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Debate

Capitalism and Climate Change: Can the Invisible Hand Adjust the Natural Thermostat?

Servaas Storm

Some say the world will end in fire,
Some say in ice.
From what I've tasted of desire
I hold with those who favor fire.
But if it had to perish twice,
I think I know enough of hate
To say that for destruction ice
Is also great
And would suffice.

(Robert Frost, 'Fire and Ice',
New Hampshire 1923)

ABSTRACT

Can climate change be stopped while fossil fuel capitalism remains the dominant system? What has to be done and what has to change to avoid the worst-case consequences of global warming? These questions are debated in the six contributions which follow. This introduction to the debate sets the stage and puts the often widely diverging views in context, distinguishing two axes of debate. The first axis ('market vs. regulation') measures faith in the invisible hand to adjust the natural thermostat. The second axis expresses differences in views on the efficiency and equity implications of climate action. While the contributions do differ along these axes, most authors agree that capitalism's institutions need to be drastically reformed and made fundamentally more equitable. This means a much broader agenda for the climate movement (going beyond carbon trading and technocratic discussion of mitigation options). What is needed for climate stability is a systemic transformation based on growth scepticism, a planned transition to a non-fossil fuel economy, democratic reform, climate justice, and changed global knowledge and corporate and financial power structures.

A PERIOD OF CONSEQUENCES

Global air and ocean temperatures are rising, oceans are acidifying and ice caps are melting, the sea level is rising and natural disasters are occurring more frequently and more intensely (IPCC, 2007b; Mann et al., 2009). Warming of the climate system is unequivocal, concludes the

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Intergovernmental Panel on Climate Change (IPCC, 2007a, 2007b). The rising heat is caused[1] by growing atmospheric concentrations of carbon dioxide (CO_2) and other greenhouse gases (GHGs). These, in turn, are due to anthropogenic emissions from fossil fuel combustion as well as to a decline in the Earth's capacity to absorb these emissions (because of tropical deforestation and ocean acidification).[2] Unabated, current increasing trends in emissions will raise Earth's average temperature this century by about 3–4°C. The huge damages such warming will likely bring to ecosystems, species, human infrastructures, societies and livelihoods are well documented (IEA, 2008; IMF, 2008; IPCC, 2007c; Pearce, 2007; Schneider, 2009; Stern, 2007, 2009; Worldwatch Institute, 2009). It also needs no elaboration that global warming is, above all, a threat to the world's poor, who are in fact least responsible for loading the air with heat-trapping gases (Battisti and Naylor, 2009; Opschoor, 2008; Stern, 2009; UNDP, 2007).

Climate change is a quintessential 'global public bad', because the incremental impact of one ton of GHG on climate change is independent of where in the world it is emitted. Hence, warming can only be stopped by *global collective action* to prevent leakage and free riding (Arrow, 2007; Roberts and Parks, 2007; Stern, 2007; Stiglitz, 2008). Besides being a global problem, climate change is also a uniquely long-run problem, both in terms of its causes and its effects. Even if we stopped emitting GHGs today, atmospheric CO_2 stocks would fall only very slowly, because the residence time in the atmosphere of emitted gases is measured in centuries and millennia and climate systems respond slowly (Archer, 2009). This inertia built into the system means that mitigation efforts today will not produce significant effects until after 2050. The long time horizon does not mean, however, that there is much time to decide on whether to act and what to do. The 'inconvenient truth' is that time is short, less than twenty years (Meinshausen et al., 2009): if CO_2 emissions continue unabated in the next twenty years, the climate system will cross a tipping point[3] beyond which global warming begins to feed on itself and becomes essentially irreversible and uncontrollable,

1. As David Archer (2009: 29) argues on the basis of the latest findings from climate change research: 'it is known with certainty that CO_2 affects the climate. . . . It is certain also that CO_2 levels in the atmosphere are rising. The response to rising CO_2 is certainly some degree of warming: no effect or a cooling effect can be ruled out. So the forecasts call for warming, but the warming could be more or less than the forecast calls for. In general, past climate changes . . . are more intense than we would have expected'. Archer's book is a useful introduction to the Earth's natural thermostat.
2. Atmospheric CO_2 concentrations have been relatively constant, fluctuating between 185 and 290 parts per million (ppm) throughout the last 650,000 years, but have rapidly and steadily increased during only the last 200 years to more than 385 ppm now.
3. Once a climate tipping point is crossed, e.g., a rise in Arctic temperatures precipitating a massive release of methane from permafrost zones, there is no turning back even if all GHG emissions were to end, because of positive feedbacks that accelerate other climate change. Some tipping points, such as the loss of Arctic summer sea ice, may be crossed within the next decade if climate change continues at the current rate.

with large-scale adverse consequences. Moreover, a delay in climate action, even by a few years, will necessitate more drastic CO_2 emission reductions later that will be extremely costly, making it practically unachievable.

In fact, we are nowhere near even the beginning of an effective response to global warming — even though our divided but ecologically interdependent world lacks neither the financial resources nor the technological capabilities to act. Growth of renewable energy supply is falling far short of what is possible and even further short of what is necessary. Pressed by the financial crisis and attempting to keep up short-term profits, major energy companies are reneging on their public commitments to invest in carbon-capture and renewable energy technologies, drastically downsizing their investments in clean energy. The Kyoto Protocol and the European Union's Emission Trading System (EU-ETS) have produced no demonstrable reductions in emissions (Lohmann, forthcoming); in fact, during the last decade, the increase in atmospheric CO_2 concentrations has accelerated to the fastest rate ever recorded and global climate conditions have gone from bad to worse, as the worst-case IPCC projections (or even worse) are being realized (Kintisch, 2009). The International Energy Agency predicts that, on current trends, GHG emissions will increase by 100 per cent by 2050 (IEA, 2008) — which is enough to propel us past several critical tipping points.

PROLEGOMENA

Many analysts (Archer, 2009; Baer with Mastrandea, 2006; Hansen, 2008; Hare, 2009; Meinshausen et al., 2009; Monastersky, 2009) think we have already crossed into 'dangerous' *terra incognita* and that what we must seek to avoid now is truly catastrophic and irreversible climate change.[4] But science is uncertain about what exactly constitutes 'dangerous human interference with the climate system', because the global climate is a complex, dynamical system. Hence, deciding what limit must be put on global warming to keep humanity outside the red zone of runaway warming inevitably involves normative and political judgements about *acceptable risks*. This explains the controversy about the rate, timing and scale of GHG emission reductions required for climate stabilization. The consensus view is that 'dangerous interference' begins once the global average temperature rises by more than 2°C above the average temperature during the pre-industrial period (Hare, 2009; IPCC, 2007b); it must be noted that the average temperature has already increased by over 0.8°C in the last 100 years and, due to climate inertia, will continue to increase even if emissions are reduced

4. Meinshausen et al. (2009) and Allen et al. (2009) reveal how close the world has come to the danger point, concluding that if we want to achieve climate stabilization, options are exhausted and emissions have to be drastically reduced before 2020.

Table 1. Climate Stabilization Targets and Risks of Overshooting

Institution/author	GHG stabilization target (ppm CO_{2eq})	Risk of resulting global warming exceeding: 2°C	3°C	4°C	Necessary reductions in CO_2 emissions (below 1990 levels) by 2050	by 2100
Nordhaus (2008)	650–700 [620]	>90%	>75%	>40%		40%
Stern (2007); IEA (2008)	550 [500]	85%	45%	15–20%	10%	50%
IPCC (2007a); UNDP (2007); IEA (2008)	450 [410]	50%	±25%	±12%	50%	70%
Hansen et al. (2008); Hare (2009); Meinshausen et al. (2009)	385 [350]	±20%	±10%	Negligible	>80%	>100%

Notes: Probability of overshooting a given equilibrium warming level: <10% is 'very unlikely'; 25% is 'unlikely'; 50% is even; 75% is 'likely'; and >90% is 'very likely'. Figures within square brackets indicate ppm CO_2.
Sources: The risk estimates are based on Hare and Meinshausen (2004) and Meinshausen (2005). The reported probabilities are mean risks (based on eight scenario studies) and presented for illustrative purposes only.

immediately. Scientists agree that to have a good chance (not a guarantee) of avoiding temperature increases above those levels, atmospheric concentrations of carbon dioxide would need to peak below 400–425 ppm of CO_2 equivalent (or CO_{2eq}) and stabilize in the long term at today's levels (about 385 ppm CO_{2eq}) or less.

The debate thus is in large measure on *acceptable risk*: how certain do we want to be of avoiding a climate-induced global cataclysm? Table 1 summarizes views on climate stabilization and associated risks of dangerous climate change; it shows that carbon dioxide emissions have to be reduced more progressively, the stricter the stabilization target and the smaller the risk of dangerous warming. To illustrate, implicit in the *Stern Review* (Stern, 2007), whose well-publicized headline message was that stabilizing GHG atmospheric concentrations at 550 ppm CO_{2eq} is strongly warranted on cost–benefit grounds, there is a (huge!) 85 per cent risk of warming exceeding the safe threshold of 2°C, a 45 per cent risk of warming in excess of 3°C and a non-negligible 15–20 per cent risk of overshooting 4°C (which is as risky as a game of Russian roulette). Climatologists lament Stern's laxity and call for significantly more stringent stabilization at less than 385 ppm CO_{2eq} to minimize the risk of passing climate tipping points. To achieve this, the world must move to zero fossil fuel emissions between 2050 and 2075 and *negative* emissions after 2075. Technically such drastic reductions will require the phasing out of coal-fired power plants by 2030, drastic reforestation, increased fuel efficiency and large-scale efforts to store carbon in soils through progress toward sustainable (organic) agriculture (Pacala and Socolow, 2004; Worldwatch Institute, 2009), but this scenario also assumes broad deployment of advanced renewable energy technologies and

of measures to increase energy efficiency that have not yet been proven (IEA, 2008).

To mainstream climate economists, the *Stern Review*'s conclusion that stabilization at 550 ppm CO_{2eq} is warranted on cost–benefit grounds, came as a shock — not because its target is too lax, but because it is seen as far too stringent and way out of line with the accepted view that climate action (spending money *now* to slow *future* global warming) is cost effective only for stabilization targets above 650 ppm CO_{2eq}. Implicit in this higher target is a huge 90–100 per cent risk of warming exceeding 2°C and a 40 per cent risk of warming in excess of 4°C. Mainstream economists berate the *Stern Review*'s 'wildly exaggerated' conclusions, arguing that it is based on 'technical errors' and 'extreme and political assumptions'. The main bone of contention is the choice of the social discount rate: mainstream economists who have weighed in publicly — such as Nordhaus (2007) and Dasgupta (2007) — reject Stern's 'extreme' assumption of a near-zero time discount rate, which gives large weight to the future benefits of prevented climate damage relative to present mitigation costs. If 'more conventional' — that is, higher — discount rates are used, the *Review*'s strong results can be shown to disappear.[5] This narrow focus on discounting is unfortunate, however: by retreating into the trenches of the age-old and never-ending discussion on what constitutes the appropriate social discount rate, economists are making themselves irrelevant — and unnecessarily so.

The point is that, when it comes to climate change, the issue of discounting is simply overwhelmed by the fact that the probability of global catastrophic change is non-zero. Even if we do all that is needed to cut down emissions to stabilize GHG concentrations at, say 450 ppm CO_{2eq}, which is roughly the IPCC (2007a) target and much below the *Stern Review* target, we cannot exclude substantial risks of very high warming in excess of 4°C or more. Such heating is bound to lead to catastrophic damage.[6] It follows that the expected value of the climate damage will be huge (a small probability of an infinite loss does represent a very big damage) and this will effortlessly dominate the benefit–cost outcomes, irrespective of the value of the discount rate (Weitzman, 2007, 2009). While climate history (Archer, 2009) documents that abrupt climate flip-flops have actually happened and often very quickly (within only a few years), economic model analyses — falling prey to A.N. Whitehead's fallacy of misplaced concreteness — neglect such low-probability high-impact climate catastrophes, focusing instead on gradual and smooth changes in median or mean global temperature, rainfall,

5. See Ackerman and Stanton (2008), Arrow (2007) and Weitzman (2007, 2009) for nuanced discussions of discounting.
6. For instance, recent findings from paleoclimatology (Archer, 2009) suggest that warming of 4°C would lead to a rise in sea level of 40 metres or more, flooding the world's (urbanized) deltas and low-lying lands, directly affecting about 20 per cent or more of the world population and indirectly affecting everyone, through its negative effects on food production, population density, diseases, forced migration and so on.

sea level and so forth (Weitzman, 2009).[7] However, once the difficult-to-quantify uncertainty about really bad climate extremes is recognized, nothing else matters except worst-case risk reduction — and climate action must be seen as an insurance policy to protect future generations against a relatively small chance of a ruinous catastrophe that is difficult to compensate by normal savings.[8] Military leaders,[9] accustomed to thinking in terms of security threats, and insurance companies, accustomed to dealing with risks, have recognized this early on. Catastrophic risks of the order posed by irreversible climate change thus place a high premium on the application of the precautionary principle, because policy errors cannot be readily corrected. Ultimately, the item under negotiation here is the long-term carrying capacity of the planet: are we willing to compromise it in return for short-term convenient energy?

AXES OF OUR DEBATE

What has to be done and what has to change to avoid the worst-case consequences of global warming and the associated broader environmental crisis? Our starting point is that global warming, which is the collateral damage of rapid and unequal capitalist development, in ways described by Karl Polanyi long ago,[10] must be seen as a key manifestation of *system failure*. Capitalism does *not* work when it comes to protecting our climate, because it is

7. I note that Stern (2007) is an exception as it explicitly includes climate change risks in its calculations of economic costs and benefits using Monte Carlo analysis.
8. The idea behind discounting — converting future costs and benefits into present discounted values — is that society has alternative investment opportunities, whose proxy rate of return is the discount rate, representing alternative capital-accumulation opportunities that would create benefits to compensate humanity for the economic losses suffered from climate change. But in case of ruinous climate change, it is difficult to imagine what the compensating investments are. Discounting then becomes meaningless. Weitzman (2009: 18) therefore suggests that 'the climate-change economist can help most by *not* presenting a cost–benefit estimate . . . as if it is accurate and objective — and perhaps not even presenting the analysis as if it is an approximation to something that is accurate and objective' but by 'just acknowledging more openly the incredible magnitude of the deep structural uncertainties that are involved in climate-change analysis'. Otherwise, 'we may be deluding ourselves and others with misplaced concreteness'.
9. See the grim report by the US Intelligence Community on how global warming could lead to political instability, (energy) wars, epidemic diseases and other strategic impacts (CAN Corporation, 2007). No commander in the field would look at risks comparable to those posed by climate change and decide not to act because of uncertainty (UNDP, 2007). See also Welzer (2008).
10. With insight and foresight, Polanyi (1944: 73) wrote: 'To allow the market mechanism to be sole director of the fate of human beings and their natural environment . . . would result in the demolition of society . . . Nature would be reduced to its elements, neighborhoods and landscapes defiled, rivers polluted, military safety jeopardized, the power to produce food and raw materials destroyed . . . . [T]he commodity fiction disregarded the fact that leaving the fate of soil and people to the market would be tantamount to annihilating them'.

'flying blind': it lacks the sensory organs that would allow it to understand and adjust to the climate system (Speth, 2008). Economists mean the same when arguing, as the *Stern Review* does, that 'climate change is the greatest externality the world has ever seen', but they typically forget to add that capitalism is, in essence, an 'externalizing machine', committed to keeping the real (environmental) costs of economic activities and their environmental liabilities off the accounting books (Martinez-Alier, this issue; Speth, 2008). This raises our question for Debate: can the process of global warming be stopped while capitalism remains the dominant system?[11]

Some observers, notably Mike Davis (2008), think this is unlikely and expect that the rich, 'the Earth's first-class passengers', will be able 'to wall themselves off from the rest of humanity' in 'green and gated oases of permanent affluence on an otherwise stricken planet'. In this 'Fire and Ice' scenario, not only ice sheets will collapse, but also human solidarity. Most observers would agree that capitalism *as we know it* is thoroughly inept when it comes to addressing climate change and that redemption can only be found, if at all, in its capacity for transformative change towards sustainability. But on this, opinions differ widely, roughly between those seeing a new, non-capitalist, system as necessary (Shiva, 2008; Wallerstein, 1999) and authors who think that a sustainable, reinvented and regulated version of a market system is possible (Speth, 2008; Stern, 2007, 2009). I think it is helpful to classify these differences of viewpoints along two broad dimensions.

The first dimension (or axis of debate) measures 'faith in the capacity of the invisible hand to adjust the natural thermostat'. At one extreme we find mainstream climate economists, Duncan Foley's (2006) 'true believers of market theology', who want to make the market work for the environment and get the prices right. Theirs is what William Nordhaus (2007: 689) calls 'simple economic insight': by allocating a full set of property rights to the atmosphere (similar in nature to patent rights, copyrights, etc.), carbon emissions get a price, which will confront energy users — billions of firms and people — with the expensive reality that burning carbon has a significant external cost that ought to be taken into account by being charged full freight for doing it. The belief is that economic incentives, self-interest and market mechanisms will achieve an efficient, least-cost solution to the climate crisis, regardless of how the target of atmospheric CO_{2eq} stabilization is set. In Martin Weitzman's (2007: 723) expressive prose:

> the *breathtakingly simple vision* [is] that steady pressure from . . . a high carbon price reflecting social costs . . . would do more to unleash the decentralized power of capitalist . . . inventive genius on the problem of researching, developing, and finally investing in economically efficient carbon-avoiding alternative technologies than all of the piece-meal command-and-control standards and patchwork subsidies making the round . . . these days.

11. The same question has been masterfully addressed by Speth (2008).

This 'breathtakingly simple vision' dominates official policy responses to climate change by the IEA (2008), the IMF (2008), the World Bank (2008), which is actually acting as a carbon market facilitator and catalyst, and the European Union, which sees its emissions trading scheme as the jewel in the crown of its climate change policy. UNDP (2007: vii) almost literally repeats Weitzman: 'this is not the time to come back to a system of massive quotas and bureaucratic controls because of climate change. Emission targets and energy efficiency targets have an important role to play but *it is the price system* that has to make it easier to achieve our goals'. And (ibid.: 11): 'carbon markets are a necessary condition for the transition to a low-carbon economy'. Likewise, the *Stern Review* (Stern, 2007: 326) states: 'Emissions trading schemes can deliver least cost emissions reductions by allowing reductions to occur wherever they are cheapest'.

Stern's particularly foreboding account of the impending costs of climate change and of the need for action makes its advocacy of the market solution all the more credible in many eyes. And remarkably perhaps, the same simple economic insight is shared by prominent ecological economists, including Daly (1996) and Porritt (2005), although their argument, based on the precautionary principle of strong sustainability, demands far lower (conservationist) levels of GHG emissions, as well as more radically equitable prior allocations of carbon emission rights.[12] Such strong advocacy of carbon trading does not follow from 'first-best' neoclassical economics which sees carbon trading as being equivalent to carbon taxation in terms of offering the lowest-cost solution to global warming (Stiglitz, 2008). However, it is widely believed, especially in policy circles, that, in our 'second-best world', carbon trading is the superior system, because trading is politically more acceptable to corporations and consumers than taxation (let alone direct regulation), and ultimately less costly (Stern, 2009).[13] Moreover, under carbon taxes, the quantity of emission reductions is argued to be uncertain (IMF, 2008).

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12. Specifically, Herman Daly (1996: 56) writes that the tradable permits idea 'can be applied to limit the greenhouse effect . . . [and] is truly a paradigm for many sensible policies', and (ibid.: 223–4), that 'the paradigm policy for solving the allocation, distribution, and scale problems seems to me to be the tradable permits plan'. Likewise, environmental leader Jonathan Porritt (2005: 237–8) argues that the 'real strength of this approach is that it is based upon a trading system' and that carbon quota trading will 'clearly have a huge impact upon the business community directing companies into ever more ingenious ways of getting the carbon out of whatever it is that they are selling'.
13. Stern (2009) describes the trade-offs between the price certainty of a tax and the quantity certainty of a carbon trade system, emphasizing that we cannot have both price and quantity certainty in an uncertain world. He points out that a carbon trade system might deal better with the oligarchic, price-manipulating nature of the oil and gas industry than a tax. I note that some authors argue that hybrid policies — combining elements of carbon taxation and a cap-and-trade system — could yield better outcomes than the respective single policy instruments; Pizer (2002) provides the argumentation and IMF (2008) presents a hybrid policy experiment.

Market sceptics do not buy any of this. They argue, on theoretical and empirical grounds, that the magic of the market will not work: putting a price on carbon emissions through tradable permits will not deliver the needed emissions reductions nor bring about the radical (non-marginal) technological progress and social change needed to wean us off carbon (Galbraith, 2008; Lohmann, forthcoming). In the words of Jeffrey Sachs (2008), a recent apostate of market theology: 'Economists like to set corrective prices and then be done with it, leaving the rest of household and business decisions to the magic of the market. This hands-off approach will not work in the case of a major overhaul of energy technology'.

Indeed, the available evidence[14] on carbon trading, including on the EU-ETS, shows that putting a price on emissions does not encourage meaningful investments in emissions-reducing technologies and even often slows the changes needed to cope with global warming, sacrificing the benefits of long-term environmental progress to the imperative of short-term cost-effectiveness and short-term profitability. Hence, Joseph Stiglitz (2008) concludes that the Kyoto principle is fatally flawed. Market enthusiasts attribute such real-life failures to mere 'problems of implementation', 'teething pains' and 'lack of political will to set tighter aggregate emission standards'; but sceptics consider them signs of deeper problems, due to which efficient markets will not develop, even if the rudiments of market structure are erected by regulatory fiat. Because there is no space here to review any of these deeper problems in great detail, I mention only the following:

1. *Fossil fuel technology lock-in* in the energy sector and industry. Due to large up-front investment costs, long operating lifetimes and network externalities, low-carbon technologies will be introduced *only if* the global carbon market provides a clear, stable and reliable signal in the form of a long-term carbon price, which is high enough to help private firms recover their investment costs plus a substantial premium for market risks associated with deploying very uncertain, unproven technologies. Market sceptics argue that carbon markets will not produce such a clear stable signal, but rather exhibit disproportionate price volatility due to market uncertainty and speculation (Galbraith, 2008; Lohmann, 2009a, 2009b, forthcoming; Mendonca, 2007; Nell et al., 2009).
2. *Problems of measurement, verification and monitoring*. Paradoxically, the artificial creation of a global carbon market demands a far more sensitive, centralized and powerful state apparatus for measurement and enforcement than is needed for conventional regulation. Even the industrialized economies so far have failed to operationalize the emissions

14. Lohmann (forthcoming) provides references. Typically, it is found that directed regulatory programmes (including performance standards and feed-in tariffs) encourage renewable energy supply growth much more strongly than market-based instruments (Mendonca, 2007; Toke, 2008).

measurements needed to underpin trading, or even to detect compliance with Kyoto targets, rendering the existing carbon emissions commodity largely fictitious even in its own terms (Lohmann, forthcoming). The measurement problem becomes compounded when the carbon trading system offers the option of earning 'carbon offsets' (as is the case under the Kyoto Protocol's Clean Development Mechanism or CDM),[15] because the 'carbon savings' of an offset project — that is, the amount of GHG which has not been emitted due to the project — cannot be measured; it is based on an unrealized counterfactual. Offsets are, as Lohmann (forthcoming) makes clear, a 'fictitious commodity' created by 'deducting what you hope happens from what you guess would have happened'. This lack of verifiability opens the door to corporate capture and carbon imperialism, intended to fabricate huge numbers of carbon credits for sale to Northern fossil fuel users, sustaining overconsumptive Northern lifestyles while turning the South into a 'carbon dump' (Bachram, 2004; Shiva, 2008).

3. *Inherent market failures*. The 'invisible hand', by itself, need not be efficient (Speth, 2008; Stiglitz, 2008) but may suffer from co-ordination failure[16] and information asymmetries, systemic risk, wrong beliefs about future prices[17] or externalities. It is a fallacy to believe that markets can think ahead so as to prepare, protect and represent the needs of the future (Galbraith, 2008; Georgescu-Roegen, 1975; Horwarth and Norgaard, 1990). Global carbon markets are bound to suffer from information asymmetries and to involve unenforceable contracts: what recourse would, say, India have when it emerged that the USA was emitting more than the contracts stipulated? Such market failures annihilate incentives to innovate.
4. *Negative spill-over effects*. The carbon-trade solution is efficient only if it is comprehensive and systemic, as Stiglitz (2008) points out: this requires that the shadow price of carbon should be approximately the same *in all uses, in all countries and at all dates*. This is a tall order. Current arrangements demonstrably deviate from this principle: the (shadow) price of carbon is higher in Kyoto Protocol countries than in

15. Emitters can obtain carbon credits (to sustain their home-country emissions) by financing purportedly carbon-saving (green) projects elsewhere, including tree plantation or ocean fertilization projects, hydroelectric dams, wind farms and efficiency schemes. Lohmann (forthcoming) and Shiva (2008) provide sobering evidence of how CDM projects work out on the ground in developing countries.
16. Stiglitz (2008) gives the following example of a co-ordination failure: builders do not install energy efficient light bulbs as standard equipment, because they know that consumers will be unhappy, since they cannot easily replace them in local stores. Local stores do not stock these light bulbs, because there is no demand. A government regulation requiring all new building to have energy efficient light bulbs solves the co-ordination problem.
17. To the cost of their shareholders and the taxpayers, US automobile manufacturers glaringly misjudged future oil and carbon prices, producing fuel-inefficient cars no longer in demand and missing the boat on energy-saving technological progress.

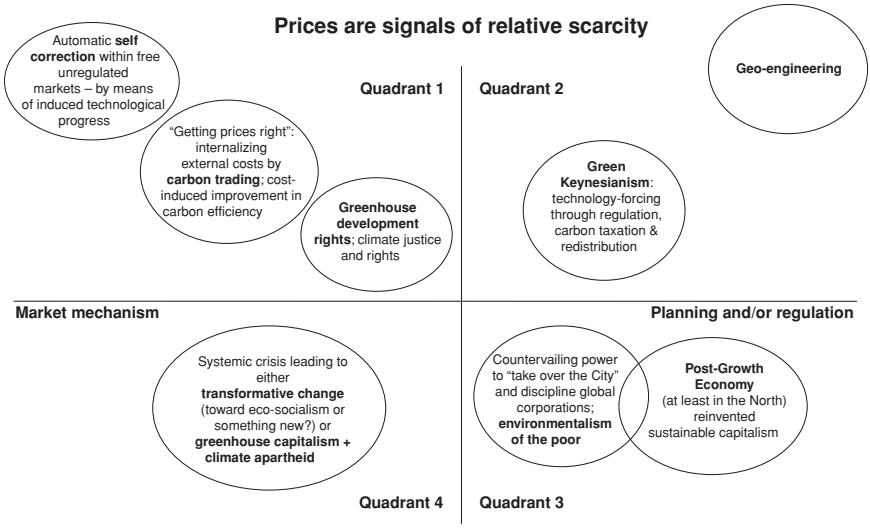
other countries; the price of carbon associated with deforestation is lower than in other uses (hence there is too much deforestation); and the price of carbon associated with industrial bio-fuels is higher than in other uses. As a result, current carbon-trade arrangements are not efficient, creating new significant external costs, borne mostly by 'the Earth's second-class passengers', the poor (Cline, 2007; Shiva, 2008). For instance, the recent shift to industrial bio-fuels, erroneously promoted as a sustainable energy option,[18] is leading to a food crisis by taking land and food crops to produce renewable feedstock (see the *Assessment* by J. Mohan Rao, this issue); a study published by the World Bank concludes that recent increases in industrial bio-fuels production and consequent large land-use shifts explain about 75 per cent of the increases in food prices (Mitchell, 2008). Likewise, over 90 per cent of the CDM carbon offset projects of the Kyoto Protocol involved 'the appropriation [of] someone else's land, someone else's water or someone else's future' (Lohmann, 2009a, forthcoming).

5. *Distributive concerns*. The question is: on whom must the incidence of the cost of adjustment be imposed? To fight climate change, the carbon price (and the price of energy) required to induce reductions in carbon emissions needs to be very high, and the effect of this on the poor could be devastating (Stiglitz, 2008). In principle, one could devise mechanisms to offset these adverse effects (using, for instance, the revenues from the auctioning of emission permits), but will this be done? Distributive concerns further complicate the 'breathtaking simplicity' of the carbon trade solution, and perhaps even fatally so.

The metaphor of the market 'can't be made to work', James Galbraith (2008: 163) concludes, 'so we need something else entirely — [a] new metaphor . . . or at least an idea that has been down so long it has nowhere to go but up', namely planning. Planning must involve a system of carbon taxation which provides the finance for public investments in renewable energy and subsidies for clean technologies, 'command-and-control' regulatory programmes (including performance standards), intellectual property right reform and aggressive industrial policy. As Sachs (2008: 40) argues: 'we will need large-scale public funding of research, development and demonstration projects; intellectual property rights to promote rapid dissemination to poor countries; and the promotion of public debate and acceptance of new options. We will need to back winners . . . to get new systems moving'. The advantages of this planning approach, as claimed by the market sceptics, are its universal applicability, superior efficacy and lower set-up costs due

18. Recent research concludes that industrial bio-fuels are not a solution to the climate crisis, because they cause more GHG emissions than conventional fossil fuels if the full emissions costs of producing them are taken into account. See Fargione et al. (2008), Pimentel and Patzek (2005) and Searchinger et al. (2008).

Figure 1. Approaches to Climate Stabilization



to existing administrative institutions (Nell et al., 2009). The dichotomy in views between market enthusiasts and sceptics is represented, on a continuous scale, by the horizontal axis of Figure 1.

The vertical axis expresses the second dimension of debate: differences in views on whether it is possible to draw a sharp line between questions concerning the efficiency of climate action and questions concerning its potential distributional or equity implications. At the top, we have the Coasean perspective, which holds that issues of efficiency and equity can be nicely separated. Efficiency supposedly is the province of economics, while equity is argued to fall in the domain of ethics and political discourse (Horwarth and Norgaard, 1990). This view holds that all that matters for the *efficient* internalization of the external costs of global warming in neutral relative prices is that atmospheric property rights are unequivocally defined and clearly assigned (Coase, 1960). For achieving a predetermined global CO_{2eq} stabilization target against the least possible costs, that is for realizing an *efficient* outcome, it does not matter how emission rights have been assigned; as Dasgupta and Heal (1979: 257), for instance, note: a resource allocation 'can be [intertemporally] efficient and yet be perfectly "ghastly" if resource depletion denies future generations the raw materials required to sustain a productive economy'. If the carbon market outcome turns out to be politically or socially unacceptable in distributional terms, corrective action can be undertaken *ex post* (by means of global redistributive taxation) or e*x ante* (by re-allocating emission rights), without interfering with

efficient carbon market processes. Importantly, for engaged scholars with progressive orientations, Coase's proposition makes it possible to argue for an allocation of emission rights radically in favour of poor populations in the least developed economies, while maintaining the proverbial efficiency of the market. This is done by ecological economists Daly (1996), Porritt (2005) and Boyce and Riddle (2007), by environmentalists such as Speth (2008), and by representatives from the climate justice movement (Sachs and Santarius, 2007). Important recent innovative attempts to marry an egalitarian philosophy and market environmentalism include the proposal for a system of greenhouse development rights or GDRs (Baer, Athanasiou and Kartha, 2008; see also Baer et al., this issue) and the emission reduction scheme proposed by Chakravarty et al. (2009).

At the other extreme we find those who think that Coase's proposition is fallacious and 'reductionist', and who argue instead that efficiency and distribution cannot be separated in a market economy (Lohmann, 2009a, 2009b; Martinez Alier, 2008). In this view, 'efficiency' is not a neutral, but a political concept. Economists define 'economic efficiency' as effectively achieving a given (climate stabilization) target against minimum monetary costs. Hence, 'efficiency' depends on the chosen target (or the chosen social welfare function), and on what is counted and not counted as costs. The question thus is: who is setting the 'rules of the game'? Who is having a say in formulating the social welfare function? Who decides which factors are to be included in the cost–benefit calculations? Do the voices of the Earth's second-class passengers weigh in as heavily as the voices of their first-class fellows? Who decides how the various costs and benefits of carbon, which are often non-monetary and incommensurable, are to be reduced to one single dimension: the money metric?[19] And what about intrinsic, infinitely large (environmental or human) values, which cannot be compromised, let alone traded, and thus fetch no price?

Coasean economics tackles these issues pragmatically, by choosing (real) GDP (or the value of consumption) as the social welfare criterion and by conflating values with market prices. In so doing, it takes for granted that, in markets, only money talks, and that without money or purchasing power, one cannot make use of the 'invisible hand'. It is true that conflicts of interest (between nations, firms or social classes) can be resolved through market exchange — as was already clear to eighteenth century political economists, as Hirschmann (1977) vividly recounts — but obviously, the rich and wealthy wield more influence over market outcomes than those endowed with lesser means. As Marx observes in *Capital* (Volume I), 'between equal

19. Consider the controversial example of what economists euphemistically call the 'value of a statistical life' (VSL) — an equivalence factor, widely used in climate-policy cost–benefit analyses to transmute climate-change induced increases in human mortality in money terms. VSL is an obnoxious example of the 'Midas Effect', analysed by Foster, Clark and York (this issue). For a critique of VSL, see Ackerman and Heinzerling (2004).

rights, force decides' (quoted in Chakravarty, 1993: 111). As a result, the interests of the rich cannot but weigh more heavily in the social welfare optimand and in determining money-metric costs. Hence, what is 'efficient' in a market system reflects minimum costs (relative to a given benefit) for the 'first-class passengers' and not necessarily so for the 'second-class' ones, whose losses or damages are often simply not counted. It therefore makes no sense to claim that markets can deliver 'efficient' outcomes, the question is 'efficient for whom?'. Prices are not distributionally neutral, they are not an unbiased reflection of value based on scarcity or internalized external costs, but are primarily 'coefficients of power'. Prices 'are set essentially by social relations', Galbraith (2008: 179) writes, and thus reflect the world's unequal market power and/or political power relationships (Chakravarty, 1993), which are determined significantly by the ownership of fossil fuels and fossil fuel technology. As Joan Martinez Alier (this issue) explains: 'We may still ask: how many tonnes of bauxite is a tribe or a species on the edge of extinction worth? And how can you express such values in terms that a Minister of Finance or a Supreme Court Judge can understand? Against the economic logic of euros and dollars, the peasant and tribal languages of valuation go unheeded'.

This market bias comes out prominently in the choice of climate mitigation *technology* (Lohmann, 2009b). Under the CDM of the Kyoto Protocol, carbon credits can be earned by investments in reducing emissions from (polluting and energy-intensive) coal-fired power plants, automobile factories and chemical plants, but the bundle of technologies recognized by the CDM does not include non-industrial farming technologies. Corporate capitalism thus puts a premium on the patent-protected standardized techno-fixes, framed and offered by the large multinational firms with huge financial interests in sustaining fossil fuel infrastructure, fossil fuel consumption and ultimately carbon emissions, while ignoring, or sometimes even destroying, the diversity of climate-resilient traditional collective knowledge systems and locally-adapted technologies, which do not contribute (or contribute less) to global warming (Lohmann, forthcoming).[20] Besides being biased, commodified knowledge, protected by private property rights, reduces the system's dynamic efficiency, as it promotes the *under*utilization of knowledge and slows down innovation (Stiglitz, 2006).[21]

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20. To illustrate, US industrial agriculture uses 80 times more energy per unit of rice output than a traditional farm in the Philippines, and 33 times more energy per unit of maize than a traditional Mexican farm (FAO, 2000). US agriculture's contribution to global warming will be correspondingly higher.
21. Knowledge is a quintessential global public good. Patents try to restrict the usage of knowledge, as one way of compensating innovators, but doing so gives rise to monopoly power, which actually reduces production and incentives to innovate. In addition, the patent system increases the cost of the most important input into innovation — knowledge — and gives rise to endless patent litigation which further restricts knowledge use.

In addition, as Foster, Clark and York (this issue) argue, Coasean economics is not able to recognize that there are intrinsic values and critical thresholds in nature. It assumes that everything is *substitutable* for something else and therefore tradable and, hence, market exchange can resolve conflict and generate overall welfare gains (with welfare being defined in money terms). As only prices and profits count, economists can be said to know the price of everything, but the value of nothing (Ackerman and Heinzerling, 2004). The bottom line is that the global carbon market price (even if it is the same *in all uses, in all countries and at all dates*) cannot adequately reflect the true *social costs* of carbon emissions, because the market mechanism only recognizes preferences when these are backed up by purchasing power, while neglecting the basic needs of the income-poor, the non-monetized value of the eco-system and intrinsic human values and indefeasible rights. Worse still, in the real world, consumers, with purchasing power, have less to say than corporations: as James Galbraith (2008: 23) points out, markets produce substantive freedom for business alone:

> it is a freedom for stable large corporations with substantial political power, for only such businesses can muster the power to exercise that freedom to the fullest: from disposition of the resources and command over labor, to the design of its products, to the pricing and the distribution and the planned obsolescence, and to the management of all the consequences, including environmental and political ones. The freedom to shop, for the rest of us, is an incident to this freedom.

This does not deny that individual consumer choices are environmentally important, but consumers' control over these choices is constrained, shaped and framed by corporations and political forces that can be reformed only through the application of 'countervailing power', based on collective political action, as opposed to individual consumer behaviour. Perhaps, after all, Weitzman's vision is just breathtakingly *simplistic*?

The two axes of debate in Figure 1 give us four broad approaches. The approach appearing in *Quadrant 1* argues that climate change can be stopped under capitalism by letting the market work for the environment. Approaches vary between those emphasizing capitalism's capacity for self-correction and endogenous, price-incentive-induced, technological problem-solving (Nordhaus, 2007, 2008; Stern, 2007, 2009) and those emphasizing radical carbon market design based on per capita carbon emission rights (UNDP, 2007; Worldwatch, 2009).

Quadrant 2 features 'Green Keynesians' who favour a global carbon tax (over carbon trading) in combination with direct regulation and (equitable) redistribution by means of a global welfare state (Bello and George, 2009; Stiglitz, 2008). This (rather top-down) approach strongly 'guides' the market, but does not want to replace it. States, at the national and supranational (global) levels, should discipline markets and force firms to invest massively in eco-friendly industry, fuel-saving technology, alternative energy, and clean transport (Rezai et al., 2009) — and all this can be financed

by new systems of global carbon taxes and Tobin taxes on international financial transactions as well as by Northern economies paying off their carbon debts to the South (Bello and George, 2009; Stiglitz, 2008); estimates suggest that this carbon debt is three times as much as the conventional financial debt that developing countries owe to the developed ones (Srinivasan et al., 2007). And part of the costs associated with climate stabilization can be met without additional financing, just by setting different investment priorities.[22]

Quadrant 3 includes those authors such as Lohmann (2009a, 2009b, forthcoming), Galbraith (2008) and Speth (2008), who also advocate a (high) global carbon tax and public investment in energy conservation, photovoltaic installations, organic agriculture and public transport, but in addition believe that deeper reforms are needed, replacing the market by alternative democratic co-ordination and decision-making mechanisms. In this view, climate stabilization requires low, no or even de-growth (at least in the North), and to make this socially and politically acceptable, capitalism's institutions governing corporations, employment, income formation, technology and knowledge processes, and trade and finance have to be fundamentally reformed to share income, employment, knowledge and technology in an equitable manner. One could argue that the ambitious agenda here is to 'save capitalism from the capitalists'.

Quadrant 4, finally, features authors according to whom there exists an un-resolvable conflict between capitalism's drive for growth and ecological sustainability (including climate stability), which can only lead to the collapse of either the capitalist system or our climate. In the first scenario (see Bello, 2008; but also Speth, 2008), which has its roots in the climate justice movement, Green socialist and feminist politics, (deep) ecology and anti-globalization movements, there is hope for a better, sustainable system, in which natural resources are collectively owned and co-operatively managed, the use of natural resources is subject to decentralized democratic decision making, and people willingly accept a low-consumption, low-growth, high equity model that results in improved welfare, a better quality of life and greater democratic control of production and (renewable) resources.[23] In the latter scenario we will be going further down the road to Mike Davis's 'first-class, second-class passengers' Earth.

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22. For example, for every dollar allocated for stabilizing the climate, the US government is spending US$ 88 on achieving security by military force and for every dollar allocated to developing new technologies to stabilize the climate, it budgeted US$ 20 to develop new weapons systems (Pemberton, 2008). The same point is made in general terms by Rezai et al. (2009): the current and future welfare costs of climate stabilization can be zero simply by re-allocating today's investable resources from building up conventional fossil fuel capital stock to building up more sustainable capital.
23. See Kovel and Lowy (2001), and articles in the journal *Capitalism Nature Socialism*.

CONTRIBUTORS TO THE DEBATE

Most contributors to the Debate section that follows are (social) scientists who are cautiously or wholly sceptical of the effectiveness of the market mechanism in addressing global warming and who argue for imposing correctives or even completely replacing the market. Notwithstanding their different perspectives, all authors accept that global warming is a real threat, that it is a global and long-run problem, which needs to be addressed globally, and that it needs to be addressed rather soon if we do not want to cross climate tipping points. The authors disagree about how to enforce a global solution to the problem of climate change, but all authors emphasize the crucial importance of equitable burden sharing. I must note that true 'believers of market theology' (in quadrant 1) are absent, as are the geo-engineers (in quadrant 2). The 'simple economic insight' of the first group is anyway the default position in most climate discussions, in no need of further explanation. Geo-engineering schemes, which require ongoing effort and resources, seem 'rather puny next to the hundred millennia life-time of global warming' (Archer, 2009: 11). Besides, many techno-fixes (such as carbon sequestration) create, on balance, more carbon emissions than they clean up. Finally, while some of our contributors sympathize with 'Green Keynesianism', no one is championing this position (in quadrant 2) solely or explicitly; prominent Green New Dealers include Al Gore, Walden Bello (2008), Susan George (Bello and George, 2009), Joseph Stiglitz (2008), and the UK's Green New Deal Group (2008).

Anil Markandya's nuanced and empirically grounded contribution falls squarely in the first quadrant of Figure 1. His argument is based on three starting points. First, real-life capitalism can only exist thanks to substantial state regulation and economists agree that the environment in general and the climate in particular need regulation. Second, Markandya accepts Stern's conclusion that climate stabilization at a level of 550 ppm CO_{2eq} is cost effective and technically feasible. Markandya thus also accepts, implicitly, the low discount rate used by Stern as well as an 85 per cent median risk of exceeding safe warming of 2°C. Third, to Markandya, critical to the success of *any* approach to climate action, capitalist or otherwise, are issues of trust and fairness in sharing the burden of the costs. Having delineated the problem thus, Markandya's principal question is: can equitable and fair climate stabilization be achieved with the capitalist institutions we have at present or do we need new institutions and new regulation? In line with quadrant 1's more mainstream climate economists, Markandya argues that market-based instruments, such as carbon trading, could do the job at lower cost than direct (command-and-control) regulation; in support, he presents examples of successful market-based approaches to cut down pollution. But Markandya deviates rather strongly from the mainstream (joining hands with ecological economists Daly and Porritt) by arguing that the global carbon price necessary to achieve the proposed climate stabilization

(at 550 ppm CO_{2eq}), must take a very high value (in his case, US$ 420 per tonne of CO_2), which is much higher than Nordhaus's (2008) optimal price of US$ 217 per tonne and a very far cry from the current (August 2009) market price of € 15 per tonne of CO_2. It follows that for more stringent stabilization targets, the 'optimal' carbon price will be substantially higher. Linearly extrapolating based on Nordhaus's and Markandya's findings, I conclude that for stabilization at a safer level of 385 ppm CO_{2eq}, we would need as high a carbon price as perhaps US$ 700 — and this completely changes the story. With a price as high as this, we cannot but expect deep price-induced reforms of fossil fuel capitalism. But a sceptic might ask, will the global carbon market produce a price as high as this? Markandya is also more radical than the mainstream in proposing a per capita global allocation of carbon emissions rights, which should take place over time.

The greenhouse development rights (GDRs) framework, presented by Paul Baer, Sivan Kartha, Tom Athanasiou and Eric Kemp-Benedict, is an innovative, workable, justice-based framework for equitable burden-sharing of the cost of climate action. By basing climate-related obligations on a national *Responsibility and Capacity Indicator*, the GDR system is designed to share in fair ways the burden of cutting GHG emissions while shielding the poor from potentially high costs. *Responsibility,* which reflects each country's historical contribution to the accumulation of atmospheric CO_2 concentrations, falls squarely on the industrialized countries of the capitalist North, which owe the developing countries a huge carbon debt. *Capacity* reflects each country's ability to deal with the climate problem without sacrificing its human development. The authors make clear that GDRs can provide a flexible mechanism to operationalize the *principle of common but differentiated responsibility*, which could help resolving the stalemate in climate negotiations (Roberts and Parks, 2007; Worldwatch, 2009). One way is to use GDRs as the basis for determining each nation's obligatory contribution to a global fund to finance mitigation and adaptation investments. Another way is to use GDRs to calculate national carbon emission reduction obligations as shares of the global mitigation requirement, which would in turn imply a particular allocation of carbon emission permits. GDRs, in other words, could be used to provide an equitable underpinning to global carbon trading. Baer et al. acknowledge fundamental limitations of their GDRs system, but make the case that (i) it is a feasible intervention, made acceptable to the mainstream of climate policy debate by intention; (ii) it is a fair intervention, which does accommodate the developing countries' claim that their right to development cannot be compromised when solving the climate problem; and (iii) it could be done quickly and as a transition strategy, which is crucial because climate action cannot wait. The GDRs system of burden-sharing can be combined with either carbon trading or carbon taxation, but, in the context of the ongoing climate negotiations, the authors see its policy potential mostly in terms of providing a (equity-based effort-sharing) base for

the Kyoto or Copenhagen Protocol carbon trading system. That is why Baer et al. can be placed in quadrant 1.

Joan Martinez Alier provides a wide-ranging introduction to (radical) ecological economics and climate change. In Martinez Alier's view, the current financial and economic crisis is a symptom of underlying ecological limits to the growth of production and finance, especially due to the exhaustion of oil and to anthropogenic climate change. He argues against Green Keynesianism (quadrant 2 of Figure 1), because, as a strategy of long-run growth, it will run into ecological constraints, which will show up in a rising oil price (which he calls the automatic growth 'de-stabilizer') and global warming. I think Martinez Alier's argument must be located in quadrant 3 (of Figure 1). As is clear from the title of his contribution, Martinez Alier's argument is that de-growth in the North is a necessary condition for climate stability and hence, addressing climate change is essentially a social issue: how to make de-growth socially and politically acceptable. This needs new social institutions (to deal with unemployment, and employment and income sharing) and new financial institutions (to stop the economy from growing with total neglect of the underlying physical realities). Southern countries obviously have much to lose and little to gain from Northern de-growth and, to offset the negative effects, Southern countries should co-operate with the aim to export less at a higher price; global eco-taxation at the oil wellhead (rather than trying to reduce end-of-pipe emissions by carbon taxes or cap-and-trade) could be used to finance an energy transition to renewables and to help the world's poor. A realist critic may plausibly argue that creating adequate global political support for the proposed transition to sustainability in North and South is a very tough order, perhaps utopian, but Martinez Alier does offer two windows of opportunity for change. First, the economic crisis of 2008–09, actually entailing substantial de-growth as well as the moral and intellectual bankruptcy of the neoliberal growth model, presents an opportunity for transformative change in the North. I must note here that Baer et al. (this issue) think otherwise, arguing that 'this is hardly a revolutionary moment . . . there is not . . . any kind of systemic alternative to the . . . capitalist world economy'. Second, Martinez Alier emphasizes the confluence of interests of Northern conservationists and the 'environmentalism of the poor' in the South, which could provide a base for global political mobilization. A final more general argument, particularly relevant for the Debate, is Martinez Alier's insistence that economic accounting is misleading, 'economics is a tool of power', which reduces a plurality of incommensurable values to one single dimension.

John Bellamy Foster, Brett Clark and Richard York mince no words: in their view, the logic of capitalism, which centres on accumulation and growth and is fuelled by competition, runs in direct opposition to environmental sustainability including climate stability. This places them squarely in quadrant 4. The authors vividly expose the alchemistic nature of 'mainstream market theology' which believes environmental limits to growth can

be overcome by what they label three 'transmutation myths': (i) the universal substitutability due to which nothing is irreplaceable or irreversible; (ii) the dematerialization of economic growth; and (iii) the conversion of nature into natural capital (expressed in financial value), assuming that once the environment gets a price, it will be safeguarded in the interest of the capitalist system itself. Capitalism is, supposedly, capable of bringing about such transmutations, which according to the mainstream blinded by the 'Midas Effect' will lead to sustainability (however weak), but which will direct us toward ecological catastrophe according to Foster, Clark and York. They see no scope for reforming capitalism from within so as to make it (strongly) sustainable, because growth and accumulation are mandatory — a life-and-death matter for firms. They highlight important radical interventions, such as Hansen's carbon tax proposal and Greenhouse Development Rights, which may be used as short-term transition strategies, but argue that a long-lasting solution to the climate crisis requires a major global social transformation (as described by Foster, 2009); the mass popular constituency needed for the radical transitory interventions could form the base for more fundamental change. The authors' approach is dialectical: the material (in this case: ecological) conditions change, while the superstructure (the capitalist economy) does not evolve; the crisis, to which the growing disharmony ultimately gives rise, gives birth to a 'green cultural revolution, in which humanity as a whole redefines its needs in relation to community, equality and sustainability'.

A reflective observer might point out that what the authors underemphasize is that, historically, capitalism when under stress has shown remarkable capacity to survive (Speth, 2008). So far, popular resistance has been neutralized quite effectively by what Gabriel Palma (2009) calls 'low-intensity democracy', which during the period 1980–2008 effectively succeeded in (politically) legitimizing (huge, global) inequalities and (mass) poverty, thus accomplishing what Palma (ibid.: 863) calls 'the most remarkable dispossession feat' ever within a democracy. Without prior change in consciousness, could the conflict between capitalism and the eco-system not be 'resolved' by further increases in inequality and poverty?

I see Minqi Li's world system's contribution as a companion piece to Foster et al. It is a central contribution to the Debate, because Li's scenario analysis sharply brings out the implications for growth of the transition to a more efficient non-fossil fuel economy, which is essential for climate stabilization. He starts by assuming that climate stabilization requires a reduction in carbon emissions of 85 per cent by 2050 and that most of this has to come from either increased energy efficiency or from new (non-fossil fuel) energy sources such as solar, hydro and wind energy. He next derives, under optimistic, but realistic, assumptions regarding technological progress and financing, the maximum (annual) growth rates of real GDP (per capita) which are consistent with given increases in energy efficiency and installation of renewable energy capacities. His results show clearly that

climate stabilization is compatible only with *modest or no* per capita income growth — globally, in the USA, and in China. This is the political heart of the climate problem: stopping global warming is only possible when growth (capitalism's *raison d'être*) is given up. This, Li believes, is not feasible politically in the USA (as former US President Bush made clear, the lifestyle of the American people cannot be compromised) and in China's current model of industrial development, and it is not feasible globally in a world system characterized by intense inter-state competition. Like Foster et al., Li sees capitalism as no longer historically viable and forced to change — Li therefore joins Foster et al. in quadrant 4.

Larry Lohmann's paper is a fundamental and hard-hitting stock-taking of the major proposals to fight climate change which are doing the political rounds these days. Lohmann treats these proposals as investment plans, not as business investment meant for short-term profit-making, but as long-term investment in the sense of mitigating global warming and at the same time providing the foundations for a secure and humane future. Unviable or 'dead' climate investment plans in his view include not only techno-fixes such as investing in agro-fuels, reducing emissions from deforestation and land degradation, ocean fertilization, carbon sequestration and storage, and nuclear energy, but also investments involving North-to-South technology transfer and investments in setting up carbon markets. Technology transfer from the North to a supposedly 'technology-deprived' South is not only skewed by entrenched Northern bias (with commodified technologies being over-protected by means of private intellectual property rights) and fossil fuel bias, but also neglects the fact that Southern (agricultural) technologies are often superior in dealing with global warming. Carbon trading, based on highly fictitious divisible, quantifiable and universally fungible emission rights, only serves to postpone investment in a long-term, non-fossil future, encouraging more ingenuity in creating possibilities for short-run (windfall) profits than in fostering innovations that lead to a trajectory away from fossil fuels. Lohmann tries to identify viable climate investments — a task which is arguably more difficult than clearing away the dead options. What it requires first and foremost is that we give up (false) hopes that (1) a replacement for fossil fuels can be found that will allow everything else to remain exactly as it is, and (2) market approaches can be the foundation of climate policy securing a humane future. Instead, Lohmann argues that climate investment should be 'localized' (not globalized or standardized), attuned to local contexts and capabilities. This, in turn — and in my view very significantly — requires a re-diversification and decentralization of the knowledge used in making investment decisions, reducing the weight given to economic and financial claims while giving more prominence to political, sociological and anthropological interventions. Lohmann is clear that this can only happen through a process of 'taking over the City', that is, imposing democratic public control over finance. This is perhaps Lohmann's major conclusion: if it wants to be effective, climate activism cannot be just about

urging global reductions in carbon emissions while keeping structures of power and knowledge much as they are. If they fail to build broad-based movements for structural reform of the capitalist system, efforts will remain futile.

BEYOND FIRE AND ICE

Can our capitalist system avoid the worst-case consequences of global warming? Participants in this Debate take radically different positions, but upon closer examination, I see important areas of (considerable, not perfect) agreement. First, all authors agree that climate stability can only be achieved by slowing down (global) economic growth significantly, to low or even negative rates, and to make this socially and politically acceptable, *capitalism's institutions have to be drastically reformed and made fundamentally more equitable*. Authors are almost unanimous that if humanity sticks to the simple insight of mainstream climate economics and continues to fight warming half-heartedly, as it is doing now, it is bound to end up in deep ecological trouble and climate *apartheid*. Opinions differ widely on how fundamental the reforms should be: Markandya, Baer and co-authors, and Martinez Alier believe some form of stationary state, or 'post-growth' capitalism is socially and politically feasible, whereas Foster, Clark and York and Li argue that climate stability is possible only when capitalism (with its inherent growth imperative) is transformed into something different. All will agree with Lohmann that the climate crisis does not have a predetermined (grandiose) outcome, but offers promise for systemic transformation, the nature and extent of which ultimately depend on contestation and struggle.

Second, most authors agree that the struggle should not be confined to only managing accelerating global warming, but be broadened to also confront the powerful forces of modern capitalism driving climate change. Authors (Lohmann most prominently) criticize the environmental and climate movement for its failure to articulate a vision of the future that is commensurate with the magnitude of the crisis. The climate discussion has been narrowed to technocratic policy discussions on aspects of cap-and-trade, that — in Speth's (2008: 80) words — 'provide neither the popular inspiration nor the political alliances needed to deal with the problem'. The climate movement has to *broaden its agenda* to embrace a healthy scepticism of growth-mania (Martinez Alier, Foster et al.), a challenge to corporate (financial sector) dominance (Lohmann), a decentralization, de-commodification and diversification of knowledge (Lohmann), a commitment to fundamental democratization of the economic process (Li, Foster et al.) — in addition to a commitment to climate justice (Baer et al., Markandya). Lohmann is right when he concludes that we need to give up all hope that a replacement for fossil fuels can be found that will allow everything else to remain exactly as it is now.

Third, what I have learned from the Debate — and this perhaps more than anything else reflects my economics bias — is that it is time to liberate current social sciences' discourse on global warming from the self-imposed, narrowly economistic straightjacket, which emphasizes CO_{2eq} stabilization targets, carbon commodification and trading, 'optimal' social discount rates and feasible *ex-post* burden sharing. Foster, Clark and York really go to the heart of the problem concluding that all viable solutions to global warming must end in the fall of Midas. We need to squarely confront the difficult-to-quantify uncertainty about climate catastrophe and freely acknowledge that the choice of *acceptable* climate risk is *inescapably political* (and not economic). Following most of the authors, who buck current conformism, I think we should recognize that there is nothing inherently superior to the carbon trading solution, because its proverbial 'efficiency' and 'least costs' are not neutral but reflect existing (unequal) economic and political power relations. We have no time to experiment with carbon market design, regulation and enforcement structures, but we do have the regulatory capacity in place (and the accumulated experience) to impose carbon taxation, feed-in subsidies for renewable energy generation, and direct command-and-control regulation (including a ban on coal use). And if we really want to do it by means of carbon trading, carbon markets need very hefty regulation and guidance, for instance by imposing a *minimum* carbon price, which is high from the beginning and is raised over time. My conclusion from all this is that the economics of climate change is *passé*: what we need now is to study the *political economy* of crossing from crisis to sustainability (Speth, 2008).

Finally, an area where there is more agreement is that fossil fuel capitalism is in a systemic crisis involving a deep and prolonged recession, global social polarization, a crisis of state legitimacy and political authority, a spiritual crisis,[24] a crisis of consumerism and *Affluenza*, and the climate crisis. Only a crisis brings real change — hence the crisis may offer a historical opportunity for change, provided there is an alternative to current capitalism that is viewed as viable and preferable by a majority in society. Here, Martinez Alier sketches the contours of a post-growth society, similar to Speth (2008) and reminding us of John Maynard Keynes (1933) who, 76 years ago foresaw a world in which society had outgrown the need

24. As Vaclav Havel has stated, civilization's course has to change and '[t]he only option is a change in the sphere of the spirit, in the sphere of human conscience. It's not enough to invent new machines, new regulations, new institutions. We must develop a new understanding of the true purpose of our existence on this Earth'. Havel is cited in Speth (2008: 200), who devotes a beautifully written chapter to the need for a new consciousness that must accompany a transformation in economics and politics towards sustainability. This discussion is clearly related to 'The Revolution for Enough' proposed by Foster, Clark and York (this issue).

for growth;[25] Lohmann focuses on the rocky political road to a system of democratic control over capital accumulation and finance; Baer, Kartha, Athanasiou and Kemp-Benedict and Markandya argue for radical (carbon) property rights distributions; and Foster, Clark and York propose a new ecological order based on social use of nature, democratic decentralized governance, and the satisfaction of present and future communal needs (Foster, 2009). The authors thus provide long-term and hopeful visions, some of which may appear rather utopian, of how to avoid going down the wrong road.

Some of these visions need time — after all, the impossible takes a little while — but climate action cannot wait.[26] Momentum for climate action is growing, also due to the United Nations Climate Change Conference, to be held in Copenhagen in December 2009, where UN member countries will negotiate a new climate treaty to replace the Kyoto Protocol, which is due to expire in 2012. The need for quick action, and the huge climate uncertainties we face, provide, I think, an argument for using and experimenting with mixed instruments to start fighting warming immediately, including the Correa-Daly carbon-tax, which could be extended to most commodity exports from the South (Martinez Alier); Ecuador's President Rafael Correa's proposal that the world pays Ecuador not to extract oil (Gallagher, 2009); James Hansen's radical carbon tax proposal (for the US, Japan and Europe) and a moratorium on new coal-fired power plants (Foster, Clark and York, this issue); proposals to force the North to repay its carbon debt to the South; proposals to require that a portion of the earnings from fossil fuel use be reinvested in the development of renewable energy; and global contraction-conversion strategies based on greenhouse development rights (Baer and co-authors, this issue). These measures can only work if we manage to 'take over the City' (Lohmann, this issue), which will, *inter alia*, require reducing shareholder primacy by rolling back their limited liability, bringing corporations under democratic control, reforming corporate lobbying, instituting effective worker participation in firm's strategic decision making and imposing environmental disclosure laws on firms (Speth, 2008). There is much reason for despair, but I believe the political-economy contributions to our Debate manage to make hope possible, rather than despair convincing.

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25. According to Keynes (1933: 365 ff.) the freedom from the struggle for subsistence would lead to great changes in moral codes: 'The love of money as a possession . . . will be recognized for what it is, a somewhat disgusting morbidity, one of those semi-criminal, semi-pathological propensities which one hands over with a shudder to the specialists in mental disease . . . I see us free, therefore, to return to . . . traditional virtue — that avarice is a vice, that the extraction of money is detestable . . .. We shall once more value ends above means and prefer the good to the useful'.
26. The effectiveness of climate action is also more important than its efficiency: emphasizing cost efficiency in the face of the climate crisis can be compared to improving the fuel efficiency of the Titanic.

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Servaas Storm works on globalization, economic development, structuralist macroeconomics and climate change, and is associated with the Department of Economics, Faculty TBM, Delft University of Technology, Jaffalaan 5, 2628 BX Delft, The Netherlands; e-mail: S.T.H.Storm@tudelft.nl.