How, if at all, can we distinguish between sustainable and unsustainable investments?

Abstract

Sustainable financial relies on a robust and accurate distinction between sustainable and unsustainable investments. Without this distinction—or where it is poorly drawn—the various tools of sustainable finance (labels and standards, penalising or supporting factors, mandatory portfolio allocations, etc.) lose their bearings.

Observing that there is currently no consensus around how to distinguish sustainable from unsustainable investments, this paper asks how, if at all, the distinction could be drawn. Three conclusions are defended: first, because sustainability is a property of systems, not individual projects, classification methods that start from individual projects are ineffective. Second, while externality pricing can harness market coordination for the identification of sustainable investments, an overreliance on this mechanism is risky: in a context of high uncertainty, the market coordination of investment runs into both epistemological and effectiveness problems. Third, deliberately translating from system-level sustainability frameworks to the classifications of investments—a form of indicative planning—may be more promising. While this, too, will inevitably be imperfect, it may encourage the risk-taking and social learning required to deliver a sustainability transition in time. An overarching message of this paper is, however, that there simply is no accurate and general methodology for reliably identifying sustainable investments.

How, if at all, can we distinguish between sustainable and unsustainable investments?

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How can we identify sustainable investments, separating and distinguishing them from unsustainable ones? Answering this question is a necessary precondition for a wide range of sustainable finance policies, whether they merely seek to improve transparency in the investment process, to create a "green spread" or "greenium" between sustainable and non-sustainable projects, or otherwise reform finance so to favour sustainable over non-sustainable investments. Without a targeting system, these policies become blind or haphazard.

The paper begins with a simple observation: the inability to generate robust data on economy-wide counterfactuals, coupled with the complexity of our division of labour, makes it challenging to identify the sustainability impacts of any one investment. One consequence is that a common methodology currently used in sustainable finance—using firm-level performance indicators (emissions, the use of land, water, or energy) and comparing them against industry-level best practice benchmarks—is profoundly flawed. This method provides neither robust information on the sustainability impacts of an investment, nor on whether the investment would fit inside the envelope of a long-run sustainable economy.

The paper then discusses two alternative approaches: first, giving up on the idea of second-guessing the price mechanism, letting externality-pricing-adjusted profitability be the judge of sustainability; second, assessing investments against absolute and context-based criteria, derived from an overall indicative plan for the economy's critical productive systems. I lay out the advantages and disadvantages of both options, showing that neither is capable of fully answering the question at hand, albeit for different reasons.

The paper concludes by identifying certain complementarities between the two approaches, and by highlighting the importance of iterative learning and risk management, given that no single method appears capable of providing robust and conclusive answers to the original question.

1. Counterfactuals, benchmarks, and the limits of project-by-project analysis

How can we distinguish a sustainable from an unsustainable investment? This is the central question of this paper. To begin answering it, it is useful to split the question into two parts: What is the definition of sustainability at stake? And given such a definition, which particular investments conform to it?

Significant progress has been made on the first question. Since the 1987 Brundtland Report, the basic definition of sustainability is "meet[ing] the needs of the present without compromising the ability of future generations to meet their own needs" (World Commission on Environment and Development 1987, 43). More recently, this basic definition has been operationalised in greater detail with the Sustainable Development Goals,[1] as well as the planetary boundaries and social foundations framework (Rockström et al. 2009; Raworth 2017). An important feature of these definitions is that they concern, by and large, system-level

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[1] The 17 goals, agreed upon in 2015, are: 1. No poverty. 2. Zero hunger. 3. Good health and well-being. 4. Quality education. 5. Gender equality. 6. Clean water and sanitation. 7. Affordable and clean energy. 8. Decent work and economy growth. 9. Industry, innovation and infrastructure. 10. Reduced inequalities. 11. Sustainable cities and communities. 12. Responsible consumption and production. 13. Climate action. 14. Life below water. 15. Life on land. 16. Peace, justice and strong institutions. 17. Partnership for the goals.

outcomes. What matters for ecological sustainability, for example, are not the emissions of an individual firm, but total CO_2 emissions; not the land-use of a single agribusiness, but overall biodiversity; not the fishing-haul of a particular company, but the overall depletion of the oceans.

While these definitions are not perfect, they provide sufficient clarity, detail and scientific rigour to be useful. Given their long gestation period and the inclusive process through which they were drawn up, particularly the SDGs, they also benefit from a high degree of political legitimacy. At this point the more relevant question is therefore the second: Presupposing a working definition of sustainability, how can we identify the particular investments that would (or would not) count as sustainable against this definition?

This identification is difficult. Moving from a definition of sustainability, even a well-operationalised one, to the identification of individual sustainable investments involves the crossing of a Rubicon: from factual to counter-factual analysis. It is no longer enough to ask *verification* questions: are emissions below a certain threshold? Is biodiversity at a certain level? Is the North Atlantic herring population collapsing, stable, or growing? Instead, counterfactual questions must be asked and answered: does the deactivation of this (set of) coal-, gas-, or nuclear power plants, and their replacement by a mix of renewable energy, energy storage and energy efficiency savings, move the relevant system-level indicators of sustainability in the right direction? How should we allocate investments between reforming agriculture, reforming healthcare, and reforming the built environment? What kind of energy storage technology holds the biggest promise? To answer these kinds of questions, counterfactual information is required.[2] Not "what is currently happening?", but rather "what *would* be happening, if…?"

Further, it is rarely enough to look at project-level or local counterfactuals: what matters are the consequences of an investment choice for the sustainability outcomes (emissions, land use, ocean conditions, etc.) of the system as a whole: "An economic activity cannot truly be considered sustainable independently from the wider system in which it operates" (EU Technical Expert Group on Sustainable Finance 2019, 24).

But due to the many linkages between different economic activities, and our inability to run economy-wide experiments, reliable system-level counterfactuals are difficult to produce: "The use of natural resources and emission of substances into air, water and soil takes place at millions and millions of economic production sites all over the world." These "form a complex web of activities reflecting a single, global, interconnected economy which impacts the environment in multi-faceted ways" (Tukker et al. 2014, 8). Knowing the consequences of changing one (or more) element(s) in a complex system, without the ability to place this system in a laboratory, is difficult and perhaps impossible: additional investment in electric vehicle production, for example, may reduce direct CO_2 emissions in transport, but energy and material use in battery production and later recycling is likely to increase. Further complicating the analysis, the engineering skills and raw materials used in EV production are now unavailable

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[2] In addition to information or beliefs about counterfactuals, a decision procedure is required to move from information to a choice: How should various desiderata (e.g. emissions, costs, other environmental goals, economic inequality, etc.) be balanced against each other? What weights should be given to various risks? Whose voice should be heard in the process?

for other purposes, where they could have unlocked greater or smaller emissions savings. It remains unclear what the overall impact or delta on system-level emissions would be.

Nor is it clear which individual investments might fit inside the envelope of an overall sustainable economy. For example, given the transport system as it stands, investments to localise food production and consumption may help to fit agriculture into an overall sustainability envelope, because they shorten transport routes and so reduce CO_2 emissions. However, if the transport system were to be decarbonised, localised agriculture may in fact be *less* sustainable than regionally specialised agriculture coupled with long-distance transport: the latter industry structure, allowing farms to specialise in whatever is best grown or raised in their particular region, can likely produce higher food yields with lower total land use. But then again, much would depend on the supply chain of decarbonised transport. And so on. In sum, producing credible, reliable estimates of how different investments fit with the sustainability of an overall system is a daunting task.

Given this difficulty, much of today's sustainable finance amounts to searching for keys under the lamppost (Capelle-Blancard and Monjon 2012), not where the key was lost: i.e. focusing on the information that is *available*, not the information that is *required*. For example, identifying trends in the performance of a particular company, e.g. reductions in CO_2 emissions over time, and comparing them against relative benchmarks, e.g. industry-level best practice,[3] carries little useful information without further contextualisation: it may be that local emission savings are generated merely by shifting polluting activity up or down the supply chain; it may be that the technology used to deliver emission savings reduces emissions in the short term,

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[3] See for example the MSCI ESG ratings methodology (MSCI ESG Research 2020, 10–12).

but prevents or renders very difficult further reductions beyond that level; or it may be that the company is reducing emissions, land use, or waste at a rate of X% per year, but that a reduction rate of Y%>X% per year would be necessary to remain below 1.5 degree of warming or avoid ecosystem collapse.

It is no surprise, then, that it has proven difficult to develop methods to classify investments as sustainable or not. Nor is it surprising that different entities put forward different classifications standards.[4]

Note, however, that this is 'merely' a specific version of a more general problem: even for 'merely productive'—as opposed to sustainable—investments, investment decisions require beliefs and information about counterfactuals, and about what happens elsewhere in the economy. For example, a profit- and productivity-oriented automotive investor will ask: "If I invest in building this car factory and hire a labour force, will this enable the production and sale of automobiles at a competitive price, without running down the capital stock? I.e. will the investment be economically productive?" Just as with sustainable investments, ascertaining the truth or falsity of this belief about a (potentially) productive investment is difficult. In this case,

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[4] See the OECD's recent report on sustainable finance (OECD 2020), esp. figure 1.4 on p. 27. For additional texture beyond the main ratings agencies, consider the following example: the Norwegian sovereign wealth fund (Norway Government Pension Fund Global) considers firms to be sustainable investments as long as they "have at least 20 percent of their business" in "low-carbon energy and alternative fuels, clean energy and energy efficiency, and natural resource management" (NBIM 2020, 81). Operationally, this translates into investments in utilities, e.g. Iberdrola, National Grid PLC, or Engie, industrials and technology firms, such as Siemens Gamesa Renewable Energy, Infineon, or Tesla, or waste management firms like Waste Connections Inc. And indeed, from one perspective these are environmentally leading firms: Iberdrola, for example, generated electricity with an average emission intensity of 110 g CO_2e/kWh in 2019 (Iberdrola 2020, 34), well below the EU grid average of 260 gCO_2e/kWh (IEA 2020). From another perspective, however, it is unclear whether these firms are actually sustainable: the draft version of the EU taxonomy of sustainable economic activities, for example, considers electricity generation sustainable only at emission intensities below 100 g CO_2e/kWh (EU Technical Expert Group on Sustainable Finance 2020b, 205).

it will depend on future changes in wage levels and the prices and availabilities of inputs and raw materials, such as semiconductors, steel, aluminium, plastic, rubber, and oil; on the evolution of consumer tastes, and of complementary technologies (like GPS navigation or good roads) and substitute technologies (like videoconferencing, air travel, trains, or public transport); on the behaviour of suppliers and competitors; on exchange rates, tariffs, and trade regimes; and, particularly in countries where most cars are bought on credit, the state of the financial system.

In other words, the productivity, just like the sustainability, of any one investment depends on the overall system it is embedded in. To evaluate it, various counterfactuals must be compared, which, due to the complexity of the overall system, are difficult to generate.

Given the isomorphic structure of the basic information- and decision-problem, a useful starting point for the identification of *sustainable* investment is thus the main methods used to identify *productive* investments. The next section discusses market-based coordination, while its main alternative, planning-based coordination, is discussed subsequently.

2. Market coordination: epistemologically efficient, but in which circumstances?

As discussed above, the productivity, just like the sustainability, of any one investment depends on the overall system it is embedded in. And as with sustainable investment, when making productivity-oriented investment decisions, counterfactual information is vital. Nevertheless, despite abundant co-dependencies between individual investments and the system they are embedded in, the market-coordination of ‘merely productive’ investment has functioned tolerably well, from a productivity perspective, in the advanced economies of Western Europe, North America, Japan and other OECD countries.

The classic description of how market competition coordinates investment is given by Hayek:

> "Assume that somewhere in the world a new opportunity for the use of some raw material, say tin, has arisen, or that one of the sources of supply of tin has been eliminated. It does not matter for our purpose—and it is very significant that it does not matter—which of these two causes has made tin more scarce. All that the users of tin need to know is that [...] in consequence they must economize tin. [...] the effect will rapidly spread throughout the whole economic system and influence not only all the uses of tin, but also those of its substitutes and the substitutes of these substitutes, the supply of all things made of tin, and their substitutes, and so on." (Hayek 1945, 526)

In other words, price increases—whether in tin or oil, in cars or computers, whether driven by new demand, a reduction in supply, new taxes or new regulation—will attract the attention of managers, households, entrepreneurs and investors, and direct them towards economizing on particular inputs, or towards finding new methods for producing them.[5] Through second-round price effects this will percolate throughout the system, so that adjustments will happen not just in the production and use of tin, in this case, but also of "its substitutes and the substitutes of these substitutes, the supply of all things made of tin, and their substitutes, and so on."

This deals with the information problem—how to identify the subset of productive investments from among the set of possible investments—not via developing a more sophisticated manner

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[5] See also Schumpeter (1942, chap. 7). While the mechanism is real, note that it is not well understood in contemporary economic theory. Strikingly, there is no convincing account of it in neoclassical economics. See also Marx (1992 [1867], chap. 15, esp. 617-8).

for producing information (as lifecycle assessments attempt to do for sustainability, for example) but via systematically decentralised trial-and-error.

The same mechanism can be applied to the identification of sustainable investments, via externality pricing: i.e. the same algorithm, but applied to different data.

The accounting frameworks required to operationalise this are variously known as Full Cost- (Bebbington et al. 2001) True Cost- (TEEB 2014), Natural Capital-(Wackernagel et al. 1999), or New Accounting (van der Lugt 2018), Integrated Reporting (IIRC 2013), or triple bottom line accounting (Thomas and McElroy 2016). Their basic structure is simple: the externalities in question are counted and priced.

This method has the advantage of preserving the Hayekian information efficiencies outlined above: If market prices are adjusted to include the environmental and social sustainability impacts associated with the relevant product, firms only need to measure and monetise *their own* sustainability behaviour, instead of having to monitor that of their suppliers and customers as well. Equally, consumers could infer that cheaper products (of the same quality) will have a better sustainability impact than more expensive products. In contrast to other ways of communicating sustainability information—in particular sustainability labels[6]—while firms' internal accounting practices would change greatly, it would not complicate firm-to-firm or

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[6] Sustainability labels were intended to help with precisely this information problem: How to identify a sustainable supplier or product without having to study them in great detail. However, a proliferation of standards means that consumers and firms must now study various competing labels to know which one best conforms to their interpretation of sustainability. In the case of coffee, for example, there are at least 9 different standards: Fair Trade, Bird Friendly, USDA Organic, Rainforest Alliance, Utz Kapeh, 4C, Starbucks' C.A.F.E. standard, Nespresso's AAA Sustainable Quality Standard, and Indonesia's ISCoffee standard. For biofuel, the European Commission recognises 17 different standards (Lambin and Thorlakson 2018, 20). In total, one article identified more than "400 ways to certify various goods and services—and much confusion for those consumers who want to choose responsibly" (Madhusoodanan 2019).

consumer-to-firm interaction. Nor, perhaps most importantly, would it change the kinds of analyses that investors would have to conduct in order to choose between different investments.[7]

Nevertheless, relying on externality pricing to identify sustainable investments is controversial, for a number of reasons (see e.g. Radermacher and Steurer 2015; Hache 2019).[8]

To begin with, there is the political difficulty of forcing sustainability accounting frameworks into the prices at which firms and consumers interact. This is pivotal: on it depend both its effectiveness as a tool for change, and its effectiveness as an information infrastructure and investment guidance. In practice, legally designing the appropriate instruments (whether taxes or cap and trade schemes), politically legislating them, administratively collecting or governing them, and—most importantly—ex post verifying that firms are not cheating in their accounting would be challenging indeed. Political will and administrative capacity would be required.

Nevertheless, similar problems affect command and control regulation, too. Automobile emission or fuel economy standards, for example, “are beset by problems such as the discrepancy between lab and on-the-road emissions tests” (Van Renssen 2018, 358); any building- or land-use-code is only as good as the enforcement capacity behind it; the same goes for minimum wage standards, or other policy instruments intended to boost social

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[7] Note that, correspondingly, the role of sustainable finance would be greatly deflated in this paradigm: the final judgement regarding whether or not an investment is sustainable would be whether or not it is (expected to be) profitable. Sustainable finance would thus converge with regular finance. To the extent that sustainable finance survives as a separate activity, it would largely consist in political analysis, trying to predict future externality pricing, and in predicting its impact on the returns of various investments.

[8] The following critiques are, broadly speaking, feasibility critiques, casting doubt over the effectiveness of the instrument. Frick and Huwe (2020) offer a normative analysis of externality pricing, in particular in the form of an emission trading scheme, demonstrating that it rests on a number of contestable normative assumptions.

sustainability.[9] While the granularity of accounting-based approaches may require more enforcement capacity than simple regulatory bans or restrictions, this extra enforcement cost may well be compensated for by the more granular adjustment of economic activity it allows for, and the additional information it generates. This question is open.

Further, there is the difficulty of identifying and quantifying the environmental and social elements of any system of sustainability accounting. How, for example, should biodiversity be rolled into an externality pricing accounting framework? “Quantification only works by reducing complexity” (Hache 2019, 50), and sustainability is an inherently complex subject matter.

Some elements of sustainability will no doubt resist quantification, so that numerical inclusion in an accounting framework will be crude, and in some cases impossible or undesirable (Radermacher and Steurer 2015). Where these elements are important, regulatory rules can be drawn up, and compliance can be made a prerequisite for classification as sustainable investment, or indeed for permission to operate as a business at all.

For elements that are difficult but not impossible to quantify, the difficulty is once again not specific to externality pricing approaches: the question is rather whether the additional granularity and information produced via quantification is worth the additional cost, for public administrations and for firms, compared to bans, prescriptions, or other forms of direct regulation. As James Scott might say, *all* state action works by reducing complexity (Scott

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[9] In the UK, for example, only 13% of firms paying below the minimum wage get detected, despite an increase in enforcement (from very low levels) in recent years. As a result, an estimated 350,000 of the 1.4 million adult UK-based workers at or close to the minimum wage were underpaid (Judge and Stansbury 2020, 4–6).

1999): counting reduces complexity with respect to the *texture* of information; bans or prescriptions reduce complexity with respect to *reacting* to information.

Similar points apply to setting prices. Just like agreeing on which quantities to measure and how to do so, agreeing on the price vector by which these quantities are to be aggregated is difficult and inherently political. To highlight but one difficulty: environmental or social ecosystems often exhibit non-linearities. A wetland, a local animal population, or the local economy of a particular region might survive and adapt reasonably well to a certain amount of pressure, but then collapse rapidly if a threshold is crossed. The same very likely holds for climate change, for which a number of potential tipping points have been identified (Lenton et al. 2008), and for financial markets, which tend to tip from exuberance to despair (Minsky 1986), often with significant consequences for particular places, people, or firms.

Market prices, actual or hypothetical, do poorly at accounting for such non-linearities, often rising or falling significantly only after a threshold has been crossed, at which point it may be too late, given path dependencies.

A crucial, if often implicit, assumption behind decentralised coordination is hence that choices are reversible and path dependencies weak, or alternatively that non-linearities are largely absent. This assumption may hold for many kinds of economic activities, from the production of shoes to the giving of haircuts. In the context of sustainability, however, it is frequently false: important social or ecological features may be both critical and irreplaceable,[10] a status that is difficult to capture in actual or hypothetical externality pricing methods.

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[10] For environmental features, this is often called "critical natural capital" (Brand 2009).

3. Market coordination in the context of uncertainty

A final critique of externality pricing as the main method for identifying sustainable investments revolves around the consequences of uncertainty for market-coordinated investment. Consider that rich countries exceed their share of planetary boundaries by such margins that minor changes are unlikely to result in overall sustainable economies (e.g. Zaccai 2019; European Environmental Agency 2019, 13; European Environmental Agency and Swiss Federal Office for the Environment 2020, 10). To further calibrate intuitions, consider that during the hardest COVID lockdowns, e.g. Italy in March and April 2020, emissions fell by only 20% relative to the same periods in 2018 or 2019 (Rugani and Caro 2020), i.e. less than half of the EU's 55% emission reductions goal for 2030. Even if the hardest of lockdowns were to be made permanent, greatly reducing traveling activity and many forms of consumption, the emission reductions would not get us to our 2030 goals—let alone the 2050 goal of net zero emissions.

Moreover, time is of the essence. In order to have a 50-66% chance of keeping global warming to 1.5 degrees or less, humanity can emit no more than around 440-340 Gt CO_2.[11] However, the existing energy infrastructure alone, i.e. the power plants, refineries, pipelines etc. in operation today, if operated according to historical norms, would likely more than exhaust this budget, emitting around 560 Gt CO_2 over their regular economic lifetime going forward (Tong

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[11] The 6th Assessment report of the Intergovernmental Panel on Climate Change (IPCC) estimated the remaining carbon budget for a 50% chance of 1.5 degrees of warming at 500 Gt CO_2. For a 66% chance, the budget is reduced to 400 Gt CO_2 (IPCC 2021, 38). However, these numbers were estimated for the beginning of 2020. With global emissions currently at around 40 Gt CO_2 p.a. (IPCC 2021, 16), at the time of writing these numbers required downwards revision by approximately a year and a half of global emissions, i.e. 60 Gt CO_2. The remaining carbon budget for 2 degrees is larger, but surrounded by considerable uncertainty, ranging from 1640 Gt CO_2 (for a 33% chance of keeping warming below 2 degrees) to 1090 Gt of CO_2 (for a 66% chance).

et al. 2019, 373).[12] This implies two things: first, every new major power plant, installation or factory, every new car, plane or ship, every new house or building that is being built today should already be built carbon-neutral. Potentially even more challenging, new assets should be designed to be compatible with a future carbon-neutral economy, i.e. not reliant on future carbon-intense production inputs or downstream carbon-intense usages.

Second, if this is not achieved (as it has not been achieved between 2018 and today) it will become necessary to retire significant amounts of power plants, factories, and transport equipment before the end of their economic lifetime. This is likely to be financially disruptive, since much industrial infrastructure is debt-financed, and since the expected earnings over its anticipated economic lifespan are often budgeted to repay this debt. The financial disruptions from writing off recently built fossil infrastructure will be further amplified by the deflation of the carbon bubble that is likely to take place once investors are convinced of the seriousness of climate change mitigation.[13]

This creates two closely related problems, both driven by the deeper problem of making investment decisions in the context of uncertainty: First, where uncertainty is high, externality pricing and sustainability accounting may fail at identifying the 'right' investments. Since this is a question of information and knowledge, this could be called the '**epistemological problem**'. Second, even where externality-adjusted prices *do* identify the right investments as

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[12] The Tong et al. paper gives a figure of 660 Gt CO_2 from 2018 forward, from which I subtracted 100 Gt CO_2 to account for the passage of 2019, 2020, and half of 2021.

[13] The carbon bubble refers to the idea that fossil fuel companies are overvalued, because if and when the world gets serious about dealing with climate change, these companies will be prevented from extracting the carbon reserves on which large parts of their economic value (in stock market valuations and elsewhere) is based. The concept was first described in Carbon Tracker (2011).

profitable (and hence sustainable), in a context of high uncertainty, this instrument may still fail to direct the required investment volumes in their direction. Since this is a question of changes in behaviour, this could be called the '**effectiveness problem**'.

In calm times, externality-pricing-adjusted current profitability is likely to be a good proxy for profitability tomorrow. Investors will be able to 'read' tomorrows profitability landscape well enough to plan their investments accordingly, so that the profitability impacts of externality pricing today feed through to the investment decisions taken with a view of tomorrow. Given the magnitude and the speed at which the sustainability transition must take place, however, once it gets seriously underway, significant uncertainty is likely to emerge about future prices, the shape of future supply chains, the nature of tomorrow's market demand, and hence tomorrow's profitability landscape. In a context of endemic uncertainty, there is no robust and objective way to evaluate future profitability. Profits today may become a poor proxy for profits tomorrow. Expectations rather than current profitability start to drive asset valuations, creating space for herd behaviour, self-fulfilling prophecies, and a misallocation of capital.[14]

Externality pricing does not address this problem. To the contrary, given where we stand today, relying mainly or only on externality pricing for the identification of sustainable investments may face an unattractive choice: either opt for gradual price paths, to protect the functioning of the investment coordination mechanism, but at the risk of dangerously delaying the transition. Or choose an ambitious price path, to inject strong market signals early, but at the

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[14] See esp. the work of Robert Shiller and George Akerlof on this (Akerlof and Shiller 2009, 2015; Shiller 2016, 2019).

risk of creating such uncertainty as to allow future expectations to swamp today's price signals, with deeply uncertain results.

In addition to this epistemological problem, sustainability accounting suffers from a problem of effectiveness. Put simply, uncertainty harms investment (Robinson 1956, 1962). The more uncertainty there is perceived to be, the larger the temptation to remain invested in liquid, low-risk assets, and to eschew long-term, high-risk investment in real assets or technologies (e.g. Keynes 1936; Levy 2021). If many, even most, investors do this, then even if, under the influence of externality pricing, the 'right' firms or projects emerge as profitable today, they might still not receive large investments. With too few investment bets placed, competitors to the existing industrial and economic fossil fuel based infrastructure must rely on the generation of internal financing, leading to potentially dangerous delays. This is the problem of effectiveness: in a context of high uncertainty, profit-oriented investors may flee to liquidity and safety, depriving riskier but potentially productive investments of external funding. This problem is not addressed, and may even be amplified, by externality pricing.

Where the identification of sustainable investments is left to the combination of sustainability accounting and decentralised, profit-oriented investing, the following pattern may thus result. Faced with high uncertainty, investors may prefer to trade existing assets, particularly real estate, and to buy liquid, low-risk financial products, in particular government bonds. Depending on expectations, narratives, and crowd dynamics, bubbles may emerge periodically around particular companies, technologies, or sectors. These bubbles can be effective mechanisms for building out systemic infrastructure;[15] but they can also be a waste of capital, with little to show for after the fact.[16] Importantly, the direction and unfolding of bubbles is only weakly influenced by contemporary product market prices—the variable that externality pricing influences most directly—instead following expectations, narratives, self-reinforcement mechanisms and other, difficult-to-predict, dynamics. In the context of climate change, this is risky: infrequent and sentiment-driven waves of large-scale investment may or may not suffice to master the transition.

Summing up, where a profound and rapid economic transformation is required, externality pricing suffers from two problems. First, epistemologically, the relative prices that sustainability accounting acts upon can easily be overwhelmed, in a context of high uncertainty, by the effects of expectations, narratives, and herd behaviour. Sustainability accounting, speaking through the voice of expected profitability, may therefore fail (in investment markets more so than in product markets) to identify actually sustainable investments. Second, in terms of effectiveness, in a context of high uncertainty, and depending on their 'animal spirits', investors often prefer liquidity over risk. As a result, even profitable, 'good' ventures may fail to get funding, so that even where price signals do identify the right ventures as profitable, it is not assured that these will receive appropriately large investment inflows. A reliance on externality pricing as the main tool to identify which investments shall count as sustainable is therefore a risky proposition.

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[15] Examples include the construction of railways in the 19th century, with multiple railway manias resulting in the rapid construction of extensive networks in Britain (1840s) and the US (1880s), or more recently the dot-com bubble, which boosted the construction of internet infrastructure particularly in the US.

[16] Examples of this type of bubble include the South Sea Bubble of 1720, the Japanese real estate bubble of the 1980s, and the US subprime mortgage crisis at the heart of the Great Financial Crisis of 2007-2008.

4. Reducing uncertainty? Indicative planning and public investment

The main alternative to market-based coordination are various forms of planning. While centrally planned command economies suffer from an abundance of well-known problems, related to soft budget constraints (Kornai 1992), information problems (Hayek 1945), institutional degeneration, and an elective affinity to authoritarian political forms, planning is worth considering in the context of sustainable finance for two reasons. First, planning has historically been useful as a tool to reduce uncertainty, e.g. in the context of French post-WWII indicative planning (Estrin and Holmes 1983; Eichengreen 2007, chap. 4). Second, planning has proven capable of pushing through major economic transformation in short periods of time (e.g. Allen 2003; Eichengreen 2007, chap. 5; Wilson 2016), which is precisely the task at hand today.

To identify sustainable investments, indicative planning could be a promising way forward: a systematic approach that looks at the economy as a whole, and on this basis develops criteria for what counts as sustainable or not. Such an approach, by giving a centralised verdict on the kinds of economic activities that count as sustainable, has the potential to reduce subjective uncertainty. While centralised sustainability verdicts are likely to be imperfect, epistemologically speaking (this will be explored further below), and while their effectiveness at mobilising investments is not guaranteed, they may help to provide a coordination device, addressing the uncertainty that was identified as a central problem for market coordination above.

What would such an approach look like in practice? A historical example is the practice of indicative planning in France after WWII (Carré, Dubois, and Malinvaud 1975), starting with the Monnet Plan of 1946-52. But perhaps the clearest and simplest contemporary example is the EU Taxonomy of Sustainable Economic Activities (EU Technical Expert Group on Sustainable Finance 2020a). This taxonomy, currently being finalised by the European Commission, is a list that specifies for each major kind of economic activity which criteria the activity must meet to be considered sustainable.[17]

While the taxonomy has obvious flaws as it stands[18], what matters for the purposes of this paper is its logical structure, and the extent to which it can overcome the problems identified with the externality pricing approach covered above.

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[17] For example, in the draft taxonomy, the activity of generating electricity is considered to be sustainable if it emits less than 100g CO_2e / kWh, and meets five "Do No Significant Harm" criteria (EU Technical Expert Group on Sustainable Finance 2020b, 205). For the activity of constructing new buildings, the criterion is a primary energy demand at least 20% lower than the level mandated by national regulation (ibid, 369). This criterion will be tightened over time "with the aim of setting the whole sector on convergence towards net-zero energy and carbon targets by 2030" (ibid.). Similar tightening intentions are signalled for the taxonomy as a whole ((EU Technical Expert Group on Sustainable Finance 2020a, 54).

[18] As it stands, the most obvious flaws are: all economic activity could be taxonomy-conforming, and yet system-level sustainability indicators could still be in the red. This is possible because "transitional activities" can be taxonomy-conforming as long as "there is no technologically and economically feasible low-carbon alternative", and as long as their "greenhouse gas emission levels … correspond to the best performance in the sector or industry" (European Union 2020, Article 10.2 and 10.2.a). For example, best-in-class cement plants could thus be taxonomy-compliant, even though their *absolute* emissions may still be far in excess of what would be consistent with a 1.5 °C warming trajectory.

Further, there are certain activities for which criteria are weak, or not yet drawn up at all. For example, for agriculture "[t]he lack of deep GHG reporting datasets from which to establish best performance benchmarks, coupled with the lack of emissions budgets or sequestration targets … at either the EU or global level, meant it was not possible to set robust absolute GHG thresholds" (EU Technical Expert Group on Sustainable Finance 2020b, 103). Maritime shipping and aviation are still missing and "The TEG [technical expert group] acknowledges that many manufacturing activities are still not currently covered in the Taxonomy, and this must be addressed" (ibid, 155).

In addition, the taxonomy does not distinguish between activities that merely fail to advance sustainability, i.e. are broadly neutral, and activities that do serious harm. From a macroprudential perspective, it would be highly desirable to have a "dirty" category, so as to accelerate a timely exit from activities that impose systemic risks on ecosystems, the climate, or other components of sustainability.

However, these flaws are not inherent in the structure of the taxonomy: Article 10.2 could be removed and the criteria can be tightened. And indeed, the taxonomy regulation itself mandates regular updates, suggesting that tightening will happen over time: Article 19.5 states that "To ensure that economic activities as referred to in Article 10(2) [i.e. "transitional activities"] remain on a credible transition pathway consistent with a climate-neutral economy, the Commission shall review the technical screening criteria for those activities at least every

Compared to externality pricing, this changes the terms of the conversation: The former operates through decentralised quantification and pricing. The latter allows discussion to start from a systemic perspective, deliberately and systemically considering the economy as a whole and then working backwards toward criteria for individual activities.[19] Where indicative planning is scaled down to a limited number of core sectors — e.g. energy, transport, buildings, agriculture and industry (esp. steel, cement, and chemicals)— the reduction in complexity may render planning more feasible. Crucially, it provides an output that gives judgements on the sustainability (or not) of individual firms, *independently of market sentiment or future expectations*. This prevents the destabilising and self-reinforcing dynamics that occur with externality pricing under conditions of uncertainty, where a company like Tesla may suddenly appear like a highly profitable investment (and hence, under the epistemological lens of sustainability accounting, like a sustainable investment).

This is a promising avenue to reduce subjective uncertainty. But does it suffice, on its own, to solve the epistemological and the effectiveness problems identified above? Not necessarily. Like the other approaches analysed above, a taxonomy approach suffers from the difficulty of identifying counterfactuals and the challenges of understanding a complex division of labour. Hence it, too, suffers from epistemological problems. Besides the usual problems associated with collecting and analysing large amounts of information (Hayek 1945; though see Phillips

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three years." Articles 26 requires the Commission to publish a report (by 31.12.2021) that lays out criteria for identifying environmentally-neutral activities and activities that significantly harm environmental sustainability— in other words, draft "grey" and "dirty" taxonomies.

[19] Indeed, as cited above, the Technical Expert Group that elaborated the draft taxonomy has explicitly highlighted the need for such a systemic perspective, pointing out "An economic activity cannot truly be considered sustainable independently from the wider system in which it operates" (EU Technical Expert Group on Sustainable Finance 2019, 24).

and Rozworski 2019 for an argument that these problems can be overcome), the future development of key technologies cannot be known with certainty, nor can future world market prices for key materials be predicted with accuracy. Nor does the systematic study of observed changes, e.g. past emission reductions from investments in renewable energy, allow for the construction of a fully reliable taxonomy. To identify the future impact of an investment a counterfactual is always required. What *would have happened* in the absence of the investment whose impact is being estimated? It is only in comparison to that scenario that impact can be deduced from observed results.[20]

Turning to the question of effectiveness, while a taxonomy will reduce uncertainty, and hence may mobilise more investment than sustainability accounting would on its own, it will not necessarily move funds into all projects that are desirable for the sustainability transition to go ahead. Projects that count as sustainable but whose financial outcomes are highly uncertain, even in the context of indicative planning, will likely not receive much private investment. Pertinently, as Mariana Mazzucato has shown, risk-taking capacity is highest in the public, not the private sector (Mazzucato 2013). And as William Janeway has shown, "the Innovation Economy depends on sources of funding that are decoupled from concern for economic return" (Janeway 2012, 1).[21] The pursuit of challenging missions, like the sustainability transition, thus requires an ambitious, confident public investment policy (Mazzucato 2021).

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[20] Counterfactuals can be extrapolated from the past, as is dominant practice, of course. But this relies on the assumption that everything else remains more or less constant (De Udo Haes 2006, 220), i.e. it serves to identify the impact of a process, product, or investment embedded in an otherwise unchanging system. Given that sustainable investment is all about *transitioning* our economies from one state to another, the use of historical baselines as implicit counterfactuals is questionable.

[21] Though Janeway is clear that this could be either public or private sources of funding.

Concerning effectiveness, a taxonomy will hence not suffice on its own. Nevertheless, it can be a useful complement to public investment, making sure that it does not proceed haphazardly. Both the actual list that constitutes the core of a taxonomy, and the process of drawing it up encourage systematic thinking and prioritization, thereby helping to identify the particular investments that would most profit from public investment (because they would not proceed otherwise). Concerning iteration and the collection of input from a wide variety of stakeholders, a taxonomy provides a clear focal point around which an iterative, inclusive process can be structured. It renders discussion more concrete—should this activity be included or excluded, or what should the specific threshold be for inclusion?—and thereby facilitates transparency and accountability.

In this manner, indicative planning can—at least potentially—accelerate the social learning process. In particular, it can identify promising avenues for systemic transformation—e.g. the combination of electrifying all energy use and switching electricity production to 100% renewables (Griffith, Calisch, and Fraser 2020)—and then trigger a systematic investment drive to move in this direction. While this may not be the optimal investment pattern straight away, through fast iteration, this has the potential to generate robust knowledge at the system-level, accelerating the learning process and thereby speeding up the transition.

Concerning iteration, however, a taxonomy approach produces relatively little information about the actual sustainability performance of an economy or an investment. The only numbers that policy makers can easily read off from a taxonomy information infrastructure are the financial volumes in compliance with it. Since the criteria for compliance often consist of thresholds and are extremely diverse between different sectors, this information is of limited use: For policy makers, it carries little to no information about actual emissions, land use, species loss, waste and recycling volumes, and so on. Equally, for firms and investors, it does little to reveal what goes on in supply chains or portfolios: Portfolio companies and upstream and downstream activities can be classified as "sustainable or not", but what precisely this means in terms of behaviour, emissions, land use, labour practices, and so on will not be clear.

In other words, a taxonomy is primarily a *steering tool* that, unlike externality pricing, reduces uncertainty and allows systemic considerations to be considered. By taking in diverse inputs and translating them into a simple list of criteria, it is well suited for translating between complex, system-level analysis and individual investors' choices. It is not, however, a useful ex-post *measurement* tool. This implies significant complementarities between a taxonomy, which operates as a steering tool, and frameworks like the SDGs or the Planetary Boundaries framework, which track the outcomes that this steering produces, and thereby provide vital input for the iteration of a taxonomy.

5. Conclusion: synergies between planning- and pricing-based approaches

The preceding discussion has shown: neither externality pricing nor indicative planning is perfect on its own, capable of identifying which investments do or do not qualify as sustainable. A taxonomy is a useful steering tool for policy makers that allows systemic planning considerations to be translated into investment-level criteria. However, it does not and cannot offer a perfect solution to the epistemological problem: hampered by the inability to observe counterfactuals, it requires constant iteration in order to correct for misjudgements and unexpected outcomes. Moreover, a taxonomy, taken by itself, does not resolve the effectiveness problem either: Merely identifying certain investments as sustainable will not make them profitable, even if it reduces uncertainty about the future development of the economy. Public investment will be one answer to this challenge, taking on certain risks that the private sector is not equipped or willing to handle; but another part of the answer must lie in externality pricing. By translating externalities into quantified and priced accounting entries, externality pricing shifts relative prices so as to make sustainable activities profitable, unsustainable activities unprofitable. In combination with a taxonomy, this will guide the decentralised, private, profit-oriented portion of investment in the direction of sustainable development.

Instead of prioritising one, a combination of both approaches, together with a data collection infrastructure that verifies system-level sustainability outcomes, thus appears most promising: a taxonomy, offering a guide to systemic change and thereby reducing uncertainty as well as helping to steer public investment; externality pricing, to enable the price-guidance of private investments; and macro-frameworks for system-monitoring, verifying the sustainability status of the economy as a whole, and hence guiding iterations and revisions of the overall policy framework.

Institutionally, this may sound challenging. But, at least in Europe, the groundwork is already laid for all three. With the SDGs and the Planetary Boundary framework, suitable macro-frameworks are already designed, and the information infrastructure required to monitor progress against them is by and large already in place (e.g. the UNFCCC Greenhouse Gas Inventory and Eurostat's SDG Indicator Set). Concerning a taxonomy approach, the EU is currently finalising the climate change mitigation and adaptation criteria of its taxonomy, and will add criteria for its remaining objectives in 2022.[22] Moreover, a permanent expert group,

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[22] A first delegated act, specifying the activity-level criteria for climate change adaptation and mitigation objectives was adopted by the European Commission on 4 June 2021, and has been passed on for scrutiny to the European Parliament and the European Council. A second delegated act for the remaining objectives (ocean and water, recycling and circular economy, pollution prevention and control, and biodiversity) is scheduled for publication in 2022.

the Platform on Sustainable Finance, is being convened to facilitate updating and revising the taxonomy over time, representing the seed of iterated planning for the sustainability transition. Concerning externality pricing and associated accounting standards, lastly, a plethora of approaches are currently being piloted, and much of the ESG data collection infrastructure that has already been put in place by the private sector will be useful for firm-level sustainability accounting once more ambitious externality pricing frameworks emerge.

Regarding implementation synergies, to assess compliance with taxonomy criteria, much of the same information is needed that externality pricing would require, too: e.g. emissions per kWh, energy use of a new building, or the land and water use required in agricultural production. Further, by having two measurement infrastructures, a bottom-up one for externality pricing and a top-down for the SDGs and the Planetary Boundaries, data can be cross-checked and its quality improved. Finally, to account for inevitable shortcomings, the policy set-up as a whole must in any case be evaluated and revised every few years. This in turn is best done in light of how the macro-indicators evolve.

Each of the three components thus adds something essential which the other two could not deliver on their own. Profitability and sustainability can be brought in line through externality pricing; systemic change can be guided through a more centralised epistemology, like the EU taxonomy, supplemented by public investment; and the aggregate impact of all investment decisions (and the policy framework that guides them) can be verified through macro-frameworks, like the SDGs or the Planetary Boundaries.

As a concluding thought, note that sustainable finance as a major private sector activity largely drops out of the picture here. In this vision, the task of identifying which investments count as sustainable is distributed across ordinary market exchange on the one hand, augmented by externality pricing, and a publicly operated system of indicative planning, in the form of a taxonomy or otherwise, on the other. What the role and value-add of private ESG-rating companies, -investment funds or -products would be in this paradigm—if any—is unclear.

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