Understanding Employment Persistence*

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[Preliminary and incomplete]

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* This research was conducted with restricted access to Bureau of Labor Statistics (BLS) data. The views expressed here do not necessarily reflect the views of the BLS or staff and members of the Board of Governors.

Macroeconomic employment inertia

Employment is a lagging indicator (Okun).

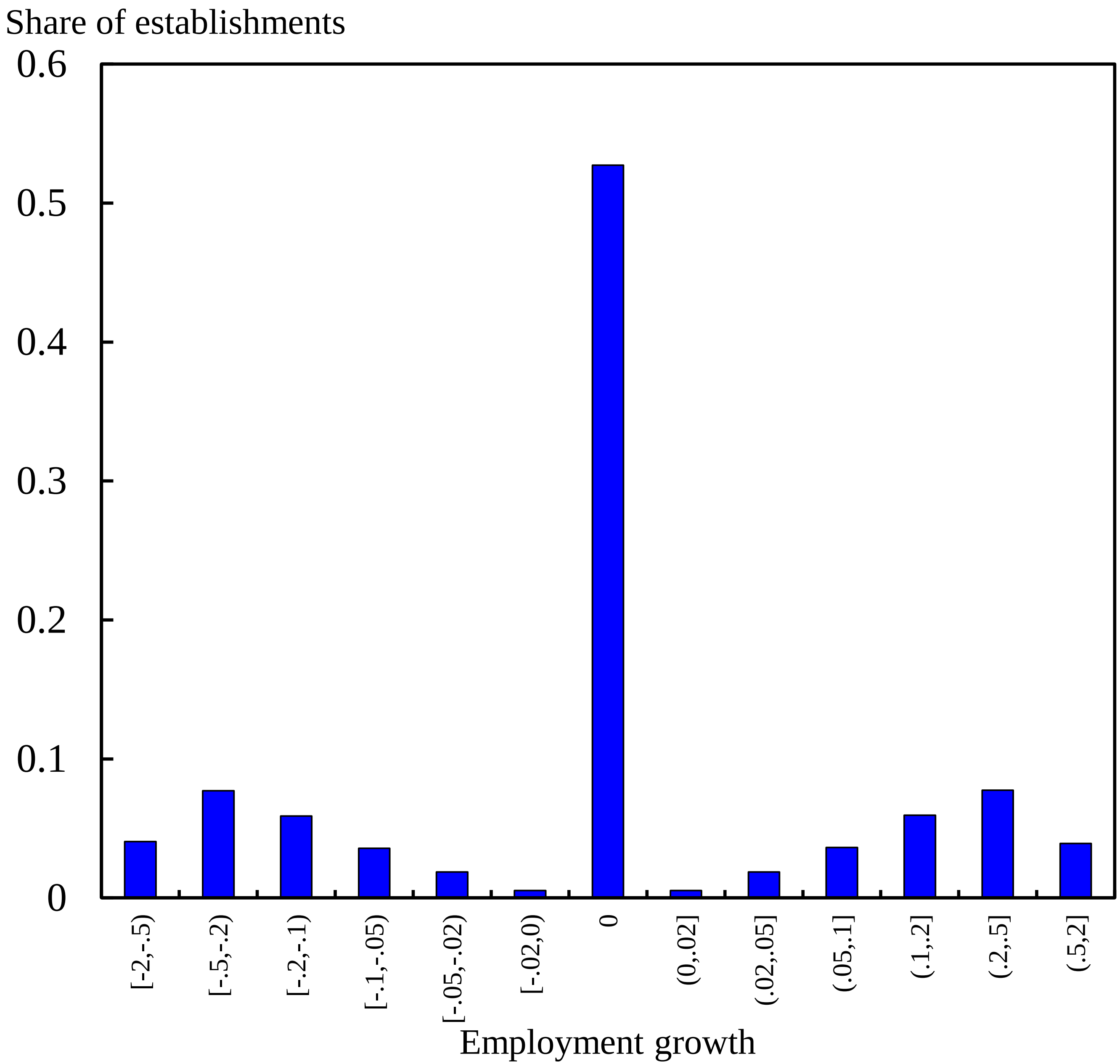
Question

What are the microeconomic origins of persistent aggregate employment dynamics?

Microeconomic employment inertia

Inaction punctured by bursts of adjustment.

Are these linked?



Distribution of employment growth, QCEW 1992-2013

Canonical approach

- Specify a model of lumpy adjustment costs.
- Match moments of the microdata.
- Draw out aggregate implications.
- Answer can depend on structure of model, moments matched etc.

Our approach / Contributions / Roadmap

1. Diagnostic.
   – Straightforward assessment of aggregate implications of popular class of theories; no estimation required.

2. Empirical application.
   – Rich U.S. microdata on establishment employment dynamics cast doubt on role of canonical models.

3. Novel micro fact.
   – Suggests the importance of replacement hiring.

4. Replacement hiring may matter for macro dynamics.
   – Vacancy chains as an amplification mechanism.

I. AGGREGATION

Aggregation

The density of employment across firms $h(n)$ evolves according to:

$$\Delta h(n) = \text{Inflow}(n) - \text{Outflow}(n)$$

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Two themes

1. Adj. costs leave clear imprint on these flows.
2. We can measure these flows in microdata.

Leading example: fixed costs

The density of employment across firms $h(n)$ evolves according to:

$$\Delta h(n) = \text{Pr(adjust to } n\text{)}\, h^*(n) - \text{Outflow}(n)$$

Density implied if **all** firms adjust

Leading example: fixed costs

The density of employment across firms $h(n)$ evolves according to:

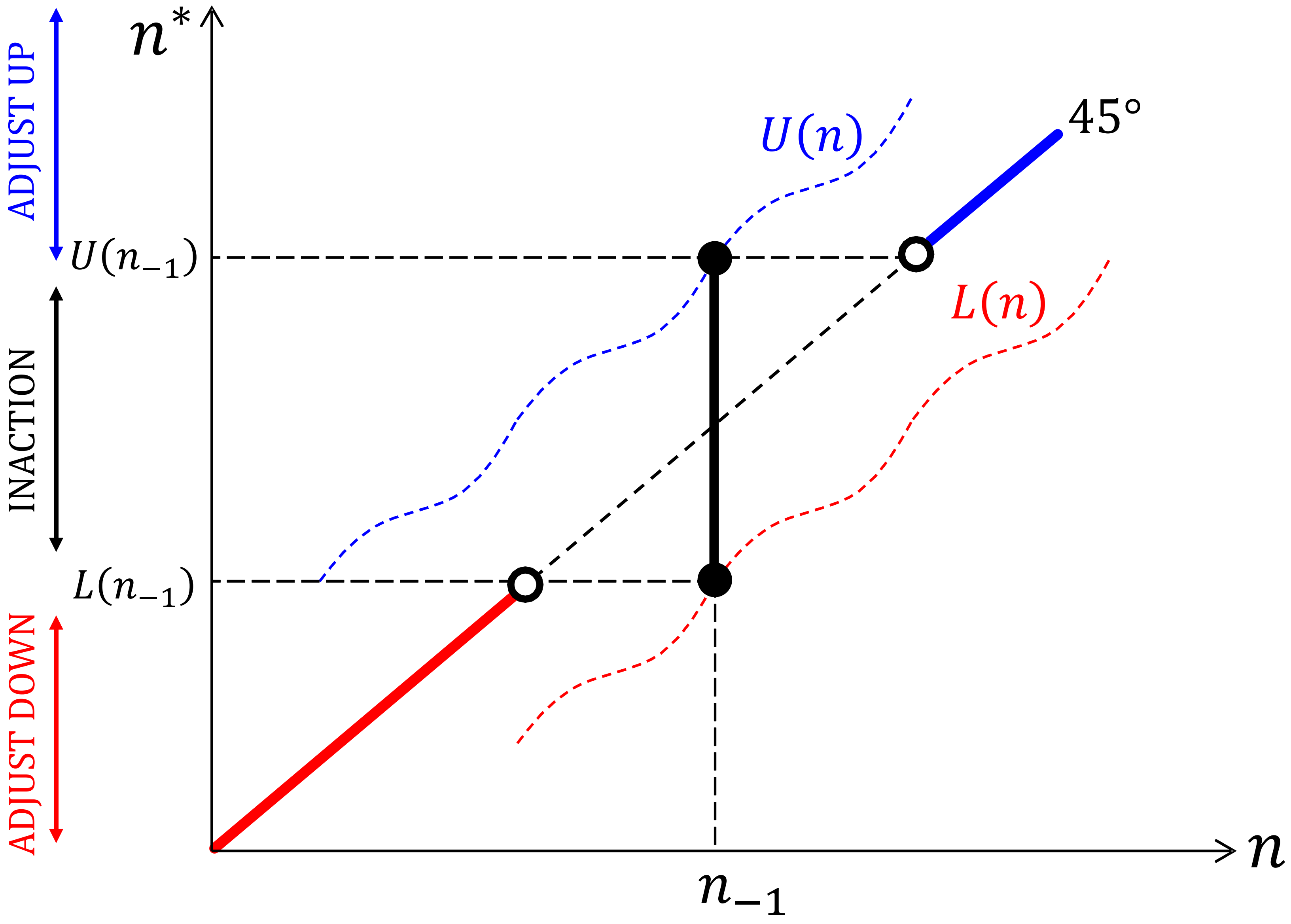
$$\Delta h(n) = \text{Pr(adjust to } n) \, h^*(n)$$
$$- \text{Pr(adjust from } n) \, h_{-1}(n)$$

Density **inherited** from past

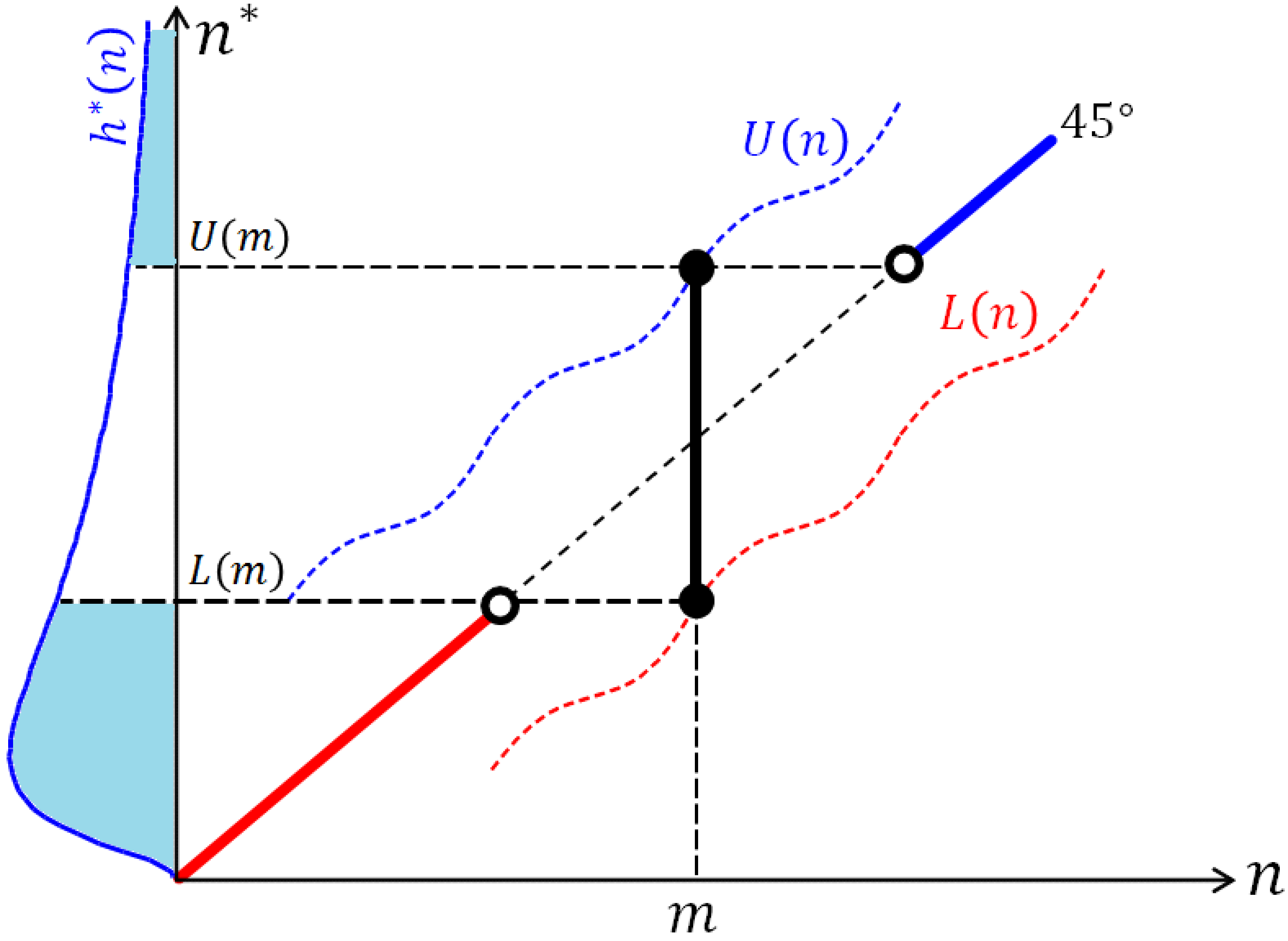
Leading example: fixed costs

The density of employment across firms $h(n)$ evolves according to:

$$\Delta h(n) = \Pr(\text{adjust to } n)\, h^*(n)$$
$$- \Pr(\text{adjust from } n)\, h_{-1}(n)$$



An *Ss* labor demand policy.

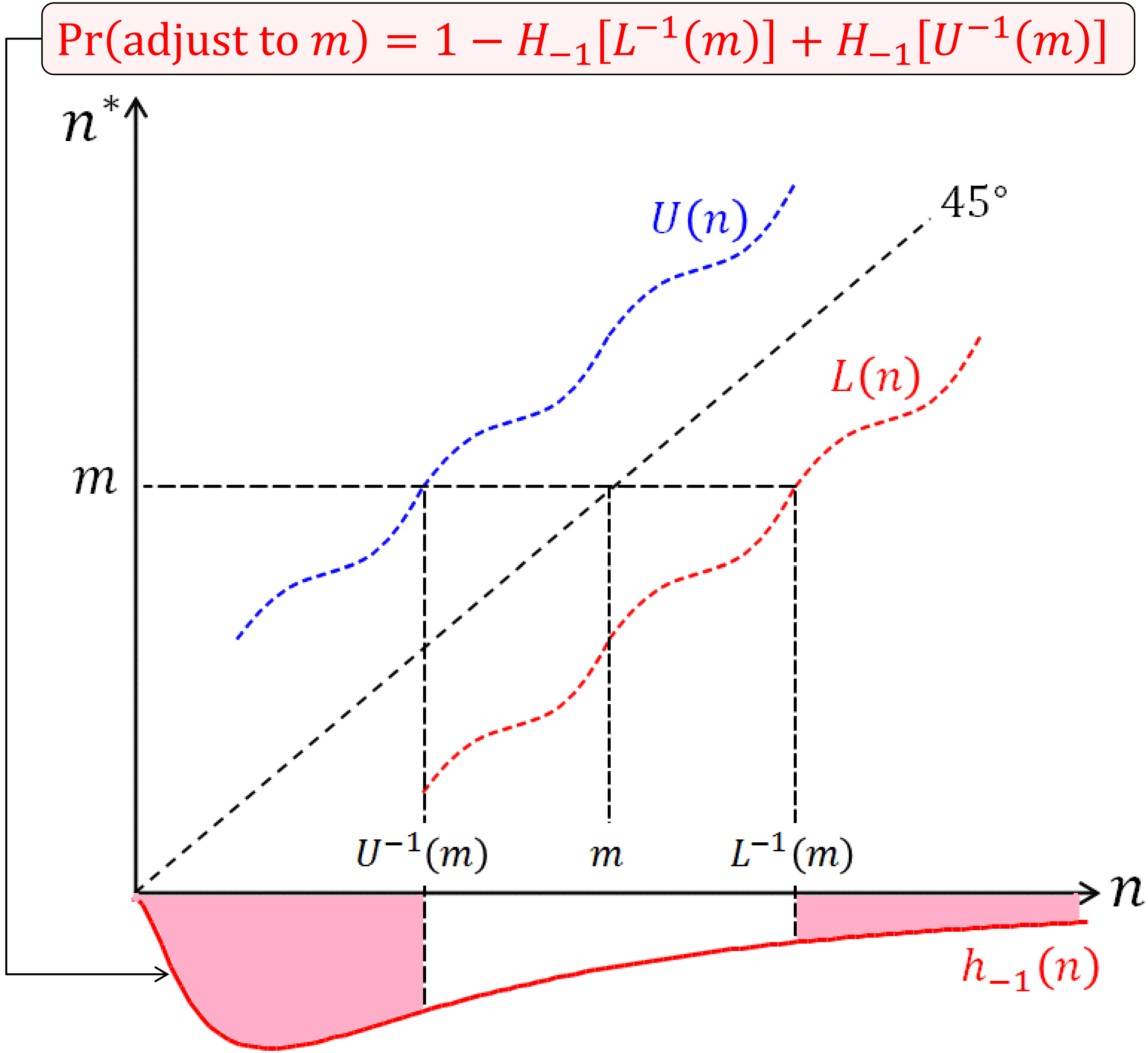


$$\Pr(\text{adjust from } m) = 1 - H^*[U(m)] + H^*[L(m)]$$

Leading example: fixed costs

The density of employment across firms $h(n)$ evolves according to:

$$\Delta h(n) = \boxed{\text{Pr}(\text{adjust to } n)} h^*(n) - \text{Pr}(\text{adjust from } n)\, h_{-1}(n)$$



Pr(adjust to m) = $1 - H_{-1}[L^{-1}(m)] + H_{-1}[U^{-1}(m)]$
n^*
$U(n)$
45°
$L(n)$
m
$U^{-1}(m)$
m
$L^{-1}(m)$
n
$h_{-1}(n)$

Leading example: fixed costs

The density of employment across firms $h(n)$ evolves according to:

$$\Delta h(n) = \Pr(\text{adjust to } n)\, h^*(n) - \Pr(\text{adjust from } n)\, h_{-1}(n)$$

Leading example: fixed costs

The density of employment across firms $h(n)$ evolves according to:

$\tau(n)$

$$\Delta h(n) = \Pr(\text{adjust to } n)\, h^*(n) - \Pr(\text{adjust from } n)\, h_{-1}(n)$$

$\phi(n)$

Leading example: fixed costs

The density of employment across firms $h(n)$ evolves according to:

$$\Delta h(n) = -\phi(n)\left[h_{-1}(n) - \hat{h}(n)\right]$$

$\hat{h}(n)$ is a flow steady state that sets $\Delta h(n) = 0$:

$$\hat{h}(n) = \frac{\tau(n)}{\phi(n)} h^{*}(n)$$

Leading example: fixed costs

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$\hat{h}(n)$ is a flow steady state that sets $\Delta h(n) = 0$:

$$\hat{h}(n) = \frac{\tau(n)}{\phi(n)} h^*(n)$$

Claim:
This is useful

II. A DIAGNOSTIC

Flow steady state as a diagnostic

Aggregate employment implied by $\hat{h}(n)$ informs path of frictionless aggregate employment:

$$\hat{h}(n) \quad = \quad \frac{\tau(n)}{\phi(n)} h^*(n)$$

Flow steady state as a diagnostic

Aggregate employment implied by $\hat{h}(n)$ informs path of frictionless aggregate employment:

$$\hat{N} = \int n\hat{h}(n)dn = \int n\frac{\tau(n)}{\phi(n)}h^*(n)dn$$

Flow steady state as a diagnostic

Aggregate employment implied by $\hat{h}(n)$ informs path of frictionless aggregate employment:

$$\hat{N} = \int n\hat{h}(n)dn = \mathbb{E}_{h^*}\left[n \cdot \frac{\tau(n)}{\phi(n)}\right]$$

Flow steady state as a diagnostic

Aggregate employment implied by $\hat{h}(n)$ informs path of frictionless aggregate employment:

$$\hat{N} = \int n\hat{h}(n)dn = \mathbb{E}_{h^*}\left[n \cdot \frac{\tau(n)}{\phi(n)}\right]$$

$$= N^* + cov^*\left(n, \frac{\tau(n)}{\phi(n)}\right)$$

Intuition I. $\widehat{N}$ as a bound for N^*

$$\widehat{N} = N^* + cov^*\left(n, \frac{\tau(n)}{\phi(n)}\right)$$

E.g. positive aggregate shock $\Rightarrow$

$$N^* \uparrow \qquad \textbf{and} \qquad cov^*\left(n, \frac{\tau(n)}{\phi(n)}\right) \uparrow$$

More likely to adjust to vs. from higher ns.

Intuition I. $\widehat{N}$ as a bound for N^*

$$\widehat{N} = N^* + cov^*\left(n, \frac{\tau(n)}{\phi(n)}\right)$$

E.g. negative aggregate shock ⇒

$$N^* \downarrow \quad \textbf{and} \quad cov^*\left(n, \frac{\tau(n)}{\phi(n)}\right) \downarrow$$

Less likely to adjust to vs. from higher ns.

Intuition II. Jump dynamics of $\widehat{N}$

$$\widehat{N} = N^* + cov^*\left(n, \frac{\tau(n)}{\phi(n)}\right)$$

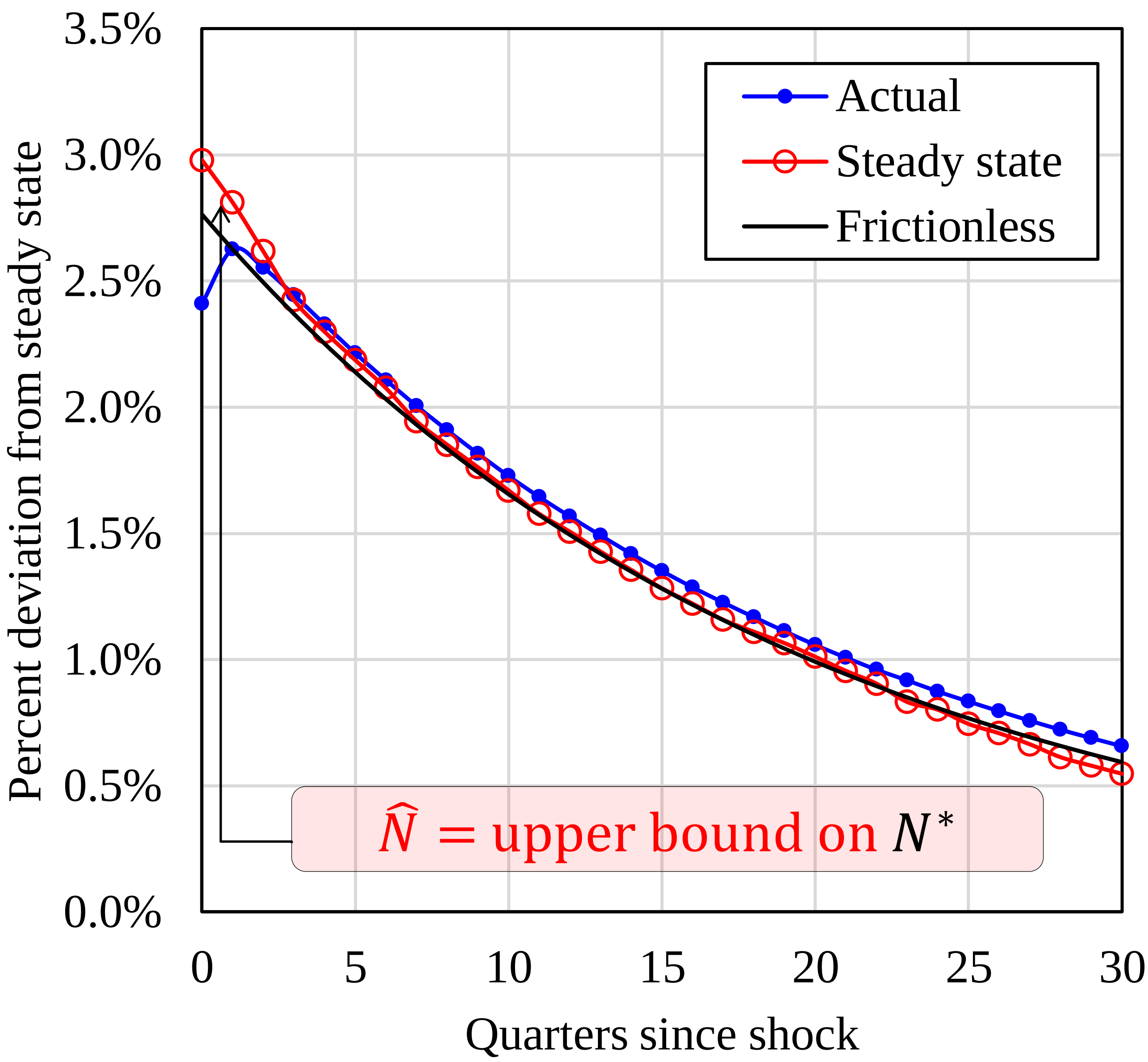
- $\tau(n)$ and $\phi(n)$ determined by policy function.
- Policy function forward looking $\Rightarrow$ jump.
- $\widehat{N}$ will inherit jump dynamics.
- We think this logic generalizes to kinked costs.

Some quantitative examples

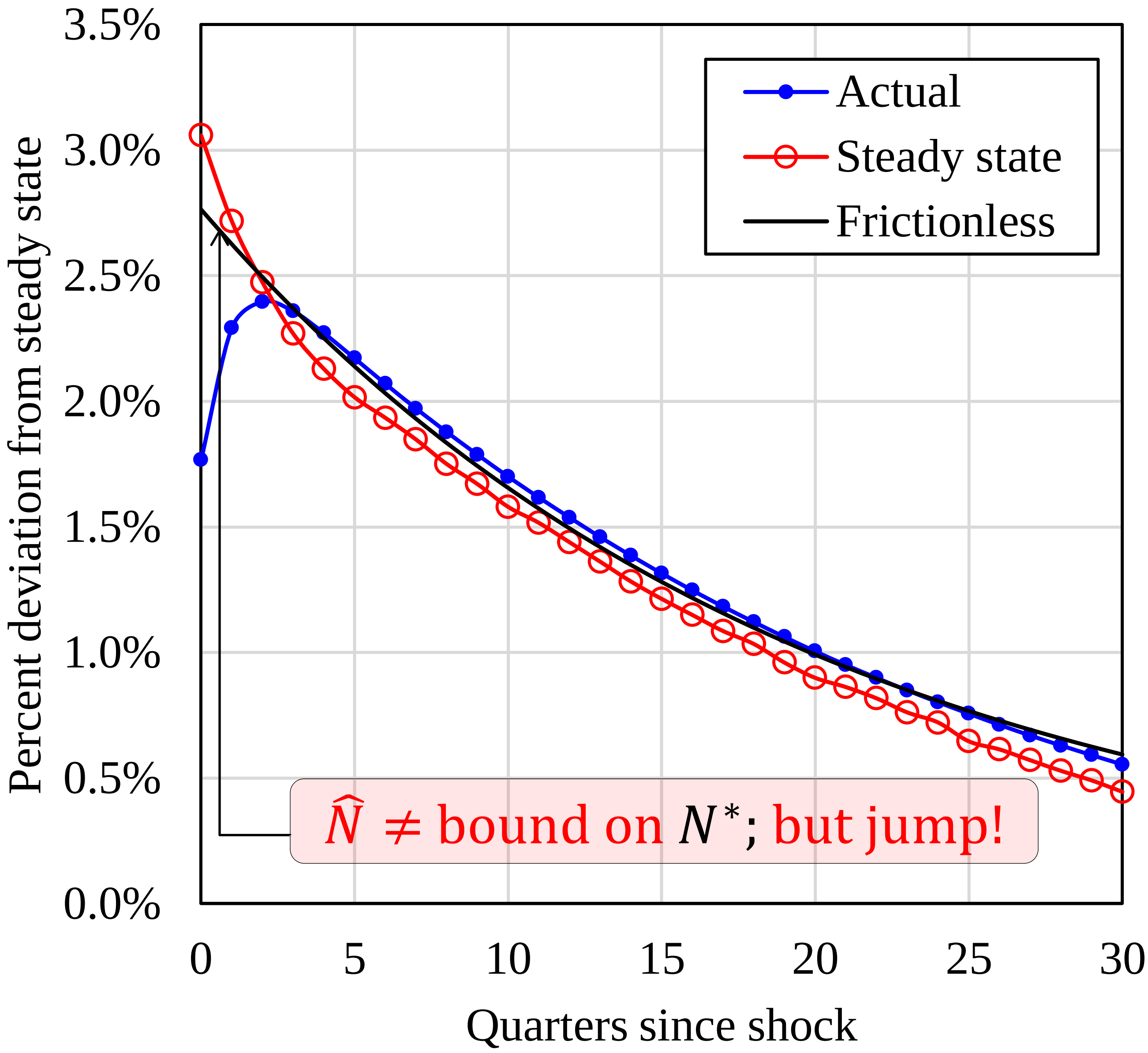
1. Pure fixed adjustment cost.
   - To see daylight b/w series, consider "large" C.
   - $\Pr(\text{inaction}) = 0.65$ per quarter. [Data suggest 0.5.]

2. Fixed and kinked adjustment costs.
   - Fix inaction rate and vary size of kinked cost.
   - $c/w \in \{0.08, 0.16\}$. [Bloom (2009) finds 0.08.]

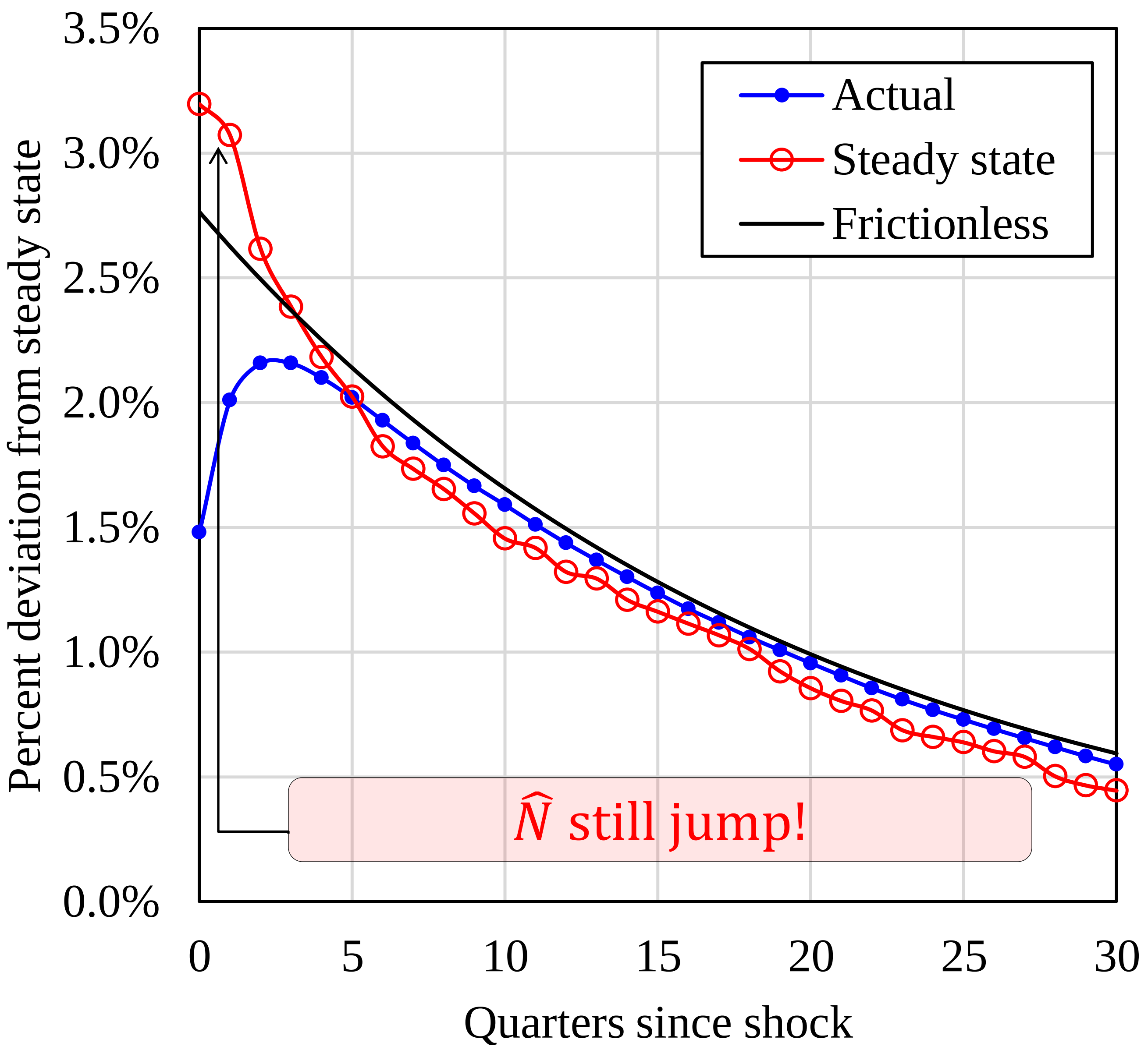
- All are for fixed aggregate state (i.e. wages).



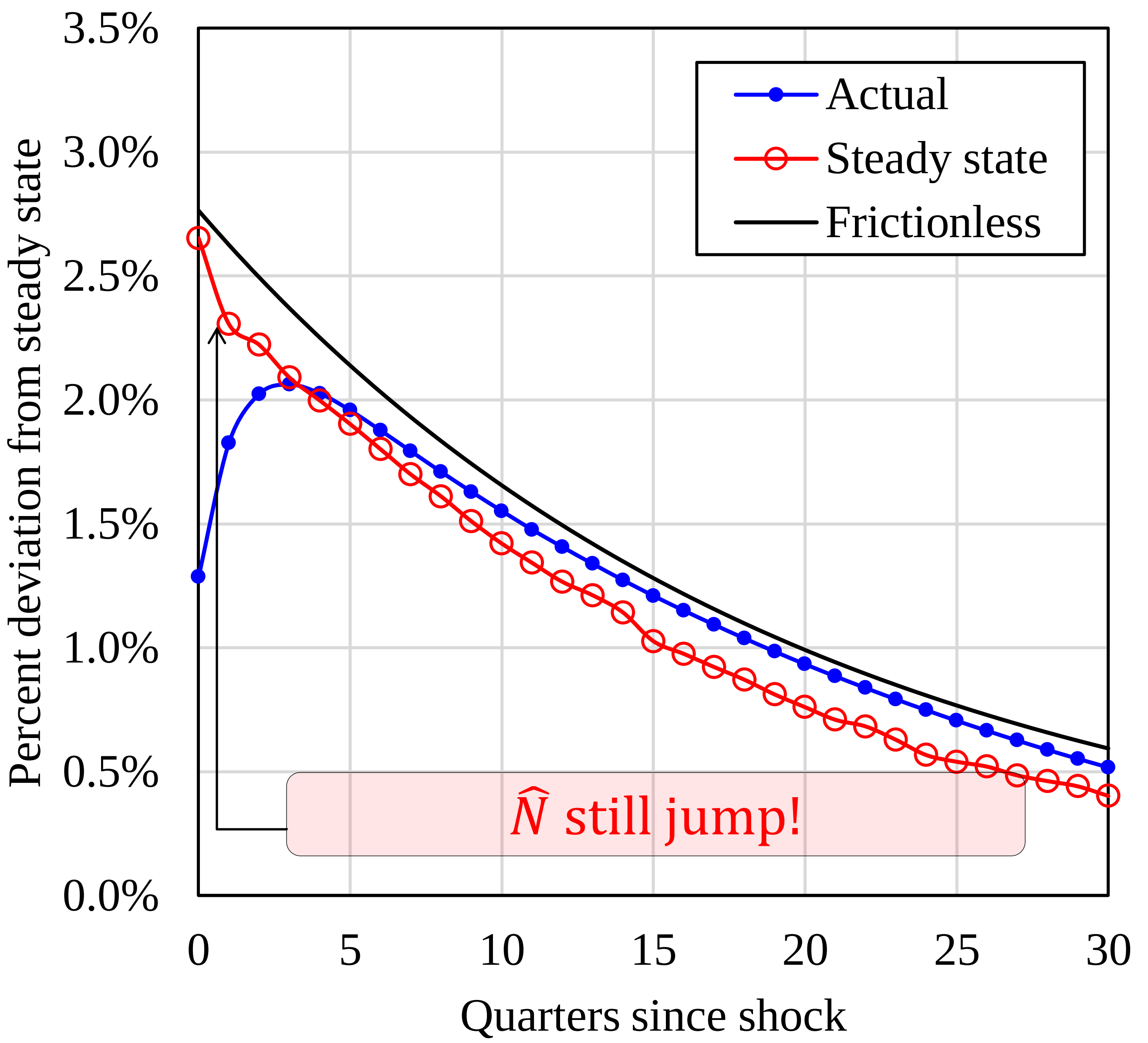
Pure fixed adjustment cost, Pr(inaction) = 0.65



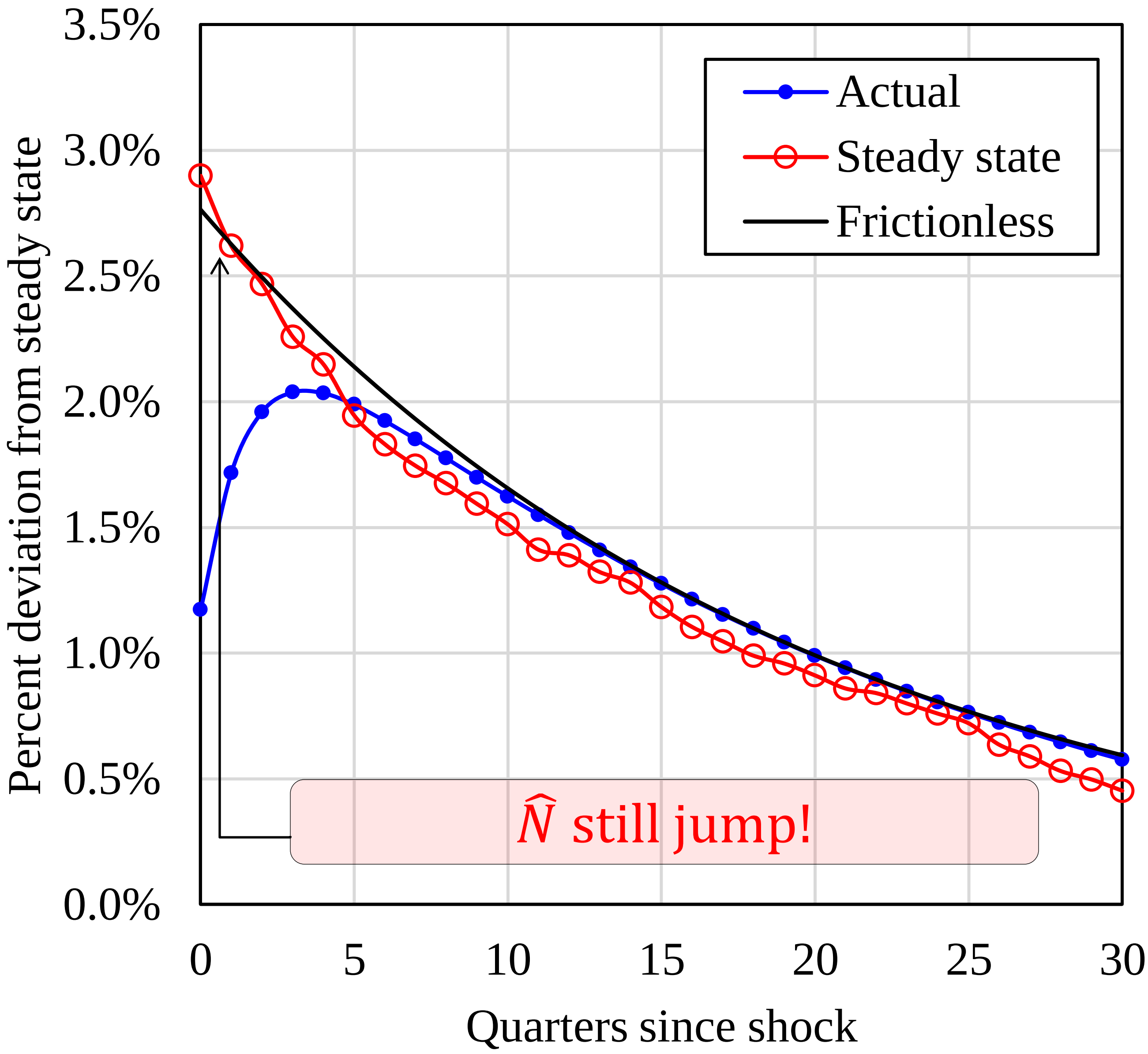
Fixed and small kinked costs, $\Pr(\text{inaction}) = 0.65$



Fixed and small kinked costs, $\Pr(\text{inaction}) = 0.8$



Fixed and large kinked costs, $\Pr(\text{inaction}) = 0.65$



Fixed and large kinked costs, $\Pr(\text{inaction}) = 0.8$

III. EMPIRICAL APPLICATION

Empirical approach

Aggregation result has clear empirical content:

We can **measure** much of the law of motion:

$$\Delta h(n) = -\,\mathrm{Pr}(\text{adjust from } n)\left[h_{-1}(n) - \hat{h}(n)\right]$$

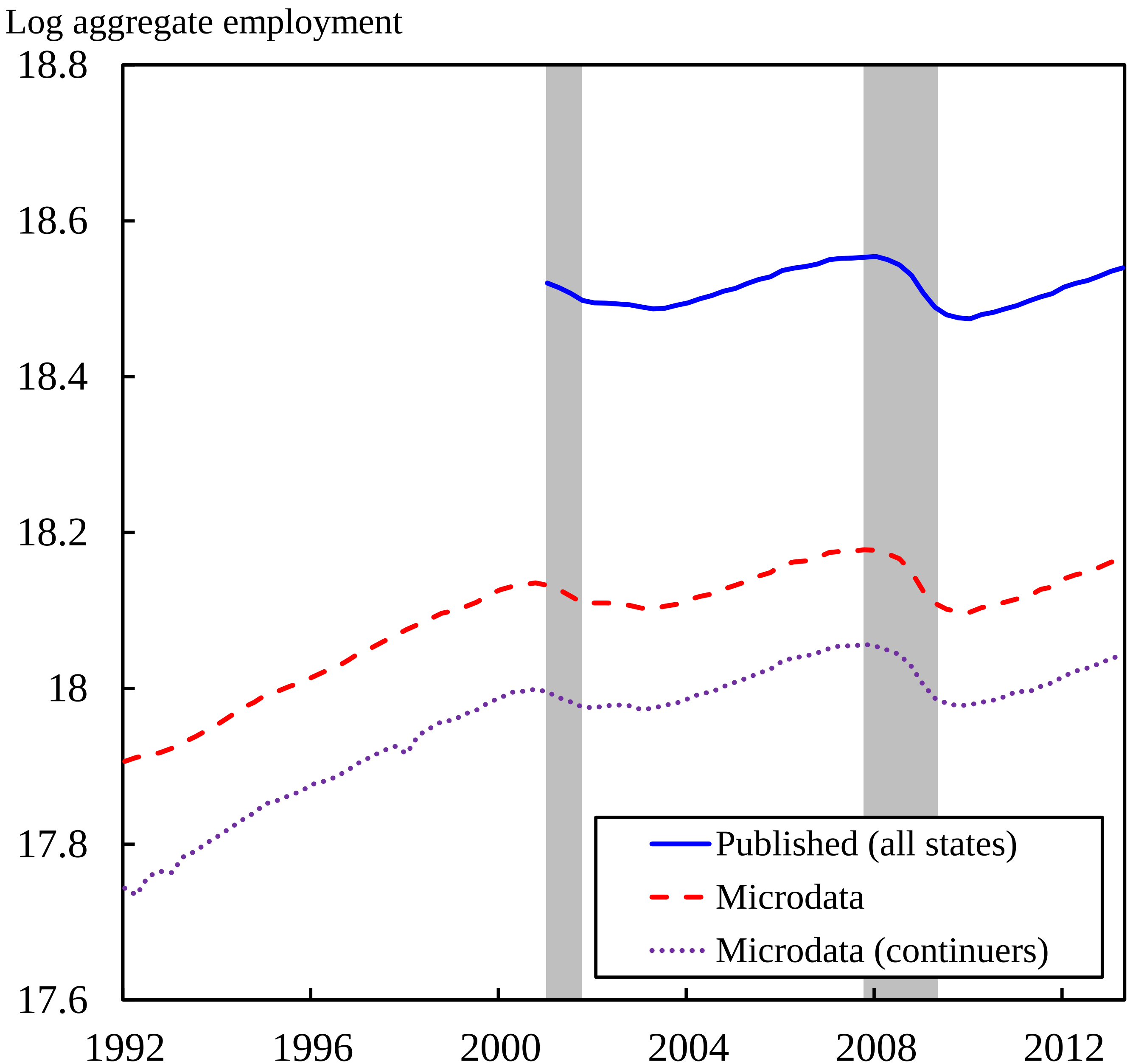
- $\Delta h(n)$: Change in mass of firms at n
- $\mathrm{Pr}(\text{adjust from } n)$: Share of firms at n that adjusts away
- $h_{-1}(n)$: Mass of firms at n last period

$\Rightarrow$ Can **estimate** $\hat{h}(n) = \dfrac{\Delta h(n)}{\mathrm{Pr}(\text{adjust from } n)} + h_{-1}(n)$.

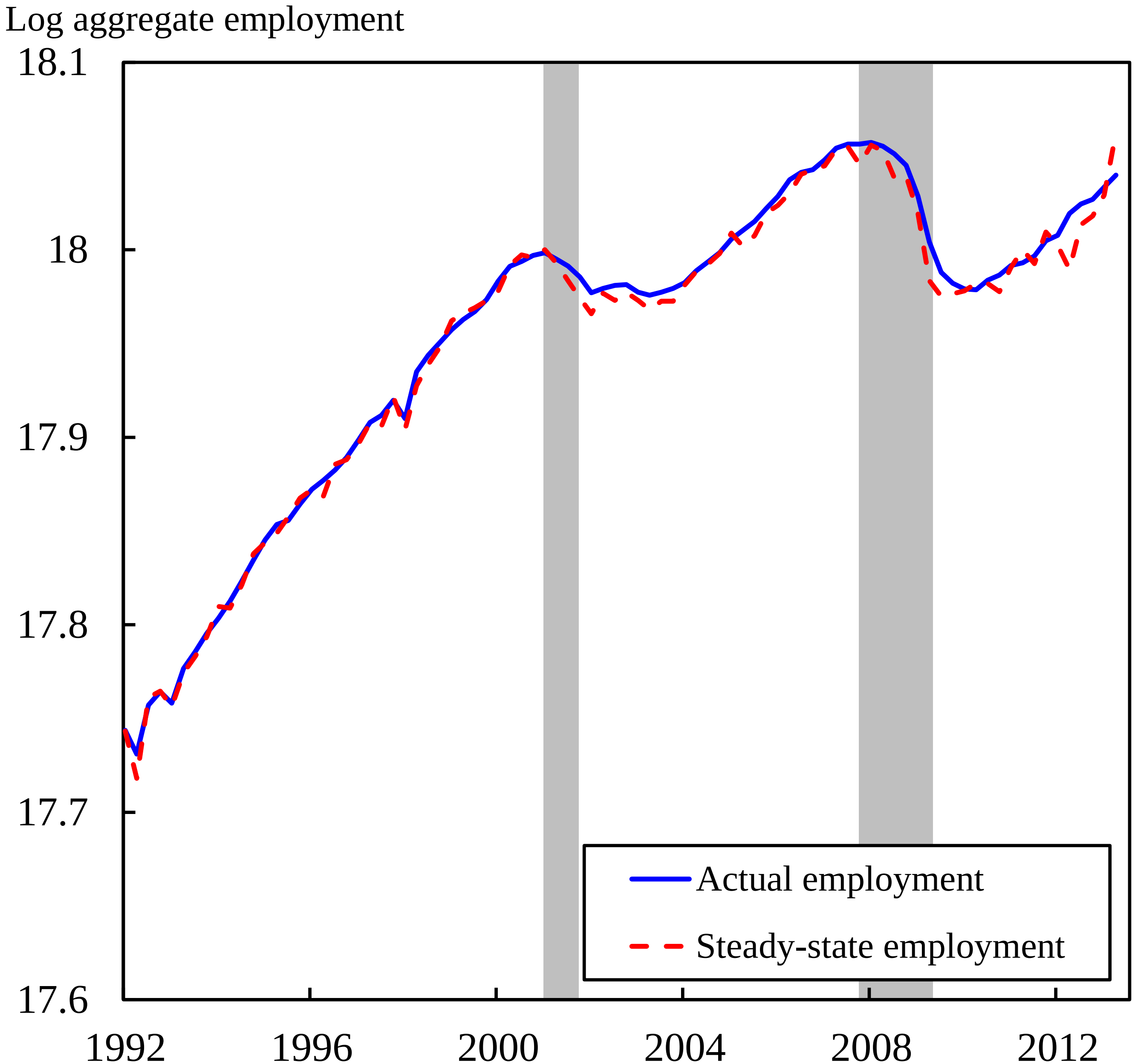
Data

- Quarterly Census of Employment and Wages.
  - Census of all UI-covered employment
  - $\approx$ 98% of U.S. employment.

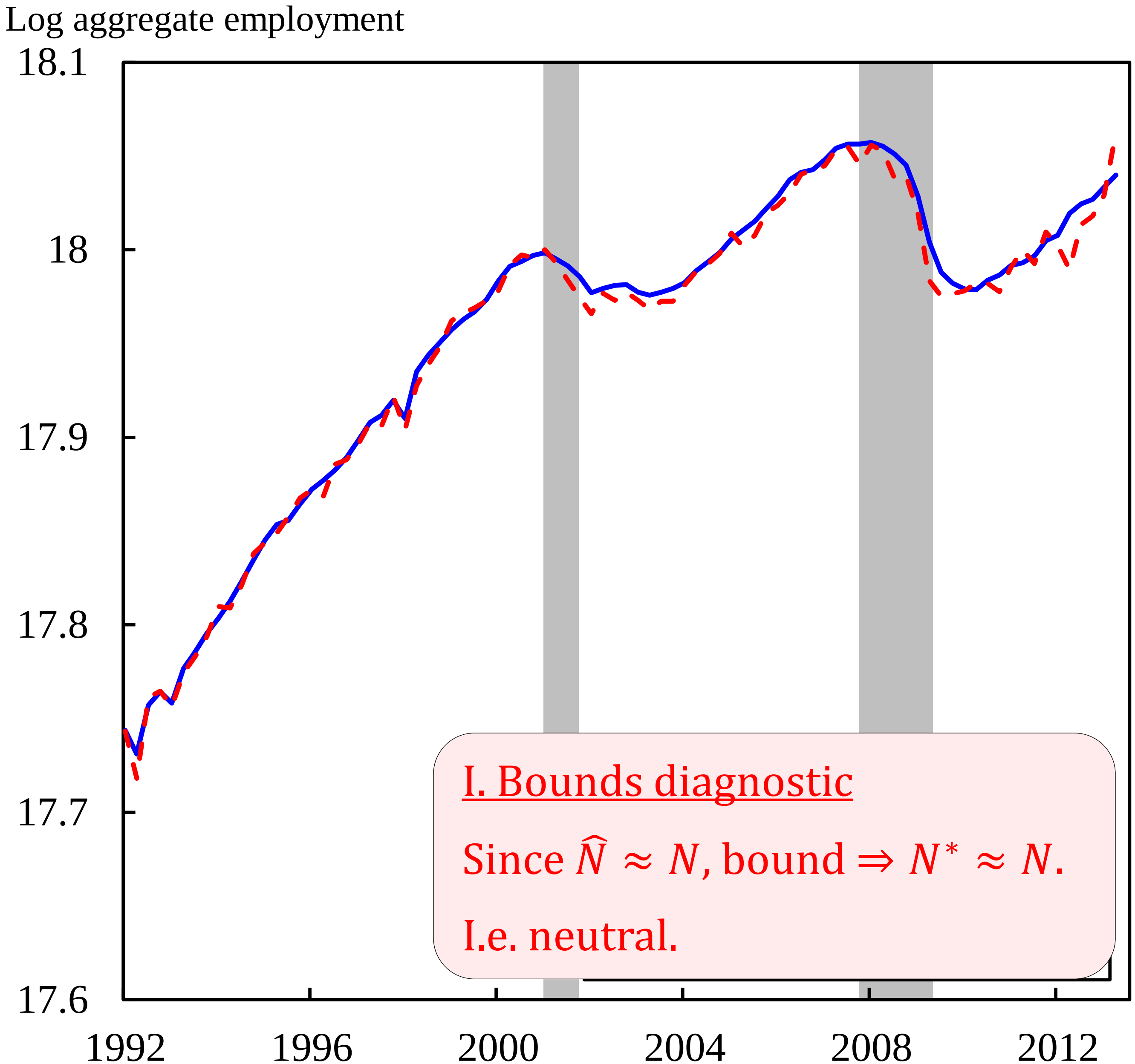
- Establishment microdata onsite at BLS.
  - Excludes MA, NH, NY, WI, FL, IL, MS, OR, WY, PA.
  - Restrict analysis to continuing, private estabs. [I.e. drop births and deaths.]
  - Broad coverage $\Rightarrow$ natural establishment panel.



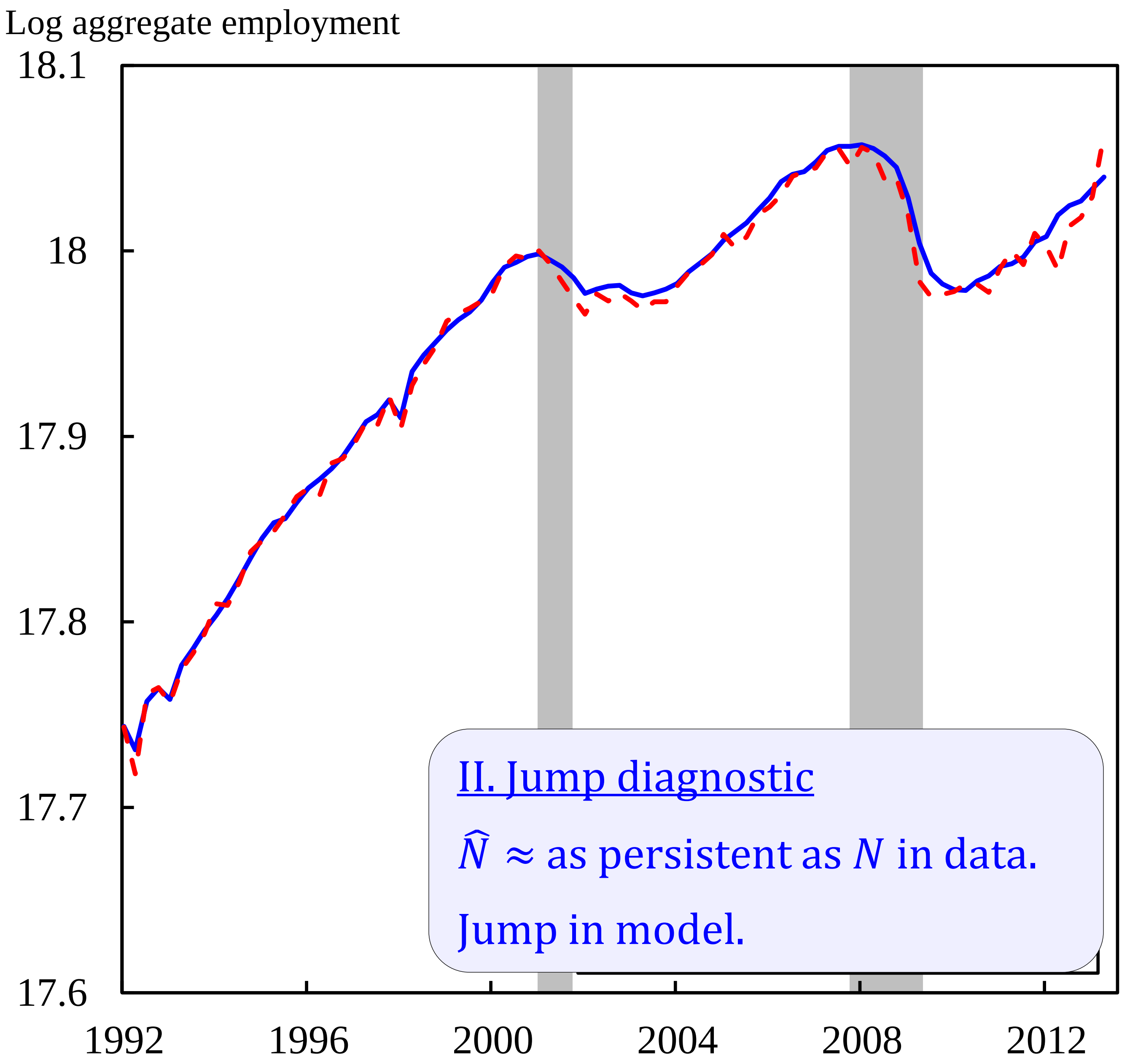
Log aggregate employment, QCEW 1992-2013



Actual vs. steady-state log aggregate employment, QCEW 1992-2013

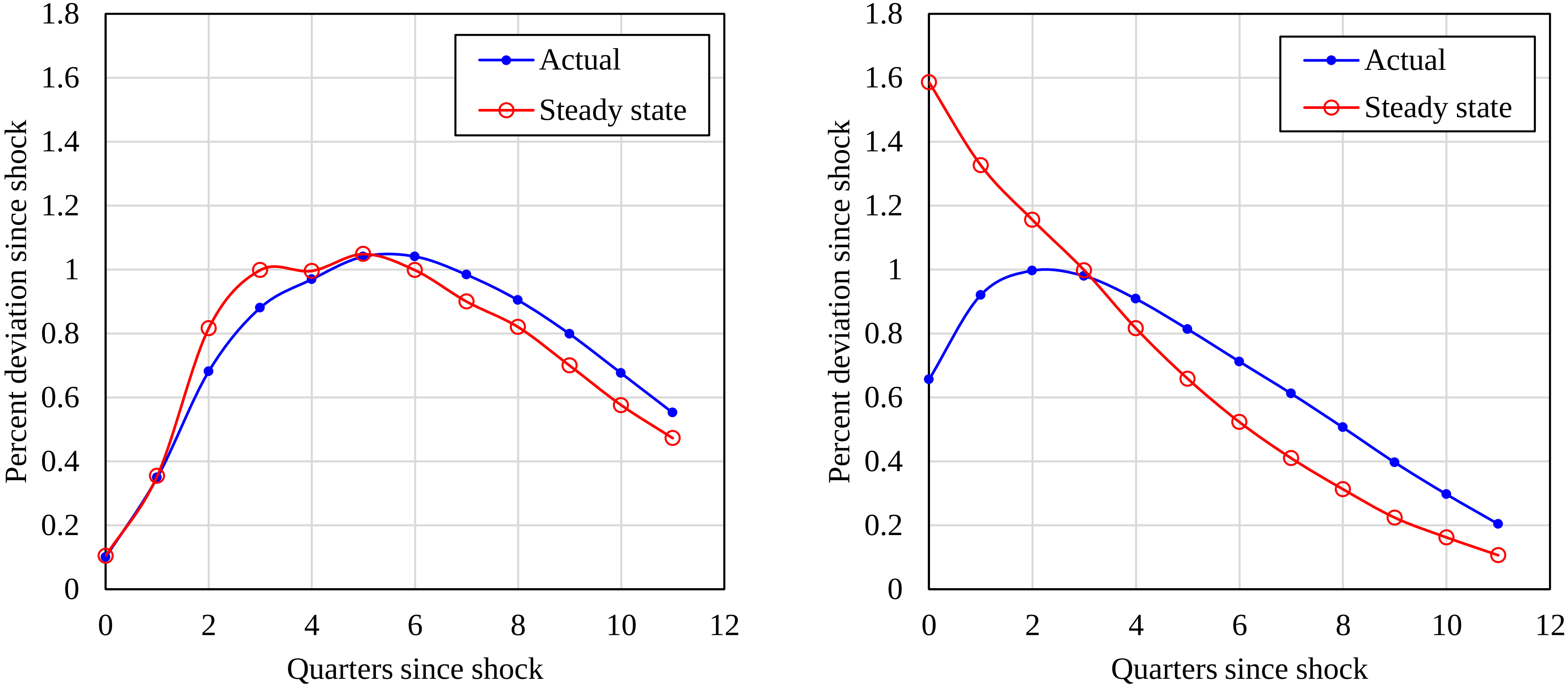


Actual vs. steady-state log aggregate employment, QCEW 1992-2013



Actual vs. steady-state log aggregate employment, QCEW 1992-2013

Data **Model** (large kinked cost)



Dynamic correlations with innovation to output, data vs. model

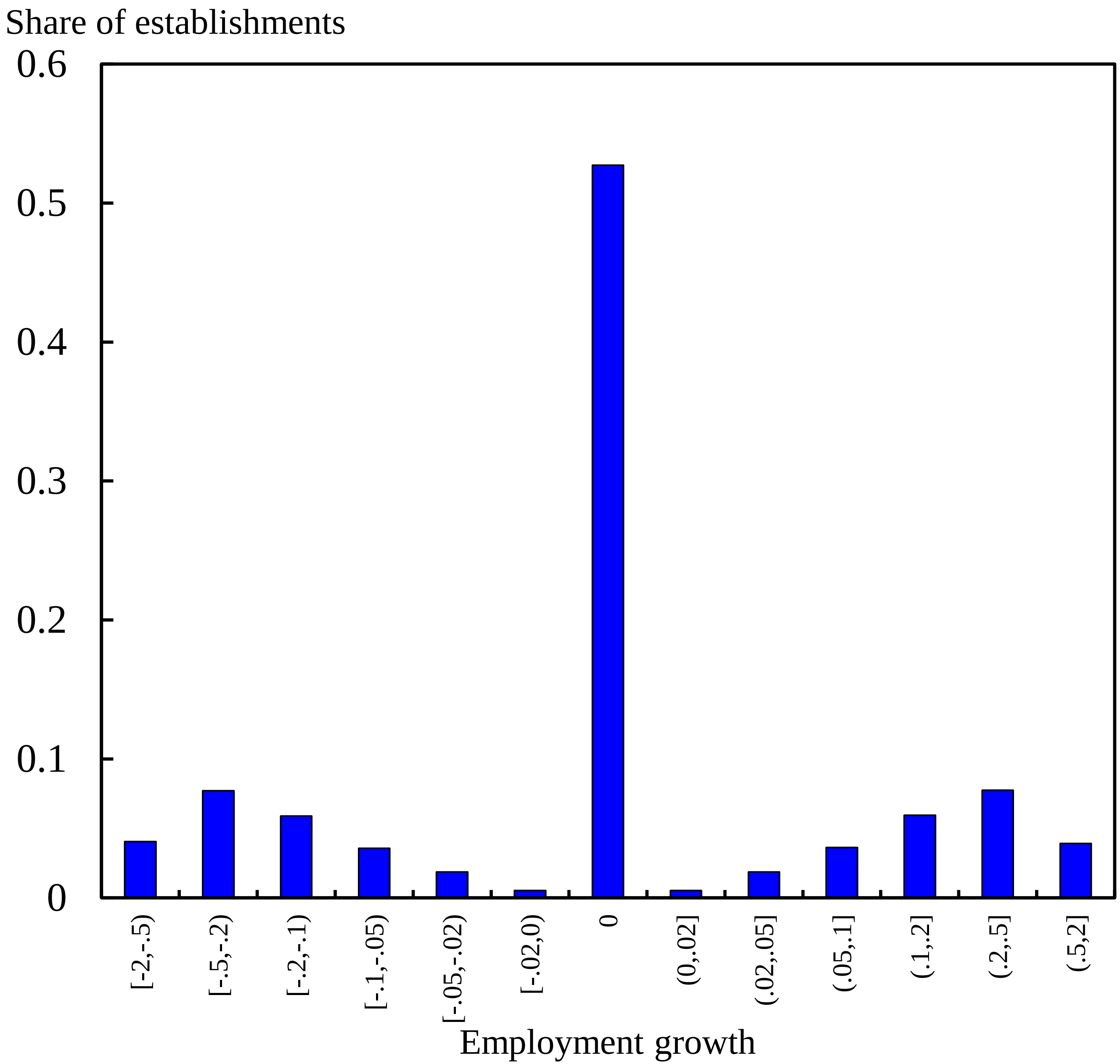
IV. SOME NEW FACTS

Back to the data: 3 facts

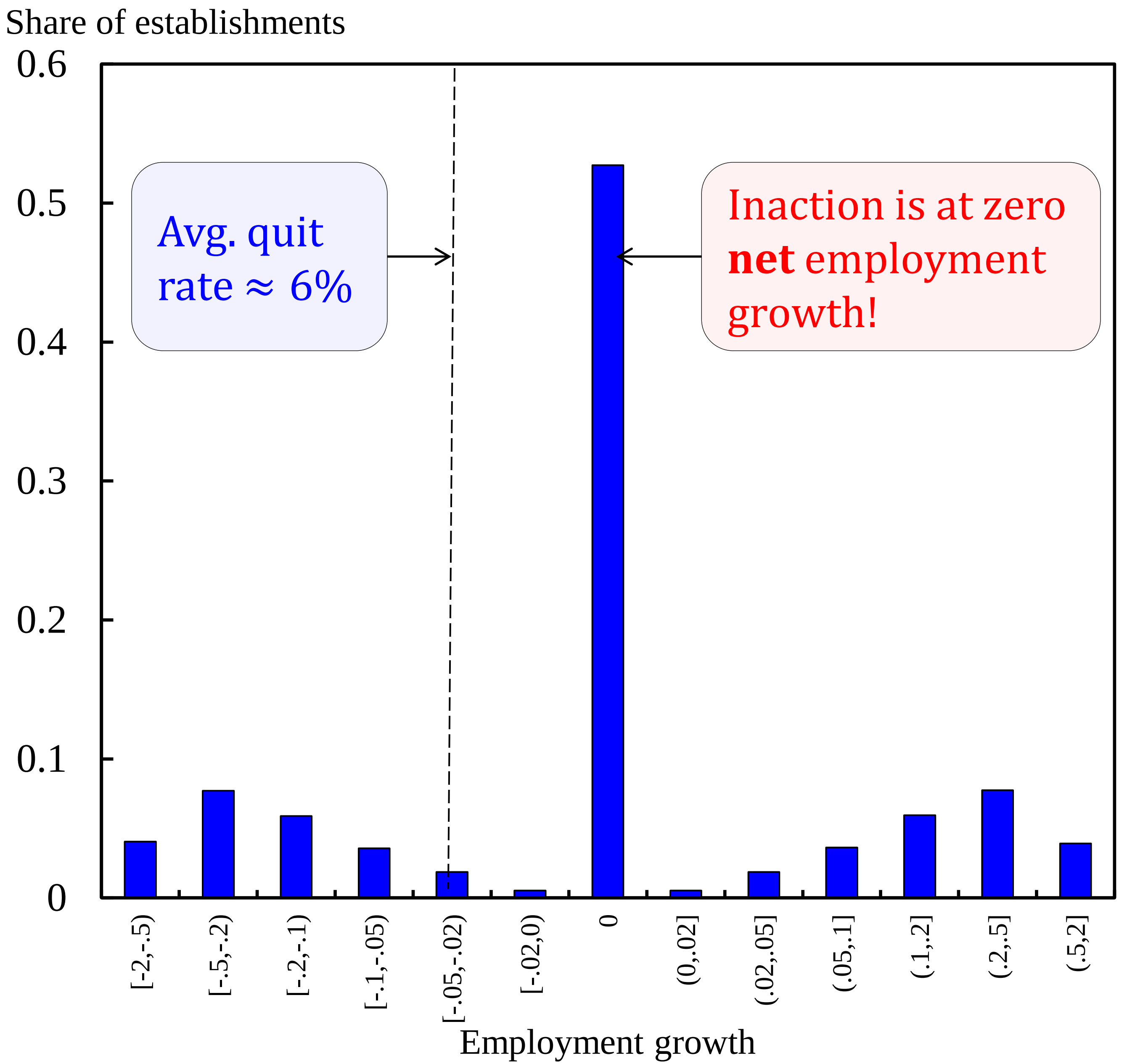
1. Inaction over **net** changes.
   – Even though quit rate is 6% per quarter (JOLTS).

2. Slow **decay** of inaction by frequency.
   – Much slower than exponential decay.

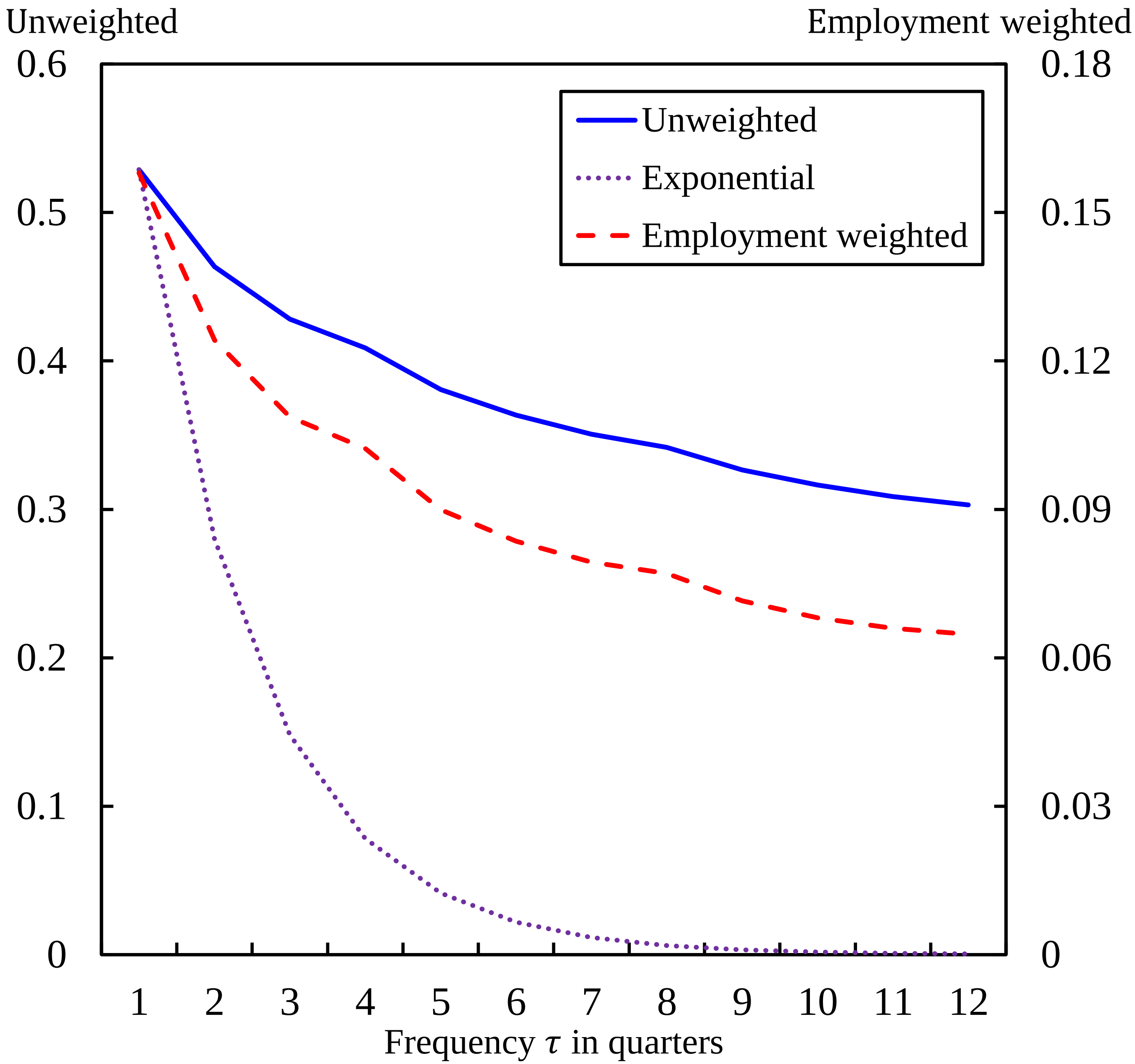
3. Inaction correlated w/ **job-to-job transitions**.
   – At both aggregate and industry levels.



Distribution of employment growth, QCEW 1992-2013



Distribution of employment growth, QCEW 1992-2013



$Pr(n_t = n_{t+\tau})$, QCEW average over 1992-2013

Slow decay of inaction

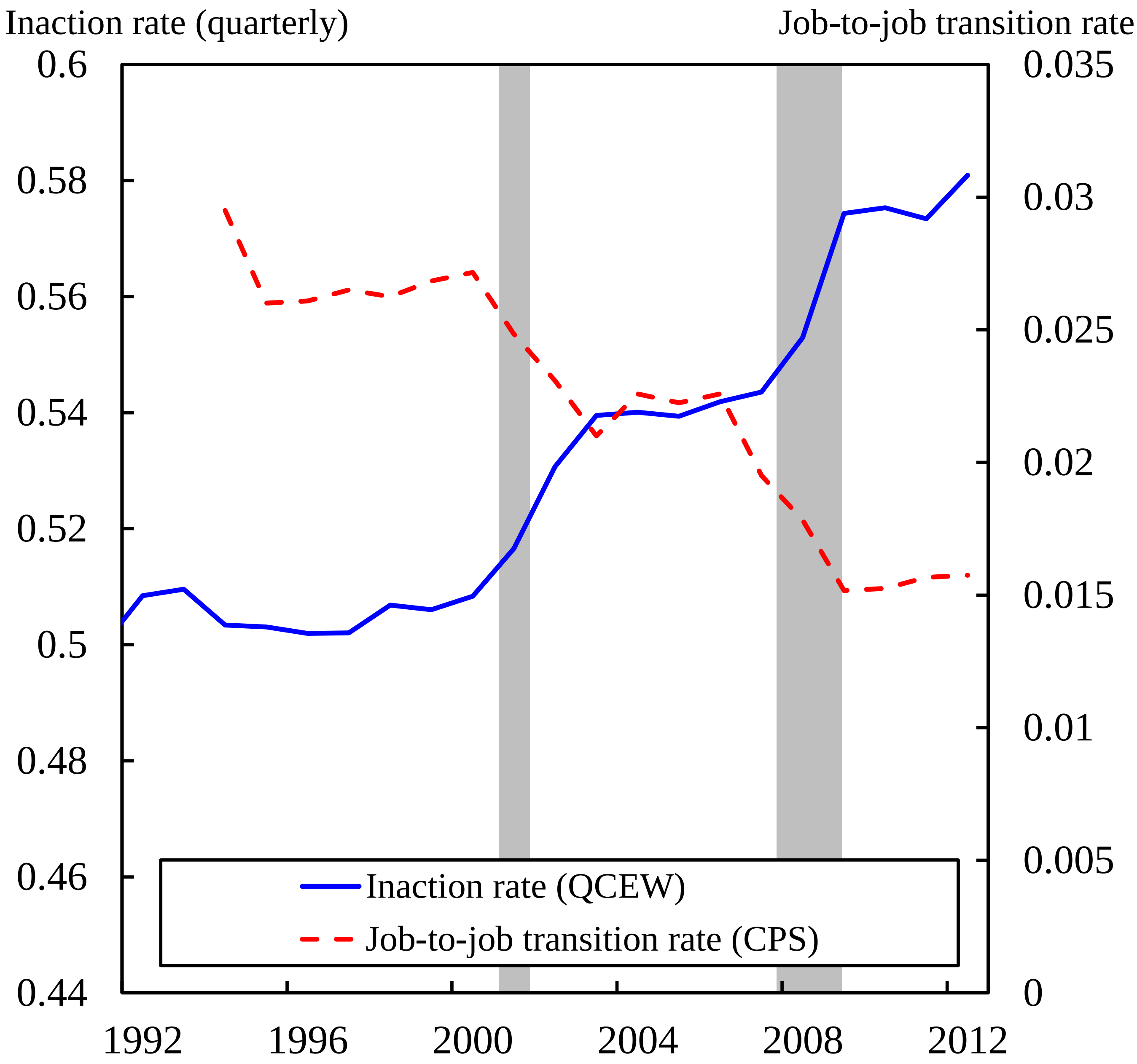
- Not captured in any of the baseline models.
  - Decay in model is essentially exponential.

Frequency τ in quarters	$\Pr(n_t = n_{t+\tau})$			
	Data	Pure fixed cost	+ small kink	+ larger kink
1	0.53	0.64	0.67	0.65
2	0.46	0.41	0.45	0.43
3	0.43	0.27	0.30	0.28
4	0.41	0.18	0.2	0.18

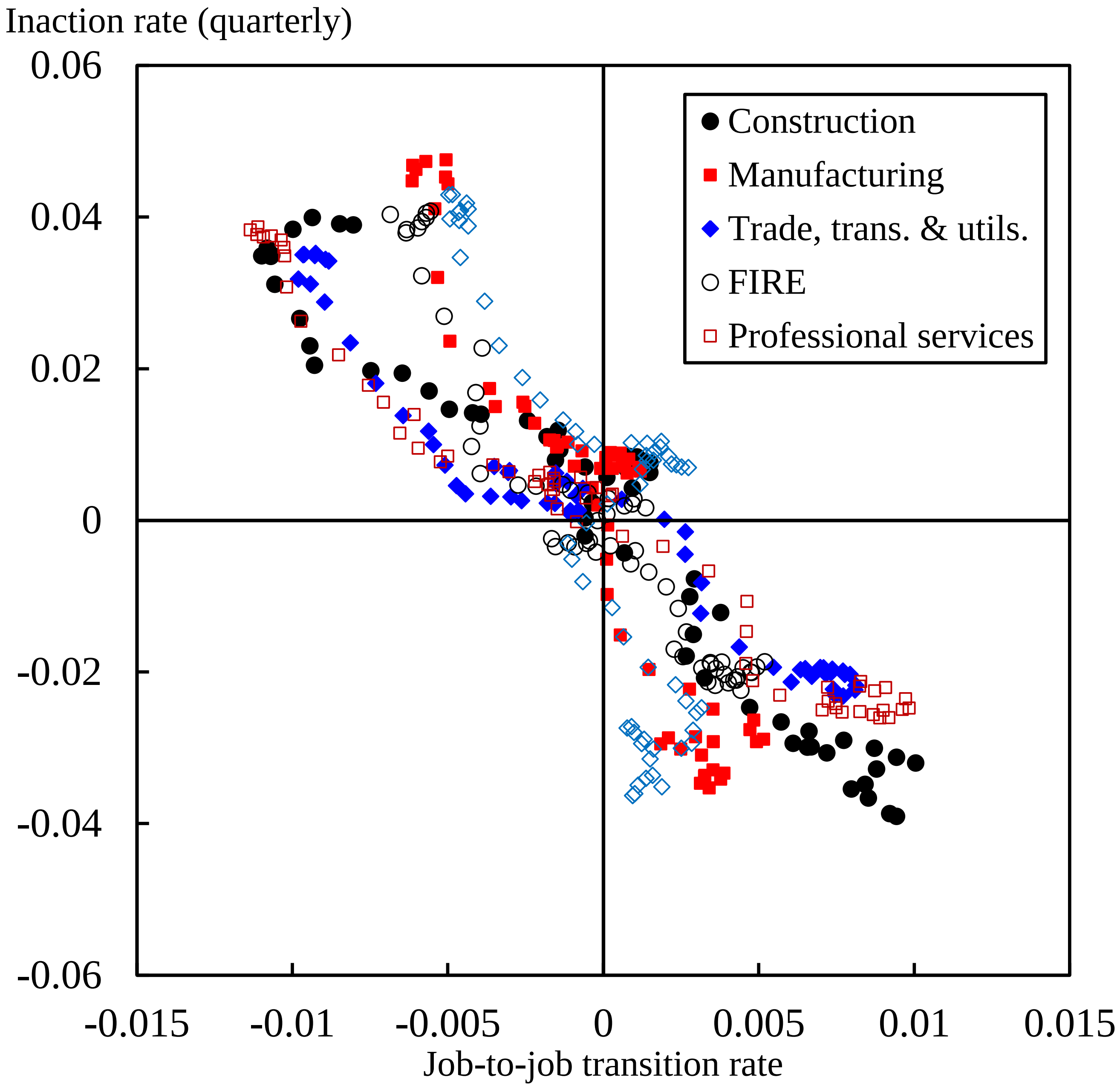
Slow decay of inaction

- Not an artefact of seasonality.
  - Decay is slow between as well as within years.
  - Similar decay in high vs. low seasonal industries.

Frequency τ in quarters	$\Pr(n_t = n_{t+\tau}) / \Pr(n_t = n_{t+1})$	
	High seasonal	Low seasonal
1	1	1
2	0.82	0.84
3	0.74	0.75
4	0.70	0.69



Aggregate inaction and job-to-job transitions, QCEW and CPS



Industry-level inaction and job-to-job transitions, QCEW and CPS

V. REPLACEMENT HIRING

Lessons from the data

- Firms appear to have **reference levels** of employment to which they return routinely.
- A lot of adjustment seen in the data is driven by **high-frequency returns** to reference level.
- Negative correlation w/ E-to-E' rate suggests role of **replacement hiring**.
- Could this matter?

A prototype model of replacement hiring

$$\Pi(n_{-1}, k_{-1}, x) \equiv$$

$\max_{n}\{pxF(n) - wn$	Revenue − costs
$-c^{+}[n - (1-\delta)n_{-1}]^{+}$	Gross hiring
$-C\mathbb{1}_{\Delta k \neq 0}$	Capacity adj.
$-c^{-}[k - n]^{-}$	Slack capacity
$+\text{Forward value}\}$	

s.t. $\Delta k = [n - k_{-1}]^{+} - [n - k_{-1}]\mathbb{1}_{n<(1-\delta)n_{-1}}$

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$$\Pi(n_{-1}, k_{-1}, x) \equiv$$

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$$+\text{Forward value}\}$$

s.t. $\Delta k = [n - k_{-1}]^+ - [n - k_{-1}]\mathbb{1}_{n<(1-\delta)n_{-1}}$

Saves a control variable

A prototype model of replacement hiring

$$\Pi(n_{-1}, k_{-1}, x) \equiv$$

Exogenous (for now)

$\max_n \{pxF(n) - wn$	Revenue − costs
$-c^+[n - (1-\delta)n_{-1}]^+$	Gross hiring
$-C\mathbb{1}_{\Delta k \neq 0}$	Capacity adj.
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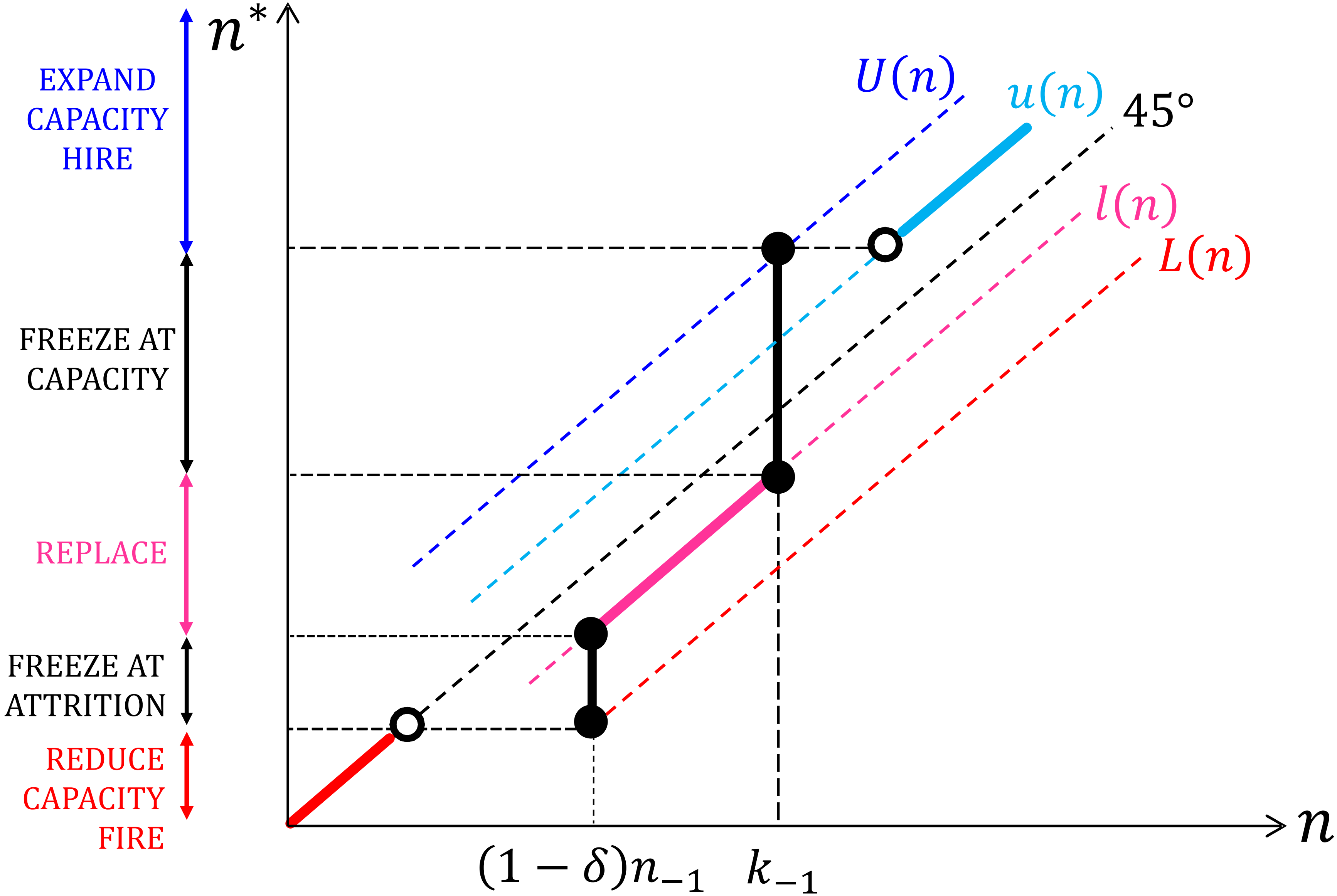
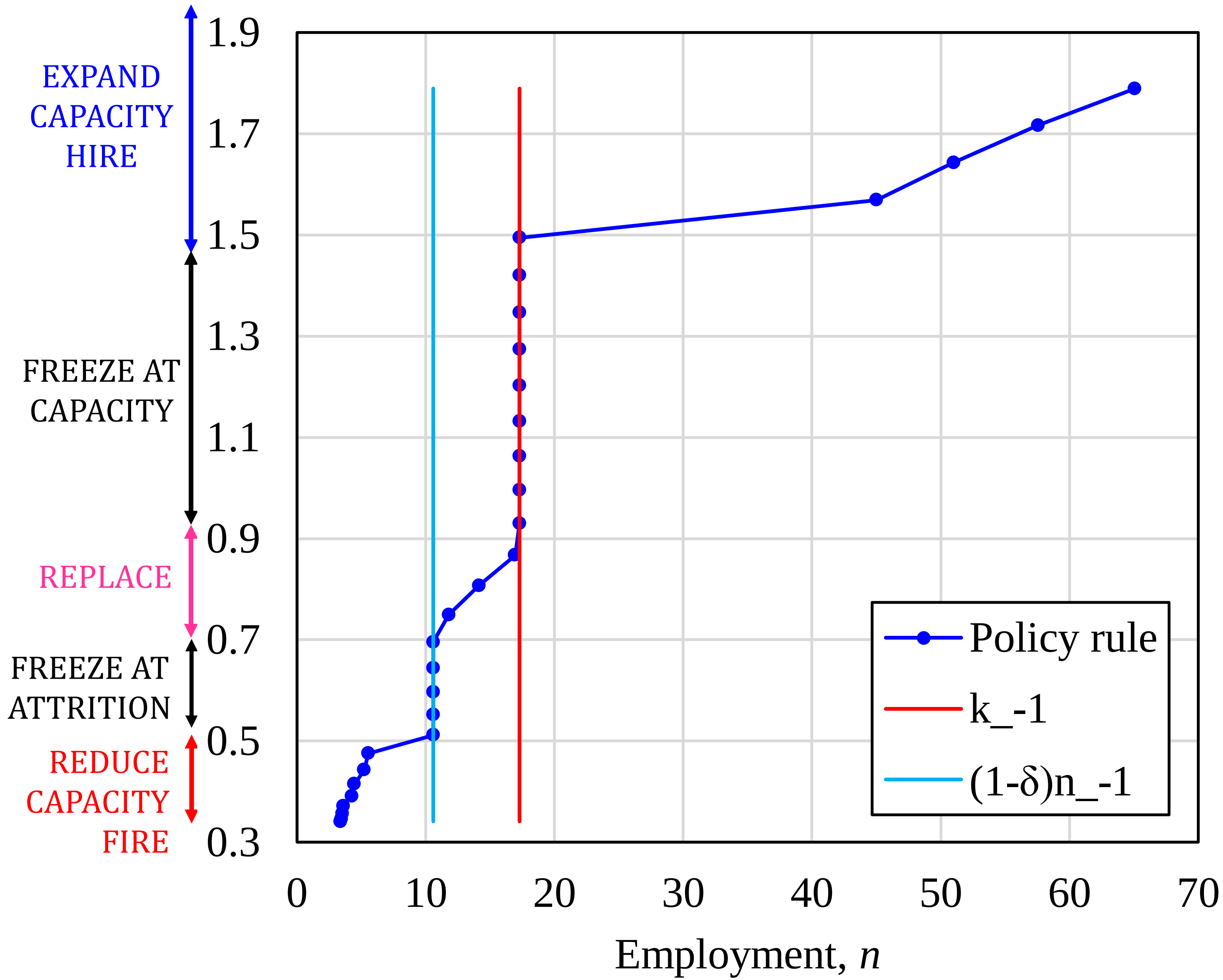
s.t. $\Delta k = [n - k_{-1}]^+ - [n - k_{-1}]\mathbb{1}_{n<(1-\delta)n_{-1}}$

Saves a control variable



A prototype model of replacement hiring



Policy function from numerical model

Model does better on slow decay of inaction

Frequency τ in quarters	$\Pr(n_t = n_{t+\tau}) / \Pr(n_t = n_{t+1})$	
	Model	Data
1	1	1
2	0.86	0.87
3	0.76	0.81
4	0.69	0.77

Why replacement hiring might matter

Search models ⇒ gross per-worker hiring cost:

$$c^+ = \frac{\text{vacancy cost}}{\text{vacancy filling rate}} = \frac{\gamma}{q(V)}$$

1. More Vs reduce q, hiring cost c^+ rises.

   → **Negative** feedback.

Why replacement hiring might matter

Search models $\Rightarrow$ gross per-worker hiring cost:

$$c^{+} = \frac{\text{vacancy cost}}{\text{vacancy filling rate}} = \frac{\gamma}{q(V)}$$

1. More Vs reduce q, hiring cost c^{+} rises.
   $\longrightarrow$ **Negative** feedback.

2. More Vs raise δ, post further Vs to replace.
   $\longrightarrow$ **Positive** feedback: Vacancy chains...

A prototype model of replacement hiring

$$\Pi(n_{-1}, k_{-1}, x) \equiv$$

$\max\limits_{n}\{pxF(n) - wn$ Revenue − costs

$- c^{+}\left[n - (1 - \delta)n_{-1}\right]^{+}$ Gross hiring

$-C\mathbb{1}_{\Delta k \neq 0}$ Capacity adj.

$-c^{-}[k - n]^{-}$ Slack capacity

$+\text{Forward value}\}$

$$\text{s.t. } \Delta k = [n - k_{-1}]^{+} - [n - k_{-1}]\mathbb{1}_{n<(1-\delta)n_{-1}}$$

A prototype model of replacement hiring

$$\Pi(n_{-1}, k_{-1}, x; V) \equiv$$

$$\max_{n}\{pxF(n) - wn \qquad \text{Revenue} - \text{costs}$$

$$-\frac{\gamma}{q(V)}\left[n - \big(1 - \delta(V)\big)n_{-1}\right]^{+} \qquad \text{Gross hiring}$$

$$-C\mathbb{1}_{\Delta k \neq 0} \qquad \text{Capacity adj.}$$

$$-c^{-}[k - n]^{-} \qquad \text{Slack capacity}$$

$$+\text{Forward value}\}$$

$$\text{s.t. } \Delta k = [n - k_{-1}]^{+} - [n - k_{-1}]\mathbb{1}_{n<(1-\delta)n_{-1}}$$

A prototype model of replacement hiring

$$\Pi(n_{-1}, k_{-1}, x; V) \equiv$$

KEY: Quit rate δ rises w/ V

$$\max_n \{pxF(n) - wn$$ Revenue − costs

$$-\frac{\gamma}{q(V)}[n - (1 - \delta(V))n_{-1}]^+$$ Gross hiring

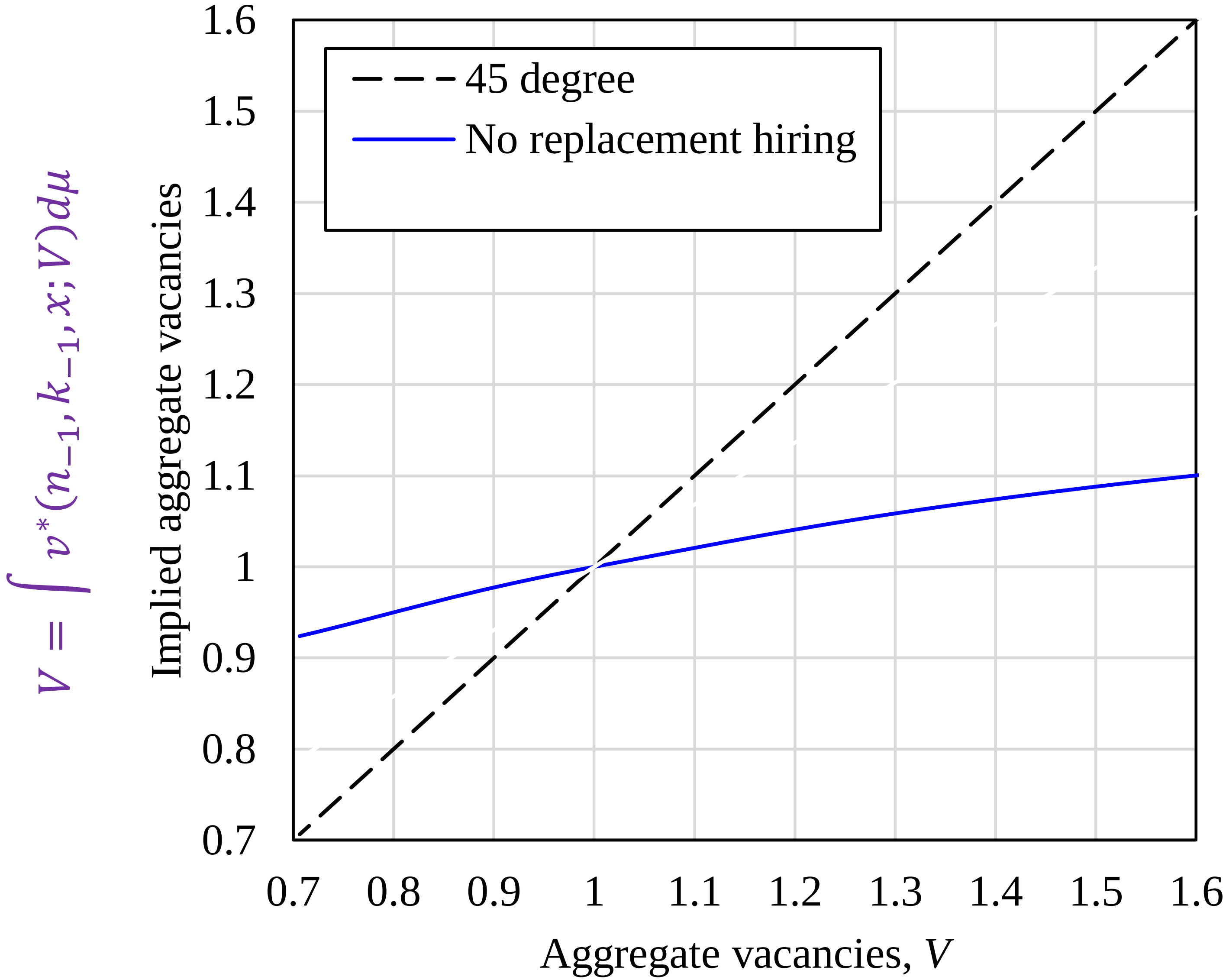
$$-C\mathbb{1}_{\Delta k \neq 0}$$ Capacity adj.

$$-c^-[k - n]^-$$ Slack capacity

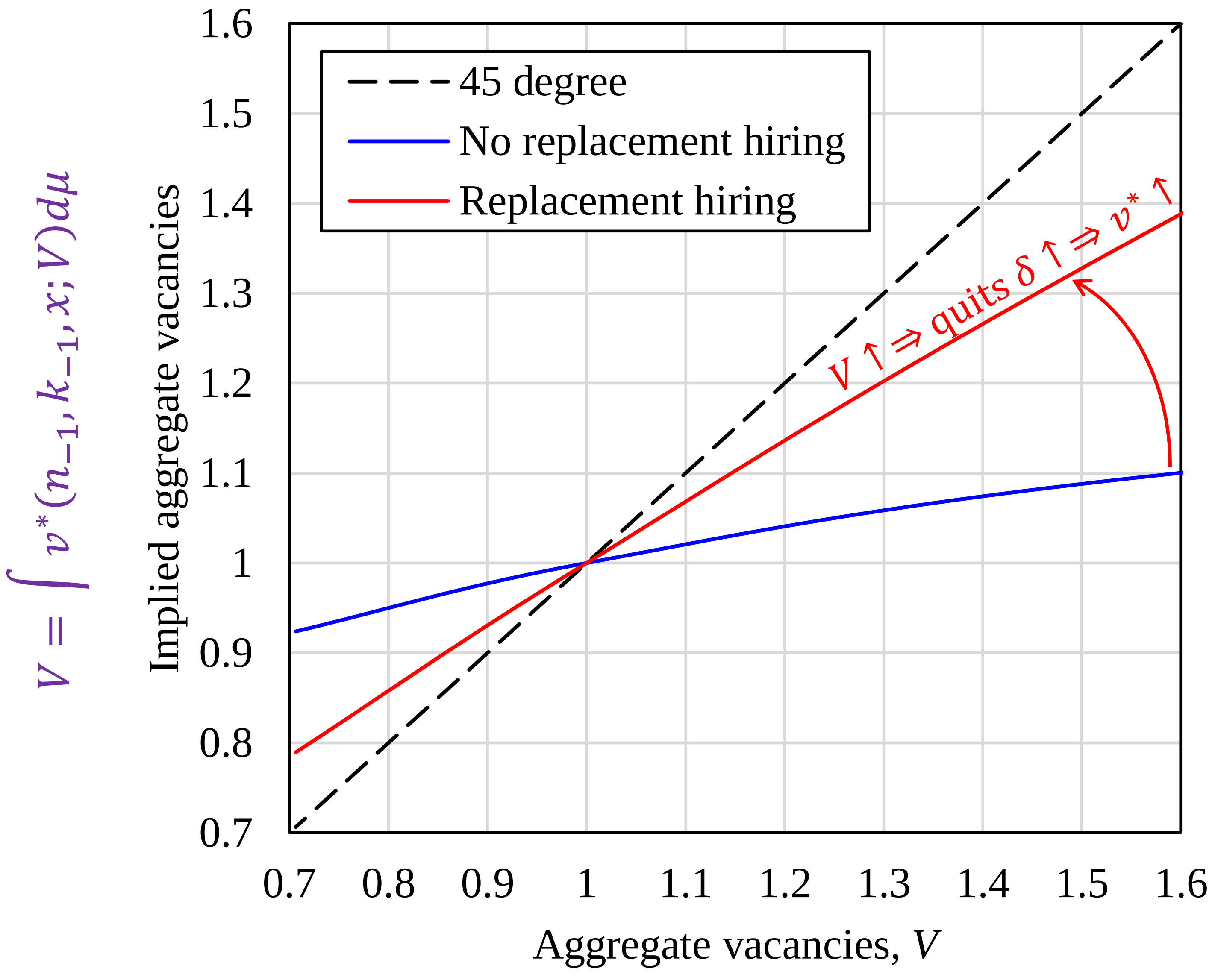
$$+\text{Forward value}\}$$

...and slack is costly.

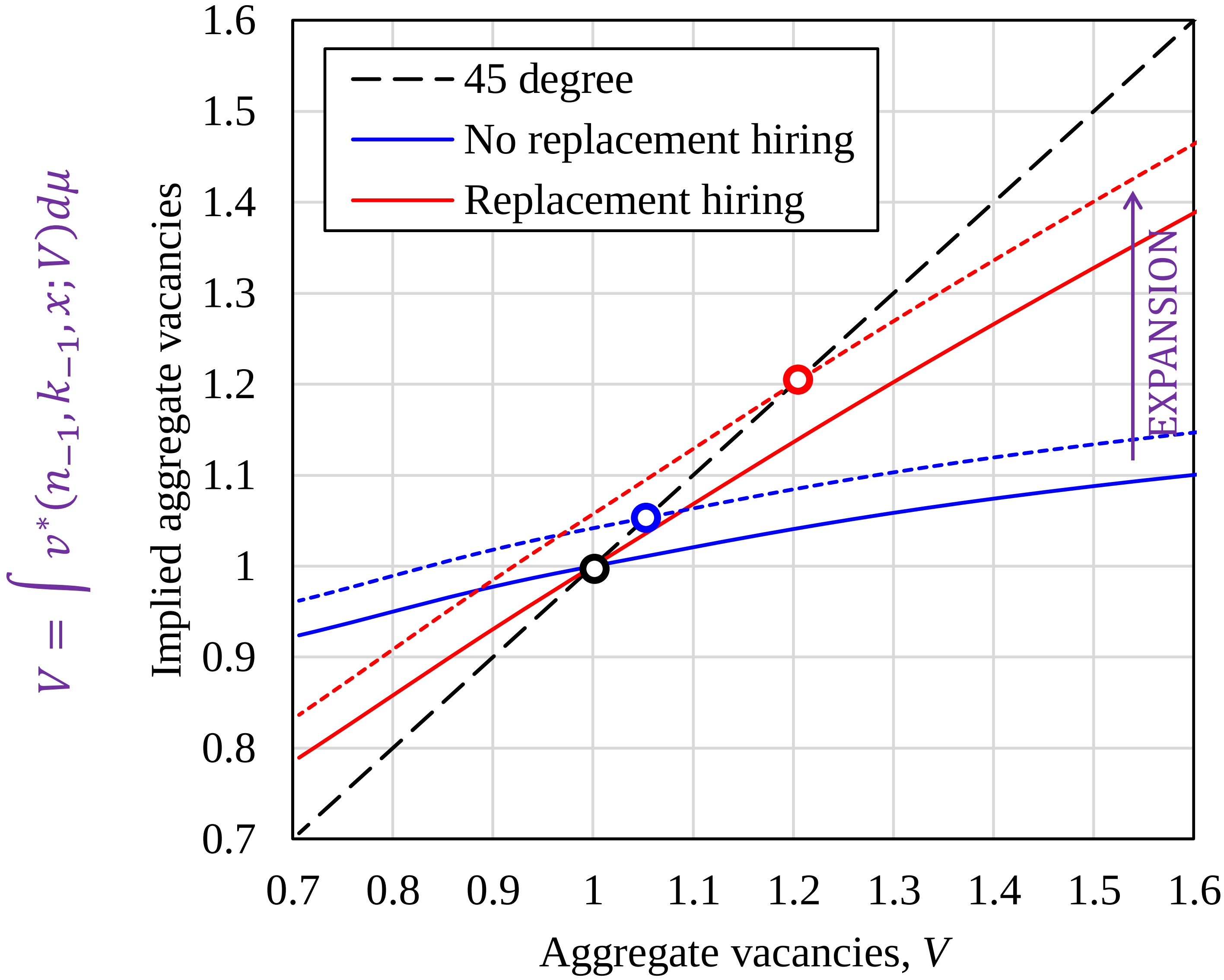
$$\text{s.t.} \quad \Delta k = [n - k_{-1}]^+ - [n - k_{-1}]\mathbb{1}_{n < (1-\delta)n_{-1}}$$



Without replacement hiring ($c^- = 0$)



With replacement hiring ($c^- > 0$)



Amplification: Vacancy chains

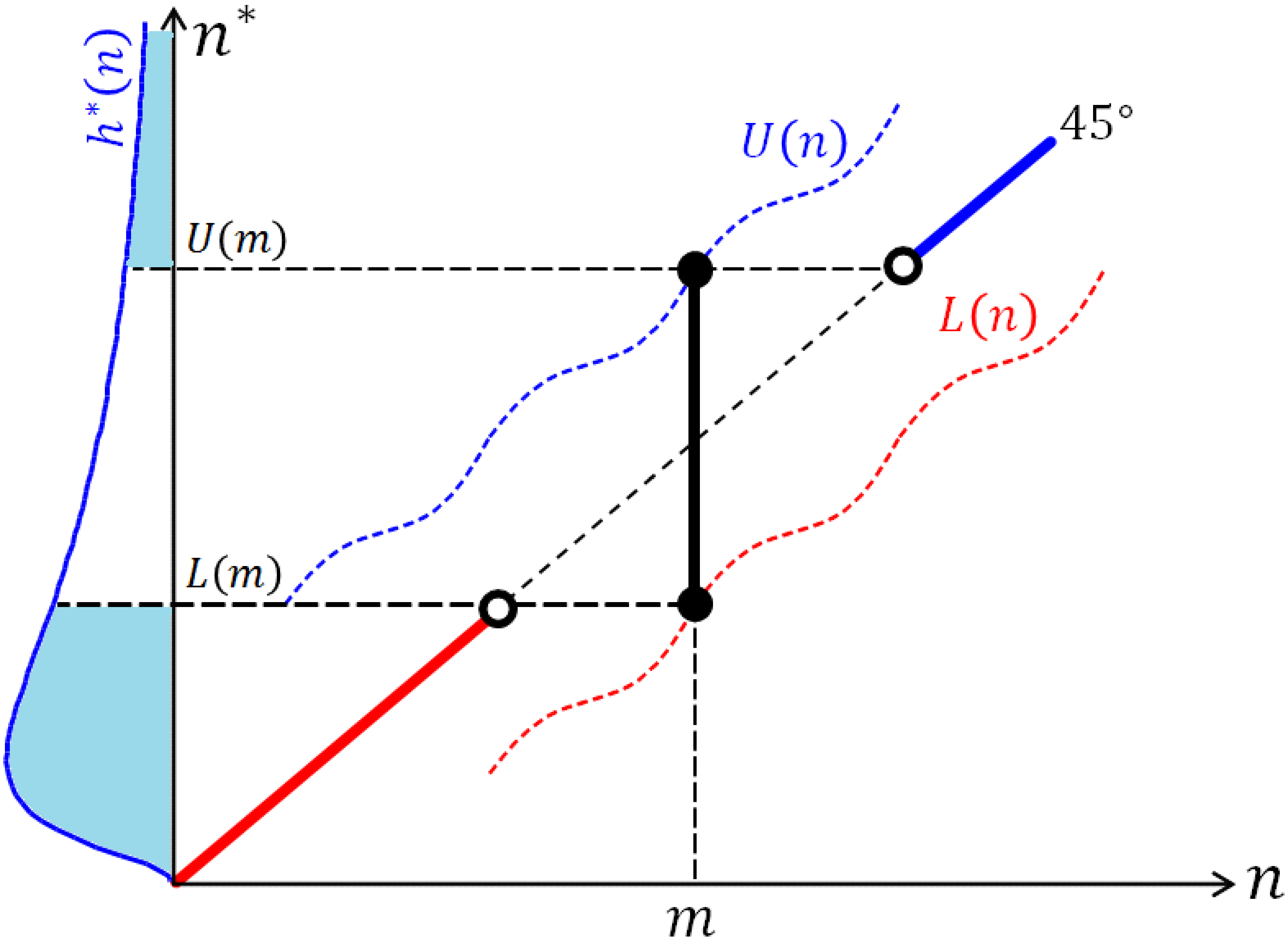
A conjecture

- Absent vacancy chains, replacement hiring model just an exotic adj. cost model.
  - $\longrightarrow$ Suspect $\widehat{N}$ diagnostic would remain jump.
- But, vacancy chains add another layer to the aggregate dynamics.
  - $\longrightarrow$ Frictions spillover and multiply across firms.
  - $\longrightarrow$ If process of poaching takes time $\Rightarrow$ persistence.
- Much more work to do: chiefly wage setting!

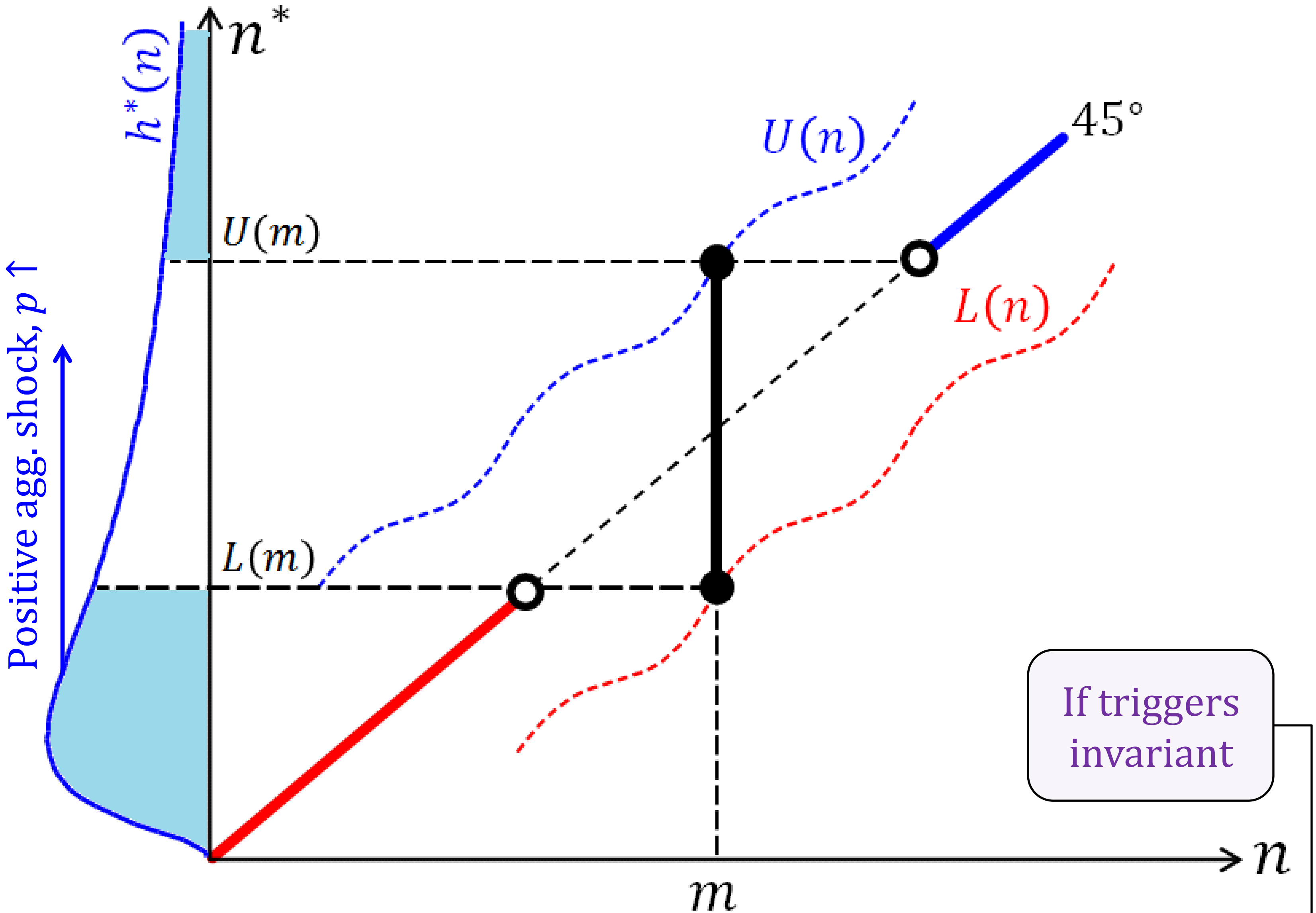
Summary of contributions

- Toward a diagnostic for the aggregate effects of popular class of adjustment frictions.
- Empirical implementation suggests models unable to explain employment persistence.
- Microdata instead suggest pervasive replacement hiring.
- Prototype model suggests aggregate dynamics could look very different in this case.

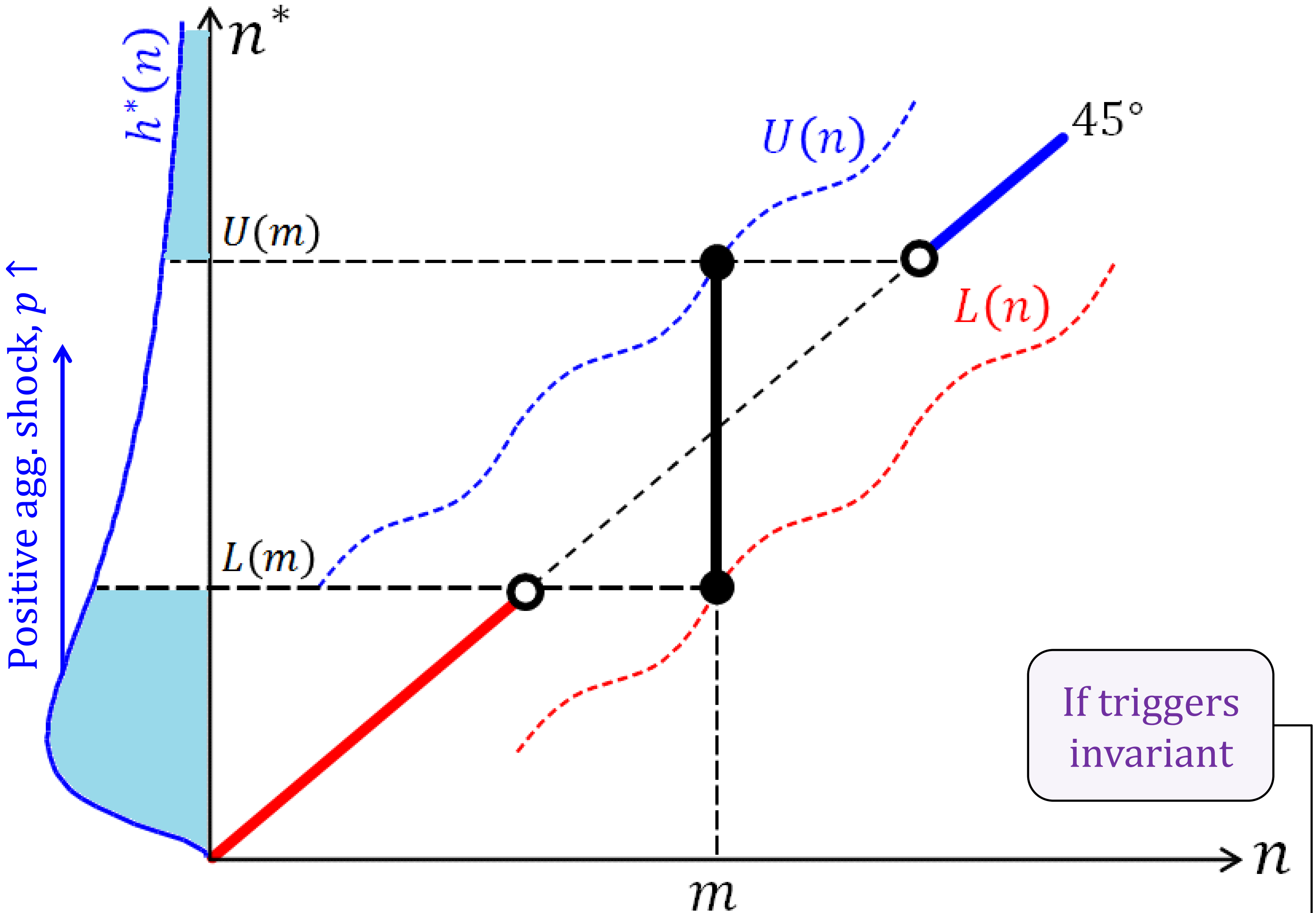
Extra slides



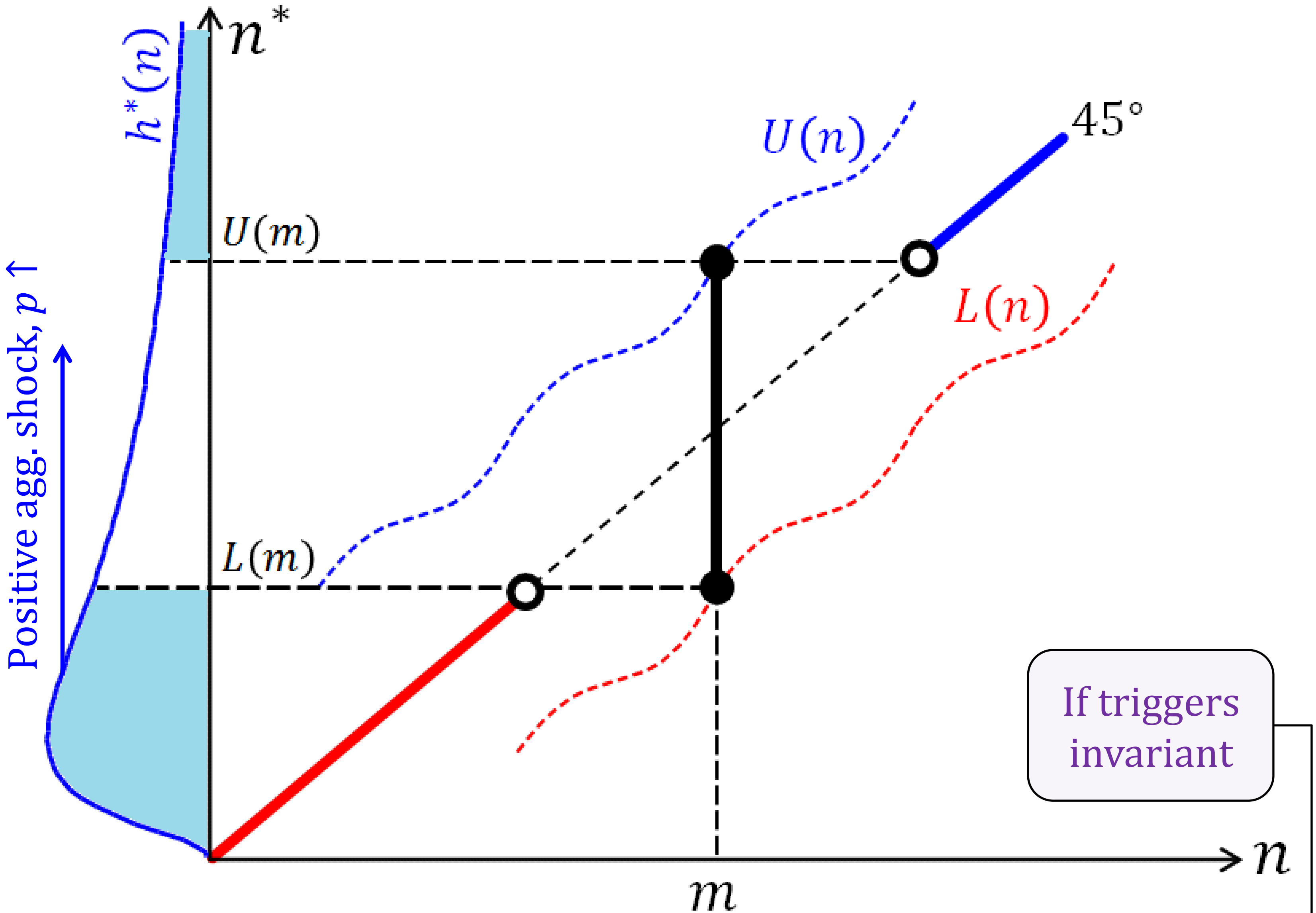
$$\phi(n) = 1 - H^*[U(n)] + H^*[L(n)]$$



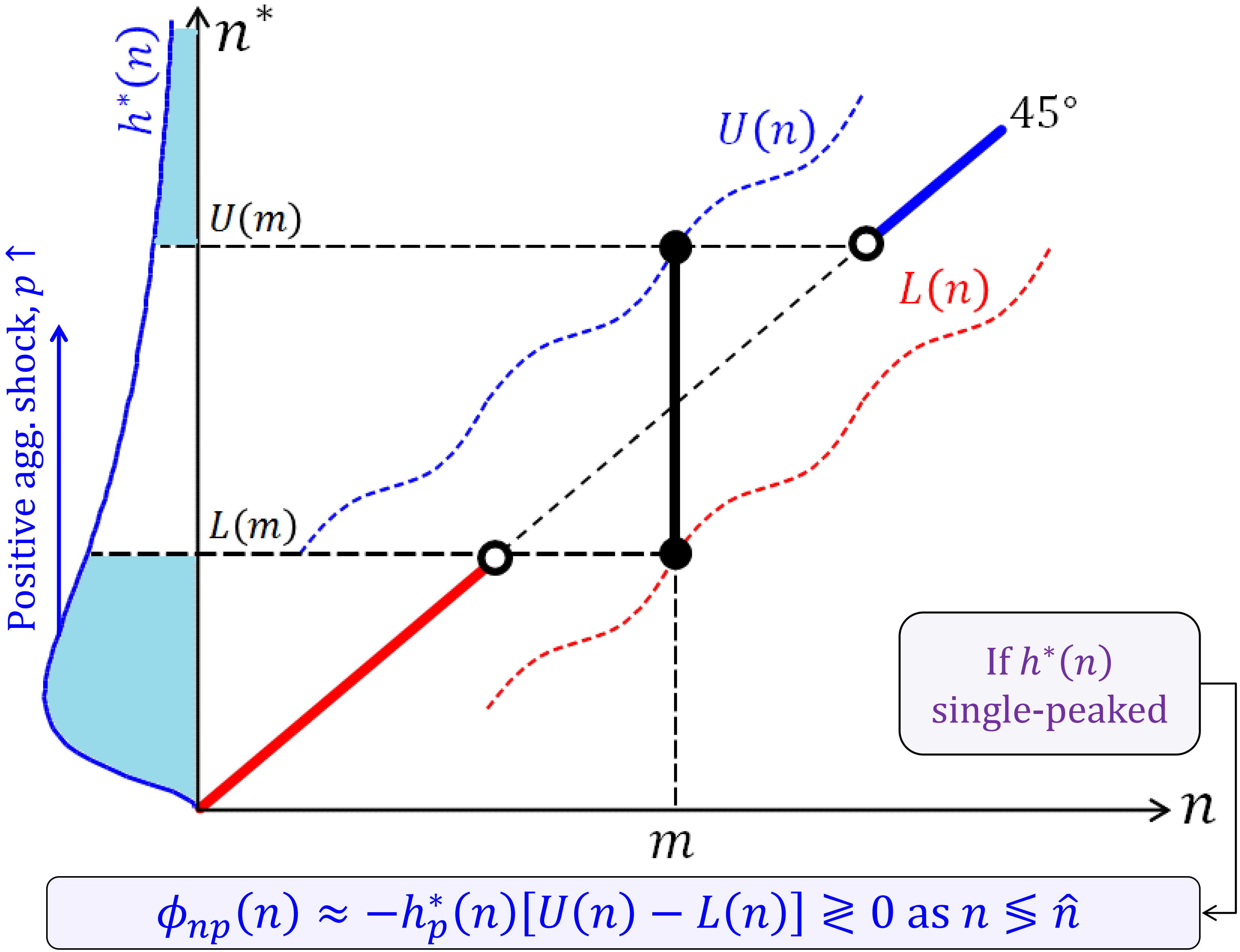
$$\phi_p(n) = -H_p^*[U(n)] + H_p^*[L(n)]$$



$$\phi_{np}(n) = -h_p^*[U(n)] + h_p^*[L(n)] \gtrless 0 \text{ as } n \lessgtr \hat{n}$$



$$\phi_{np}(n) \approx -h_p^*(n)[U(n) - L(n)] \gtrless 0 \text{ as } n \lessgtr \hat{n}$$



n^*
$h^*(n)$
Positive agg. shock, p ↑
$U(n)$
$45°$
$U(m)$
$L(n)$
$L(m)$
If $h^*(n)$
single-peaked
n
m
$\phi_{np}(n) \approx -h_p^*(n)[U(n) - L(n)] \gtrless 0$ as $n \lesseqgtr \hat{n}$

Canonical model

Aggregate productivity

Idiosyncratic shock

$F'' < 0$

$$\max_{n_t} \mathbb{E}_t \sum_{s=t}^{\infty} \beta^{s-t} \begin{Bmatrix} p_s x_s F(n_s) - w_s n_s \\ -C\mathbb{1}[\Delta n_s \neq 0] \end{Bmatrix}$$

Fixed adj. cost

Lemma (Gertler and Leahy, 2008)

The optimal labor demand policy approximately takes the *Ss* form,

$$n = \begin{cases} n^* & \text{if} \quad n^* \notin [L(n_{-1}), U(n_{-1})], \\ n_{-1} & \text{if} \quad n^* \in [L(n_{-1}), U(n_{-1})], \end{cases}$$

where

- $n^*(x, p)$ coincides with frictionless analogue;
- $L(n_{-1}) < U(n_{-1})$ are time-invariant.

Intuition

- <u>$n^*(x, p)$ coincides with frictionless analogue</u>
  - Envelope Theorem: Prob. of inaction $= O(\sqrt{C})$.
  - Optimality: Return to inaction $\in [0, C] = O(C)$.
  - Probability × Return $= O(C^{3/2}) \approx 0$.

- <u>$L(n_{-1}) < U(n_{-1})$ are time-invariant</u>
  - n^* sufficient statistic for shocks to $\{x, p, w\}$.
  - $L(n_{-1}) < U(n_{-1})$ reflect curvature of $F(n)$.

Proof of bounding result

Myopia is approximately optimal (Gertler/Leahy 2008):

$$\mathbb{E}[\Pi'] = \mathbb{E}\left[\Pi'_{\text{adjust}} - C\right]$$

$$+ \Pr(\text{inaction})\,\mathbb{E}\left[\Pi'_{\text{inaction}} - \Pi'_{\text{adjust}} + C\right].$$

$O(\sqrt{C})$ by envelope theorem $\times$ $\in [0, C]$ by optimality $= O\left(C^{3/2}\right)$

Some quantitative examples

1. Pure fixed adjustment cost.

$$\max_n \{pxF(n) - wn \qquad \text{Revenue} - \text{costs}$$

$$-C\mathbb{1}_{\Delta n \neq 0} \qquad \text{Fixed adj. cost}$$

$$+\text{Forward value}\}$$

Adjustment policy takes *Ss* form as above.

Some quantitative examples

2. Fixed and kinked adjustment costs

[à la Cooper et al. (2007) and Bloom (2009)].

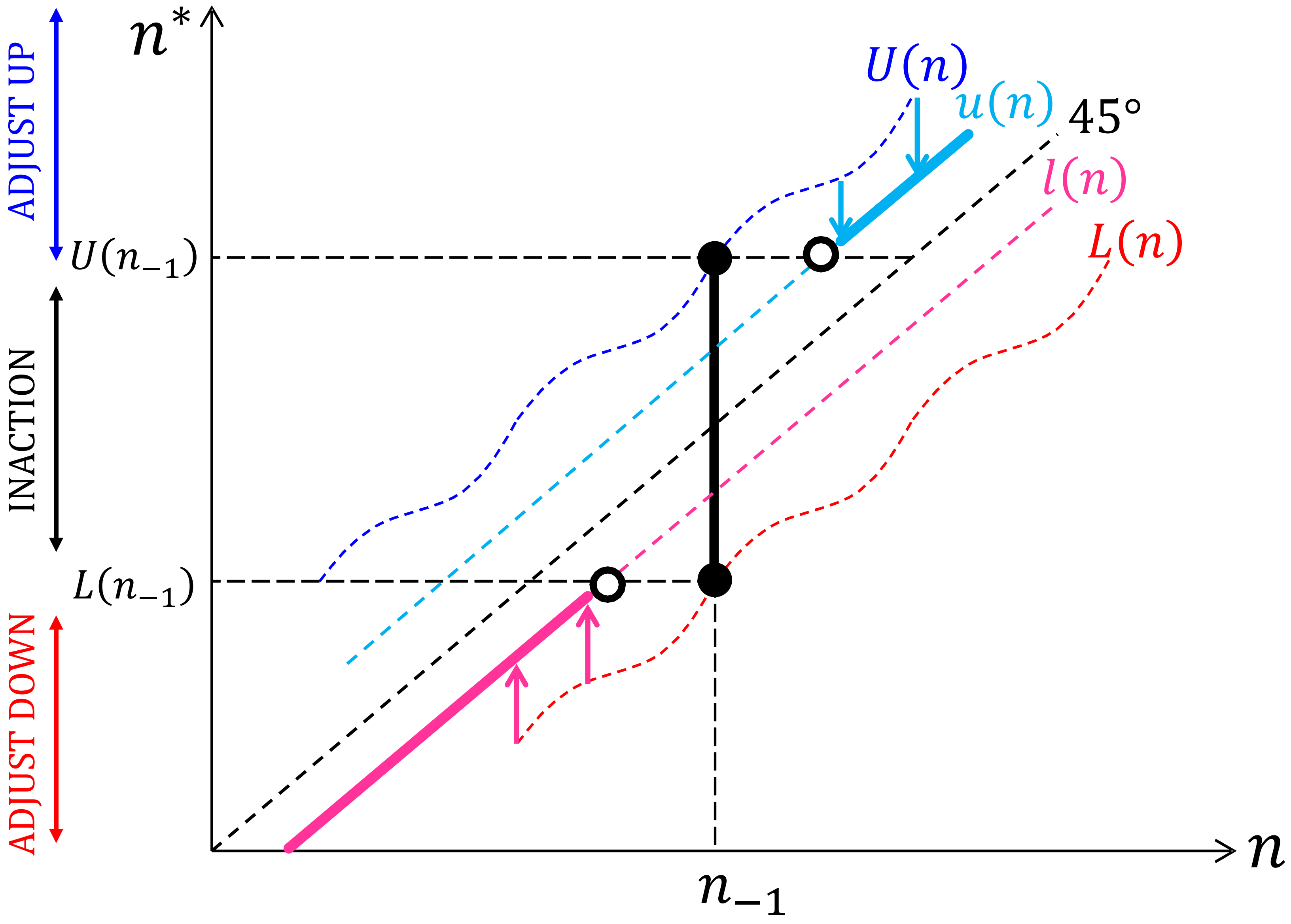
$$\max_n \{pxF(n) - wn$$ Revenue − costs

$$-C\mathbb{1}_{\Delta n \neq 0}$$ Fixed adj. cost

$$-c|\Delta n|$$ Kinked adj. cost

$$+\text{Forward value}\}$$

Kinked costs attenuate size of adjustments.



Allowing for kinked adjustment costs

Aggregation with kinked costs

The density of employment across firms $h(n)$ evolves according to:

$$\Delta h(n) = -\phi(n)\left[h_{-1}(n) - \hat{h}(n)\right]$$

$\hat{h}(n)$ is a flow steady state that sets $\Delta h(n) = 0$:

$$\hat{h}(n) = \frac{\Pr(\text{down to } n)\, h_l^*(n) + \Pr(\text{up to } n)\, h_u^*(n)}{\Pr(\text{from } n)}$$

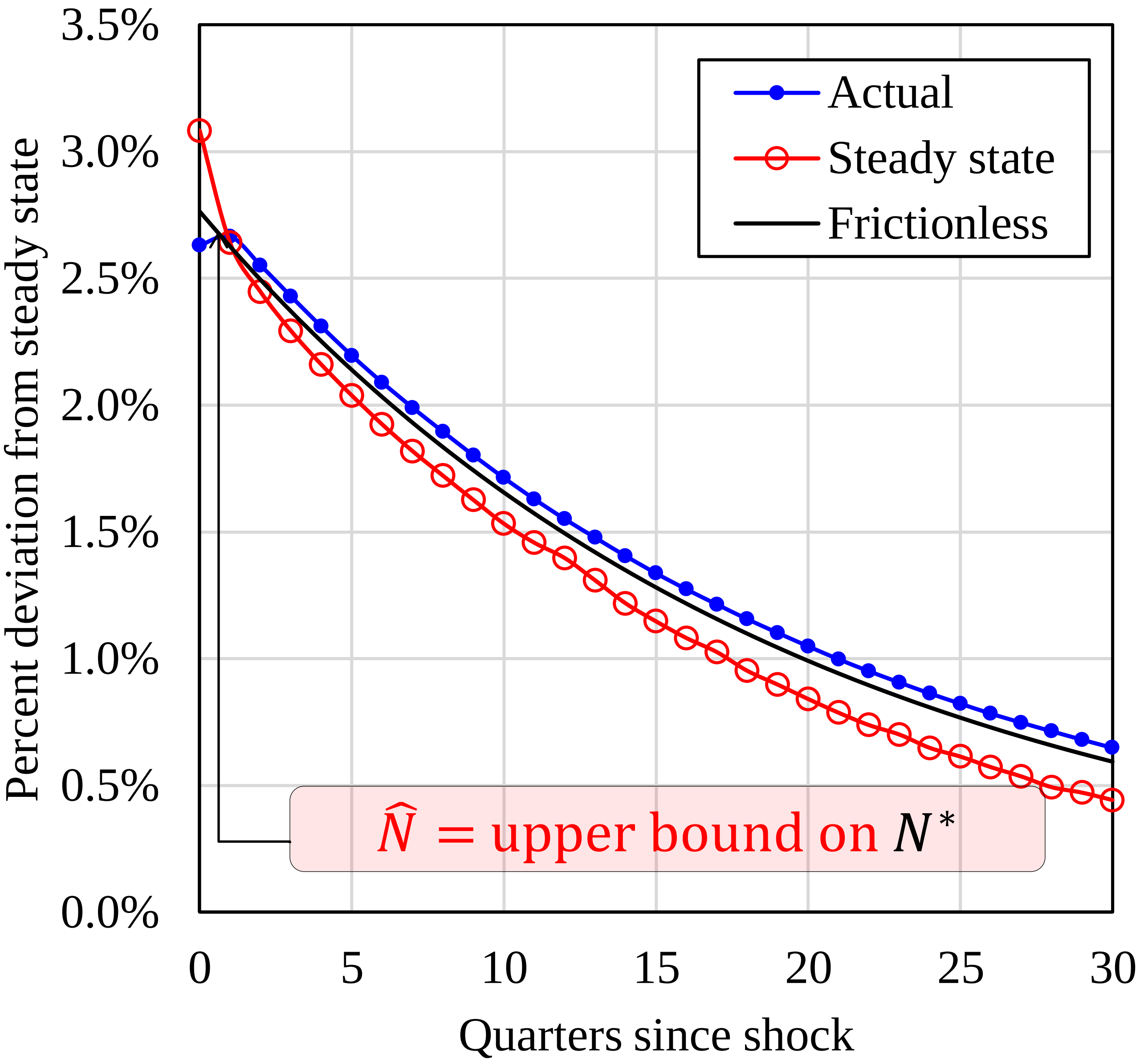
Aggregation with kinked costs

The density of employment across firms $h(n)$ evolves according to:

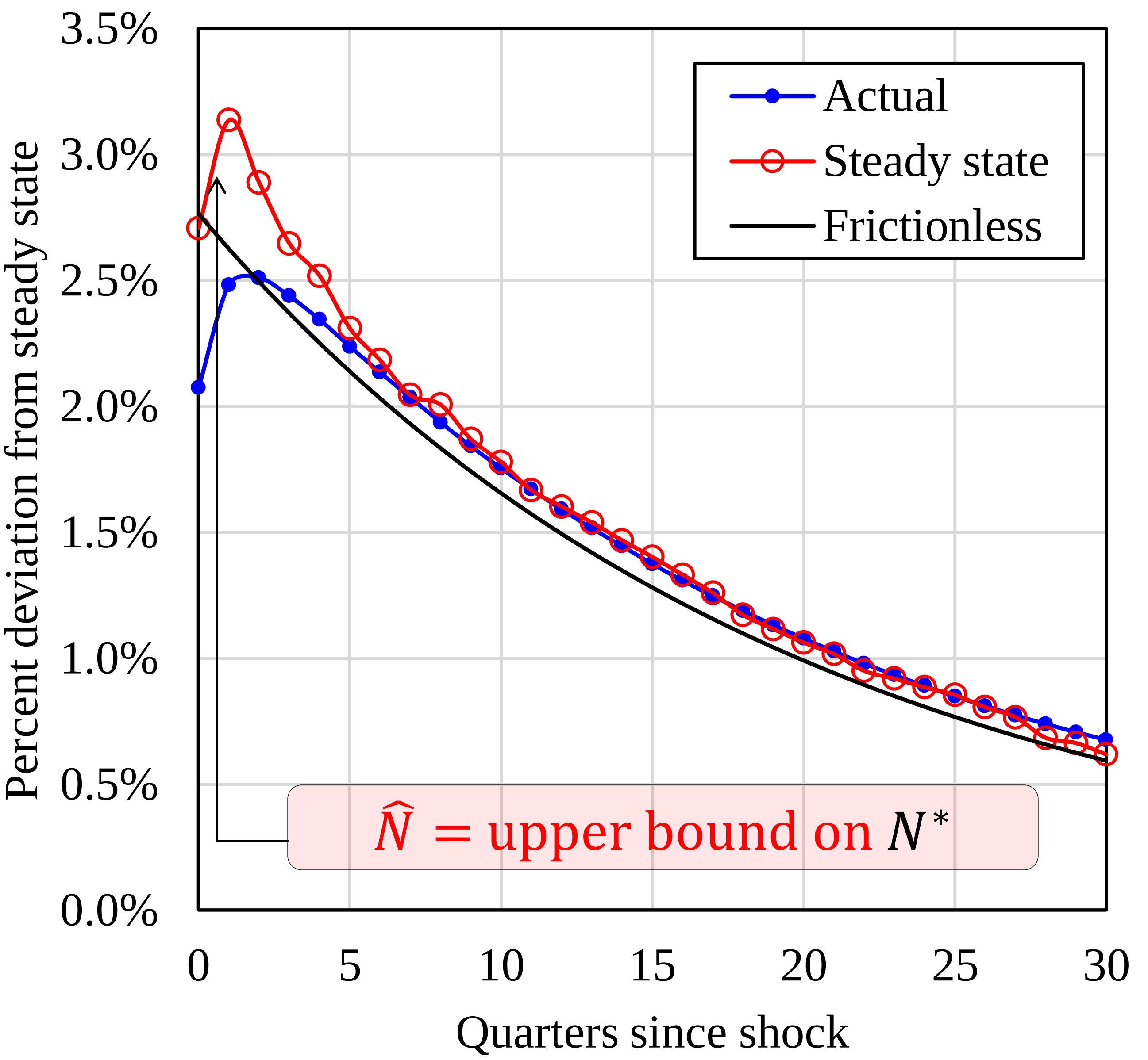
$$\Delta h(n) = -\phi(n)\left[h_{-1}(n) - \hat{h}(n)\right]$$

$\hat{h}(n)$ is a flow steady state that sets $\Delta h(n) = 0$:

$$\hat{h}(n) = \frac{(1 - H_{-1}[L^{-1}l(n)])\ h_l^*(n) + H_{-1}[U^{-1}u(n)]\ h_u^*(n)}{1 - H^*[U(n)] + H^*[L(n)]}$$



Pure fixed adjustment cost, Pr(inaction) = 0.5



Pure fixed adjustment cost, $\Pr(\text{inaction}) = 0.8$

Dynamic correlations with output

Two steps:

1. Regress (HP-filtered) output on 4 lags of itself; residual is the "output innovation".
2. Regress (HP-filtered) employment on 4 lags of itself as well as the current and first, second, and third-lagged values of the output innovation.

- Figure reports response to 1% output innovation.
- Do same for actual and flow steady-state employment in both data and model-generated time series.