
Article:
Genovese, A., Lowe, B.H. orcid.org/0000-0002-5081-952X, Bimpizas-Pinis, M. et al. (1 more author) (2024) Planning for a future free from rebound effects. Futures, 164. 103479. ISSN 0016-3287

https://doi.org/10.1016/j.futures.2024.103479

Futures 164 (2024) 103479

Contents lists available at ScienceDirect

Futures

journal homepage: www.elsevier.com/locate/futures

Planning for a future free from rebound effects

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ARTICLE INFO

Keywords:
Circular economy
Democratic economic planning
Environmental policy
Post-growth
Sustainable consumption

ABSTRACT

This paper argues that attempts to mitigate rebound effects within growth-orientated economic systems are self-defeating. This arises because rebound effects contribute to economic expansion and individual 'welfare' improvements (i.e., they are welcome and even desirable) and they flourish in traditional market systems where resource allocation is conducted in an *ex-post* fashion. As such, in the context of the transition towards more sustainable societies, we suggest that *ex-ante* economic planning and coordination mechanisms are needed to help eliminate rebound effects. Specifically, we argue that mechanisms adopted in contemporary supply chains demonstrate the technical feasibility of economic planning. Such techniques, framed within a democratic economic planning architecture, could therefore encourage moves towards a future that allows us to live within biophysical limits. An interdisciplinary research agenda is proposed to this end.

1. Introduction

It has taken nearly 30 years for the annual COP summits to assert a clear link between climate breakdown and fossil fuels (Guardian, 2023). This delay unambiguously suggests that political leaders are at best slow to comprehend the magnitude of the anthropogenic ecological crisis (Lamboll et al., 2023), the urgent need for humanity to live within planetary boundaries (Rockström et al., 2009; Richardson et al., 2023), and the implications of the continued pursuit of economic growth fostered by the dynamics of capitalist accumulation (Liodakis, 2018; Jensen et al., 2023).

Nonetheless, the stark reality of environmental breakdown has managed to spur several 'new' sustainability paradigms that look to confront these challenges, including the post-growth notion (Jackson, 2021; Paulson & Büchs, 2022) and the circular economy concept (Kirchherr et al., 2017; Marjamaa & Mäkelä, 2022). However, innovative ideas such as these are not immune from age-old problems. One such problem is the *rebound effect* in which behavioural and systemic responses drive production and consumption decisions that counteract efforts to instigate positive environmental change. Whilst rebound effects date back to Jevon's Paradox and coal use in the 19th Century, it is only more recently that the literature has formalised what was perhaps always suspected i.e., that rebound effects can trigger economic growth (Lange & Berner, 2022), thereby leadng to further resource use, as well as individual welfare improvements, understood as preference satisfaction (Chan & Gillingham, 2015). As a result, it is also now clear that incentives to address rebound effects as part of efforts to tackle the anthropogenic environmental crisis are fundamentally compromised given the salience of growth and 'welfare' in the current economic paradigm.

Motivated by the recent 2023 *Beyond Growth Conference* at the European Parliament, the aim of this paper is to present a novel research agenda that seeks not to measure rebound effects or to mitigate their impact, as is the norm in the literature (e.g., Font

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https://doi.org/10.1016/j.futures.2024.103479
Received 21 December 2023; Received in revised form 10 August 2024; Accepted 20 September 2024
Available online 25 September 2024

Vivanco et al., 2016a), but to *eliminate* them from occurring in the first place. It is only by doing this that society can harness the full measure of human ingenuity and direct it towards pressing efforts to tackle the existential crisis we are in. Moreover, it is only by recognising what really contributes to this crisis that we can properly diagnose the radical approaches that are needed.

As researchers, our focus is on the transition to the circular economy (CE) and thus in what follows we primarily draw on this context to argue our case. However, our arguments go beyond any specific sustainability narrative. Indeed, in its more robust forms, the CE is implemented through strategies that focus on closing, slowing, and dematerializing material loops. These strategies, known as the 'higher' R-imperatives, aim to reduce unnecessary production, reuse products at the end of their life, and create durable goods through preventive design for sharing, renting, or leasing (Castro et al., 2022). Consequently, the CE aligns with the post-growth ideas that inspired this work (Schröder et al., 2019; Bauwens, 2021). By post-growth, we refer to a macroeconomic environment where objectives shift towards the equitable reduction of production and consumption, with a focus on improving quality of life and community resilience, all while staying within ecological limits (Daly, 1973 and 2014; Jackson, 2009).

The paper proceeds as follows: Section 2 provides a brief discussion of rebound effects (or "rebounds"); Section 3 expands on the idea that rebound effects are enabled and encouraged by the logic and incentives inherent within, and inseparable from, the current economic paradigm; Section 4 introduces *ex-ante* planning and coordination mechanisms – and particularly those that characterise modern global supply chains – and how these could counteract tendencies toward overconsumption and overproduction. Finally, Section 5 concludes by introducing a research agenda centred on democratic economic planning as a means of eliminating rebound effects.

2. Rebound effects

Rebound effects are phenomena in which the gains achieved from improving resource efficiency are offset, either partially or completely, by an increase in overall consumption or production (Lange & Berner, 2022). In such cases, efficiency improvements can even result in "backfire," where the increase in resource usage is proportionally larger than the efficiency improvement, thus leading to higher net impacts. Whilst traditionally understood in the context of energy efficiency improvements and their impact on energy usage (Greening et al., 2000), as new sustainability concepts have emerged, an ever-expanding variety of new rebound effects are being identified that focus on different contexts, trigger mechanisms and levels of economic aggregation (e.g. sufficiency rebound: Figge et al., 2014; environmental rebound: Font Vivanco et al., 2016b; psychological motivations behind rebound effects: Dütschke et al., 2018; symbiotic rebound: Figge & Thorpe, 2019; material efficiency rebound: Skelton et al., 2020; sharing economy rebound: Meshulam et al., 2023).

One of these 'new' rebound effects occurs in the context of a CE. The CE refers to "an economic system that is based on business models which replace the 'end-of-life' concept with reducing, alternatively reusing, recycling and recovering materials in production/distribution and consumption processes" (Kirchherr et al., 2017, p.224–5). As such, the CE claims to be a new paradigm that can square the circle of economy-society-nature interactions (Ellen MacArthur Foundation, 2012). Nonetheless, as Zink and Geyer (2017) have highlighted, the CE is not immune from rebounds, in this case driven by *income* and *substitution* effects. These dual effects have the potential to make secondary production routes (i.e., waste products that can be reused in new production processes) less attractive, resulting in a failure to reduce primary production that relies on the extraction of virgin resources (Zink & Geyer, 2017). Insufficient substitutability is linked to the perception of secondary goods being of inferior quality, making them less desirable to the end customer. Consequently, secondary goods are produced in addition to, rather than instead of primary goods, thus reducing (and potentially nullifying) the benefits of CE practices. According to the law of supply and demand, the increase in the supply of (cheaper) secondary goods will also result in a decrease in the price of substitutes (primary goods) since suppliers are competing to attract more buyers. The decrease in prices stimulates the demand (and production) for both goods (price effect) since consumers perceive themselves to have a comparatively higher income than before (income effect). As a result, the occurrence of a *circular economy rebound effect* could mean that the displacement of virgin resources is not realised (*Ibid*).

In a wider sense, pro-environmental actions also have the potential to spur an *environmental rebound effect* i.e., "environmental consequences [not linked to energy use] from changes in demand in response to efficiency changes from technical improvement" (Font Vivanco et al., 2016b, p.61). There are also rebound effects associated with sufficiency-based strategies, which are more in keeping with the notion of post-growth. For example, uncoordinated individual action to restrict consumption in the name of environmental awareness can lower the prices of goods, which then attracts *other* consumers who demand more (Alcott, 2008).

Despite the ongoing academic enquiry into rebound effects and their related implications though, there seems to be a lack of concrete policy actions to limit the depletion of non-renewable resources and enable truly sustainable practices. While several initiatives concentrate on waste reduction and recycling (e.g., the EU's Circular Economy Action Plan), they fail to prioritise, in a realistic way, the fundamental importance of decreasing the demand for energy and virgin materials in *absolute* terms, which should be the first imperative for the transition towards a sustainable future (Meadows et al., 1972; Daly, 2014). This disregard can even be seen in much of the influential climate mitigation modelling, which fails to address what Grubler et al. (2018) themselves describe as 'the big economic elephant in the room' i.e., the presence of rebound effects. This omission is all the more remarkable given that rebound effects fundamentally undermine attempts to 'decouple' material and energy use from Gross Domestic Product (GDP) (Hickel et al., 2021).[1] Indeed, while environmental sustainability has become a central tenet of policymaking, in some instances the commitment to

[1] See also Hickel and Kallis (2020) who indicate that the consideration of rebound effects in climate/environmental modelling is the exception rather than the rule.

it appears to be more rhetorical than substantive. In the next section, we suggest why this might be.

3. Rebound effects, economic growth and welfare

Much of the academic work on rebound effects assumes that their very presence necessitates their mitigation, in a comparable way to that of a negative externality i.e. where the social costs of an activity diverge from the private costs giving rise to overproduction, overconsumption and the need for intervention typically in the form of taxes and permits (International Risk Governance, 2013; Chan & Gillingham, 2015). However, treating rebound effects in this way is not necessarily congruent with the logic of the economic system in which they occur.

Building on the novel typology of rebound effects developed by (Lange et al., 2021), Lange and Berner's (2022) find that 14 of 22 rebound mechanisms, at all levels of economic aggregation (micro, meso and macro), contribute directly to economic growth. As such, rebound effects feed into the economic growth paradigm, which has become deeply ingrained in societies and is seen as an indispensable means of financing fundamental societal objectives (Schmelzer, 2015). Indeed, this view has elevated GDP as the primary indicator of national success, with policies and decisions prioritising its expansion, often over underlying social and environmental concerns (Pinyol Alberich et al., 2023). As Daly (1973) suggested, the means (i.e. GDP growth) has become the ultimate end in itself and is no longer understood as an instrument with a deeper purpose. Consequently, an orientation towards short-term profits and gains has developed, emphasising overproduction and overconsumption at the expense of longer-term social and environmental considerations.

It is not just economic growth that rebound effects can spur though: as Chan and Gillingham (2015) show, in an 'idealised' market with an absence of countervailing negative externalities, rebound effects can also improve individual and thus social welfare, at least as understood by mainstream economics. This occurs, it is argued, because rebound effects are providing consumers with an expanded choice set i.e., the provision of cheaper services that consumers value. So, whether it is providing cheaper reused or remanufactured products (CE rebound) or enabling a wider range of energy-based activity (energy rebound), rebound effects can facilitate individual preferences, which are a foundational element of mainstream economics. In this context, taxes, permits and caps (i.e., the 'traditional' means of countering environmental damage) can only ever treat the symptoms rather than the root cause of the problem (Lowe et al., 2024).

More broadly, the implementation of sustainability strategies such as those based on the CE, within the traditional dynamics of market economies, is another key factor driving rebound effects, as resource allocation is conducted *ex-post* through market signalling (Zink & Geyer, 2017). Consequently, in a CE context, for example, the division of primary and secondary resources used in production activities or made available as consumer goods is determined by market mechanisms resulting from individual transactions. In other words, decisions regarding the implementation of CE practices are made individually and atomistically by economic agents, and coordination only occurs *ex-post*, through the operation of market forces. As such, we believe that there is scope for *ex-ante* resource allocation strategies to anticipate energy and material needs, thereby helping deliver superior environmental performance. This includes the elimination of rebound effects that would otherwise be endemic to the current market-driven economic system.

4. Reconceiving economic planning - lessons from history and practice

The need for *ex-ante* resource allocation strategies is openly acknowledged in certain schools of thought (e.g., post-growth economics), where the perspective of a *planned* transition towards an economy characterised by a reduction in energy is explicitly mentioned (Durand et al., 2024). However, the specific mechanisms of such a planning process are not precisely set out.

This omission might be related to the historical legacy of the failure of planned economies, which, among other issues, showed that pure central planning strategies can give rise to undesirable outcomes. These include, for example, inflation in intermediate material requirements, and the difficulty of leveraging the tacit knowledge of economic actors in the productive process (Adaman & Devine, 2002), both of which could significantly undermine the innovative and entrepreneurial activities at the root of the development of CE approaches. And this is not to mention the ideological baggage that is dredged up when seeming to challenge the 'end of history' narrative by proposing alternatives to the institutions of neoliberal capitalism, even if this is a pragmatic response to ecological decline positioned separately to questions of individual representation (Fukuyama, 2006).

Nonetheless, it is important to highlight that elements of planning are still clearly present in today's economic systems. The role played by large corporations in planning wide portions of the economy through the end-to-end control of their supply chains was already pointed out by Galbraith (1967). More recently, Phillips and Rozworski (2019) argue that companies like Walmart and Amazon operate in a way that resembles large-scale planning, making use of refined logistical algorithms and computational power, and relying on long-term collaboration with supply chain partners. Indeed, as Mandel (1986) suggests, rather than being the result of auction-based searches across a multiplicity of vendors in order to achieve marginal price cuts, buyer-supplier relationships are often formed as instances of long-term cooperation, which often remain stable for years if not decades. Such long-term integration mechanisms often play a pivotal role in the functioning of modern supply chains, and their role has also been pointed out as crucial in the transition towards a CE (Bimpizas-Pinis et al., 2022), with higher levels of supply chain integration and closer collaboration leading to superior performance in terms of CE objectives (Calzolari et al., 2024).

Such contemporary advances in demand forecasting and production planning, albeit within commercial and privately-owned corporations, demonstrates the technical feasibility of economic planning approaches on a significant scale. These technical developments, if placed under democratic control - for instance, through forms of negotiated coordination at a territorial, industrial and supply chain level - could represent useful tools for the transition towards a more sustainable society. However, this would require

Table 1
Democratic economic planning models: planning mechanisms and institutions.

Model	Planning Mechanism	Institutions
Devine (1988)	A Negotiated Coordination framework, focusing on representation of productive sectors and units (which are socially owned) at multiple levels and on an iterative procedure.	At a central level: national planning commission; national chamber of interests; national representative assembly. At a decentralised level: sectoral negotiated coordination bodies; local and regional levels of decision-making. Market exchange for current output.
Albert and Hahnel (1991)	A participatory planning procedure in which councils and federations of workers and consumers propose and revise their own activities under rules designed to guarantee outcomes that are both efficient and equitable.	At a central level: national federations of producers and national federations of consumers; prices, adjustments, and facilitation boards. State agencies and ministries. At a decentralised level: local workers' and consumers' councils. Self-managed workplaces.
Cockshott and Cottrell (1993)	Direct allocation based on labour value calculation, with market clearing prices for consumer goods.	At a central level: central planning bureau and planning procedure; definition of output goals for local projects. At a decentralised level: direct democracy mechanisms (through referenda and polls) for resource allocation.

Adapted from: Tremblay-Pepin (2022)

settings (such as coordination and planning boards) that go beyond the fundamental institutions of the current economic system. Such a need is explicitly acknowledged by ecological economics, which as a discipline is sceptical about the capability of the dominant institutions of capitalism (such as the market and private enterprises) (Georgescu-Roegen, 1971; Daly, 2014) and their ability to drive a transition towards a more sustainable future, given their difficulties in capturing the complexity of ecological processes, the inter-dependent nature of the environment, and value incommensurability (Daly & Farley, 2011; Planning for Entropy, 2022).

In this context, the literature provides some examples of democratic economic planning models that could be informative here, such as the negotiated coordination model by Devine (1988); the participatory planning framework from Albert and Hahnel (1991), and the computerised and algorithmic labour-based resource allocation mechanism devised by Cockshott and Cottrell (1993), which is based on an input-output representation of the economy. It is important to mention that all these models explicitly highlight the necessity of purpose-made institutions for democratic coordination of production planning at territorial (including national, regional and local contexts), industrial, and supply chain levels to achieve optimal allocation performance (Table 1). However, it must be emphasised that such models did not explicitly address ecological concerns in their initial conceptualisations, even if they have been subject to recent revisions where environmental constraints are openly recognised (Nishat-Botero, 2023).

The possibility of integrating the distinctive features of such models in order to develop a novel framework for the transition towards a more sustainable and just society has recently been proposed, with the aim of (Planning for Entropy, 2022): (i) constructing deliberative planning institutions at multiple levels, similarly to the ones offered by each model and detailed in Table 1; (ii) taking advantage of computing developments for decision-aid in developing the first iterations of feasible plans; and (iii) institutionalising non-reductionist categories that express the complexities of social metabolisms in biophysical and ecological terms (e.g., energy and mass flows), instead of output terms (e.g., GDP), and that could be employed for strategic-level planning and for imposing constraints on production levels and the usage of non-renewable resource stocks. Also, the deliberative and participative nature of these models (which specifically acknowledge the role of planning boards, along with workers' and consumers' councils) provides an excellent framework to accommodate alternative production structures and arrangements (based, for instance, on cooperative and peer-to-peer paradigms), inspired by sufficiency strategies, such as the ones proposed by Robra et al. (2020),(2021).

With specific reference to the implementation of CE strategies, such planning frameworks could also address the role played by secondary resources used in production activities or made available as consumer goods. For instance, the utilisation of such resources could be modelled in economy-wide planning efforts in order to achieve optimal displacement rates of primary production and thus prevent rebound effects. With this in mind, in the closing section, we present an indicative research agenda to this end.

5. Interdisciplinary research agenda – a new approach within an old system?

What does this line of argumentation mean for the current economic paradigm; does this need to be abandoned, or is it compatible with democratic planning and coordination mechanisms, informed by environmental concerns, that are 'nested' amid the current dominant economic logic? There will be those who say that the very idea of planning is antithetical to the creative and self-interested ethos necessary to drive renewable energy and cleaner production technologies. Others, if they recognise the rationale for planning as a way of pre-empting rebound effects, may still see this as compatible with the green growth/eco-efficiency agenda. For example, if efficiencies are no longer harnessed to propel quantitative economic expansion as the elimination of rebound effects suggests, this could still be seen as compatible with 'dematerialisation' and continued expansion of the socially constructed value of economic growth, enabled by new business models that are more experiential in nature.

However, we would argue that developing democratic economic planning mechanisms to eliminate rebound effects, beginning at the supply chain level could be a pragmatic model for, or stepping stone towards, something more ambitious. Frederic Jameson quipped that it is "easier to imagine the end of the world than the end of capitalism;" perhaps the innocuous concept of a supply chain based on coordination and trust holds out an example of how to *begin* to pursue this, how to begin to enable visions such as Piero Sraffa's (1960) *Production of Commodities by Means of Commodities*, and even how to provoke other systemic changes such as the

Table 2
Interdisciplinary research agenda.

Discipline	Indicative research questions
Behavioural economics	How would the language and concepts of market primacy (e.g., 'choice,' 'allocation,' 'welfare,' 'efficiency,' 'utility,' and the 'free market') influence decision-making and policy outcomes within a nested planning system?
Computer science	How can scalable algorithms be developed to enable coordination and integration measures across different levels of representation for solving ex-ante resource allocation problems?
Ecological economics	How can alternative theories of value, driven by biophysical measures such as energy and mass flows, be developed and implemented to pre-empt rebound effects in sustainable resource management?
Politics	What are the most effective participatory mechanisms for planning at various levels of governance, and how can these mechanisms be integrated to enhance the effectiveness and inclusivity of decision-making processes?
Psychology	How could consumer and normative pressures influence the adoption of coordination and integration measures in decision-making processes, and what psychological mechanisms can be leveraged to enhance their effectiveness?
Sociology	How could social and cultural factors influence the acceptance and effectiveness of democratic economic planning initiatives within a predominantly capitalist system?

implementation of alternative theories of value that are driven not by indistinct 'utility' but by biophysical measures such as energy and mass flows that would forestall rebound effects in the first place (Lowe & Genovese, 2022). After all, if planning and coordination are good enough for Walmart and Amazon, can they not be harnessed in the public realm to tackle the most crucial goals that humanity faces?

This agenda would require a significant interdisciplinary effort (Table 2). In the short term, the transition to a nested system would need to be addressed. As such, indicative themes might include how to address the *language* and *concepts* associated with market primacy; the consumer and normative *pressures* that might further systemic adaptation; how *technology* (broadly defined) could support such a transition, and suitable participatory *mechanisms* that would enable planning and coordination at different spatial scales and how these levels and associated stakeholders might be coordinated. In the longer term, where the transition may involve surmounting rather than coexisting with the dominant economic paradigm, fundamental changes in theorising *value* and *values* and how this can be used to orchestrate economic and environmental systems, might also be considered.

However, this agenda (and similar initiatives) would also benefit from the energy, drive and determination of those scholars, politicians and activists who attended the historic 2023 *Beyond Growth Conference* and demonstrated that there is growing recognition of the need for radical and urgent new thinking in the transition to a just and sustainable future. It is just this energy, drive and determination that we need to harness to ensure that political leaders are clear both about all the root causes of the environmental crisis, and the enormity of the challenge we face. To this end, we hope that a serious re-evaluation of rebound effects – rather than ignoring them as the 'big economic elephant in the room' – could encourage a widespread recognition of the desirability of democratic economic planning. Moreover, we hope that the medium of change that we are advocating, precisely because of all its historical baggage, boosts the active reappraisal of the current economic paradigm and therefore encourages moves towards a future that allows us to live within biophysical limits.

CRediT authorship contribution statement

Andrea Genovese: Writing – review & editing, Writing – original draft, Funding acquisition, Conceptualization. **V.G. Ram:** Writing – original draft, Conceptualization. **Meletios Bimpizas-Pinis:** Writing – original draft, Conceptualization. **Ben Lowe:** Writing – review & editing, Writing – original draft, Conceptualization.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

No data was used for the research described in the article.

Acknowledgements

This research has been supported by Horizon Europe's research and innovation call HORIZON-CL5-2021-D1-01, Grant agreement number 101056862, CO2NSTRUCT project, and by the HORIZON-MSCA-2021-SE-01-01 scheme, grant agreement 101086465 (ExPliciT project), which has also been funded by the UKRI Horizon Europe Guarantee programme (grant agreement EP/X039676/1). We would like to thank the two anonymous reviewers for their invaluable feedback and constructive comments, which have significantly enhanced the quality of this manuscript.

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