Stochastic Convergence amongst Mexican States

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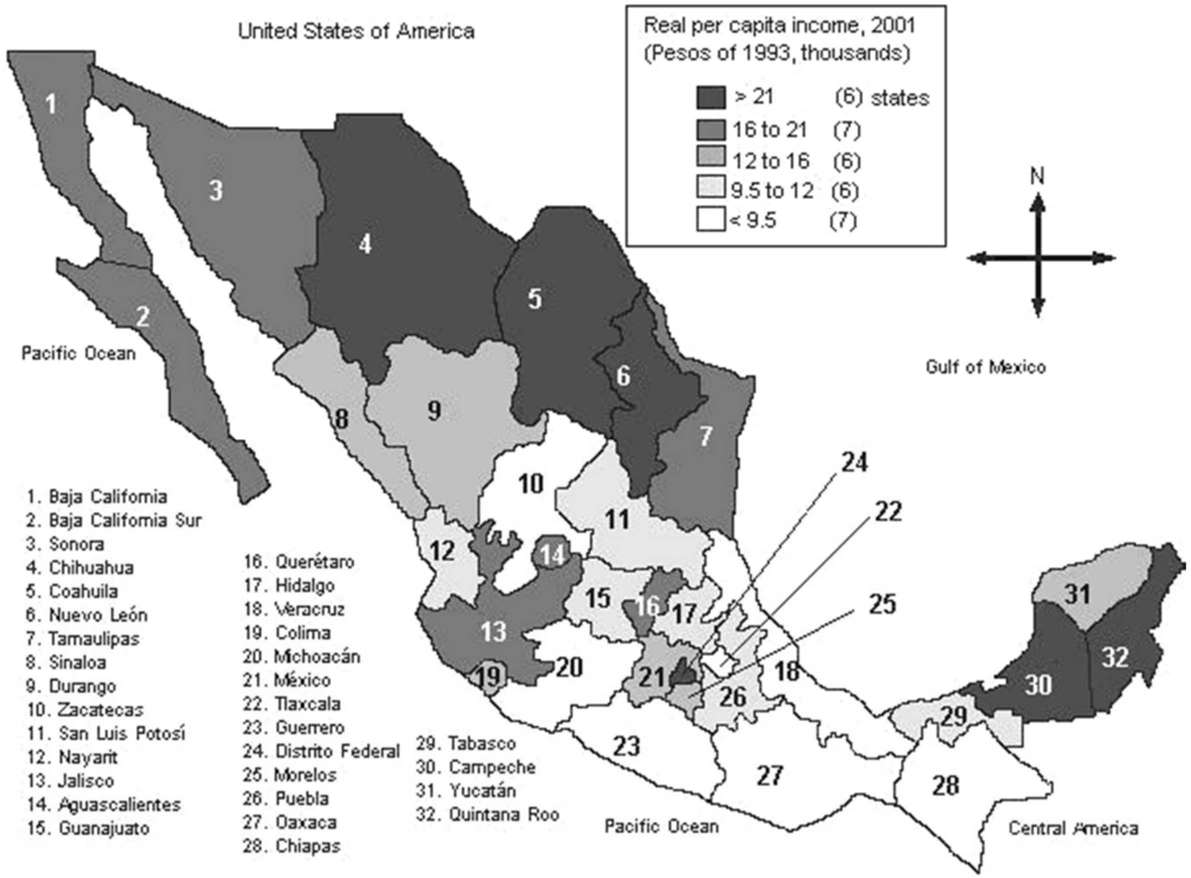
Motivation

- Economic growth differentials have recently been tackled from very diverse perspectives.
- Previous contributions that address the case of Mexico conclude that the regional differences have been tinged by two radically different tendencies: a first lapse of time where there has been a convergent process up to 1980, followed by a recent period where the convergence process has been either stopped or reversed (see Carayannis, 1994; Esquivel, 1999; Cermeño, 2001; among others).
- The methodological framework adopted in this research presents, for first time, evidence on convergence analysis for the Mexican case by means of the stochastic convergence approach (see Carrion-i-Silvestre and German-Soto, 2007).

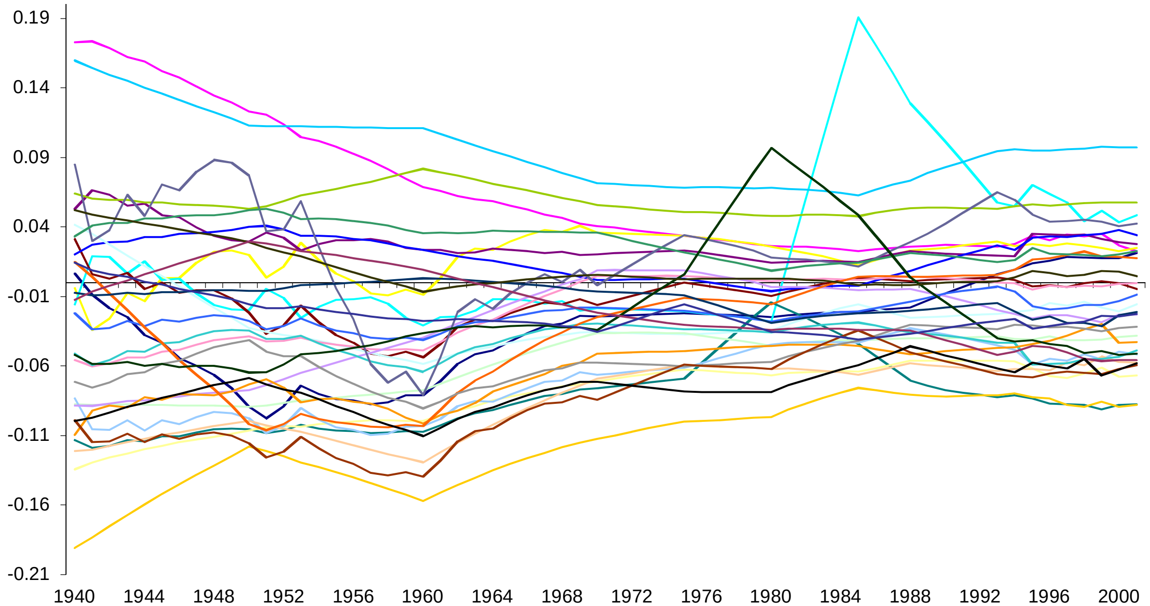
Introduction

- The stochastic convergence has the advantage that it allows us identifying not only the existence of a convergence process amongst the investigated series, but also which regions are converging and which are not.
- This is essential to the examination of the regional differences of a country that has experienced important economic events (debt crisis, devaluations or increase of openness) that have affected the development of the regions in different ways.
- In order to take into account all these features, our analysis considers the presence of these exceptional events, treating them as structural changes.
- After controlling for the presence of structural breaks evidence in favour of stochastic convergence increases, although some states still show divergence.

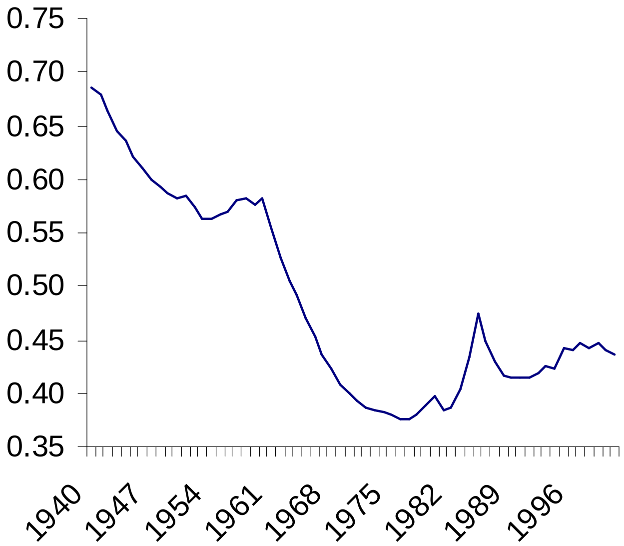
Real per capita income of the Mexican states

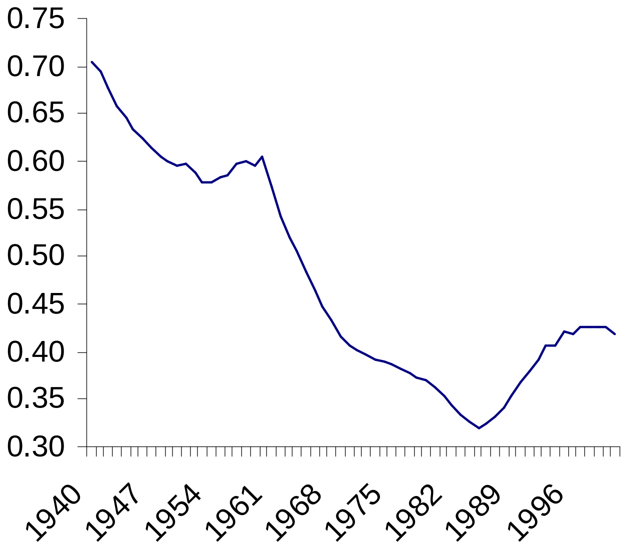


Per capita state income (deviations)

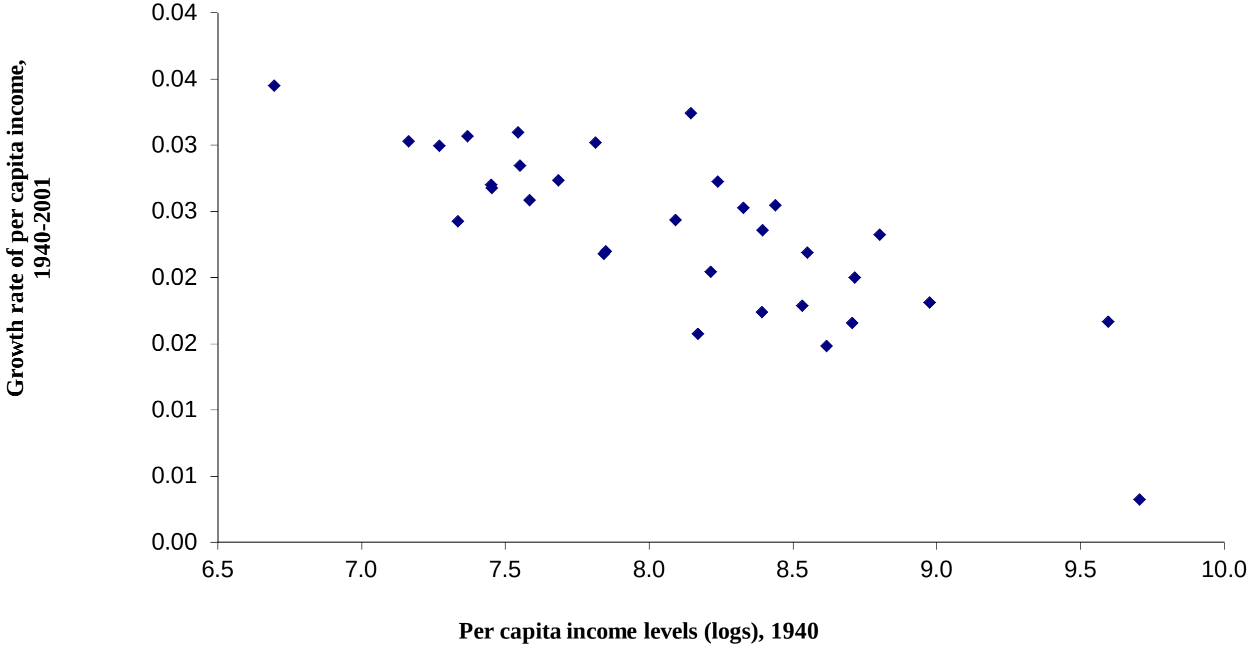


Dispersion of relative regional per capita incomes





Absolute convergence amongst Mexican states, 1940-2001



The stochastic convergence hypothesis

- The notion of stochastic convergence is as follows (Bernard and Durlauf, 1995; Evans and Karras, 1996):

(1) $$\lim_{t \to \infty} \left(y_{i,t} - a_t \right) = \delta_i ,$$

- In order to account for the unobservable commond trends:

(2) $$\lim_{t \to \infty} \left(\overline{y}_t - a_t \right) = \frac{1}{N} \sum_{i=1}^{N} \delta_i ,$$

- If a convergent process exists, then:

$$\lim_{t \to \infty} \left(\overline{y}_t - a_t \right) = 0$$

- So, substracting (2) from (1), stochastic convergence exists if, and only if,

(3) $$\lim_{t \to \infty} \left(y_{i,t} - \overline{y}_t \right) = \delta_i .$$

- Convergence will be absolute if, and only if, the unconditional mean δ_i = 0 in (3), while convergence is said to be conditional when $\delta_i \neq 0$ in (3).
- Some authors propose to model deviations from the equilibrium (δ_i) as combination of a time trend and a stochastic process, that is:

(4) $$\delta_i = \mu_i + \beta_i \, t.$$

- Consequently, assessing the presence of stochastic convergence is equivalent to testing for cointegration with the known cointegrating vector, *i.e*. analysing the stochastic properties of $\left(y_{i,t} - y_t\right)$ through the application of unit root tests.
- If not conditional or absolute convergence, regional and national output can be related, but with a cointegration vector other than (1, -1).
- This means, that we should to examine common trends, estimating a cointegrating vector.

Unit root tests with structural breaks

- Visual inspection of relative per capita incomes indicates that the presence of structural changes might be affecting the behaviour of the time series, which would bias the stochastic convergence analysis that has been carried out.
- The unit root tests with structural breaks can be specified using a general regression equation:

(5) $$y_{i,t}^{*} = \mu_i + \beta_i t + \sum_{j=1}^{m} \theta_{i,j} DU_{i,j,t} + \sum_{j=1}^{m} \gamma_{i,j} DT_{i,j,t} + \sum_{j=1}^{m} d_{i,j} D(T_b)_{i,j,t} + \alpha_i y_{i,t-1}^{*} + \sum_{j=1}^{k} c_j \Delta y_{i,t-j}^{*} + \varepsilon_{i,t},$$

- Type of break:
  - Model An: one change in the constant.
  - Model A: one change in constant with linear trend.
  - Model C: one change in trend.
  - Models AAn, AA and CC: two structural changes.

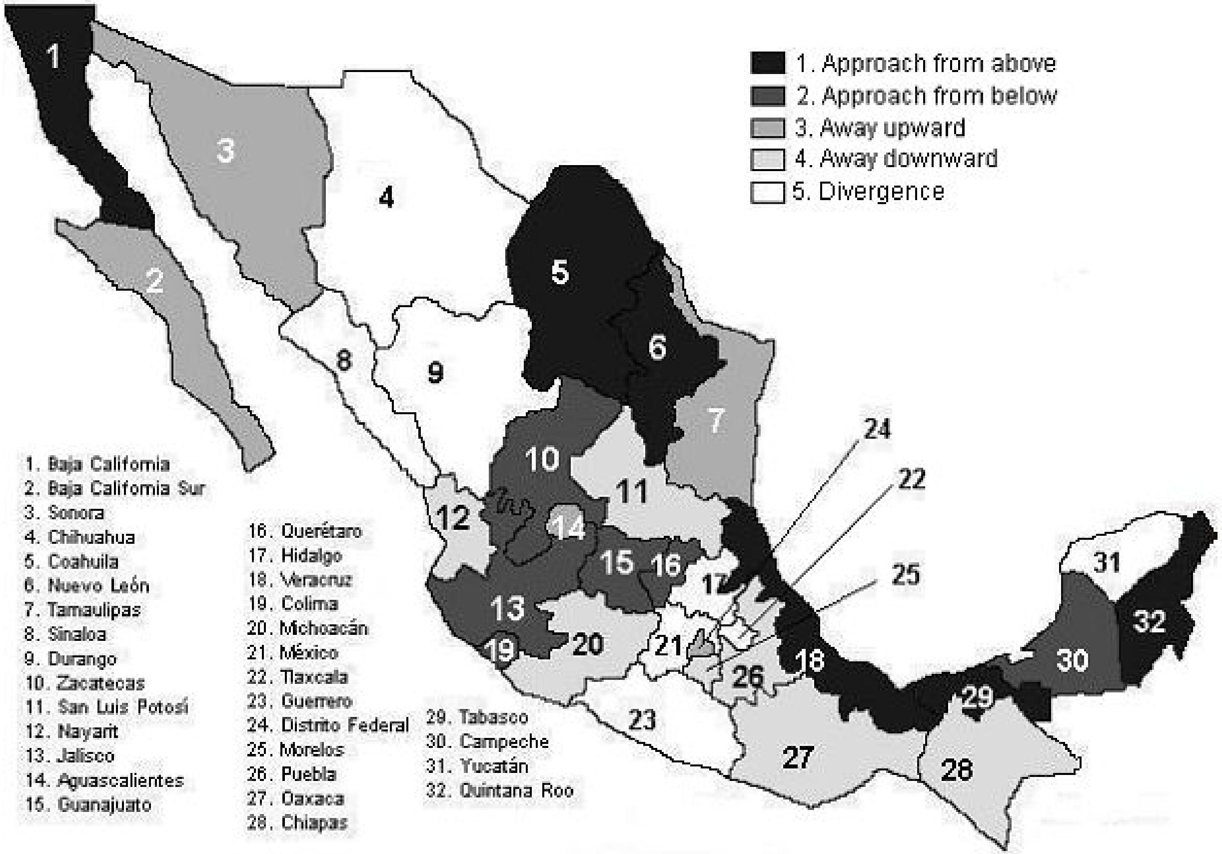
Results of the model

	Model	$T_{b,1}$*	$T_{b,2}$*	μ	β	θ_1	γ_1	θ_2	γ_2	d_1	t_α^*	k
Aguascalientes	CC	1951	1960	0.263	-0.047	0.148	0.024	0.123	0.030		-7.421[a]	8
				(1.470)	(-2.826)	(5.489)	(1.489)	(6.257)	(6.402)			
Baja California	An	1950		0.049		-0.037				0.047	-5.110[b]	0
				(2.698)		(-2.745)				(2.045)		
Baja California Sur	CC	1951	1960	0.616	-0.057	0.149	0.041	0.203	0.016		-7.398[a]	7
				(3.877)	(-3.844)	(4.402)	(2.649)	(6.918)	(3.702)			
Campeche	AAn	1980	1995	-0.065		0.435		-0.160			-8.627[a]	6
				(-4.640)		(8.790)		(-4.228)				
Coahuila	AA	1957	1994	0.235	-0.001	-0.046		0.108			-6.326[b]	7
				(5.185)	(-2.404)	(-3.030)		(5.777)				
Colima	AA	1953	1964	-0.109	0.002	-0.123		0.147			-6.267[b]	7
				(-4.931)	(2.111)	(-4.123)		(4.207)				
Chiapas	C	1975		-0.245	0.002	0.110	-0.009				-7.236[a]	3
				(-7.091)	(4.612)	(5.669)	(-6.511)					
Distrito Federal	AA	1985	1995	0.177	-0.002	0.048		0.038			-7.991[a]	3
				(7.608)	(-7.220)	(7.696)		(5.024)				
Guanajuato	A	1960		-0.092	0.000	0.035					-5.606[b]	3
				(-5.354)	(1.317)	(4.927)						
Jalisco	AAn	1950	1960	-0.041		-0.021		0.064			-6.934[a]	4
				(-4.580)		(-2.786)		(6.769)				
Michoacán	AAn	1950	1960	-0.105		-0.045		0.075			-7.174[a]	5
				(-6.083)		(-4.625)		(7.790)				
Morelos	AA	1953	1976	-0.140	0.003	-0.056		-0.029			-6.057[b]	5
				(-5.922)	(5.249)	(-4.320)		(-2.514)				
Nayarit	AAn	1968	1994	-0.191		0.037		-0.065			-5.582[b]	5
				(-5.491)		(3.605)		(-3.930)				
Nuevo León	AAn	1950	1960	0.047		0.029		-0.023			-5.959[a]	5
				(5.075)		(6.133)		(-6.789)				

Results of the model

Oaxaca	AAn	1950	1960	-0.038		-0.067		0.056			-5.153[c]	1
				(-2.320)		(-6.715)		(7.640)				
Puebla	AAn	1952	1963	-0.159		-0.050		0.099			-5.699[b]	0
				(-4.855)		(-3.928)		(5.780)				
Querétaro	AAn	1960	1980	-0.090		0.080		0.025			-6.419[a]	1
				(-6.580)		(6.093)		(2.818)				
Quintana Roo	CC	1950	1953	0.851	-0.062	-0.492	0.310	-0.542	-0.242		-7.272[b]	6
				(2.734)	(-1.909)	(-3.876)	(5.036)	(-6.832)	(-4.580)			
San Luis Potosí	AA	1950	1963	-0.164	0.003	-0.059		-0.051			-6.780[b]	5
				(-5.905)	(6.017)	(-4.641)		(-3.357)				
Sonora	AA	1972	1994	0.239	-0.002	-0.043		0.049			-5.955[c]	7
				(5.620)	(-4.168)	(-3.706)		(4.403)				
Tabasco	C	1975		-0.105	0.003	0.152	-0.013				-6.192[b]	2
				(-5.124)	(3.807)	(4.627)	(-5.508)					
Tamaulipas	CC	1958	1983	0.388	-0.018	-0.024	0.018	-0.027	0.003		-6.697[c]	8
				(6.436)	(-6.625)	(-2.627)	(6.535)	(-4.083)	(4.849)			
Veracruz	CC	1956	1993	-0.006	0.001	0.048	-0.006	0.077	-0.009		-6.682[c]	7
				(-0.260)	(0.469)	(4.654)	(-2.537)	(6.594)	(-4.853)			
Zacatecas	CC	1968	1994	-0.605	-0.006	0.033	0.014	0.114	-0.030		-7.926[a]	7
				(-8.027)	(-4.981)	(2.351)	(6.462)	(4.512)	(-5.190)			

Stochastic convergence analysis



Common trends with regime shifts

- The convergence process may be characterizaed by common trends that changed in time, that is, it is posible the presence of a regime shift in the cointegratin vector (Gregory and Hansen, 1996).
- In this case, we prove changes in level (model L), trend (model T) and regime shift (model S):

(6) Model L: $$y_{i,t} = \mu_i + \theta_i\, DU_{i,t} + \alpha_i\, \bar{y}_t + u_{i,t},$$

(7) Model T: $$y_{i,t} = \mu_i + \theta_i\, DU_{i,t} + \beta_i\, t + \alpha_i\, \bar{y}_t + u_{i,t},$$

(8) Model S: $$y_{i,t} = \mu_i + \theta_i\, DU_{i,t} + \alpha_{i,1}\, \bar{y}_t + \alpha_{i,2}\, \bar{y}_t DU_{i,t} + u_{i,t},$$

Results: co-integration tests with regime shifts

State	Model	ADF (T_b*)	Z_t (T_b*)
Baja California	S	-4.77[b] (1964)	-5.01[b] (1964)
Campeche	S	-4.79[c] (1981)	-4.88[c] (1982)
Colima	S	-5.11[b] (1963)	-5.01[b] (1963)
Chiapas	T	-4.90[c] (1977)	-5.26[b] (1978)
Chihuahua	T	-5.33[b] (1983)	-5.38[b] (1983)
Distrito Federal	T	-5.22[b] (1993)	
Guerrero	S	-4.93[c] (1983)	
Hidalgo	L		-4.43[c] (1953)
Nayarit	T	-5.35[b] (1969)	
Oaxaca	L	-4.52[c] (1974)	
Puebla	S		-4.69[c] (1965)
Querétaro	S	-5.23[b] (1955)	
Quintana Roo	L	-5.19[a] (1955)	-5.27[a] (1955)
Sinaloa	S	-4.96[b] (1969)	
Sonora	T	-5.46[a] (1976)	-5.49[a] (1976)
Tabasco	T	-4.87[c] (1977)	-5.06[b] (1978)
Veracruz	T		-4.97[c] (1949)
Zacatecas	L	-4.63[b] (1977)	

Conclusions

- This work uses the time series approach to examine whether the pattern of relative regional per capita incomes in Mexico over the past sixty years is consistent with the convergence hypothesis.
- In general, standard unit root and co-integration statistics are unable to find evidence on the convergence hypothesis.
- However, this conclusion is reversed in most of cases when the presence of structural breaks is accounted for.
- This finding is not consistent for all states, because the estimation of the deterministic component reveals that Mexican states not share the common trend defined by the national mean.

Regional policy implications

- In order to achieve greater territorial cohesion and to reduce the gap amongst states (mainly the dichotomy North-South), greater efforts for the policy-makers to promote economic development in the South of Mexico may be needed.
- Reforms on trade liberalization could be accentuating the regional differences because this kind of processes tend to concentrate the production factors as infrastructure, and human and physical capital.
- Remember, Mexico is governed under a federal system, then convergence should prevail amongst its regions.

Thank you…

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