1 International

1.1 Backus, Kehoe and Kydland (1992): International Real Business Cycles

- This article investigates whether an open-economy version of the RBC model is consistent with the international data on output, consumption and trade.

- In closed economies, domestic savings ($S$) equals domestic investment ($I$).

- It is helpful to keep in mind the national income accounting identity: $NX = EX - IM = S - I = (Y - C) - I$.

- In the world economy, countries experience correlated technology shocks. Given the ability to borrow and lend internationally, we should expect different co-movements of macro variables within and across countries.

- In particular, we might expect countries to have smoother consumption (as they share risk) and more volatile investment (as capital moves to find the highest return).

1.1.1 Properties of International Business Cycles

Table 1 shows the cyclical properties of HP-filtered U.S. quarterly data (1954-1989).

- Typical volatilities and co-movements.

- Net exports ($NX$) are less volatile than output and slightly counter-cyclical.

Table 2 shows the international co-movements for 12 developed countries.

- Contemporaneous correlations with the U.S. are generally positive for output and consumption.

- Contemporaneous correlations with the U.S. are larger for output than for consumption.

- Correlation between saving and investment rates vary widely across countries. The correlation is large and positive for Germany, Japan and the U.S.

- Net exports are negatively correlated with output.
1.1.2 Model of the World Economy

Two countries with the same preference/technology structure and a domestic labor pool. Each country produces the same good and is subjected to a specific technology shock.

The expected utility function is given by

$$E_0 \sum_{t=0}^{\infty} \beta^t U(c_i^t, l_i^t)$$

where $U(c, l) = (e^{t l^1 - \mu})^{\gamma} / \gamma$ and $i = \{h, f\}$.

Output in each country ($y_i^t$) is given by the production function:

$$F(\lambda, k, n) = \lambda k^h n^1 - \theta.$$  

World output ($y_h^t + y_f^t$) is allocated to consumption and investment:

$$F(\lambda_h^t, k_h^t, n_h^t) + F(\lambda_f^t, k_f^t, n_f^t) = [c_h^t + c_f^t] + [x_h^t + x_f^t].$$

Net exports ($nx_i^t$) are given by

$$nx_i^t = y_i^t - (c_i^t + x_i^t).$$

The model also includes (i) distributed lag of leisure, (ii) inventories, and (iii) time-to-build technology. These three features are suppressed here.

**Technology Shock Process** The vector of technology shocks $\lambda_t = (\lambda_h^t, \lambda_f^t)$ follows a VAR(1) process:

$$\lambda_{t+1} = A\lambda_t + \epsilon_{t+1}$$

where $\epsilon_t = (\epsilon_h^t, \epsilon_f^t)$ is the vector of driving shocks. The driving shocks are serially independent with variance-covariance matrix

$$V = \begin{bmatrix} \sigma_h^2 & \sigma_{h,f} \\ \sigma_{f,h} & \sigma_f^2 \end{bmatrix}.$$  

The technology shocks have

- contemporaneous correlation $\sigma_{h,f} = \sigma_{f,h}$ and
- spillover effects $A_{12}$ and $A_{21}$. 
Welfare Theorems and Solution Technique  The social planner problem is to maximize

\[ \psi E_0 \sum_{t=0}^{\infty} \beta^t U(c^h_t, l^h_t) + (1 - \psi) E_0 \sum_{t=0}^{\infty} \beta^t U(c^f_t, l^f_t) \]

for \( \psi = 0.5 \). The second welfare theorem of economics states that this solution can be supported as a competitive equilibrium for a certain set of prices. The first welfare theorem states that this competitive equilibrium is Pareto optimal.

Backus et al.’s solution technique involves...

- Substitute the constraints into the objective.
- Approximate the resulting function near the steady state using a second-order Taylor series approximation.

1.1.3 Steady State and Parameter Values

The model is calibrated for symmetric countries, except for \( A \) and \( V \). The steady state for the world economy is therefore the closed economy replicated twice. The parameter values are

<table>
<thead>
<tr>
<th>Parameter</th>
<th>( \beta )</th>
<th>( c/y )</th>
<th>( x/y )</th>
<th>( \delta )</th>
<th>( \theta )</th>
<th>( \sigma )</th>
<th>( J )</th>
<th>( \mu )</th>
<th>( \gamma )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value</td>
<td>0.99</td>
<td>0.75</td>
<td>0.25</td>
<td>0.025</td>
<td>0.36</td>
<td>0.01</td>
<td>4</td>
<td>0.34</td>
<td>-1</td>
</tr>
</tbody>
</table>

The shock process is estimated from a bivariate VAR. For U.S./Europe it is

\[
A = \begin{bmatrix} 0.904 & 0.502 \\
0.149 & 0.908 \end{bmatrix}
\]

with \( \sigma_{e,h} = 0.00906 \), \( \sigma_{e,f} = 0.00797 \), and \( \text{corr}(e^h_t, e^f_t) = 0.258 \). The eigenvalues are 0.994 and 0.818.

For U.S./Canada it is

\[
A = \begin{bmatrix} 0.796 & 0.131 \\
0.000 & 0.989 \end{bmatrix}
\]

with \( \sigma_{e,h} = 0.00874 \), \( \sigma_{e,f} = 0.01023 \), and \( \text{corr}(e^h_t, e^f_t) = 0.434 \). The eigenvalues are 0.989 and 0.796.

The benchmark, symmetrized version is

\[
A = \begin{bmatrix} 0.906 & 0.088 \\
0.088 & 0.906 \end{bmatrix}
\]

with \( \sigma_{e,h} = \sigma_{e,f} = 0.00852 \) and \( \text{corr}(e^h_t, e^f_t) = 0.258 \).
1.1.4 Results

Table 4 shows the results from the benchmark theoretical world economy.

- Standard deviation of simulated output is 1.55% (U.S. economy is 1.71%).
- Standard deviation of simulated consumption is 0.62% (U.S. economy is 0.84%).
- Standard deviation of simulated investment is 16.91% (U.S. economy is 5.38%).
- Standard deviation of simulated \( nx/y \) ratio is 2.90% (U.S. economy is 0.45%).
- Correlation of simulated \( nx/y \) and \( y \) is -0.02 (U.S. correlation is -0.36).
- Correlation of simulated saving and investment rates is 0.28 (U.S. correlation is 0.68).
- Correlation of simulated home and foreign output is -0.18 (U.S./Europe correlation is 0.70).
- Correlation of simulated home and foreign consumption is 0.88 (U.S./Europe correlation is 0.46).

Figure 2 presents the IRFs for home and foreign technology shocks from the benchmark economy. Figure 2 presents the intuition behind the co-movements of the home and foreign variables.

Backus et al. (1992) also consider other variations of the model: (i) asymmetric spillovers; (ii) large spillovers; (iii) high risk aversion; (iv) durable leisure; (v) one-quarter time-to-build; (vi) transport costs; and (vii) autarky.

1.1.5 Conclusions

- Backus et al. (1992) investigate how the standard RBC performs in a symmetric two-country global model.
- Backus et al. find a robust consumption/output anomaly:
  - Consumption across countries is more highly correlated in the model than in the data.
  - Output across countries is more highly correlated in the data than in the model.