

Decoupling Natural Resource Use from Economic Growth: An Agent-Based Modelling Approach

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Abstract: The current economic crisis draws renewed attention to the underlying mechanisms of the market economy and its increasing effects on the environment (MDG's, 2008). One area of particular concern is the focus on economic growth, induced by the monetary system, which requires an ever increasing use of natural resources. Daly (2011) pointed out that the interest rates associated with the stock of debt forces society to create a continuously increasing income flow, resulting on the accumulation of more and more debt to finance the economic growth ultimately and reduce the availability of natural resources. However, the impact on the environment is not factored in to the cycle of interest, debt, growth, thus creating the so-known negative externalities. This disjunction between the economic and natural resource systems may be preventing sustainable development (ICSU, ISSC, 2015).

Despite the fact that decoupling economic growth from natural resource consumption is at the heart of initiatives such as the Green Economy Initiative of UNEP, conceptual frameworks for achieving it are still in their infancy and, therefore, further models are required (UNEP, 2011). Based on this, we construct a conceptual agent-based model (ABM), implemented in NetLogo (Wilensky, 1999), in order to determine whether there is a built in bias in the economic system towards unsustainable outcomes related with energy consumption and resource use. We also wished to examine which combination of variables may lead to more sustainable use of natural resources. Our monetary model simulates a basic credit economy, consisting of three agents: bank, firms, and households. We model the access to a resource by the industry, which consumes energy through a resource exploitation process. We include households which consume the resources made available by the industry. Finally, the bank settles payments and extends loans with interest to the industry and households. The economic activity is modelled through a financial market, which includes both a goods market (i.e. money spent by households on assets delivered by the industry) and a debt market (i.e. credit delivered by the bank for the industry and households).

Our ABM model is designed to be as simple as possible while capturing the desired dynamics. It rests on a set of macroeconomic functions. In particular, we use Steve Keen's 'vault' model of a Wicksellian pure credit economy (2009, 2010a) and also his cyclical model of the macro-economy (2010b, 2011a,b) as a basis, which was able to reproduce the real macroeconomic trends that occurred between 1970 and 2010. We replicate these models by adding additional environmental variables (e.g. energy consumption), necessary to obtain more information from the environmental pillar of sustainability.

We expect our model to show how credit, created by the bank, is brought into the economy endogenously at the demand of the market. Due to this, our simulations may show positive short-run trends in economic indicators. However, in the long-run this may give way to economic collapse, as long as the driving forces of productivity and population growth exist. As Keen (2010) argues, this occurs because the money that funds economic growth does not enter according to private profit-seeking, but rather for speculative goals. As a consequence, economic growth has negative effects on the other two pillars of sustainability (i.e. social and environmental), creating a decoupling process between the growth curve of debt and energy production, and the decline curve of total resources available in the system. In our model, more sustainable outcomes may be obtained when the curves of total debt and resource availability are parallel over time. This could be achieved, for example, by reducing resource consumption or in a system that would not rely on an increasing stock of debt for industrial growth, but rather on expanding money supply only when deflationary pressures reveal a need for more money.

Keywords: *Agent-based model (ABM), debt monetary system, sustainable development, economic and environmental decoupling, natural resources.*