Central Bank Balance Sheet Policies Without Rational Expectations

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Discussion by Carlo Galli (University College London)

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The Paper

- CB balance sheet policies (QE & FX interventions)
  - Empirics: debated yet relevant effects on asset prices
  - Theory: policy is irrelevant in a frictionless world (Wallace (1981))

- Friction: bounded rationality (level-k thinking)

- Main results:
  1. Level-k thinking makes policy relevant, in various settings
  2. Generates forecast errors related to policy $\rightarrow$ consistent with data

Discussion Points

- Bounded rationality: what is level-k thinking?

- Asset pricing application $\rightarrow$ 2 questions to be asked
  1. Micro: how does it work, what do we learn?
  2. Macro: is the application appropriate?

Level-k Thinking in Beauty Contests

- Nash equilibrium implies
  - agents have a high degree of rationality
  - agents assume others have a high degree of rationality
- Many experimental results violate this

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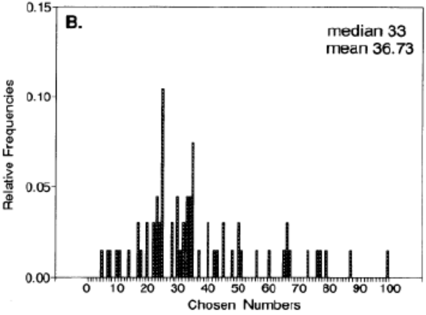
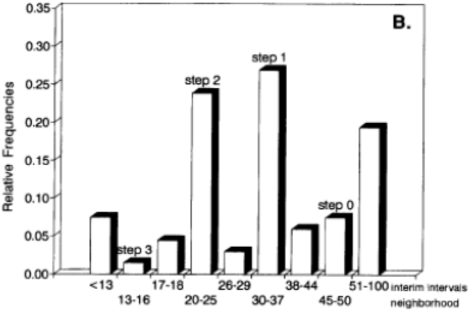
p-Beauty Contest game

- N players, each picks a number $s_i \in \{1, 2, ..., 100\}$
- closest to $p \times \frac{\sum_i s_i}{N}$ wins, with $p \in (0, 1)$
- iterated deletion of dominated strategies:
  1. even if all play 100, I should guess $p \times 100$
  2. if all play $p \times 100$, I should guess $p^2 \times 100$
  3. and so on... $\rightarrow$ Nash Eqm is 1

p=2/3 Beauty Contest Game





Nagel (1995)

- if people play at (uniform) random → 50 (level-0, non-strategic)
- if people best-respond to level-0 → 33 (level-1)
- if people best-respond to level-1 → 22 (level-2)
- and so on...

Asset Prices and Balance Sheet Policies

Infinite horizon $t = 1, 2, \ldots$

Markets

- risky asset, pays $r^x_{t+1} \sim N(r^x, \sigma^2)$ each period, fixed supply $\bar{X}$
- risk-free asset in infinite supply with gross return R

Agents

- have CARA utility $U(c_{t+1}) = -e^{-\gamma c_{t+1}}$
- OLG, agents live 2 periods, born with (w), consume only when old

$$c_{t+1} - wR = \underbrace{(r^x_{t+1} + q_{t+1} - q_t R)}_{\mathcal{R}_{t+1}} x_{t+1} - T_{t+1}$$

Government

- finances risky-asset purchases with risk-free debt $\rightarrow B_{t+1} = q_t X^G_{t+1}$
- transfers profits to *old* agents

$$-T_{t+1} = \mathcal{R}_{t+1} X^G_{t+1}$$

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Rational Expectations Equilibrium

- CARA-Normal ⇒ mean-variance maximization

$$x_{t+1} = \frac{E_t(\mathcal{R}_{t+1})}{\gamma \text{Var}(\mathcal{R}_{t+1})} - X^G_{t+1} \quad \rightarrow \quad q^{REE}_t = \left(q^{REE}_{t+1} + r^x - \gamma\sigma^2\bar{X}\right)/R$$

- REE price is present expected value of risk-adjusted dividends,

$$q^{REE} = \frac{r^x - \gamma\sigma^2\bar{X}}{R-1}$$

- $q^{REE} \perp \{X^G_t\}_{t\geq 0}$: QE crowds out private investment

Temporary Equilibria, 1-period QE ($X_3 > 0$)

- Status-quo: no QE ($T_t = 0, X_t^G = 0 \ \forall t$)
- At $t = 0$, one-period QE announcement: $X_3^G > 0 \rightarrow T_3 = -\mathcal{R}_3 X_3^G$
  - policy is known to all k-types

($\mathbf{k = 1}$)

- **agents' beliefs = status-quo eqm distribution**
- $\tilde{E}_t^{k=1}(q_{t+1}) = q_{t+1}^{REE}$, still $T_3 = 0$
- asset demand in $t = 2$

$$x_3^{k=1} = \frac{\tilde{E}_t^{k=1}(\mathcal{R}_3)}{\gamma \mathrm{Var}(\mathcal{R}_3)}$$

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- $k = 1$ temporary eqm prices

$$q_2^{k=1} = \frac{q^{REE} + r^x - \gamma\sigma^2(\bar{X} - X_3^G)}{R} = q^{REE} + \frac{\gamma\sigma^2 X_3^G}{R}$$
$$q_{t<2}^{k=1} = q^{REE}$$

Temporary Equilibria, 1-period QE ($X_3 > 0$)

$(\mathbf{k} = \mathbf{2})$

- **agents beliefs = eqm distribution if everyone is $(\mathbf{k} = \mathbf{1})$**
- $\tilde{E}_1^{k=2}(q_2) = q_2^{k=1}$
- understand taxes are risky:

$$T_3 = -\mathcal{R}_3^{k=1} X_3^G, \quad x_3^{k=2} = \frac{\tilde{E}_t^{k=1}(\mathcal{R}_3)}{\gamma \text{Var}(\mathcal{R}_3)} - X_3^G$$

- $k = 2$ temporary eqm prices

$$q_2^{k=2} = q^{REE} \qquad \perp X_3^G$$

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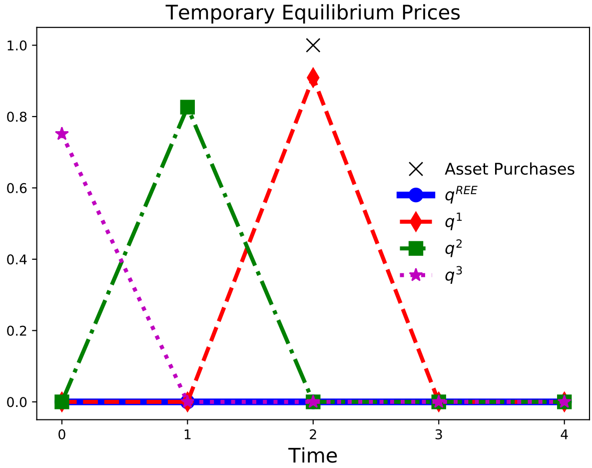
$$q_2^{k=2} = q^{REE} \qquad \perp X_3^G$$

$$q_1^{k=2} = \frac{q_2^{k=1} + r^x - \gamma\sigma^2 \bar{X}}{R} = q^{REE} + \frac{\gamma\sigma^2 X_3^G}{R^2}$$

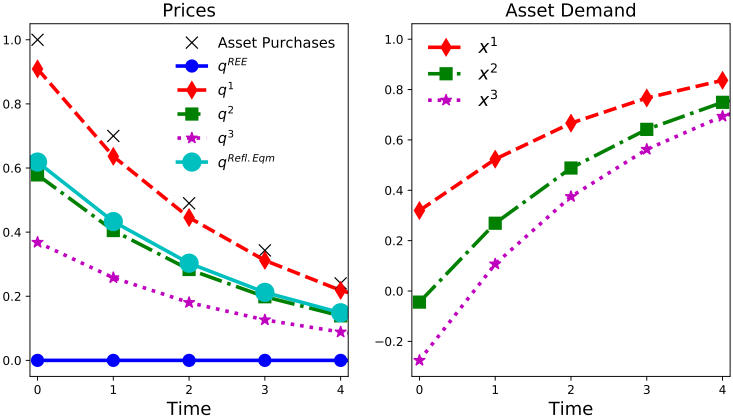
Temporary Equilibria, 1-period QE ($X_3 > 0$)

To simplify, let risk-adjusted expected dividend $(r^x - \gamma\sigma^2\bar{X}) = 0$

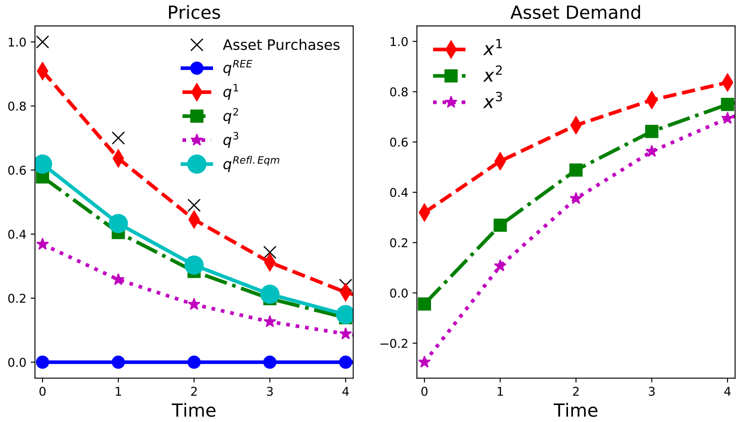


$\Rightarrow$ **$\mathbf{t = 0}$ effect of $\mathbf{X_t^G}$ only for $\mathbf{k = t}$ agents**

Reflective Equilibrium, multi-period QE ($X_t = \delta^{t-1}$)



Discussion



Comments

1. **k-type distribution assumed constant over time**. What if k-types are long-lived?
   - lower $k \rightarrow$ largest positions/risks
   - with exit, mass $\uparrow$ and QE effect weaker $\approx$ effects of learning in paper

Discussion

2. **k believes everyone else is $\mathbf{k-1}$**: strong "illusory superiority"
   - what if agents know the type distribution?

3. **$\mathbf{k \geq 2}$ get $\mathbf{Cov(\mathcal{R}_{t+1}, T_{t+1})}$ perfectly**
   - no within-period QE effects for $k \geq 2$
   - $\neq$ Fahri and Werning (2016), Garcia-Schmidt and Woodford (2015)
   - **static beauty contest $\approx$ dynamic sequential trading?**

4. **Gov't agencies large players in mortgage market for decades**
   - are gov't balance sheet policies really novel for mkt participants?
   - Fieldhouse et al. (2018)

Bottomline

- Nice, clear, novel asset pricing application of level-k expectations

- Application hinges on restrictions *within* level-k thinking
  - results somewhat robust to learning and (some) rational agents

- Choice of bounded rationality/information friction
  - empirical justification from forecast errors seems right way to go