The epistemology of sustainable finance: how, if at all, can sustainable investments be distinguished from unsustainable investments?

Abstract. The practice of sustainable finance relies on a robust and accurate distinction between sustainable and unsustainable investments. This article asks how, if at all, this distinction can be drawn. It observes that, first, because sustainability is largely a property of systems, not individual projects, most ESG ratings today are ineffective at drawing this distinction. Second, it argues that a reasonable alternative would be to rely on traditional finance, using externality pricing to let market mechanisms draw the distinction between sustainable and unsustainable investments. This can account for systemic interactions but, in a context of high uncertainty and a rapidly needed transformation, is a risky tool for the coordination of investment. Third, it shows that deriving individual project classifications from system-level sustainability frameworks and transition pathways—a form of indicative planning—could be a useful tool to address these challenges. While this, too, will be imperfect, it could be combined with externality pricing and may encourage the risk-taking and social learning required to deliver a sustainability transition in time.

Keywords: sustainable investment; sustainable finance; sustainability; planning; externality pricing; uncertainty

Word count: 8,374 words, excluding bibliography

This work was supported by the Royal Academy of Science, Letters and Fine Arts of Belgium and the Belgian Federal Holding and Investment Company (SFPI-FPIM)

The epistemology of sustainable finance: how, if at all, can sustainable investments be distinguished from unsustainable investments?

1. Introduction

How can sustainable investments be distinguished from unsustainable ones? Answering this question is a necessary precondition for a wide range of sustainability policies. Whether they seek to improve transparency in the investment process, to create a green spread or "greenium" between sustainable and non-sustainable projects, to tax unsustainable and subsidize sustainable ones, to implement 'a precautionary financial policy' (Chenet, Ryan-Collins, & van Lerven, 2021) or green window guidance (Dikau & Volz, 2021), or to ban unsustainable investments or economic activities tout court: without a reliable and robust distinction to guide them, these and similar policies become blind or haphazard.

Drawing this distinction is one of the primary objectives of sustainable finance (Jeucken, 2001; Krosinsky, 2016; Schoenmaker & Schramade, 2019), and a prerequisite to 'making finance flows consistent with a pathway towards low greenhouse gas emissions and climate-resilient development', as the 2015 Paris Agreement stipulates (Article 2.1c of the Paris Agreement).

This paper begins by asking whether, hitherto, the field has delivered on this promise. Finding that it has not, it next asks how, if at all, it might do so in the future. The central epistemological challenge is the inability to generate robust data on economy-wide counterfactuals. Coupled with the complexity of our division of labour, this makes it difficult to identify the sustainability impacts of any one investment. One consequence is that the most common methodology currently used in sustainable finance—using firm-level performance indicators (e.g. emissions, the use of land, water, or energy) and comparing them against 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.

In light of this, 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 the sustainability of investments (e.g. Fatemi & Fooladi, 2013); second, assessing investments against absolute and context-based criteria (e.g. Climate Counts & Center for Sustainable Organizations, 2013; Walenta, 2020), derived from indicative planning.

The first of these would circumvent the thorny question of how to arrive at ESG- or other sustainability ratings by collapsing sustainable finance back into regular finance. Externality-adjusted prices, not ESG ratings or other non-price metrics, would be the arbiters of sustainability. The second, in contrast, would constitute a profound transformation, rather than a reduction, of sustainable finance. In order for absolute and context-based criteria to be credible, they must be coherent and such that, were investment to be aligned with them, the economy would indeed be on a sustainable path. Sustainable finance would thus depend on, or become a part of, an indicative planning infrastructure laying out overall transition paths for the economy.

I lay out the epistemological advantages and disadvantages of both options, showing that, for different reasons, neither is fully capable of robustly and reliably distinguishing sustainable from unsustainable investments. Having said this, the latter approach, linking sustainable finance to indicative planning, may help provide the focus and encourage the risk-taking and social learning needed to deliver a sustainability transition in time.

The paper concludes by identifying complementarities between both approaches, and by highlighting that a number of institutional preconditions for a hybrid approach are already in place in the context of the European Union.

2. Really existing sustainable finance

How, if at all, can sustainable finance distinguish a sustainable from an unsustainable investment? This is the central question of this paper.

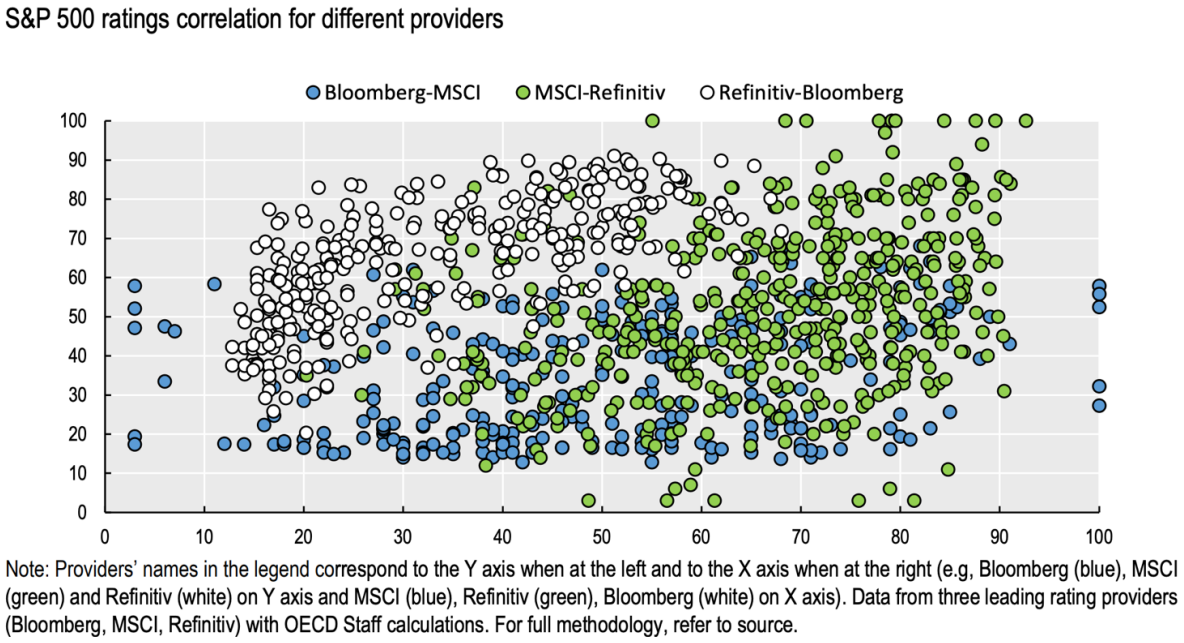
To render it more tractable, it is useful to split the question into two parts: How to define sustainability? And given a definition, how can particular investments be identified as sustainable or not?

While there remain differences over how precisely to define sustainability (Chatterji, Durand, Levine, & Touboul, 2016), 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, p. 43). Since then, this definition has been operationalised in detail with the Sustainable Development Goals, as well as the planetary boundaries and social foundations framework (Raworth, 2017; Rockström et al., 2009). While these are not perfect, they provide sufficient clarity, detail and scientific rigour to be both credible and practicable. Given their long gestation period and the comparatively inclusive processes through which they were drawn up, particularly the SDGs, they also benefit from a high degree of political legitimacy. The more urgent task of sustainable finance, at this point, is therefore the second: Presupposing a working definition of sustainability, can sustainable finance identify the particular investments that would (or would not) count as sustainable against this definition?

A first set of observations suggests that, at this time, the field is struggling to perform this task of identification. Different sustainable finance ratings agencies rarely agree on how to rate the same company. A recent OECD study highlights 'how fundamentally different these [ESG] ratings can be depending on the provider … Among the major market data providers such as Bloomberg, Thomson Reuters, FTSE, MSCI and Sustainalytics, the methodologies

vary significantly … the correlation is low between the scores they assign to the same companies' (OECD, 2020, p. 26). This OECD study is not an outlier: another recent study, covering six prominent agencies,[1] finds an average correlation of 0.54 between their respective ESG ratings, compared to a 0.99 correlation for regular credit ratings (Berg, Kölbel, & Rigobon, 2020, pp. 7–8; see also Chatterji et al., 2016 and Gibson Brandon, Krueger, & Schmidt, 2021). Figure 1 from the OECD study, reproduced below, gives a graphic representation of this weak correlation.

Figure 1. ESG scores from different providers for the same firms correlate weakly



Note: Providers' names in the legend correspond to the Y axis when at the left and to the X axis when at the right (e.g, Bloomberg (blue), MSCI (green) and Refinitiv (white) on Y axis and MSCI (blue), Refinitiv (green), Bloomberg (white) on X axis). Data from three leading rating providers (Bloomberg, MSCI, Refinitiv) with OECD Staff calculations. For full methodology, refer to source.

Source: OECD (2020, p. 27)

Part of why ESG ratings are poor at tracking actual sustainability impacts, as indicated by their wide dispersion, is that they are not always intended to do so. The ESG ratings of both MSCI and Sustainalytics, the two most important in the industry,[2] aim to measure the financial

[1] MSCI, KLD, Sustainalytics, Vigeo Eiris (Moody's), RobecoSAM (S&P Global), Asset4 (Refinitiv).

[2] A survey of investors found that 'Across the interviews and survey, the ratings most favored by investors were MSCI and Sustainalytics' (SustainAbility, 2020, p. 33). According to Bloomberg

risk *of* sustainability policies (e.g. Pigouvian taxes or direct environmental regulation, e.g. a regulatory ban on a key chemical input) *to* companies: 'Of the negative externalities that companies in an industry generate, which issues may turn into unanticipated costs for companies in the medium to long term?' (MSCI ESG Research, 2020, p. 3).[3] The impact *of* companies *on* sustainability outcomes is not what MSCI and Sustainalytics aim to track in the first place.[4] The same holds for Standard and Poor's[5] and Moody's[6] ESG ratings.

Refinitiv, another important ESG ratings provider, does aim to track sustainability impacts: 'ESG scores from Refinitiv are designed to transparently and objectively measure a company's relative ESG performance, commitment and effectiveness' (Refinitiv, 2021, p. 3). However, here, too, there are good reasons to question whether the scores truly track sustainability outcomes, rather than merely tracking financial outcomes indirectly: Berg,

---

Intelligence, '60% of all the money retail investors have plowed into sustainable or ESG funds globally has gone into ones built on MSCI's ratings' and 40% of all financial industry spending on ESG data goes to MSCI (Simpson et al., 2021).

[3] In Sustainalytics case, the 'ESG Risk Ratings measure the degree to which a company's economic value is at risk driven by ESG factors' (Sustainalytics Inc., 2021, p. 4).

[4] The MSCI methodology also tracks the potential opportunities of ESG issues for the firms in question—'Conversely, which ESG issues affecting an industry may turn into opportunities for companies in the medium to long term?' (MSCI ESG Research, 2020, p. 3)—but this, too, concerns the potential financial profit that a firm may reap from ESG-related policy and events, not the impact that a firm has on ESG outcomes.

[5] 'The CSA [Corporate Sustainability Assessment, S&P's ESG rating] has become a reference tool for companies to gauge the financial materiality of their sustainability performance' (Standard and Poor's, 2022, p. 4).

[6] 'VE's [Vigeo.Eiris, Moody's ESG ratings subsidiary] ESG scores measure the degree to which companies take into account and manage material Environmental, Social and Governance […] risks and opportunities that affect sustainable value creation for the company and/or its stakeholders' (Vigeo Eiris, 2020, p. 4).

Fabisik, and Sautner (2021) find 'widespread and repeated changes to the *historical* ESG scores of Refinitiv ESG'. Studying these ex-post revisions of historical ESG scores, they find that, 'while there is a positive link between ESG scores and stock returns in the rewritten data, we fail to observe such a relationship in the initial data' (p. 2). In other words, through the rewriting of past ESG scores, a link between ESG scores and profitability is established.[7]

Given that ESG scores are generally investor-paid, unlike credit scores, which are generally investee-paid (Sangiorgi & Spatt, 2017), this leads the authors to conclude that ex-post revision 'plausibly originates from the rating vendor's incentive to retroactively strengthen the link between ESG scores and returns' (Berg et al., 2021, p. 2). Instead of scores reflecting genuine sustainability impacts, it thus appears that they are re-calculated from time to time so to correlate with strong financial performance, in order to better sell these scores to investors.

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

Challenges along these and similar lines have led to intense criticisms of sustainable finance in general, and of ESG ratings in particular, both from within the industry (Armstrong, 2021; Fancy, 2021) and from outside (Lagoarde-Segot, 2019; Pareen, 2021; Simpson, Rathi, & Kishan, 2021). The aim of this article, however, is not to add to these criticisms or inquire into the political economy and incentives behind sustainable finance as currently practiced, but to inquire how, if at all, sustainable finance *could* identify sustainable investments. In other words, is there, notwithstanding the shortcomings in actually existing sustainable finance, hope

[7] Note that score changes emerge 'to a large extent from changes in how the raw data were combined and aggregated into ESG scores', and only 'to a small extent from continuous, ex-post changes to the granular input variables that make up the ESG scores … For example, though 86% of firms had their ESG score rewritten between February and March 2021, only 6% had a rewriting of any raw data item' (Berg et al., 2021, p. 5). Put differently: improvements of data quality over time do not explain the ex-post link between ESG performance and stock returns.

in it? Could a better version succeed at identifying sustainable investments?

From this perspective, a more fundamental epistemological problem becomes apparent. Moving from a definition of sustainability, even a well-operationalised one, to the identification of individual sustainable investments requires moving from factual to counter-factual analysis.[8] To verify if global emissions are consistent with a 1.5 °C warming trajectory, for example, it is in principle sufficient to collect observational data from the Mauna Loa Observatory, Hawaii, and check if instrument readings are stabilising at or below 430 to 450 parts per million. Observational data suffices to answer whether emissions are or are not below a certain threshold, whether biodiversity is improving or deteriorating, or whether the North Atlantic herring population is collapsing, stable, or growing.

To classify investment choices, however, it is not enough to ask verification questions and answer them via observational data. Instead, to make investment decisions, counterfactual questions must be asked and answered: what are the consequences, *if* this or that investment would go ahead?

Given that 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,' which 'form a complex web of activities reflecting a single, global, interconnected economy which impacts the environment in multi-faceted ways' (Tukker et al., 2014, p. 8), it is rarely enough to look at counterfactuals at the project- or local level: what matters are the consequences of

[8] 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 voices should be heard in the process? This paper focuses on the epistemological process through which sustainable investments might be identified, but recognises that there remain deep questions around how to move from such information—if indeed reliable information on this could be generated, which this paper disputes—to investment choices themselves.

an investment choice for the sustainability outcomes (for example greenhouse gas emissions, land use, or ocean conditions) of the—complex—system as a whole (Holling, 2001).

Counterfactuals can be extrapolated from the past, as is dominant practice, of course. But this relies on the assumption that everything else in the economy, other than the project being evaluated, remains more or less constant (De Udo Haes, 2006, p. 220). Given that sustainable investment is all about *transitioning* our economies from one state to another, the forward extrapolation of historical baselines as implicit counterfactuals is questionable (see also Freidberg, 2013, 2015 on this).

For example, given the transport system as it stands, investments to localise food production and consumption are likely to improve the sustainability performance of the economy as a whole, because they shorten transport routes and so reduce CO_2 emissions. However, if the transport system were to be decarbonised, localised agriculture may become *less* sustainable than regionally specialised agriculture coupled with long-distance transport. Localising agriculture might reduce transport mileage, but the latter industry structure, allowing farms to specialise in whatever is best grown or raised in their particular region, could produce higher food yields with lower total land use.

Then again, much would depend on the supply chain of decarbonised transport: if decarbonisation takes the form of electric vehicles, and crucial raw materials are sourced from socially and environmentally destructive mining, localised agriculture may be the more sustainable option, after all. Unless, in turn, the battery supply chains were to become sustainable, e.g. because zinc-air batteries become commercially viable. And so on.[9]

[9] For vivid illustrations of these complexities and interactions, see Read (1958) or, in a more artistic vein, Thwaites (2011).

As a result, 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, does not allow for conclusive classification: it may be that local emission savings are generated merely by shifting polluting activity up or down the value chain (Babiker, 2005); it may be that the company is reducing one of multiple critical sustainability outcomes—e.g. emissions, land use, or waste—but is causing significant direct or indirect increases in another outcome; it may be that the technology used to deliver emission savings reduces emissions in the short term, but prevents or renders difficult further reductions beyond that level in the future (Seto et al., 2016; Unruh, 2000); or it may be that an initially positive effect turns negative, or vice versa, because of interaction effects with changes elsewhere in the economy (Lipsey & Lancaster, 1956). As the Technical Expert Group that elaborated the EU's draft taxonomy pointed 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, p. 24).

In other words, even if the structural incentives facing sustainable finance practitioners could be changed, addressing some of the problems covered above, a fundamental epistemological problem would remain: Given the many interconnections that constitute contemporary economies, the only reliable way to determine the system-level impact and sustainability outcomes of an investment would be a direct comparison between an economy in which the investment went ahead, with an otherwise identical, counterfactual one in which it does not. This method is not available.

Does this render sustainable finance a moot endeavour? Not necessarily. Note that the problem outlined above is 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, about what happens elsewhere in the economy. In the case

of automotive manufacturing, for example, whether or not an investment will be productive and profitable will depend on future 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, 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 complex 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 epistemological identification of *sustainable* investment is thus the main methods used to identify *productive* investments. The next section discusses the first of the two archetypical coordination mechanisms, market-based coordination, while its main alternative, planning-based coordination, is discussed subsequently.

4. Profit-based 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. Nevertheless, despite abundant co-dependencies between individual investments and the complex system they are embedded in, the profit-based coordination of productive investment has functioned well, from a productivity perspective, in the advanced economies of Western Europe, North America, Japan and other OECD

countries.[10]

The classic description of how profit-oriented competition coordinates investment is given by Hayek:[11]

> '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, p. 526)

Hayek points out that 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. Using their local knowledge, these agents will then try to economise on the inputs in question, to substitute them, or to find new methods to produce and sell them.[12] Through second-round price effects, this percolates 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.'

---

[10] This is not to deny that market coordination can be—and often is—suboptimal for a number of reasons, including positive and negative externalities, information asymmetries, public goods, monopoly and oligopoly, the volatility and non-rationality of financial markets in the face of fundamental uncertainty, the existence of multiple equilibria, and the possibility of market economies to enter demand-side secular stagnation. For an overview on this, see Cassidy (2009).

[11] For a more recent, critically appreciative description, see Benanav (2020).

[12] See also Schumpeter (1942, Chapter 7) and Marx (1992 [1867], chap. 15, esp. 617-8) on this.

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 for producing information (as lifecycle assessments attempt to do for sustainability, for example)[13] but via systematically decentralised trial-and-error, drawing on the specific and local knowledge of the managers and capitalists empowered to make production decisions.

The same mechanism can be applied for the identification of sustainable investments, via externality pricing. The accounting frameworks required to operationalise this are variously known as Full Cost- (Bebbington, Gray, Hibbitt, & Kirk, 2001), True Cost- (TEEB, 2014), Natural Capital- (Wackernagel et al., 1999), triple bottom line- (Thomas & McElroy, 2016) or simply New Accounting (van der Lugt, 2018). 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 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. Consumers can 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[14]—while firms'

---

[13] On the challenges associated with lifecycle assessments, see Freidberg (2013, 2015). Freidberg's sobering conclusion is that 'it is far from clear that LCA can capture the complexity of products' 'lives' in measures that are simultaneously practical, legible and scientifically credible' (Freidberg, 2013, p. 571).

[14] 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

internal accounting practices would change greatly, it would not complicate firm-to-firm or consumer-to-firm interaction. Investment choices would continue to proceed through trial-and-error, decentrally, coordinated via their relative profitability.

Relying on externality pricing to identify sustainable investments is controversial, for a number of reasons.[15] Among the most prominent is the difficulty of quantifying and pricing the environmental and social impacts to be tracked by sustainability accounting (see e.g. Hache, 2019; Liu, 2017; Radermacher & Steurer, 2015; Robertson, 2004), but among the most problematic, particularly in the case of climate change, are the effects of pervasive uncertainty on this mechanism.

Three issues are particularly problematic from an epistemological point of view: First, environmental or social ecosystems often exhibit non-fungibilities. Important social or ecological features may be both critical and irreplaceable (Brand, 2009), so that their marginal rates of substitution should be infinity. But insofar as pricing inherently introduces fungibility in accounting terms, this is a feature that externality pricing cannot represent or capture.

Second, 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

---

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 & Thorlakson, 2018, p. 20).

[15] 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 contestable normative assumptions.

crossed. Similar discontinuities exist for climate change at the planetary scale (Lenton et al., 2008). Market prices, whether externality-adjusted or not, 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, profit-driven 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 and toothbrushes to many service sector activities. In the context of sustainability, however, it is frequently false, a status that is difficult to capture in actual or hypothetical externality pricing methods.

A third, more fundamental critique revolves around the consequences of uncertainty for profit-based investment coordination. The essence of this critique is that, under uncertainty, the mechanism itself becomes unreliable, rendering it unsuitable for existential challenges like climate change.

On the one hand, where uncertainty is high, externality pricing and sustainability accounting may fail at identifying the 'right' investments. Where the future is deeply uncertain, there is no robust and objective way to evaluate future profitability. Expectations rather than current profitability start to drive asset valuations, creating space for herd behaviour, self-fulfilling prophecies, and a misallocation of capital.[16] This uncoupling of investment from today's price- and profitability landscape may be called the expectations problem.

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 would force an unattractive choice: either opt for gradual price paths, to protect

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

the functioning of the investment coordination mechanism, but at the risk of dangerously delaying the transition;[17] or choose an ambitious price path, to inject strong market signals early, but at the risk of creating such uncertainty as to allow future expectations to swamp today's price signals.[18] Given the unruly nature of expectations and expectation formation, this latter scenario contains significant risks: capital may or may not flow into the necessary investments in time.

On the other hand, in addition to the expectations problem, externality pricing under uncertainty suffers from a problem of caution. The higher uncertainty, the larger the temptation for investors to hold liquid, low-risk, financial 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, the spread on illiquid vs liquid investments rises, depressing real investment (Robinson, 1956, 1962). Even if, under the influence of externality pricing, the 'right' firms and projects stand out as sustainable (on the basis of good operating profits), they might still struggle to attract financing. Competitors to the existing fossil fuel-based industries and infrastructures would then have to rely on the generation of internal financing, leading to potentially dangerous delays.

Hence, even if the prior problems of creating artificial fungibility and accounting poorly for tipping points could be solved, externality pricing would struggle with the consequences of uncertainty. Where the identification of sustainable investments is attempted via this

---

[17] 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 400-500 Gt CO2 (IPCC, 2021, p. 29). 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 660 Gt CO_2 over their regular economic lifetime, as calculated from 2018 forward (Tong et al., 2019, p. 373).

[18] This risk is particularly acute for cap and trade schemes, which introduce additional volatility into the process of externality pricing (Baldursson & von der Fehr, 2004).

mechanism, the following pattern may 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;[19] but they can also be a waste of capital, with little to show for after the fact.[20] 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 spur the changes that are required to master the transition.

5. Reducing uncertainty? Indicative planning and public investment

The main alternative to the decentralised, profitability-based identification of sustainable investment projects are various forms of a planning-based identification of sustainable investment projects.

Planning, particularly in the context of investment choices, must be distinguished from a command economy. By planning, I refer to the setting of economic priorities and the selection of investment projects via non-market means. A command economy, in contrast, is one

[19] 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 greatly boosted the construction of internet infrastructure particularly in the US.

[20] 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.

particular way of injecting plans, priorities and project choices into the division of labour, namely via command and control measures.[21] As France, Sweden, Japan and other mixed economies demonstrated in the wake of WWII, there are a variety of more desirable ways via which plans can be injected into an economy: from direct public investment, via taxes and subsidies, to banking regulation, credit guidance, and foreign exchange allocation, to name but a few.[22]

Planning in this sense is distinguished from profit-based, decentralised project identification by the *level* at which plans are drawn up, and the *process* through which coherence is striven for. 'Planning is as central to market economies as it is to any other type of economy, the only difference being that planning in a market economy is *decentralized* and delegated from the state to the firm, which relies on *fictitious projections of profit opportunities, rather than on policy goals*, to make decisions' (Beckert, 2016, p. 311, highlights added). In other words, planning involves proceeding directly from policy goals to project identification, rather than relying on expected profitability as the signals around which many decentralised planners coordinate.

Planning is generally argued to have three advantages. First, providing the guidance necessary to rapidly channel and redeploy resources in line with political priorities. Historically, examples of this include forcing the transition from a peace- to a war-time economy (Devons, 1970; Wilson, 2016), accelerating post-war reconstruction (Massé, 1962),

[21] See esp. Wilhelm (1985) on this.

[22] See, for example, Johnson (1982). Another example is the UK war economy in WWII: 'The war economy was planned on the basis of conscious direct allocation, even though production was undertaken by firms that remained predominantly privately owned and motivated by profit' (Devine, 1988, p. 32).

or using industrial policy in pursuit of export-led (Johnson, 1982; Norton, 1970) or heavy industrial (Allen, 2003) growth.

Second, reducing uncertainty (Estrin & Holmes, 1983). Here, theorists of planning generally distinguish between objective and subjective (Dobb, 1955, p. 77, 1960, pp. 7–8) or primary and secondary (Koopmans, 1957, pp. 162–163) uncertainty. Primary or objective uncertainty refers to our (unavoidable) inability to know the future; secondary or subjective uncertainty refers to the (avoidable) uncertainty arising from individual, atomised decision-makers not knowing what decisions others, similarly situated decision-makers will take (Devine, 1988, p. 16).[23] The advantage of planning, it is argued, lies in its ability to reduce subjective or secondary uncertainty, by coordinating major investment decisions in advance.

Third, and closely related to the second advantage, planning can help overcome Prisoners' Dilemma- (Devine, 1988, p. 14) and Stag Hunt- (Skyrms, 2001) type problems. The mechanism here is not just epistemological, based on the reduction of subjective uncertainty (for Stag Hunts)[24] or on the introduction of beneficial constraints (for Prisoners' Dilemmas),[25] but also sociological: whether in the case of French post-WWII planning, where civil servants, trade unionists, and managers and entrepreneurs met in Modernization Commissions (Massé, 1965), or Japanese industrial policy, where the focus was on bilateral meetings between the

---

[23] Revolutionary changes in technology or individual natural disasters are generally examples of objective uncertainty; whether there will be sufficient charging points for electric vehicles to take off is an example of subjective uncertainty.

[24] 'According to the witnesses we have consulted, it seems likely that the growth expectations set forth in the Second National Plan (1954-7) were in contradiction to the conventional wisdom at the beginning of the 1950s, which expected that only low rates of growth were possible. … The picture of a growing economy provided by the Plan, in which production was sure of finding sales, probably played a significant part in the resumption of growth after 1952' (Carré et al., 1975, p. 471).

[25] On beneficial constraints, see Streeck (1997).

Ministry of International Trade and Industry (MITI) and business (Johnson, 1982), the process of indicative planning can forge new personal connections, create shared beliefs and expectations, and foster the undertaking of mutual commitments (Delors, 1978). In this sense, planning can be understood as an alternative to the various financial and other mechanisms that generate the 'Imagined Futures' that underlie market-coordinated investment (Beckert, 2016).

Against these advantages, Mises (1920) and Hayek (1940, 1945) have argued that, given the sheer complexity of a modern division of labour, rational planning is difficult and likely impossible. Mises saw the problem arising from an absence of prices for producer goods: where these prices are lacking, different projects cannot be compared in the same unit, rendering choices either infinitely complex or arbitrary. But given that planning today would take place in the context of market economies, where prices exist and the profit motive operates, this critique does not apply. Unlike comprehensive planning in a command economy, indicative planning for the purpose of identifying sustainable investments can and would draw on price information that is revealed through competition. Price-based assessments would not be final—the very purpose of indicative planning being to bring in additional information that is not yet contained in the structure of prices—but it would provide useful inputs giving order-of-magnitude information about the economic costs of different options.

More fundamentally, Mises mischaracterised the problem to be solved in the first place. An 'economy is not a set of equations waiting to be solved, either with a capitalist price system or a socialist computer. It is better understood as a network of decision-makers, each with their own motivation, using information to make decisions, and generating information in turn.' (Benanav, 2020). Proceeding from this understanding of the economy as a network of decision-makers, Hayek argued that the information on which planners had to rely would either not be produced in the absence of profit-incentives (Hayek, 1940, p. 139), or, if it did exist, would

have to be found in the heads of millions of individuals, from where it could not readily be aggregated (Hayek, 1945, passim).

Based on a more accurate image of the economic process, Hayek's critique hits home: there is no successful example of comprehensively planning an entire economy.[26] Vital micro-level information, concerning what alternative inputs a firm could use, which machines need replacing soon and how easy will it be to get that replacement, how price-sensitive customers are for this good or that good, only exists decentrally and—this is Hayek's key point—planning cannot easily make use of it.

However, while Hayek's critique is convincing, it is conclusive only for the case of *comprehensive* planning, where the attempt is made to develop a plan for the entire economy, down to the micro-level. For less granular versions of planning, for example at the industry-, sectoral, or macro-level, the case is not quite so clear. Broad judgements about which sectors might be most central for industrialising an economy, for winning a war, or—in today's context—reducing carbon emissions, land use, and biodiversity loss: these judgements can and historically have been made successfully by planning bodies.[27] Examples include early Soviet industrialisation (Allen, 2003), UK and US wartime economic management (Devons, 1970; Wilson, 2016), or Japanese and South Korean industrialisation (Johnson, 1982; Norton, 1970). Here, the historical record shows that 'For a small number of strategic objectives, given overriding priority', planning can identify the right priorities (Devine 1988, p. 10).

---

[26] Though see Benanav (2020), drawing on Neurath (Neurath, 2005 [1925]), for suggestive thoughts on how to preserve decentralisation in a democratic planning procedure.

[27] The importance of planning at an appropriate level of granularity has long been recognised by practitioners of planning: A key principle of French post-WWII planning, for example, was: 'Respect for orders of magnitude is essential. A superstitious focus on digits behind the decimal point is absurd' (Massé, 1965, p. 176).

The knowledge needed to do this successfully depends on the particular ends pursued by the planners. In the South Korean case, for example, the Economic Planning Board, the Ministry of Finance and the Ministry of National Construction used six different models[28] in order to draw up both low-granularity five-year plans, and higher-granularity annual plans (also known as Overall Resource Budgets). In line with the limits of the models, the scope of planning was not comprehensive. Instead, it was 'very much oriented toward investment programs in industry and social overhead, by sector and project, and the savings and export problems.' In contrast, 'employment, education, agriculture, and social welfare received much less attention', in part because they were not seen as binding constraints at the time (Norton, 1970, p. 59). In the climate case, it is striking that a set of new models is currently being developed around the US budgetary process, precisely to estimate the climate consequences of this or that set of tax-and-spend policies (Tooze, 2021). While none of these tools—neither the set of models used in Korea to identify export-oriented growth priorities, nor the set of models currently being built to assess the US budgeting process through a climate lens—could develop comprehensive plans, they each may generate the knowledge required to drive particular changes into the economy.

This points the way towards what a successful use of planning for the identification of sustainable investments might look like: instead of attempting to plan for the entire economy, a focus could be placed on agriculture, energy, transport, housing and industry[29], which between them account for the vast majority of emissions, land-, and material use. It will not be

[28] Input-output, macro-economic growth model, rate-of-return project-level calculations, a short-term stabilization model, regional linear programming model, and a mixed-integer model 'to insure consistency of demand and supply for unusually lumpy investments' (Norton, 1970, pp. 61–62).

[29] Within the industry sector, the production of steel, cement, fertilizers, and plastics are responsible for the vast majority of sectoral emissions.

possible to plan these sectors down to the last nuts and bolts; but it has already been shown feasible to evaluate which broad technological and infrastructural investments might be required to achieve a net-zero economy (Boston Consulting Group, 2021; Consentec & Fraunhofer-Institut für System- und Innovationsforschung ISI, 2021; Deutsche Energie-Agentur GmbH, 2021; Kopernikus-Projekt Ariadne, 2021; e.g. for Germany: Prognos, Öko-Institut, & Wuppertal Institut, 2021).

A reasonable way to think about planning as a method for identifying sustainable investments, then, is to conceive of it as sketching out a backbone—the approximate shape that the five crucial sectors must have to be sustainable—around which other economic activity can then unfold. In other words, planning is better understood as a method for *changing* an economy, through deliberately readjusting a limited number of its core elements, rather than as a method for *running it*, where it would likely falter on the shoals of complexity and the importance of decentralised knowledge.

6. Indicative planning applied to sustainable finance

What could a planning-based approach to sustainable finance look like in practice? A useful historical example is the Monnet plan for the reconstruction of France after WWII (Carré, Dubois, & Malinvaud, 1975).

The Monnet Plan navigated a situation not entirely unlike ours today. In the postwar moment, both domestic funds and foreign exchange were scarce. Since dollars and francs were not freely exchangeable at the time, they had to be budgeted for separately, acting as a double budget constraint, paralleling the economic and ecological constraints that are binding today. The Monnet Plan navigated this tightly binding double constraint through prioritization. Instead of attempting to plan for all sectors, the Plan focused on six strategic industries: electricity, steel, coal mining, transport, cement, and agricultural machinery. ‘Bottlenecks were broken during the early days’ (Kindleberger, 1967, p. 295), and while not all targets were

reached, the plan provided 'discipline, direction, vision, confidence, and hope' (Yergin & Stanislaw, 2002, p. 14).

The process of sectoral planning was led by a core staff in the *Commissariat général du Plan*, numbering around 100. This core staff cooperated with a number of so-called modernization commissions, composed of representatives from the state, employers, and trade unions, which tackled either specific sectors or cross-cutting themes like finance or labour.[30] With ten to thirty members each, they acted as two-way transmission belts: on the one hand, they provided the *Commissariat général du Plan* with expertise on feasibility. On the other hand, they generated commitment among firms and unions to help realise the plan's targets.

A similar planning process could be imagined today: a small core planning unit could be set up as a central hub. The primary task of this unit would be to assemble transition commissions for each of the five sectors, as well as for cross-cutting issues like financing, labour, and regional balance. These commissions, facilitated by the core staff, would lay out transition paths that meet the double budget constraint faced today.

Once a set of transition plans has been drawn up, major investment projects in the five sectors at stake could be deemed sustainable or not, depending on their fit with overall sectoral trajectories. In terms of operational templates, this could follow the example of the Science-Based Targets initiative (SBTi), which assesses firms' climate plans not relative to the plans and performances of their peers, but according to whether or not they are consistent with limiting global temperature rise to 1.5 °C or less;[31] or with the EU Taxonomy for Sustainable

---

[30] According to Pierre Massé, sometime called the 'doyen of French post-war planning', these commissions were 'probably the most consequential creation of Jean Monnet' (Massé, 1965, p. 154).

[31] While it provides a valuable template, SBTi has been criticized both for approving insufficiently ambitious climate plans (Lo, 2021) and for questionable internal governance practices (Hodgson, 2022). Given its potential importance for the future development of the economy, this highlights the

Activities, which provides a roster of multiple criteria[32] for assessing whether an economic activity is sustainable or not. Crucially, absolute and context- or planning-based criteria would provide guidance on the sustainability (or not) of individual projects *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 an entire asset class like crypto currencies may suddenly appear like a highly profitable investment, and hence, under the epistemological lens of sustainability accounting, like a sustainable investment.

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

Compared to externality pricing, using planning to identify sustainable investment projects 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. Where indicative planning is scaled down to a limited number of core sectors—energy, transport, buildings, industry and agriculture—the reduction in complexity may render it feasible, notwithstanding Hayek's insightful critique of comprehensive planning.

---

importance of establishing a public process for deriving sustainability judgements from overall scenarios, plans and trajectories, rather than relying on a private organisation for doing so.

[32] These are partly absolute, as with a limit of 100gCO_2/kWh for the generation of electricity, and partly relative, as with Article 10(2) of the Taxonomy Regulation, which provides that 'an economic activity for which there is no technologically and economically feasible low-carbon alternative shall qualify' as sustainable if it 'has greenhouse gas emission levels that correspond to the best performance in the sector or industry; does not hamper the development and deployment of low-carbon alternatives; and does not lead to a lock-in of carbon-intensive assets, considering the economic lifetime of those assets' (European Parliament and the Council, 2020, pp. 29–30)

This is a promising avenue to reduce subjective uncertainty. But does it suffice, on its own, to solve the epistemological problems identified above? Not necessarily. Like the evaluation of individual projects in contemporary sustainable finance practices, indicative planning suffers from the difficulty of identifying counterfactuals and the challenges of understanding a complex division of labour. The future development of key technologies, for example, cannot be known with certainty, nor can future world market prices for key materials be predicted with accuracy. Major consumer trends, too, may surprise in one way or another, as could the reactions of agriculture and other nature-dependent industries to the unfolding of climate change. While indicative planning can strive to map out *sufficient* transition paths, i.e. investment patterns with high likelihoods of fitting inside the planetary boundaries, it cannot claim to deliver *optimal* transitions paths. As with project-level analysis, robust comparisons can only be made with historical trends, not relative to the universe of counterfactual adjustment paths.

Given the incompleteness of knowledge that a planning-based classification of investment would suffer from, regularly iterating the transitions paths in light of new information would be key. But concerning such iteration, the only numbers that policy makers can easily read off from prior planning-based classifications of investments are the financial volumes in compliance with it. This 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 system of indicative planning 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 series of transition paths and then investment project classifications, it is well suited for translating between system-level analysis and individual (public or private) investment choices. It is not, however, a useful ex-post *measurement* tool. This implies significant complementarities between planning-based investment classification, which operates as a steering tool, and measuring frameworks associated with the SDGs[33] and with the various forms of sustainability accounting mentioned above, which provide vital input for the iteration of indicative plans. Price and cost data, generated through the continuous operation of competitive markets, would also provide valuable information.

This shows: neither externality pricing nor indicative planning are sufficient on their own, capable of conclusively identifying which investments do or do not qualify as sustainable. An indicative-planning based classification system can be a useful steering tool for policy makers to guide the backbone of industrial transformation. However, by itself this approach does not and cannot offer a complete solution to the epistemological problem: Hampered by the inability to observe counterfactuals and the inevitable surprises that afflict any plan as it confronts reality, it requires constant iteration in order to correct for misjudgements and unexpected outcomes.[34]

Legally and institutionally, a groundwork is already laid for a combination of both approaches, at least in the EU context. The EU taxonomy provides a legal framework via which

---

[33] E.g. Eurostat's SDG Indicator Set (Eurostat, 2020).

[34] Moreover, on a practical rather than epistemological level, 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 (Mazzucato, 2013); but another part of the answer lies in externality pricing.

indicative plans could be translated into investment-level classifications. While the first delegated acts leave much to be desired, suffering from both excess complexity and insufficient ambition, they provide a ready-made legal infrastructure via which transition paths and scenario analyses like Prognos, Öko-Institut, and Wuppertal Institut (2021) or Boston Consulting Group (2021) could be operationalised. Concerning externality pricing and associated accounting standards, a variety of approaches are being piloted, [35] and much of today's ESG data collection infrastructure and routines will be useful for firm-level sustainability accounting once more ambitious externality pricing frameworks emerge.

Each component thus adds something essential which the other could not deliver on their own. Systemic change can be guided through indicative planning for a small set of core sectors; profitability and sustainability can be brought in line through externality pricing, which also provides the micro-level data required to iterate plans over time. The aggregate impact of investment decisions, and of the policy framework that guides them, can in turn 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, translated to the investment level via 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.

[35] See for example the Environmental Profit and Loss accounts pioneered by Kering and PWC (Kering S.A., 2020).

Bibliography

Bibliography}

Akerlof, G. A., & Shiller, R. J. (2009). *Animal Spirits*. Princeton: Princeton University Press.

Akerlof, G. A., & Shiller, R. J. (2015). *Phishing for Phools: The Economics of Manipulation and Deception*. Princeton: Princeton University Press.

Allen, R. C. (2003). *Farm to Factory: A Reinterpretation of the Soviet Industrial Revolution*. Princeton: Princeton University Press.

Armstrong, R. (2021, August 24). The ESG investing industry is dangerous. *The Financial Times*.

Babiker, M. H. (2005). Climate change policy, market structure, and carbon leakage. *Journal of International Economics*, *65*(2), 421–445. https://doi.org/10.1016/J.JINTECO.2004.01.003

Baldursson, F. M., & von der Fehr, N.-H. M. (2004). Price volatility and risk exposure: on market-based environmental policy instruments. *Journal of Environmental Economics and Management*, *48*(1), 682–704. https://doi.org/10.1016/j.jeem.2003.06.004

Bebbington, J., Gray, R., Hibbitt, C., & Kirk, E. (2001). *Full Cost Accounting: An Agenda for Action*. London: Certified Accountants Educational Trust.

Beckert, J. (2016). *Imagined Futures: Fictional Expectations and Capitalist Dynamics*. Cambridge, MA: Harvard University Press.

Benanav, A. (2020). How to Make a Pencil. *Logic Magazine*, *12*(December).

Berg, F., Fabisik, K., & Sautner, Z. (2021). *Is History Repeating Itself? The (Un) predictable Past of ESG Ratings*. (August), 51.

Berg, F., Kölbel, J., & Rigobon, R. (2020). Aggregate Confusion: The Divergence of ESG Ratings. *Working Paper*. https://doi.org/10.2139/ssrn.3438533

Boston Consulting Group. (2021). *Klimapfade 2.0: Ein Wirtschaftsprogramm für Klima und Zukunft*. Berlin.

Brand, F. (2009, January 15). Critical natural capital revisited: Ecological resilience and sustainable development. *Ecological Economics*, Vol. 68, pp. 605–612. https://doi.org/10.1016/j.ecolecon.2008.09.013

Carré, J.-J., Dubois, P., & Malinvaud, E. (1975). *French Economic Growth* (J. P. Hatfield, Trans.). Stanford: Stanford University Press.

Cassidy, J. (2009). *How Markets Fail*. New York: Picador.

Chatterji, A. K., Durand, R., Levine, D. I., & Touboul, S. (2016). Do ratings of firms converge? Implications for managers, investors and strategy researchers. *Strategic Management Journal*, *37*(8), 1597–1614. https://doi.org/10.1002/smj.2407

Chenet, H., Ryan-Collins, J., & van Lerven, F. (2021). Finance, climate-change and radical uncertainty: Towards a precautionary approach to financial policy. *Ecological Economics*, *183*, 106957. https://doi.org/10.1016/j.ecolecon.2021.106957

Climate Counts, & Center for Sustainable Organizations. (2013). *Assessing Corporate Emissions Performance through the Lens of Climate Science*.

Consentec, & Fraunhofer-Institut für System- und Innovationsforschung ISI. (2021). *Langfristszenarien für die Transformation des Energiesystems in Deutschland 3 Kurzbericht: 3 Hauptszenarien*. Aachen & Karlsruhe.

De Udo Haes, H. A. (2006). How to approach land use in LCIA or, how to avoid the Cinderella effect? Comments on 'key elements in a framework for land use impact assessment within LCA1. *International Journal of Life Cycle Assessment*, *11*(4), 219–221. https://doi.org/10.1065/lca2006.07.257

Delors, J. (1978). The decline of French planning. In S. Holland (Ed.), *Beyond Capitalist Planning*. Oxford: Basil Blackwell.

Deutsche Energie-Agentur GmbH (Ed.). (2021). *dena-Leitstudie Aufbruch Klimaneutralität*. Berlin.

Devine, P. (1988). *Democracy and Economic Planning*. Cambridge: Polity.

Devons, E. (1970). *Papers on Planning and Economic Management*. Manchester: Manchester University Press.

Dikau, S., & Volz, U. (2021). Out of the window? Green monetary policy in China: window guidance and the promotion of sustainable lending and investment. *Climate Policy*, 1–16. https://doi.org/10.1080/14693062.2021.2012122

Dobb, M. (1955). *On Economic Theory and Socialism*. London: Routledge & Kegan Paul.

Dobb, M. (1960). *An Essay on Economic Growth and Planning*. London: Routledge & Kegan Paul.

Estrin, S., & Holmes, P. (1983). *French Planning in Theory and Practice*. London: George Allen & Unwin.

EU Technical Expert Group on Sustainable Finance. (2019). *Taxonomy Technical Report*. Brussels.

European Parliament and the Council. (2020). Regulation (EU) 2020/852 of 18 June 2020 on the establishment of a framework to facilitate sustainable investment, and

amending Regulation (EU) 2019/2088. *Official Journal of the European Union*, 13–43.

Eurostat. (2020). Sustainable Development in the European Union: Monitoring report on progress towards the SDGs in an EU context, 2020 edition. In *Greener Management International* (Vol. 2001). https://doi.org/10.9774/gleaf.3062.2001.wi.00007

Fancy, T. (2021). *The Secret Diary of a 'Sustainable Investor'*. Medium.

Fatemi, A. M., & Fooladi, I. J. (2013). Sustainable finance: A new paradigm. *Global Finance Journal*, *24*(2), 101–113. https://doi.org/10.1016/j.gfj.2013.07.006

Freidberg, S. (2013). Calculating sustainability in supply chain capitalism. *Economy and Society*, *42*(4), 571–596. https://doi.org/10.1080/03085147.2012.760349

Freidberg, S. (2015). It's Complicated: Corporate Sustainability and the Uneasiness of Life Cycle Assessment. *Science as Culture*, *24*(2), 157–182. https://doi.org/10.1080/09505431.2014.942622

Frick, M., & Huwe, V. (2020). Klimapolitik zwischen Markt, Deliberation und Hegemonie – Der Emissionshandel und das Politische. *ZEW Discussion Paper*, *20*(060).

Gibson Brandon, R., Krueger, P., & Schmidt, P. S. (2021). ESG Rating Disagreement and Stock Returns. *Financial Analysts Journal*, *77*(4), 104–127. https://doi.org/10.1080/0015198X.2021.1963186

Hache, F. (2019). *50 Shades of Green Part II: The Fallacy of Environmental Markets*. https://doi.org/10.2139/ssrn.3547414

Hayek, F. A. von. (1940). Socialist Calculation: The Competitive 'Solution'. *Economica1*, *7*(26), 125–149.

Hayek, F. A. von. (1945). The Use of Knowledge in Society. *American Economic Review*, *35*(4), 519–530.

Hodgson, C. (2022, February 2). Climate targets oversight group under scrutiny over its own governance. *The Financial Times*.

Holling, C. S. (2001). Understanding the complexity of economic, ecological, and social systems. *Ecosystems*, *4*(5), 390–405. https://doi.org/10.1007/s10021-001-0101-5

IPCC. (2021). Summary for Policymakers. In V. Masson-Delmotte, P. Zhai, A. Pirani, S. L. Connors, C. Péan, S. Berger, … B. Zhou (Eds.), *Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge: Cambridge University Press.

Jeucken, M. (2001). *Sustainable Finance and Banking: The Financial Sector and the*

Future of the Planet. London: Routledge.

Johnson, C. (1982). *MITI and the Japanese Miracle*. Stanford: Stanford University Press.

Kering S.A. (2020). *Environmental Profit & Loss 2019 Group Results*. Paris.

Keynes, J. M. (1936). *The General Theory of Employment, Interest, and Money*. London: Macmillan.

Kindleberger, C. (1967). French Planning. In M. F. Millikan (Ed.), *National Economic Planning*. Washington, D.C.: NBER.

Koopmans, T. (1957). *Three Essays on the State of Economic Science*. New York: McGraw-Hill.

Kopernikus-Projekt Ariadne. (2021). *Ariadne-Report: Deutschland auf dem Weg zur Klimaneutralität 2045 - Szenarien und Pfade im Modellvergleich*. Potsdam: Potsdam-Institut für Klimafolgenforschung (PIK).

Krosinsky, C. (2016). *The State of Sustainable Finance in the United States*. New York: United Nations Environmental Programme.

Lagoarde-Segot, T. (2019). Sustainable finance. A critical realist perspective. *Research in International Business and Finance*, *47*(April), 1–9. https://doi.org/10.1016/j.ribaf.2018.04.010

Lambin, E. F., & Thorlakson, T. (2018). Sustainability Standards: Interactions Between Private Actors, Civil Society, and Governments. *Annual Review of Environment and Resources*, *43*(1), 369–393. https://doi.org/10.1146/annurev-environ-102017-025931

Lenton, T. M., Held, H., Kriegler, E., Hall, J. W., Lucht, W., Rahmstorf, S., & Schellnhuber, H. J. (2008, February 12). Tipping elements in the Earth's climate system. *Proceedings of the National Academy of Sciences of the United States of America*, Vol. 105, pp. 1786–1793. https://doi.org/10.1073/pnas.0705414105

Levy, J. (2021). *Ages of American Capitalism*. New York: Random House.

Lipsey, R. G., & Lancaster, K. (1956). The General Theory of Second Best. *The Review of Economic Studies*, *24*(1), 11. https://doi.org/10.2307/2296233

Liu, J. C. E. (2017). Pacifying uncooperative carbon: examining the materiality of the carbon market. *Economy and Society*, *46*(3–4), 522–544. https://doi.org/10.1080/03085147.2017.1408250

Lo, J. (2021, February 6). Science Based Targets initiative accused of providing a 'platform for greenwashing'. *Climate Home News*.

Marx, K. (1992). *Capital, Vol. 1: A Critique of Political Economy.* (E. Mandel, Ed.; B. Fowkes, Trans.). London: Penguin.

Massé, P. (1962). French Methods of Planning. *The Journal of Industrial Economics*, *11*(1), 1–17.

Massé, P. (1965). *Le plan ou l'anti-hasard*. Paris: Éditions Gallimard.

Mazzucato, M. (2013). *The Entrepreneurial State: Debunking Public vs. Private Sector Myths*. London: Anthem Press.

Mises, L. von. (1920). Die Wirtschaftsrechnung im sozialistischen Gemeinwesen. *Archiv Für Sozialwissenschaft Und Sozialpolitik*, *47*(1), 86–121.

MSCI ESG Research. (2020). *MSCI ESG Ratings Methodology*. New York: MSCI Inc.

Neurath, O. (2005). Economic Plan and Calculation in Kind. In *Otto Neurath Economic Writings Selections 1904–1945* (pp. 405–465). https://doi.org/10.1007/1-4020-2274-3_14

Norton, R. (1970). Planning with Facts: The Case of Korea. *The American Economic Review*, *60*(2), 59–64.

OECD. (2020). *Sustainable and Resilient Finance: OECD Business and Finance Outlook 2020*. Paris: OECD Publishing.

Pareen, A. (2021, October 5). Climate-Friendly Investment Funds Are a Scam. *The New Republic*.

Prognos, Öko-Institut, & Wuppertal Institut. (2021). *Klimaneutrales Deutschland 2045. Wie Deutschland seine Klimaziele schon vor 2050 erreichen kann: Zusammenfassung im Auftrag von Stiftung Klimaneutralität, Agora Energiewende und Agora Verkehrswende*. Berlin.

Radermacher, W. J., & Steurer, A. (2015). Do we need natural capital accounts for measuring the performance of societies towards sustainable development, and if so, which ones? *Eurostat Review on National Accounts and Macroeconomic Indicators*, (1).

Raworth, K. (2017). *Doughnut economics: seven ways to think like a 21st-century economist*. London: Random House.

Read, L. (1958). I, pencil. *Freeman*, *8*(12).

Refinitiv. (2021). *Environmental, Social and Governance Scores from Refinitiv*. New York.

Robertson, M. M. (2004). The neoliberalization of ecosystem services: Wetland mitigation banking and problems in environmental governance. *Geoforum*, *35*(3), 361–373. https://doi.org/10.1016/j.geoforum.2003.06.002

Robinson, J. (1956). *The Accumulation of Capital*. London: Macmillan.

Robinson, J. (1962). *Essays in the Theory of Economic Growth*. London: Macmillan.

Rockström, J., Steffen, W., Noone, K., Persson, Å., Chapin, F. S., Lambin, E. F., … Foley, J. A. (2009). A safe operating space for humanity. *Nature*, *461*(7263), 472–475. https://doi.org/10.1038/461472a

Sangiorgi, F., & Spatt, C. (2017). The Economics of Credit Rating Agencies. *Foundations and Trends in Finance*, *12*(1), 1–116. https://doi.org/10.1561/0500000048

Schoenmaker, D., & Schramade, W. (2019). *Principles of Sustainable Finance*. Oxford: Oxford University Press.

Schumpeter, J. A. (1942). *Capitalism, Socialism, and Democracy*. New York: HarperCollins.

Seto, K. C., Davis, S. J., Mitchell, R. B., Stokes, E. C., Unruh, G., & Ürge-Vorsatz, D. (2016). Carbon Lock-In: Types, Causes, and Policy Implications. *Annual Review of Environment and Resources*, *41*, 425–452. https://doi.org/10.1146/ANNUREV-ENVIRON-110615-085934

Shiller, R. J. (2016). *Irrational Exuberance* (3rd ed.). Princeton, N.J.: Princeton University Press.

Shiller, R. J. (2019). *Narrative Economics: How Stories Go Viral and Drive Major Economic Events*. Princeton: Princeton University Press.

Simpson, C., Rathi, A., & Kishan, S. (2021, December 10). The ESG Mirage. *Bloomberg*.

Skyrms, B. (2001). The Stag Hunt. *Proceedings and Addresses of the American Philosophical Association*, *75*(2), 31–41.

Standard and Poor's. (2022). *Frequently Asked Questions 2022: Corporate Sustainability Assessment (CAS)*. New York.

Streeck, W. (1997). Beneficial Constraints: On the Economic Limits of Rational Voluntarism. In J. R. Hollingsworth & R. Boyer (Eds.), *Contemporary Capitalism: The Embeddedness of Institutions* (pp. 197–219). Cambridge: Cambridge University Press.

SustainAbility. (2020). *Rate the Raters 2020: Investor Survey and Interview Results*.

Sustainalytics Inc. (2021). ESG Risk Ratings - Methodology Abstract About Sustainalytics. *Special Report*, (January), 1–15.

TEEB. (2014). *The Economics of Ecosystems and Biodiversity (TEEB) for Agriculture & Food: Concept Note*.

Thomas, M., & McElroy, M. W. (2016). *The MultiCapital Scorecard: Rethinking Organisational Performance*. Chelsea, VT: Chelsea Green Publishing.

Thwaites, T. (2011). *The Toaster Project: Or a Heroic Attempt to Build a Simple*

Electric Appliance from Scratch. New York: Princeton Architectural Press.

Tong, D., Zhang, Q., Zheng, Y., Caldeira, K., Shearer, C., Hong, C., … Davis, S. J. (2019). Committed emissions from existing energy infrastructure jeopardize 1.5 °C climate target. *Nature*, *572*(7769), 373–377. https://doi.org/10.1038/s41586-019-1364-3

Tooze, A. (2021). RIP: A climate revolution in fiscal policy? *Chartbook*, *61*.

Tukker, A., Bulavskaya, T., Giljum, S., de Koning, A., Lutter, S., Simas, M., … Wood, R. (2014). *The Global Resource Footprint of Nations. Carbon, water, land and materials embodied in trade and final consumption calculated with EXIOBASE 2.1*. Leiden/Delft/Vienna/Trondheim: The Netherlands Organisation for Applied Scientific Research.

Unruh, G. C. (2000). Understanding carbon lock-in. *Energy Policy*, *28*(12), 817–830. https://doi.org/10.1016/S0301-4215(00)00070-7

van der Lugt, C. (2018). *Blueprint 2: The Blueprint for New Accounting: Laying the foundations for Future-Ready Reporting*. Reporting 3.0.

Vigeo Eiris. (2020). *ESG Assessment Methodology: Executive Summary (August 2020 edition)*. Paris.

Wackernagel, M., Onisto, L., Bello, P., Linares, A. C., Falfán, I. S. L., García, J. M., … Guerrero, M. G. S. (1999). National natural capital accounting with the ecological footprint concept. *Ecological Economics*, *29*(3), 375–390. https://doi.org/10.1016/S0921-8009(98)90063-5

Walenta, J. (2020). Climate risk assessments and science-based targets: A review of emerging private sector climate action tools. *WIREs Climate Change*, *11*(2). https://doi.org/10.1002/wcc.628

Wilhelm, J. (1985). The Soviet Union Has an Administered, Not a Planned, Economy. *Soviet Studies*, *37*(1).

Wilson, M. R. (2016). *Destructive Creation: American Business and the Winning of World War II*. Philadelphia: University of Pennsylvania Press.

World Commission on Environment and Development. (1987). *Our Common Future*. https://doi.org/10.1017/CBO9781107415324.004

Yergin, D., & Stanislaw, J. (2002). *The Commanding Heights*. New York: Simon and Schuster.