The International Transmission of Shocks
A Factor Structural Analysis Using Forecast Data

Kajal Lahiri
Department of Economics
University at Albany, SUNY
(Joint work with Herbert Zhao)

For presentation at "Forecasting Issues in Developing Economies"
International Monetary Fund
April 26-27, 2017, Washington, DC

Background and Motivation

Possible changes in transmission of shocks after 2008 crisis

- Emerging market economies, with their impressive growth records and increasing weight in the international trade and financial markets, have never been closer to the center stage of the global economy than they are today.
- However, changes in global business cycle dynamics, especially since the 2008 global economic and financial crisis, are confounding the relationship between the emerging market economies (EMEs) and the industrialized countries (ICs), especially with respect to the origin, transmission, and impact of real and financial shocks.
- Whether the world market is witnessing a period of increased convergence or accelerated decoupling regionally and globally remains unclear.

Background and Motivation (cont.)
Difference between ICs and EMEs

- While many industrialized countries (ICs) are still suffering from the ensuing debt crisis and a slow recovery, major emerging market economies (EMEs) seem to have taken on a robust and vibrant path of continued growth.
- Canova (2005) uses a set of VAR models and quarterly data from 1990 to 2002 to extract regularities regarding the effect of United States-originated shocks on eight Latin American countries. The author specifically documented that the patterns of transmission from the United States to Latin American countries are different from those between developed economies.

Literature and Current Issues

Lack of recent studies, especially for EMEs

- There is a long string of theoretical and empirical literature devoted to these issues. Theoretical models do not justify the strong empirical correlations - "international correlation puzzle", Bergholt and Sveen (2013)
- Yet, relatively few studies have documented the propagation of shocks involving emerging market economies (EMEs), which could significantly differ from that among industrialized countries (ICs).
- Moreover, the few existing studies often concentrate on "normal times" instead of crisis periods, which usually have more profound economic and political impact.

Literature and Current Issues (cont.)

Difficulties preventing thorough studies of EMEs

- As discussed in, e.g., Agenor et al. (2000), Kose et al. (2003) and Canova (2005), this reflects several difficulties that are particularly prohibitive in studying the EMEs during episodes of crisis.
- The first difficulty is caused by the often limited amount of reliable data.
- The second difficulty is caused by unanticipated events affecting the EMEs.
- The third difficulty is caused by frequent regime changes and radical reforms, which often follow an unanticipated shock.

Literature and Current Issues (cont.)

Lack of up-to-date evidence even on ICs

- Recent literature generally finds mixed evidence as to the importance, the pattern, and the propagation of global and regional shocks:
- For example, Bordo and Helbling (2011) focus on ICs and document strong co-movement of business cycles.
- Kose et al. (2012) find diminished importance of global shocks and less evidence of synchronization globally, and find evidence of synchronization *within the group* of ICs and *within the group* of EMEs.
- But the data used in Kose et al. (2012) ends in 2008 – not capturing possible changes after the crisis.

A Novel Approach

Using forecasts instead of official statistics

- This paper uses monthly multi-horizon fixed-target real GDP forecasts, instead of the actual (quarterly) real GDP, to analyze the global business cycles and propagation of shocks.
- As the forecast horizon goes up to 24 months, the amount of data available permits detailed subsample analysis of each individual crisis period, which would not be possible if actual quarterly data is used.
- Under long run efficiency, i.e., all available information is used in the forecast eventually, the estimates obtained using forecasts are identical to those from the actual real GDP growth rates.

Objectives and Overview

EMEs vs. ICs; “normal periods” vs. “crisis periods”

- The main objective is to quantify the international propagation of global, regional, and idiosyncratic country-specific shocks between the industrialized countries and Asian emerging market economies.
- The United States is chosen as a representative of ICs, given its role in the 2008 crisis. India and China are selected to represent EMEs due to their importance in global trade and growth.
- An FSVAR model is used to extract common and country-specific shocks and estimate the time it takes for news to propagate to the United States and India.
- Subsamples around the 1997 and 2008 crisis are examined in an attempt to identify and quantify possible systematic changes in the propagation mechanism.

Benefit of Using Monthly Forecasts

Addressing the lack of reliable and up-to-date evidence from crisis periods

- This paper addresses two important issues.
- The first concerns how quickly shocks of different origins transmit.
  - Most of the existing studies rely exclusively on annual or quarterly data and assume that no idiosyncratic shocks transmit contemporaneously.
  - With monthly data, the within-quarter transmissions are identified in this study.
- The second question concerns the possible changes in the propagation mechanisms during crisis periods.
  - As crisis often lasts for no more than a year or two, few existing studies examined crisis periods in isolation of the non-crisis periods.
  - With monthly data, the 1997 Asian financial crisis period and the 2008 global crisis period are carefully studied.

Consensus Forecasts Data

A leading international economic survey since 1989

- Every month, the Consensus Economics Inc. surveys more than 700 professional economists representing organizations such as government agencies, large multinational banks, as well as consulting and research firms.
- *The Consensus Forecasts - G7 & Western Europe* provides monthly coverage of the major industrialized countries since 1989.
- *The Asia Pacific Consensus Forecasts* provides monthly coverage of the major Asian emerging market economies since 1990.
- Not all survey respondents forecast for all the countries. Instead, in each country, Consensus Economics Inc. surveys about 10 to 30 forecasters.

Real GDP Growth Forecasts

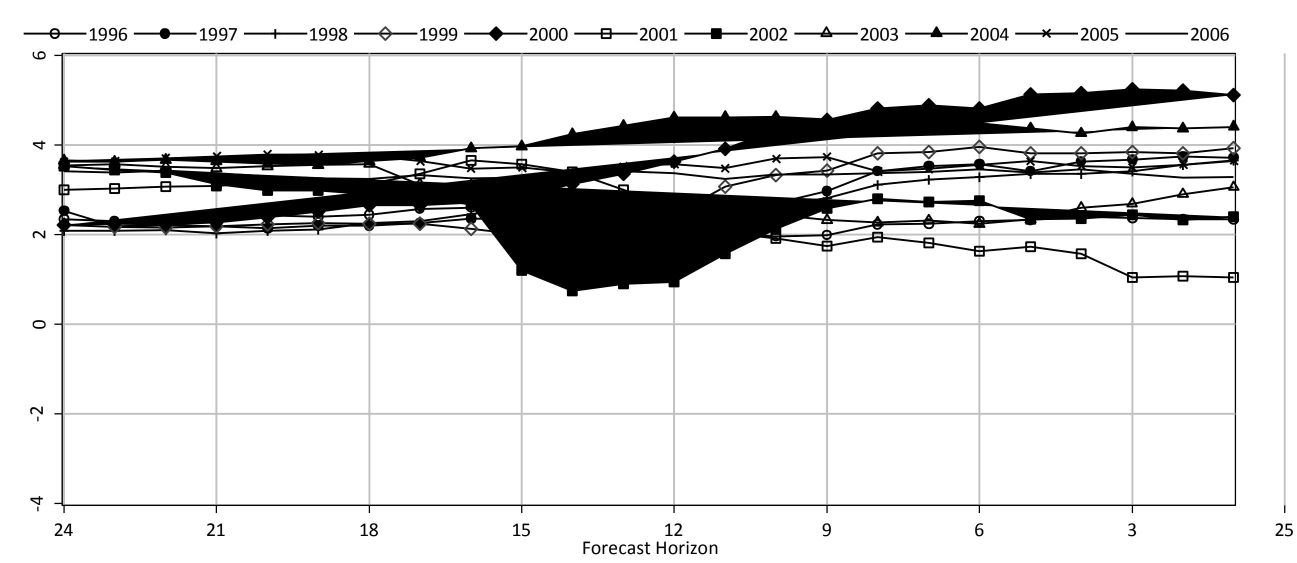
Monthly multi-horizon fixed target forecasts

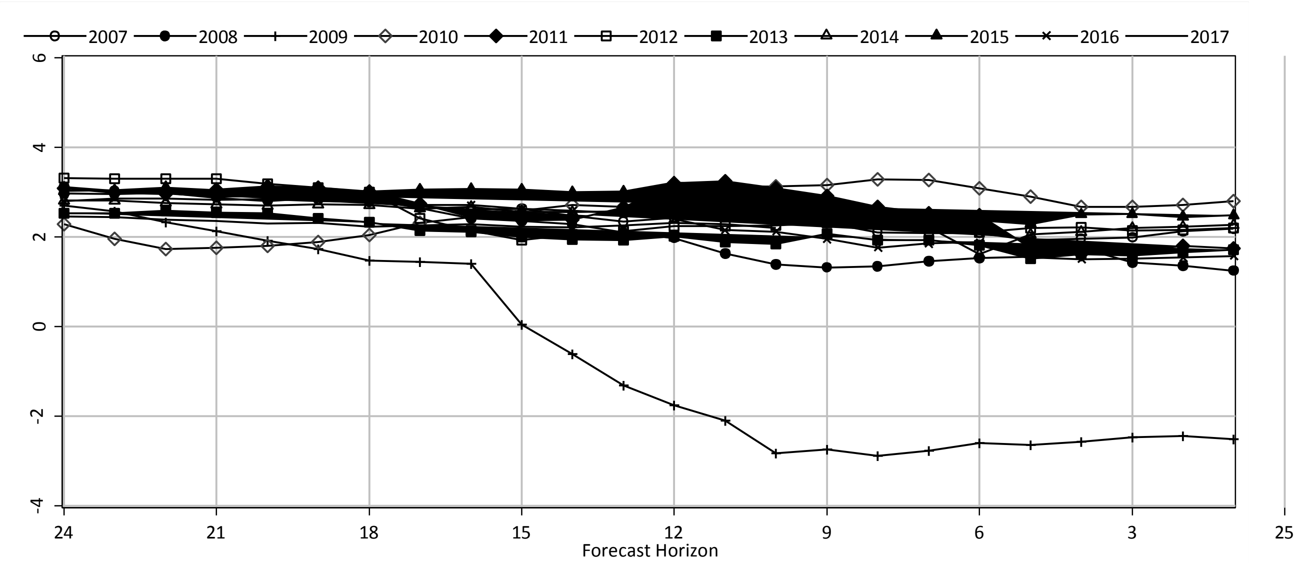
- This study focuses on real GDP growth rate forecasts.
- Each month, every individual forecaster reports two forecasts, one for the current year, the other for the next year.
- For all the months within a year, the targets of the forecasts remain fixed and the forecast horizon decreases as time progresses.
- For current year forecasts, the forecast horizon decreases from 12 months to 1 month from January to December. For next year forecasts, the forecast horizon decreases from 24 to 13 from January to December.
- See *Isikler, Lahiri and Loungani: "How Quickly Do Forecasters Incorporate News? Evidence from Cross-country Surveys", Journal of Applied Econometrics, 2006.*

Forecasters for Selected Countries in Jan 2009 Survey

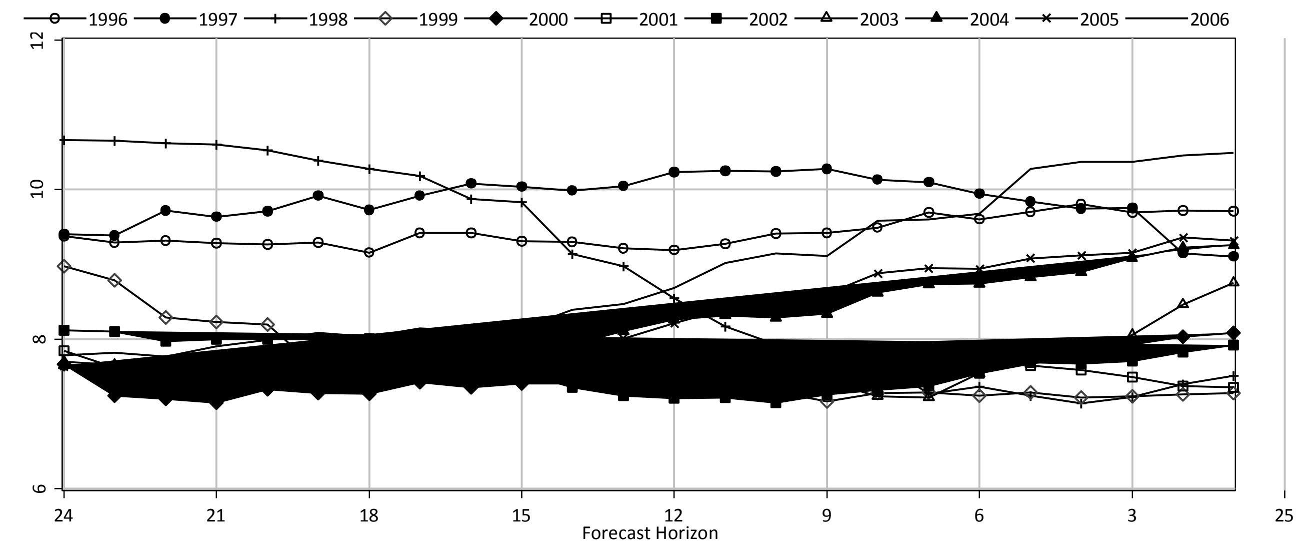
United States	United Kingdom	India	China
Bank of America Corp	Bank of America	Bank of Tokyo-Mitsubishi UFJ	Bank of China (HK)
Barclays Capital	Barclays Capital	CRISIL	Bank of East Asia
Credit Suisse	Beacon Econ Forecasting	Citigroup	Citigroup
DuPont	BNP Paribas	Dresdner Bank	Credit Suisse
Eaton Corporation	Cambridge Econometrics	Experian Business Strat	Deutsche Bank
Econ Intelligence Unit	Capital Economics	Goldman Sachs	Econ Intelligence Unit
Fannie Mae	Citigroup	HSBC	Goldman Sachs Asia
First Trust Advisors	Confed of British Industry	ICICI Bank	HSBC Economics
Ford Motor Corp	Credit Suisse	IHS Global Insight	Hang Seng Bank
General Motors	DTZ Research	JP Morgan Chase	IHS Global Insight
Georgia State University	Economic Perspectives	Moody's Economy.com	ING
IHS Global Insight	HBOS	Morgan Stanley	JP Morgan Chase
Inforum - Univ of Maryland	HSBC	Nomura	Nomura
JP Morgan	IHS Global Insight	Tata Services (DES)	Oxford Economics
Macroeconomic Advisers	ING Fincial Markets	UBS	UBS
Merrill Lynch	ITEM Club		
Moody's Economy.com	JP Morgan		
Morgan Stanley	Liverpool Macro Research		
Northern Trust	Lloyds TSB Fincial Markets		
Oxford Economics	Merrill Lynch		
Swiss Re	Oxford Economics		
The Assn of Home Builders	RBS Fincial Markets		
The Conference Board	Schroders		
Univ of Michigan - RSQE	Societe Generale		
Wachovia Corp			
Wells Capital			

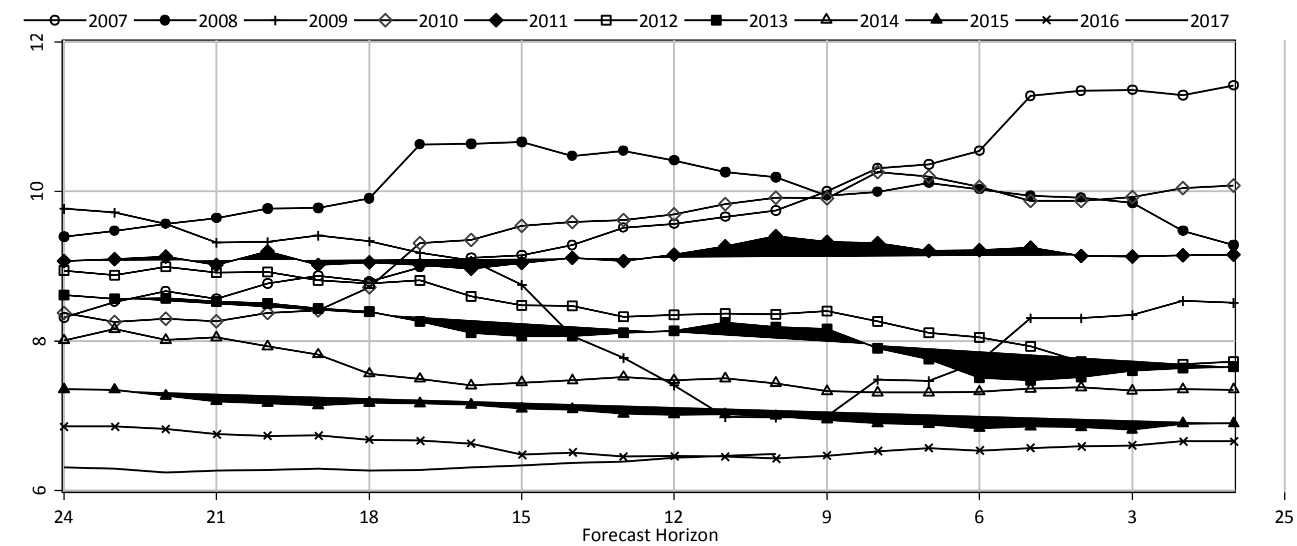
Forecasts of U.S. Real GDP Growth: 1996 to 2017



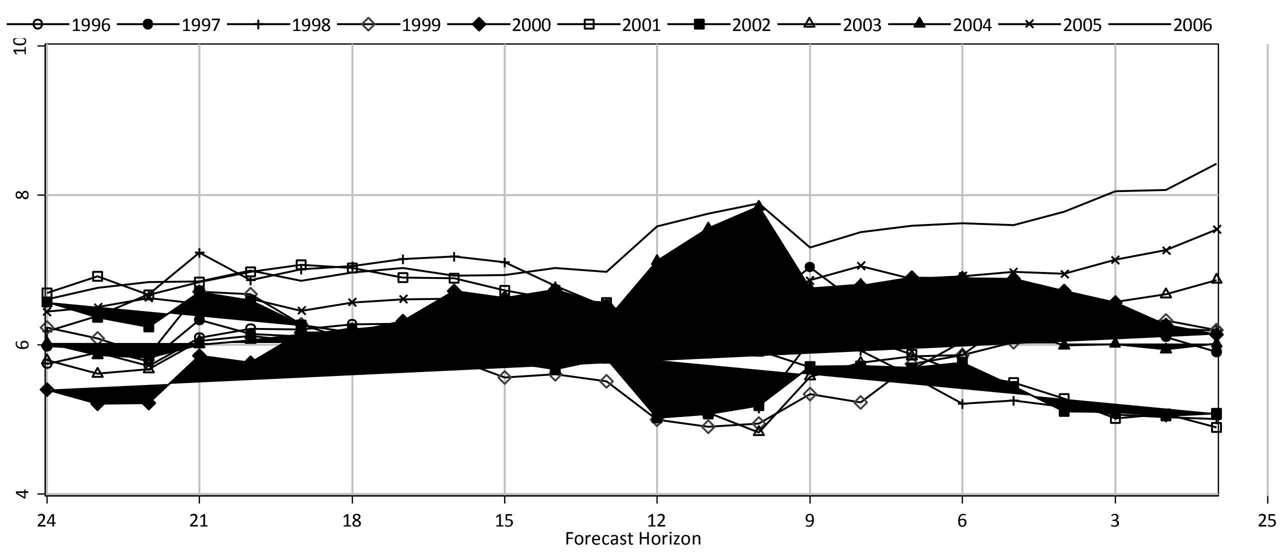


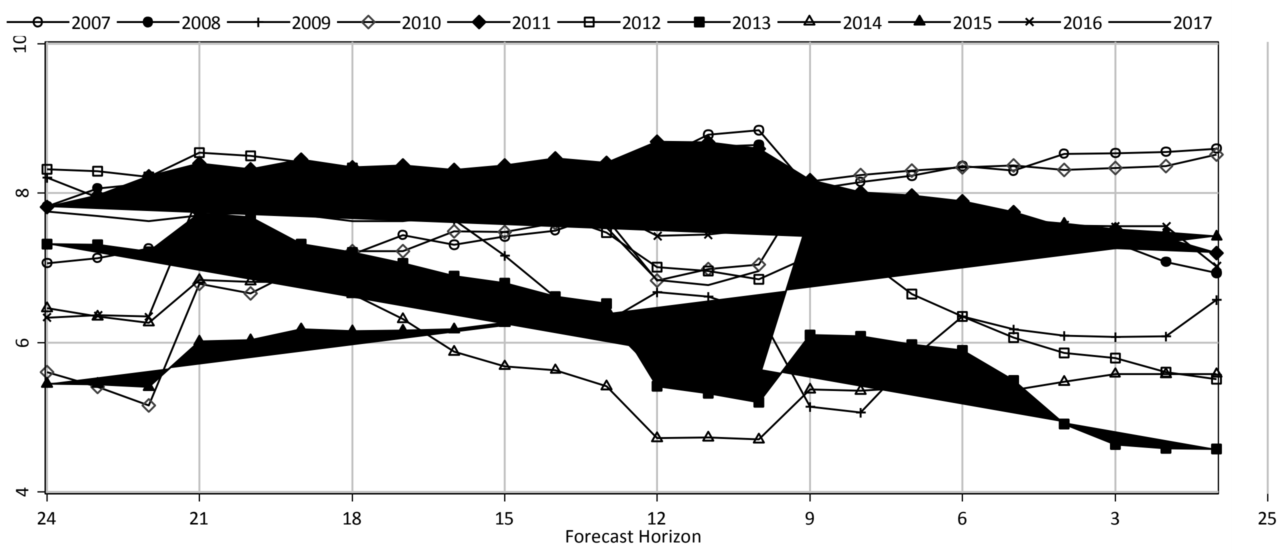
Forecasts of China Real GDP Growth: 1996 to 2017





Forecasts of India Real GDP Growth: 1996 to 2017



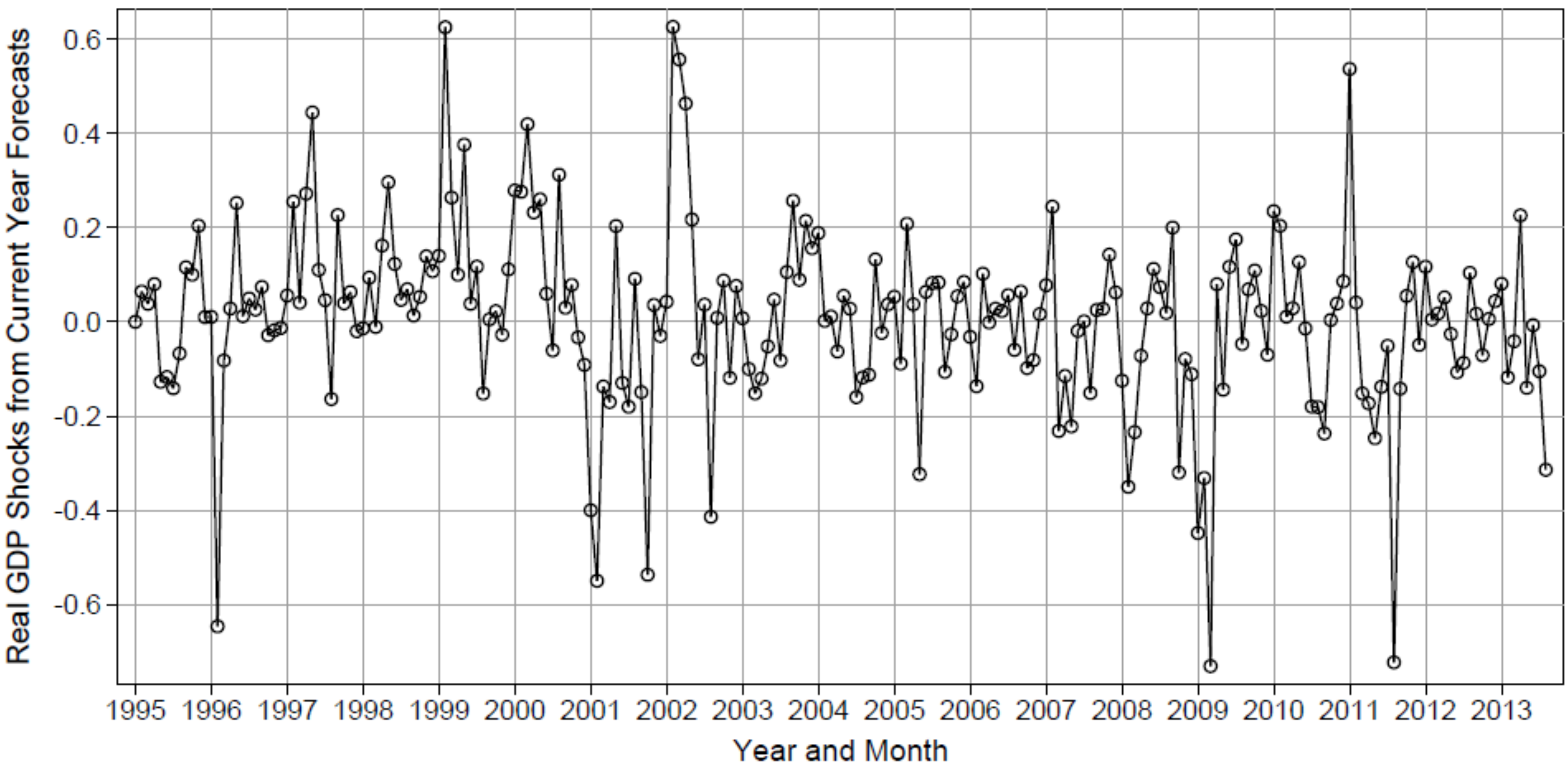


Forecast Revisions

Representing real time flow of news

- The series of forecast revisions by definition reflect the changes in the forecasters' information set in real time.
- The series of forecast revisions are computed without the need for actual annual real GDP growth data.
- Unlike USA or Europe, the evolution of fixed target forecasts are quite different and volatile for EMEs.

U.S. Current Year Forecast Revisions



Notations

Let y_t be the target variable for time period t. In this study, y_t is the annual real GDP growth rate for year t.

Let i be the country index ($i \in \{1, 2, 3, \ldots, J\}$) and let h denote forecast horizon ($h > 0$).

Define forecast revision $r_{i,t,h}$ as the difference between two consecutive forecasts of the same target, i.e., $r_{i,t,h} = y_{i,t,h} - y_{i,t,h+1}$.

$\varepsilon_{i,t,h}$ denotes the news that became available between the time when horizon $h + 1$ forecast is made and the time when horizon h forecast is made

Let β_s ($s \in \{0, 1, 2, 3, \ldots\}$) represents the usage of news $\varepsilon_{i,t,s}$.

Forecast Revisions and Forecast Efficiency

Forecast revision at horizon h can be written as

$$r_{i,t,h} = \beta_0 \varepsilon_{i,t,h} + \beta_1 \varepsilon_{i,t,h+1} + \beta_2 \varepsilon_{i,t,h+2} + \beta_3 \varepsilon_{i,t,h+3} + \dots \qquad (1)$$

For the purpose of this study, a set of forecasts are considered "fully efficient" if each forecast incorporates all relevant news that becomes available at the time or before the forecast is made.

When this is the case, forecast revisions should not contain any news except what becomes available contemporaneously, i.e., in equation (1), $\beta_s = 0 \ \ \forall s \geq 1$.

A VAR Model of Forecast Revisions

For open economies, news about foreign countries' real GDP may be of value in forecasting domestic real GDP. This mechanism can be represented in a VAR(p) model

$$\boldsymbol{r}_{t,h} = \boldsymbol{c} + \boldsymbol{B}_1 \boldsymbol{r}_{t,h+1} + \boldsymbol{B}_2 \boldsymbol{r}_{t,h+2} + \boldsymbol{B}_3 \boldsymbol{r}_{t,h+3} + \ldots + \boldsymbol{B}_p \boldsymbol{r}_{t,h+p} + \boldsymbol{\varepsilon}_{t,h} \quad (2)$$

where $\boldsymbol{r}_{t,h} = (r_{1,t,h}, r_{2,t,h}, r_{3,t,h}, \ldots, r_{J,t,h})'$ is a $(J \times 1)$ vector of all countries forecast revisions and $\boldsymbol{B}_k, k = 1, 2, 3, \ldots, p$ is a $(J \times J)$ coefficient matrix.

A VAR Model of Forecast Revisions (Cont.)

Let $E(\varepsilon_{t,h}\varepsilon'_{t,h}) = \boldsymbol{\Omega} = \{\sigma_{i,j}\}, i,j \in \{1,2,3,\ldots,J\}$. The VMA($\infty$) form of this VAR($p$) model is simply the multivariate version of the relationship in equation (1) with utilization of both domestic and foreign news:

$$\boldsymbol{r}_{t,h} = \boldsymbol{\mu} + \boldsymbol{M}_0\varepsilon_{t,h} + \boldsymbol{M}_1\varepsilon_{t,h+1} + \boldsymbol{M}_2\varepsilon_{t,h+2} + \boldsymbol{M}_3\varepsilon_{t,h+3} + \ldots \quad (3)$$

where for normalization, $\boldsymbol{M}_0$ is assumed to be the identity matrix $\boldsymbol{I}$.

A VAR Model of Forecast Revisions (cont.)

In our context, the amount of revision a rational and efficient forecaster should make to her forecast represents all the relevant news, in the sense that $\varepsilon_{t,h} = \mathrm{E}(\boldsymbol{y}_t|\mathcal{I}_{t,h}) - \mathrm{E}(\boldsymbol{y}_t|\mathcal{I}_{t,h+1})$, where $\boldsymbol{y}_t = (y_{1,t}, y_{2,t}, y_{3,t}, \ldots, y_{J,t})'$ is a vector of all the countries' real GDP growth rates.

Therefore, equation (3) can be rewritten as

$$\begin{aligned} \boldsymbol{r}_{t,h} =& \boldsymbol{\mu} + \boldsymbol{M}_0[\mathrm{E}(\boldsymbol{y}_t|\mathcal{I}_{t,h}) - \mathrm{E}(\boldsymbol{y}_t|\mathcal{I}_{t,h+1})] \\ &+ \boldsymbol{M}_1[\mathrm{E}(\boldsymbol{y}_t|\mathcal{I}_{t,h+1}) - \mathrm{E}(\boldsymbol{y}_t|\mathcal{I}_{t,h+2})] \\ &+ \boldsymbol{M}_2[\mathrm{E}(\boldsymbol{y}_t|\mathcal{I}_{t,h+2}) - \mathrm{E}(\boldsymbol{y}_t|\mathcal{I}_{t,h+3})] \\ &+ \boldsymbol{M}_3[\mathrm{E}(\boldsymbol{y}_t|\mathcal{I}_{t,h+3}) - \mathrm{E}(\boldsymbol{y}_t|\mathcal{I}_{t,h+4})] + \ldots \end{aligned} \tag{4}$$

GIRF and Cumulative Intertemporal FEVD

The ordering-free generalized VAR model of Koop et al. (1996) and Pesaran and Shin (1998) is used.

The $(J \times 1)$ vector of k-period ahead scaled generalized impulse response function is given by $\boldsymbol{\Psi}_j(k) = \sigma_{jj}^{-1/2} \boldsymbol{M}_k \boldsymbol{\Omega} \boldsymbol{e}_j$, where $\boldsymbol{e}_j$ is the jth column of an identity matrix.

The cumulative intertmporal forecast error variance decomposition (Isiklar and Lahiri, 2006) is used as an aggregate measure of the degree of forecast efficiency.

For a country i, the cumulative proportion of the variations in the forecast revisions of the real GDP forecasts that can be attributed to the relevant news that becomes available during the last m periods is given by $\theta_{i,m} = \left[\sum_{h=0}^{m} (\boldsymbol{e}_i' \boldsymbol{M}_h \boldsymbol{\Omega} \boldsymbol{M}_h' \boldsymbol{e}_i)\right] / \left[\sum_{h=0}^{\infty} (\boldsymbol{e}_i' \boldsymbol{M}_h \boldsymbol{\Omega} \boldsymbol{M}_h' \boldsymbol{e}_i)\right]$.

Factor Structural VAR Model

To identify and estimate the regional and global business cycle shocks and their roles in determining each country's growth, a factor structural VAR (FSVAR) model is employed.

The model consists of the VAR model in equation (2) and the following factor structure for the reduced form errors $\varepsilon_{t,h}$

$$\varepsilon_{t,h} = \boldsymbol{\Lambda} \boldsymbol{f}_{t,h} + \boldsymbol{A} \boldsymbol{u}_{t,h} \tag{5}$$

where $\boldsymbol{f}_{t,h}$ is a $(r \times 1)$ vector of common shocks that may be region-specific or common to all the countries, $\boldsymbol{\Lambda}$ is a $(J \times r)$ matrix of factor loadings, $\boldsymbol{A}$ is a $(J \times J)$ matrix that captures the contemporaneous interaction between countries, and $\boldsymbol{u}_{t,h}$ is a $(J \times 1)$ vector of country-specific shocks with $\mathrm{E}(\boldsymbol{u}_{t,h} \boldsymbol{u}'_{t,h}) = \mathrm{diag}(\sigma_{u1}, \ldots, \sigma_{uJ}) = \boldsymbol{D}$.

Similar to Stock and Watson (2005), the assumption of no contemporaneous propagation of country-specific shocks is maintained in this study, i.e., $\boldsymbol{A} = \boldsymbol{I}$.

FSVAR IRF and FEVD

The FSVAR model consists of equation (2) and (5) can be written as

$$\boldsymbol{r}_{t,h} = \boldsymbol{\mu} + (\boldsymbol{\Lambda f}_{t,h} + \boldsymbol{u}_{t,h}) + \boldsymbol{M}_1(\boldsymbol{\Lambda f}_{t,h+1} + \boldsymbol{u}_{t,h+1}) + \boldsymbol{M}_2(\boldsymbol{\Lambda f}_{t,h+2} + \boldsymbol{u}_{t,h+2}) + \dots \quad (6)$$

As an example, the cumulative proportion of the variance of forecast revisions that can be attributed to the collection of regional and/or global shocks in the past m periods is given by

$$\theta_i^f = \left[\sum_{h=0}^{m}\sum_{s=1}^{r}(\boldsymbol{e}_i'\boldsymbol{M}_h\boldsymbol{\Lambda\Lambda}'\boldsymbol{M}_h\boldsymbol{e}_s)\right] / \left[\sum_{h=0}^{\infty}\sum_{s=1}^{r}(\boldsymbol{e}_i'\boldsymbol{M}_h\boldsymbol{\Omega}\boldsymbol{M}_h\boldsymbol{e}_s)\right]$$

Remarks on FSVAR Model

Advantages over GVAR and FAVAR

- The factor structural VAR model has several advantages over alternative methods.
- The global VAR model (GVAR) (Dees et al., 2007) is best suited to study the effects of shocks originated in specific sectors of a specific country, since a VAR model is developed for each country.
- The factor-augmented VAR (FAVAR) (Bernanke et al., 2005) models are good for studies in which the responses of a large set of variables are under examination.
- The FSVAR model is also consistent with the rational inattentiveness theory in Sims (2003).

Implications of Forecast Efficiency

If forecasts are perfectly efficient in that $\boldsymbol{r}_{t,h} = \varepsilon_{t,h}$, then economically meaningful estimates can be obtained by static factor analysis.

Define long-run efficiency as that there exists a p such that $\boldsymbol{M}_i = 0 \; \forall i > p$, i.e., all relevant information is used within p periods.

Given a sufficiently long forecast horizon $h \geq p$, the total amount of utilization of news $\varepsilon_{t,h}$ in the final forecast that includes the entire series of revision $\sum_{\tau=0}^{p} \boldsymbol{r}_{t,h-\tau}$ is given by $\boldsymbol{\Gamma} \equiv \sum_{i=0}^{p} \boldsymbol{M}_i$, which is the cumulative impulse response function in the FSVAR model.

This cumulative impulse response equal the responses of actual real GDP growth shocks *aggregated over horizons*.

Implications of Forecast Efficiency (cont.)

The total utilization of international news as represented by the common factors $\boldsymbol{f}_{t,h}$ is $\sum_{i=0}^{p} \boldsymbol{M}_i \boldsymbol{\Lambda}$. So the amount of variation accounted for by the jth common factor in country i's real GDP growth variations is

$$\omega_{ij} = \left(\boldsymbol{e}_i' \tilde{\boldsymbol{\Lambda}} \boldsymbol{e}_j\right)^2 \left[\sum_{s=1}^{J} \left(\boldsymbol{e}_i' \tilde{\boldsymbol{\Lambda}} \boldsymbol{e}_s\right)^2 + \sum_{s=1}^{J} \left(\boldsymbol{e}_i' \tilde{\boldsymbol{M}} \boldsymbol{e}_j\right)^2\right]^{-1} \quad (7)$$

where $\tilde{\boldsymbol{\Lambda}} = \sum_{i=0}^{p} \boldsymbol{M}_i \boldsymbol{\Lambda}$ and $\tilde{\boldsymbol{M}} = \sum_{i=0}^{p} \boldsymbol{M}_i \boldsymbol{D}$ denote the inefficiency adjusted total utilization of news in common factors and country-specific shocks respectively.

Assuming long-run efficiency in $p \leq h$ periods, the share of total news utilization should be the average variance decompositions that are based on actual real GDP growths.

Country and Country Groups

Composition of country groups and the weights

- A total of 16 countries are include in the VAR and FSVAR analysis. India, Japan, China, and United States enter the models directly.
- Countries in Europe, Northeast Asia, and Southeast Asia form three groups before entering the models.
- The real GDP growth $y_{g,t}$ of a group containing countries $i=1,2,\ldots,G$ is given by

$$y_{g,t} = \sum_{i=1}^{G} Y_{i,t}\, y_{i,t} \Big/ \sum_{i=1}^{G} Y_{i,t}$$

where $Y_{i,t}$ is country i's GDP valued at purchasing power parities.

Countries in Country Groups and Their Weights

Year	Europe				Northeast Asia			Southeast Asia				
	UK	France	Germany	Italy	HK	Korea	Taiwan	Indonesia	Malaysia	Philippines	Singapore	Thailand
1995	0.219	0.218	0.337	0.226	0.121	0.533	0.346	0.437	0.122	0.154	0.049	0.239
1996	0.226	0.217	0.334	0.224	0.123	0.529	0.348	0.434	0.123	0.154	0.049	0.240
1997	0.231	0.219	0.329	0.222	0.125	0.523	0.351	0.440	0.129	0.153	0.055	0.223
1998	0.230	0.222	0.325	0.223	0.123	0.502	0.376	0.434	0.132	0.160	0.058	0.216
1999	0.231	0.223	0.326	0.221	0.116	0.517	0.367	0.413	0.142	0.162	0.064	0.219
2000	0.237	0.227	0.317	0.219	0.119	0.518	0.364	0.394	0.150	0.161	0.075	0.220
2001	0.238	0.229	0.314	0.219	0.119	0.530	0.351	0.399	0.147	0.157	0.075	0.222
2002	0.241	0.233	0.313	0.212	0.117	0.538	0.345	0.384	0.152	0.154	0.079	0.231
2003	0.246	0.225	0.317	0.212	0.116	0.542	0.341	0.367	0.157	0.150	0.080	0.246
2004	0.251	0.226	0.315	0.208	0.118	0.546	0.337	0.367	0.158	0.143	0.090	0.243
2005	0.251	0.228	0.315	0.207	0.122	0.544	0.334	0.371	0.160	0.134	0.098	0.238
2006	0.250	0.227	0.315	0.207	0.122	0.544	0.333	0.376	0.157	0.132	0.097	0.238
2007	0.244	0.230	0.317	0.209	0.123	0.545	0.332	0.381	0.154	0.131	0.097	0.237
2008	0.238	0.231	0.320	0.212	0.126	0.553	0.322	0.404	0.157	0.128	0.087	0.224
2009	0.235	0.236	0.316	0.214	0.121	0.559	0.320	0.427	0.144	0.128	0.083	0.219
2010	0.227	0.237	0.326	0.210	0.118	0.557	0.325	0.440	0.136	0.124	0.086	0.214
2011	0.222	0.237	0.332	0.208	0.121	0.555	0.324	0.472	0.131	0.118	0.081	0.198
2012	0.227	0.236	0.333	0.205	0.120	0.557	0.323	0.468	0.131	0.119	0.080	0.202
2013	0.231	0.239	0.332	0.199	0.120	0.557	0.324	0.475	0.131	0.125	0.079	0.190
2014	0.235	0.236	0.336	0.194	0.118	0.554	0.328	0.478	0.134	0.128	0.077	0.183
2015	0.235	0.236	0.336	0.194	0.118	0.554	0.328	0.478	0.134	0.128	0.077	0.183
2016	0.235	0.236	0.336	0.194	0.118	0.554	0.328	0.478	0.134	0.128	0.077	0.183
2017	0.235	0.236	0.336	0.194	0.118	0.554	0.328	0.478	0.134	0.128	0.077	0.183

Fiscal Year Forecasts for India

Matching calendar year forecasts with fiscal year forecasts

- A fiscal year in India starts from April and ends in March. For most months of a year, forecast horizons of forecasts made for calendar year and fiscal year are only 3 months apart.
- But for the forecasts made in January to March, the target years are one year apart and the horizons are 9 months apart.
- To address this issue, all the next year calendar year forecasts and all the current year fiscal year forecasts reported in January, February, and March's surveys are deleted.
- This results in losing 3 out of 24 observations per target year.

Fiscal Year Forecasts for India (cont.)

Matching calendar year forecasts with fiscal year forecasts

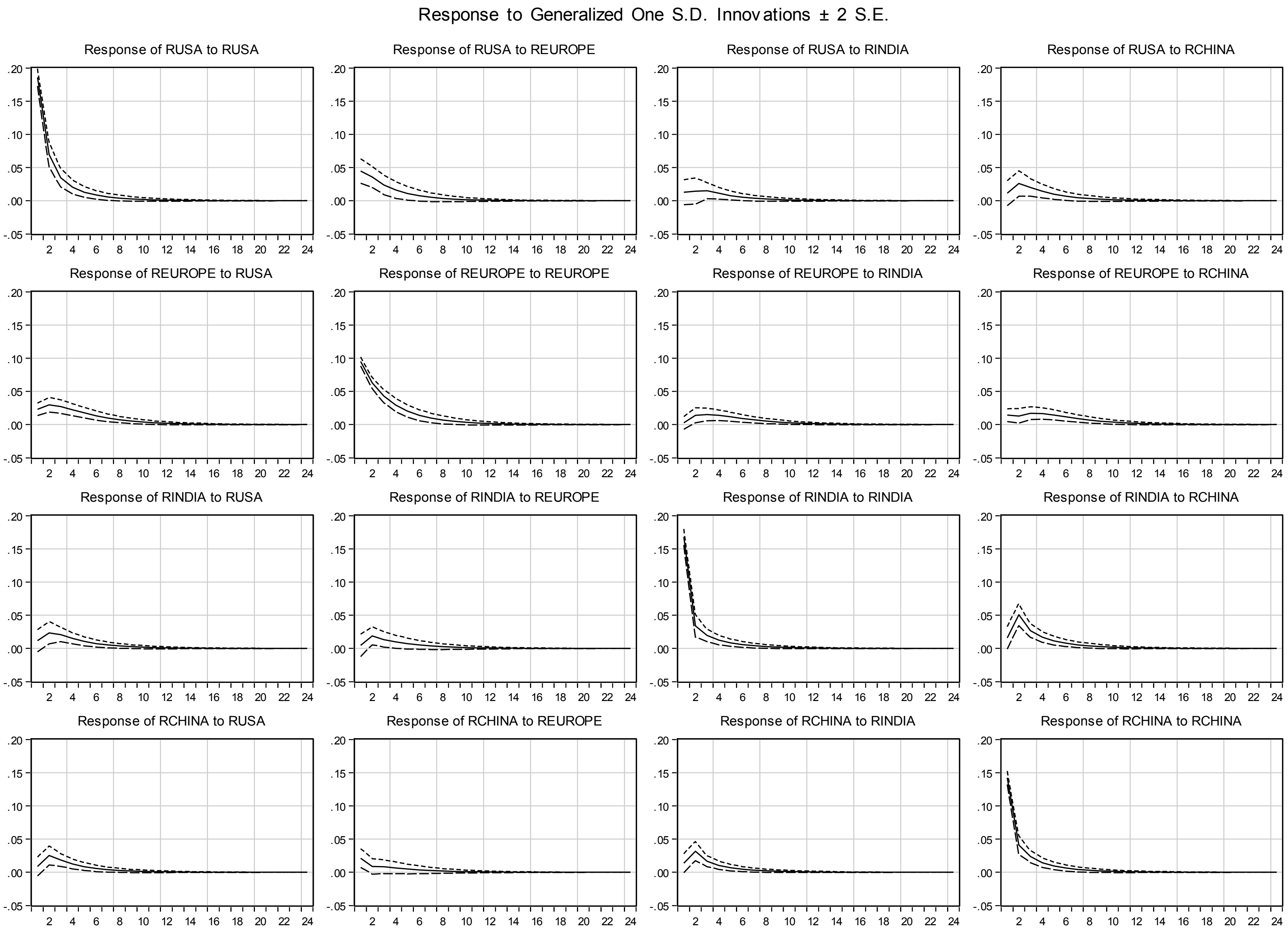
		Jan	Feb	Mar	Apr	May	...	Dec
Curr. Yr.	Target Year	2008	2008	2008	2008	2008	...	2008
(Cal.)	Horizon	12	11	10	9	8	...	1
Next Yr.	Target Year	**2009**	**2009**	**2009**	2009	2009	...	2009
(Cal.)	Horizon	**24**	**23**	**22**	21	20	...	13
Curr. Yr.	Target Year	**2007**	**2007**	**2007**	2008	2008	...	2008
(Fisc.)	Horizon	**3**	**2**	**1**	12	11	...	4
Next Yr.	Target Year	2008	2008	2008	2009	2009	...	2009
(Fisc.)	Horizon	15	14	13	24	23	...	16

Data in bold are forecasts that are unused.

Additional Empirical Strategies

- One lag is selected for VAR and FSVAR based on Akaike and Schwarz's Bayesian information criteria.
- The FSVAR estimation is performed in a manner similar to Clark and Shin (2000). Parameters of the factor model part are estimated by maximum likelihood.
- Residual-based nonparametric bootstrap method is used to compute confidence intervals for the impulse responses and variance decompositions with 1000 bootstrap replications.
- Two common factors are selected for FSVAR. The effect of the second factor on United States is constrained to be 0 for identification.

Forecast Efficiency: Generalized impulse responses

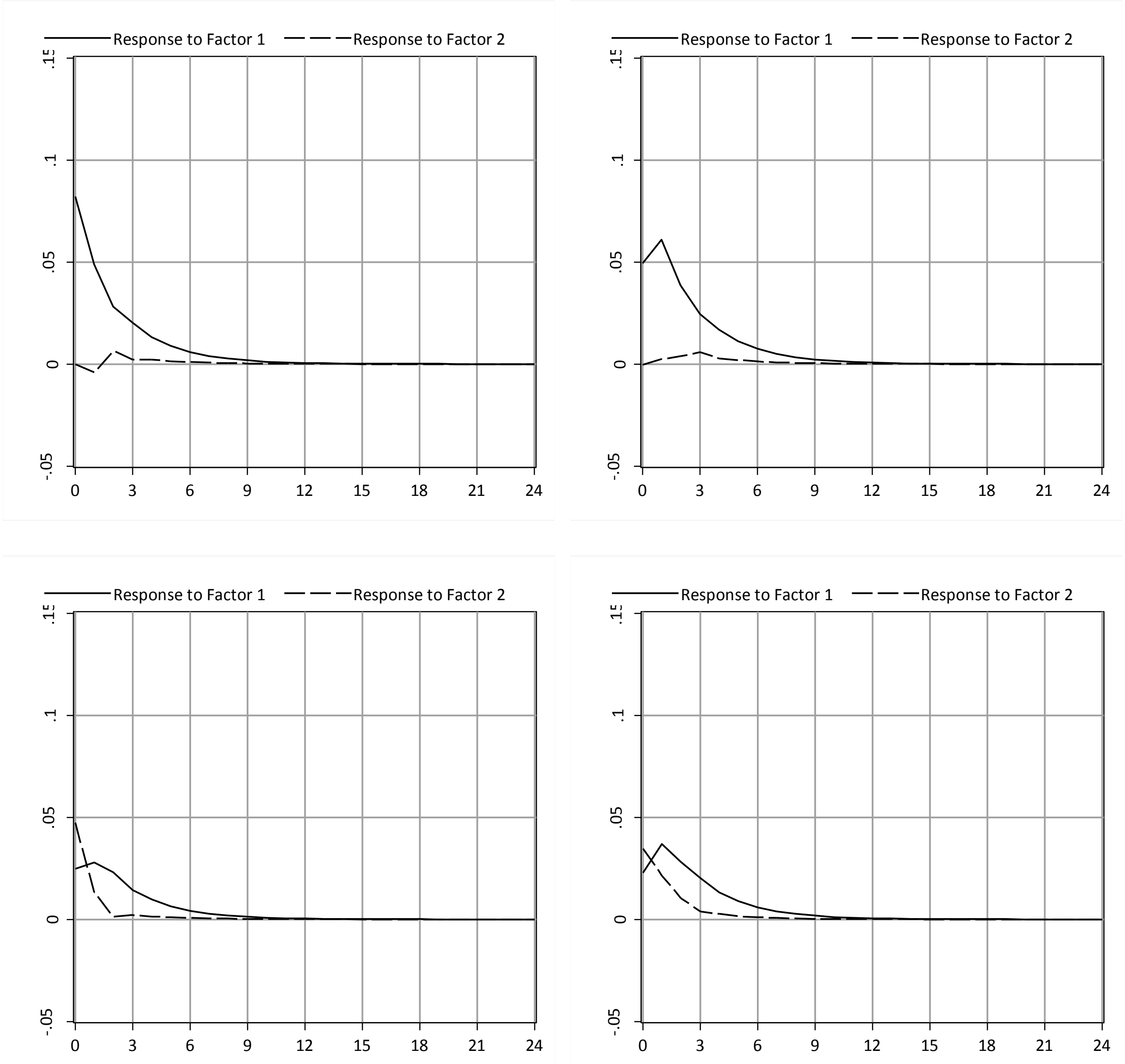


Cumulative Intertemporal Variance Decomposition (VAR Model):

Proportion of Total News Utilized

Months	USA	Europe	Japan	India	China	S.E. Asia	N.E. Asia
1	0.764	0.459	0.667	0.801	0.804	0.541	0.505
2	0.914	0.686	0.813	0.919	0.923	0.757	0.736
3	0.964	0.818	0.901	0.962	0.966	0.869	0.862
4	0.984	0.897	0.949	0.981	0.984	0.931	0.929
5	0.993	0.943	0.974	0.991	0.992	0.965	0.964
6	0.996	0.969	0.987	0.995	0.996	0.982	0.982
7	0.998	0.984	0.993	0.998	0.998	0.991	0.991
8	0.999	0.991	0.997	0.999	0.999	0.995	0.995
9	1.000	0.995	0.998	0.999	1.000	0.998	0.998
10	1.000	0.998	0.999	1.000	1.000	0.999	0.999
11	1.000	0.999	1.000	1.000	1.000	0.999	0.999
12	1.000	0.999	1.000	1.000	1.000	1.000	1.000

FSVAR Impulse Responses to Common Shocks



Cumulative Intertemporal Variance Decomposition (FSVAR Model) – Proportion of Common International News Utilized

Months	USA	Europe	Japan	India	China	S.E. Asia	N.E. Asia
1	0.326	0.181	0.187	0.109	0.160	0.160	0.257
2	0.634	0.570	0.561	0.530	0.567	0.610	0.639
3	0.826	0.793	0.799	0.783	0.795	0.829	0.838
4	0.921	0.907	0.911	0.903	0.907	0.926	0.929
5	0.965	0.958	0.961	0.957	0.958	0.968	0.969
6	0.984	0.982	0.983	0.981	0.981	0.986	0.986
7	0.993	0.992	0.992	0.992	0.992	0.994	0.994
8	0.997	0.996	0.997	0.996	0.996	0.997	0.997
9	0.999	0.998	0.999	0.998	0.998	0.999	0.999
10	0.999	0.999	0.999	0.999	0.999	0.999	0.999
11	1.000	1.000	1.000	1.000	1.000	1.000	1.000
12	1.000	1.000	1.000	1.000	1.000	1.000	1.000

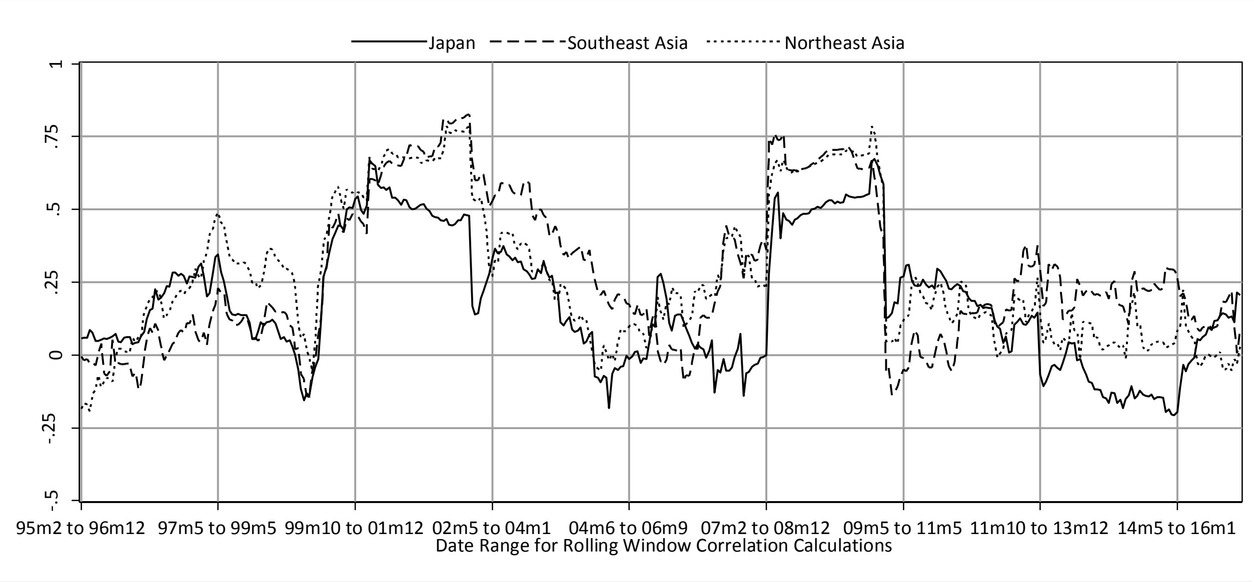
Remarks

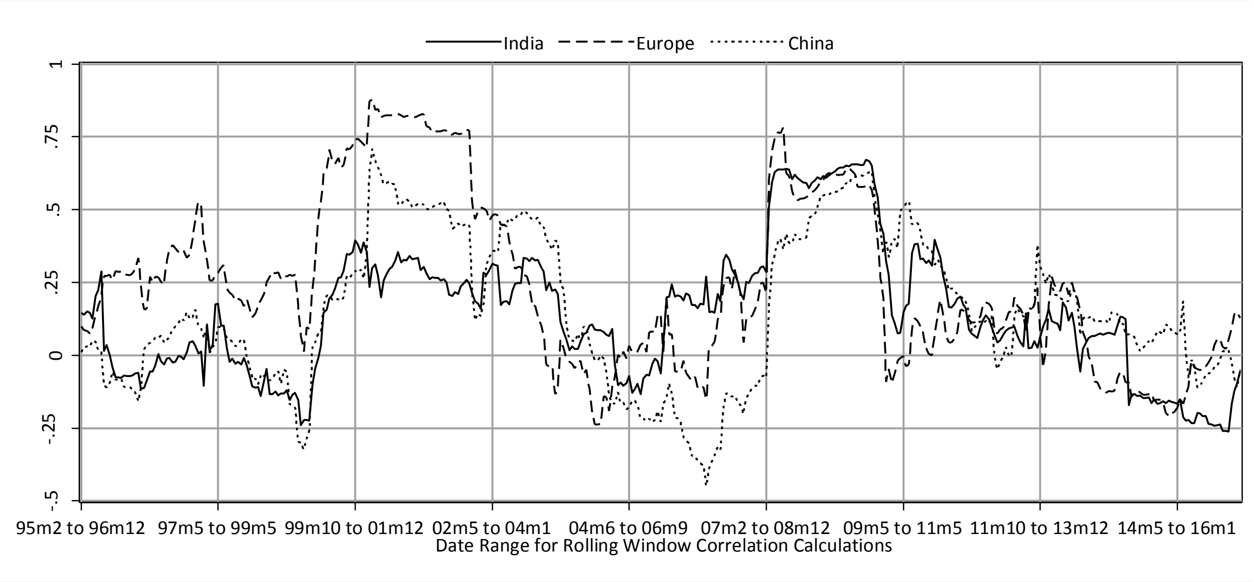
- While the forecasts are not perfectly efficient, the degree of inefficiency is low.
- A period of six months seems to be sufficient for most if not all the relevant information to be incorporated into the forecasts.
- Given that the longest forecast horizon in the data is 24 months, there is more than sufficient time for all relevant information to be used.
- The results highlight the importance of using monthly data, as more than half of the information in news is absorbed within the first quarter.

Correlations Between Forecast Revisions – full sample

Correlations	USA	Europe	Japan	India	China	S.E. Asia
Europe	0.404					
Japan	0.304	0.384				
India	0.202	0.204	0.231			
China	0.188	0.290	0.239	0.271		
S.E. Asia	0.200	0.297	0.378	0.342	0.444	
N.E. Asia	0.422	0.528	0.502	0.368	0.404	0.661

Rolling Correlations of 36 Forecast Revisions (21 Months) with US





Steady State Variance Decomposition (FSVAR Model)-Full Sample

Country	USA	Europe	Japan	India	China	S.E. Asia	N.E. Asia
USA	**0.712**	**0.420**	0.089	0.074	**0.120**	0.108	0.165
Europe	0.003	0.226	0.002	0.002	0.004	0.001	0.002
Japan	0.004	0.002	**0.619**	0.002	0.004	0.010	0.003
India	0.001	0.004	0.015	**0.722**	0.001	0.001	0.001
China	0.015	0.016	0.030	0.052	**0.685**	0.005	0.015
S.E. Asia	0.003	0.001	0.000	0.000	0.001	0.121	0.011
N.E. Asia	0.014	0.013	0.017	0.005	0.003	0.026	**0.254**
Factor 1	**0.246**	**0.315**	**0.199**	**0.093**	0.089	**0.170**	**0.409**
Factor 2	0.002	0.002	0.029	0.049	0.094	**0.559**	0.140

Subsample Analysis

- The FSVAR model is estimated using four subsamples and the resulting steady state variance decompositions are reported.
- The first subsample covers the time immediately before and during the 1997 Asia financial crisis and is from February 1995 to December 1998.
- The second subsample covers the period after the crisis until one year before the 2008 crisis and is from January 1999 to November 2006.
- The third subsample, from December 2006 to July 2010 covers the 2008 crisis.
- The last subsample covers the post-crisis period up to August 2013.

Steady State Variance Decomposition (FSVAR Model) – Subsamples

Country	USA	Europe	Japan	India	China	S.E. Asia	N.E. Asia
			Subsample 1: Feb 1995 to Dec 1998				
USA	**0.905**	**0.688**	0.007	0.013	0.016	0.015	0.022
Europe	0.000	0.019	0.000	0.000	0.000	0.001	0.000
Japan	0.014	0.009	**0.706**	0.010	0.072	0.004	0.022
India	**0.056**	0.050	0.002	**0.678**	0.013	0.004	0.002
China	0.004	0.012	0.035	0.036	**0.503**	0.003	0.006
S.E. Asia	0.002	0.002	0.003	0.003	0.006	**0.065**	0.009
N.E. Asia	0.003	0.002	0.078	0.012	0.004	0.025	**0.390**
Factor 1	0.009	**0.205**	0.043	0.022	0.070	0.022	0.109
Factor 2	0.006	0.014	**0.126**	**0.225**	**0.317**	**0.861**	**0.439**
			Subsample 2: Jan 1999 to Nov 2006				
USA	**0.416**	**0.286**	0.044	0.035	**0.134**	0.079	0.112
Europe	0.001	0.128	0.000	0.000	0.002	0.001	0.001
Japan	0.037	0.028	**0.606**	0.012	0.094	0.024	0.017
India	0.007	0.005	0.038	**0.762**	0.007	0.002	0.006
China	0.020	0.015	0.040	0.025	**0.597**	0.014	0.010
S.E. Asia	0.001	0.001	0.000	0.001	0.002	0.051	0.001
N.E. Asia	0.081	0.075	0.029	0.018	0.023	0.099	**0.343**
Factor 1	**0.431**	**0.459**	**0.197**	**0.116**	0.105	**0.339**	**0.499**
Factor 2	0.007	0.005	0.045	0.032	0.036	**0.391**	0.011
			Subsample 3: Dec 2006 to Jul 2010				
USA	**0.506**	**0.363**	**0.303**	**0.227**	**0.271**	**0.319**	**0.290**
Europe	0.074	0.178	0.055	0.048	0.053	0.077	0.070
Japan	0.011	0.024	0.149	0.018	0.017	0.031	0.024
India	0.011	0.011	0.030	**0.239**	0.004	0.019	0.013
China	0.090	0.122	0.143	0.153	**0.496**	0.154	0.154
S.E. Asia	0.025	0.029	0.035	0.026	0.030	0.053	0.032
N.E. Asia	0.000	0.000	0.000	0.003	0.001	0.001	0.007
Factor 1	**0.275**	**0.261**	**0.193**	0.181	0.116	**0.326**	**0.291**
Factor 2	0.006	0.011	0.092	0.105	0.013	0.021	0.119
			Subsample 4: Aug 2010 to Mar 2017				
USA	**0.897**	**0.338**	0.036	**0.134**	0.191	**0.577**	0.242
Europe	0.001	**0.337**	0.006	0.001	0.005	0.002	0.005
Japan	0.003	0.001	**0.654**	0.003	0.028	0.003	0.008
India	0.009	0.005	0.003	**0.749**	0.012	0.006	0.003
China	0.021	0.015	0.011	0.027	**0.477**	0.013	0.006
S.E. Asia	0.001	0.002	0.001	0.003	0.010	**0.254**	0.000
N.E. Asia	0.000	0.001	0.003	0.001	0.005	0.000	0.160
Factor 1	**0.068**	0.091	**0.216**	0.057	**0.227**	0.076	**0.323**
Factor 2	0.000	0.209	0.069	0.025	0.045	0.067	**0.253**

Conclusions

- During non-crisis period, convergence through the effect of common international shocks and idiosyncratic country-specific shocks are the most important.
- There is a notable level of co-movement within the group of industrialized countries and within the group of emerging market economies.
- Over the entire sample, the common factor representing shocks to the ICs has significant effect on the emerging market economies, but the common factor representing the EMEs has little effect on the ICs.
- However, during crisis periods, depending on the nature of the crisis, the importance of sources of shocks and the level of convergence vary.