Animal Spirits, Heterogeneous Expectations and the Amplification and Duration of Crises

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Animal Spirits (Keynes)

much of (macro)economic activity is governed by animal spirits

- people have non-economic motives
- they are not always rational in pursuit of economic interests

Keynes: animal spirits are the main source of economic fluctuations

... but animal spirits disappeared from the neoclassical, rational model
Animal Spirits (Akerlof and Shiller, 2009)
How human psychology drives the economy, and why it matters for global capitalism

5 animal spirits: confidence, fairness, corruption, money illusion and stories

- cornerstone animal spirit: confidence
- behavioral economics: how the economy really works, when people are human
- animal spirits difficult to conceptualize, model and measure

Goal of this paper: dynamic equilibrium model of agents’ confidence

Main Result: sudden collapse of confidence accelerates and amplifies downturn or crisis and slows down recovery
Main hypothesis: heterogeneous expectations
Brock and Hommes, 1997

**main tool for modeling confidence** in market for loans
- lenders’ **heterogeneous expectations** about the (exogenous) probability of success/failure of borrowers

**Main finding:**
- In the presence of a (small) **fraction of pessimistic beliefs**, an unexpected **negative shock** to credit markets triggers these pessimistic beliefs to become **self-fulfilling**, **amplifying** a “crisis” and **slowing down** recovery
Model

- market for loans
- overlapping generations (OG) structure for households
- households savings into a riskless asset or a risky asset (productive investments)
- no banks, but households can lend to firms
- firms borrow capital for productive investment and pay wages to households
- market clearing determines the “contract rate” for loans (i.e. the interest rate, downpayments, and other loan requirements)
Households: 2-period OG

**Maximize utility** 

\[ u_t = \ln c_{t,t} + \ln c_{t,t+1} \]

under the **budget constraints**

\[

c_{t,t} \leq w_t - s_t , \\
c_{t,t+1} \leq \omega_o + s_t[(1 - \delta_t)\rho + \delta_t\lambda_{t+1}^e] ,
\]

- \( c_{t,t}/c_{t,t+1} \): **consumption** when young/old;
- \( w_t = w_{p,t} + \omega_y \), real **wages** + labour endowment when young;
- \( s_t \) real **savings** when young;
- \( \delta_t \) **fraction** invested in risky asset;
- \( \lambda_{t+1}^e = p_{t+1}^e r_t \) expected **return on capital**
- \( p_{t+1}^e \) expected probability of success
Households Savings function

optimal saving

\[ s_t = \frac{1}{2} \left( w_t - \frac{\omega_o}{\mu_{t,t+1}^e} \right). \]

with expected average return on investment

\[ \mu_{t+1}^e =: (1 - \delta_t) \rho + \delta_t \lambda_{t+1}^e \]

Assuming zero endowment when old i.e., \( \omega_o = 0 \), savings is

\[ s_t = \frac{w_t}{2}. \]
Firms demand for loanable funds

Firms borrow to finance productive investments

- \( p_t \) probability of success
- \( 1 - p_t \) probability of bankruptcy

Firms choose capital \( x_t \) to maximize

\[
\max_{x_t} \left\{ p_t g(x_t) - r_t x_t \right\},
\]

where \( r_t = 1 + r_{0,t} \) is contract rate for loans (i.e. “rental rate” on capital + other conditions for loans)

optimal demand for loans:

\[
x_t = x(r_t; p_t) = g' \left( \frac{r_t}{p_t} \right).
\]

wages from the productive sector (returns to other factor):

\[
w_{p,t} := p_{t-1} g(x_{t-1}) - r_{t-1} x_{t-1}.
\]
Market Equilibrium under Homogeneous Expectations

demand for loans \equiv \text{total supply of loans}

homogeneous expectations on probability of success:

\[ x(r_t; p_t) = S_t(r_t; p_{t+1}^e) \]

loan supply correspondence

\[ S_t(r_t) := \frac{w_t}{2} \bar{\nu} [r_t > r_t^* = \frac{\rho}{p_{t+1}^e}] \]

[no arbitrage; risk-neutrality; expected loan return]

\[ \lambda_{t+1}^e(r_t) = p_{t+1}^e r_t = \rho \quad \implies \quad r_t^* = \frac{\rho}{p_{t+1}^e}. \]
Temporary Equilibria: Homogeneous Expectations

temporary equilibrium A or B depending on demand curve

\[ r^*_A = \frac{\rho}{p^e_{t+1}} \]
Dynamics under Homogeneous Expectations

exogenous stochastic **probability process** AR(1)

\[ p_{t+1} = \mu + a(p_t - \mu) + \epsilon_t, \]

- naive expectations: \[ p_{t+1}^e = p_t \]
- average expectations \[ p_{t+1}^e = \frac{1}{i+1} \sum_{i=0}^{t} p_i \]
- minimum expectations: \[ p_{t+1}^e = \min\{p_{t+1-T}, p_{t-T}, \ldots, p_{t-1}, p_t\} \]
- rational expectations: \[ p_{t+1}^e = \mu + a(p_t - \mu) \]
Dynamics under Homogeneous Naive Expectations
Dynamics under Homogeneous Expectations (average)
Rational Expectations
Pessimistic Expectations (minimum, 5 lags)
Dynamics under Homogeneous Expectations

- **average expectations** smoothes out aggregate behavior (no extremes)
- **minimum expectations** amplifies the crisis and slows down recovery
Heterogeneous Expectations (Brock and Hommes, 1997)

J types of lenders, with expectations on return of risky asset:

\[ \lambda_{j,t+1} = p_{j,t+1} r_t \]

**performance measure:** relative past squared errors

\[ \eta \text{ memory parameter} \]

\[ U_{j,t} = r_t^2 (p_t - p_{j,t})^2 + \eta U_{j,t-1}, \]

\[ u_{j,t} = U_{j,t} / U_{tot}^t, \quad U_{tot}^t = \sum_{j=1}^J U_{j,t}. \]

**fractions:** discrete choice model with asynchronous updating

\[ n_{h,t} = \delta n_{h,t-1} + (1 - \delta) \frac{e^{-\beta u_{h,t-1}}}{z_{t-1}}, \]

where \( z_{t-1} \) is a normalization factor. The parameter \( \delta \in [0, 1] \) – the inertia of the traders.
Market Equilibrium under Heterogeneous Expectations

demand for loans  ≡  total supply of loans

**heterogeneous expectations** on probability of success:

\[ x(r_t; p_t) = S_t(r_t; p_{1,t+1}^e; \cdots, p_{J,t+1}^e) \]

**total supply** of loans under heterogeneous expectations

\[ S_t(r_t) = \frac{w_t}{2} \sum_{j=1}^{J} n_{j,t} \mathbb{I}[p_{j,t+1}^e r_t > \rho] , \]
Temporary Equilibria: Heterogeneous Expectations 2 Types

temporary equilibrium A, B, D or C depending on demand curve
Two type example: average versus minimum beliefs
Two type example: rational versus minimum beliefs

Model

Cars Hommes

Animal Spirits and Heterogeneous Expectations
Conclusions

- **confidence** in economy can be modeled with lenders’ heterogeneous expectations about the probability of success of firms (banks)
- a small fraction of **pessimistic**, minimum expectations **amplifies a crises** and **slows down recovery**;
- other types of human behaviour, such as **trend following** and **fear** makes these effects even stronger
- **policy makers** must take **boundedly rational heterogeneous expectations** into account to **manage** a complex economy
Thanks very much

- suggestions are more than welcome ...
- We need more research on complexity in economics and finance
  and a big science EU Flagship such as FuturICT
- ... not only for scientists, but also for policy makers