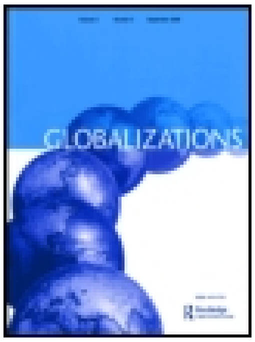

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COMMENTARY

The failure of Integrated Assessment Models as a response to 'climate emergency' and ecological breakdown: the Emperor has no clothes

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ABSTRACT
In this brief commentary we provide some parallel points to complement Steve Keen's paper in the recent *Globalization's* special forum on 'Economics and Climate Emergency'. Keen's critique of climate and economy Integrated Assessment Models (IAMs) is wide-ranging, but there is still scope to bring to the fore the general issues that help to make sense of the critique. Accordingly, we set out six key inadequacies of IAMs and argue towards the need for a different approach that is more realistic regarding the limits to growth.

KEYWORDS
Integrated Assessment Models; DICE; Climate Emergency; limits to growth

In this brief commentary we provide some parallel points to complement Steve Keen's paper in the recent *Globalization's* special forum on 'Economics and Climate Emergency' (Gills & Morgan, 2020; Keen, 2020). There are now many critiques of Integrated Assessment Models (IAM) and these range from technical disputes regarding appropriate quantities for variables to more fundamental critiques of the assumptions, concepts and purposes of IAMs (for the latter see also Dale, 2018; Hickel, 2018; Murphy, 2018). Keen's critique encompasses much of this range, but there is still scope to bring to the fore the general issues that help to make sense of the critique. As Keen's paper suggests, IAMs give the impression of being rooted in data, which tends to give them status as science as well as policy influence in key decision making and advisory circles (governments, the IPCC, etc.). Climate and economy focused IAMs are, however, deeply unrealistic in how they represent Earth and Human systems and the relation between the two. This applies to what are termed 'simple' IAMs, such as 'DICE', but also 'complex' IAMs (see later).[1] By underestimating the real consequences of human activity – built into economic structure – IAMs convey the impression that planetary wide economic growth and thus continued expansion of material and energy use is feasible (on growth see e.g. Smil, 2019). This distracts from development of alternatives better able to assess the potential future risks of climate change, which would in turn lead to more appropriate policy responses at a basic societal level. In so far as IAMs promote complacency, they undermine attempts to inform the public and induce appropriate concern, despite that there clearly is increasing disquiet being expressed in many quarters regarding Climate Emergency and

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ecological breakdown (for context of arguments for delay see Galbraith, 2020; Lamb et al., 2020). Moreover, in promoting complacency IAMs disguise what George Monbiot refers to as a 'grim truth' i.e. 'that the rich are able to live as they do only because others are poor: there is neither the physical nor the ecological space for everyone to pursue private luxury'. As such, IAMs serve to reproduce inequality whilst facilitating the reproduction of types of economy that are simply not sustainable. This must change and making ad-hoc tweaks to standard models to fix some superficial aspects of shortcomings will not be enough to drive that change.

The need for proper context

For the majority of human history, the long term rate of economic growth per capita was close to zero. Societies were mostly agricultural and the production processes they sustained depended partly on rudimentary technologies, such as plows and domesticated animals, but mostly on access to sunlight, water, and soil nutrients – all factors that are made available through natural cycles in the Earth's System. Prosperity has varied as civilizations have risen and fallen, but it wasn't until very recently, when humans found a way to harness new forms of energy (i.e. energy that was buried in the form of fossil fuels) that societies' populations and economies began to grow continuously and significantly. Since 1800, the world population has grown from one billion to 7.76 billion in 2018 and some projections anticipate 10 billion by the end of the century. The story of economic growth follows a similar path. It was not until the invention of the steam engine and the discovery of coal as a source of energy that societies began experiencing rates of economic growth larger than 0.14%. Between 1500 and 1820, the growth rate of per capita income in Western Europe was 0.14% – not too different from the growth rate between 1000 and 1500, which was 0.12% (see Chang, 2014).[2] And a policy focus on GDP metrics really only came to the fore with the development of national income accounting and then the dissemination of this after World War II (Masood, 2016; Spash, 2020). According to the World Bank, global GDP was US$ 1.4 trillion in 1960 and it was US$ 87.6 trillion in 2019. Of course, reference to just the numbers tells us nothing about distribution and responsibility for associated climate effects, it just tells us that there are more of us affecting more of the planet (modifying land, sea and air). However, if we focus on consumption of resources and carbon emissions, it remains the case that the vast majority of *impact* is created by relatively few countries, corporations and people (see Gore, 2020; Heede, 2014).[3]

In any case, for the last 200 years, the unlocking of energy from fossils has allowed humans to grow in population and measured 'wealth' at a rate beyond that which an 'unperturbed' biogeochemical cycle is capable of maintaining (see e.g. Motesharrei et al., 2016). Fossil fuels are reservoirs of energy and historically have enabled humans to use more energy than is made available to them in the form of wind, sunlight, fire, and running water. It is by using additional fossil fuel energy sources that humans have been able to develop economic systems of resource use that have sustained growth at levels well beyond that of previous societies. However, there is no evidence that they are able to avoid or manage the consequences of doing this. There is no evidence that contemporary economies have or are able to in the near future decisively 'dematerialise' or transition from some degree of 'relative decoupling' to 'absolute decoupling' of economic activity and growth in material and energy use and associated issues like carbon emissions (see e.g. Fletcher & Rammelt, 2017; Parrique et al., 2019). And it is now widely acknowledged that we have surpassed the Earth's capacity to restore and repair the damage imposed by this kind of increasing human activity (e.g. Ripple et al., 2020). Current trends in extinction rates, coral reef decay, ocean pollution and acidification, overfishing, deforestation, air pollution and climate change point towards critical tensions, if not collapse (e.g. Ceballos et al., 2017; Lenton et al., 2020). Increased social strife around the world can be considered another sign of unsustainable growth pathways (e.g. Abel et al., 2019; Gleick, 2014). Ultimately ecological damage and accelerated climate change and its consequences are a signal that economic growth and likely population growth are not realistic options if we are to avoid dangerous Earth System transitions.

The recent IPCC *Global Warming of 1.5°C* report (IPCC, 2018) and the deficits published in the annual UNEP *Emissions Gap* reports (see Christensen & Olhoff, 2019) have placed greater pressure on governments across the world to immediately increase investment in mitigation and adaptation and take more urgent action to reduce emissions – and this has resulted in further negotiations via the COP process and the UNFCCC and different countries are now beginning to announce they will aim for 'net zero' emissions by mid-century (though currently statutory commitments, detailed plans and implementation are mainly lacking and there is considerable scepticism regarding what 'net' might mean). Still, it is increasingly clear that more delay and gradual incremental change will be insufficient. Moreover, it remains the case that the IPCC approach to change is itself not sufficiently ambitious. This brings us to the subject of Integrated Assessment Models and what follows is best read in the context of Keen's paper (Keen, 2020). IPCC reports include various 'simulated scenarios' generated from IAMs.[4] Whilst there are many uses for IAMs we are mainly interested in those used to estimate the 'social cost of carbon' and to evaluate alternative abatement policies. As Keen makes abundantly clear, although these seem rigorous and are technically impressive in their apparent complexity, they are fundamentally flawed. In principle IAMs explore how the 'Human System' (essentially economic activity) affects and interacts with the Earth System, but the assumptions used to construct IAMs are unrealistic and the relation between Human Systems and the Earth System is unrepresentative. Ultimately IAMs are a symptom, a reflection of an even more profound problem with how social planners, policymakers, and global political and economic powers are dictating the way in which natural and human resources are managed (or mismanaged).

In the following section, we identify several major flaws in IAMs. Conclusions from IAMs about the impact of a warming scenario are unreliable, misleading, and founded on oversimplifying assumptions. Although much of the discussion will only focus on 'simple' IAMs, the main criticism applies also to what are termed 'complex' IAMs (see below).

Key inadequacies of IAMs

1. The rational expectations assumption

IAMs incorporate mainstream macroeconomic models and these are typically constructed using an assumption of 'rational expectations'. In general, this means models represent individual components of the system as optimizing agents with full information of the system and with a clear 'decision rule'. This facilitates tractability, ensuring definite outcomes. Real behaviour in human societies is different, participants have limited knowledge, diverse information, interests and motivations and systems are emergent, organic and evolving. These restrictions have important implications for the economic outcomes of the models.[5] Ultimately, IAMs impose unrealistic assumptions about behaviour and therefore represent the *wrong* system. Put another way, they model human systems inadequately but do so because this leads to equilibrium solutions and optimality when equations are solved. This leads to further practical problems of expression built into the mathematics and coding.

2. Lack of real complexity

IAMs are limited in their capacity to incorporate complexities, nonlinearities, non-convexities, tipping points, and uncertainties: all typical features of climate change. Often, IAMs are formulated in an optimization language such as GAMS (General Algebraic Modelling System) or AMPL (A Mathematical Programming Language). At the same time, IAMs leave many 'degrees of freedom' for the modeller. This means the modeller has great leeway in choosing the functional forms and parameter values used in the model. Clearly, this can (and has in many high profile cases) led to radically varying conclusions regarding the implied 'social cost of carbon' (SCC) and 'optimal' abatement policy. For example, Nordhaus (2008) finds that optimal abatement should initially be very limited, consistent with a SCC of around $20 or less, while Stern (2008) concludes that an immediate and drastic cut in emissions is necessary, consistent with a SCC above $200. Whilst survey research indicates that many modellers prefer higher values for costs (and lower discount rates) than Nordhaus (Drupp et al., 2020), his work as Nobel prizewinner is extremely influential and the more important point is that there is *no decisive* (objective) determinant of the values used in these models.

In general, modelling offers an overly optimistic future, predicting the impact of climate change to be only a few points decrease in otherwise expanding world GDP per capita by the end of the century – even for high levels of warming. In some models, even a global temperature increase above +5 degrees Celsius would cost less than 7% of the world's future GDP (see Nordhaus, 1994; Roson & Van der Mensbrugghe, 2012). This leads to complacency – statements such as 'a century of climate change is about as good/bad for welfare as a year of economic growth' (see Tol, 2018). Moreover, there is a major disjuncture here with the consensus amongst Climate Scientists and Earth System scientists regarding the nature and significance of changes in climate and ecosystems (Lenton et al., 2020). This raises deep questions regarding the integration of climate science into IAMs.

3. 'Integrated' does not mean what you think it means

'Simple' IAMs, such as 'DICE', are narrowly focused, they set up some way to measure cost and benefits of climate change – typically the relationship between some measure of economic activity and emissions i.e. the 'social cost of carbon'. As such, they do not model more complex economic and climate processes. 'Complex' IAMs use additional linked modules representing the global economy, as well as its energy, land, and climate systems to look at energy technologies, energy use choices, land-use changes, and the societal trends behind emissions of greenhouse gases (GHG). There are numerous identified conceptual or technical problems with these. For example, the use of a climate sensitivity parameter, dubious presuppositions such as a continual optimal rate of fossil fuel *extraction*, and dubious assumptions such as infinite potential sinks for carbon and instantaneous effects of emissions reduction policy. Perhaps the most fundamental problem is that in IAMs Earth and Human Systems do not feedback on each other. The use of terms such as 'coupling' (focused on 'uni-coupling') tends to obscure this deep lack of realism.

For example, in reality, changes in climate hazards can trigger human migration across different regions of the world, which in turn will have effects on land use, water availability, deforestation, desertification, and so on. Also, climate change may eventually make certain areas of the world hostile living places based on temperature rises leading to falling economic output, population decline, social inequality and political crises. However, these complex feedbacks are not adequately expressed in IAMs. Instead they depend on exogenous projections fed into the models. This lack of realistic feedback means IAMs are unable to accurately estimate the economic cost of environmental degradation (including climate change). They are unable to adequately represent human responses to changing climate and ecological processes. This also affects complementary scenario analyses, and these too are unable to represent realistic human responses to environmental impacts, including in regional economic activity. These may take forms in reality that are assumed away in the majority of simulated exercises, notably responses leading to real collapses in economic activity and thus measured GDP. The general problem is revealed by the form that Representative Concentration Pathways, or RCPs, and Shared Socioeconomic Pathways, or SSPs take. These are set out in IPCC reports and population distribution and population density projections from current IAMs are *exactly the same* for a scenario with sustainable development (SSP1) and a scenario with fossil-fuel intensive development (SSP5) (see Asefi-Najafabady et al., 2018).[6] This is obviously implausible, revealing a lack of sensitivity to the specifics of possible processes (the real evolution of a mutually dependent system). Clearly, current analytical approaches are unfit for impact evaluation or adaptation and mitigation planning – at the local and global level (given the obvious scalability problem). To reiterate a point made earlier, the apparent rigor and technical complexity of IAMs convey a sense of authority that is unfounded.

4. The use of a 'representative agent' in the economic model

We have already suggested that IAMs model human systems inadequately, but there is more to this. The economy that IAMs model is built from a kind of economic agent whose behaviour bears no resemblance to real people, real people whose actual activity would (will) in reality play a key role in how an economy and society evolve in the context of a changing climate. In a simple IAM, much like in any other mainstream macroeconomic model, there is, for the purpose of simplicity, only *one* agent, the 'representative agent'. This agent is supposed to represent the economic decisions of all actors in the global economy. Since this economic agent makes all decisions in the economy, she effectively determines who gets what (the distribution and, since she is 'representative', all wealth is effectively equally distributed in the model – between herself). By implication, institutional contexts and thus variation in and significance of government and governance decisions are rendered irrelevant by this simplification. As a representative agent she stands in for both a simplified *consumer* and *producer*.

In reality, of course, consumers have *different* traditions and habits, religions, income levels, access to resources, and risk preferences. Producers also vary in size from sole traders to global corporations, and so vary in market sector, use of technologies and a whole host of other issues expressive of power and influence both economic and political. Moreover, real people are *not* narrowly focused optimizing calculative economically 'rational' entities. They are not 'consumers' or 'producers' in this reductive sense and yet a simplified economic agent is basic to the agent as both consumer and producer in the form of a mathematical 'function'.

5. The economic agent as consumer: discounts that shouldn't count

Real people bear no resemblance to the consumer as decisionmaker in a discounted utility or preference function for the kind of agent found in the models. For the agent in the function 'satisfaction' is derived from only two activities: consumption and leisure. Effectively, the agent maximizes her 'welfare' through the value placed on *current* consumption (or leisure). She rationally prefers more to less and, rather than delay, she derives *more* satisfaction from *instantaneous* rather than future consumption ('discounting' the future merely determines the relative *weight* placed on the present compared to the future and this agent is incapable of attaching meaning to projects or goals as 'dreams'). Here, experience of the world is as a pure processor of all available 'information', but as a fully equipped optimizer she cannot be persuaded in or more importantly *against* her own best interest, she cannot be misinformed through ideology or manipulated through marketing. In this model world, there is implied foresight regarding a known future and no true or fundamental 'uncertainty', and she is always in or tending to an 'equilibrium' position (a curious term in so far as a representative agent applies).

Moreover, in 'assessing' consumption no attention is paid by the agent to the type of good or service produced, where it is produced and how it is produced – whether it involves practices that are environmentally and socially harmful, whether the supply chain operates via adverse incorporation, modern slavery, human rights abuse and/or in undemocratic places. This agent does not hold moral views that prevent her *over*-consuming. Nor is this agent capable of kindness, generosity, or compassion towards others – not only because there are no others, but also because even if there were others, she would not derive any 'satisfaction' from any of these activities. She is, however, capable of 'risk aversion', but in the models this is a constant, which means it does not change based on level of wealth.

Clearly, all this is deeply problematic in so far as the agent is an amoral unit making brute calculations in an amoral economy, which itself lacks adequate mutual relation to the environment on which she depends. Learning and evolution play no real role here despite that models run as simulations. Nowhere is this more obvious than when making decisions with inter-generational consequences. A discount rate in an IAM is a way to 'distribute' the generational wealth gap (and we will return later to this idea of 'wealth'). Having a positive discount rate means a combination of three things: (1) the agent values her own well-being over the well-being of descendants, (2) She discounts the wealth of future generations because she expects them to be wealthier, and (3) there is some reason why it is not 'optimal' in the model to transfer some well-being onto future generations. Point one introduces a tacit utilitarian and potentially selfish variant of individualism into the agent despite the amorality of agents in other respects, whilst points two and three are inconsistent and likely unfounded *if* our economies continue to operate along the grounds presupposed by the models, since those models legitimate destructive expansionary economies by misrepresenting their real consequences. It is not a given that future generations will be better off in a climate and ecologically damaged future and so there are in fact *many* morally rational reasons to engage in 'transfer' (whilst again acknowledging that even the language of this seems odd to anyone less transactional than a mainstream economist). It may be the case that discounting makes some sense for some purposes and especially over short time horizons, but *not* when considering the fate of the species.

Discount rates have been a major source of distraction and delay over the decades, but in so far as they have influence it is important to consider their implications – the higher they are then the more the present is valued over the future.[7] A recent essay in *Time Magazine* attempts to express the weirdness of the calculation by drawing on the work of the Oxford moral philosopher Derek Parfit (Walsh, 2019). At a discount rate of 5% annually, one death next year is more important than a billion deaths in 500 years. Or in monetary terms, with a 5% discount rate, it would be worth spending *no more than* $2200 today in order to try to prevent US$ 87 trillion in damages in 500 years. This US$ 87 trillion is equivalent to global GDP in 2019. The numbers matter less here than the absurdity of, in effect, thinking about what the future is 'worth' in this way (for Parfit it led to unpleasant consequentialist conclusions about the value of a human). According to this logic we would be prepared to spend *less* than what a couple of expensive computers might cost in order to secure economic activity on a scale currently seen for the whole planet. A typical IAM uses a 3% discount rate. For reference, the climate-change denying Trump administration has used an annual discount rate of 7% for its analysis of the social cost of carbon.

6. The economic agent as producer: the damage done by damage functions

The economic agent as producer is equally problematic. In a simple model, the agent produces only one aggregate or composite good that represents all possible goods and services in the global economy. There is only one way to produce this good and it is to use Capital and Labor drawing on available technology. This single composite good/sector typically takes a neoclassical 'Constant Elasticity of Substitution' functional form, though this can be relaxed and more sectors can be added to the model.[8] Perhaps more important is the role of technology in the model and how environmental degradation affects production. Besides the production function, there are two factors that enter the production decision: technology and a penalty term that represents 'lost production' due to environmental degradation. In the models, technological advancement is exogenous and there are no delays in its impact on production.[9] Exogeneity essentially means that technology is *not* an induced or learned response to cumulative environmental consequences – deliberate investment in R&D to invent more fuel-efficient machines, or new methods to drill non-conventional sources of oil and gas, carbon capture, development of renewables, etc.

New technologies in IAMs simply appear (at a given rate) and impact the entire production composite instantly and uniquely. Moreover, it is only through technology that the system moves forward. Production does not involve 'learning' to use capital and labour differently, decisions cannot involve consequences of education or law – doing more with less, doing less with less or any other range of changes to the social arrangement of production. There is no presumption of response in these terms, but production is the major way in which IAMs give the impression (not the reality) of responsiveness to ecological and climate effects via the penalty term for environmental degradation's effect on production – the so-called damage function. As with discount rates, the construction of the function is conceptually dubious and the values used are highly disputable. The damage function reduces the output level by some fraction that supposedly reflects how natural conditions reduce productive capacity. Damage functions have been heavily criticized for their lack of empirical or theoretical foundations.

The typical damage function only takes mean global temperature into account. As Keen shows and others have before him, the values and calibrations used in the models are easily manipulated (and even some of those who construct IAMs acknowledge this, see Keen, 2020; Pindyck, 2013, 2017; Pottier, 2016; Weitzman, 2011). Formally, the penalty term only affects the output level and not output growth. This means that 'damage' amounts to some reduction in that output level as an economy *expands*. This is quite different than allowing global temperature increases to have permanent impacts through time. And more fundamentally it is quite different than the more comprehensive approach to a system of *embedded* measurement of throughput pioneered by ecological economists (see Spash, 2017). Furthermore, the probability distributions that stand behind damage functions do not allow for 'fat tails' or high impact climate events. More fundamentally, the whole approach does not allow for the basic uncertainty inherent to complex evolutionary processes – a situation where it makes less sense to rely on probability distributions for degrees of precision and more on commonsense prudential conduct, based on a deeper understanding of systems, sub-systems, structures and tendencies (IAM use is thus typically quite different in context than the approach pioneered in early works, like the *Limits to Growth,* Meadows et al., 1972). Overall, the use of a damage function is profoundly misleading if policymakers take the output from popular IAMs as guidance for policy action. Costs from climate change and ecological breakdown tend to be radically underestimated and benefits from investment in mitigation and adaptation (as well as social redesign to just stop doing things that have clear adverse cumulative consequences) tend to be woefully underappreciated.

Conclusion

It should be clear that the IAM Emperor has 'no clothes' and that we need different attire. In addition to Keen's essay, these are issues explored across the various other essays in the special forum on Climate Emergency, and of course, in many other places (e.g. Hickel & Kallis, 2019). It should also be clear that IAMs play a key role in distracting attention from the feasibility of societies and economies built around the assumption of limitless economic growth. Historical trends of natural resource depletion show that economic growth is no longer sustainable. Yet, the mainstream narrative, even among some scientists (climate, and environmental scientists included), is failing to embrace the idea that the core force driving our current environmental problems is limitless economic growth. When leaders and experts claim the global economy is growing, what they call growth does not really account for the depletion of natural resources or the environmental damage that industrialization and superfluous consumption tied to obsolescence and 'lifestyles' (which are available to relatively few but offered as an aspiration for all) are causing to the entire planet. In any case, the purpose of societies should not be just to grow in the sense of becoming materially richer based on some reductive concept of GDP (and there are of course many alternatives to this measurement). And whilst reducing carbon emissions is merely one step that must be taken to address climate change, it is far from sufficient to resolve catastrophic planet-wide ecological consequences. It is a disturbing idea that getting our economic accounting systems to recognize environmental costs and benefits is not primarily an issue of data quality: measurement systems tell as much about the motives of their designers as they do about what is being measured (Masood, 2016). Failing to account for environmental damages only means increased economic growth is convenient for those designing the accounting system.

Countries in the global North are not genuinely more sustainable in ecological or climatological terms in so far as they have transferred polluting industries to 'developing' countries such as China and India. This transfer of low-tech and polluting industries has now made China the world's biggest polluter (see Smith, 2016).[10] Overwhelmed with pollution, China is now transferring some of its own industrial pollution to other countries.[11] The level of irony in this story is epic and the message is clear, transfers and technological change alone cannot solve planetary-scale problems if undifferentiated and continuous economic growth remains the basic premise of our economic system, since this has inevitable consequences for continued material and energy *overuse*. This must change and it seems this is something that civil society around the world increasingly recognizes, despite the policy drag created by IAMs. For example, and as the Covid-19 pandemic also illustrates, the USA has had to contend with the weaponization of science for ideological ends and this is very evident in the case of partisan divides on climate change. But partisanship only goes so far and in a recent Pew Research Center survey, over 74% of American adults agreed that 'the country should do whatever it takes to protect the environment', compared with 23% who said 'the country has gone too far in its efforts to protect the environment'.[12] Forest fires, droughts, floods and hurricanes, it seems, are becoming more persuasive than complacent political rhetoric, but more needs to be done to develop and propagate real solutions and 'just transitions' (Newell & Simms, 2020).

Notes

1. 'DICE' stands for 'Dynamic Integrated model of Climate and the Economy. The regional version is referred to as 'RICE'.
2. Note Chang's work has become a subject of critique by Clive Spash because of his lack of attention to limits to growth.

3. The richest 26 people in the world possess the same wealth as the poorest half of humanity, and they are also disproportionate emitters of GHG (the top 10% of the world's top earners produce almost half of the world's carbon emissions).
4. To be clear, the IPCC and various modelers recognize that IAMs can be problematic but still continue to use them. See, https://www.carbonbrief.org/qa-how-integrated-assessment-models-are-used-to-study-climate-change
5. For example, a standard result of mainstream models is the full employment of labor in the economy: meaning that anyone who is willing and able to work can find a job and unemployment is zero.
6. And see also Asefi-Najafabady et al. (2014).
7. For classic argument see Nordhaus (1991).
8. And of course, mirroring the utility function, work is a disutility rather than a complex phenomenon constituted through social relations and providing a source of meaning and status.
9. Although some IAMs try to model these delays by imposing a logistic function on how new technologies are adopted.
10. However, Smith argues that whilst it is true China produces emissions on behalf of other countries, China also has its own internal dynamics of ecological and climate effects (the role of the CCP), see also Smith (2020).
11. See: https://www.npr.org/2019/04/29/716347646/why-is-china-placing-a-global-bet-on-coal
12. A support rate of 74% is far greater than the support received by the Civil Rights movement in America in the 1960s. A nationwide Gallup poll in February 1965 found 26% of Americans citing civil rights as a problem facing the nation, second only to the expanding war in Vietnam, cited by 29%. See: https://www.pewresearch.org/fact-tank/2015/03/05/50-years-ago-mixed-views-about-civil-rights-but-support-for-selma-demonstrators/

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