to produce biofuel for diesel engines, the rest is used to make margarine. Both manufacturers assume their share of the costs incurred by the farmer for generating CO_2 potential, plus the cost of CO_2 potential for the production of fuel and margarine (likewise a form of fuel – for hungry human beings). The same applies to the owner of a forest who fells fir trees for the construction industry. The wood contains CO_2 potential that must be paid for.

9 Carbon dioxide (CO_2) serves here as a proxy for other atmospheric greenhouse gases, such as methane. (In addition to natural sources such as melting permafrost and rice fields, the digestive tracts of livestock, especially cows, are a prominent source of methane – which is one of the arguments against the increasing consumption of meat in an increasing global population). Because different substances act differently over time in the atmosphere, using CO_2 as a proxy for other gases is not without its problems, but satisfactory for our purposes here.

Revolution in circular flows

An illustration of the additional cash flows arising in the petrol value chain. Goods increase in price because the additional costs are passed on to the consumer. By the same token, when forest owners fell their trees, they too incur costs because they generate CO_2 potential.



Own figure

We now consider the opposite side, namely the *recuperators*. Although these activities have largely been ignored in discussions of the climate crisis, it is not so that the atmosphere-as-commons has no regenerative potential. In fact, the opposite is true. Through photosynthesis, plants convert free CO_2 into solid, non-oxidised carbon. Because plants are providing a service beneficial for the atmosphere, they should be compensated accordingly, and at a price equal to the cost levied on the producers of CO_2 potential. What one side has until now externalised (at zero cost), can now be internalised by the other.

In order for this scheme to function, a single convention is needed that applies equally throughout a part of, or ideally, the whole world: net zero. The creation potential must not exceed the recuperation potential. And that applies not only to CO_2, but also to other greenhouse gases.[10] In areas of the world party to the convention, certificates for generation potential and certificates for recuperation would be *traded freely* at a price determined by the market. As such, if potential income from recuperation activities resulted in unproductive land being afforested, the CO_2 price would tend to fall, as would occur if solar or nuclear-powered facilities converted CO_2 into solid carbon. The price would also sink if, due to terror attacks or a new

10 The convention could also aim to overshoot the net-zero target, in other words, net zero minus X or Y, in order to remove excess CO_2 and other contaminants over time. This could be effective in addressing legacy CO_2, for example, or an exogenous event such as a large volcanic eruption.

pandemic, flight numbers dropped and cruise ships remained at anchor. By contrast, the price would rise should economic activities powered by fossil fuels increase or if, as a result of drought, the recuperation capacity in certain areas decreased.

The trading and clearing of CO_2 certificates would take place via blockchain or comparable systems. In principle, a *CO_2 certificate* would have the properties of an *asset-backed coin* and could thus be treated as a type of circulating currency. It would have the advantage, unlike other forms of money, of being non-inflationary. Would an organised national or supranational market be required for trading and clearing? Who ensures sufficient market liquidity? Who enforces the newly created property rights? The issue of regulation is addressed in the last section of this paper, but this much can already be said: there are convincing arguments in favour of a spontaneous order, as postulated by economist F. A. von Hayek. Through stakes in certificates, the atmosphere – currently owned by everyone and thus no one – would, so to speak, be privatised in a self-organising process.

To monitor generation of potential and recuperation, the systems that already play a significant role in social and economic life could be implemented. Google Earth can measure a plot of land almost down to the millimetre; coupling this capability with the owner of a recuperation activity, would, aside from routine work, be "merely" a matter of the respective land and property regulations. However, it is important that the recorded activities can be reliably ascertained, just as today's navigation systems can show where breakdowns have occurred on motorways.

Must the combustion process, the actual generation of CO_2 by consumers as end users, be subject to oversight? If the creation of CO_2 potential is consistently recorded at the source: no. Because then the cost is automatically passed onto the consumer last in line. But for that, consumers are fully free as to how they wish to generate "their" CO_2, be it to run a charity event or take a spin in a classic car. In other words, the freedom of the individual would not be significantly limited – unless one sees compensating for costs that have until now been externalised as a restriction on freedom. But here, too, it is not possible to take a bath without getting wet. The more CO_2-intensive a product or process, the more expensive it will be. The devil-may-care attitude to polluting the atmosphere, such as through cheap flights, will face a reckoning.

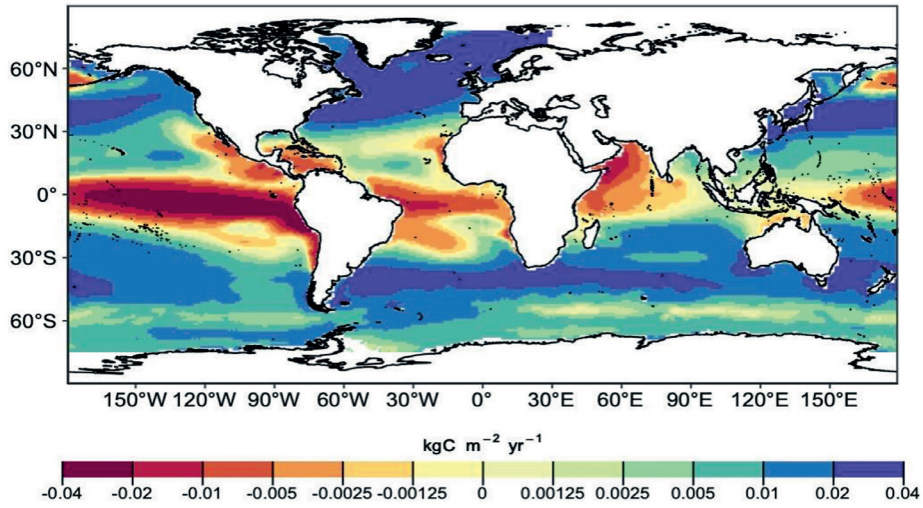
If global participation in this kind of compensation system cannot be attained, which is probable given the current state of world affairs, the agreed system must levy tariffs to protect itself from other systems. Imports must be increased in price by the equivalent CO_2 compensation costs, and income from such tariffs could be used to lower the price of export goods

saddled with the cost of CO_2 compensation. Although this solution is admittedly sub-optimal from the perspective of attaining a global CO_2 balance, it is at least reasonably workable from the perspective of trade policy.

And now to the substantial issue of the ocean. The world's oceans play a critical role in the balance of CO_2 emission and recuperation. But with significant geographical differences, as the following figure shows. The reason lies in the differences in water temperature: the warmer the water, the more likely it is to emit CO_2; the cooler the water, the more likely it is to recuperate CO_2.

Not all oceans are equal

Capture and emission of CO_2 by the world's oceans



Source: Global Carbon Project, Global Carbon Budget 2021

Together, the oceans form part of a highly complex system that is inextricably linked with the chemical composition of the atmosphere. The higher the CO_2 concentration in the air, the more CO_2 the oceans absorb. But the recuperation of CO_2 by the oceans has its price: carbonic acid makes the water ever more acidic. Research on these matters has certainly not come up with definitive findings: What are the oceans' limits as a carbon sink? And at what water temperatures would emissions start to accelerate?

Unlike with land, however, assigning the world's oceans to specific owners is almost inconceivable. Most likely the oceans will remain a commons for a long time to come. Theoretically, their estimated capacity as a carbon sink could be calculated into a net-zero convention – per head,

per land area, or per economic performance, or using a combined factor that takes several components into account. Vastly simpler, however, is an approach that excludes the world's oceans and focuses on CO_2 recuperation by landmasses and through human technologies.

Is that a desirable world? We do not know, nor do we wish to judge. The risks on the path to this "world of compensation" is the topic of section F, and we will address the matter there. Here, our observation is this: if the theoretical framework provided by Coase and Hardin holds, then this new world will emerge, whether desirable or not, just as other equilibria emerge of their own accord when the requisite conditions come into being. And that these, based on the change in information and transaction costs, do exist in our case has been sufficiently proved. Interestingly, there is already empirical evidence for this last assertion. One instance is the firm Climax, which helps organisations assess their ecological footprint by determining, among other things, the CO_2 emissions generated by their business activities and the matching opportunities for CO_2 recuperation. We have referred to some existing recuperation technologies in section B.

E Better the journey is *not* the destination

The basic premise of this position paper is that technological innovation precipitates structural change. Karl Marx took a similar view, even if in his case the Hegelian dialectic on the course of history always culminated in one thing: technological innovation – the great enabler that inspires the zeitgeist, the philosophical mind, the opinion leader, the person on the street, and that is a catalyst for upheaval, revolution and new eras. For us, there is no question the world is currently undergoing a period of radical change, a change driven by supremely efficient data collection, storage, analysis and processing, as well as virtually unlimited low-cost communications. There would be no outcry about discrimination, no movements on gender issues or advocacy for disadvantaged groups if technology had not made the discrimination of each and every individual down to the smallest details of their existence a possibility. No climate movement if innumerable satellites were not continually monitoring what takes place (and fails to take place) on earth, and if better models for understanding ecological processes were not continually being developed. No climate movement, were it not possible to precisely measure the ecological footprint of consumers – and then profit from their guilty consciences.

The restless compulsion to reshape our world that we are currently observing in the social, economic and political domain is, put simply, the logical outcome of the *real enablement* brought about in recent years by rapid technological innovation. This compulsion is borne out in a range of matters and often without a holistic view – in other words, without weighing up the advantages and disadvantages and without taking account of other legitimate interests. Compulsion seeks maximisation, not optimisation. Take for instance the advocates of wind power who want to install as many wind turbines as possible on as many hills and crests as possible – without much thought for the landscape or natural environment. Or, in a similar vein, the proponents of solar power who have propped up the momentary success of their business model with substantial subsidies and fixed purchase commitments. The finite nature of government coffers? Not a problem – at least not for them.

Compulsion and folly, however, seem to make alarmingly good bedfellows. Take for instance, as recently reported, the Swiss city of Winterthur's decision to acquire an electric fire truck – for no less than one million francs. Surely this begs the question of the ecological benefit of driving a superheavy electric vehicle to a fire – the mother of all CO_2 events – if the CO_2 emitted on route is only fractionally lower than that of a conventional fire truck? Indeed, if we are to keep our heads (a difficult task in times of compulsion and radical change, what with the Jacobins threatening from all sides), then we must also question, especially from an ecological perspective, not just the electrification of a single fire truck, but the foreseeable electrification of the entire automobile industry. Indeed, it is common knowledge how long an electric car must be driven around before its ecological footprint is smaller than that of a conventional car – depending on the intensity of use, it is years. And this is true only when the electricity does not stem from coal or gas power stations; otherwise, the point of ecological break-even is never reached. Put differently: it is possible that problematic political constellations have the potential to cause an immense industry with countless ancillary industries, in fact an entire mobile society, to drive off merrily in the wrong direction.

In more general terms: in times of compulsion and upheaval, the probability of *malinvestment* is high. That paths will be taken in the full knowledge that they are foolhardy. That, under the supposed or manifest pressure of the zeitgeist and expert committees, pseudo rather than real solutions will be chosen. That sceptics and agnostics will be silenced and stigmatised. That next to the main concern, no room exists for other legitimate concerns. That decisions are moralised in one form or another, even in bodies whose governance rules should preclude the same, such as the boards of corporations. Indeed, "morality" often manifests as implied

12 "Abgasfrei unterwegs zum Grossbrand: Die Feuerwehr soll nicht mehr nur Flammen bekämpfen, sondern auch die Erderwärmung" (Emission-free fire trucks: the fire department fights both flames and global warming) from the Swiss NZZ newspaper dated 6 January 2022.

group pressure, and it can cling to a governing body like sticky gunk, negating its capacity to function.

Immense malinvestments: as common as these may be in times of upheaval – because the range of real options are more numerous than they are in ordinary times, because maximisation trumps optimisation, and because folly, fuelled by moralisation, flourishes under such conditions – they must be avoided at all costs when making economic decisions, be it on investment matters or on the strategic positioning of a company. To align decisions with catchphrases, which go hand in hand with compulsion and upheaval, is to court disaster. One example: there is currently much talk of "decarbonisation" and the "carbon bubble" – the one-sided dependency of economic development and thus stock prices on the extraction of free carbon and its oxidisation in the service of economic value creation and consumption. Such catchwords might suggest that the future will be carbon-free. Which is, of course, complete nonsense. As long as life on this planet exists, we will be dealing with carbon: its extraction, its use and its removal. The much vaunted "decarbonisation" of the modern automobile could prove completely wrong in this respect, and the price much too high. It would – alternatively – also be conceivable that, thanks to considerably higher fuel prices and the uberisation[13] of public and private transport, considerably fewer carbon-fuelled cars could lead to a better outcome than when every household sports a multi-tonne Tesla.

In other words, in times of compulsion and upheaval, *strategic composure* is more important than ever before. This means treating with due scepticism "simple" solutions that ultimately yield more negative side-effects than positive main effects. Such scepticism is also warranted where hypes with little theoretical or empirical foundation result in political decisions that favour a particular approach. The one-sided promotion of weather-dependent wind and solar-power solutions in Northern Europe and the EU Commission's ensuing return to nuclear power options speaks for itself. Without the threat of power shortages on grey and windless days, the EU's managing body would hardly have taken such an unpopular decision. Not that wind and solar power are wrong per se. Indeed, investments in such areas make sense and ultimately generate returns. Rather, this warning is directed at artificial, politically motivated and, ultimately, costly decisions that generally have a short half-life. Or put differently: where favour is bestowed, danger looms. Favour is a fickle friend.

13 The uberisation of the economy amounts to a markedly better utilisation of existing capital, in this specific case, that of the existing vehicles. In general, maximising utilisation of existing capital goods also makes sense from an ecological perspective.

Strategic composure is further warranted wherever remedy is sought through formalisation and regulation. In the well-intended attempts of investment managers to develop transparent decision-making criteria and bring about "good" in matters of sustainability, systems have been developed in recent years to categorise and evaluate capital investments. The preoccupation with such rating systems – the ESG criteria is just one; many providers have their own in-house evaluation systems – demonstrates that considerable room for manoeuvre remains. Presumably to serve the implicit and very legitimate aim of adequately diversifying investments. But: more diversification implies less relevance – a classic trade-off situation. The most relevant recommendation would be a single investment. But it could be the wrong one.

By following ESG or comparable criteria, the investment manager is probably doing no wrong, which is certainly in line with the "strategic composure" recommended herein. And companies that diligently apply ESG criteria are likewise doing no wrong – and, in times of increasingly moralising capital markets, are right on the money. So far, so (relatively) good. Those who expect more of themselves and their decision making, however, must take a closer and more exact look – and be willing to accept one or another basic assumption about the shape of the future. The risk of being judged wrong on various matters in the short term comes with the territory.

This is because compulsion and upheaval do not imply a clear and well-mapped motorway, but wrong turns, obstacles and chasms. No doubt capital will be obliterated on occasion. Perhaps electric cars will prove a long-term flop (and maybe not least for the environment), and it will seem foolish not to have backed hydrogen-powered cars from the outset. Perhaps the green investment wave, as initiated by the EU, will be clearly counteracted by completely different developments in China, the US and elsewhere. Perhaps the market-based CO_2 compensation scheme described in section D will not quickly or only partially take hold. Then the path to sustainability will prove a drawn out, stop-gap solution beset by shortcomings that, in their turn, receive symptomatic treatment but no fundamental cure.

F Ultimately, a great deal more is at stake

What sensible person would be opposed to sustainability? Certainly not the economist, who has internalised the notion that all people at all times strive to maximise their own future utility in line with their personal values and beliefs. Indeed, the more sustainable the future, the more valuable the present.[14] Using the theoretical frameworks posited by Coase and Hardin, this paper has demonstrated that, with information and transaction costs gravitating towards zero, a gradual and quasi-automatic internalisation of externalities will set in. And where it is no longer possible to transfer externalities to an undefined community, sustainability will result.

For the ideal-typical world outlined in section D, we proposed registering CO_2 potential directly at the source: the coal mine, the oil well, the forest, the agricultural field. A conceivable alternative, of course, would be registering actual combustion – the oxidation of carbon – at the place of emission: the engine that burns a certain quantity of fuel per 100 kilometres, the cruise liner that, after leaving harbour, burns heavy fuel oil to convey its carousing cargo over the oceans, or the homeowner, whose house burns down courtesy of a withered Christmas tree. However, after thorough debate, we rejected this option for various reasons:

- The potential offshoots in the use of carbon are intricate and infinite. For instance, recycled plastic may end in a (monitorable) waste incineration plant, but perhaps as litter in the landscape or, via waterways, in the oceans, leaving the floodgates for misuse wide open.
- As a consequence, every conceivable endpoint would require monitoring. The risk of this leading to a surveillance state is real and already apparent in certain cases.
- Whatever is subject to monitoring is also open to influence. In section C, we addressed the potential of AI to micromanage aspects of social life.
- The number of sources generating CO_2 potential (such as oil wells, coal mines, forests, farms) is manageable, thus making monitoring feasible. Individual rights are not significantly impacted by the monitoring of CO_2 potential at the source.

When CO_2 compensation is levied at the source, the cost is passed on exclusively through the neutral price. Put differently: the system is indifferent to why the CO_2 potential is being generated, as long as it is compensated. Nonetheless, the risks posed to human freedoms through the process of internalising previously externalised costs are considerable. The aim

14 This notion is most easily expressed by the discounted cash flow method of calculating present value

$$\text{Present value} = \frac{p_1 * \text{cashflow}_1}{(1+\text{interest rate})^1} + \frac{p_2 * \text{cashflow}_2}{(1+\text{interest rate})^2} + \ldots + \frac{p_n * \text{cashflow}_n}{(1+\text{interest rate})^n}$$

The factor p represents the total probability of occurrence and encompasses all environmental influences that could eventuate on the path to the future.

must therefore be to establish a system that functions with as few controls as possible. Because controls are synonymous with social costs.

By contrast, it may – or highly likely will – happen that internalising previously externalised costs will generate new challenges in a community, namely challenges of a social nature. The price for CO_2 may prove too high for some institutions. Any social compensation measures that become necessary must be maintained outside of the system, otherwise *real cost pricing* will be undermined – as is already the case in many places and in many institutions[15].

In our view, what is *not* adequate or effective are systems that apply a steering tax to control the creation of CO_2. Why?

- With steering taxes on the most commonly used goods (to which CO_2 creation certainly belongs), a large percentage of the collected funds flows back to the group that paid them – an inherent contradiction with some self-defeating effects.
- Under such systems, recuperation of CO_2 is not compensated. The commons does not disappear but is administered by a (colonial?) collective that may later change its mind.
- Under such systems, no market price for CO_2 evolves.
- The risk that a steering authority misappropriates income for its own purposes is obvious and it has happened in the past.[16]

To be sure: as long as an ideal-typical world of compensation is not on the horizon, then *second-best solutions are acceptable*. But second-best solutions can, over time and through technological developments, also become the second worst.

There is by all means scope for shaping a *world without a commons*. This world will emerge because it has become possible, and it will emerge because it is essential to safeguarding human life on this planet. Let us use this scope wisely.

15 For instance, public transport in Switzerland is massively subsidised by government funding. Bus and train passengers, however, are blind to the price distortion and instead think their tickets expensive.

16 For instance, a new Swiss CO_2 law that was rejected by voters on 13 June 2021 included a CO_2 levy that would partly fund government activities and, as such, resembled a normal tax and not a steering tax.

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