Hysteresis and the European Unemployment Problem Revisited

Jordi Galí

CREI, UPF, Barcelona GSE

December 2015
Figure 1. Unemployment Rate in the Euro Area
Figure 1. Unemployment Rate: United States vs. Euro Area
Unemployment: Europe vs. United States

- Unit root tests:
  - U.S. unemployment rate ⇒ stationary
  - Euro area unemployment rate ⇒ nonstationary (unit root)

- Autocorrelations
Figure 2. Unemployment Rate: Autocorrelations
Figure 2.a  Euro Area Unemployment: Autocorrelation
1970Q1-2014Q4 (180 obs.)
Outline

- What is the source of the unit root in European unemployment?
- Reference framework: a New Keynesian model with unemployment
- Three hypotheses:
  1. the *natural rate* hypothesis
  2. the *long run tradeoff* hypothesis
  3. the *hysteresis* hypothesis
- Empirical assessment
- What are the implications for monetary policy? (follow up paper)
A Benchmark Framework

- Based on Galí (2011) and Galí-Smets-Wouters (2012)
- Monopolistic competition and nominal rigidities in goods and labor markets
- Representative household with large number of members
- Heterogeneity within each household: (i) occupational, (ii) disutility from work
- Three possible statuses: employed, unemployed, non-participant
A Benchmark Framework

- Staggered wage setting à la Calvo:
  \[ w_t = \theta_w w_{t-1} + (1 - \theta_w) w_t^* \]

- Optimal wage setting rule:
  \[ w_t^* = \mu^w + (1 - \beta \theta_w) \sum_{k=0}^{\infty} (\beta \theta_w)^k E_t \left\{ w_{t+k} \mid t \right\} \]

  where \( w_{t+k} \mid t \equiv p_{t+k} + c_{t+k} + \varphi n_{t+k} \mid t \) and \( \mu^w \equiv \log \frac{\epsilon_w}{\epsilon_{w-1}} \)

- Implied wage dynamics equation
  \[ \pi_t^w = \beta E_t \{ \pi_{t+1}^w \} - \lambda_w (\mu_t^w - \mu^w) \]

  where \( \mu_t^w \equiv w_t - p_t - (c_t + \varphi n_t) \) is the average wage markup.
Aggregate participation:

\[ w_t - p_t = c_t + \phi l_t \]

Unemployment rate:

\[ u_t \equiv l_t - n_t \]

Key relation:

\[ \mu^w_t = \phi u_t \]

Natural rate of unemployment:

\[ \mu^w = \phi u^n \]
Figure 6. The Wage Markup and the Unemployment Rate

\[ w_t - p_t \]

\[ \mu_{w,t} \]

\[ u_t \]

Labor supply

Labor demand

Employment

Labor force
A Benchmark Framework

- Implied wage Phillips curve (Galí (2011)):

\[ \pi^w_t = \beta E_t \{ \pi^w_{t+1} \} - \lambda_w \varphi(u_t - u^n) \]

- Extension with indexation:

\[ \pi^w_t = \pi^p_{t-1} + \beta E_t \{ \pi^w_{t+1} - \pi^p_t \} - \lambda_w \varphi(u_t - u^n) \]

- Monetary policy

\[ \hat{i}_t = \phi_i \hat{i}_{t-1} + (1 - \phi_i) \left[ \phi_\pi (\pi^p_t - \pi^*) + \phi_y \Delta y_t \right] \]

where \( \hat{i}_t \equiv i_t - (\rho + \pi^*) \)
A Benchmark Framework

- Equilibrium

\[ u_t \sim I(0) \]
A Benchmark Framework

- Equilibrium
  \[ u_t \sim I(0) \]

- Source of stationarity: optimal wage setting ⇒
  \[ (1 - \beta \theta_w) \sum_{k=0}^{\infty} (\beta \theta_w)^k E_t \{ \mu_{t+k|t}^w \} = \mu^w \]

  where \( \mu_{t+k|t}^w \equiv w_t^* - w_{t+k|t} \)

  ⇒ \( \mu_t^w \sim I(0) \) ⇒ \( u_t \sim I(0) \)

- How can we modify that benchmark model to generate a unit root in the unemployment rate?
The Natural Rate Hypothesis

- Assumption:
  
  \[ u_t^n \sim \text{random walk} \]

- Source: non-stationarity in the desired markup

  \[ \mu_{w,t}^n \sim \text{random walk} \]

- Natural rate of unemployment:

  \[ \mu_{w,t}^n = \phi u_t^n \]

- Implication:

  \[ u_t \sim I(1) \]
The Natural Rate Hypothesis

Empirical assessment

\[ u_t = u_t^n + \tilde{u}_t \]

\[ \pi_t^w = \pi_{t-1}^p - \lambda_w \varphi \sum_{k=0}^{\infty} \beta^k E_t \{ \tilde{u}_{t+k} \} \]

\[ \pi_t^{w,*} = \pi_{t-1}^p - \lambda_w \varphi \sum_{k=0}^{\infty} \beta^k E\{ \tilde{u}_{t+k} | x_t, x_{t-1}, ... \} \]

where \( x_t \equiv [\tilde{u}_t, \pi_t^w - \pi_{t-1}^p, \tilde{u}_{t-1}, \pi_{t-1}^w - \pi_{t-2}^p, ... ] \)

\( \tilde{u}_t \sim \text{cyclical component of a MBN decomposition of } \{ u_t \} \)

Under the null that the model is "true":

\[ \pi_t^{w,*} = \pi_t^w \]

Evidence
Figure 8. The Natural Rate of Unemployment and the Unemployment Gap under the Natural Rate Hypothesis
Figure 9a. Wage Inflation: Actual vs. Predicted under the Natural Rate Hypothesis (1970-2014)

corr = 0.91
Figure 9b. Wage Inflation: Actual vs. Predicted under the Natural Rate Hypothesis (1999-2014)

corr = 0.24

corr = -0.20
The Long Run Tradeoff Hypothesis

Assumption:

\[ \pi_t^* \sim \text{random walk} \]

Implications:

\[ \pi_t^W \sim I(1) \]
\[ u_t \sim I(1) \]

in the absence of (full) indexation, given

\[ \pi_t^W = \beta E_t\{\pi^W_{t+1}\} - \lambda_w \varphi(u_t - u^n) \]
Figure 11. A Long Run Tradeoff between Wage Inflation and Unemployment?
Empirical assessment:

Cointegrating relation:

\[ u_t = u^n - \frac{1-\beta}{\lambda_w \varphi} \pi^w_t \]

*Baseline calibration* \( (\varphi = 5) \Rightarrow -\frac{1-\beta}{\lambda_w \varphi} = -0.52 \) (lower if indexation)

*Evidence*: cointegrating coefficient of -2

*Alternative calibration*: \( \varphi = 0.08 \Rightarrow s.d.(u_t) = 22\% \)
The Hysteresis Hypothesis

- **Insider-outsider model** of the labor market: Blanchard-Summers, Gottfries-Horn, Lindbeck-Snower,…
- Key feature: wages set with a view to ensuring the jobs of insiders
- Wage setting rule: set $w^*_t(j)$ such that

$$
(1 - \beta \theta_w) \sum_{k=0}^{\infty} (\beta \theta_w)^k E_t \left\{ n_{t+k|t}(j) \right\} = n^*_t(j)
$$

- Insiders’ evolution:

$$
n^*_t(j) = n_{t-1}(j)
$$
The Hysteresis Hypothesis

- Implied wage inflation Phillips curve:

\[ \pi_t^w = \beta E_t \{ \pi_{t+1}^w \} + \lambda_n \Delta n_t \]

where \( \lambda_n \equiv \frac{1-\theta_w}{\theta_w \epsilon_w} \)

- Equilibrium:

\[ u_t \sim I(1) \]
The Hysteresis Hypothesis

- Empirical assessment:

\[
\pi_t^w = \pi_{t-1}^p + \lambda_n \sum_{k=0}^{\infty} \beta^k E_t \{ \Delta n_{t+k} \}
\]

\[
\pi_{t,1}^w = \pi_{t-1}^p + \lambda_n \sum_{k=0}^{\infty} \beta^k E \{ \Delta n_{t+k} | x_t, x_{t-1}, \ldots \}
\]

where \(x_t \equiv [\Delta n_t, \pi_t^w - \pi_{t-1}^p, \Delta n_{t-1}, \pi_{t-1}^w - \pi_{t-2}^p, \ldots] \)
Figure 13a. Wage Inflation in the Insider-Outsider NK Model (1970-2014)
corr = 0.91
Figure 13b. Wage Inflation in the Insider-Outsider NK Model (1999-2014)

corr = 0.55
The Hysteresis Hypothesis

Empirical assessment:

\[ \pi^w_t = \pi^p_{t-1} + \lambda_n \sum_{k=0}^{\infty} \beta^k E_t\{\Delta n_{t+k}\} \]

\[ \pi^{w,*}_t = \pi^p_{t-1} + \lambda_n \sum_{k=0}^{\infty} \beta^k E\{\Delta n_{t+k}|x_t, x_{t-1},...\} \]

where \( x_t \equiv [\Delta n_t, \pi^w_t - \pi^p_{t-1}, \Delta n_{t-1}, \pi^w_{t-1} - \pi^p_{t-2},...] \)

Comparison with benchmark model with constant natural rate:

\[ \pi^{w,*}_t = \pi^p_{t-1} - \lambda_w \varphi \sum_{k=0}^{\infty} \beta^k E\{\hat{u}_{t+k}|x_t, x_{t-1},...\} \]

where \( x_t \equiv [\hat{u}_t, \pi^w_t - \pi^p_{t-1}, \hat{u}_{t-1}, \pi^w_{t-1} - \pi^p_{t-2},...] \)
Figure 13c. Wage Inflation: Insider-Outsider vs. Constant Natural Rate Models
Monetary Policy Design with Insider-Outsider Labor Markets and Hysteresis

- Optimal monetary policy

\[
\min E_0 \sum_{t=0}^{\infty} \beta^t \left( (1 + \varphi)(1 - \alpha)\hat{n}_t^2 + \frac{\epsilon_p}{\lambda_p}(\pi_p^t)^2 + \frac{\epsilon_w(1 - \alpha)}{\lambda_w}(\pi_w^t)^2 \right)
\]

subject to

\[
\pi_p^t = \beta E_t\{\pi_p^{t+1}\} + \lambda_p \alpha \hat{n}_t + \lambda_p \tilde{\omega}_t
\]

\[
\pi_w^t = \beta E_t\{\pi_w^{t+1}\} + \lambda_n \Delta \hat{n}_t
\]

\[
\tilde{\omega}_{t-1} \equiv \tilde{\omega}_t - \pi_w^t + \pi_p^t + \Delta a_t - \Delta x_t
\]

for \( t = 0, 1, 2, \ldots \) where \( \tilde{\omega}_t \equiv \omega_t - (a_t - \alpha n + \log(1 - \alpha) - x_t) \)
Optimal policy vs. baseline simple rule

\[ i_t = 0.9i_{t-1} + 0.1(1.5\pi^p_t + 0.5\Delta y_t) \]
Figure 4.a  Optimal Policy vs. Simple Rule: Technology Shocks

- Optimal Policy vs. Simple Rule: Technology Shocks
- Output:
- Unemployment:
- Price Inflation:
- Wage Inflation:
- Nominal Rate:
- Real Rate:
Figure 4.b  Optimal Policy vs. Simple Rule: Markup Shocks

- Output
- Unemployment
- Price Inflation
- Wage Inflation
- Nominal Rate
- Real Rate
Figure 4.c  Optimal Policy vs. Simple Rule: Demand Shocks

- Output
- Unemployment
- Price Inflation
- Wage Inflation
- Nominal Rate
- Real Rate
Monetary Policy Design with Insider-Outsider Labor Markets and Hysteresis

- Optimal policy vs. baseline simple rule

\[ i_t = 0.9i_{t-1} + 0.1(1.5\pi^p_t + 0.5\Delta y_t) \]

- Optimal policy vs. augmented simple rule

\[ i_t = 0.9i_{t-1} + 0.1(1.5\pi^p_t + 0.5\Delta y_t - 0.5u_t) \]
Figure 5.a  Optimal vs. Augmented Rule: Technology Shocks

- Output vs. Technology Shocks
- Unemployment vs. Technology Shocks
- Price Inflation vs. Technology Shocks
- Wage Inflation vs. Technology Shocks
- Nominal Rate vs. Technology Shocks
- Real Rate vs. Technology Shocks
Figure 5.b  Optimal vs. Augmented Rule: Markup Shocks

- Output
- Unemployment
- Price inflation
- Wage inflation
- Nominal rate
- Real rate
Figure 5.3  Optimal vs. Augmented Rule: Demand Shocks
Monetary Policy Design with Insider-Outsider Labor Markets and Hysteresis

- Optimal policy vs. baseline simple rule

\[ i_t = 0.9 i_{t-1} + 0.1 (1.5 \pi_t^p + 0.5 \Delta y_t) \]

- Optimal policy vs. augmented simple rule

\[ i_t = 0.9 i_{t-1} + 0.1 (1.5 \pi_t^p + 0.5 \Delta y_t - 0.5 u_t) \]

- Welfare
<table>
<thead>
<tr>
<th></th>
<th>(\gamma = 0)</th>
<th>(\gamma = 0.9)</th>
<th>(\gamma = 1)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Technology</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Simple</td>
<td>0.085 1.0</td>
<td>0.158 1.0</td>
<td>1.003 1.0</td>
</tr>
<tr>
<td>Optimal</td>
<td>0.041 0.48</td>
<td>0.044 0.27</td>
<td>0.045 0.04</td>
</tr>
<tr>
<td>Augmented</td>
<td>0.049 0.58</td>
<td>0.050 0.31</td>
<td>0.051 0.05</td>
</tr>
<tr>
<td><strong>Markup</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Simple</td>
<td>0.036 1.0</td>
<td>0.071 1.0</td>
<td>0.267 1.0</td>
</tr>
<tr>
<td>Optimal</td>
<td>0.014 0.38</td>
<td>0.015 0.21</td>
<td>0.015 0.05</td>
</tr>
<tr>
<td>Augmented</td>
<td>0.027 0.74</td>
<td>0.019 0.26</td>
<td>0.021 0.07</td>
</tr>
<tr>
<td><strong>Demand</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Simple</td>
<td>0.128 1.0</td>
<td>0.281 1.0</td>
<td>1.765 1.0</td>
</tr>
<tr>
<td>Optimal</td>
<td>0.0 0.0</td>
<td>0.0 0.0</td>
<td>0.0 0.0</td>
</tr>
<tr>
<td>Augmented</td>
<td>0.007 0.05</td>
<td>0.006 0.02</td>
<td>0.007 &lt; 0.01</td>
</tr>
</tbody>
</table>
Summary and Concluding Remarks

- Sources of the unit root in European unemployment
  - unit root in the natural rate? unlikely
  - changes in inflation target? unlikely (by itself)
  - hysteresis: more plausible

- Implications of insider-outsider model for monetary policy
  ⇒ rationale for a dual mandate, with strong weight on unemployment stabilization

- Further research: embed insider-outsider setup in a empirical medium scale DSGE model
Figure 2.b  Euro Area Unemployment: Autocorrelation
1985Q1-2014Q4 (120 obs.)
Figure 2.c  Euro Area Unemployment: Autocorrelation

1999Q1-2014Q4 (64 obs.)
Figure 3. Dynamic Response of the Unemployment Rate

- Technology shock
- Markup shock
- Demand shock

Legend:
- $\gamma=0$
- $\gamma=0.5$
- $\gamma=0.9$
- Standard
<table>
<thead>
<tr>
<th></th>
<th>1 lag</th>
<th>4 lags</th>
</tr>
</thead>
<tbody>
<tr>
<td>1970Q1-2014Q4</td>
<td>-2.03</td>
<td>-1.91</td>
</tr>
<tr>
<td></td>
<td>(-2.87)</td>
<td>(-2.87)</td>
</tr>
<tr>
<td>1985Q1-2014Q4</td>
<td>-2.97*</td>
<td>-1.82</td>
</tr>
<tr>
<td></td>
<td>(-2.88)</td>
<td>(-2.88)</td>
</tr>
<tr>
<td>1999Q1-2014Q4</td>
<td>-2.11</td>
<td>-0.87</td>
</tr>
<tr>
<td></td>
<td>(-2.90)</td>
<td>(-2.91)</td>
</tr>
</tbody>
</table>

Note: *t*-statistics of Augmented Dickey-Fuller tests (with intercept) for the null of a unit root in the unemployment rate. Sample period 1970Q1-2014Q4. Asterisks denote significance at the 5 percent level. Critical value (adjusted for sample size) for the null of a unit root shown in brackets.
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\varphi$</td>
<td>Curvature of labor disutility</td>
<td>3.4</td>
</tr>
<tr>
<td>$\beta$</td>
<td>Discount factor</td>
<td>0.99</td>
</tr>
<tr>
<td>$\alpha$</td>
<td>Decreasing returns to labor</td>
<td>0.26</td>
</tr>
<tr>
<td>$\epsilon_w$</td>
<td>Elasticity of substitution (labor)</td>
<td>4.3</td>
</tr>
<tr>
<td>$\epsilon_p$</td>
<td>Elasticity of substitution (goods)</td>
<td>3.8</td>
</tr>
<tr>
<td>$\theta_p$</td>
<td>Calvo index of price rigidities</td>
<td>0.75</td>
</tr>
<tr>
<td>$\theta_w$</td>
<td>Calvo index of wage rigidities</td>
<td>0.75</td>
</tr>
<tr>
<td>$\phi_i$</td>
<td>Lagged interest rate coefficient</td>
<td>0.9</td>
</tr>
<tr>
<td>$\phi_\pi$</td>
<td>Inflation coefficient</td>
<td>1.5</td>
</tr>
<tr>
<td>$\phi_y$</td>
<td>Output growth coefficient</td>
<td>0.5</td>
</tr>
</tbody>
</table>
Table 3: Unemployment Persistence in the Standard New Keynesian Model

<table>
<thead>
<tr>
<th></th>
<th>$\rho_u(1)$</th>
<th>$\rho_u(4)$</th>
<th>$\rho_u(8)$</th>
<th>$\rho_{u,\pi}$</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Data</strong></td>
<td>0.99</td>
<td>0.97</td>
<td>0.91</td>
<td>$-0.76$</td>
</tr>
<tr>
<td><strong>Standard NK Model</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Technology</td>
<td>0.96</td>
<td>0.72</td>
<td>0.36</td>
<td>0.26</td>
</tr>
<tr>
<td></td>
<td>(0.93,0.98)</td>
<td>(0.53,0.84)</td>
<td>(0.03,0.64)</td>
<td>(0.07,0.41)</td>
</tr>
<tr>
<td>Markup</td>
<td>0.95</td>
<td>0.69</td>
<td>0.33</td>
<td>0.60</td>
</tr>
<tr>
<td></td>
<td>(0.91,0.97)</td>
<td>(0.49,0.81)</td>
<td>(-0.01,0.59)</td>
<td>(0.59,0.64)</td>
</tr>
<tr>
<td>Demand</td>
<td>0.81</td>
<td>0.41</td>
<td>0.14</td>
<td>$-0.81$</td>
</tr>
<tr>
<td></td>
<td>(0.72,0.87)</td>
<td>(0.18,0.60)</td>
<td>(-0.16,0.42)</td>
<td>(-0.89,-0.71)</td>
</tr>
</tbody>
</table>

*Note:* Based on 200 simulations of 180 observations each. Persistence of driving forces: $a = 1$, $x = 0.99$, and $z = 0.99$. For each statistic, the table reports the median and 95% confidence interval (in brackets).
Table 4
Unemployment Persistence in the NK-IO Model

<table>
<thead>
<tr>
<th>Data</th>
<th>$\rho_u(1)$</th>
<th>$\rho_u(4)$</th>
<th>$\rho_u(8)$</th>
<th>$\rho_{u,\pi}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.99</td>
<td>0.97</td>
<td>0.91</td>
<td>-0.76</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Technology</th>
<th>Std. NK</th>
<th>$\gamma = 0.0$</th>
<th>$\gamma = 0.9$</th>
<th>$\gamma = 1.0$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>(0.93,0.98)</td>
<td>(0.53,0.84)</td>
<td>(0.03,0.64)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.97</td>
<td>0.94</td>
<td>0.99</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.94,0.85)</td>
<td>(0.56,0.89)</td>
<td>(0.66,0.98)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.76</td>
<td>0.76</td>
<td>0.90</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.57,0.84)</td>
<td>(0.57,0.87)</td>
<td>(0.76,0.97)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.42</td>
<td>0.73</td>
<td>0.73</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.07,0.66)</td>
<td>(0.39,0.90)</td>
<td>(0.39,0.90)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.29</td>
<td>0.34</td>
<td>0.12</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.14,0.49)</td>
<td>(0.25,0.50)</td>
<td>(-0.15,0.36)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Markup</th>
<th>Std. NK</th>
<th>$\gamma = 0.0$</th>
<th>$\gamma = 0.9$</th>
<th>$\gamma = 1.0$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>(0.91,0.97)</td>
<td>(0.94,0.96)</td>
<td>(0.94,0.99)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.94</td>
<td>0.97</td>
<td>0.98</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.90,0.96)</td>
<td>(0.94,0.99)</td>
<td>(0.93,0.99)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.58</td>
<td>0.80</td>
<td>0.86</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.37,0.72)</td>
<td>(0.64,0.90)</td>
<td>(0.63,0.96)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.11</td>
<td>0.52</td>
<td>0.70</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.21,0.37)</td>
<td>(0.18,0.78)</td>
<td>(0.28,0.90)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.57</td>
<td>0.48</td>
<td>0.28</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.55,0.61)</td>
<td>(0.45,0.55)</td>
<td>(0.07,0.44)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Demand</th>
<th>Std.NK</th>
<th>$\gamma = 0.0$</th>
<th>$\gamma = 0.9$</th>
<th>$\gamma = 1.0$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>(0.69,0.86)</td>
<td>(0.84,0.97)</td>
<td>(0.88,0.99)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.80</td>
<td>0.92</td>
<td>0.96</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.68,0.86)</td>
<td>(0.84,0.97)</td>
<td>(0.88,0.99)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.37</td>
<td>0.75</td>
<td>0.86</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.14,0.57)</td>
<td>(0.48,0.91)</td>
<td>(0.58,0.96)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.07</td>
<td>0.58</td>
<td>0.74</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.16,0.39)</td>
<td>(0.15,0.85)</td>
<td>(0.24,0.92)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-0.99</td>
<td>-0.53</td>
<td>-0.36</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(-0.99,-0.99)</td>
<td>(-0.71,-0.36)</td>
<td>(-0.63,-0.03)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: Based on 200 simulations of 180 observations each. Persistence of driving forces: $\alpha = 1$, $\rho = 0.9$, and $\theta = 0.9$. 