Asian Business Cycle Synchronization – A Structural Factor Model Approach

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What is this paper about

- Output co-movement in Asian economies
- The evolution of Asian business cycle synchronization
- A structural analysis on the underlying driving forces

Why do we study Asian busines cycle synchronization?

- Decoupling from the world business cycle?
  - Is Asian growth external demand-led?
  - Independent recovery from the global recession?
- Common peg in exchange rate or more monetary policy coordination
  - The more synchronized business cycle, the more suitable a common currency option
  - More asymmetric underlying shocks require more flexible monetray policies
- Intra-regional risk insurance scheme
  - Asymmetry of underlying shocks
- Evolution of synchronization
  - Help shed light on what is the driving force behind such a pattern

Literature Review

- Bilateral correlation assessment, e.g. Eichengreen and Bayoumi (1996), etc
  - Bilateral correlation ignores the third-country effect
- Structural VAR, Kin, Lee, and Park (2009)
  - Difficulty in identifying global shocks and regional shocks
- Multi-level factor model, Kose, Otrok and Whiteman (2003, 2008)
  - Annual data from 1960 to 2005 (pre-global crisis)
  - No evolution
  - Assume only one factor at each geographic layer
  - Most importantly, the latent factors lack economic explanation

Previous findings

- Strong Asian Cycles
  - Moneta and Ruffer (2006): did not separate the global synchronization from the observed regional co-movement
  - Kose et al. (2008): relative strong regional cycles, evidence for decoupling, without including the most recent crisis period
- Strong intra-regional and inter-regional dependence in Asia
  - Kin, Lee, and Park (2009), Takagi and Kozuri (2008)
  - Asia's output responds significantly to both regional and global output shocks

Our recipe

- Develop a multiple-level structural factor model
  - To separate the regional business cycle from the global cycle
  - To separate different economic structural factors (demand factors vs supply factors)
  - Allow more than one structural factor at each geographic layer
- Quarterly data covering 1981Q1 to 2008Q4
  - Include the most recent crisis
  - Make possible the study of the evolution of Asian business cycle synchronization

Main results

- Output synchronization
  - Strong global cycle and regional cycle for Asia
  - Strengthening role of global factor over time for both Asia and G-7
  - Strengthening role of Asian regional factor, while weakening role of G-7 group factor
- Co-movement in supply shocks are the main driving force for Asian business cycle synchronisation
  - Over time, both the global and regional common supply factors were significantly stronger for emerging Asia
  - The contribution of both global and regional demand factors remained stable over two subsamples
- For the G-7, global factors matter
  - Both global supply and demand factors strengthened greatly
  - Regional factors weakened

A Multi-level Factor Model: the Basic Framework

$$
\begin{aligned}
y_{it}^{j} &= \gamma_i^{j'} G_t + \lambda_i^{j\prime} F_t^j + e_{it}^j, \; i = 1, ..., N_j, \; j = 1, 2 \\
G_t &= \rho_g G_{t-1} + v_{g,t} \\
F_t^j &= \rho_f^j F_{t-1}^j + v_{f,t}^j \\
G_t &: \quad \text{global common factor} \\
F_t^j &: \quad \text{group } j\text{'s group-specific factor} \\
N_j &: \quad \text{number of series in group } j \\
N &: \quad \sum N_j, \; \text{total number of units}
\end{aligned}
$$

- 16 economies, $i = 1, ...16$
- 2 groups: 9 Asian economies, and G-7
- One global factor
- Two group factors: Asia and G-7

A Multi-level Factor Model (Cont.)

- G_t, F_t^j $(j = 1, 2)$ are mutually orthogonal
- All units respond to G_t, but a unit in group j only respond to F_t^j given G_t
- γ_i, λ_i^1 and λ_i^2
  - factor loadings
  - measure the heterogenous response to the change of factors
- G_t, F_t^j are assumed to follow AR processes
- If more variance is explained by a certain factor, the unit is more synchronized with this factor

$$\gamma_i^{j'2} Var(G_t) / var(y_{it}^j)$$

  - A group of units all highly synchronized with this factor, they are also mutually more synchronized
  - A more standard benchmark than using a reference country

Problems with the Model

- Number of factors
  - 1 global factor, 1 regional factor in each region in International business cycles (Kose, et al, 2003)
  - More than one at each layer: Amengual and Waston (2007), Mathew Harding (2010)
  - But this will complicate the estimation
- Meaning of the factors
  - Unobserved, capture the common shocks among units
  - But lack further economic explanation

A Structural Factor Model

- A VAR view
  - $y_t = M(L)u_t$, u_t is a vector of shocks
  - Thus co-movement in y_t should be caused by co-movement in u_t
- A structural VAR approach following Blanchard and Quah (1989)

$$A_0 \begin{bmatrix} y_{it} \\ \pi_{it} \end{bmatrix} = A_1 \begin{bmatrix} y_{i,t-1} \\ \pi_{i,t-1} \end{bmatrix} + A_2 \begin{bmatrix} y_{i,t-2} \\ \pi_{i,t-2} \end{bmatrix} + \begin{bmatrix} u_{it}^s \\ u_{it}^d \end{bmatrix}$$

- With supply shocks and demand shocks

$$\begin{bmatrix} u_{it}^s \\ u_{it}^d \end{bmatrix} \sim \left(\begin{bmatrix} 0 \\ 0 \end{bmatrix}, \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} \right)$$

- The Wold representation

$$y_{it} = C(L)u_{it}^s + D(L)u_{it}^d$$

A Structural Factor Model(cont.)

- The multi-level factor model for the underlying shocks

$$
\begin{aligned}
u_{it}^{s} &= \gamma_i^{s,g} g_t^{s} + \gamma_i^{s,k} f_t^{s,k} + \vartheta_{it}^{s};\ i = 1, \ldots N \\
u_{it}^{d} &= \gamma_i^{d,g} g_t^{d} + \gamma_i^{d,k} f_t^{d,k} + \vartheta_{it}^{d};\ i = 1, \ldots N
\end{aligned}
$$

- Combined with the MA(∞) representation of y_{it}

$$
\begin{aligned}
y_{it} &= (C(L)\gamma_i^{s,g} g_t^{s} + D(L)\gamma_i^{d,g} g_t^{d}) + (C(L)\gamma_i^{s,k} f_t^{s,k} \\
&\quad + D(L)\gamma_i^{d,k} f_t^{d,k}) + (C(L)\vartheta_{it}^{s} + D(L)\vartheta_{it}^{d})
\end{aligned}
$$

- Thus, identify supply factors and demand factors, at both the global level and the regional level
- More complicated SVAR model will allow identification of more economic shocks

State-space representation and the estimation method

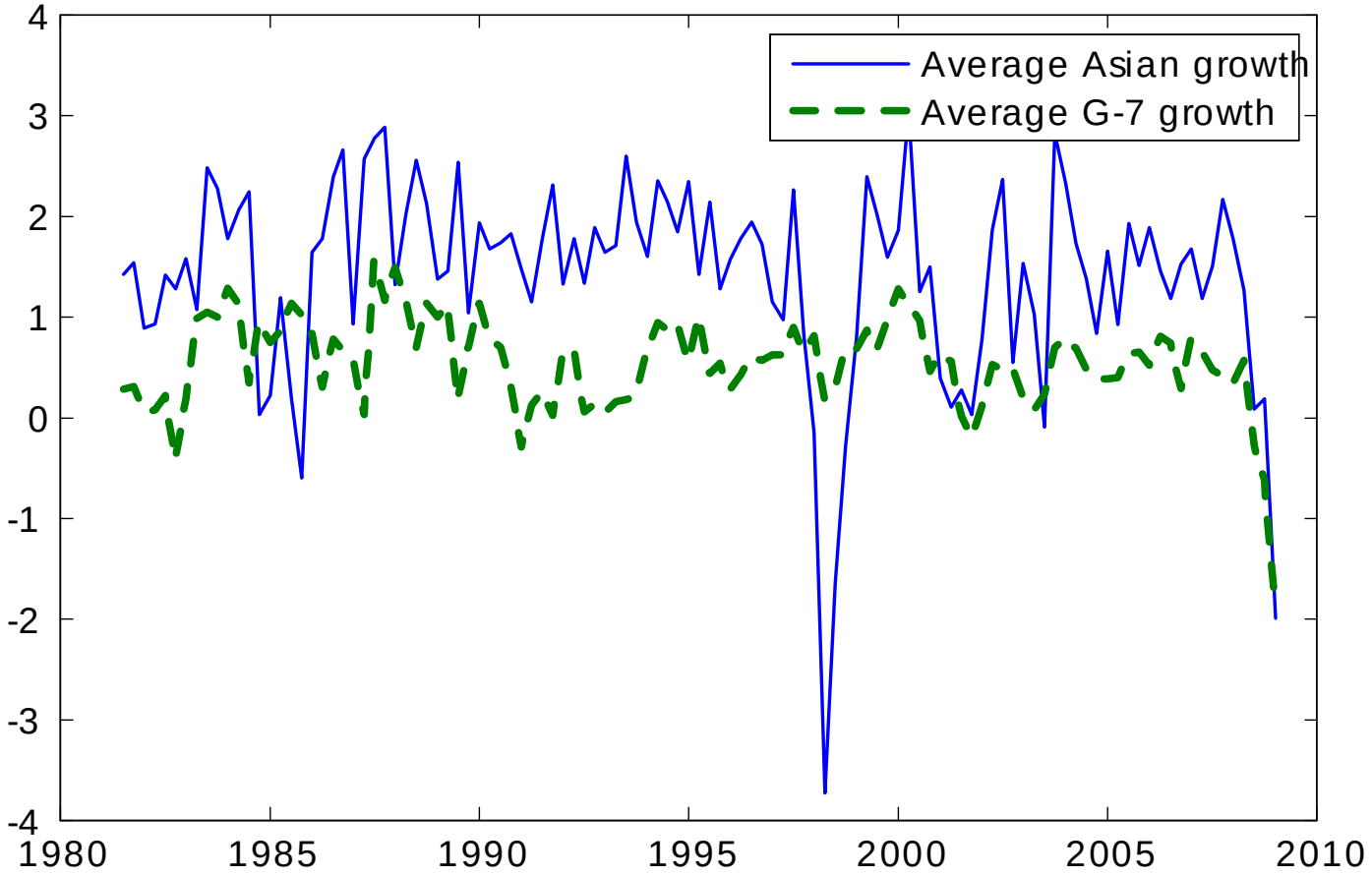
- State-space representation

$$\begin{bmatrix} G_t \\ F_t^1 \\ F_t^2 \end{bmatrix} = \begin{bmatrix} \rho_g & 0 & 0 \\ 0 & \rho_f^1 & 0 \\ 0 & 0 & \rho_f^2 \end{bmatrix} \begin{bmatrix} G_{t-1} \\ F_{t-1}^1 \\ F_{t-1}^2 \end{bmatrix} + \begin{bmatrix} v_{g,t} \\ v_{f,t}^1 \\ v_{f,t}^2 \end{bmatrix}$$

$$\begin{bmatrix} y_t^1 \\ y_t^2 \end{bmatrix} = \begin{bmatrix} \Gamma^1 & \Lambda^1 & 0 \\ \Gamma^2 & 0 & \Lambda^2 \end{bmatrix} \begin{bmatrix} G_t \\ F_t^1 \\ F_t^2 \end{bmatrix} + \begin{bmatrix} e_t^1 \\ e_t^2 \end{bmatrix}$$

- Assumption: $v_{g,t}$, $v_{f,t}^1$, $v_{f,t}^2$, e_t^1, e_t^2 mutually uncorrelated

On average, how different is Asia?



What do we expect?

- Theoretically:
  - Complicated effect on output comovement from both trade and financial integration
  - Trade in substitutes generates resource-shifting effect, (-), Backus et.al (1992)
  - *Trade in complements generates demand-supply spillover (+) , Burstein (2008)*
- Empirically:
  - Positive effect of both trade and financial integration, Frankel and Rose (1998), Imbs (2006), Shin and Wang (2003)
  - *Vertical production linkage is the main channel, di Giovanni and Levchenko(2010), Ng (2010)*
  - Highly fragmented production in Asia (vertical trade)
- Will we observe higher degree of synchronization in Asia? Overtime, compared with the G-7?

Empirical results: full sample 1981Q1 to 2008Q4

- Figure 1: Estimated Factors

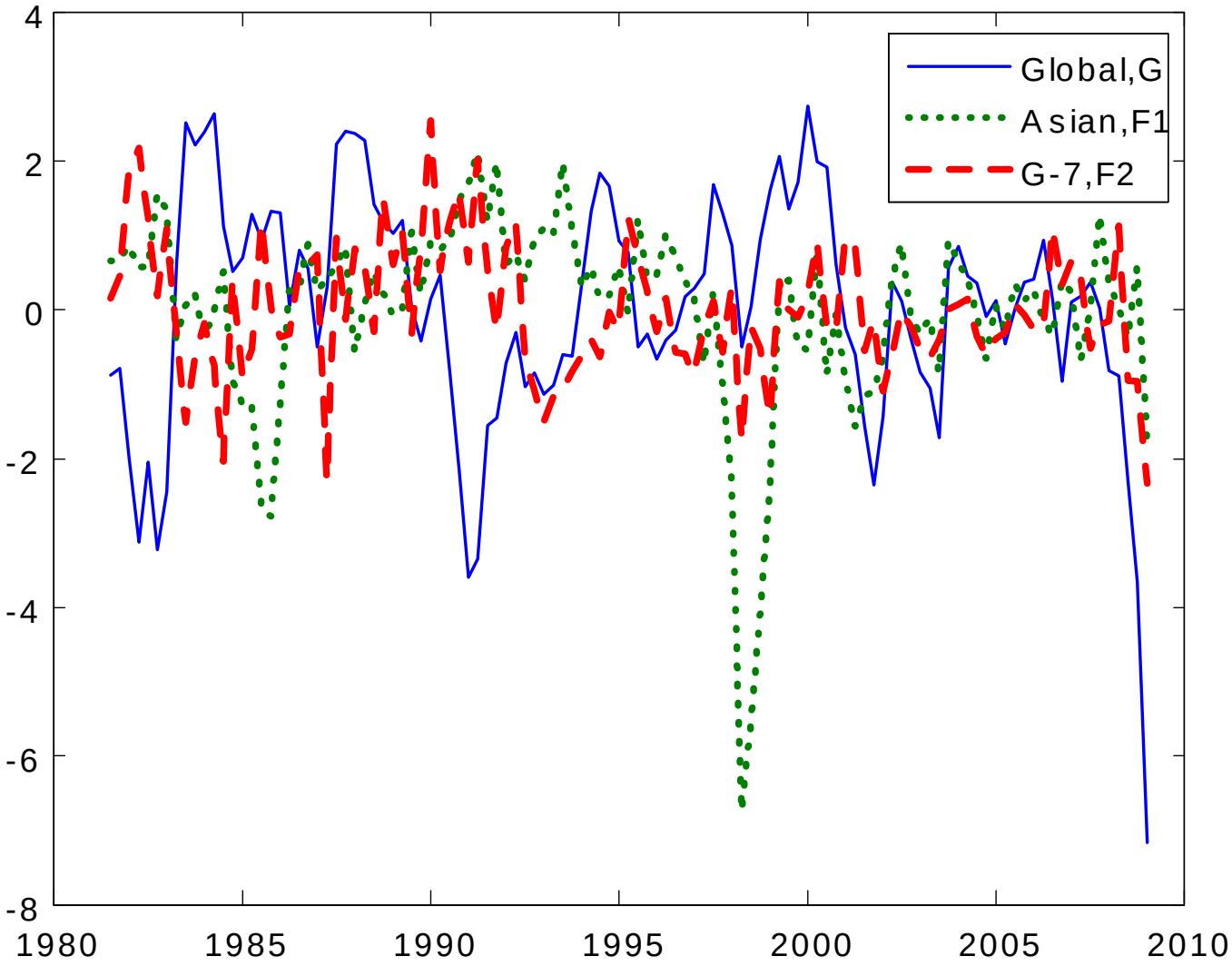


Table 4. Variance decomposition, full sample 1981Q1 to 2008Q4

	Global Factor	Asian Factor	G-7 Factor
HKSAR	0.13	0.21	
China,Mainland	0.05	0.02	
Indonesia	0.05	0.33	
Korea	0.15	0.24	
MYS	0.06	0.39	
PHL	0.01	0.02	
SGP	0.21	0.27	
TWN	0.16	0.08	
THA	0.03	0.20	
JAP	0.12		0.15
FRA	0.27		0.19
DEU	0.13		0.12
ITA	0.26		0.14
GBR	0.36		0.003
CAD	0.47		0.07
USA	0.42		0.03
World Average	0.18		
Asian Group Average	0.10	0.19	
G-7 Group Average	0.29		0.10

Empirical findings I: output co-movement

- Full sample, 1981 Q2 to 2008 Q4
  - Global Factor: early 80s, early 90s debt crisis, early 2000 IT bubbles, 2008 global financial crisis
  - Asian regional factor: middle 80s, 1997 Asian financial crisis
- Strong global cycles
  - More important for G-7 than for Asia: 29% versus 10%, on average
  - HKSAR, Korea, SGP, TWN are more integrated with G-7 than the others
- Strong group cycles
  - Stronger Asian regional cycle than G-7 cycle: 19.5% versus 10%
  - China does not show much synchronization with either the world cycle or the regional cycle

Table 7. The evolution of synchronization, sub-sample results

		1981Q2-1994Q4	1995Q1-2008Q4	1981Q2-2008Q4
China,Mainland	global	0.18	0.08	0.05
	regional	0.07	0.03	0.02
Asian Group Average	global(↑)	0.07	0.20	0.10
	regional(↑)	0.12	0.20	0.19
	total	0.19	0.40	0.29
G-7 Group Average	global(↑)	0.13	0.44	0.29
	regional(⇓)	0.25	0.06	0.10
	total	0.38	0.49	0.39

- Global sync: both groups greatly intensified
- Regional sync: $\begin{cases} \text{Asian} \uparrow, 12\% \rightarrow 20\% \\ G7 \downarrow \text{(significantly)}, 25\% \rightarrow 6\% \end{cases}$

Table. The evolution of supply and demand factors, group average

		1981Q2-1995Q4	1996Q1-2008Q4	1981Q2-2008Q4
Asia	global supply(↑)	0.030	0.302	0.114
	regional supply(↑)	0.051	0.295	0.179
	global demand(↓)	0.039	0.024	0.034
	regional demand	0.107	0.101	0.068
G-7	global supply(↑)	0.087	0.398	0.278
	regional supply(↓)	0.204	0.089	0.125
	global demand(↑)	0.189	0.339	0.390
	regional demand(↓)	0.167	0.092	0.112

Empirical findings II: Emerging Asia

- Evolution of supply factors
  - a lot stronger over time, both global and regional
- Evolution of demand factors
  - Stable over time, both global and regional

Empirical findings III: G-7

- Evolution of global factors
  - a lot stronger over time, both supply factor and demand factor
- Evolution of regional factors
  - weakened over time, both supply factor and demand factor

Policy implications

- Asian economies are not as commonly perceived dependent on external demand
  - Strong regional cycle
    - Strong synchronisation in supply shocks
    - Stronger regional demand factor than global demand factor
  - The role of demand factors are stable over time, and supply factors are dominant in the recent period
- Not a complete decoupling
  - Global factors can still account for a large portion of the volatilities in Asian output fluctuations
  - The role of global supply factor intensified over time
- Common currency may not be an optimal option
  - Asia is merging into the world economy
  - More asymmetric shocks compared with G-7 group
- Therefore, an intra-regional risk insurance scheme might be useful (especially a delinked China)

Work to be done

- What is the theory behind the observed international synchronisation?
- Candidate: trade, financial integration, etc
  - Let us think about trade first
  - Theory and empirical findings do not match
  - What is the solution?
- Our findings point out the important role of the long-run supply factors

Thank you!