Modeling Economic Globalization: The Central Theorem of Globalization

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Abstract

Present economic theory lacks an integrated approach to explain the current globalization phenomenon. Main principles go back to Ricardian comparative cost advantages and Heckscher-Ohlin factors proportion. The five fundamental globalization types help us to understand the different manifestations and evolution of international business but they do not tell us why globalization is happening. Does a common denominator exist? Grounded on entropy-based inequality measure and related risk concept, it is possible to state a comprehensive globalization thesis leading to the Central Theorem of Globalization, explaining why globalization is taking place. The accompanying genotypic risk metrics allows also to measuring the globalization degree of the economic system. The ultimate explanation leads to risk-deducted value creation combining the fundamental economic laws of maximizing profit by minimizing risk reflecting the enthalpy law of thermodynamics. (Key words: Foreign Trade, Entropy-Based Inequality Measure, Risk Metric, Statistical Entropy, Minimum Risk Principal, Central Theorem of Globalization, Measuring Globalization)

Introduction

Why is economy globalizing? Does an intrinsic reason exist, a sort of divine systemic force which controls this evolution, or is it just the lunatic actions of some managers to let their companies operate on a global level to increase profits? Many phenomena in nature are global appearances, such as the tides or the rotation of the earth, and cannot be controlled by human intervention. All these natural phenomena are governed by physical laws, in thermodynamics e.g. by the concept of entropy and free enthalpy. The concept of entropy defined by Clausius and Boltzmann has been transposed by Shannon also to non-thermodynamic application, and Theil in 1967 applied it to economics to measure income inequalities as an alternative to the Gini index. Entropy has different interpretations, and generally speaking, it is a measure of the irreversibility of a transformation. Commonly it is used as a measure of disorder. Processes evolve naturally to the state of maximum disorder. Also the economic system is composed of a multitude of actors which can be compared to a differentiated thermodynamic system. Is it possible to apply the concept of entropy also to globalization? How could we give an economic interpretation to thermodynamic entropy? We will see that globalization happens because it has to happen and it will happen whether we want it or not.

Inequality as a Measure of Risk

From the paradigmatic interpretation of thermodynamic entropy we can define risk as a dualistic view of order in an economic system, therefore the more order (or inequality) that exists in an economic system the more risky the economic system (or vice versa, the more equality a system shows the less risk it presents). Take, for example, the big difference in welfare among different regions being potentially a social bomb. Let us define a new inequality measure ψ_{XY} measuring the inequality or

diversity of an attribute of a subsystem X∩Y compared to the system X. We could call it the comparison of the „within subgroups" characteristics with the related "between subgroups" characteristics. Let us define $\psi_{XY}=1$ the riskless state of the system

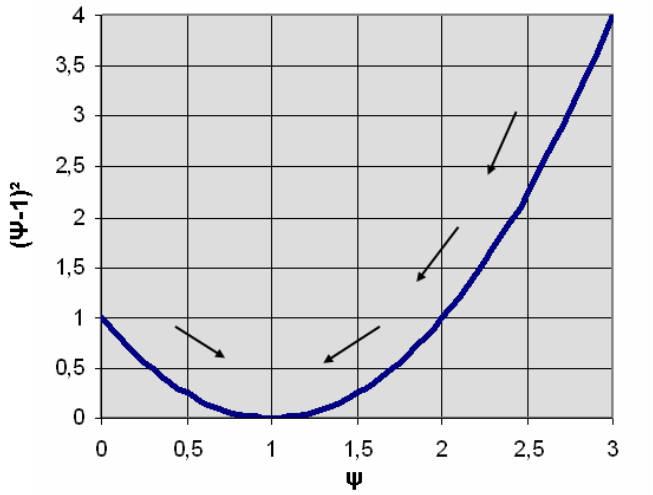

Abbildung 1: Inequality and the related risk function

because no diversity exists anymore between the subsystem X∩Y and the system X and therefore the risk $r_{XY}=0$. Fig.1 shows the risk function of a single element of a system. The greater the inequality compared to the riskless state $\psi_{XY}=1$, the larger the risk of this element. Whereas inequality refers rather to an element of a system, the concept of risk can be applicable to the entire system by defining risk as the second momentum of the inequalities compared to the attractor 1 (see apendix). This is very similar to the statistics variance with the exception that the pole is not the mean but the attractor. We can interpret this risk metric as a statistical entropy measure of the system. According to the Pigou-Dalton Transfer Principle and the interpretation of entropy law, we can state the following

Minimum Risk Principle:
An economic system has the latent tendency to evolve into a state with more equality corresponding to a state with a lower risk.

Risk as a Measure for Globalization

Let us go a step further by applying the Minimum Risk Principle to analyze type 1 globalization, i.e. the material globalization dealing with physical flows of a product α, applying to which country exports to which countries, and which country imports from which countries represented by the trade matrix $T^{\alpha}=[t_{XY}]$. For a trade system we can build the market share vector of an economy and calculate the inequality measure ψ_{XY} as the market share of X in Y compared to the overall market share of X. The overall market share of X for type 1b globalization will most probably be similar to the factors proportion according to Heckscher-Ohlin. For economy X we can calculate the risk $r_X(\psi_{XY})$ of its portfolio of activities in the countries Y. The lower the inequalities in each country Y the lower the risk value and therefore the higher the globalization degree of the country X. If the inequality is $\psi_{XY}=1$ for all Y then country X has the same market share in all countries Y and its portfolio of trade-flows is proportional to the market composition according to its competitiveness. Due to the fact that a low risk corresponds to an uniform-distribution we can now enounce the

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.

as well as the

Corollary to the CTG:
Generally, according to the Minimum Risk Principle, systems have the latent tendency to evolve to the state of lower risk. This means of course fueling of globalization because of exporting to other countries and with that decreasing inequality. Therefore the evolution of globalization can be explained with the concept of minimizing risk presented here.

The result of the CTG and its corollary is due to the built-in intrinsic forces of globalization and why globalization will take place independently of new growth opportunities in newly emerging economic regions. We can consider the CTG and its corollary as the basic concept to explain that our economy will globalize naturally with the existing deregulation tendency. This risk metric is a genotypic measure, bearing the intrinsic law of globalization. Additional concepts are described in "Modeling Economic Globalization – A Post-Neoclassic View on Foreign Trade and Competition".

Maximizing Value Net of Risk

But entropy is not the sole governing physical law of thermodynamics. Indeed, if a transformation happens is determined by free enthalpy. The same is also applicable to economics. Minimizing risk is only one cardinal law, maximizing profit is the other cardinal one. Indeed, an economic actor is ready to accept a higher risk if finally it yields a higher profit. Globalization is extending the business scope to new geographic areas, and the aim is

- to increase the profit generation (explicit strategy of profit maximization), and at the same time
- it reduces the risk of the portfolio (implicit law of risk minimization).

The final governing principle of economic globalization is therefore risk deducted value maximization. With this principle we can explain the rational of any economic actor comprising MNE (Multi National Enterprises) and why globalization happens independently of which globalization type 1 (material) and related subtypes or type2 (financial participation).

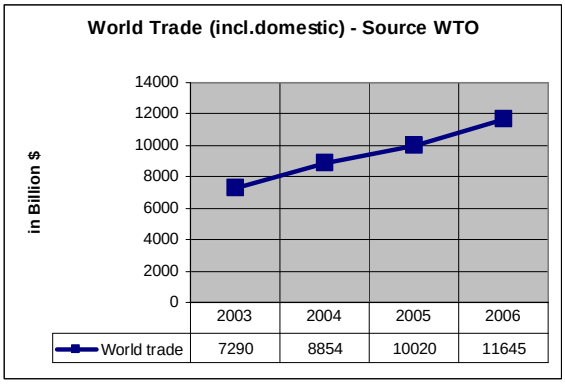

Abbildung 2: Evolution of wolrd trade 2003-06

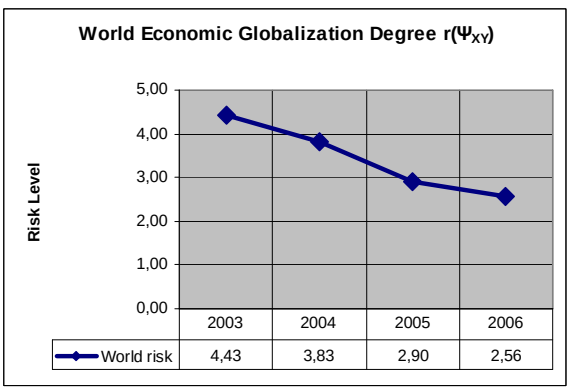

Abbildung 4: The economic system is globalizing

Statistical Evidence

According to WTO source, world-trade increased during 2003-2006 from 7'290 to 11'645 billion USD (fig.2). This evolution of type 1 globalization has been accompanied by increasing profits of companies and wealth of nations. Now the question: Has only the trade volume increased (between the same economic countries) or has also the globalization degree increased (i.e. the interweavement of old and new economic partners)? For that we refer to fig.3 which shows the network of trade for the year 2006 with the calculation of correspondent inequalities and risk measures. Analysing the risk values of the economies in 2006, we observe that Europe with 0,24 has the lowest risk value, i.e. the highest globalization degree, followed by Asia with 0,25 and North America with 0,72. Compared to the 2005 calculations (not shown here), Europe increased its risk level by 0,01 while America reduced it by 0,01 and Asia reduced it by 0,03 documenting the increasing interweavement of Asian economics with other economic regions. But has overall globalization evolved between 2003 and 2006? Fig.4 shows that the world trade risk has steadily diminished from 4,43 in 2003 attaining the value of 2,56 in 2006, i.e. economic globalization has increased during this period every year and will most probably increase further.

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

2006	North Am	SC Am	Europe	CIS	Africa	Middle E	Asia		
$\mathbf{t_{XY}}$	A	B	C	D	E	F	G	Supply	p_X
A	**905,30**	**107,30**	**279,30**	**8,30**	**21,70**	**42,10**	**314,10**	1678,10	0,14
B	**135,00**	**111,50**	**86,40**	**6,10**	**11,30**	**7,90**	**61,80**	420,00	0,04
C	**430,30**	**66,60**	**3651,50**	**141,60**	**120,20**	**128,90**	**366,40**	4905,50	0,42
D	**24,20**	**7,60**	**246,50**	**80,30**	**5,70**	**13,30**	**45,60**	423,20	0,04
E	**79,80**	**11,30**	**148,10**	**1,40**	**32,80**	**6,30**	**72,60**	352,30	0,03
F	**72,30**	**4,40**	**102,80**	**3,00**	**20,90**	**71,60**	**339,60**	614,60	0,05
G	**708,30**	**69,50**	**603,80**	**49,70**	**69,90**	**111,40**	**1638,50**	3251,10	0,28
Demand	2355,20	378,20	5118,40	290,40	282,50	381,50	2838,60	11644,80	1,00
p_Y	0,20	0,03	0,44	0,02	0,02	0,03	0,24	1,00	

$p_{XY\infty}$	A	B	C	D	E	F	G		p_X
A	0,38	0,28	0,05	0,03	0,08	0,11	0,11		0,14
B	0,06	0,29	0,02	0,02	0,04	0,02	0,02		0,04
C	0,18	0,18	0,71	0,49	0,43	0,34	0,13		0,42
D	0,01	0,02	0,05	0,28	0,02	0,03	0,02		0,04
E	0,03	0,03	0,03	0,00	0,12	0,02	0,03		0,03
F	0,03	0,01	0,02	0,01	0,07	0,19	0,12		0,05
G	0,30	0,18	0,12	0,17	0,25	0,29	0,58		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	$\mathbf{r_X(\Psi_{XY})}$
A	2,67	1,97	0,38	0,20	0,53	0,77	0,77	**0,72**
B	1,59	8,17	0,47	0,58	1,11	0,57	0,60	**7,52**
C	0,43	0,42	1,69	1,16	1,01	0,80	0,31	**0,24**
D	0,28	0,55	1,33	7,61	0,56	0,96	0,44	**6,43**
E	1,12	0,99	0,96	0,16	3,84	0,55	0,85	**1,29**
F	0,58	0,22	0,38	0,20	1,40	3,56	2,27	**1,44**
G	1,08	0,66	0,42	0,61	0,89	1,05	2,07	**0,25**
								2,56
$\mathbf{r_Y(\Psi_{XY})}$	**0,59**	**7,67**	**0,28**	**6,57**	**1,24**	**1,00**	**0,54**	***2,56***	***r(Ψ XY)***

Abbildung 3: World trade matrix with inequalities and risk measure for 2006

Appendix

The mathematics to compute globalization

Let us define

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

where ψ_{XY} is a measure of inequality or diversity of a subsystem ($X \cap Y$) compared to the system X where $p_{XY}>0$ and $p_X>0$ is the attribute (market shares in our case). Further, let us define the risk function of a single element,

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

interpreted as inequality of a characteristic $\psi_{XY}=p_{XY}/p_X$ within a system compared to the riskless state $\psi_{XY}=1$ of the system. Let us define the following world supply/demand or origin/destination matrix of trade for a product 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 trade flows are represented by the quadratic matrix T^{α} where each element t_{XY} denotes the physical quantity of the product α exported from the country of origin X to the country of destination Y. 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 each element of ψ^{α} is computed as

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

The elements $\psi_{XY}>0$ of the quadratic matrix ψ^{α} represent the market share diversity ratios of all supply economies X for a certain product α. The rows correspond to the inequality vectors ψ_X for the economies X.

$$\psi^{\alpha}_{X} = \left[\psi^{\alpha}_{XA}, \psi^{\alpha}_{XB}, \dots, \psi^{\alpha}_{XZ} \right]$$

The corresponding risk $r(\psi_X)$ of the portfolio of activities of economy X can be defined as

Risk of a Portfolio:

The risk $r_X(\psi_{XY})$ of a portfolio ψ_X of inequalities is the 2nd momentum of the elements belonging to the inequality vector relative to the attractor 1

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

where the value 1 means equality and card(Z) is the number n of elements from A to Z of the inequality row vector.

Extending the concept of risk from an economy X to all economies corresponding to the whole trade matrix T^{α} we can compute the risk of the economic system

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

And generalizing for a competitive system with m competitors and n customers

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

The inverse value of risk defines the statistical entropy of the economic trade system. The same concepts can also be applied to type 2 globalization dealing with FDI (Foreign Direct Investments). It may also apply to which goods are produced (or demanded) by which country calculating the portfolio risk of supply and demand of a political economy.

References

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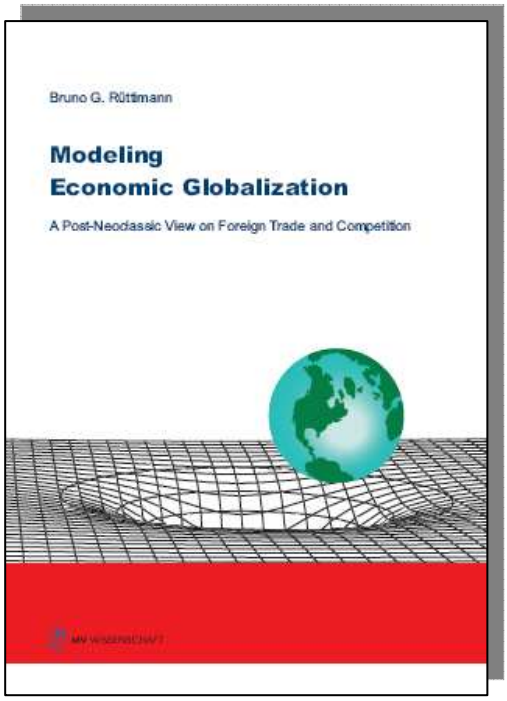

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