

A Monetary Multisectoral Model for Human and Nature Interaction

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There are widespread concerns that current trends in population, primary energy-use and natural resource-use are unsustainable, but the possibilities of an overshoot and collapse remain controversial. Two important features seem to appear across societies that have collapsed: (1) Ecological Strain and (2) Economic Stratification. In a pathbreaking paper, Motesharrei et al. (2014) introduced a new and fairly simple model (HANDY) and several simulated scenarios that offer significant implications in terms of human starvation and possible collapse of industrial societies. The model has just four equations that describe the evolution of the populations of Elites and Commoners, Nature, and accumulated Wealth. Mechanisms leading to collapse are discussed and the measure “Carrying Capacity” is introduced. The model suggests that the estimation of Carrying Capacity is a practical means for early detection of a collapse. Collapse can be avoided, and population can reach a steady state at the maximum carrying capacity, if the rate of depletion of nature is reduced to a sustainable level, and if resources are distributed equitably among the population.

Unfortunately, this dynamical system contains no economic forces that could describe how the reduction of nature depletion, as well as a more egalitarian distribution of wealth, could be achieved. If, in addition, one takes into account the necessity, for most industrialised countries, to shift from a high-carbon energy mix to a low-carbon one in order to address the climate challenge, whether an escape from the collapse due to the peak of natural resources is attainable remains an open question.

In the present paper, we therefore complement HANDY with an “economic” dynamical system, inspired from Goodwin (1957). We start by coupling the special case of a model proposed in Keen (1995) with HANDY. In the absence of a government sector, the Keen model consists of the three-dimensional system (14) describing the dynamics of wages, employment rate and private debt. Its key insight is that, in boom times when profits are high, firms can choose to invest more than their profits by borrowing from the banking sector. If profits are low, on the other hand, the production sector might also want to invest less than their profits to pay down debt, thereby engaging in the familiar debt-deflation dynamics described in Fisher (1933). The dynamics of the economy then reduces to that of a planar oscillator in $\mathbb{R}_+^2$:

$$\begin{cases} d\omega_t = \omega_t(\Phi(\lambda_t) - \alpha)dt \\ d\lambda_t = \lambda_t(\kappa(\omega_t) - \gamma)dt \end{cases}$$

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(where $\omega_t \in (0, 1)$ is the wage share in GDP and $\lambda_t \in (0, 1)$, the employment rate) supplemented with a dynamics for private corporate debts.

$$dD_t = r_t D_t + \kappa(\omega_t) - s\pi_t$$

where r_t is the interest rate of the Central Bank, and π_t is the profit of firms, $s \in (0, 1)$ is the fraction of profit which is reinvested.

As shown in Grasselli and Costa Lima (2012), this dynamics leads to the possibility of two very distinct equilibria : a “good equilibrium” characterized by finite private debt and nonzero wage share and employment rate, and a “bad equilibrium” characterized by infinite private debt and vanishing wage share and employment rate. Moreover, for typical parameter values, both equilibria are locally stable. As emphasized throughout Minsky (1982), the debt-deflation mechanism can be halted by government intervention, since it follows from Kalecki’s profit equation that government spending increases firm profits. We formalize this insight by introducing government expenditures, subsidies, and taxation into the Keen model. In addition, we introduce heterogeneous households, endogenous money creation by the banking sector and a multisectoral production sector, where short-run non-substitutability between inputs are captured through a short-term Leontieff input-output matrix that distinguishes, in particular, between clean and dirty technologies of production.

This dynamics is eventually coupled with HANDY.

To put it in a nutshell, we provide numerous insights that complement the main conclusion of Motesharrei et al. (2014). First, we confirm that the business as usual (with no state intervention in order to foster the energy shift) leads to a global collapse. Interestingly enough, the collapse comes even quicker for the “good” equilibrium. Debt-deflation, by reducing activity, simply postpones the end of the story. On the other hand, we show that an escape road from this collapse is possible provided the state intervenes strongly so as:

- to foster the energy shift by public expenditures,
- to drive the wealth distribution towards a more egalitarian state through taxes and expenditures.

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