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:

$$\Delta h(n) = \text{Inflow}(n) - \text{Outflow}(n)$$
Aggregation
The density of employment across firms $h(n)$ evolves according to:

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

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:

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

Density implied if all firms adjust
Leading example: fixed costs

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

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

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.

\[ n^* = n_{-1} + 45^\circ \]

\[ U(n) \]

\[ L(n) \]

\[ n_{-1} \]

\[ U(n_{-1}) \]

\[ L(n_{-1}) \]
Pr(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:

\[
\Delta h(n) = \Pr(\text{adjust to } n) h^*(n) - \Pr(\text{adjust from } n) h_{-1}(n)
\]
Pr(adjust to $m$) = $1 - H_{-1}[L^{-1}(m)] + H_{-1}[U^{-1}(m)]$
Leading example: fixed costs

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

\[
\Delta h(n) = \text{Pr(adjust to } n) \ h^*(n) - \text{Pr(adjust from } n) \ h_{-1}(n)
\]
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:

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

$\hat{h}(n)$ 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

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

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

$\hat{h}(n)$ 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:

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

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

$$= N^* + \text{cov}^* \left( n, \frac{\tau(n)}{\phi(n)} \right)$$
Intuition I. $\hat{N}$ as a bound for $N^*$

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

E.g. positive aggregate shock $\Rightarrow$

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

More likely to adjust to vs. from higher $n$s.
Intuition I. $\hat{N}$ as a bound for $N^*$

\[
\hat{N} = N^* + \text{cov}^* \left(n, \frac{\tau(n)}{\phi(n)}\right)
\]

E.g. negative aggregate shock $\Rightarrow$

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

Less likely to adjust to vs. from higher $n$s.
Intuition II. Jump dynamics of $\hat{N}$

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

- $\tau(n)$ and $\phi(n)$ determined by policy function.
- Policy function forward looking $\Rightarrow$ jump.
- $\hat{N}$ 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, $Pr(\text{inaction}) = 0.65$
Fixed and small kinked costs, $Pr(\text{inaction}) = 0.65$

\(\hat{N} \neq \text{bound on } N^*; \text{ but jump!} \)
Fixed and small kinked costs, $Pr(\text{inaction}) = 0.8$
Fixed and large kinked costs, Pr(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:

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

⇒ Can **estimate** \( \hat{h}(n) = \frac{\Delta h(n)}{\Pr(\text{adjust from } n)} + h_{-1}(n). \)
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.
Actual vs. steady-state log aggregate employment, QCEW 1992-2013
I. Bounds diagnostic

Since $\hat{N} \approx N$, bound $\Rightarrow N^* \approx N$.

I.e. neutral.
II. Jump diagnostic

$\hat{N} \approx$ as persistent as $N$ in data.

Jump in model.

Actual vs. steady-state log aggregate employment, QCEW 1992-2013
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
Inaction is at zero net employment growth!

Avg. quit rate $\approx 6\%$
\[ \Pr(n_t = n_{t+\tau}), \text{ QCEW average over 1992-2013} \]
Slow decay of inaction

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

<table>
<thead>
<tr>
<th>Frequency $\tau$ in quarters</th>
<th>Pr($n_t = n_{t+\tau}$)</th>
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</thead>
<tbody>
<tr>
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<td>Data</td>
</tr>
<tr>
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<td>0.53</td>
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<tr>
<td>2</td>
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<td>3</td>
<td>0.43</td>
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<tr>
<td>4</td>
<td>0.41</td>
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</table>
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.

<table>
<thead>
<tr>
<th>Frequency $\tau$ in quarters</th>
<th>$\Pr(n_t = n_{t+\tau}) / \Pr(n_t = n_{t+1})$</th>
<th>High seasonal</th>
<th>Low seasonal</th>
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<td>4</td>
<td>0.70</td>
<td>0.69</td>
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</table>
Aggregate inaction and job-to-job transitions, QCEW and CPS

Inaction rate (quarterly) vs. Job-to-job transition rate (CPS)

- Inaction rate (QCEW)
- Job-to-job transition rate (CPS)

1992 to 2012

*Graph showing trends in inaction rate and job-to-job transition rate.*
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

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

\[
\max_{n} \{ pxF(n) - wn \} \quad \text{Revenue} - \text{costs}
\]

\[ -c^+[n - (1 - \delta)n_{-1}]^+ \quad \text{Gross hiring} \]

\[ -C1_{\Delta k \neq 0} \quad \text{Capacity adj.} \]

\[ -c^-[k - n]^-(k - n) \quad \text{Slack capacity} \]

\[ + \text{Forward value} \]

s.t. \( \Delta k = [n - k_{-1}]^+ - [n - k_{-1}]1_{n < (1 - \delta)n_{-1}} \)
A prototype model of replacement hiring

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

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

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

\[ \max_{n} \{ p x F(n) - wn \} \quad \text{Revenue - costs} \]

\[ -c^+ [n - (1 - \delta)n_{-1}]^+ \quad \text{Gross hiring} \]

\[ -C 1_{\Delta k \neq 0} \quad \text{Capacity adj.} \]

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

+Forward value\}

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

Saves a control variable

Exogenous (for now)
A prototype model of replacement hiring

\[ n^* \]

EXPAND CAPACITY
HIRE

FREEZE AT CAPACITY

REPLACE

FREEZE AT ATTRITION

REDUCE CAPACITY
FIRE

\[ U(n) \]
\[ u(n) \]
\[ 45^\circ \]

\[ l(n) \]
\[ L(n) \]

\[ (1 - \delta)n_{-1} \]
\[ k_{-1} \]

A prototype model of replacement hiring
Policy function from numerical model

Employment, $n$

Idiosyncratic productivity, $x$

Employment, $n$

Policy rule

$k_{-1}$

$(1-\delta)n_{-1}$
Model does better on slow decay of inaction

\[
\Pr(n_t = n_{t+\tau}) / \Pr(n_t = n_{t+1})
\]

<table>
<thead>
<tr>
<th>Frequency ( \tau ) in quarters</th>
<th>( \Pr(n_t = n_{t+\tau}) / \Pr(n_t = n_{t+1}) )</th>
<th>Model</th>
<th>Data</th>
</tr>
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<tbody>
<tr>
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<td>3</td>
<td>0.76</td>
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<tr>
<td>4</td>
<td>0.69</td>
<td>0.77</td>
<td></td>
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</table>
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 \( V \)s reduce \( q \), hiring cost \( c^+ \) rises.
   \[ \rightarrow \text{Negative feedback.} \]
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 $V$s reduce $q$, hiring cost $c^+$ rises.
   $\rightarrow$ **Negative** feedback.

2. More $V$s raise $\delta$, post further $V$s to replace.
   $\rightarrow$ **Positive** feedback: Vacancy chains...
A prototype model of replacement hiring

\[
\Pi(n_{-1}, k_{-1}, x) \equiv \\
\max_{n} \{ pxF(n) - wn \} \quad \text{Revenue – costs} \\
- c^+ [n - (1 - \delta) n_{-1}]^+ \quad \text{Gross hiring} \\
- C \mathbb{1}_{\Delta k \neq 0} \quad \text{Capacity adj.} \\
- c^- [k - n]^- \quad \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

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

\[ \max_{n} \{ pxF(n) - wn \} \quad \text{Revenue} - \text{costs} \]

\[ -\frac{\nu}{q(V)} [n - (1 - \delta(V))n_{-1}]^+ \quad \text{Gross hiring} \]

\[ -C\mathbbm{1}_{\Delta k \neq 0} \quad \text{Capacity adj.} \]

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

\[ + \text{Forward value} \}

s.t. \[ \Delta k = [n - k_{-1}]^+ - [n - k_{-1}] \mathbbm{1}_{n < (1 - \delta)n_{-1}} \]
A prototype model of replacement hiring

\[ \Pi(n_{-1}, k_{-1}, x; V) \equiv \max_n \{ p x F(n) - wn \} \]

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

+ Forward value

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

KEY: Quit rate \( \delta \) rises w/ \( V \)

...and slack is costly.
Without replacement hiring ($c^- = 0$)
\[ V = \int \nu^* (n_{-1}, k_{-1}, x; V) d\mu \]

With replacement hiring \((c^- > 0)\)
\[ V = \int v^*(n_{-1}, k_{-1}, x; V) d\mu \]

- **Implied aggregate vacancies**
- **Aggregate vacancies, \( V \)**
- **Amplification: Vacancy chains**

- **45 degree**
- **No replacement hiring**
- **Replacement hiring**

\[ V \] vs. \[ \text{Aggregate vacancies}, \ V \]
A conjecture

• Absent vacancy chains, replacement hiring model just an exotic adj. cost model.
  → Suspect $\hat{N}$ diagnostic would remain jump.

• But, vacancy chains add another layer to the aggregate dynamics.
  → Frictions spillover and multiply across firms.
  → 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
\[ \phi(n) = 1 - H^*[U(n)] + H^*[L(n)] \]
Positive agg. shock, $p$

$$\phi_p(n) = -H_p^*[U(n)] + H_p^*[L(n)]$$
\[ \phi_{np}(n) = -h_p^* [U(n)] + h_p^* [L(n)] \geq 0 \text{ as } n \leq \hat{n} \]
\[
\phi_{np}(n) \approx -h_p^*(n)[U(n) - L(n)] \geq 0 \text{ as } n \leq \hat{n}
\]
\[ \phi_{np}(n) \approx -h_p^*(n)[U(n) - L(n)] \geq 0 \text{ as } n \leq \hat{n} \]

If \( h^*(n) \) single-peaked.
Canonical model

\[
\max_{n_t} \mathbb{E}_t \sum_{s=t}^{\infty} \beta^{s-t} \left\{ p_s x_s F(n_s) - w_s n_s \right\} - C1[\Delta n_s \neq 0]
\]

Aggregate productivity

Idiosyncratic shock

\( F'' < 0 \)

Fixed adj. cost
**Lemma (Gertler and Leahy, 2008)**

The optimal labor demand policy approximately takes the Ss form,

\[
    n = \begin{cases} 
        n^* & \text{if } n^* \not\in [L(n_{-1}), U(n_{-1})], \\
        n_{-1} & \text{if } n^* \in [L(n_{-1}), U(n_{-1})], 
    \end{cases}
\]

where

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

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

• $L(n_{-1}) < U(n_{-1})$ are time-invariant
  
  – $n^*$ 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 \cite{GertlerLeahy2008}:

$$
\mathbb{E}[\Pi'] = \mathbb{E}[\Pi_{\text{adjust}}' - C] \\
+ \Pr(\text{inaction}) \mathbb{E}[\Pi_{\text{inaction}}' - \Pi_{\text{adjust}}' + C].
$$

$$
\leq O(\sqrt{C}) \text{ by envelope theorem} \times \epsilon \in [0, C] \text{ by optimality} = O(C^{3/2})
$$
Some quantitative examples

1. Pure fixed adjustment cost.

\[
\max_n \{ pxF(n) - wn - C1_{\Delta n \neq 0} + \text{Forward value} \} = \text{Revenue} - \text{costs} + \text{Fixed adj. cost}
\]

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)].

\[
\max_n \{ p x F(n) - w n - C 1_{\Delta n \neq 0} - c |\Delta n| \} + \text{Forward value}
\]

Revenue − costs

Fixed adj. cost

Kinked adj. cost

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:

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

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

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

\( \hat{N} = \text{upper bound on } N^* \)
\[ \hat{N} = \text{upper bound on } N^* \]

**Pure fixed adjustment cost, Pr(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.