Financial Regulation

704B Macroeconomic Theory II
Lecture 12

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Motivation

- Financial sector is one of the most regulated industries in the economy
- It often takes the form of imposing an upper limit on risky investment or leverage
- Why do we need financial regulation? Why do private agents over-borrow or invest?
- Financial frictions imply agents under-borrow and invest relative to the first best…

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- Argument: Private agents over-borrow/invest relative to the second-best

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     - If I invest too much, I have to sell assets during a crisis
     - This lowers the asset price, redistributing from more productive to less
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  2. **Aggregate demand externality** (Farhi-Werning, 2016, Korinek-Simsek, 2016)
     - If I borrow too much, I have to deleverage more during crisis
     - This redistributes from borrowers to lenders, reducing agg. demand
     - I don't internalize such negative effects because I take agg. demand as given

Pecuniary Externality

Over-Simplified Version of Lorenzoni (2008)
based on Moore (2013), Kurlat (2021)

Environment

- Three periods, $t = 0,1,2$
- Two groups of agents: Entrepreneurs and households
- Entrepreneurs have initial endowment n, households have $\{e_t\}$ each period
- All agents have utility $U = c_0 + c_1 + c_2$
- Entrepreneurs can invest at $t = 0$
  - requires s units of maintenance cost per investment at $t = 1$ (liquidity shock)
  - returns $z > 1 + s$ units of consumption at $t = 2$ for each unsold capital
- Households can buy capital from entrepreneurs $t = 1$ at price q
  - returns $F(k) = k^\alpha$ units of consumption at $t = 2$, where $\alpha < 1$

Entrepreneur Problem

- No financial market
- The only way for entrepreneurs to finance $t = 1$ maintenance cost is to sell capital
- Entrepreneurs solve

$$
\begin{aligned}
\max_{c_0^e, c_1^e, c_2^e, k^e, \bar{k}} \quad & c_0^e + c_1^e + c_2^e \\
\text{s.t.} \quad & c_0^e + \bar{k} = n \\
& c_1^e + s\bar{k} = q(\bar{k} - k^e) \\
& c_2^e = z k^e \\
& c_t^e \geq 0
\end{aligned}
$$

Fire Sales

- Entrepreneur's value function at $t = 1$:

$$V(\bar{k}, q) = \max_{c_1^e, c_2^e, k^e} c_1^e + c_2^e$$

$$\text{s.t.} \quad c_1^e + s\bar{k} \leq q(\bar{k} - k^e)$$
$$c_2^e = zk^e$$

- Assume parameters are such that $z > q > s$

  $\Rightarrow$ optimal to carry capital as much as possible, $c_1^e = 0$

$$k^e = \frac{q - s}{q}\bar{k}, \quad k^h \equiv \bar{k} - k^e = \frac{s}{q}\bar{k} \tag{1}$$

- Pluging back,

$$V(\bar{k}, q) = \underbrace{\frac{z}{q}}_{\text{rate of return (>1)}} \underbrace{(q - s)\bar{k}}_{\text{net worth}}$$

Privately Optimal Investment

- Entrepreneur's optimal investment solves

$$\max_{c_0^e, \bar{k}} c_0^e + V(\bar{k}, q)$$

$$c_0^e + \bar{k} = n$$

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Privately Optimal Investment

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$$\max_{c_0^e, \bar{k}} c_0^e + V(\bar{k}, q) \quad \frac{z}{q}(q - s)\bar{k}$$

$$c_0^e + \bar{k} = n$$

- Focus on interior solution (n large enough). In such equilibrium,

$$\frac{z}{q}(q - s) = 1$$

Household Problem

- Households solve

$$\max_{c_0^h, c_1^h, c_2^h, k^h} c_0^h + c_1^h + c_2^h$$

$$c_0^h = e_0$$

$$c_1^e + qk^h = e_1$$

$$c_2^h = e_2 + F(k^h)$$

$$c_t^h \geq 0$$

- Optimal demand for capital

$$F'(k^h) = q \tag{2}$$

Equilibrium Investment

- Plug $k^h = \frac{s}{q}\bar{k}$ into (2), and define $q(\bar{k})$ as the solution to

$$q(\bar{k}) = F'\left(\frac{s}{q(\bar{k})}\bar{k}\right) \quad \Leftrightarrow \quad q(\bar{k}) = (s\bar{k})^{\frac{\alpha-1}{\alpha}}$$

- Note $q'(\bar{k}) < 0$:
  - More initial investment leads to more file sales at $t = 1$
  - This lowers asset price, which lowers net worth of entrepreneurs
  - Then entrepreneurs have to sell even more to finance maintenance at $t = 1$
- Plugging into (1), equilibrium investment $\bar{k}$ solves

$$\frac{z}{q(\bar{k})}(q(\bar{k}) - s) = 1$$

Constrained Planner's Problem

- Suppose the planner could regulate the amount of investment
- But takes the financial frictions (no financial market) as given
  - Unrealistic and uninteresting to think the government can complete the market
- Would the planner choose the same $\bar{k}$ as the equilibrium?
- We look for constrained efficient allocation (as in search model)
- Implementation: tax on investment + lump-sum transfer

Socially Optimal Investment

- Welfare (total consumption) for given $\bar{k}$:

$$W(\bar{k}) \equiv -\bar{k} + \frac{z}{q(\bar{k})}(q(\bar{k}) - s)\bar{k} - q(\bar{k})\frac{s}{q(\bar{k})}\bar{k} + F\left(\frac{s}{q(\bar{k})}\bar{k}\right) + \text{constant}$$

where $q(\bar{k}) = (s\bar{k})^{\frac{\alpha-1}{\alpha}}$

- The planner takes into account how investment affects prices (private agents didn't)
- Around the equilibrium,

$$\frac{dW(\bar{k})}{d\bar{k}} = \underbrace{\frac{z}{q(\bar{k})}(q(\bar{k}) - s) - 1}_{=0} + \underbrace{\frac{sq'(\bar{k})}{q(\bar{k})}\bar{k}\left(\frac{z}{q(\bar{k})} - 1\right)}_{<0} < 0$$

Over Investment

Over-Investment through Pecuniary Externality (Lorenzoni, 2008)

In equilibrium, private agents over-invest relative to constrained efficient allocation.

- Why? By reducing investment, the planner reduces fire sales, raising asset price q
- This redistributes wealth from households to entrepreneurs at $t = 1$
- But why does this improve welfare? Entrepreneurs value wealth more!
  - entrepreneurs' marginal value of wealth: $z/q > 1$
  - households' marginal value of wealth: 1
- In equilibrium, private agents take prices as given.
- They cannot think "if we all invest less, it prevents fire sales, improve our net worth"

Aggregate Demand Externality

Simplified Version of Korinek and Simsek (2016) and Farhi and Werning (2016)

Environment

- Consider an environment similar to Eggertsson and Krugman (2012)
  - but with endogenous ex-ante borrowing decision at $t = 0$
- $t = 0,1,\ldots,\infty$. Potential output $\bar{Y}$ in each period
- Two equal mass of households: patient (discount factor β^h) and impatient (β^l)

$$\sum_{t=0}^{\infty} (\beta^i)^t \ln(c_t^i)$$

- All agents have no existing debt at the start of $t = 0$ can borrow freely:

$$c_0^i = Y_0 + b_0^i$$

- For $t \geq 1$, borrowing limit of ϕ:

$$c_t^i = Y_t + b_t^i - (1 + r_{t-1}) b_{t-1}^i, \quad (1 + r_t) b_t^i \leq \phi$$

Ex-Post Equilibrium

- Solve equilibrium backward. Assume ϕ low enough so that it binds for $t \geq 1$

- Assume the economy is in a steady state with flexible price $Y_t = \bar{Y}$ for $t \geq 2$
  - From Euler of patient households, $(1+\bar{r}) = 1/\beta^h$
  - From the budget constraint of impatient households:
$$\bar{c}^l = \bar{Y} - \bar{r}\phi/(1+\bar{r})$$
  - From the market clearing,
$$\bar{c}^h = \bar{Y} + \bar{r}\phi/(1+\bar{r})$$

- Solve for $t = 1$ eqm given $(1+r_0)b_0^h = -(1+r_0)b_0^l$
  - Impatient household's consumption from the budget constraint:
$$c_1^l = Y_1 + \phi/(1+r_1) - (1+r_0)b_0$$
  - Patient household's consumption from Euler:
$$c_1^h = \frac{1}{\beta^h(1+r_1)}\bar{c}^h$$

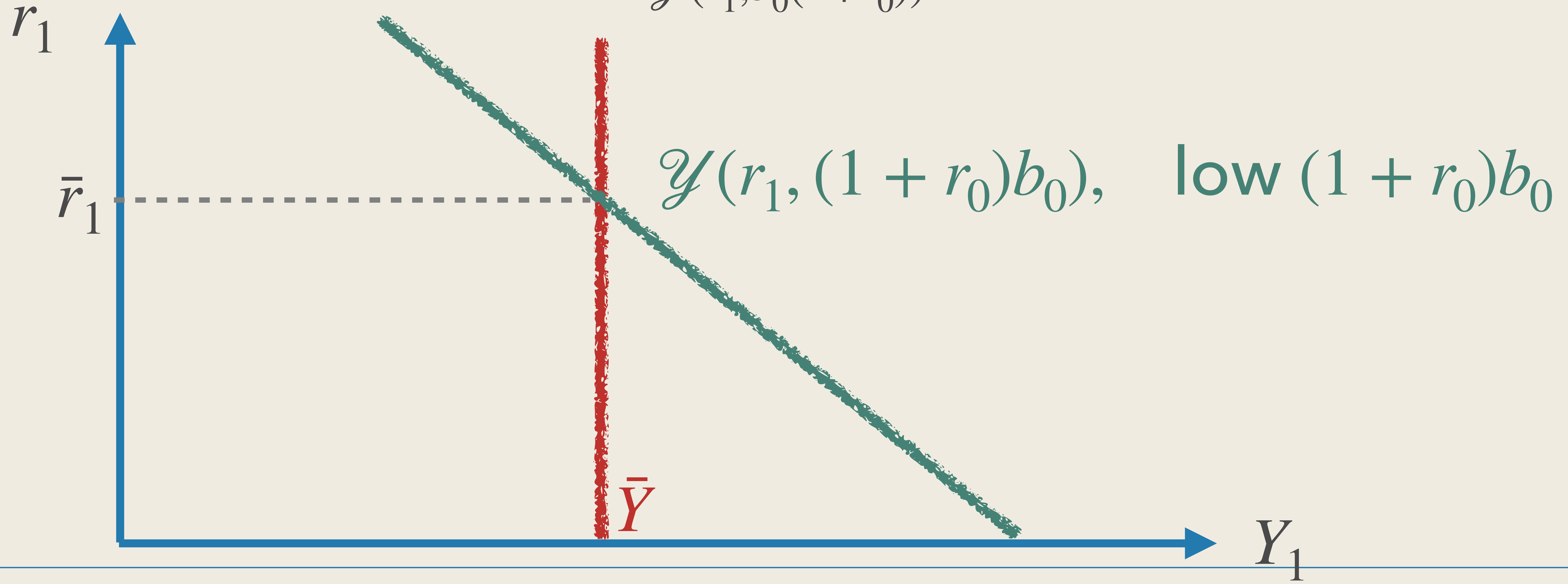
More Ex-Ante Debt Recession ⇒ Recession

- The goods market clearing at $t = 1$, $Y_1 = \frac{1}{2}c_1^h + \frac{1}{2}c_1^l$, implies

$$Y_1 = \frac{1}{2}\frac{1}{\beta^h(1+r_1)}\bar{c}^h + \frac{1}{2}\left(Y_1 + \phi\frac{1}{1+r_1} - (1+r_0)b_0\right)$$

- Solving for Y_1:

$$Y_1 = \underbrace{\frac{1}{\beta^h(1+r_1)}\bar{c}^h + \frac{\phi}{1+r_1} - (1+r_0)b_0}_{\mathcal{Y}(r_1, b_0(1+r_0))}$$



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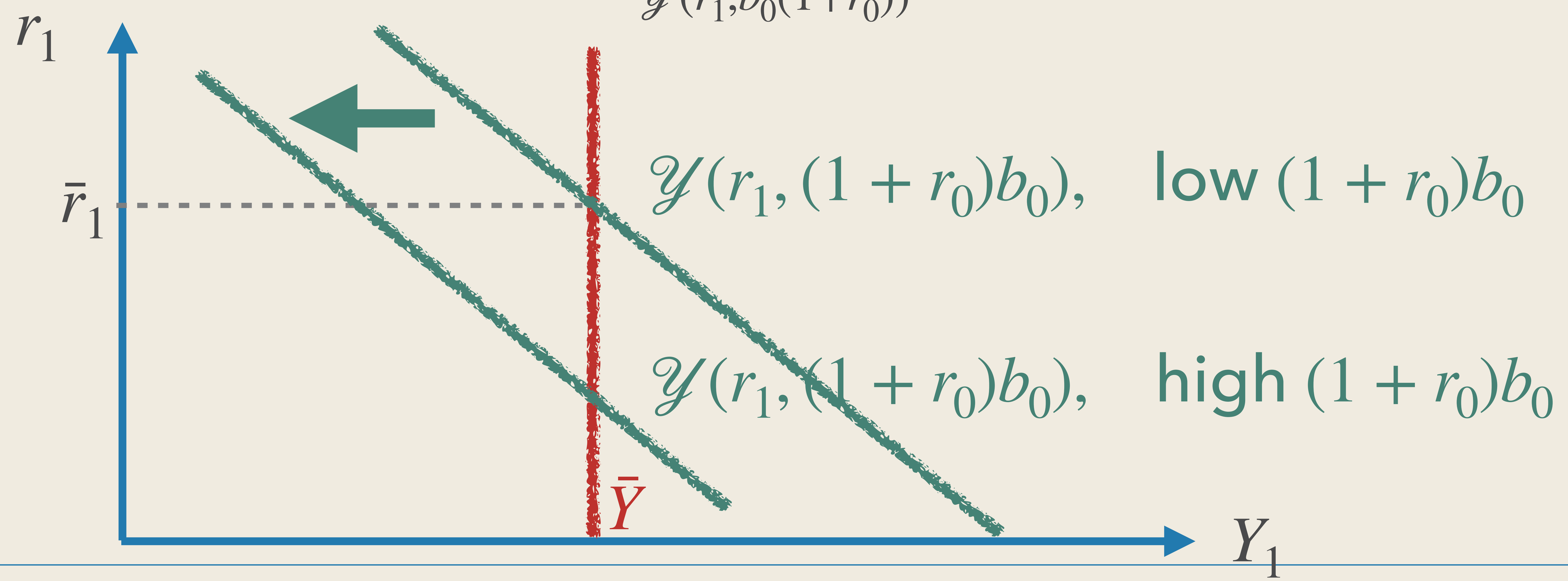

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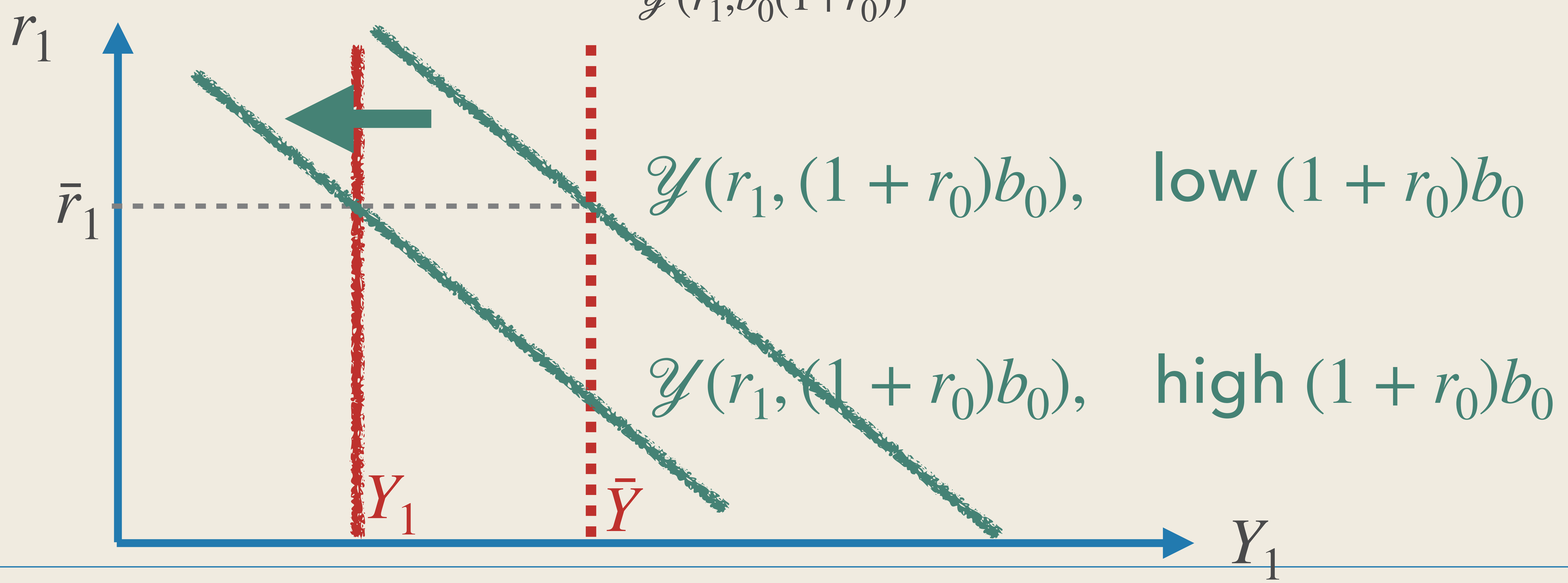

Ex-Ante Equilibrium

- Since there's no borrowing constraint at $t = 0$, Euler holds for both types:

$$u'(c_0^h) = \beta(1 + r_0)u'(c_1^h)$$

$$u'(c_0^l) = \beta(1 + r_0)u'(c_1^l)$$

- Combining equilibrium borrowing/lending at $t = 0$ satisfies

$$\frac{\beta^h u'(c_1^h)}{u'(c_0^h)} = \frac{\beta^l u'(c_1^l)}{u'(c_0^l)}$$

$$c_0^h + c_0^l = Y_0$$

Constrained Efficiency

- Suppose the planner cannot do anything after $t \geq 1$
- But the planner can impose the borrowing limit at $t = 0$: $(1 + r_0)b_0 \leq \phi_0$
- Also allow lump-sum transfer between h and l at $t = 0$.
- Would the planner want to intervene by imposing a binding debt limit?

Planner's Problem

- Welfare for a given ϕ_0

$$W(\phi_0) = \max_{c_0^h, c_1^h, c_0^l, c_1^l} \lambda^h \left[u(c_0^h) + \beta^h u(c_1^h) + (\beta^h)^2 \bar{V}_2^h\right] + \lambda^l \left[u(c_0^l) + \beta^l u(c_1^l) + (\beta^l)^2 \bar{V}_2^l\right]$$

subject to

$$c_0^h + c_0^l = Y_0$$

$$c_1^l = Y_1 + \phi - \phi_0$$

$$c_1^h = Y_1 - \phi + \phi_0$$

$$Y_1 = \mathcal{Y}(\bar{r}_1, \phi_0)$$

Planner's Problem

- Welfare for a given ϕ_0

Continuation value after $t = 2$ (independent of ϕ_0)

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- Around the equilibrium,

$$\frac{dW(\phi_0)}{d\phi_0} = \underbrace{-\frac{\beta^l u'(c_1^l)}{u'(c_0^l)} + \frac{\beta^h u'(c_1^h)}{u'(c_0^h)}}_{=0} + \underbrace{\left(\beta^h \frac{u'(c_1^h)}{u'(c_0^h)} + \beta^l \frac{u'(c_1^l)}{u'(c_0^l)}\right) \frac{\partial \mathcal{Y}(\bar{r}_1, \phi_0)}{\partial \phi_0}}_{<0} < 0$$

Over Borrowing

Over-borrowing through Aggregate Demand Externality (Farhi & Werning, 2016, Korinek & Simsek, 2016)

In equilibrium, private agents over-borrow relative to constrained efficient allocation.

- Why? By reducing borrowing, it reduces repayment of impatient HHs at $t = 1$
- This redistributes wealth from low MPC to high MPC households at $t = 1$
- This improves welfare by raising agg. demand, increasing consumption and income
- But in equilibrium, private agents take aggregate demand as given
- They cannot think
  "if we all borrow less, we will increase our net worth, increase aggregate demand"