The great moderation and the US external imbalance

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Conditional Standard Deviation of GDP

Net Foreign Asset Position

Fraction of GDP
This paper

- Takes the US *great moderation* as given
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- Analyzes and measures how much of the US external imbalance it can explain
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**Contributions**
- Introduce a “new” fundamental in the debate on the US external adjustment
- Understand patterns of international capital flows in environments with time varying risk
What are the links?

- Consumption link

If great moderation is greater in US than abroad and international risk-sharing is incomplete, it causes a fall in relative precautionary savings motive. This increases scope for international inter-temporal trade and US imbalance.

Investment link: Changing relative risk between US and ROW should change international allocation of capital and affect net foreign asset positions.
What are the links?

Consumption link If *great moderation* greater in US than abroad *and* international risk-sharing incomplete: It causes a fall in *relative* precautionary savings motive → Increases scope for international inter-temporal trade → US imbalance
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- **Investment link**
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How big are these effects?

- Write the simplest open economy model which
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- Write the simplest open economy model which
  - Has country specific risk and precautionary saving motive
  - Has explicit investment decisions
  - Captures second moments effects and (potentially) changes in steady states
Fact 1. In US decline in BC volatility large across all frequencies
Facts about Great Moderation in the G3

- Fact 1. In US decline in BC volatility large across all frequencies
- Fact 2. Decline in BC volatility in US larger than in Europe or Japan at most frequencies
The US great moderation across frequencies

Real GDP % deviations from Trend

Growth Rates

HP

LP60

LP80

GDP % deviations from Trend
Changes in BC volatility in the G3

US (LP 80)

Japan (LP 80)

Europe (LP 80)
## Changes in BC volatility in the G3

<table>
<thead>
<tr>
<th>Filter</th>
<th>Country</th>
<th>60.1-83.4</th>
<th>84.1-05.4</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Growth</td>
<td>US</td>
<td>1.08</td>
<td>0.51</td>
<td>-0.57</td>
</tr>
<tr>
<td></td>
<td>Japan</td>
<td>1.25</td>
<td>0.78</td>
<td>-0.47</td>
</tr>
<tr>
<td></td>
<td>EU</td>
<td>0.77</td>
<td>0.42</td>
<td>-0.35</td>
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<td>HP</td>
<td>US</td>
<td>1.90</td>
<td>0.96</td>
<td>-0.94</td>
</tr>
<tr>
<td></td>
<td>Japan</td>
<td>1.68</td>
<td>1.12</td>
<td>-0.56</td>
</tr>
<tr>
<td></td>
<td>EU</td>
<td>1.08</td>
<td>0.73</td>
<td>-0.35</td>
</tr>
<tr>
<td>HP80</td>
<td>US</td>
<td>3.15</td>
<td>2.05</td>
<td>-1.10</td>
</tr>
<tr>
<td></td>
<td>Japan</td>
<td>3.13</td>
<td>2.35</td>
<td>-0.88</td>
</tr>
<tr>
<td></td>
<td>EU</td>
<td>1.58</td>
<td>1.84</td>
<td>+0.26</td>
</tr>
</tbody>
</table>
Two countries, one good

Business cycles driven by country specific TFP shocks, with time varying volatility

Competitive factor markets and full risk sharing within a country (repr. agent)

Only asset traded internationally is a non-contingent bond, subject to constraints

Agents choose between consumption, investment in domestic capital and international bonds
The model, I

Preferences

\[ E_0 \sum_{t=0}^{\infty} \beta^t \frac{1}{1 - \sigma} c_{it}^{1-\sigma} \]

Technologies:

\[ y_{it} = A_{it} k_{it-1}^{\theta} l_{it}^{1-\theta} \]

\[ k_{it} = (1 - \delta) k_{it-1} + x_{it} - \phi(k_{it-1}, x_{it}) \]
The model, II

Shocks

\[
\begin{bmatrix}
A_{1t} \\
A_{2t}
\end{bmatrix} = \begin{bmatrix}
\rho & \psi \\
\psi & \rho
\end{bmatrix} \begin{bmatrix}
A_{1t-1} \\
A_{2t-1}
\end{bmatrix} + \begin{bmatrix}
M(t)\varepsilon_{1t} \\
\varepsilon_{2t}
\end{bmatrix}
\]

\[
\begin{bmatrix}
\varepsilon_1(s^t) \\
\varepsilon_2(s^t)
\end{bmatrix} \rightarrow N(0, \Sigma), \quad \Sigma = \begin{bmatrix}
\sigma_{\varepsilon}^2 & \eta\sigma_{\varepsilon}^2 \\
\eta\sigma_{\varepsilon}^2 & \sigma_{\varepsilon}^2
\end{bmatrix}
\]
Constraints:

\[ c_{it} + x_{it} + \frac{b_{it}}{R_t} \leq y_{it} + b_{it-1} \]
\[ b_{it} \geq -\bar{b}\bar{y} \]

Equilibrium:

\[ c_{1t} + x_{1t} + c_{2t} + x_{2t} = y_{1t} + y_{2t} \]
\[ b_{1t} + b_{2t} = 0 \]
The experiment

- Before 1984 world is in symmetric equilibrium in equal volatility of TFP shocks ($M(t) = 1 \forall t$)
- In 1984 agents in both countries learn that volatility in US TFP shocks has permanently fallen ($M(t) = 1 - \lambda < 1 \forall t$)
- Compute the expected path of variables before and after the change
- Analog to impulse response to a change in second moment
Key parameters

- Relative risk aversion: $\sigma = 5$
- Persistence of TFP shocks: $\rho = 0.98$
- Relative reduction in volatility of US shocks innovation: set it so that, given persistence, model matches the fall in HP80 standard deviation ratio between US and G3: $\lambda = 30\%$
- Borrowing constraint: 100% of GDP
Imbalances and consumption dynamics

- Risk faced by US consumers fall
- US precautionary motive falls, equivalent to an increase in US discounting
- US increases preference for consumption today relative to consumption tomorrow, increases US borrowing
- Increase scope for international inter-temporal trade results in increase in interest rate and steady state imbalance.
Expected Responses (High adj. costs)

**Consumption**

- US
- Rest of the World

**Real Interest Rate**

**Current Account**

**Net Foreign Asset Position**
From FONC for investment and bonds we get,

\[ R = \frac{\text{cov}(F'_k u'_c)}{\mathbb{E}(u'_c)} + \mathbb{E}F'_k = \frac{\text{cov}(F'_k u'_c)}{\mathbb{E}(u'_c)} + \mathbb{E}F'_k \]

\[ \mathbb{E}F'_{ki} = \text{Exp. return to capital net of adj. costs}, \]

\[ 0 > \frac{\text{cov}(F'_k u'_c)}{\mathbb{E}(u'_c)} = \text{Risk premium term}. \]
\begin{align*}
\mathbb{E} F'_{k1} - \mathbb{E} F'_{k2} &= \frac{\text{cov}(F'_{k2}u'_{c2})}{\mathbb{E}(u'_{c2})} - \frac{\text{cov}(F'_{k1}u'_{c1})}{\mathbb{E}(u'_{c1})} \\
\end{align*}

- conditional on any state, if US volatility falls, \( \text{cov}(F'_{k1}u'_{c1}) \) falls in abs. value, \( \mathbb{E} F'_{k1} - \mathbb{E} F'_{k2} \) falls too
- Increased capital/investment in US relative to RoW
Conditional Investment dynamics

Investment

Capital stock

% Deviation from SE

1980 2000 2020 2040

1980 2000 2020 2040

US

Rest of the World

% Deviation from SE

1980 2000 2020 2040

1980 2000 2020 2040

-0.6
-0.4
-0.2
0
0.2

-0.4
-0.3
-0.2
-0.1
0
0.1

©
Unconditional Investment dynamics

**Investment**

- US
- Rest of the World

**Capital stock**

- US

% Deviation from SE

- 1980 2000 2020 2040
- -0.7 -0.6 -0.5 -0.4 -0.3 -0.2 -0.1 0

$\%$ Deviation from SE

- 1980 2000 2020 2040
- -0.2 -0.1 0 0.1 0.2

Legend:
- **US**
- **Rest of the World**
Why does the US invest less?

- Moderation changes (the distribution of) TFP states
- Investment function convex in TFP (Oi 61)
- On average after moderation US invests less
Investment and TFP (post-moderation)

![Graph showing Investment vs. TFP for different regions (US, RoW), post-moderation.](image-url)
Investment flows significantly affect the response of imbalance to GM
Overall assessment

- We do not wish to explain *total* US imbalances but rather assess the importance of our channel.
- In 2006 US global imbalances 24% of GDP, imbalances vis-a-vis Europe and Japan 12%.
- Under benchmark parameters, fall in volatility can generate an imbalance in 2006 of around 7.5%.
<table>
<thead>
<tr>
<th>Sensitivity of US imbalances (% of GDP) to</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Risk Aversion, $\sigma$</strong></td>
</tr>
<tr>
<td>$\sigma = 2$</td>
</tr>
<tr>
<td>Imb.</td>
</tr>
<tr>
<td><strong>Borrowing Constraint (% of GDP) $\bar{b}$</strong></td>
</tr>
<tr>
<td>$\bar{b} = 0$</td>
</tr>
<tr>
<td>Imb.</td>
</tr>
<tr>
<td><strong>Persistence of shocks, $\rho$</strong></td>
</tr>
<tr>
<td>$\rho = 0.96$</td>
</tr>
<tr>
<td>Imb.</td>
</tr>
<tr>
<td><strong>Relative fall in US volatility, $\lambda$</strong></td>
</tr>
<tr>
<td>$\lambda = 1/4$</td>
</tr>
<tr>
<td>Imb.</td>
</tr>
</tbody>
</table>
What happens with more intl diversification?

- Consider CM model: consumption equalized, investment response similar as in IM
- Different measure of NFA (forward v/s backward looking)

\[ w(s^t) = c(s^t) + x(s^t) - y(s^t) + \sum_{s^{t+1}} w(s^{t+1}) q(s^{t+1}, s^t) \]

\[ w(s^t) = x(s^t) - x^*(s^t) + y^*(s^t) - y(s^t) + \sum_{s^{t+1}} w(s^{t+1}) q(s^{t+1}, s^t) \]
Imbalances in complete and incomplete markets

<table>
<thead>
<tr>
<th>Time</th>
<th>Complete Markets</th>
<th>Incomplete Markets</th>
</tr>
</thead>
<tbody>
<tr>
<td>1980</td>
<td>-0.16</td>
<td>-0.14</td>
</tr>
<tr>
<td>1990</td>
<td>-0.14</td>
<td>-0.12</td>
</tr>
<tr>
<td>2000</td>
<td>-0.12</td>
<td>-0.10</td>
</tr>
<tr>
<td>2010</td>
<td>-0.10</td>
<td>-0.08</td>
</tr>
<tr>
<td>2020</td>
<td>-0.08</td>
<td>-0.06</td>
</tr>
<tr>
<td>2030</td>
<td>-0.06</td>
<td>-0.04</td>
</tr>
<tr>
<td>2040</td>
<td>-0.04</td>
<td>-0.02</td>
</tr>
</tbody>
</table>

NFA (percent of GDP)
Imbalances in complete and incomplete markets

- In IM investment dynamics is unanticipated. RoW investing more leads to more RoW borrowing. Lowers overall US imbalance.
- In CM investment dynamics is anticipated. RoW investing more leads to high RoW relative wealth. Only source of US imbalance.
Why is US accumulating more and more external debt?
We investigate a simple reason, i.e. US aggregate risk has decreased more than in other countries.
Does not explain the whole imbalance but a non-trivial fraction, finding fairly robust
Important to keep in mind when doing external adjustment analysis
Help us understand the link between volatility, consumption and investment dynamics and imbalances