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## ***COPING WITH THE COLLAPSE: A STOCK-FLOW CONSISTENT MONETARY MACRODYNAMICS OF GLOBAL WARMING***

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### **Overview**

Taking advantage of over forty years of hindsight available since *The Limits to Growth* (LtG) was published (Meadows et al., 1972, 1974), several attempts to review how society is tracking relative to their ground-breaking modelling have addressed the question of whether the global economy is on a path of sustainability or collapse. Turner (2008) and Hall and Day (2009) tend to confirm the LtG standard-run scenarios, which forecast a collapse in living standards due to resource constraints in the twenty-first century. On the other hand, over a similar time frame, international efforts based around a series of United Nations (UN) conferences have yielded rather mixed results (Linner and Selin, 2013, Meadowcroft, 2013). In these simulations at least, the unravelling of the global economy and environment is essentially due to the growing scarcity of natural resources (energy, minerals, water...), while climate change plays little role, if any. Given the ongoing awareness of climate change damages, crystallized at the diplomatic level in the Paris Agreement of December 2015, this raises the question of whether global warming might *per se* induce a similar breakdown of the world economy. This paper examines this issue, presenting a macroeconomic model of endogenous growth that enables to take into consideration both the economic impact of climate change and the pivotal role of private debt.

### **Method**

Using a Goodwin-Keen approach, based on the Lotka-Volterra logic, we couple its nonlinear dynamics of underemployment and income distribution with abatement costs. Moreover, various damage functions à la Nordhaus and Dietz-Stern reflect the loss in final production due to the temperature increase caused by the rising levels of carbon dioxide emissions. We incorporate endogenous drivers of growth and allow climate change to damage these drivers. Our modelling approach is also compatible with multiple long-run equilibria, it is stock-flow consistent (Godley and Lavoie, 2012), and exhibits endogenous monetary cycles and growth, viscous prices, private debt, and underemployment. An empirical estimation of the model at the world-scale enables us to simulate plausible trajectories for the planetary business-as-usual scenario. We analyse the extent to which slower demographic growth or higher carbon pricing allow a global breakdown to be avoided. The paper concludes by examining the conditions under which the +1.5°C target, adopted by the Paris Agreement (2015), could be reached.

### **Results**

By combining financial and environmental aspects, the stock-flow consistent macroeconomic model introduced in this paper allows us to evaluate economic growth, or possible (forced) degrowth, depending on the dynamics of labour productivity, damages induced by global warming, the demographic trend, and climate sensitivity, as well as the carbon price path. Our main finding is that, even though the short-run impact of climate change on economic fundamentals may seem *prima facie* rather minor, its long-run dynamic consequences may lead to an extreme downside. Under plausible circumstances, global warming forces the private sector to leverage in order to compensate for output losses; the private debt overhang may eventually induce a global financial collapse, even before climate change could cause serious damage to the production sector. Under more severe conditions, the interplay between global warming and debt may lead to a secular stagnation followed by a collapse in the second

half of this century. These results complete the path-breaking work of LtG by adding a third cause of possible collapse to the scarcity of natural resources and pollution (other than CO<sub>2</sub> emissions).

### **Conclusion**

Curbing the demographic trend does postpone the potential disaster but is not sufficient to avoid it. However, a carbon price starting at US\$ 12 t/CO<sub>2</sub> in 2015 and reaching US\$ 29 t/CO<sub>2</sub> in 2055 suffices to restore perpetual growth whenever climate sensitivity is 2.9. With a high climate sensitivity of 6, a much more severe carbon price path is needed, starting for instance at US\$ 65.5 t/CO<sub>2</sub> in 2015 and finishing at a level higher than US\$ 285 t/CO<sub>2</sub> in 2050. Given the radical uncertainty that plagues climatologists' knowledge about climate sensitivity, these results call for strong and immediate action. This can take the form of a high carbon price (or price corridor, since there is no reason for the relevant incentivizing price to be uniform throughout the world), starting immediately above US\$ 65.5 t/CO<sub>2</sub>, and rapidly increasing. Finally, it seems too late for the world economy to be able to reach the +1.5°C target, unless with a stroke of luck climate sensitivity turns out to be very low.

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