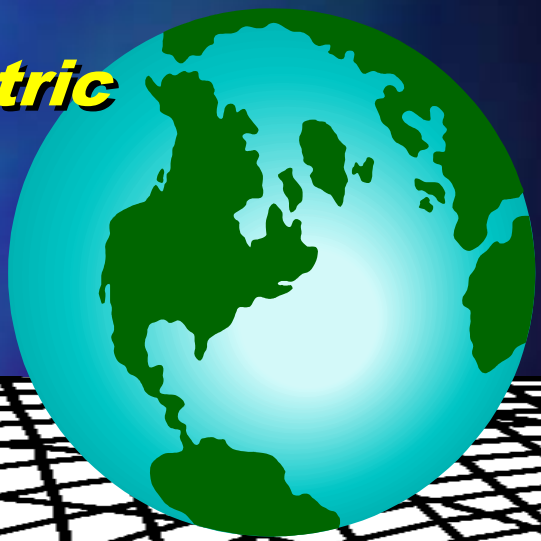
4th International Conference on Globalization
University of Ostrava, September 16-17, 2009

Measuring Economic Globalization

Entropy-Based Inequality Risk Metric



Bruno G. Ruettimann

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Entropy-Based Interpretation of Risk

Introductory concepts

- The 1st Principle of Thermodynamics: efficiency
- The 2nd Principle of Thermodynamics: irreversibility
  - Concepts of entropy according to:
    - Clausius (measure of thermal exchange)
    - Boltzmann (measure of disorder)
    - Shannon (content of information) → H.Theil
- Inequality measures:
  - Pareto rule, Lorenz curve, several indexes such as Gini, Herfindahl, Atkinson-Kolm-Sen, ...

Entropy-Based Interpretation of Risk

Risk and Order

From the thermodynamic interpretation of entropy

- **Let us define risk as a dualistic view of order in an economic system**
- **...therefore:**

the more order (or inequality) → the more risky the system (less entropy)

- **Let us introduce Ψ_{XY} as a measure of inequality (or diversity) of an attribute of a subsystem XY $(X \cap Y) \in X$ compared to the system X**

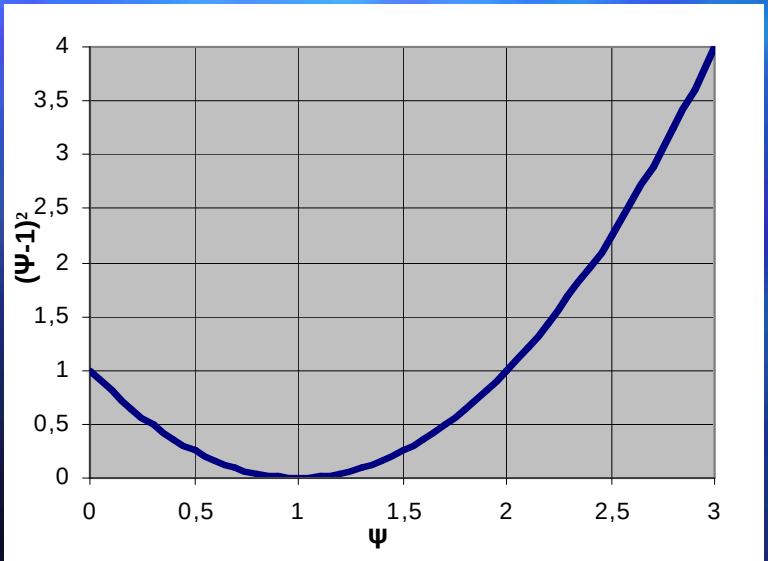
$$\psi_{XY} = \frac{p_{XY}}{p_X}$$

Entropy-Based Interpretation of Risk

Equality as a natural Law

- Let us define risk r_{XY} of a single element and its relative risk function as

$$r_{XY} = (\psi_{XY} - 1)^2 = \left(\frac{p_{XY}}{p_X} - 1 \right)^2$$



- minimum risk is attained in Ψ=1, the state of equality

- **Minimum Risk Principle:**

An economic system has the latent tendency to evolve into the state with more equality corresponding to a state with lower risk

Entropy-Based Interpretation of Risk

Trade and inequality matrix

- A supply/demand system for a product α can be described by the following trade matrix T^{α}

$$T^{\alpha} = \begin{bmatrix} t^{\alpha}_{AA} & t^{\alpha}_{AB} & \dots & t^{\alpha}_{AZ} \\ t^{\alpha}_{BA} & t^{\alpha}_{BB} & \dots & t^{\alpha}_{BZ} \\ \dots & \dots & \dots & \dots \\ t^{\alpha}_{ZA} & t^{\alpha}_{ZB} & \dots & t^{\alpha}_{ZZ} \end{bmatrix} = \left[t^{\alpha}_{XY} \right]$$

- the corresponding inequality matrix Ψ^{α} for the trade matrix T^{α} is

$$\psi^{\alpha}_{\infty} = \begin{bmatrix} \psi^{\alpha}_{AA} & \psi^{\alpha}_{AB} & \dots & \psi^{\alpha}_{AZ} \\ \psi^{\alpha}_{BA} & \psi^{\alpha}_{BB} & \dots & \psi^{\alpha}_{BZ} \\ \dots & \dots & \dots & \dots \\ \psi^{\alpha}_{ZA} & \psi^{\alpha}_{ZB} & \dots & \psi^{\alpha}_{ZZ} \end{bmatrix} = \left[\psi^{\alpha}_{XY} \right]_{\infty}$$

where

$$\psi^{S\alpha}_{XY\infty} = \frac{p_{XY\infty}}{p_X} = \frac{t^{\alpha}_{XY} \Big/ t^{\alpha}_{\bullet Y}}{t^{\alpha}_{X\bullet} \Big/ t^{\alpha}_{\bullet\bullet}} = \frac{t_{XY} \cdot t_{\bullet\bullet}}{t_{\bullet Y} \cdot t_{X\bullet}}$$

Entropy-Based Interpretation of Risk

Defining Portfolio Risk

- The inequality vector Ψ_X of an economy X is

$$\psi_X = \left[\psi_{XA}, \psi_{XB}, \ldots, \psi_{XZ}\right]$$

- The corresponding risk $r_X(\Psi_{XY})$ of the portfolio of activities of an economy X is

$$r(\psi_X^{\alpha}) = \frac{\sum_{y=A}^{Z} (\psi_{Xy}^{\alpha} - 1)^2}{card(Z)}$$

- **Definition:**

The risk $r(\Psi_X)$ of a portfolio Ψ_X of inequalities is the 2nd momentum of the elements belonging to the inequality vector Ψ_X relative to the attractor 1 where the value 1 means equality and card(Z) is the number of elements from A to Z of the row vector.

Entropy-Based Interpretation of Risk

Risk of an economic system

- Extending the concept of risk from an economy X to all economies corresponding to the whole trade matrix T^{α}

$$r(\psi_{\infty}^{\alpha}) = \frac{\sum_{x=A}^{Z} r(\psi_{x}^{\alpha})}{card(Z)}$$

or generalized

$$r(\psi^{\alpha}) = \frac{\sum_{i=1}^{m}\sum_{j=1}^{n} (\psi_{ij}^{\alpha} - 1)^2}{m \cdot n}$$

- i.e. the risk of the trade matrix is the average of all supplying economies' risk.

- extended to a supplier/customer system within an industry the risk is the 2nd momentum of all elements of the industry trade matrix

Risk as a Governing Law of Globalization

The Central Theorem of Globalization

Based on the former findings we can enounce:

- ***Central Theorem of Globalization (CTG):***

The lower the risk of an economy or the whole economic system, the more globalized the present economy or the whole economic system for the product under evaluation. Hence, a globalized economic system is less risky.

Maximizing Value Net of Risk

Overall governing economic rational

From the thermodynamic interpretation of free enthalpy:

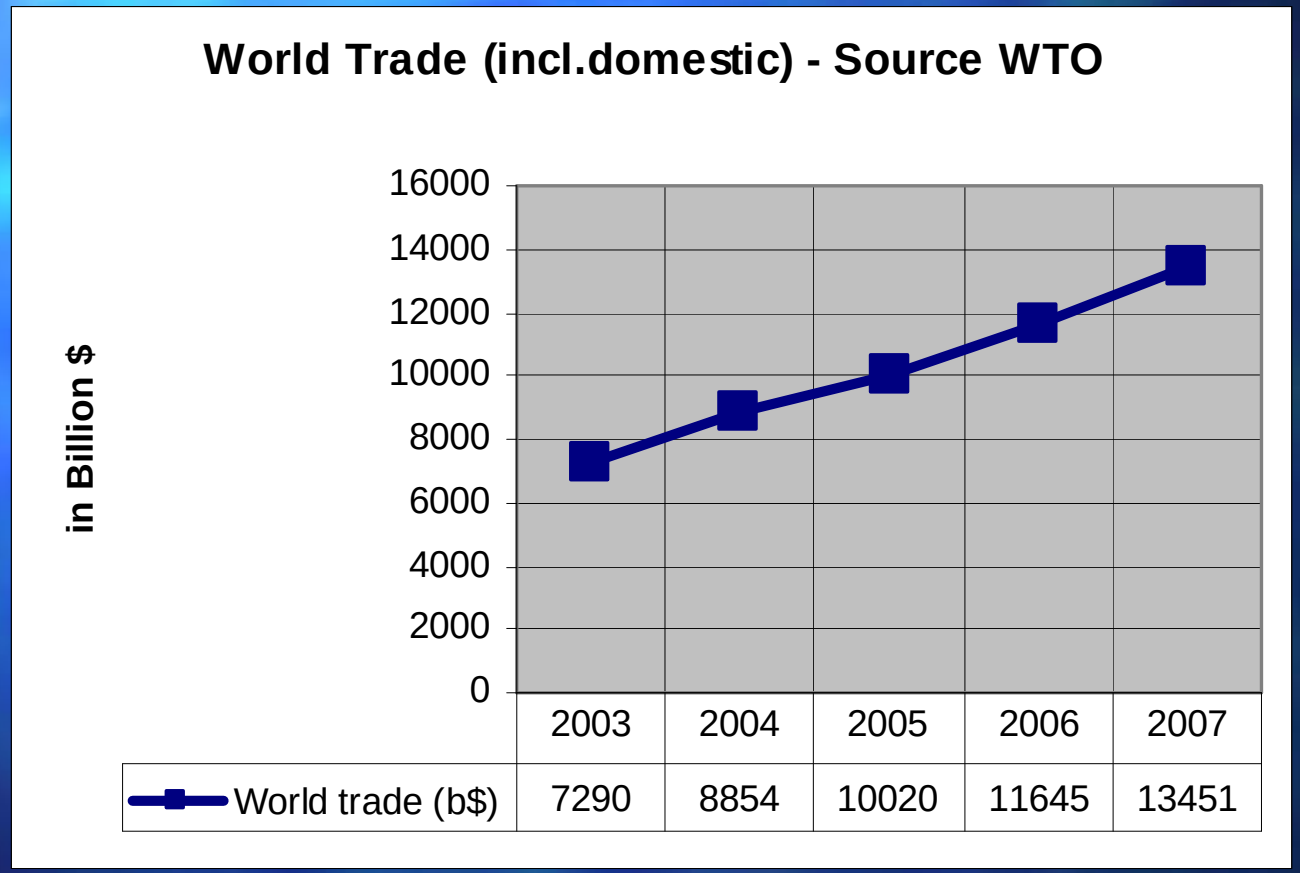
- Globalization means extending the business scope to new geographic areas, with the aim to
  - increase profit generation → maximizing profit
  - reduceing risk of the portfolio → minimizing risk

- The Free Macroeconomic Profit Function is:

$$u_X^{\alpha} = y_X(C, p, C_M) - r(C, \rho, C_M) = u_X^{\alpha}(C, p, \rho, C_M)$$

Measuring Globalization during 2003-2007

Evolution of World Trade between 2003-2007



→ Is economy really globalizing (intended as interweavement)?

Measuring Globalization during 2003-2007

World trade and inequality matrix in 2007

Network of world merchandise trade by region (source: WTO International Trade Statistics, Table A2)

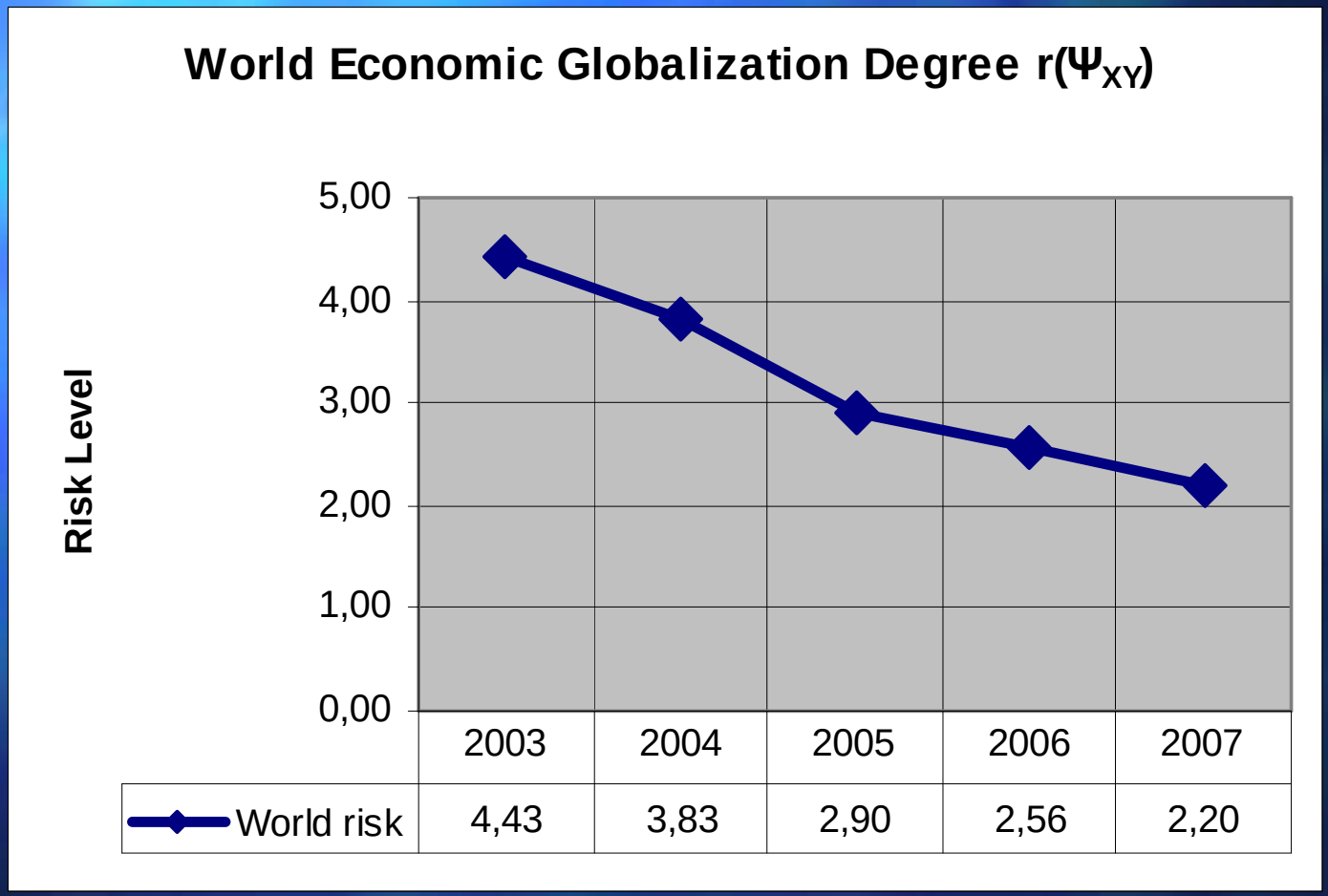
2007 t_{XY}	North Am A	SC Am B	Europe C	CIS D	Africa E	Middle E F	Asia G	Supply	p_X
A	**951,18**	**130,65**	**328,74**	**12,42**	**27,27**	**50,08**	**352,12**	1852,46	0,14
B	**151,30**	**122,04**	**105,64**	**6,44**	**13,68**	**9,10**	**80,23**	488,43	0,04
C	**458,50**	**80,40**	**4243,56**	**189,05**	**147,71**	**152,92**	**433,67**	5705,81	0,42
D	**23,56**	**6,28**	**287,45**	**103,20**	**6,87**	**16,24**	**59,62**	503,22	0,04
E	**91,87**	**14,62**	**167,55**	**0,94**	**40,47**	**10,53**	**80,88**	406,86	0,03
F	**83,93**	**4,36**	**108,30**	**4,76**	**27,53**	**93,37**	**397,30**	719,55	0,05
G	**756,39**	**92,30**	**714,64**	**79,78**	**91,35**	**150,44**	**1889,82**	3774,72	0,28
Demand	2516,73	450,65	5955,88	396,59	354,88	482,68	3293,64	13451,05	1,00
p_Y	0,19	0,03	0,44	0,03	0,03	0,04	0,24	1,00	

$p_{XY\infty}$	A	B	C	D	E	F	G	p_X
A	0,38	0,29	0,06	0,03	0,08	0,10	0,11	0,14
B	0,06	0,27	0,02	0,02	0,04	0,02	0,02	0,04
C	0,18	0,18	0,71	0,48	0,42	0,32	0,13	0,42
D	0,01	0,01	0,05	0,26	0,02	0,03	0,02	0,04
E	0,04	0,03	0,03	0,00	0,11	0,02	0,02	0,03
F	0,03	0,01	0,02	0,01	0,08	0,19	0,12	0,05
G	0,30	0,20	0,12	0,20	0,26	0,31	0,57	0,28
	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00

Ψ_{XY}	A	B	C	D	E	F	G	$r_X(\Psi_{XY})$
A	2,74	2,11	0,40	0,23	0,56	0,75	0,78	**0,79**
B	1,66	7,46	0,49	0,45	1,06	0,52	0,67	**6,15**
C	0,43	0,42	1,68	1,12	0,98	0,75	0,31	**0,24**
D	0,25	0,37	1,29	6,96	0,52	0,90	0,48	**5,29**
E	1,21	1,07	0,93	0,08	3,77	0,72	0,81	**1,24**
F	0,62	0,18	0,34	0,22	1,45	3,62	2,25	**1,50**
G	1,07	0,73	0,43	0,72	0,92	1,11	2,04	**0,23**
								2,20
$r_Y(\Psi_{XY})$	**0,65**	**6,34**	**0,28**	**5,42**	**1,19**	**1,04**	**0,51**	***2,20***	***$r(\Psi_{XY})$***

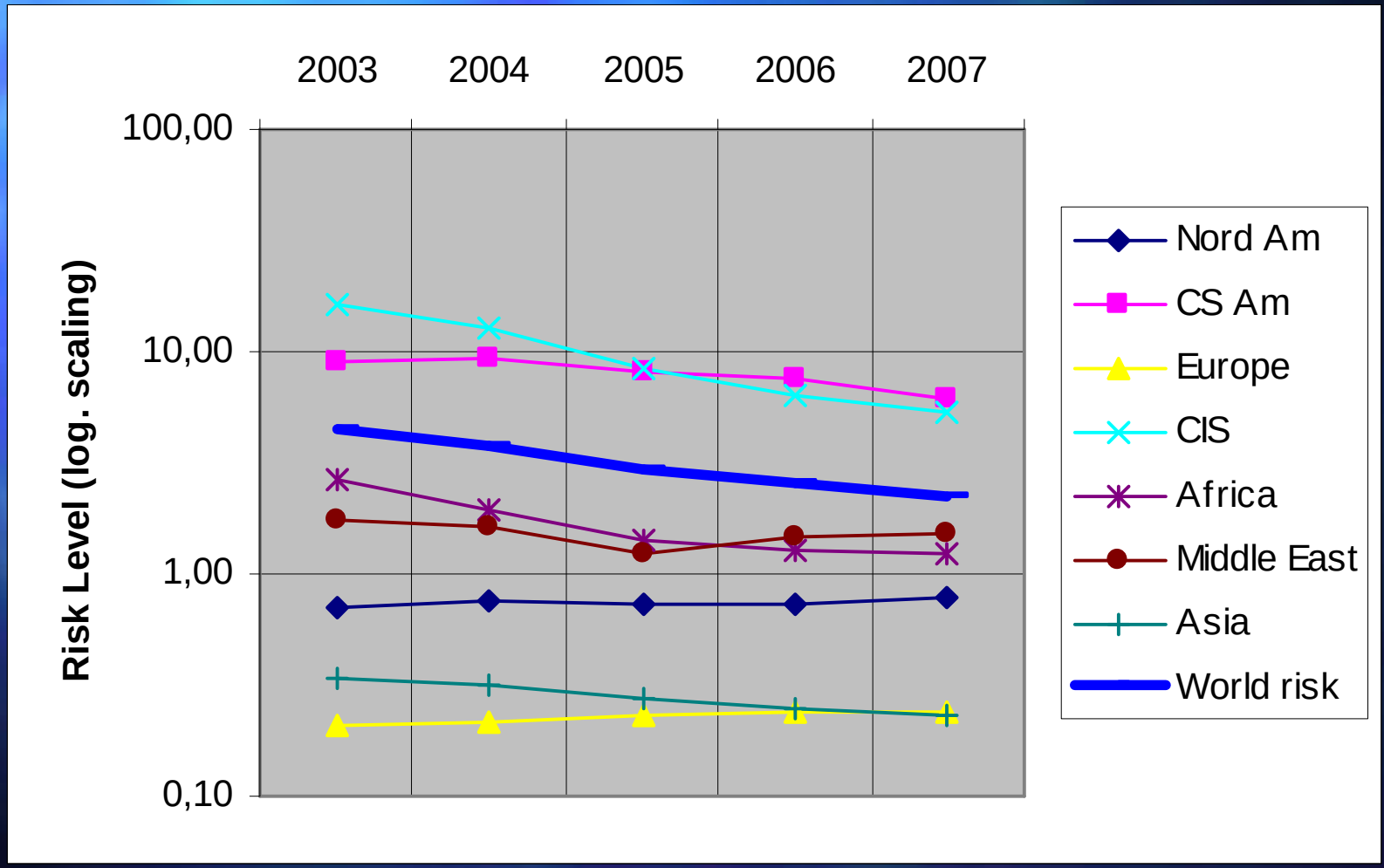
Measuring Globalization during 2003-2007

The economic system is globalizing



Measuring Globalization during 2003-2007

Evolution of supply (export) risk measures during 2003-2007 for macro-economic regions



Measuring Globalization during 2003-2007

Conclusions

- World economic system is globalizing
  - The inter-regional economic interweavement is increasing
- Different evolution in different economic regions
  - Stagnant globalization in advanced economies
  - Strong global expansion of emerging economies
- Asia has sur-passed Europe in 2007 as the most globalized export region

- Interesting will be to see the evolution of globalization degree during the 2009 economic crisis

Modeling Economic Globalization

A Post-Neoclassic View on Foreign Trade and Competition