Discussion of

"A Macroeconomic Model with a Financial Sector"
by Brunnermeier and Sannikov

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*The views here do not necessarily represent those of the Richmond Fed or the Federal Reserve System

The goal of the paper

- Study how limits to the amount of leverage by productive agents can have important implications for the dynamics of aggregate variables (like output) in the economy

- The authors develop a dynamic stochastic general equilibrium economy (in continuos time) and study global dynamics

- They also use the model (under reasonable extensions) to study externalities and securitization

- This is an impressive and ambitious piece of technical work

- But beware: this is no paper for beginners (in the continuous-time literature)

What they show

- In the benchmark economy, aggregate net worth and the price of capital can display, occasionally, significant departures from their modal values (i.e., where they spend most of the time) $\longrightarrow$ situations that look like "downward spirals" in prices and "feedback loops"

- Price volatility increases when the economy enters these downward spirals

- Externalities may result on excessive exposure to this type of event

- ... and many other (potentially) very interesting things

- Being a beginner, though, I could not get pass the benchmark economy and trying to understand the economics of what was going on there $\longrightarrow$ this is what I will talk about (...what else could I do?)

My version of the benchmark economy

- There is a large number agents (called *experts*) which own capital k_t and have a technology of production $y_t = ak_t$

- Capital (is irreversible, I think, and) depreciates at a (common to all experts) random rate with mean δ ($\longrightarrow$ the exogenous aggregate shock in the economy)

- Experts
  - consume output
  - are risk-neutral $\longrightarrow u(c_t) = c_t$
  - discount the future at rate ρ

- Experts can also:
  - invest to increase their capital stock (but there are "adjustment costs")
  - trade capital (among each other) in a competitive market at the endogenous equilibrium price p_t, which they (of course) take as given (also, there is a natural lower bound on p_t)
  - borrow at a fix rate $r < \rho$ (from, say, an ATM machine) and have to always repay their debt d_t

- Expert net worth, $n_t = p_t k_t - d_t$ is restricted to be always greater than (or equal) to zero

- There are well-crafted justifications for these restrictions in the paper (but these reduced-forms are what is ultimately used for solving the model)

What happens in this economy?

Suppose we want to study a discrete-time version (recursively)

- The agent's problem:

$$V(k_t, d_t, K_t, D_t) = \max \left\{ c_t + \frac{1}{1+\rho} E\left[V(k_{t+1}, d_{t+1}, K_{t+1}, D_{t+1})\right] \right\}$$

subject to

$$ak_t + (d_{t+1} - d_t) = c_t + \iota(i_t) + rd_t + p_t s_t$$

$$\begin{aligned} k_{t+1} &= i_t + s_t + (1 - (\delta + \varepsilon_t))k_t \\ n_t &= p_t k_t - d_t \geq 0 \end{aligned}$$

where s_t is purchases/sales of new capital and ε_t is a random variable with mean zero

- Market clearing for capital: $s_t = 0$; and $K_t = k_t$ and $D_t = d_t$ (representative agent)

- Solving for an equilibrium is not easy (for many reasons, as far as I can tell $\rightarrow$ not just the non-negativity constraint on n_t $\rightarrow$ also risk-neutrality, ak technology, $r < \rho$)

- Some conjectures: Given a sequence of equilibrium prices so that $s_t = 0$, what does the agent want to do?

  - the agent is risk-neutral and can borrow at a rate lower than the discount rate $\rightarrow$ borrowing seems attractive

  - but the constraint on n_t implies that, eventually, the agent has to sacrifice consumption to repay (cannot roll over ballooning debt)

  - in order to repay debt the agent has to produce output (and not consume all) or sell capital $\rightarrow$ hence, it is not always optimal to borrow to consume

  - in fact, if a or p_t is expected to be high tomorrow then the agent may want to delay consumption

- The authors solve for an equilibrium in a continuous-time version (makes solving actually possible)

- They can actually characterize the global dynamics in the economy

- They find that:
  - agents consume only when aggregate net worth η_t reaches a threshold η^*
  - the price of capital p_t is increasing in η_t
  - the aggregate level of net worth stays most of the time near η^* but, occasionally, may "spiral" down and stay for some time in a low level (away from η^*)
  - prices p_t follow η_t down the spiral!

Some closing remarks

- The solution method is (very far) from trivial, and understanding what is going on in the equilibrium is very hard (i.e., it was for me)

- What is driving things? Which features of the model are responsible for the main findings?

- In my opinion, the occasional downward spirals in net worth and prices are really interesting, and potentially very important $\rightarrow$ note that the downward spirals happen in the *unique* equilibrium, *without externalities* of any sort

- We need to know more about them: why and how they happen (in the model)? how robust are they? how important quantitatively? would downward spirals happen away from steady state in most Kiyotaki-Moore type of economies?

- Kocherlakota's (2000) dictum $\rightarrow$ not too hard to write an economy in which credit constraints amplify and propagate exogenous shocks
  - but, is such an economy *relevant* qualitatively and quantitatively?
  - Kocherlakota writes down one (that appears to be) not quantitatively relevant (and there are many other examples)
  - results are based on analysis "around" the steady state

- Brunnermeier and Sannikov study global dynamics but in what appears to be a very stylized economy

- They show that large aggregate (partly endogenous) fluctuations can happen in equilibrium (sometimes?) $\rightarrow$ how robust is this finding, qualitatively and quantitatively?

In my (small) mind this remains an open question