Market Power and Price Stickiness

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Imperfect Competition

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- Monopolistic competition: continuum of firms (Dixit-Stiglitz)
  - simple and tractable
  - reigns supreme: trade, macro, growth, …

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- Monopolistic competition: continuum of firms (Dixit-Stiglitz)
  - simple and tractable
  - reigns supreme: trade, macro, growth, …

- Oligopoly: finite number of firms
  - more realistic and complicated
  - extensive IO literature
  - "rise in market power": markups, concentration, superstar firms, …
- **Q:** Oligopoly important for macro and monetary policy?

This Paper

- Standard macro models…
  - representative agent, infinite horizon
  - consumption, labor and money
  - nominal rigidities a la Calvo

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- Standard macro models…
  - representative agent, infinite horizon
  - consumption, labor and money
  - nominal rigidities a la Calvo
- This paper
  - oligopoly with any *n* firms
  - general demand structure
    (e.g. Kimball, not just CES)

Setup

- Households: consumption, labor, money
- Firms: continuum of sectors s…
  - n_s firms within sector s
  - Calvo: frequency λ_s of price change

- One time, unanticipated "MIT shock" to money
- Start with **Markov equilibrium** ("Dynamic Oligopoly and Price Stickiness")

$$\int_0^\infty e^{-\rho t} U\left(C(t), L(t), \frac{M(t)}{P(t}\right) dt$$

$$C(t) = G(\{C_s(t)\}_s)$$

$$C_s(t) = H(c_{s,1}(t), c_{s,2}(t), \ldots, c_{s,n}(t))$$

(Golosov-Lucas)

$$\int_0^\infty e^{-\rho t} U\left(C(t), L(t), \frac{M(t)}{P(t}\right) dt$$

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$$C(t) = G(\{C_s(t)\}_s) \longrightarrow C(t) = \left(\int_S C_s(t)^{1-\frac{1}{\omega}} ds\right)^{\frac{1}{1-\frac{1}{\omega}}}$$

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(Kimball)

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$$P(t)C(t) + \dot{B}(t) + \dot{M}(t) = W(t)L(t) + \tilde{\Pi}(t) + T(t) + r(t)B(t)$$

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$$\mathbb{E}_0 \int_0^\infty e^{-\int_0^t r(s)ds} \widetilde{\Pi}^{i,s}(t) dt$$

$$\widetilde{\Pi}^{i,s}(t) = c_{i,s}(t)\left(p_{i,s}(t) - W(t)\right)$$

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Calvo pricing
Poisson arrival

$$\mathbb{E}_0 \int_0^\infty e^{-\int_0^t r(s)ds} \widetilde{\Pi}^{i,s}(t) dt \xrightarrow{\lambda_s}$$

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Calvo pricing
Poisson arrival
λ_s $\longrightarrow$

Reset strategy

$$p^*_{i,t} = g^{i,s}(p_{-i,s}; t)$$

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Calvo pricing
Poisson arrival
λ_s $\longrightarrow$

Reset strategy

$$p^*_{i,t} = g^{i,s}(\underbrace{p_{-i,s}}_{\{p_{j,s}\}_{j\neq i}}; t)$$

Equilibrium

$$\{C(t), L(t), M(t), P(t), W(t), r(t)\}$$

$$\{c_{i,s}(t), p_{i,s}(t)\}$$

$$\{g^{i,s}(p_{-i,s}; t)\}$$

- agents: $\{P(t), W(t), r(t)\} \xrightarrow{\text{max}} \{C(t), L(t), M(t)\}$
- firms: $\left.\begin{array}{l}\{C(t), P(t), W(t), r(t)\} \\ \{g^{-i,s}(\cdot; t)\}\end{array}\right\} \xrightarrow{\text{max}} g^{i,s}(p_{-i,s}; t)$
- market clearing:

$$L(t) = \int \sum_{n_s} c_{i,s}(t) ds$$

Steady State

- Constant C, L, M, P, W, r

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  - household optimization and market clearing

$$C = L$$

$$\frac{U_C}{P} = \frac{U_L}{W} = \frac{U_m}{rP}$$

$$r = \rho$$

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$$\rho V(p) = D^i(p)(p_i - W) + \lambda \sum_j \left[V\left(g\left(p_{-j}\right), p_{-j}\right) - V(p)\right]$$

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  - steady state price vector $P = g\left(P, P, \ldots, P\right)$

Money Shock

- Starting at steady state…

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- Starting at steady state…
- …unanticipated permanent shock to money…

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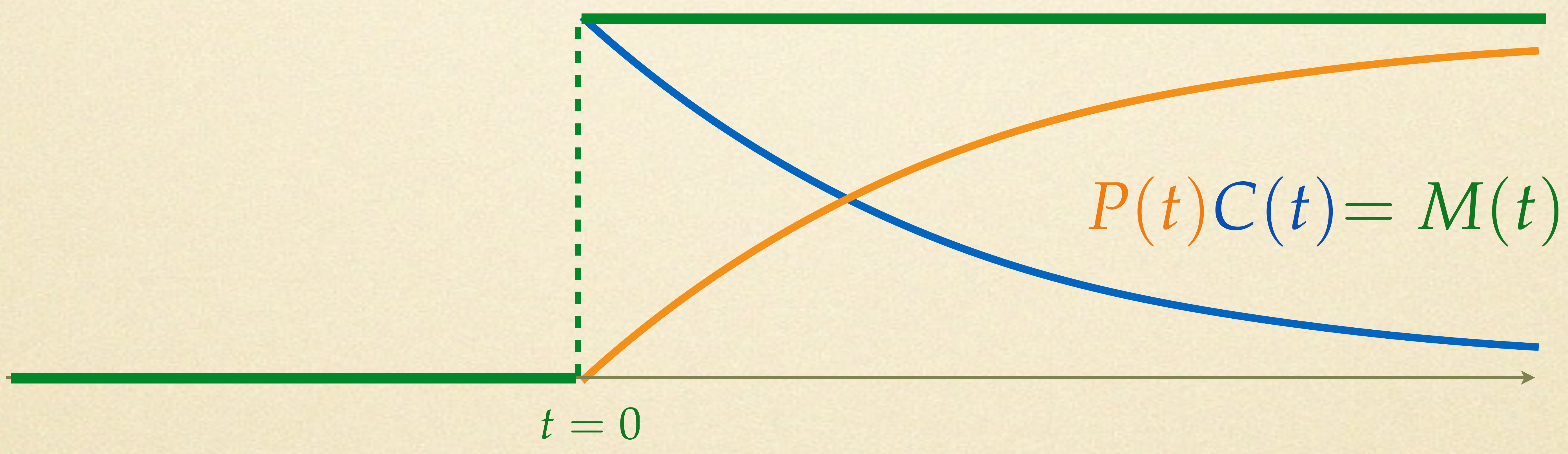

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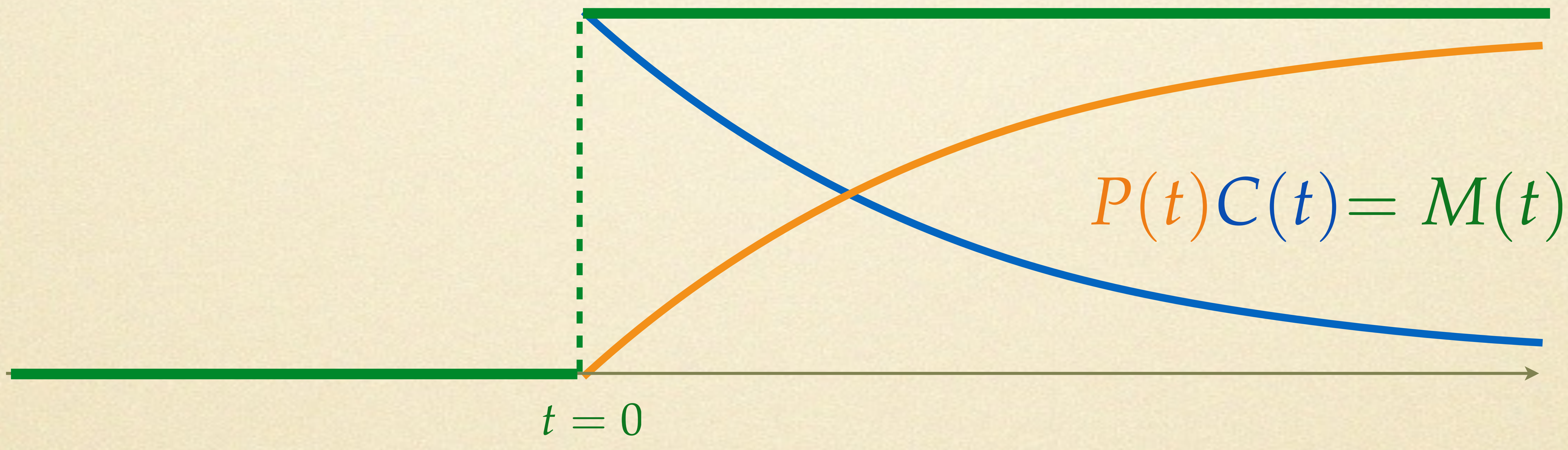

- Nominal interest rate unchanged…

$$r(t) = \rho$$

Money Shock

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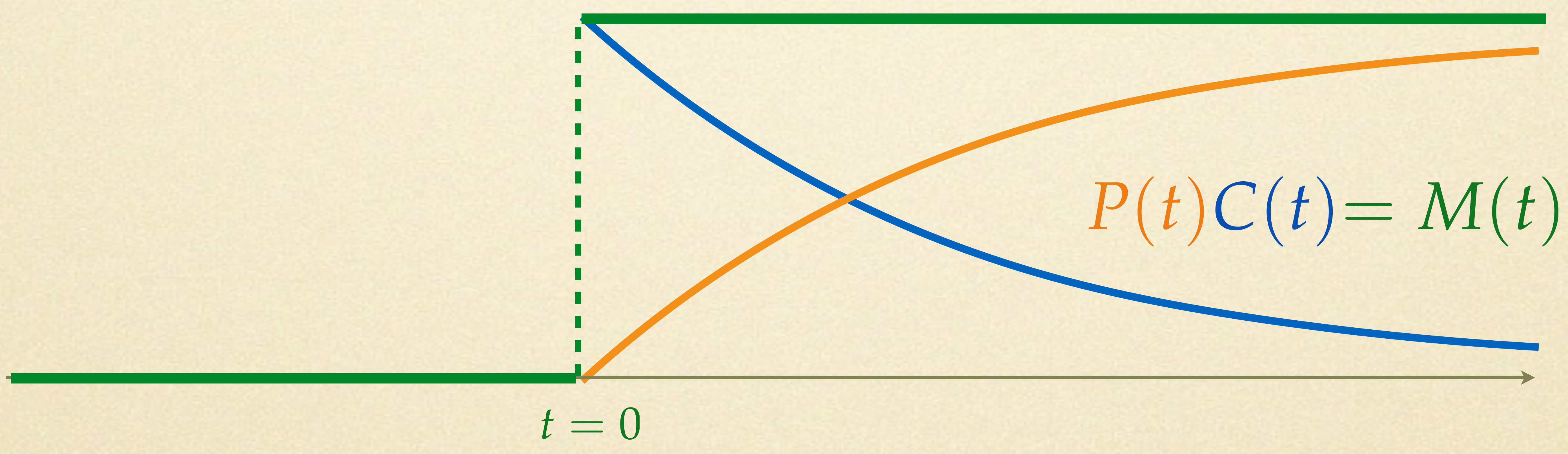


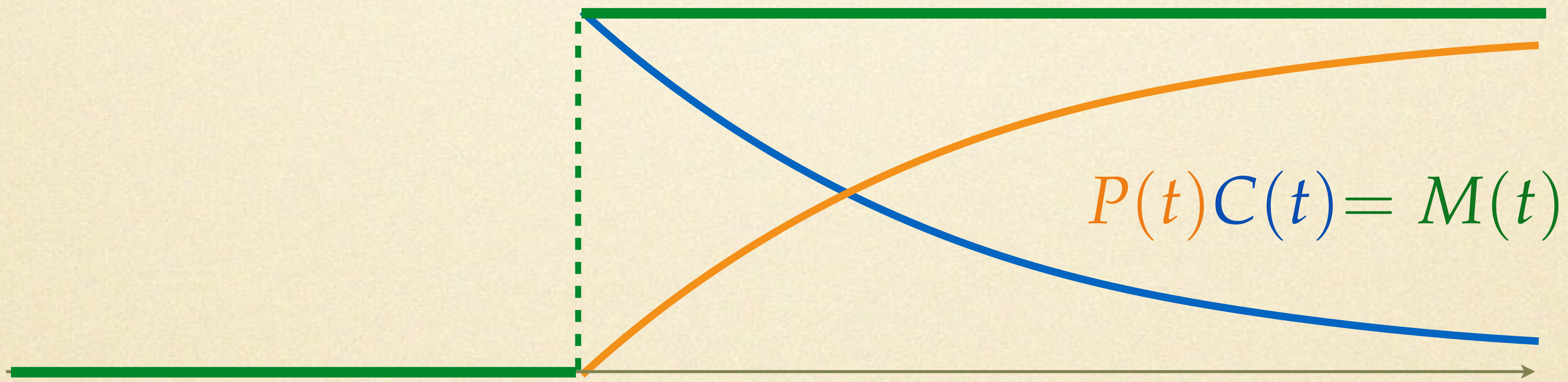
- Nominal interest rate unchanged…

$$r(t) = \rho$$

- Wage jumps to new level: $W = (1 + \delta)W_{-}$

Money Shock

- Starting at steady state…
- …unanticipated permanent shock to money…

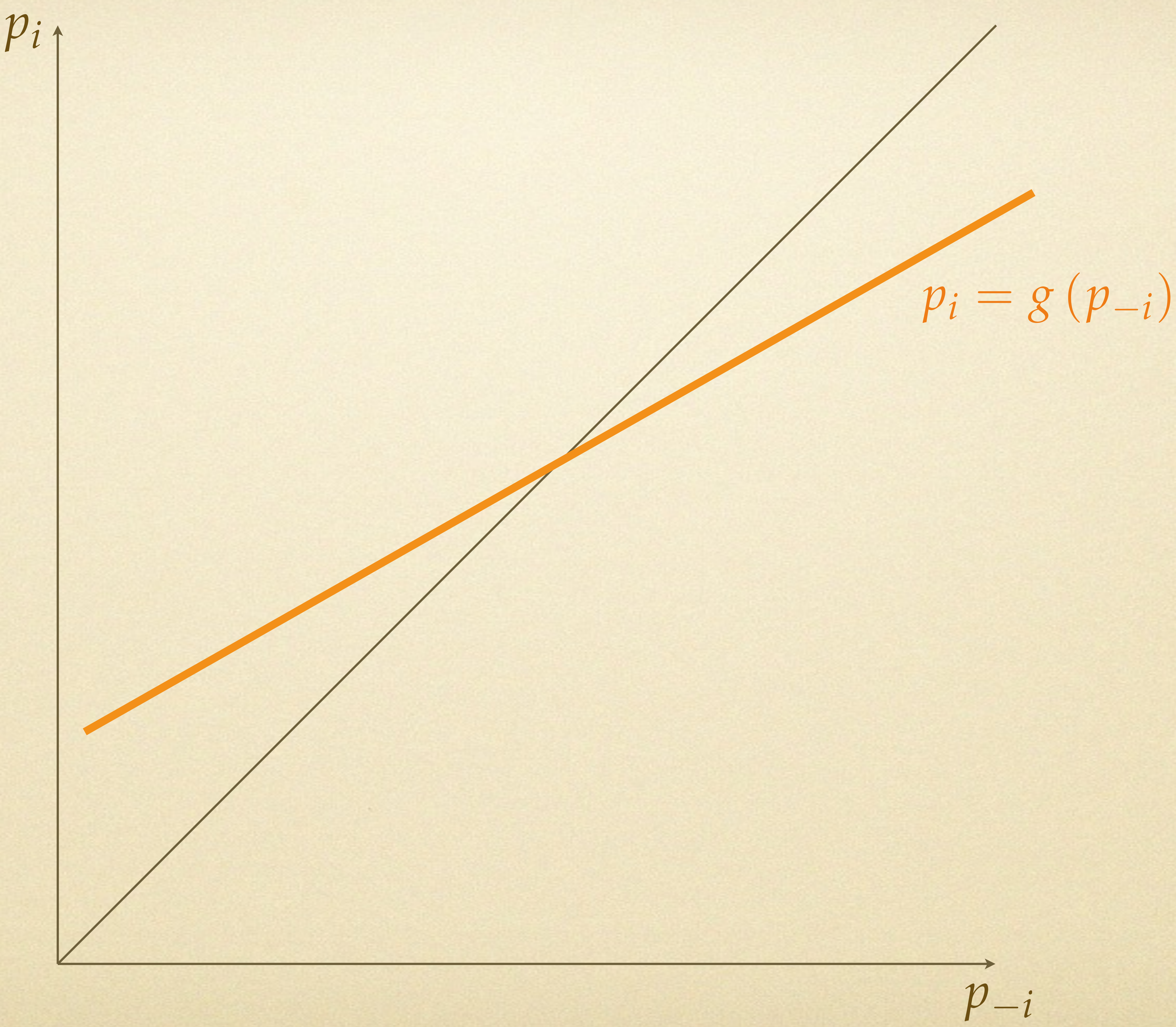


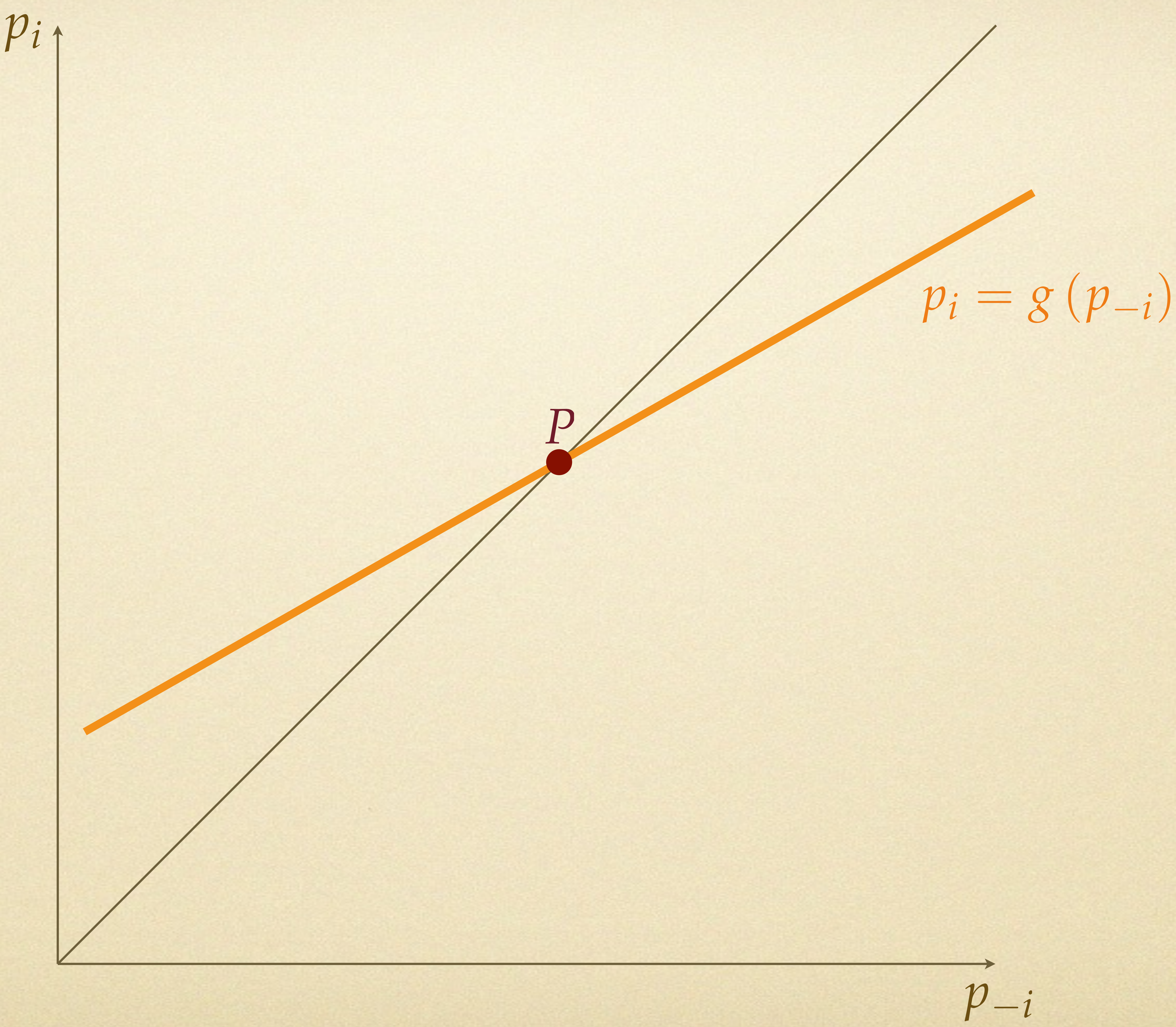
Result #1.

Equilibrium transition after shock δ satisfies steady-state policies…

$$\hat{p}_{i,s} = g\left(\hat{p}_{-i,s}\right)$$

with $\hat{p}_{i,s} = p_{i,s}/(1+\delta)$


p_i
$p_i = g\left(p_{-i}\right)$
p_{-i}



p_i
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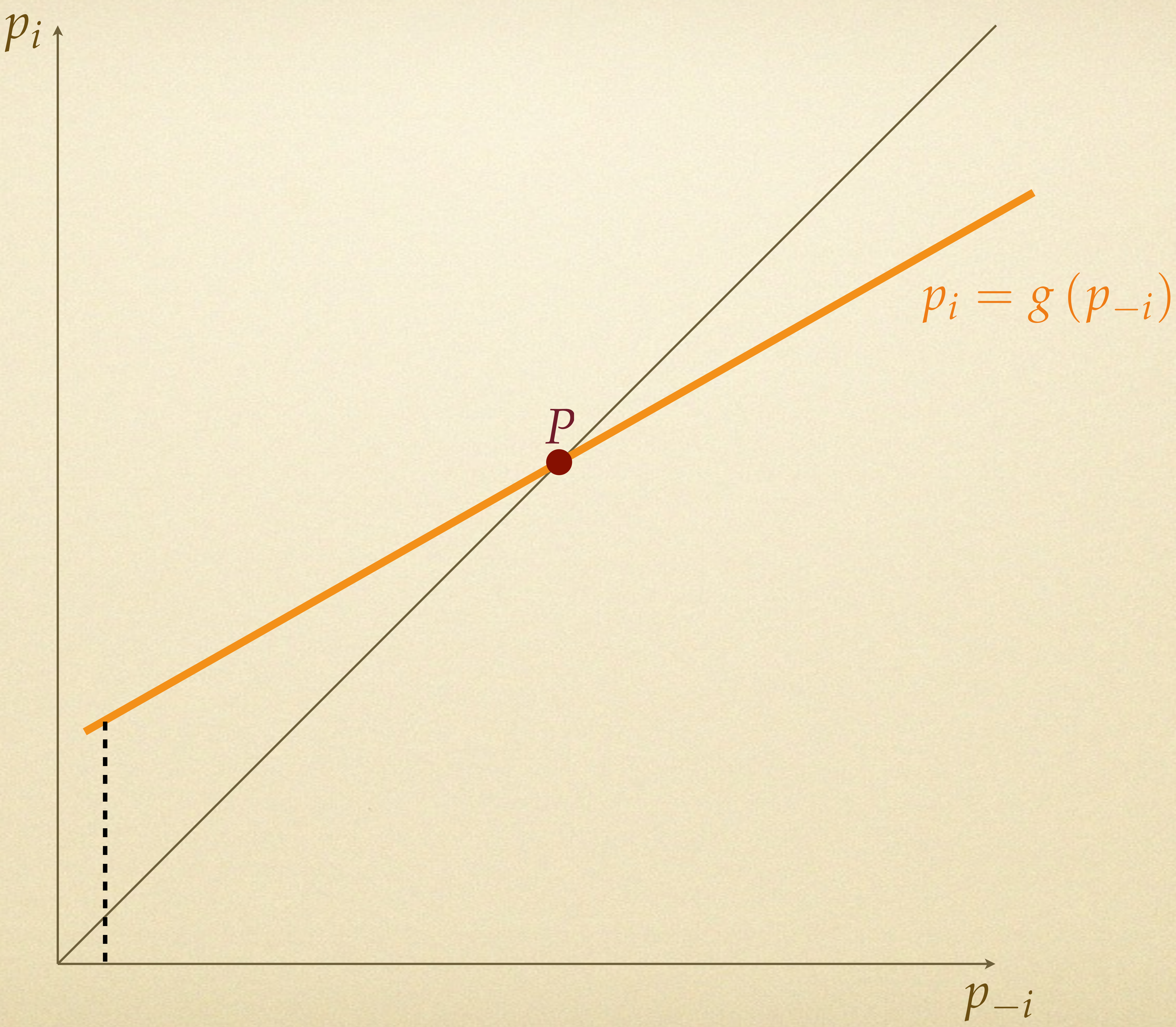
P
p_{-i}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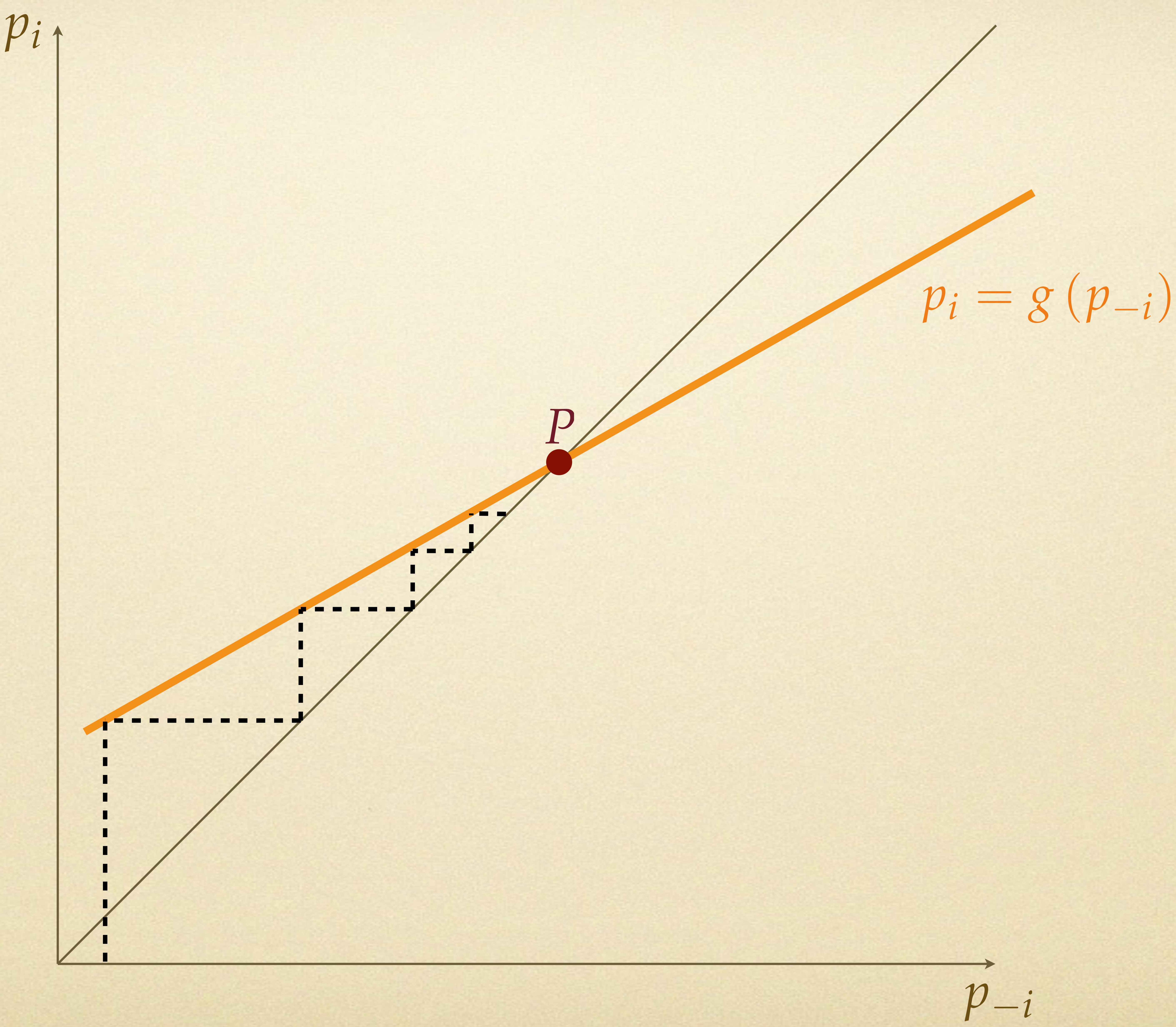
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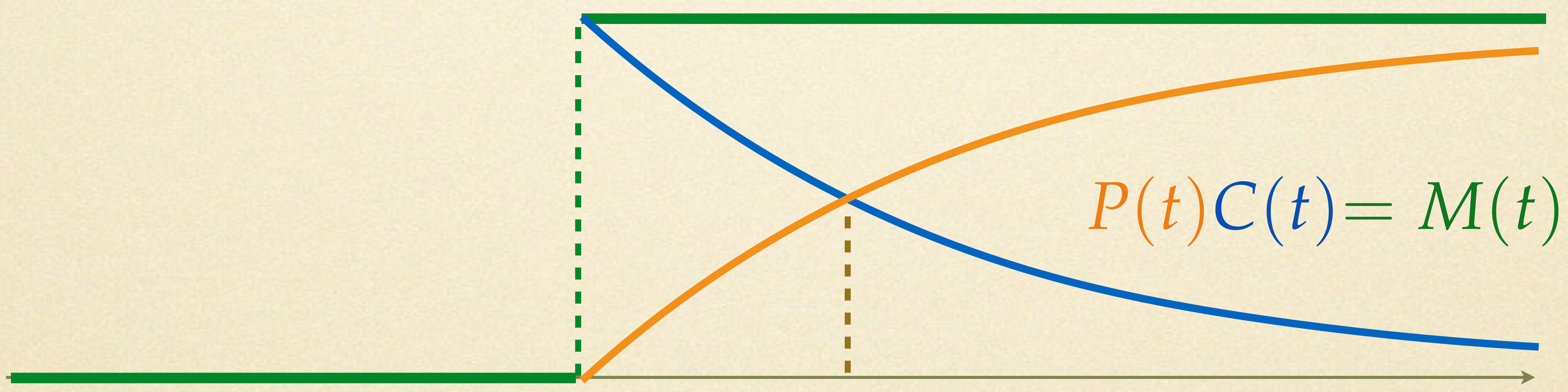
Money Shock

- Starting at steady state…
- …unanticipated permanent shock to money…

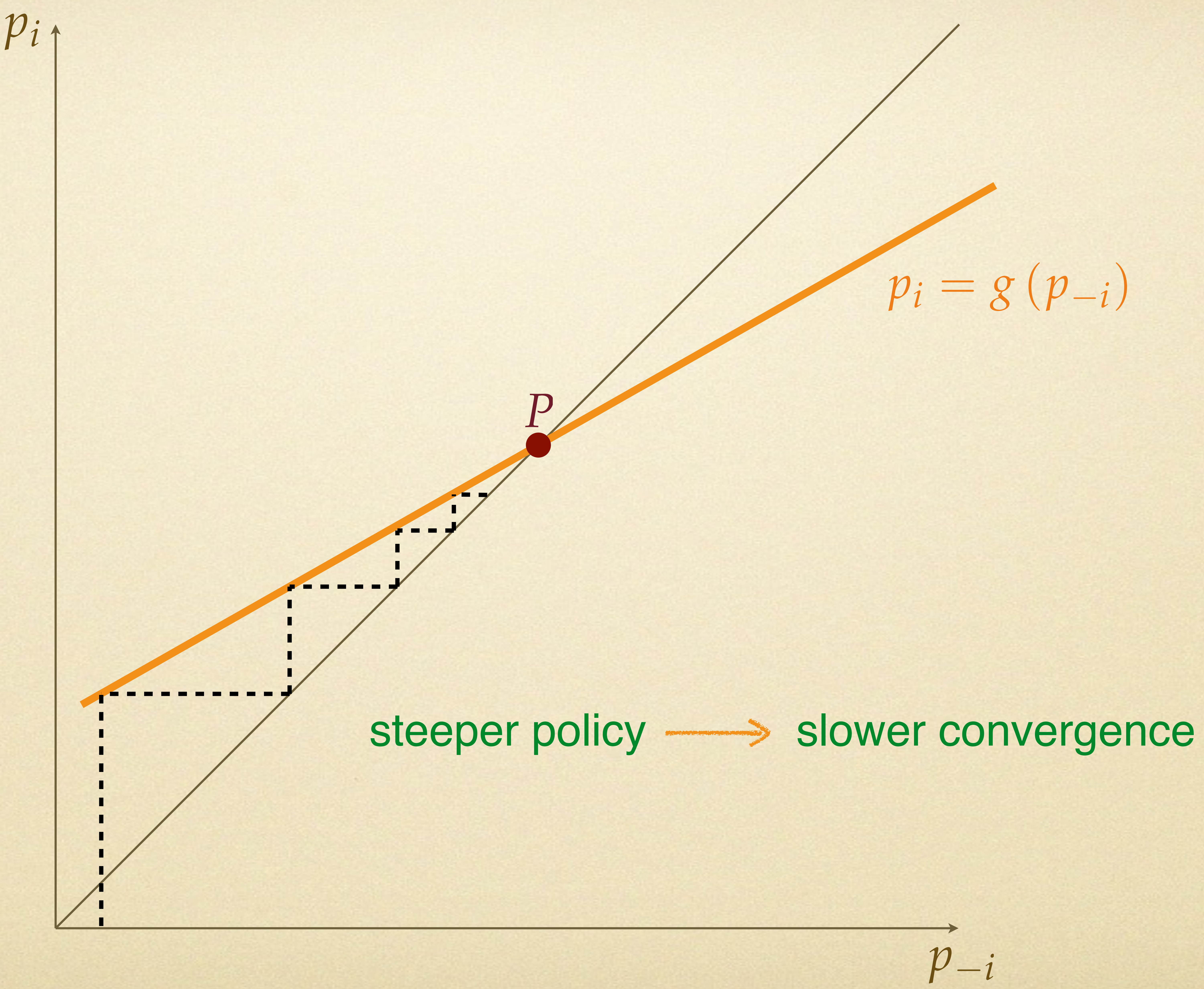


Result #2.

$$\log P(t) - \log \bar{P} = -\delta\ e^{-\lambda(1-B)t}$$

$$B = (n-1)\,\frac{\partial g^i}{\partial p_j}(\bar{p})$$

extensions: heterogeneous productivity / costs across and within sectors


p_i
P
$p_i = g(p_{-i})$
steeper policy ⟶ slower convergence
p_{-i}

Metrics for Stickiness

- Cumulative Output

$$\int_0^\infty e^{-rt} \log\left(\frac{C(t)}{\bar{C}}\right) dt = \delta \int_s \frac{\zeta_s ds}{r + \lambda_s \left(1 - B_s\right)}$$

- Half Life: $\log(2) \cdot h$

$$h = \frac{1}{\lambda(1 - B)}$$

- Phillips Curve?

$$\dot{\pi}(t) = \rho\pi(t) - \kappa\, mc(t)$$
$$\pi(t) = \kappa \int e^{-\rho s} mc(t + s) ds$$

Metrics for Stickiness

Result #3

After M shock

$$\longrightarrow \quad \dot{\pi}(t) = \rho\pi(t) - \kappa\, mc(t)$$

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Metrics for Stickiness

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$$\kappa \approx \frac{1}{h^2}$$

- Phillips Curve?

$$\dot{\pi}(t) = \rho\pi(t) - \kappa\, mc(t)$$

$$\pi(t) = \kappa \int e^{-\rho s} mc(t+s) ds$$

Sufficient Statistic

Result #4

$$B = \frac{1 + \frac{\rho}{\lambda}}{1 + \frac{1}{(n-1)[(\epsilon-1)(\mu-1)-1]}}$$

$$\mu = \frac{P}{W}$$

$$\epsilon = \frac{-\partial \log D^i}{\partial \log p_i}$$

Sufficient Statistic

Result #4

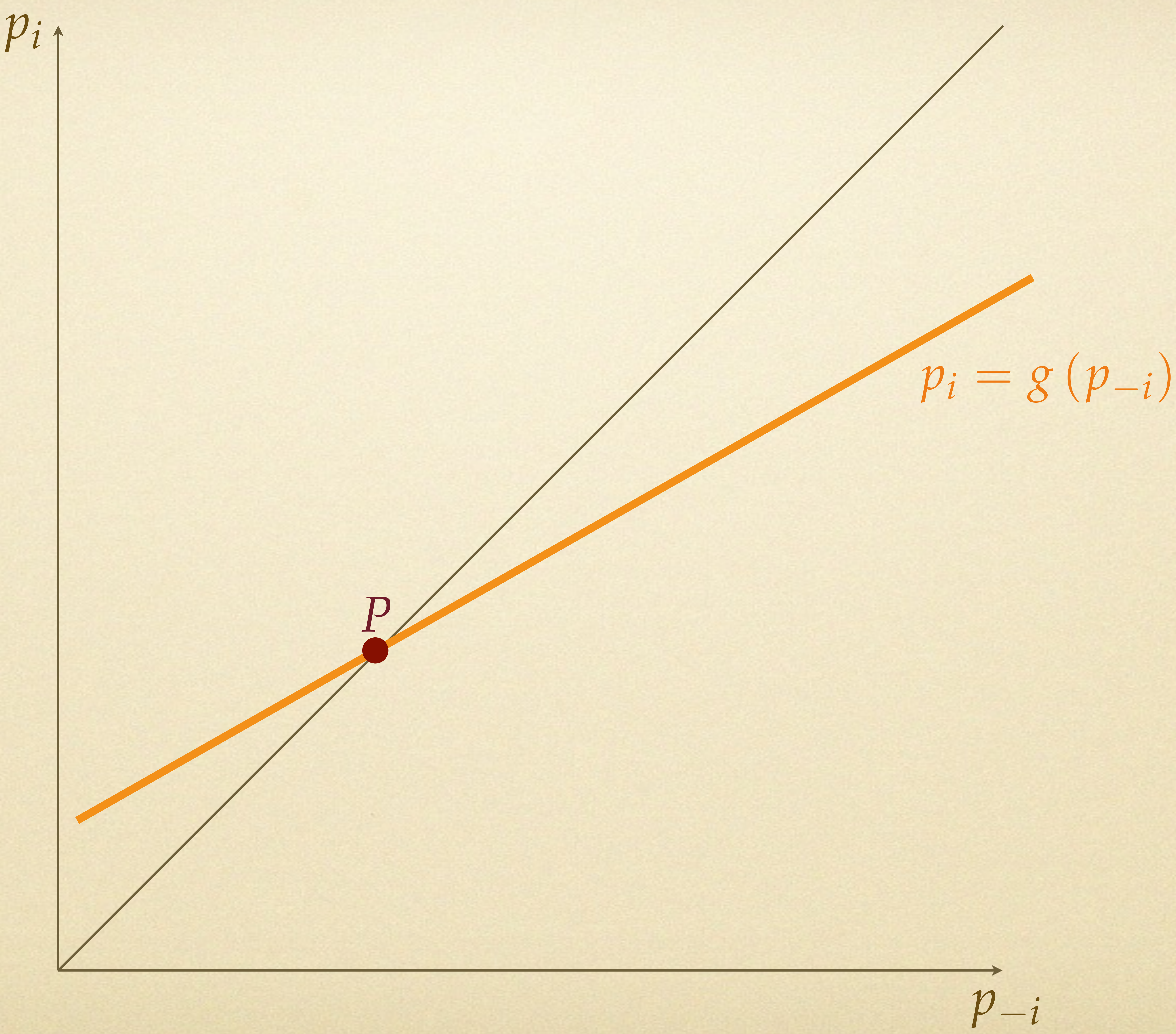
$$B = \frac{1+\frac{\rho}{\lambda}}{1+\frac{1}{(n-1)[(\epsilon-1)(\mu-1)-1]}}$$

$$\mu = \frac{P}{W}$$

$$\epsilon = \frac{-\partial \log D^i}{\partial \log p_i}$$

- Intuition… (reverse causality)
  - Nash markup ⟺ $B = 0$
  - higher markup ⟺ rivals mimic my price (high B)

$$\frac{\mu - 1}{\mu^{\text{Nash}} - 1} = 1 + \frac{1}{n-1} \cdot \frac{B}{1-B}$$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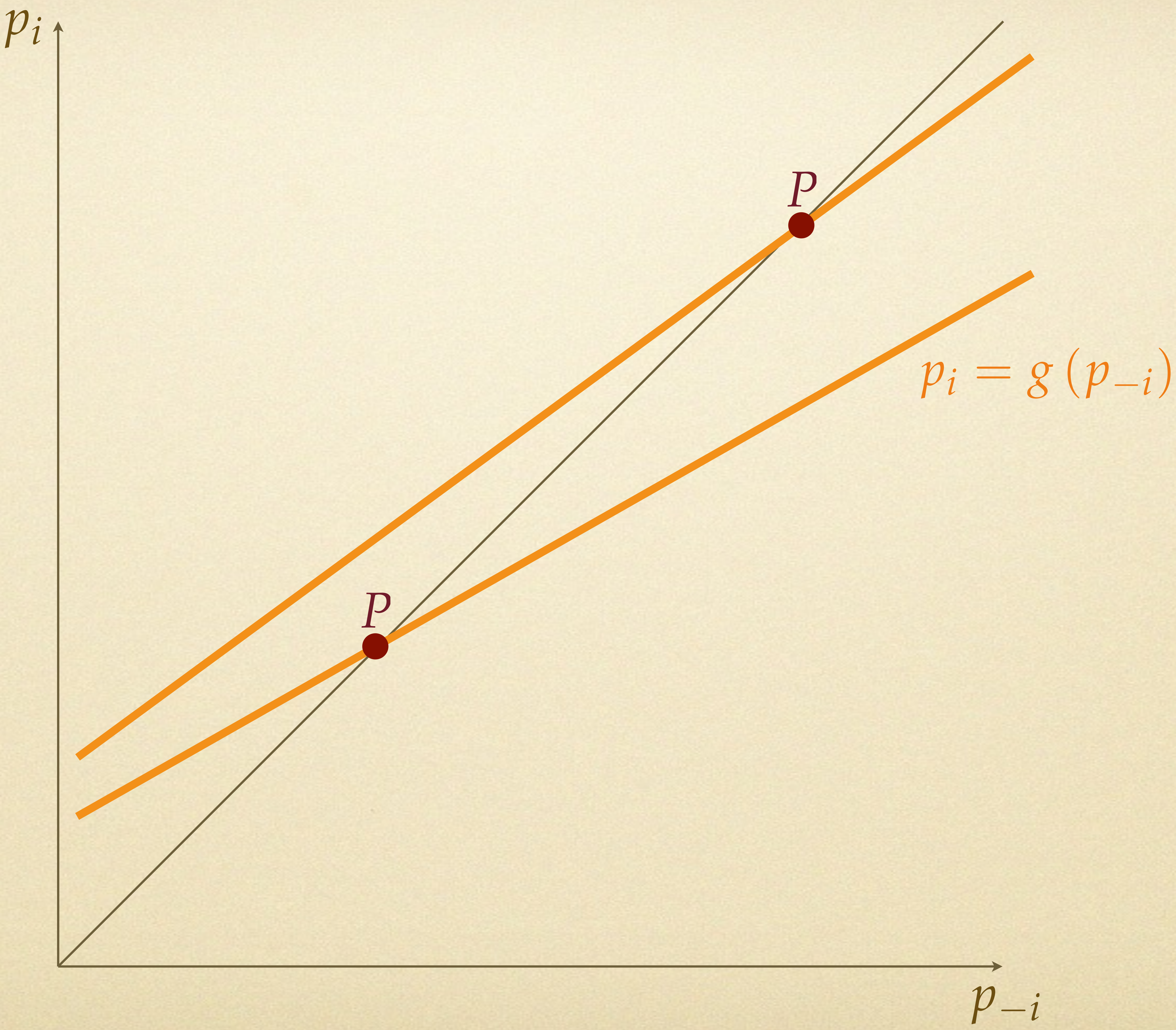
$p_i = g(p_{-i})$
P
p_{-i}



p_i
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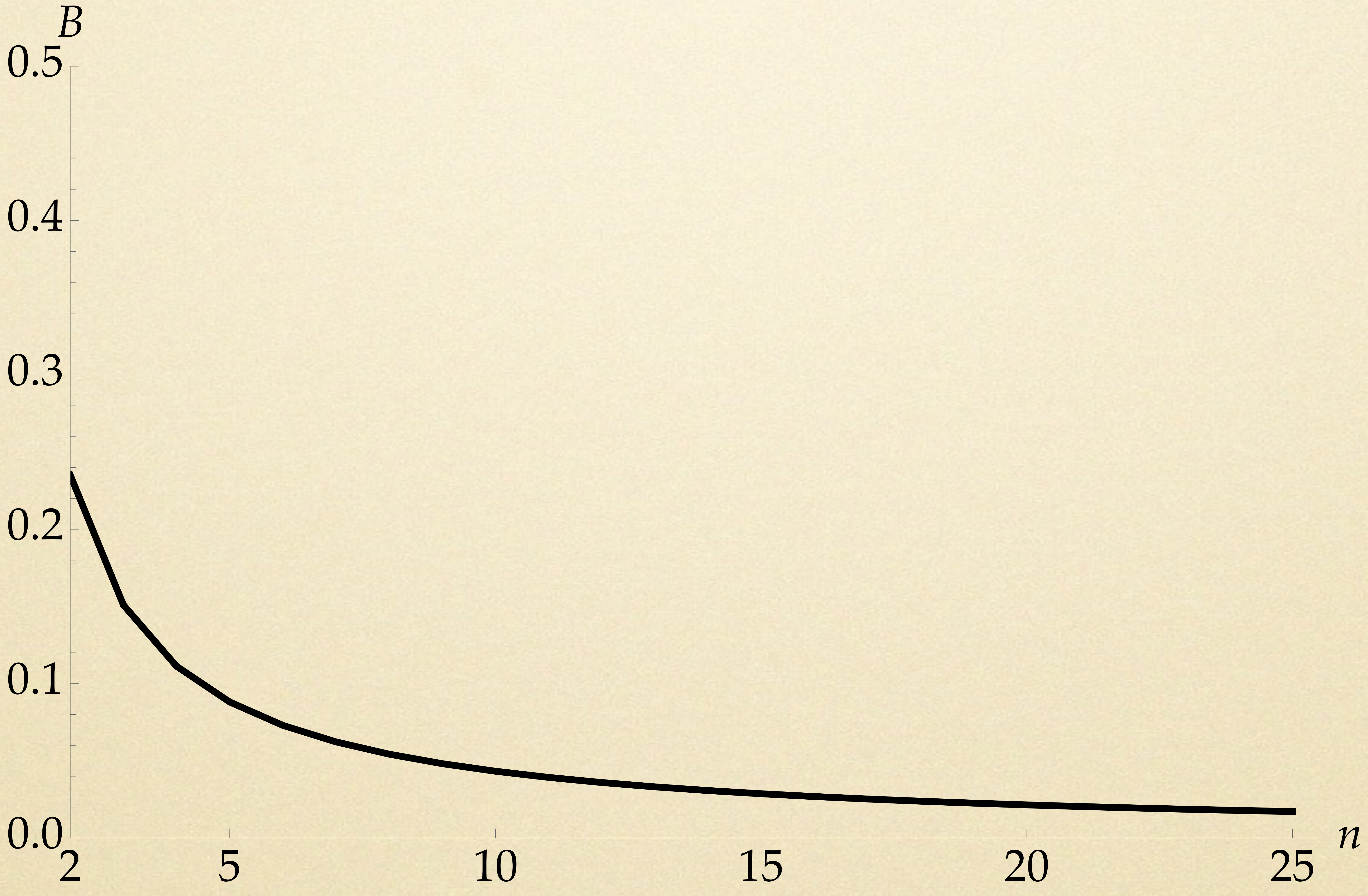
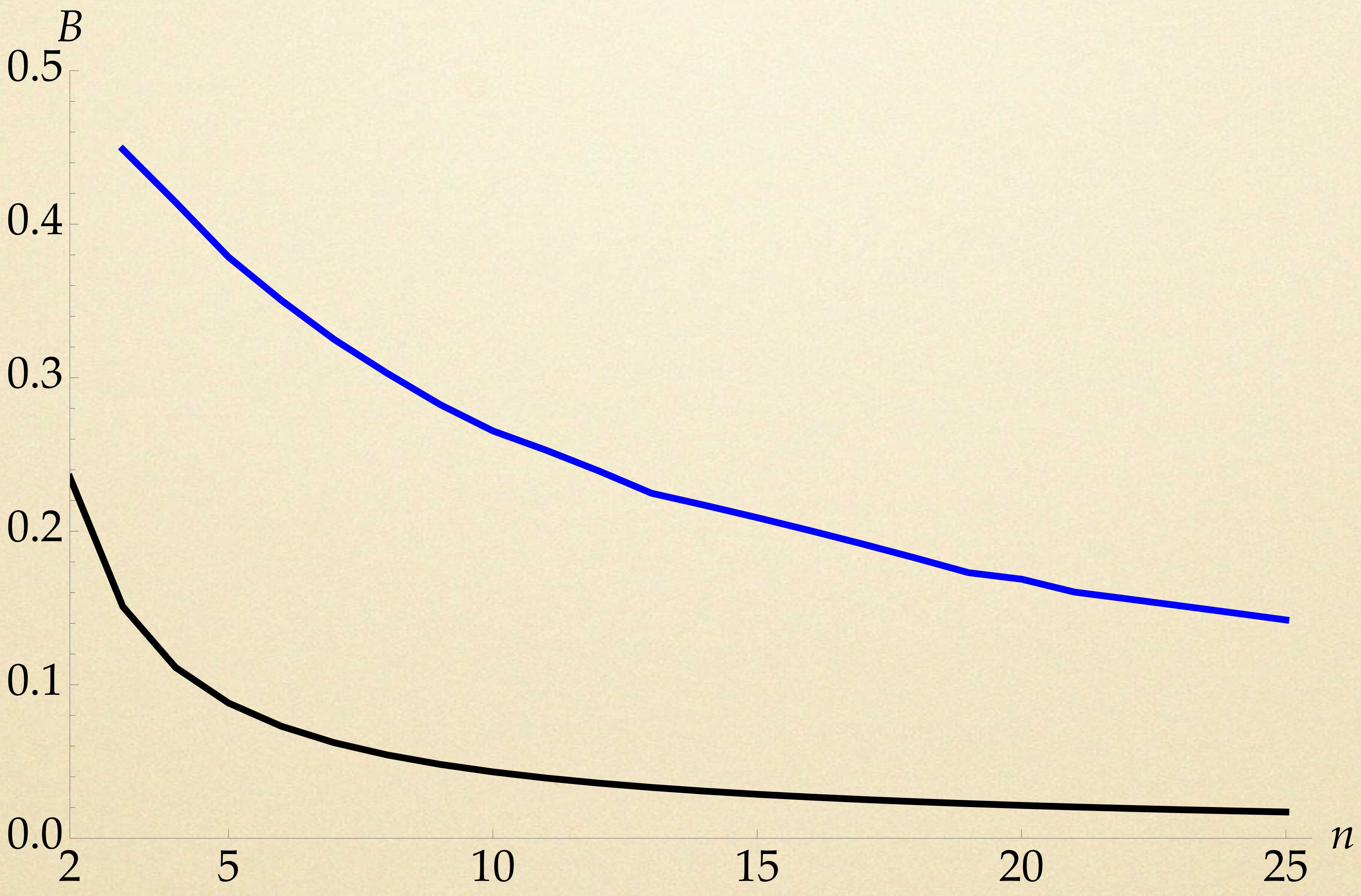
Slope B (CES)



CES vs pass-through data from Amiti et al. (2019)



Summary

- Results…

1. Oligopoly tractable!
2. Sufficient statistic formula
3. Comparative Statics in *n*:
   big amplification when calibrated to pass-through evidence
4. Decomposition: Strategic vs Kimball-like effects
5. Standard NK Phillips curve good fit

Ongoing Work: Non-Markov Equilibria

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  - Trigger strategies, Abreu-Pearce-Stachetti methods
  - **Today:** Perfect collusion (Folk theorem $\rho \to 0$)

Ongoing Work: Non-Markov Equilibria

- So far focus on Markov as in IO…
- Non-Markov equilibria?
  - Trigger strategies, Abreu-Pearce-Stachetti methods
  - **Today:** Perfect collusion (Folk theorem $\rho \to 0$)

- Finding:
  - Collusion leads to even more stickiness than Markov

Markov vs Collusion

- Markov

$$\rho V(p) = D^i(p)(p_i - W) + \lambda \sum_j \left[V\left(g\left(p_{-j}\right), p_{-j}\right) - V(p) \right]$$

$$g\left(p_{-i}\right) \in \arg\max_{p_i} V\left(p_i, p_{-i}\right)$$

- Collusion:

$$\rho V^c(p) = \sum_j D^j(p)(p_j - W) + \lambda \sum_j \left[V^c(g^c(p_{-j}, p_{-j}) - V^c(p) \right]$$

$$g^c(p_{-i}) \in \arg\max_{p_i} V^c(p_i, p_{-i})$$

g^c: equilibrium path of prices, NOT trigger strategies that sustain collusion

Slope under Collusion

Result

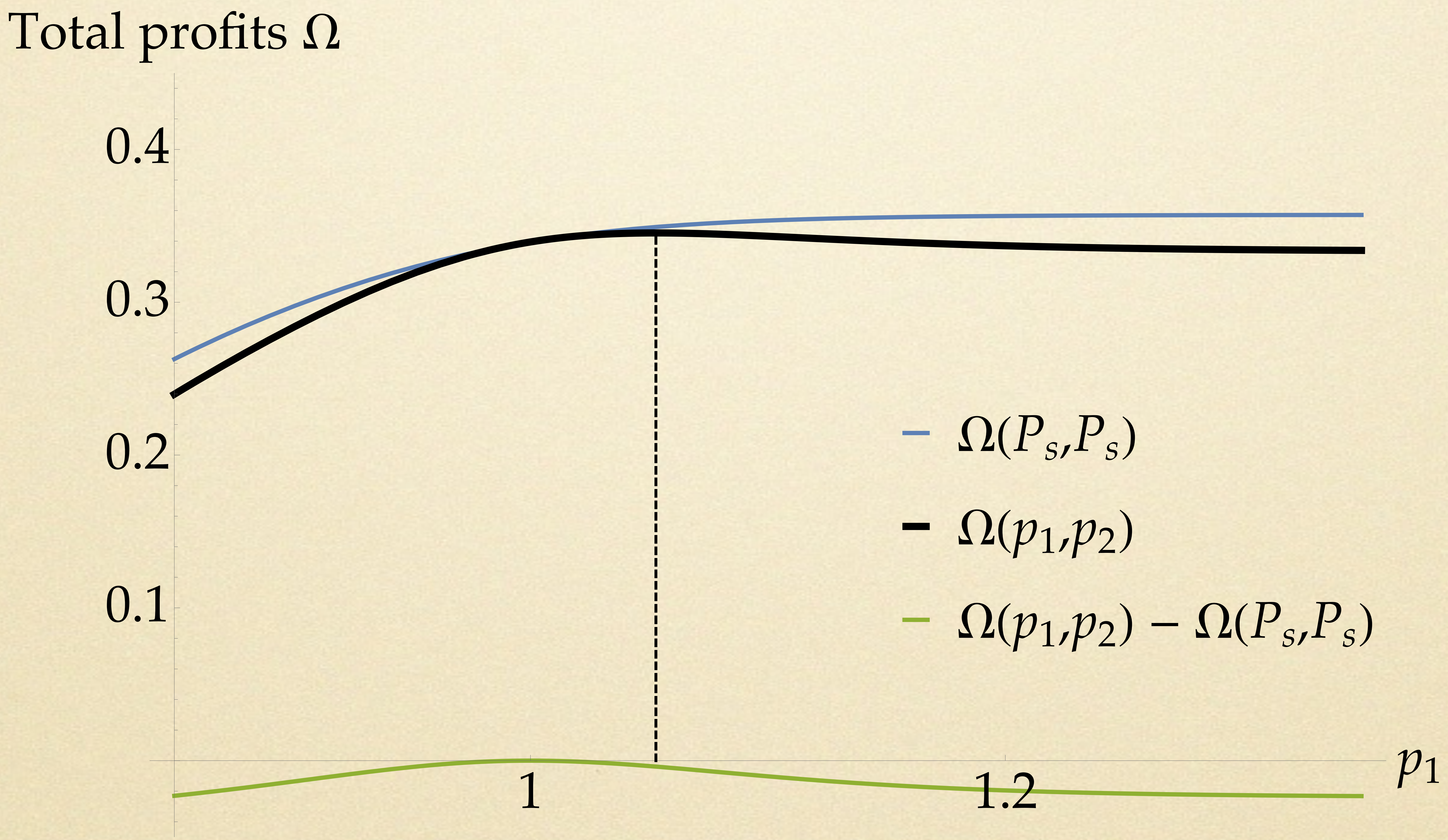
$$B^c = \frac{\Gamma^c}{1 + \sqrt{(1 - \Gamma^c)\left(1 + \frac{\Gamma^c}{n-1}\right)}}$$

$$\Gamma^c = 1 - \frac{\omega}{\epsilon}$$

$$\epsilon = \frac{-\partial \log D^i}{\partial \log p_i}$$

- no superelasticity effects
- higher elasticity ϵ ⟶ more stickiness

Slope under Collusion



higher elasticity ϵ → larger "distortion" from price wedge $p_1 \neq p_2$

Change in n: Markov vs Collusion