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Earth System Dynamics
Discussions

Interactive comment on "Energetic regimes of the global economy – past, present and future" *by* Andrew Jarvis and Carey King

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RC1 - "The authors provide an analysis of globally aggregate measures relating energy consumption and efficiency with economic throughput along semicentennial time scales. Their analysis, based on putting together time series data and plotting them to later comment on their relations, captures the supply shocks of the 1970s."

Response - Of the three data presentations we show, only one is a time series (Figure 2), and this is not of the primary energy use (PEU) or gross world product (GWP) data we analyse, but rather the growth rates of these data and that of the implied aggregate energy efficiency (AEE) linking the two. The two central data presentations (Figures 1 and 3) explore the long-run scaling relationship between PEU and GWP (Figure 1)

and the parallel relationships between the growth rates of PEU, GWP and AEE (Figure 3). Also, the analysis is not restricted to the supply shocks of the 1970's as is being inferred here. This episode simply appears to de-mark the two thermodynamic regimes we identify and discuss at length.

RC1 - "The authors make implications connected with current debates. In these times of highly-granular data leading to pioneering insights and debates, large scale analyses can still be a source of great and valuable insights, especially when applied to large-scale thermodynamics as endeavoured in this manuscript."

Response - We agree.

RC1 - "We found in this manuscript an interesting attempt in this direction, however, a number of concerns arise to the reader: The value of the insights provided is mostly based on a very simplified analysis"

Response - We believe the fact that we have 'simplified' our analysis as much as possible is a strength of the work, allowing us to focus on to-date overlooked global-scale systemic behaviour. Given our focus, we do not believe we have oversimplified our analysis, although we do anticipate the paper could precipitate more detailed follow-on analyses. Parsimony is a foundational principle in science and if we can tell our story using the simplest possible analysis this should be celebrated. In this light, we have attempted to describe the co-evolution of the economy via the feedbacks among growth in PEU, GWP and AEE that are still largely underappreciated or ignored in economics. Furthermore, we believe our analysis is underpinned by a strong theoretical foundation derived from metabolic scaling theory and non-equilibrium thermodynamics. We believe this is certainly a stronger foundation than that provided by neoclassical growth theory and its derivatives as currently used to inform climate policy.

RC1 - ", and compared with the simplified analysis and the timing of its most significant events, the implications drawn are slightly far-fetched (e.g. see lines 467-471)."

Response - Firstly, by "timing of its most significant events" we infer RC1 is again referring to the 1970's supply shocks. Not only are these shocks not the central focus of this paper (see above), the conclusions we are drawing in lines 467-471 do not relate these events, but rather the observation drawn from Figures 1 and 3 that the efficiency of the economy when translating primary energy to useful work is itself subject to regularities. The sentences in question read:

"For example, the data and reasoning of this paper support a conclusion that future enhancements in energy efficiency intended for emissions reduction are at significant risk of being co-opted to support GWP growth. This tendency could well become amplified in the era of declining GWP growth and stagnation we appear to be entering, where the battle to restore growth might become ever more pressing."

We appreciate the consensus view as reflected in the SSPs is that energy efficiency can be manipulated largely independently from changes in either GWP or PEU, but our analysis indicates otherwise given the persistence in the growth in energy use and GWP is itself associated with the optimisation of the efficiency linking the two, behaviour that appears to have persisted for at least the past 70 years. As a result, we do not think it is at all "far-fetched" to assume this historically-established and thermodynamically predictable pattern might persist.

Put simply, if a government were to choose between GDP growth and energy use reduction when manipulating efficiency, the historical data indicate the former has, to-date, taken precedence, and the thermodynamic origins of this behaviour mean it is likely to continue into the future, especially if GDP growth were becoming ever harder to achieve (again something the thermodynamics predicts). However, the text we offer is stated in terms of policy at 'risk', not as an inevitability, and the text in question is simply attempting to alert decision makers to this risk.

RC1 - "Overall, despite the facts that the motivation has merits and that the manuscript goes in an original research direction, the reader sees that the methodological ap-

proach is not sound enough to explore this topic. For these reasons, and due to further concerns expressed above, I am inclined to suggest a rejection."

Response - We contest the assertion the "the methodological approach is not sound enough to explore this topic", pointing to the data, analysis and theoretical arguments presented in the paper to back up our claim that our approach is simple, but sound. RC1 needs to substantiate their assertion, citing either evidence derived from the paper, or reputable alternative explanations that are both theoretically sound and supported by the data we present. We believe that if these explanations existed we'd not be writing this paper.

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