Dynamic Oligopoly 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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  - simple and tractable
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- 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 ?

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

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- Here:
  - oligopoly with any n firms
  - general demand structure (e.g. Kimball, not just CES)
- Results
  1. Sufficient statistics for M shocks
  2. Calibration and counterfactuals
  3. Inspecting the mechanism
  4. Phillips Curve

Literature

- Mongey (2016)

- Rotemberg-Saloner (1986), Rotemberg-Woodford (199)

- IO Literature (dynamic): Ericson-Pakes (1995), Bajari-Benkard-Levin (2007), …

- Passthrough Literature (static): Goldberg (1985), Atkeson-Burstein (2008), Gopinath-Itskhoki (2010), Arkolakis-Costinot-Donaldson-Rodríguez Clare (2015), Amiti-Itskhoki-Konings (2019)

Setup

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

- Equilibrium concepts for oligopoly game…
  - Markov: dominant equilibrium concept in IO **(Today)**

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

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(Golosov-Lucas)

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Reset strategy

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

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$\{p_{j,s}\}_{j \neq i}$

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

- firms: $\left.\begin{matrix}\{C(t), P(t), W(t), r(t)\} \\ \{g^{-i,s}(\cdot; t)\}\end{matrix}\right\} \xrightarrow{\max} g^{i,s}(p_{-i,s}; t)$

- 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 and market clearing

$$C = L$$

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$$r = \rho$$

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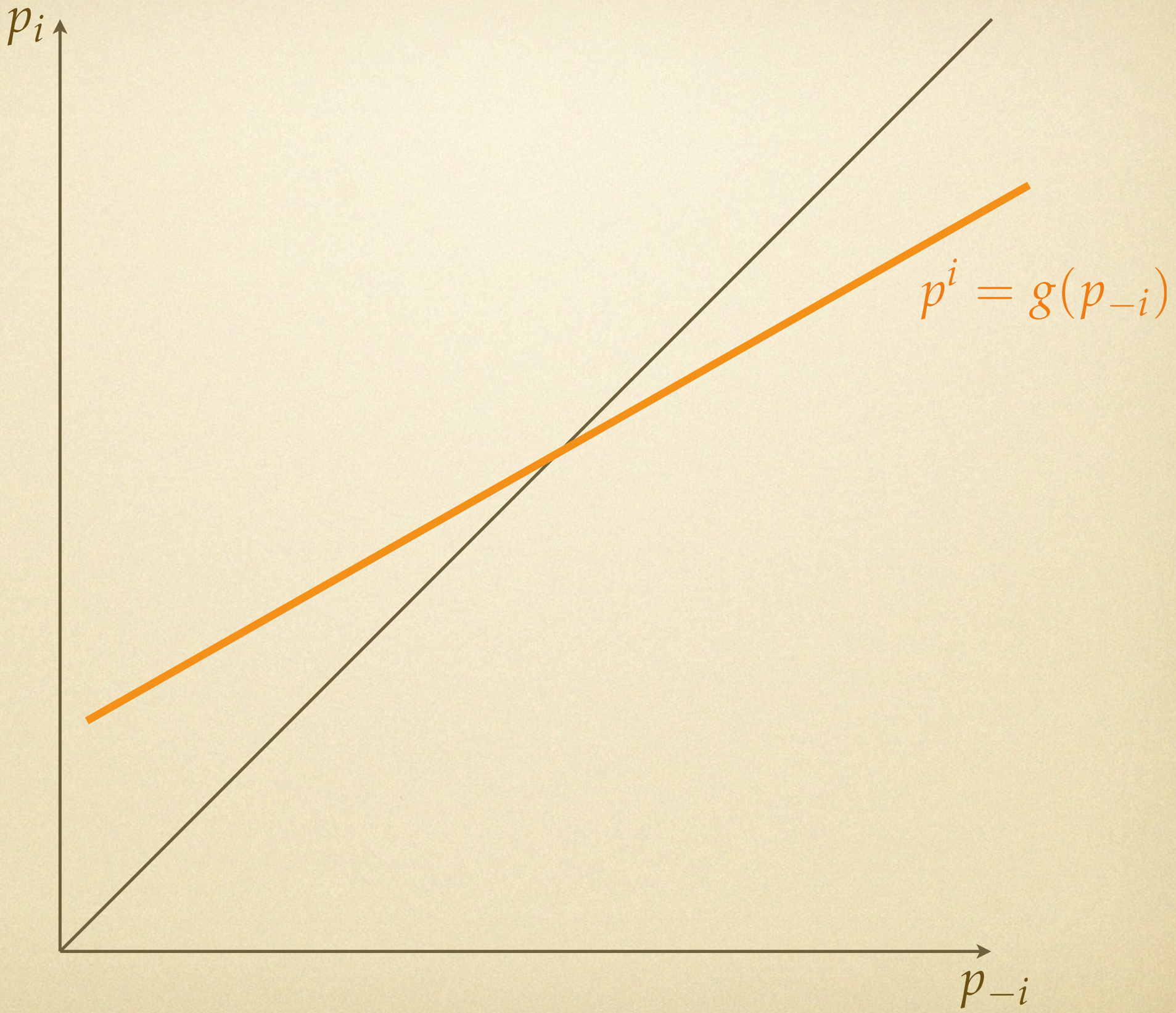
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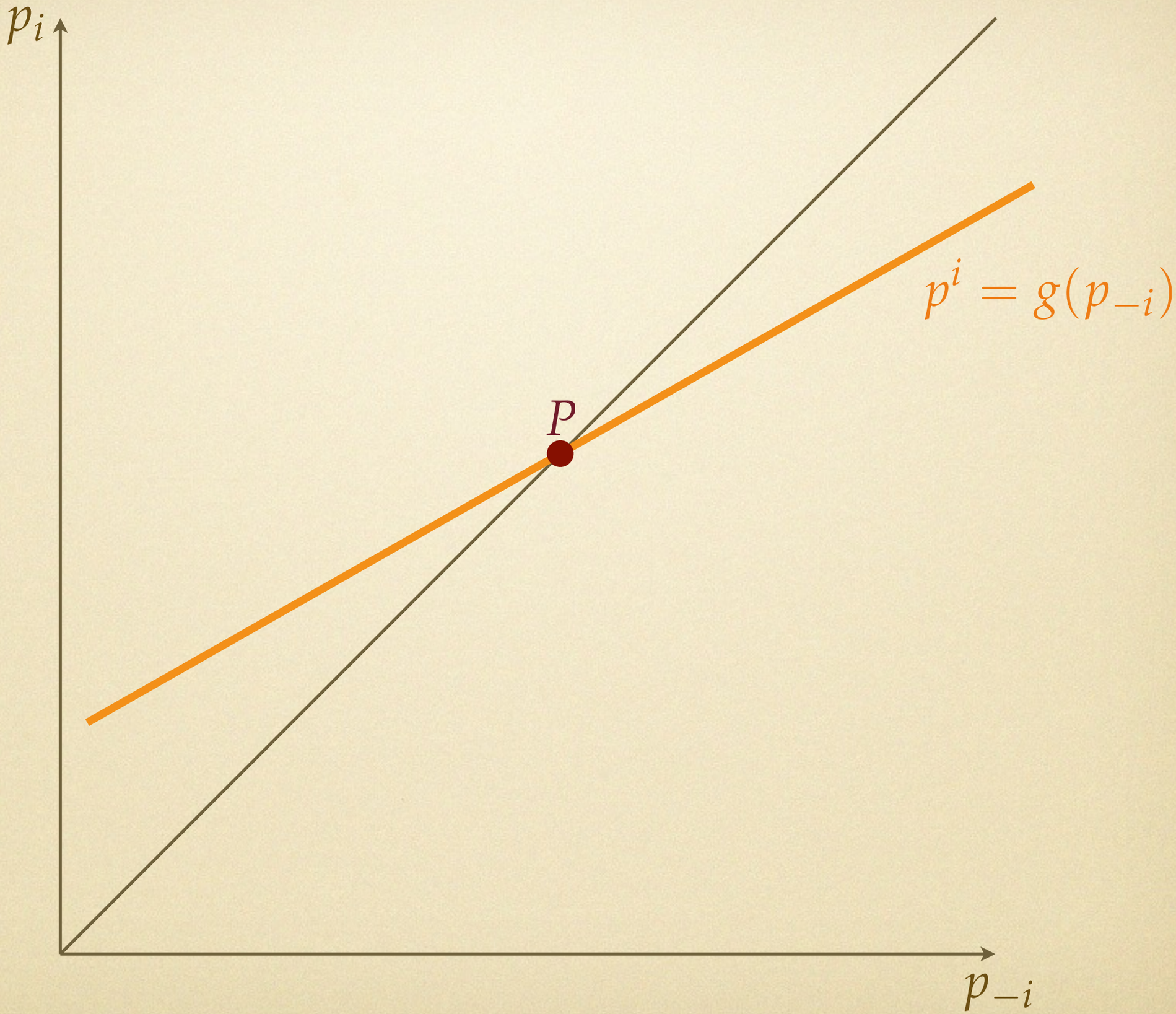
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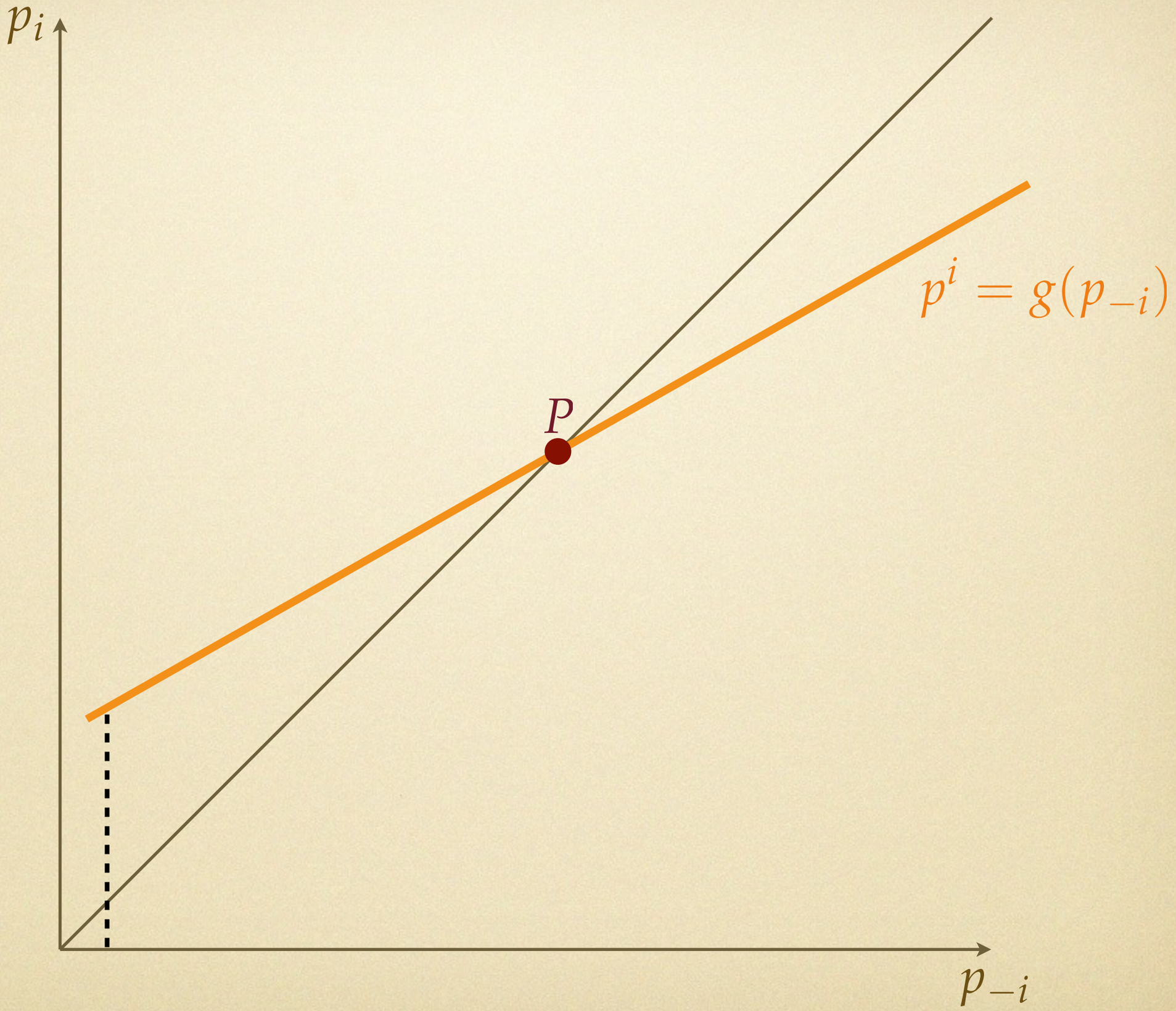
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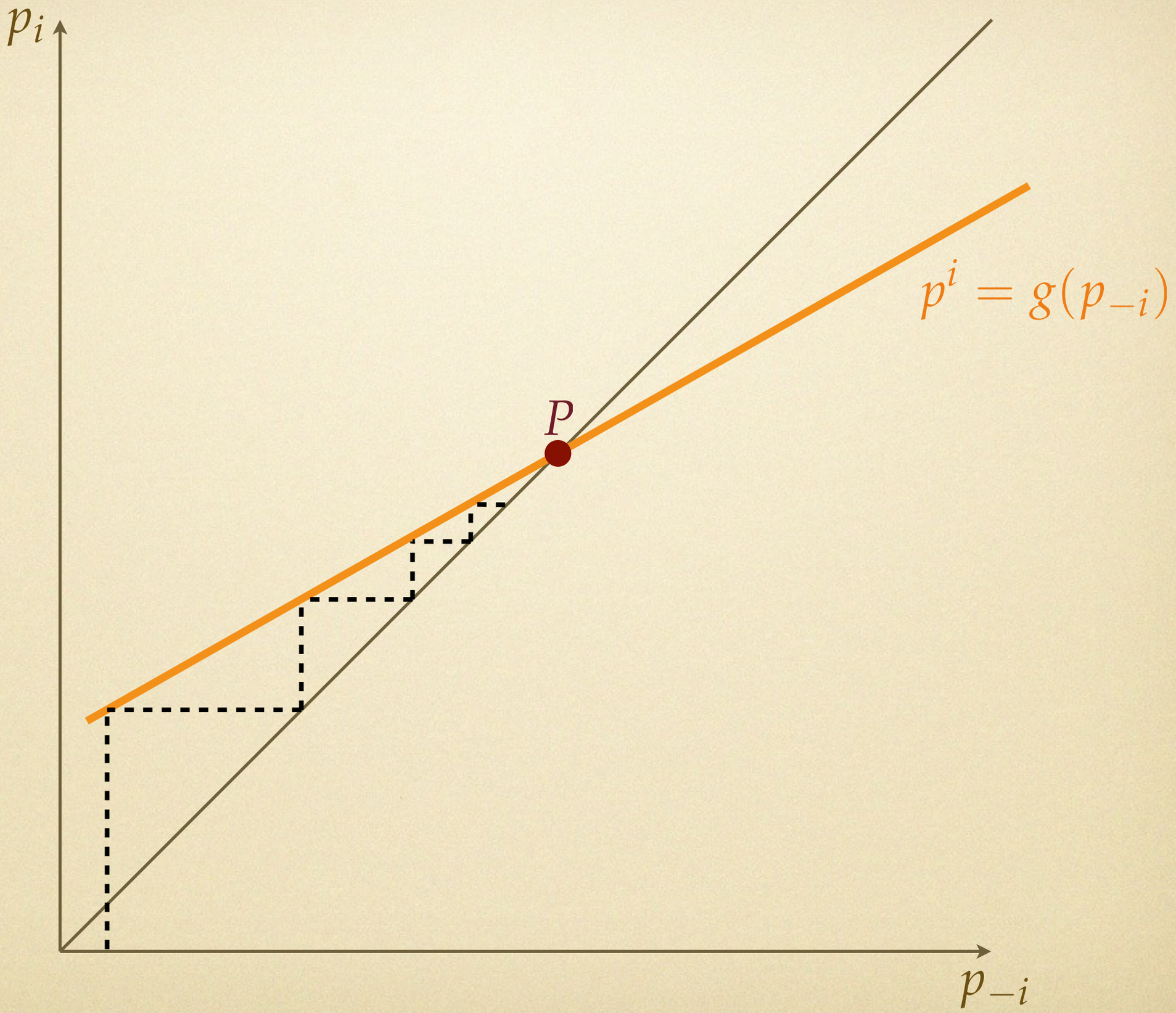
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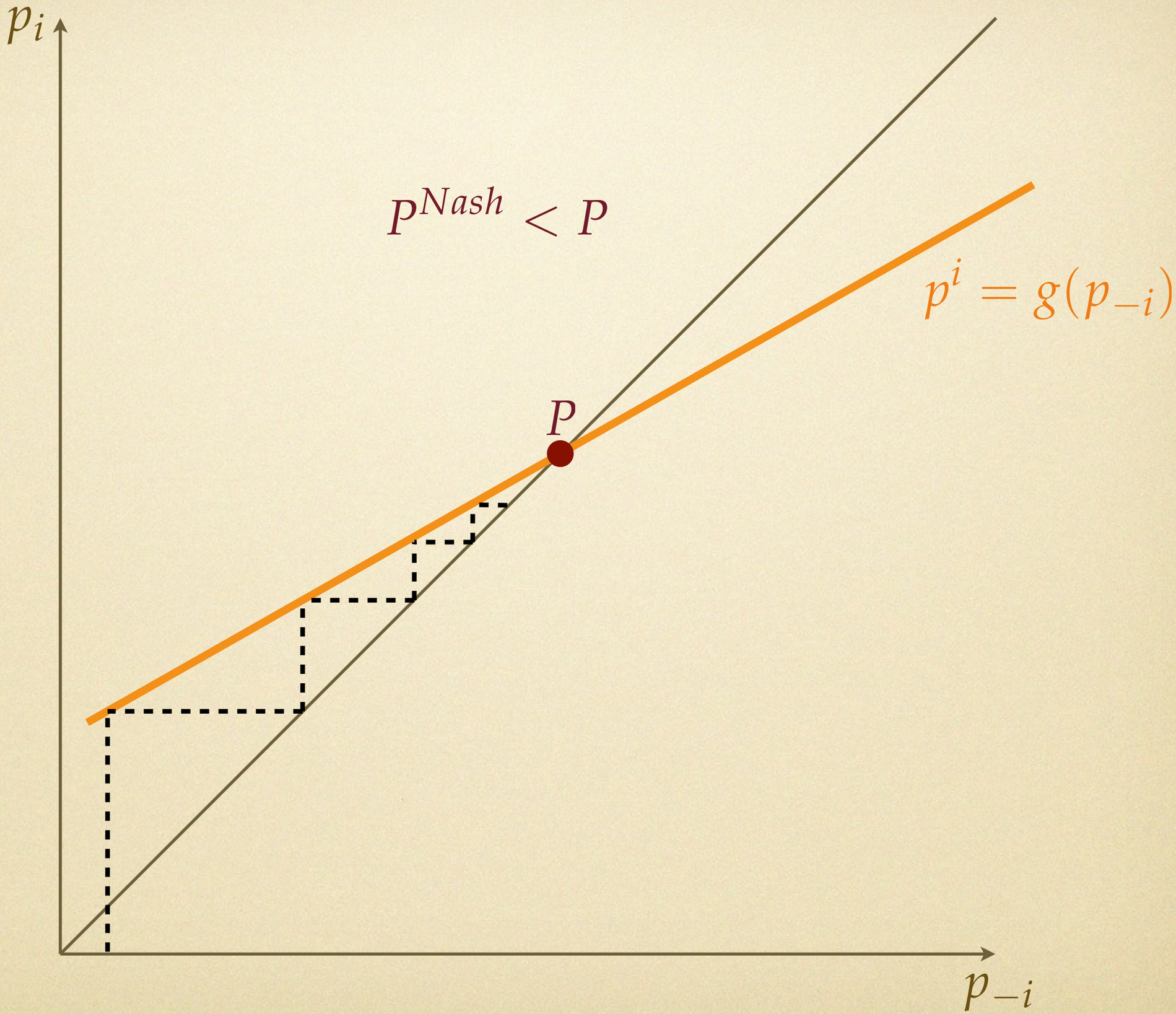
  - steady state price vector $P = g(P, P, \ldots, P)$


p_i
$p^i = g(p_{-i})$
p_{-i}


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1. Sufficient Statistics

Money Shock

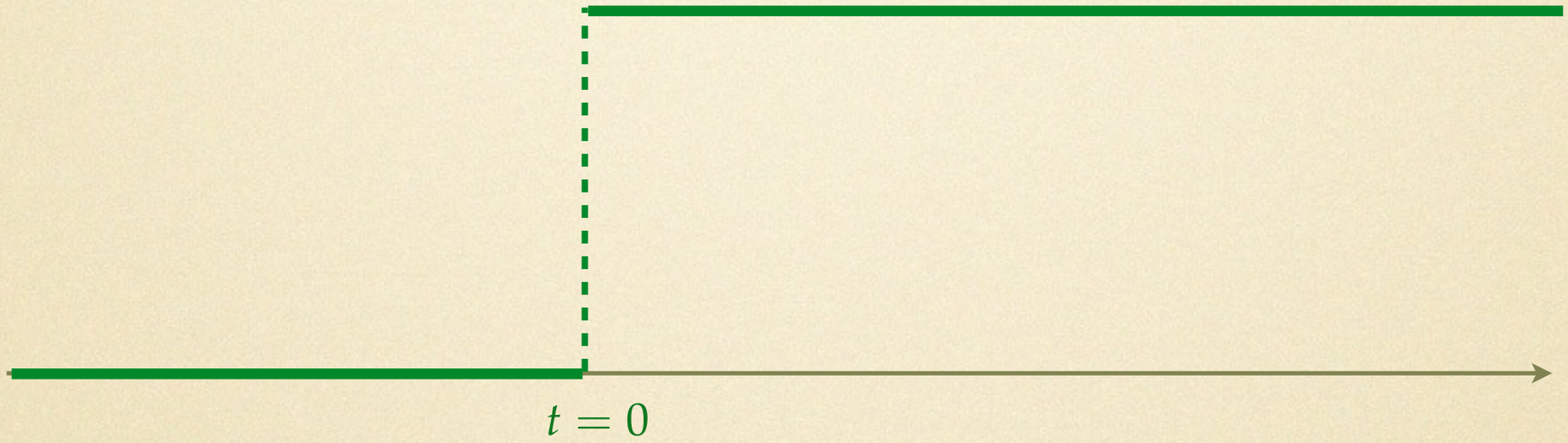
- Starting at steady state…

Money Shock

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

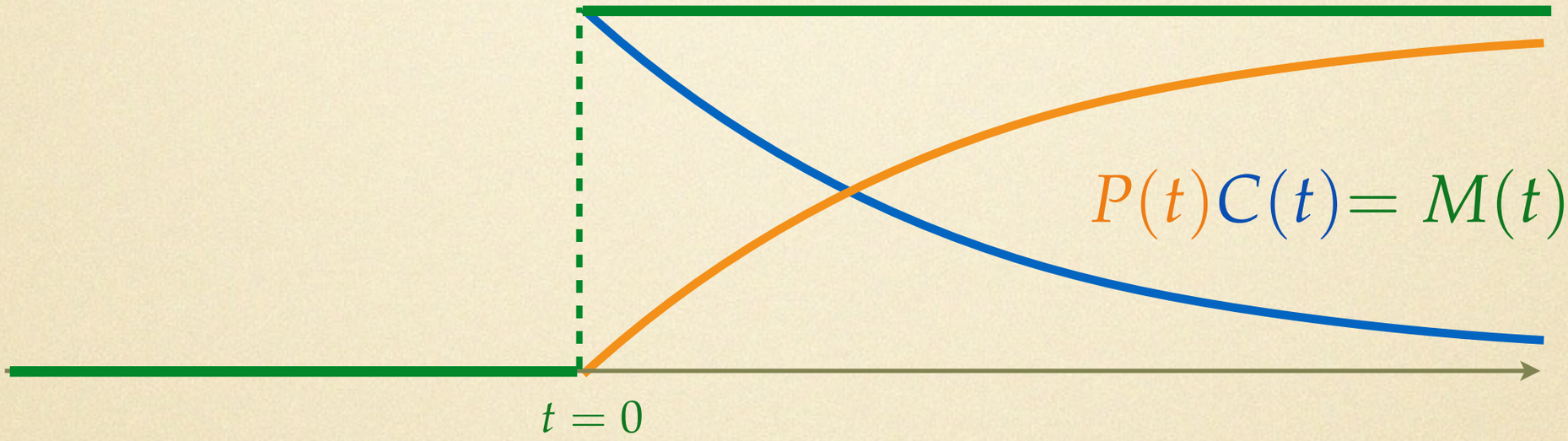
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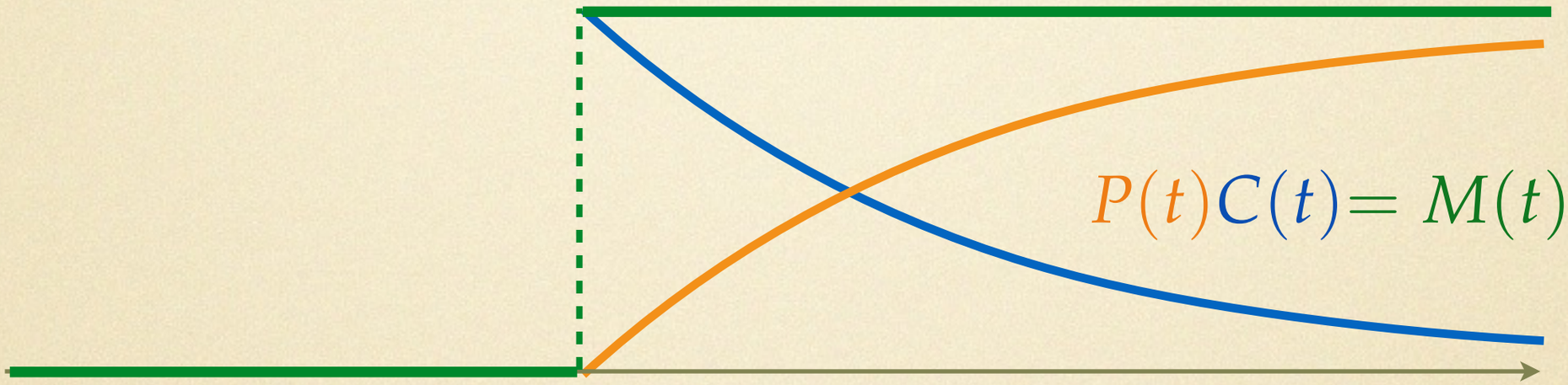


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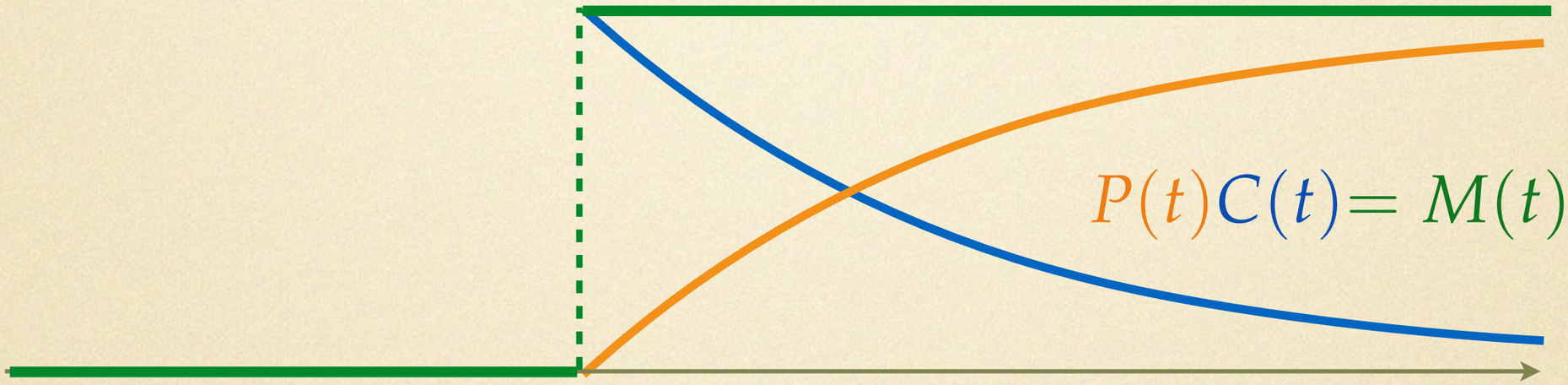


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Proposition. (Aggregation)

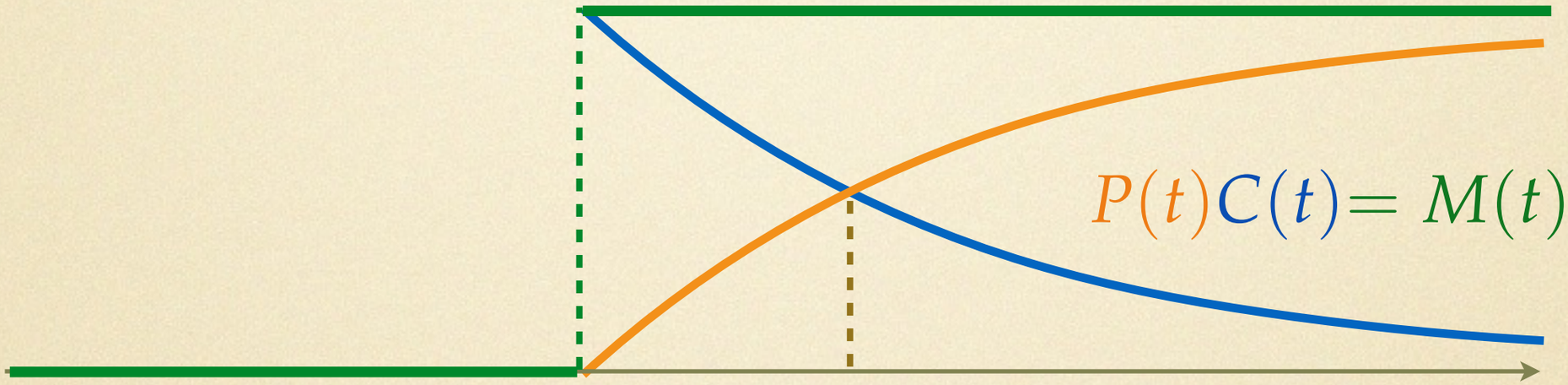
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$$\beta_n \equiv \frac{\partial}{\partial p_j} g(P^*)$$

extensions: heterogeneous λ, productivity, costs

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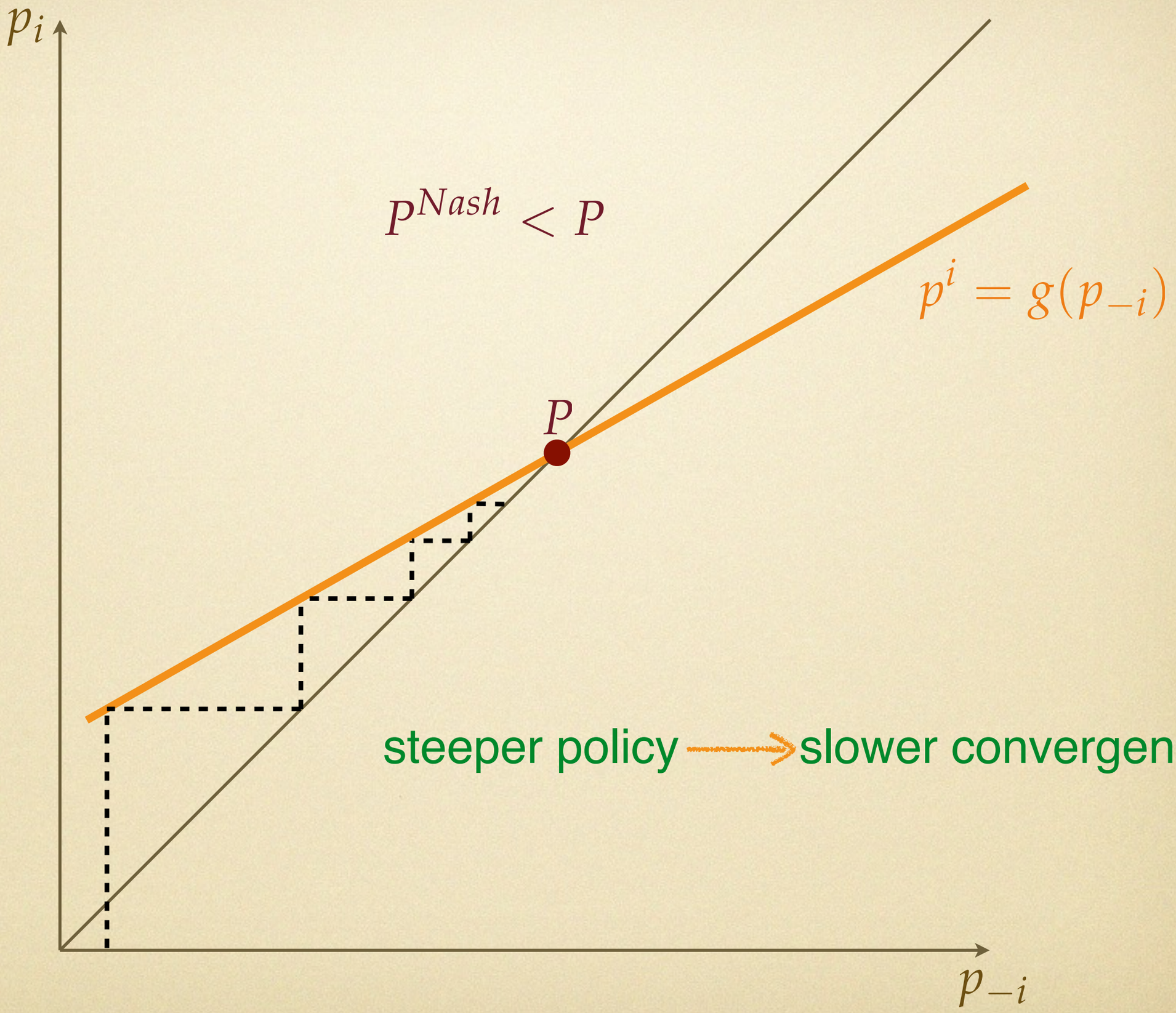


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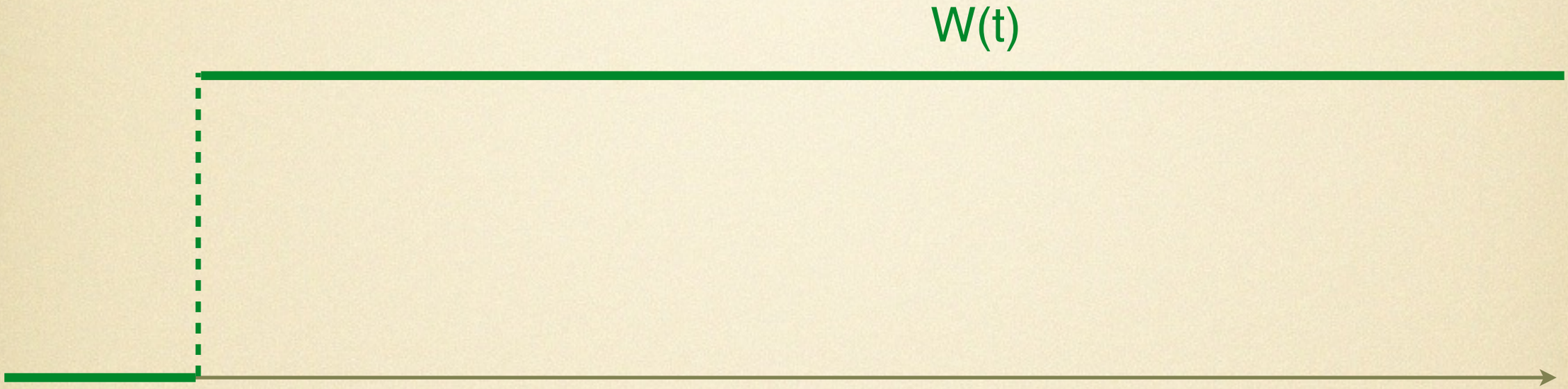
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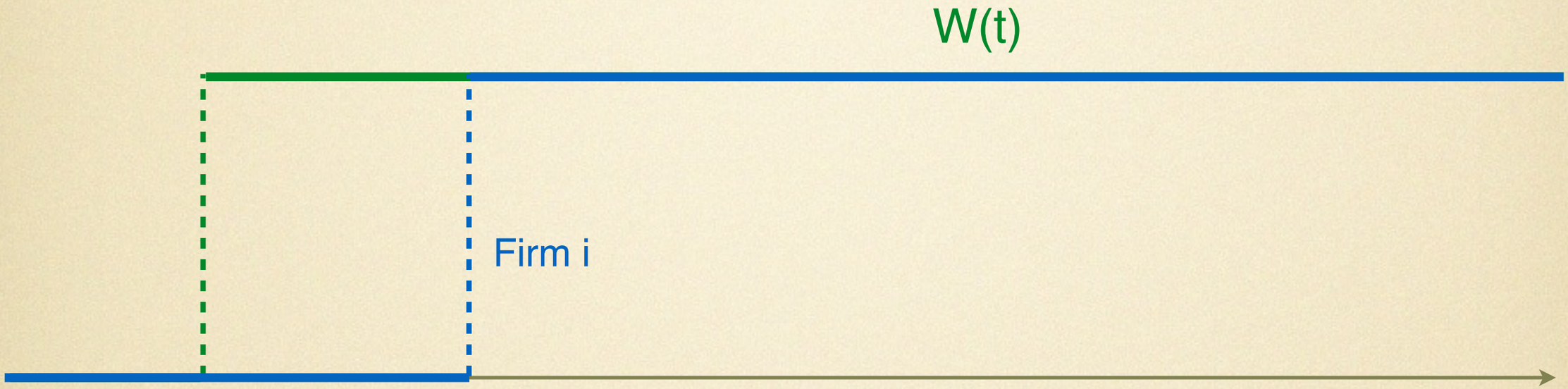
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steeper policy ⟶ slower convergence
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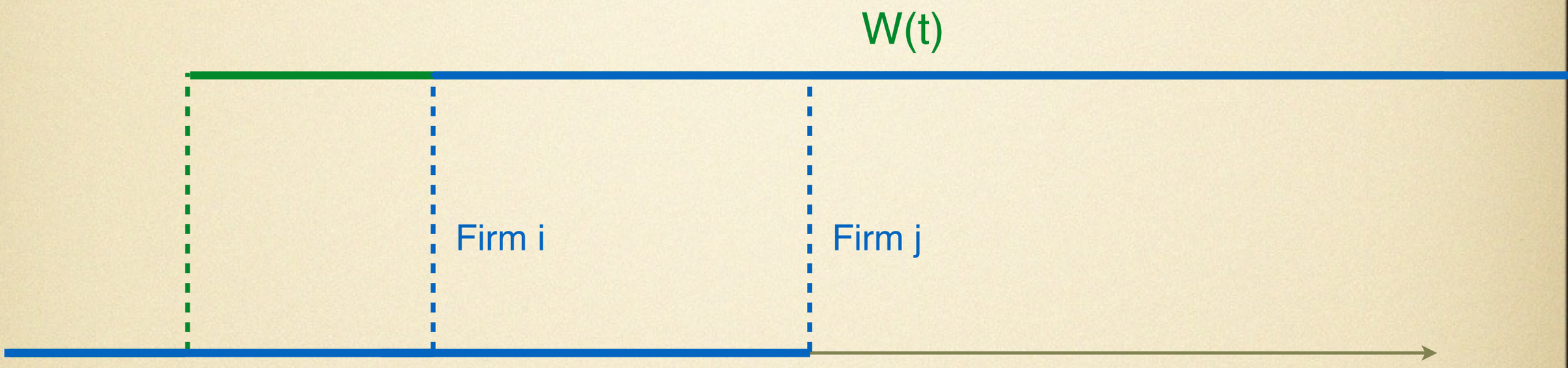
Monopolistic vs Duopoly with CES



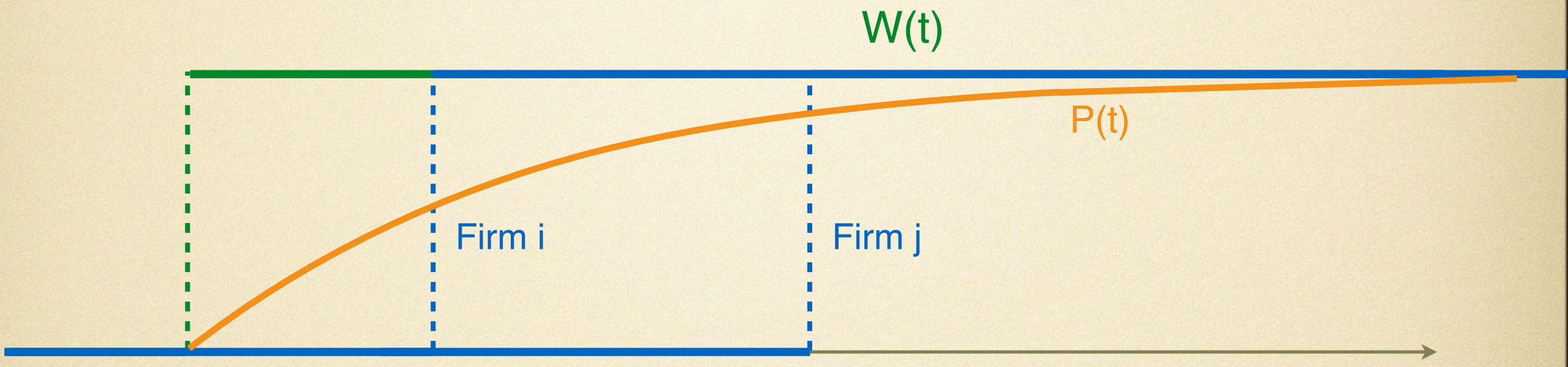
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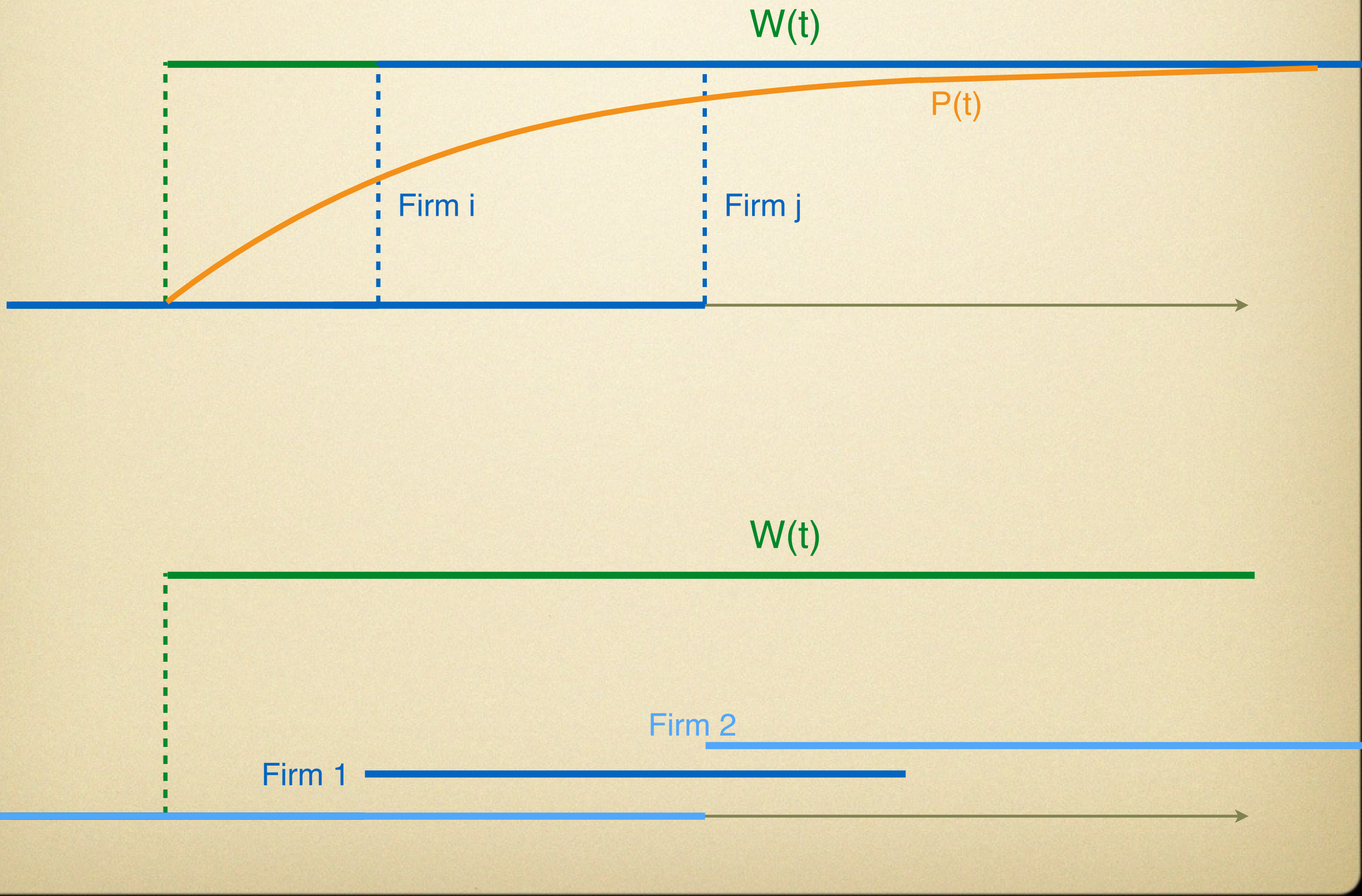
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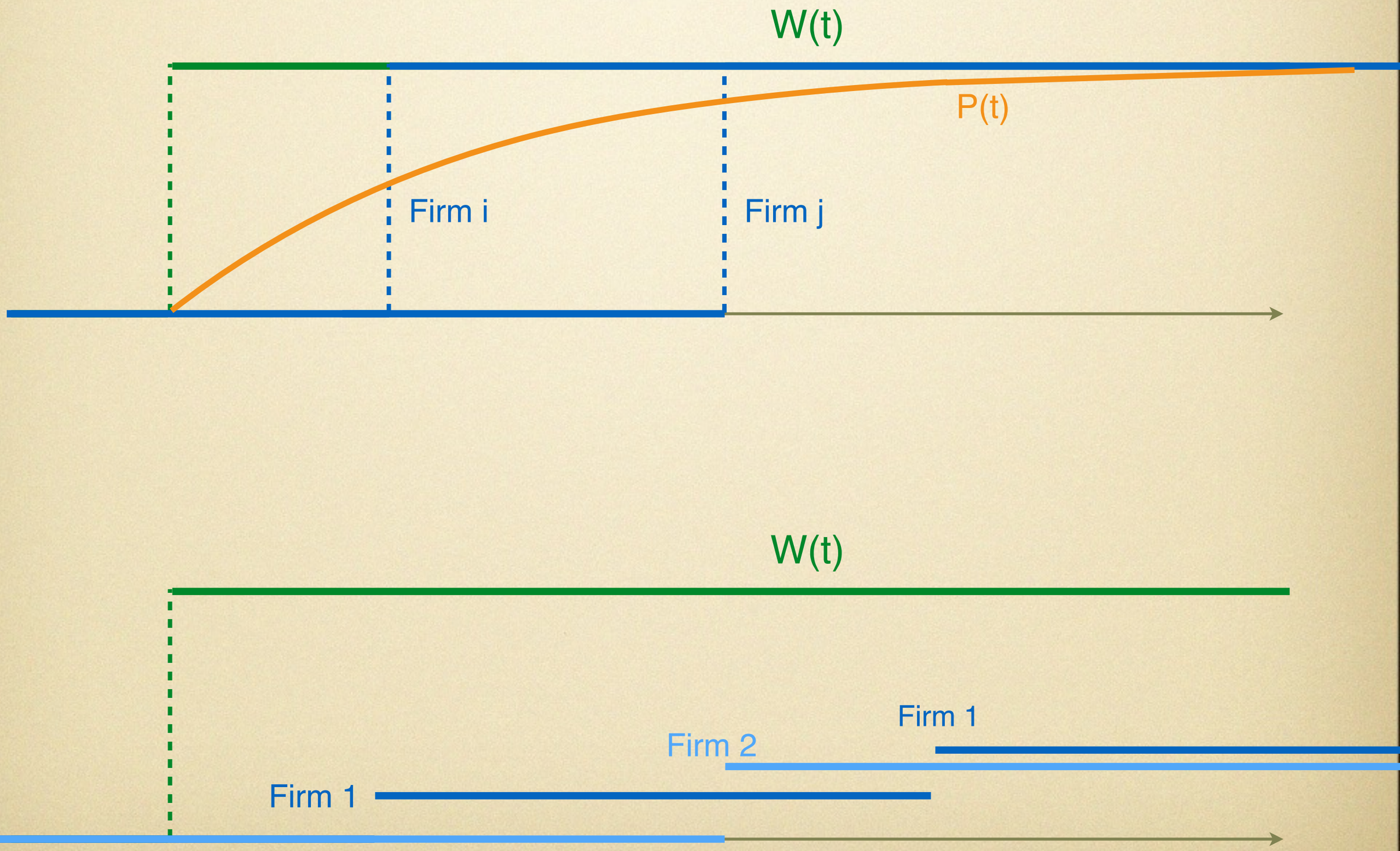
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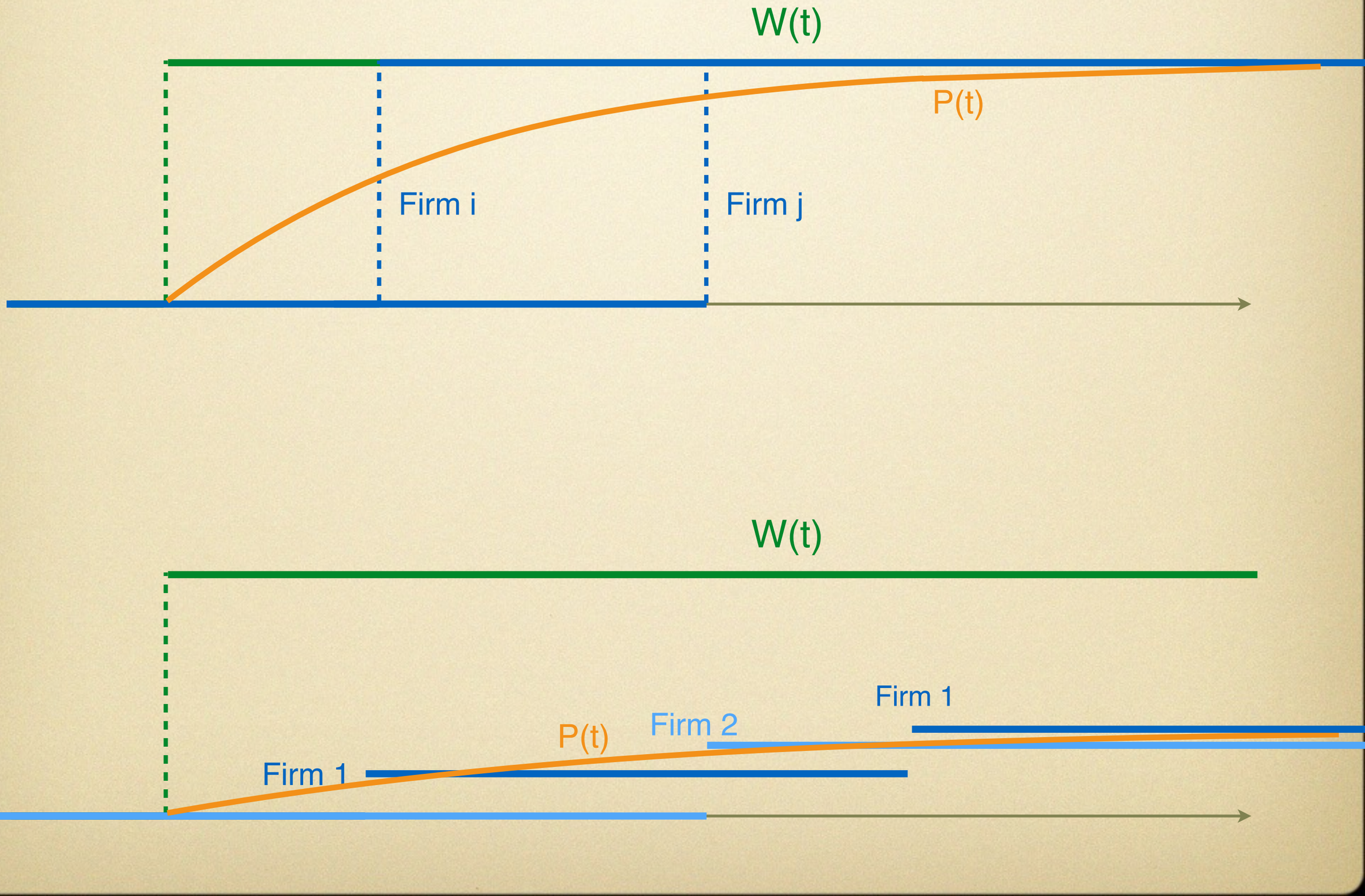
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Sufficient Statistic

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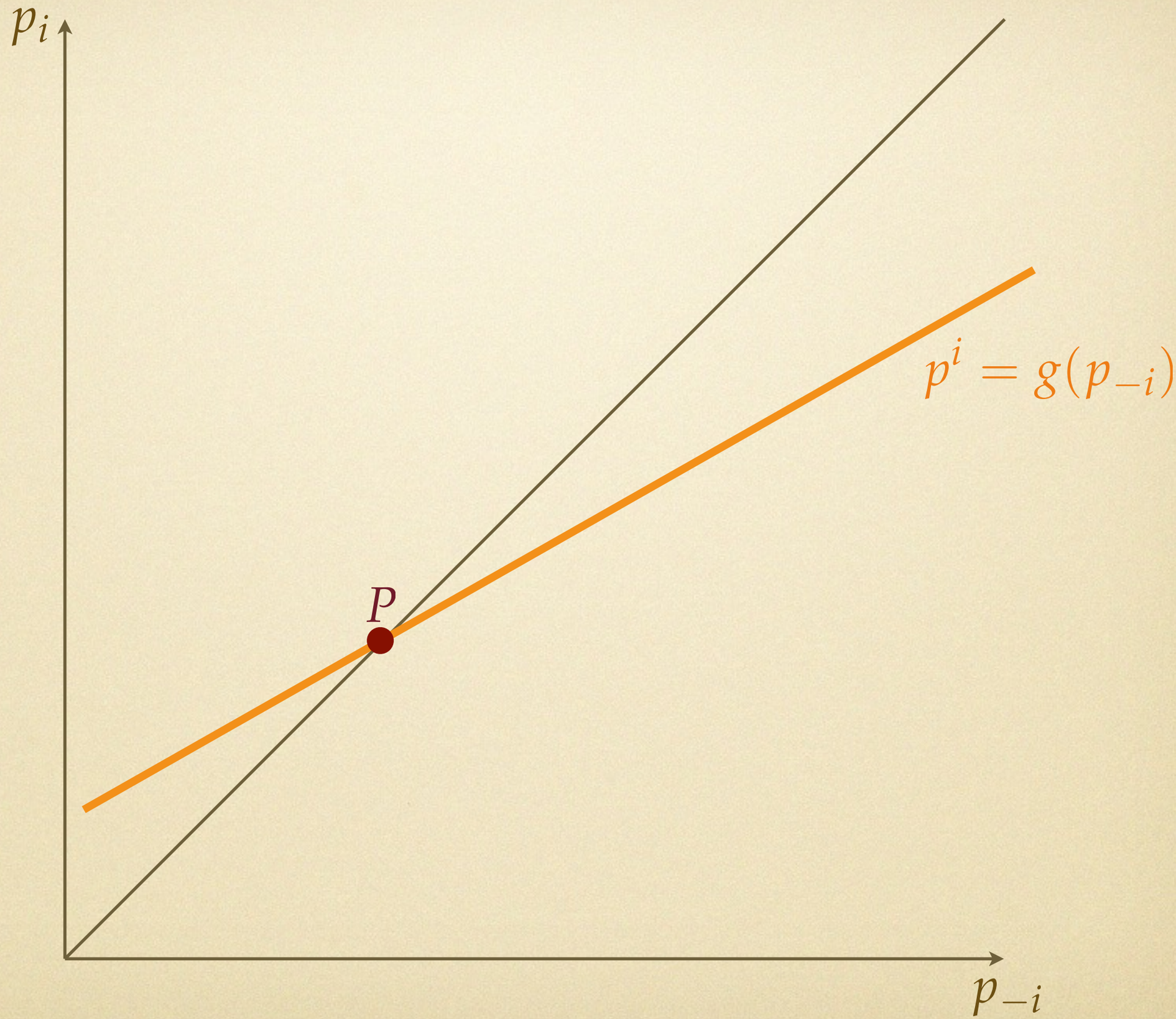
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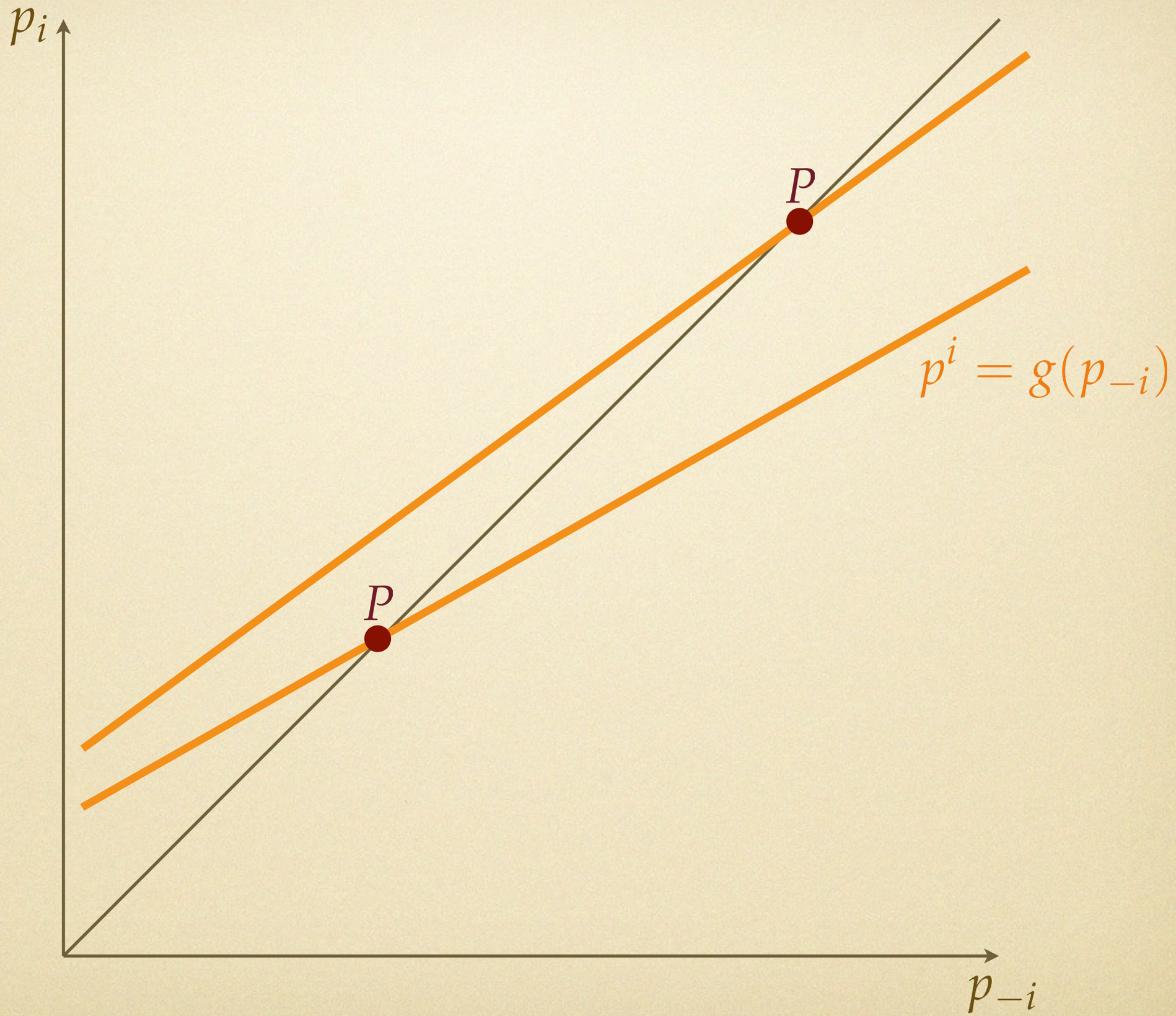
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- Con…
  - markup observable? maybe
  - elasticity observable? maybe


p_i
$p^i = g(p_{-i})$
P
p_{-i}


p_i
P
$p^i = g(p_{-i})$
P
p_{-i}

2. Counterfactuals

Solving MPE

Solving MPE

- Comparative statics/counterfactuals?
  - must solve entire MPE
  - challenging: large state

Solving MPE

- Comparative statics/counterfactuals?
  - must solve entire MPE
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- Our approach: perturb preferences to make equilibrium strategies locally polynomial (e.g., linear)
  - related to Krusell-Klein-Rios-Rull
  - can match demand elasticities up to arbitrary order
  - check approximation with other methods

Kimball Demand

$$\frac{1}{n}\sum \Psi(\frac{c_i}{C}) = 1$$

$$\Psi'(x) = \frac{\eta - 1}{\eta} \exp\left(\frac{1 - x^{\theta/\eta}}{\theta}\right) \quad \text{(Klenow-Willis)}$$

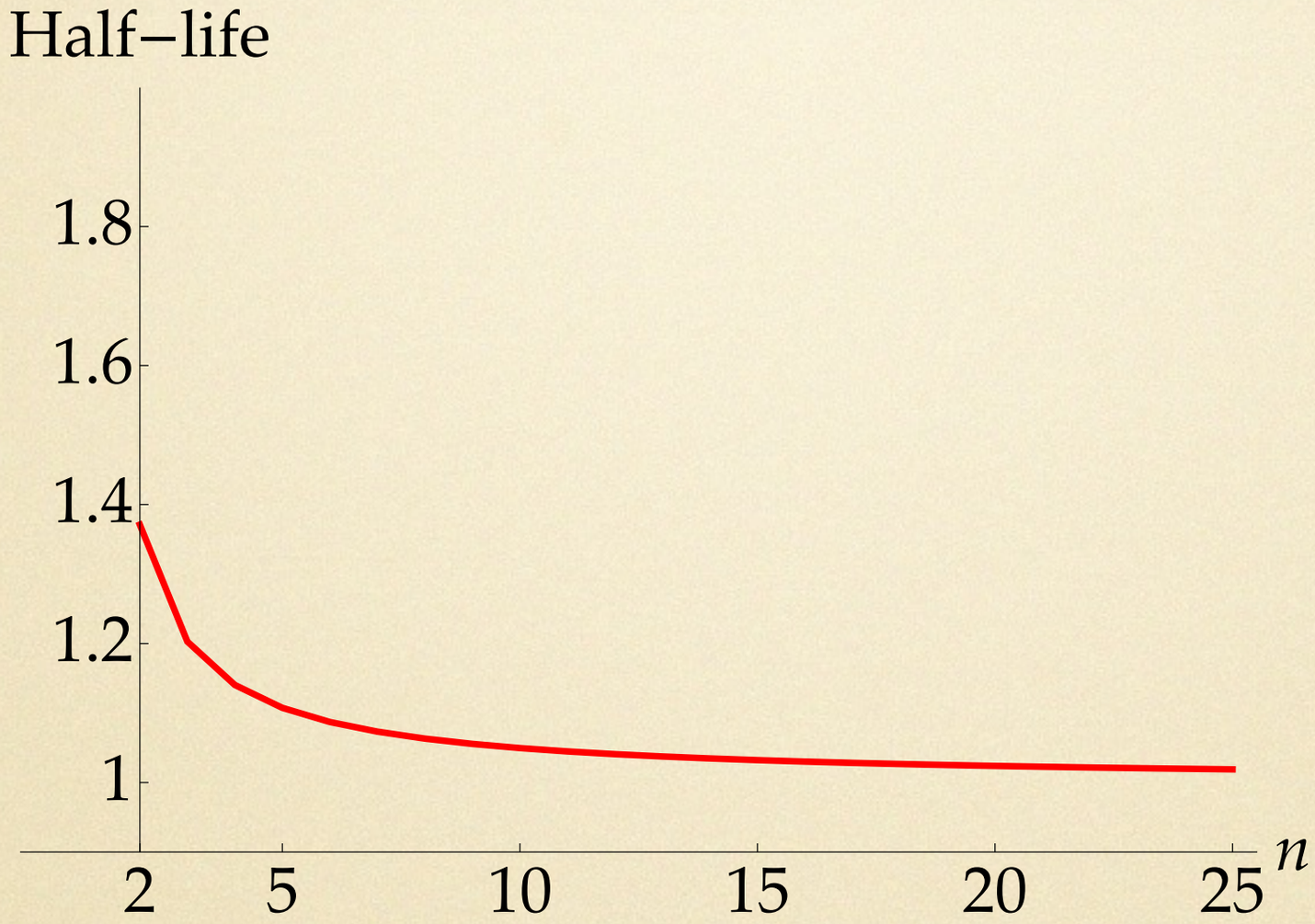
- Under monopolistic competition

  → elasticity η

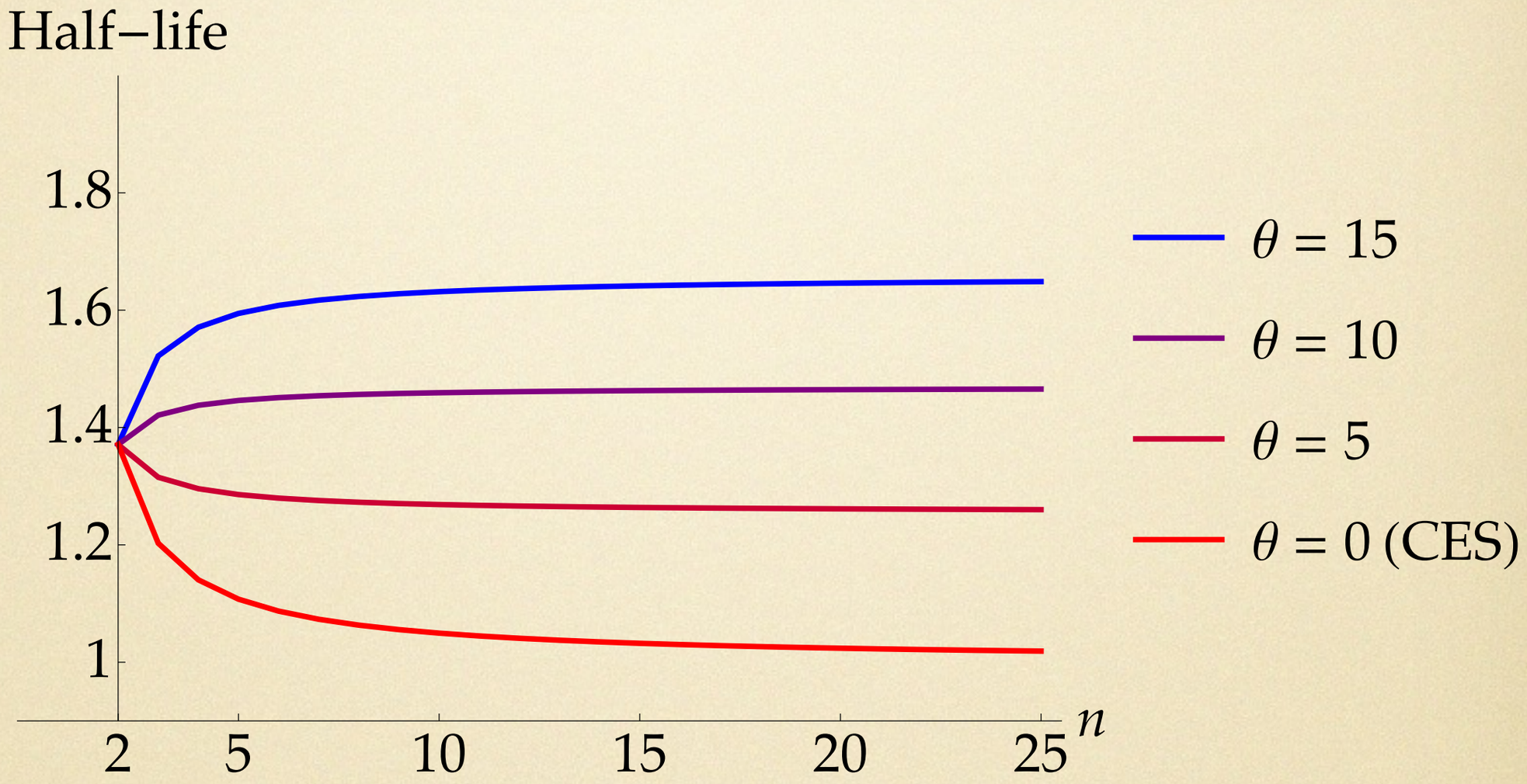
  → superelasticity θ

- Oligopoly: elasticities also depend on n

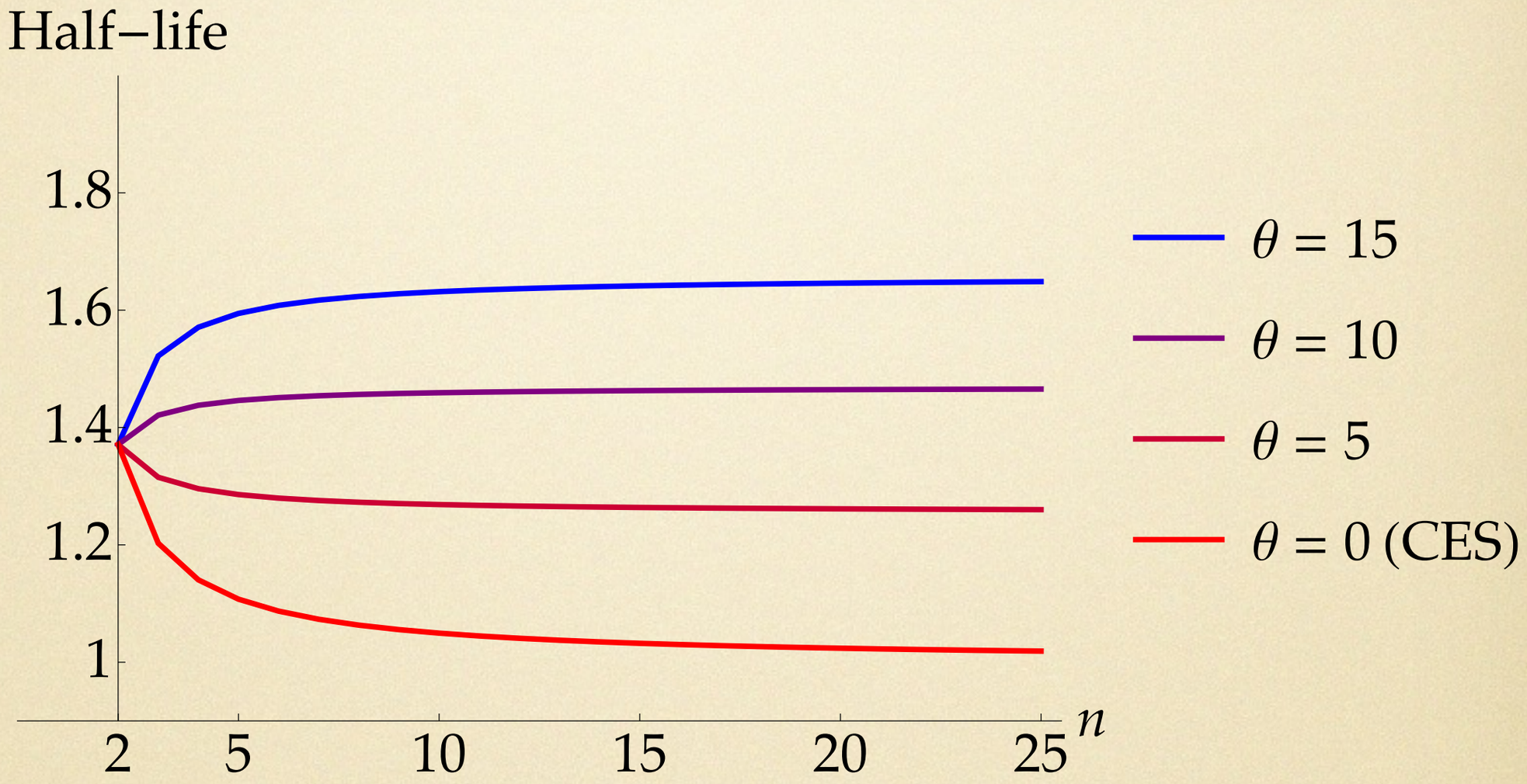
Kimball Demand



Kimball Demand



Kimball Demand



- Low θ similar to CES: slowest convergence at $n=2$
- But with high enough θ, fastest convergence at $n=2$!
- Duopoly is knife-edge: half-life stuck at CES level…
  … in contrast: $n \geq 3$ arbitrarily large as θ increases

Pass-Through

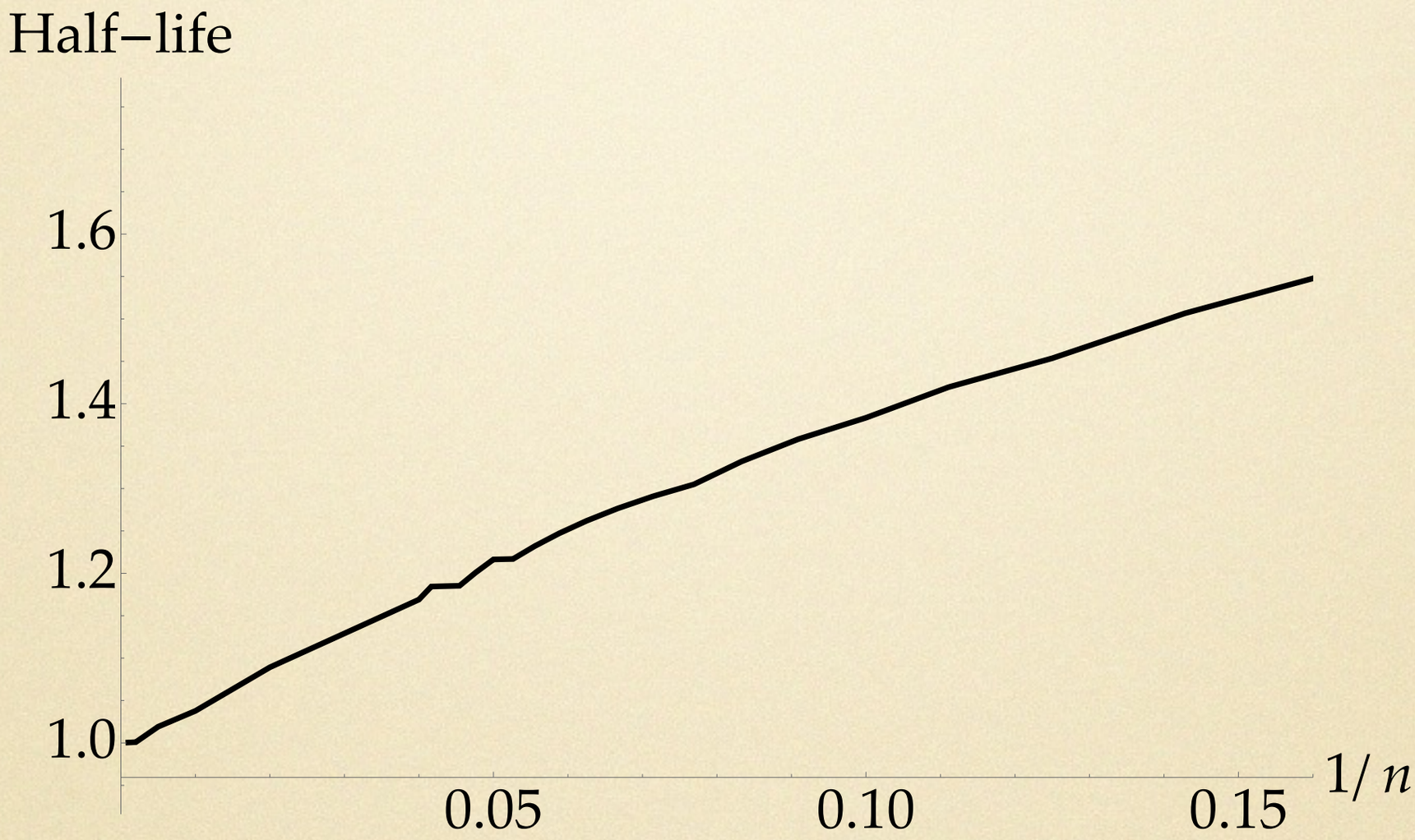
- Amiti-Itskhoki-Konings 19: own cost pass-through
  - high for small firms
  - low for large firms
  - consistent with CES Cournot but not Bertrand

- Depart from CES to match

  pass-through = f(market share)

  in dynamic (Bertrand) model

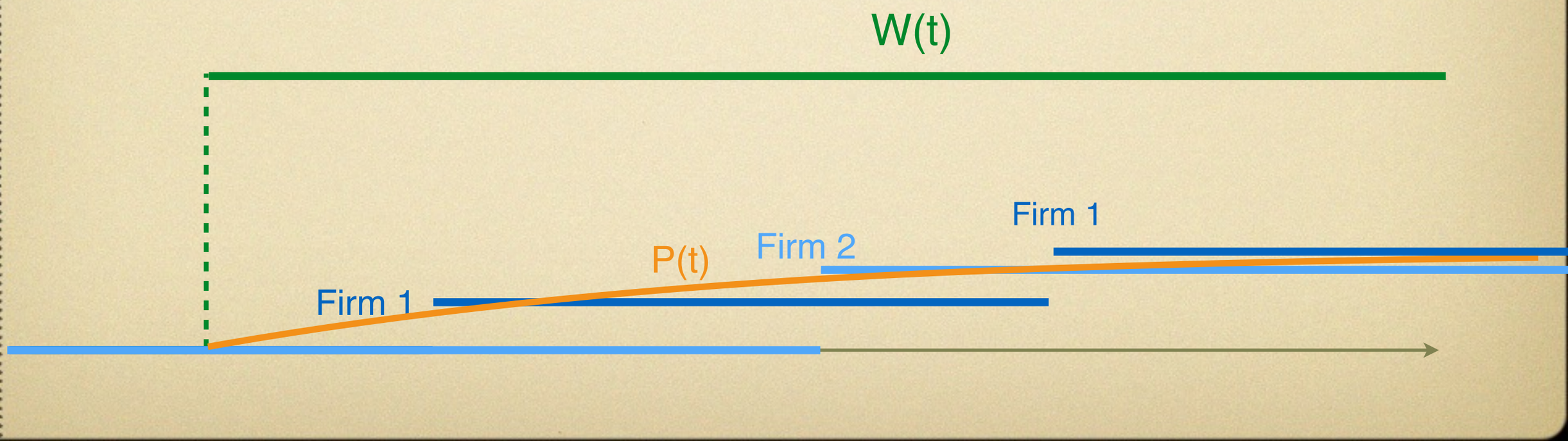
HHI and Half-life



- National HHI 0.05 to 0.1 (e.g., Gutierrez-Philippon): MP 15% stronger
- Local HHI 0.15 to 0.05 (Rossi-Hansberg, Sarte, Trachter): MP 25% weaker

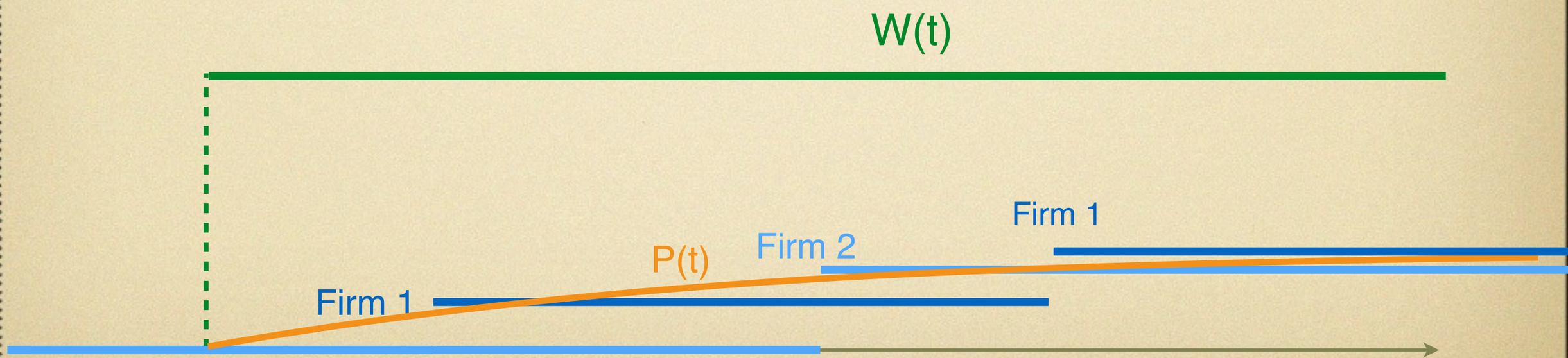
3. Inspecting the mechanism

Inspecting Mechanism



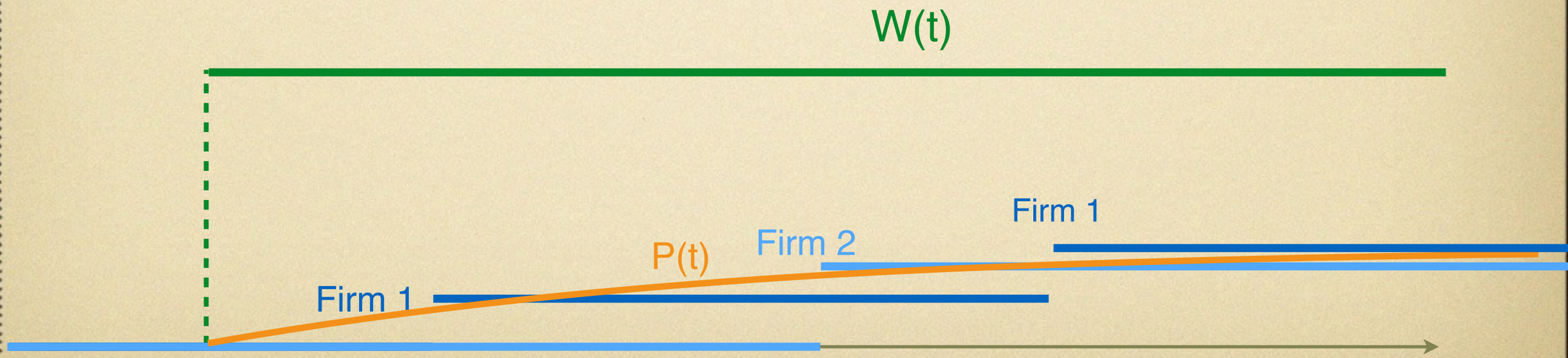
Inspecting Mechanism

- Two effects with finite n…
  - feedback: firm i cares about others' prices
  - strategic: firm i can affect others' prices



Inspecting Mechanism

- Two effects with finite n…
  - feedback: firm i cares about others' prices
  - strategic: firm i can affect others' prices
- Feedback effect with $n = \infty$
  - inputs from other firms
  - Kimball (1995) demand



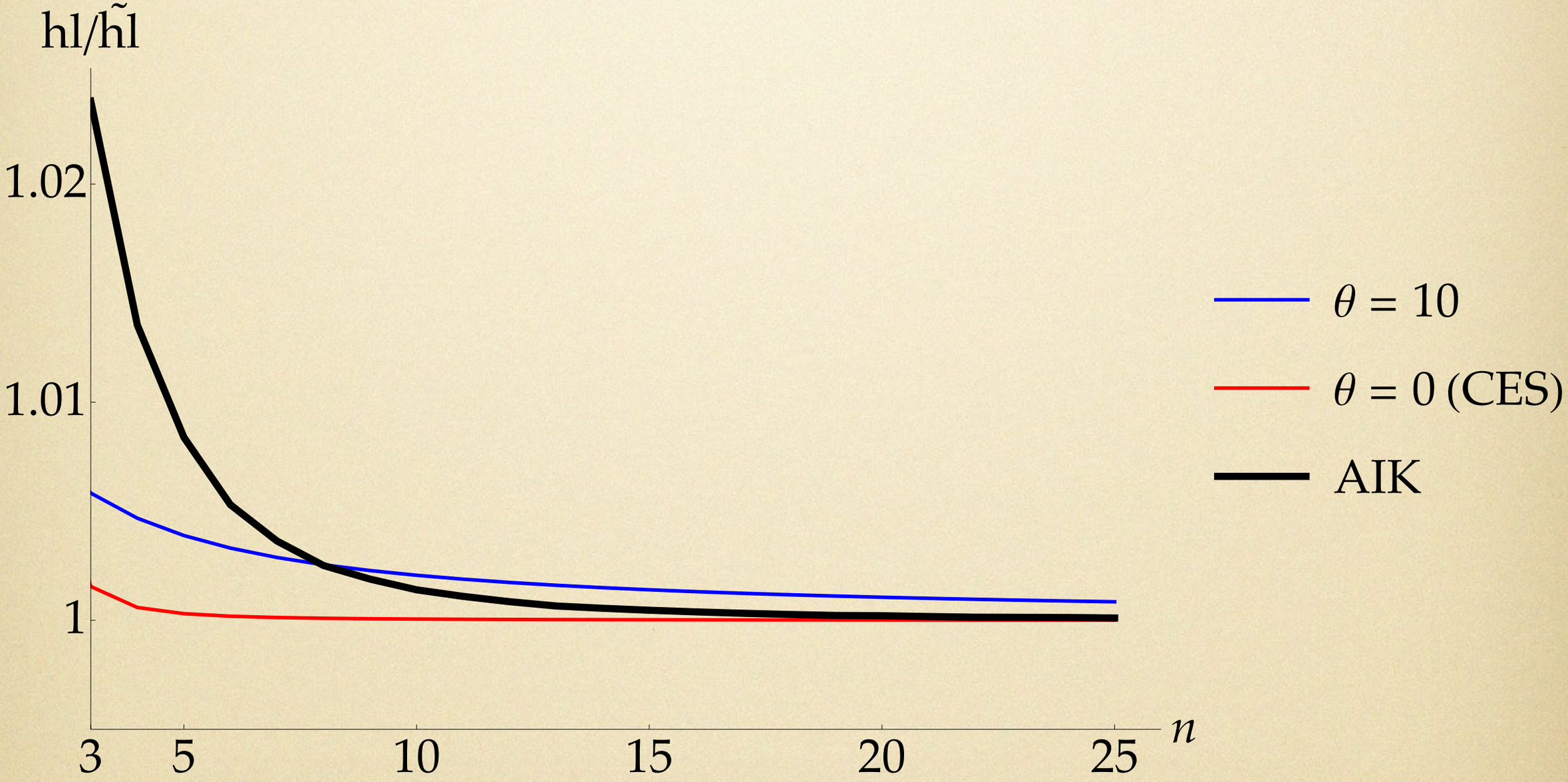
Inspecting Mechanism

- Compare MPE with n firms to

as if monopolistic market

  - $n = \infty$ and modified Kimball preferences to match elasticities
  - $\Leftrightarrow$ equilibrium if n firms ignore how they affect rivals' pricing $\rightarrow$ "non-strategic" model

Small strategic effects



4. Phillips Curve

Phillips Curve

- Generalize preferences and allow arbitrary paths of
  - Interest rate shocks
  - Real shocks

- Monopolistic NKPC
  - First order ODE
  - Inflation only depends on future MC
  - Kimball $\Leftrightarrow$ less frequent adjustment (lower λ)

- Oligopolistic NKPC
  - Higher order ODE: inflation persistence
  - Not just MC: demand, interest rates
  - Not equivalent to lower λ

Phillips Curve

- Standard NKPC

$$\dot{\pi} = 0.05\pi - 1.05mc$$

- Oligopoly: Example with $n = 3$
  - MPE

$$\dot{\pi} = 0.07\pi - 0.28mc$$

$$+1.31\ddot{\pi} + 0.45\dot{mc} + 0.03(r - \rho)$$

  - Non-strategic (= monopolistic Kimball)

$$\dot{\pi} = 0.05\pi - 0.27mc$$

3-Eq Oligopoly NK

- Combine with Euler equation

$$\dot{c} = \sigma^{-1}\left(r - \pi - \rho - \epsilon^r\right)$$

- Taylor rule

$$r = \rho + \phi\pi + \epsilon^m$$

- AR(1) ϵ^r, ϵ^m shocks

n	Model	$\sigma(\pi)$		$\sigma(c)$	
		ϵ^r	ϵ^m	ϵ^r	ϵ^m
∞	$\theta = 0$ (CES)	2.2%	2.7%	0.8%	1.0%
∞	$\theta = 10$	2.0%	2.4%	1.0%	1.3%
10	MPE	2.3%	2.8%	1.1%	1.4%
	Non-strategic	2.7%	3.3%	1.4%	1.7%

Conclusions

- Monopolistic competition used pervasively
- Our paper: oligopoly…
  - methods to solve micro and macro
  - sufficient statistics and aggregation
  - concentration amplifies non-neutrality
    - for simple shocks: mostly driven by implied demand shape, rather than n per se
    - more differences with Phillips curve and general shocks