Macro-Sectoral-Financial dynamics in Energy Technology Transitions

Topic:
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Limiting global temperature increases to 1.5Â°C will necessitate a transition away from fossil fuels and towards a net zero carbon energy system. While such a transition is necessary to avoid the catastrophic effects of climate change, it might also lead to a number of transition risks and transition opportunities. For example, a reduction in the demand for fossil fuels could lead to the stranding of fossil fuel related assets, reductions in the market value of fossil fuel firms, and defaults on fossil fuel firm debts. If large enough, these negative impacts could have (via their impacts on banks and financial markets) serious negative repercussions for the rest of the economy. In addition, a transition to net zero carbon energy system may lead to a decline in the energy return on energy invested (EROI) of the energy sector. Declines in EROI are likely to lead to increases in energy prices and so the general price level, which are in turn likely to negatively affect economic activity. On the other hand, the large levels of investment required for the transition are likely to lead to significant increases in demand and so employment and output. Crucially, each of these risks and opportunities are likely to affect the different sectors and industries that make up the economy in different ways.

Despite the fact the macroeconomic, sectoral and financial implications of a transition to net zero are not well understood, to date only a small number of models exist that attempt to simulate the potential economic effects of different types of energy transitions. The majority of these models, however, do not include a financial sector or financial assets, and instead focus purely on the â€˜realâ€™ side of the economy. In addition, to our knowledge none of these models are able to simulate how the potential benefits of an energy transition (increases in employment and output due to an increase in green investment) are likely to interact with all the different potential risks (asset stranding, loan defaults, changes in equity market values, and reductions in EROI) along different transition pathways, or how sectoral specific impacts might feedback and affect other sectors and the broader economy. As such, the modelling of how asset stranding, changes in EROI, increases in green investment (and how that investment is financed) might affect the financial and real sides of the economy (and how these impacts might feedback and interact with each other) remains something of a gap in the literature.

In order to address this gap, this paper presents a stock-flow consistent (SFC) model with an integrated input-output (IO) model for the study of the economic and financial impacts of energy transitions, with a particular focus on energy investment, investment financing, capital asset stranding, changes in EROI, and sectoral impacts. The model consists of a household sector, a government sector, a banking sector, an external sector 15 non-energy firm sectors and 10 electricity sectors. Novel or semi-novel aspects of the model include multiple firm sectors and goods types, the integration of an input-output model and an almost ideal demand system into the larger SFC model, the endogenisation of firmsâ€™ markups based on target profit rates and loan defaults that affect the bankâ€™s capital position and so its lending rates.

We use this model to investigate the economic impacts of different types of transitions to a low carbon economy. Particular focus is placed on the interactions between changes in EROI, fossil fuel firm asset stranding and financial transition risks (i.e. loans defaults and asset prices changes on financial markets), changes in investment and investment financing, and interactions between these factors and the different sectors that make up the economy.