New Metrics for Economic Complexity: Measuring the Intangible Growth Potential of Countries

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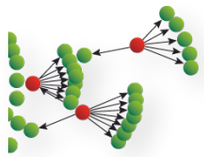
A. Tacchella, A. Gabrielli, A. Zaccaria



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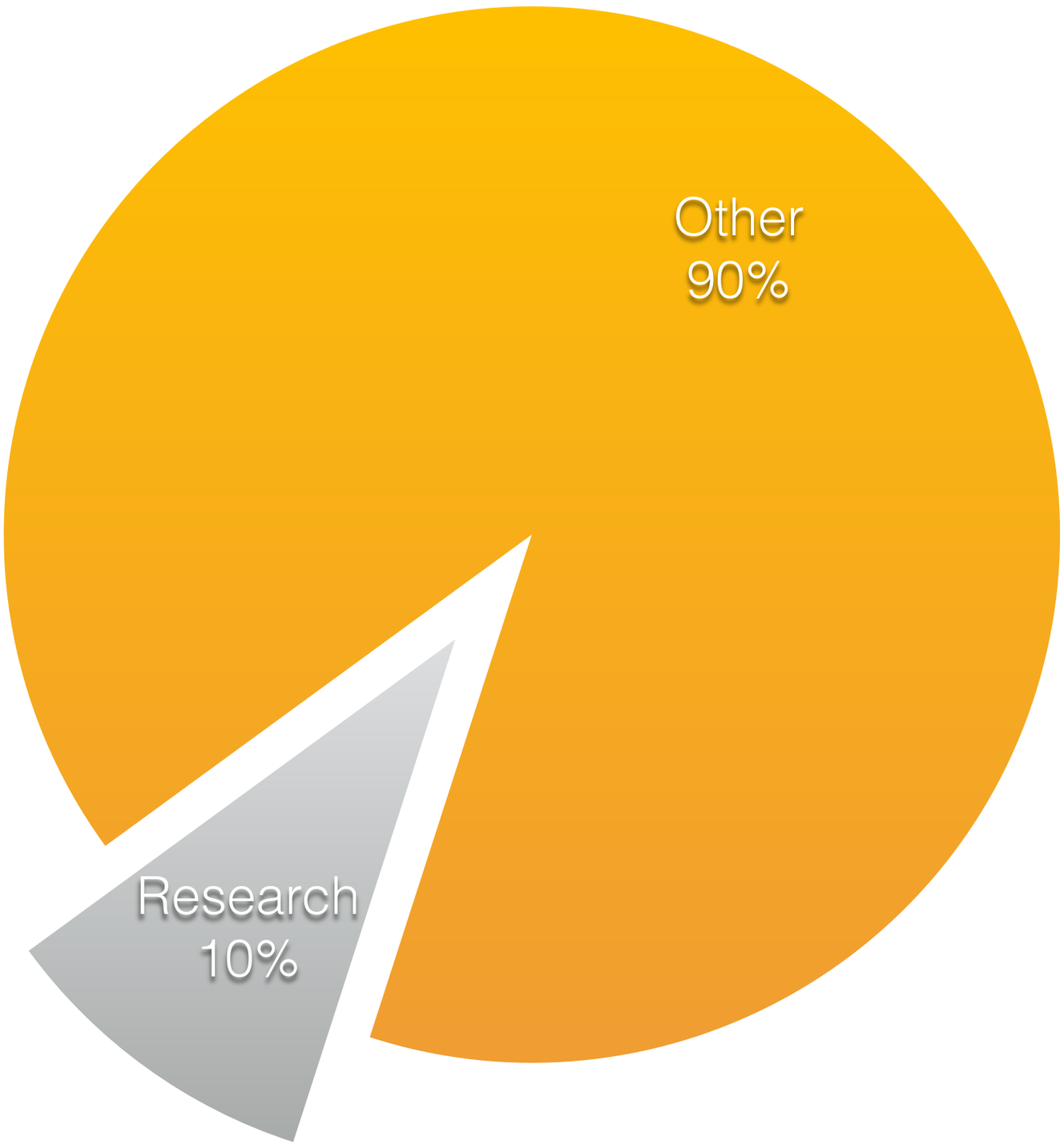
What do physicists do?



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Why do physicists gravitate towards jobs in finance?

The City might not seem an obvious destination for physics graduates, but there are some surprising links between the two

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October 18, 2013 1:12 pm

Physicists and the financial markets

By Stephen Foley

Physicists have been lured into the financial market for decades, prized for their insights and data-crunching skills. But in a time of turbulence, flash crashes and high-frequency trading, can they really spot things that others miss?

Physics

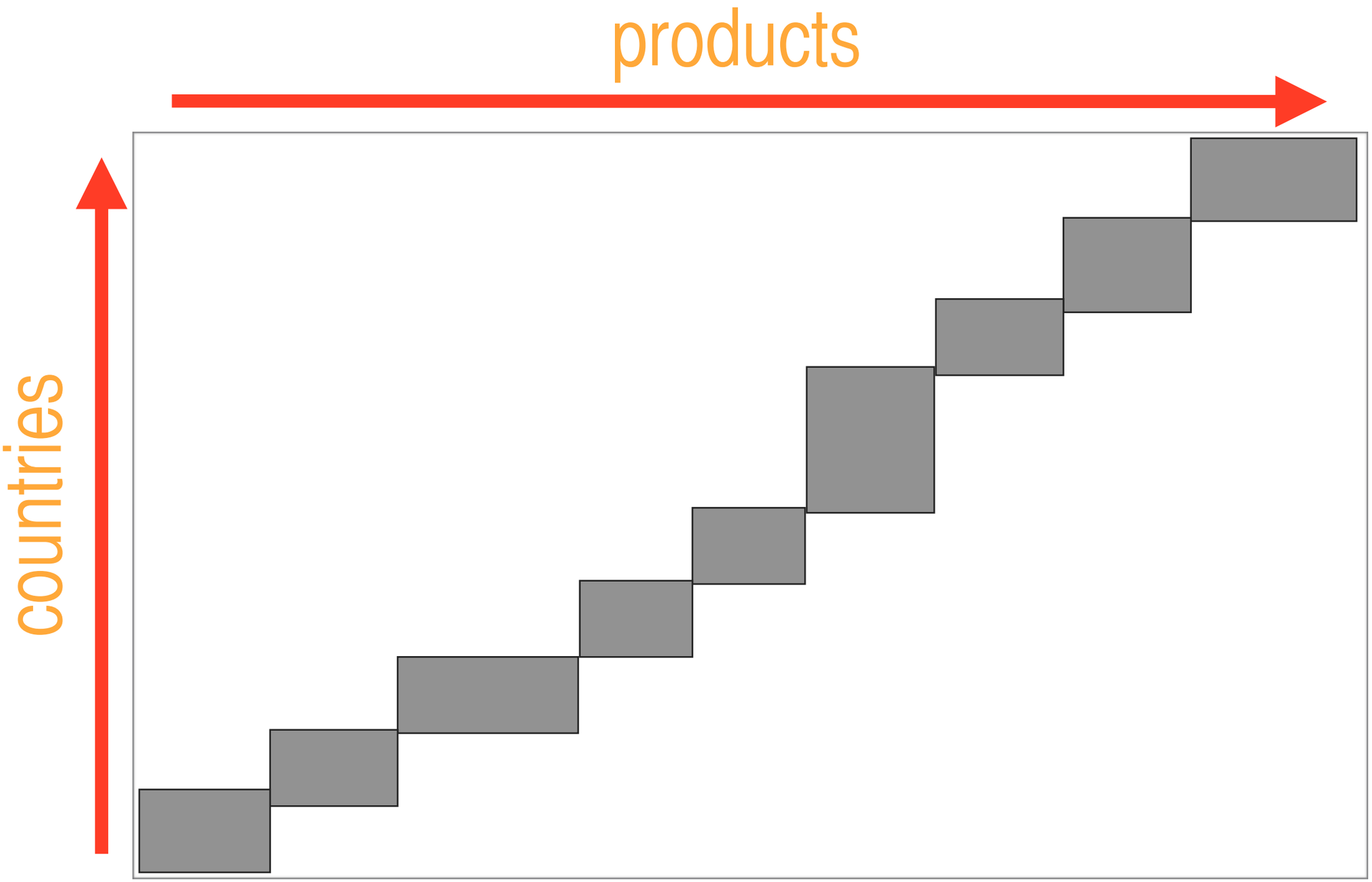
Finance + Economics

Economic Complexity

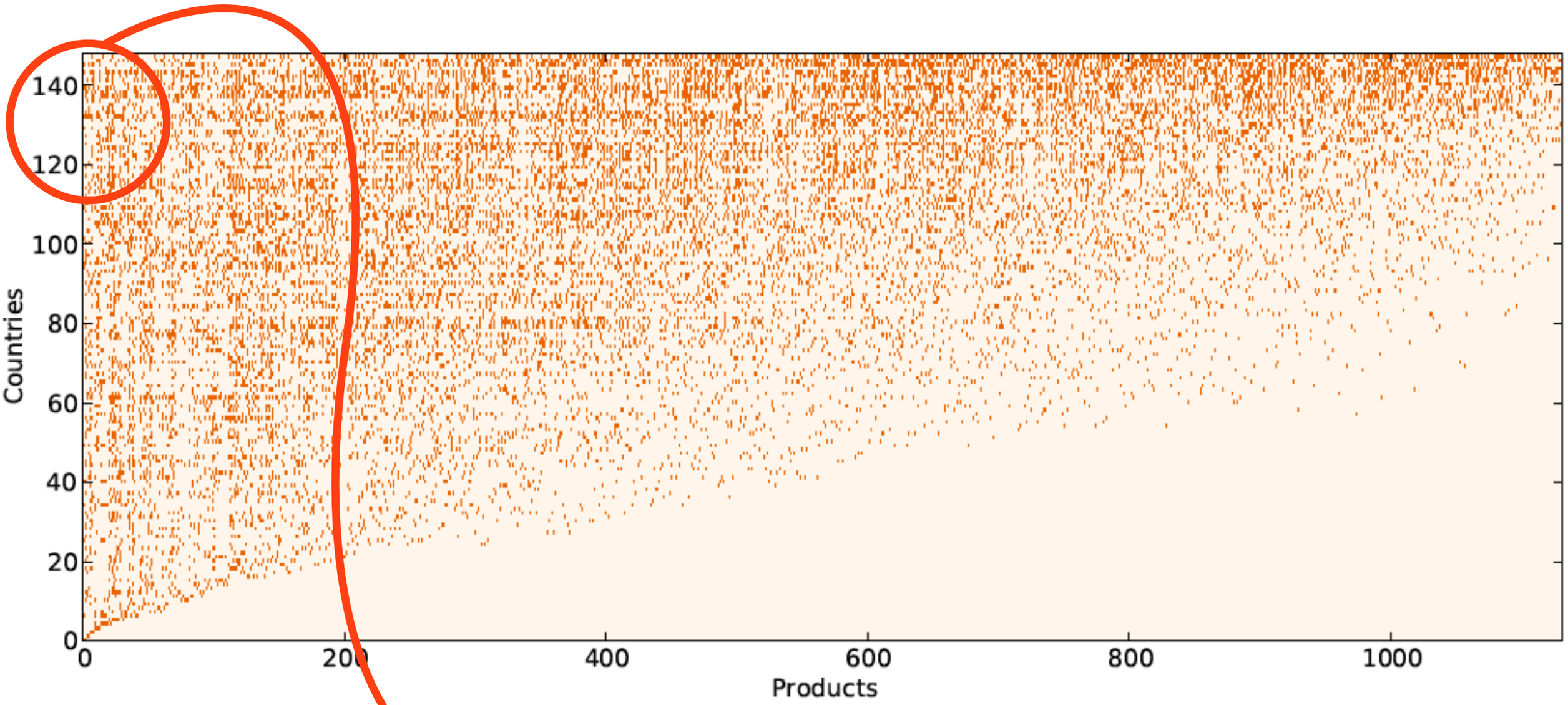
"It is the great multiplication of the productions of all the different arts, in consequence of the division of labour, which occasions, in a well-governed society, that universal opulence which extends itself to the lowest ranks of the people."

Adam Smith – The Wealth of Nations

Classic Theories (Smith, Ricardo)
Efficiency and Specialization

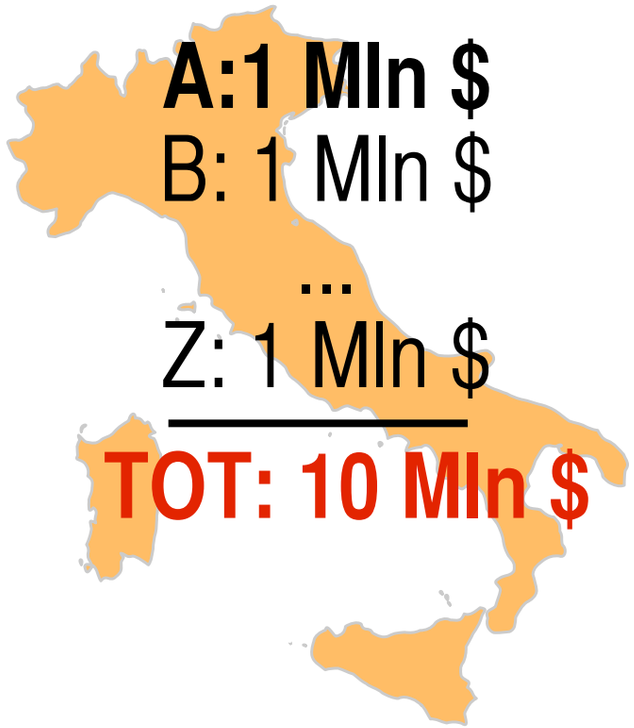


Most diversified countries are the most competitive countries!



Database COMTRADE
Year 2010

Evidence for leading role of **DIVERSIFICATION** with respect to competitive advantage (specialization)

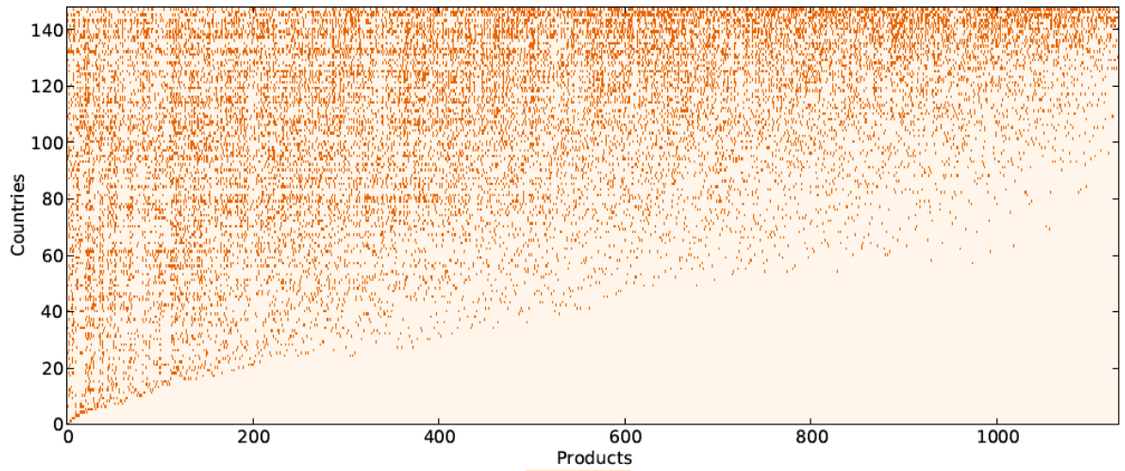


BIO: Adaptation, Ecosystems, Evolvability

Key challenge

from qualitative to quantitative

NEW **METRICS** FOR THE **COMPETITIVENESS OF COUNTRIES** AND THE **COMPLEXITY OF PRODUCTS**



1. a product is produced by a diversified country
2. a product is produced by a poorly diversified country
3. a country produces a widely diffused product
4. a country produces an exclusive or non-ubiquitous product

1. little insight in the complexity of the product.
2. very informative.
3. little insight in the fitness of the country.
4. very informative on the country fitness.

NON-LINEAR COUPLING BTW **FITNESS OF COUNTRIES** AND **COMPLEXITY OF PRODUCTS**

MEASURING INTANGIBLE PROPERTIES

New metrics for Fitness of countries and Complexity of products

Fitness

$$\tilde{F}_c^{(n)} = \sum_p M_{cp} Q_p^{(n-1)}$$

$$F_c^{(n)} = \frac{\tilde{F}_c^{(n)}}{\langle \tilde{F}_c^{(n)} \rangle_c}$$

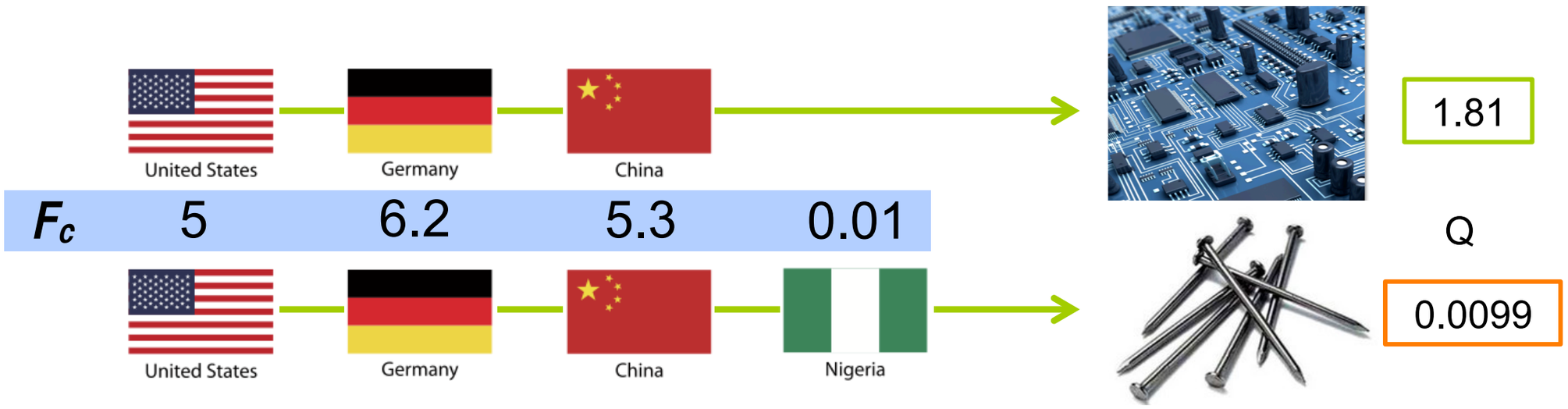
Complexity

$$\tilde{Q}_p^{(n)} = \frac{1}{\sum_c M_{cp} \frac{1}{F_c^{(n-1)}}}$$

$$Q_p^{(n)} = \frac{\tilde{Q}_p^{(n)}}{\langle \tilde{Q}_p^{(n)} \rangle_p}$$

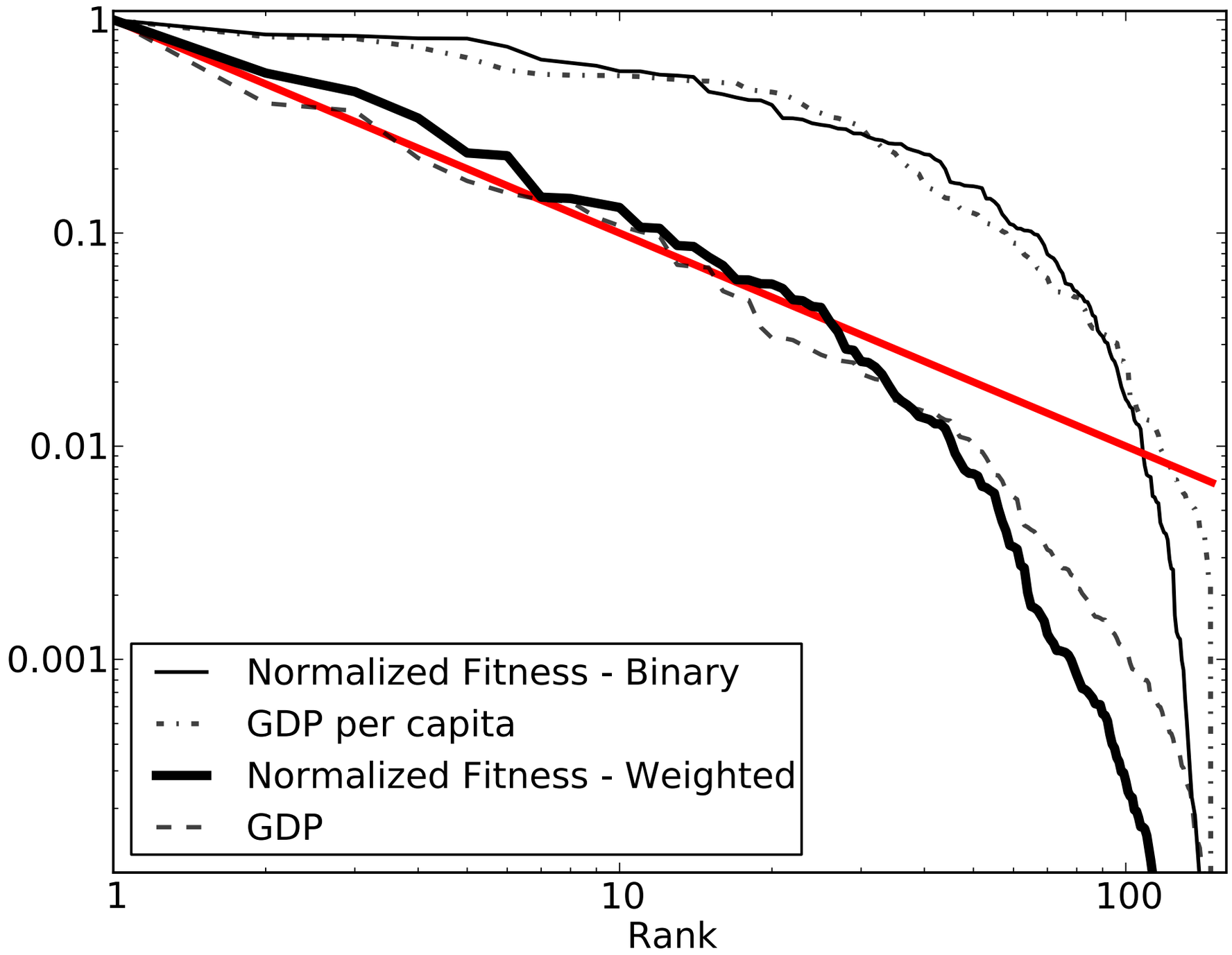
F_c: diversification weighted by complexity

Q_p: Extremal non-linear complexity of products.
A **single low fitness producer** implies low complexity



Intensive definition correlates with intensive measure of wealth

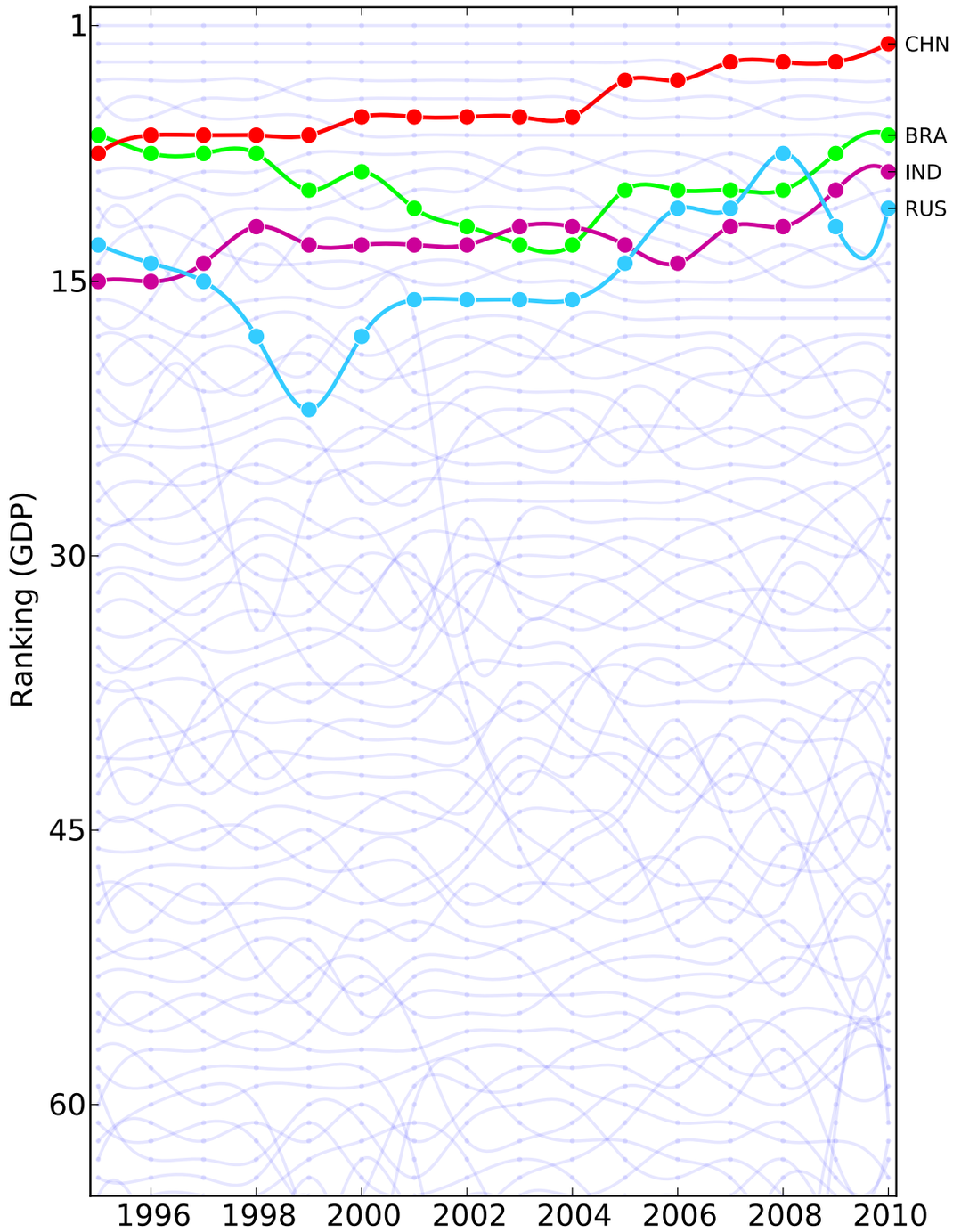
Extensive definition correlates with extensive measure of wealth



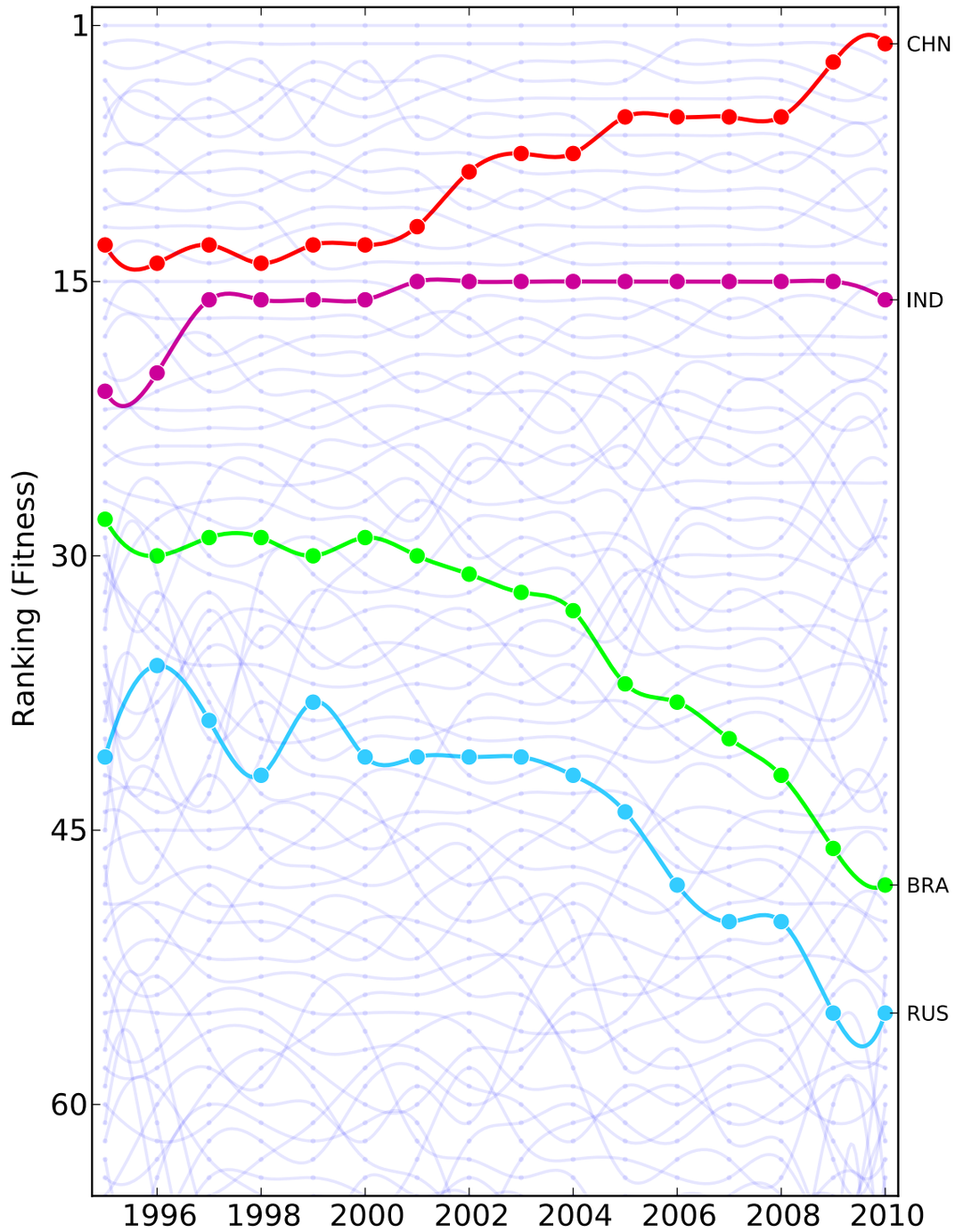
BRIC – Time Evolution (1995–2010)

GDP is not enough

GDP



Fitness



Key challenge 2

how to forecast economic growth

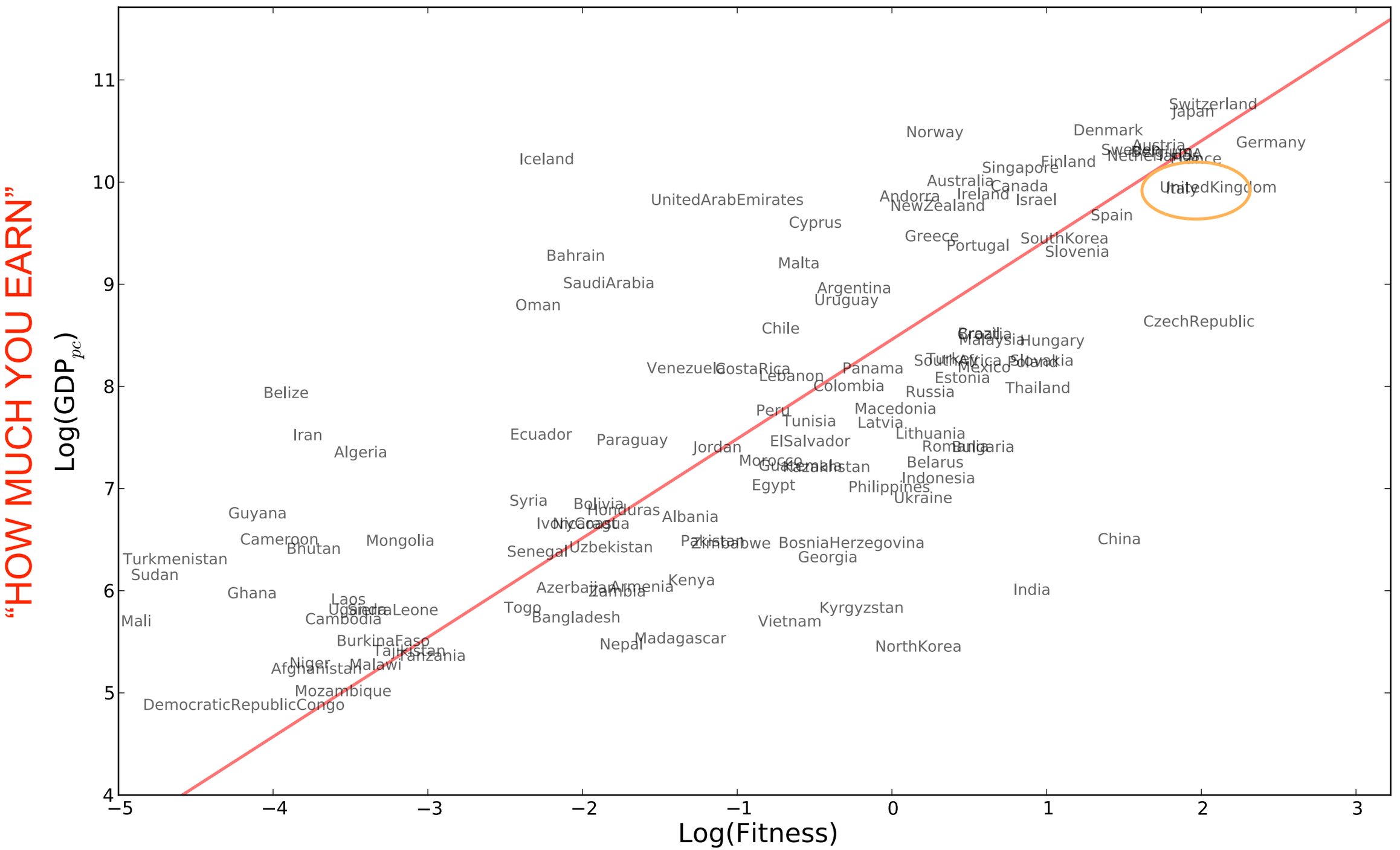
SCIENTIFIC GROUNDING OF ECONOMIC PREDICTION

(beyond std tools and Reinhart and Rogoff excel-gate)

M. Cristelli, A. Tacchella, L. Pietronero, *The Heteregenous Dynamics of Economic Complexity,* (Working paper)

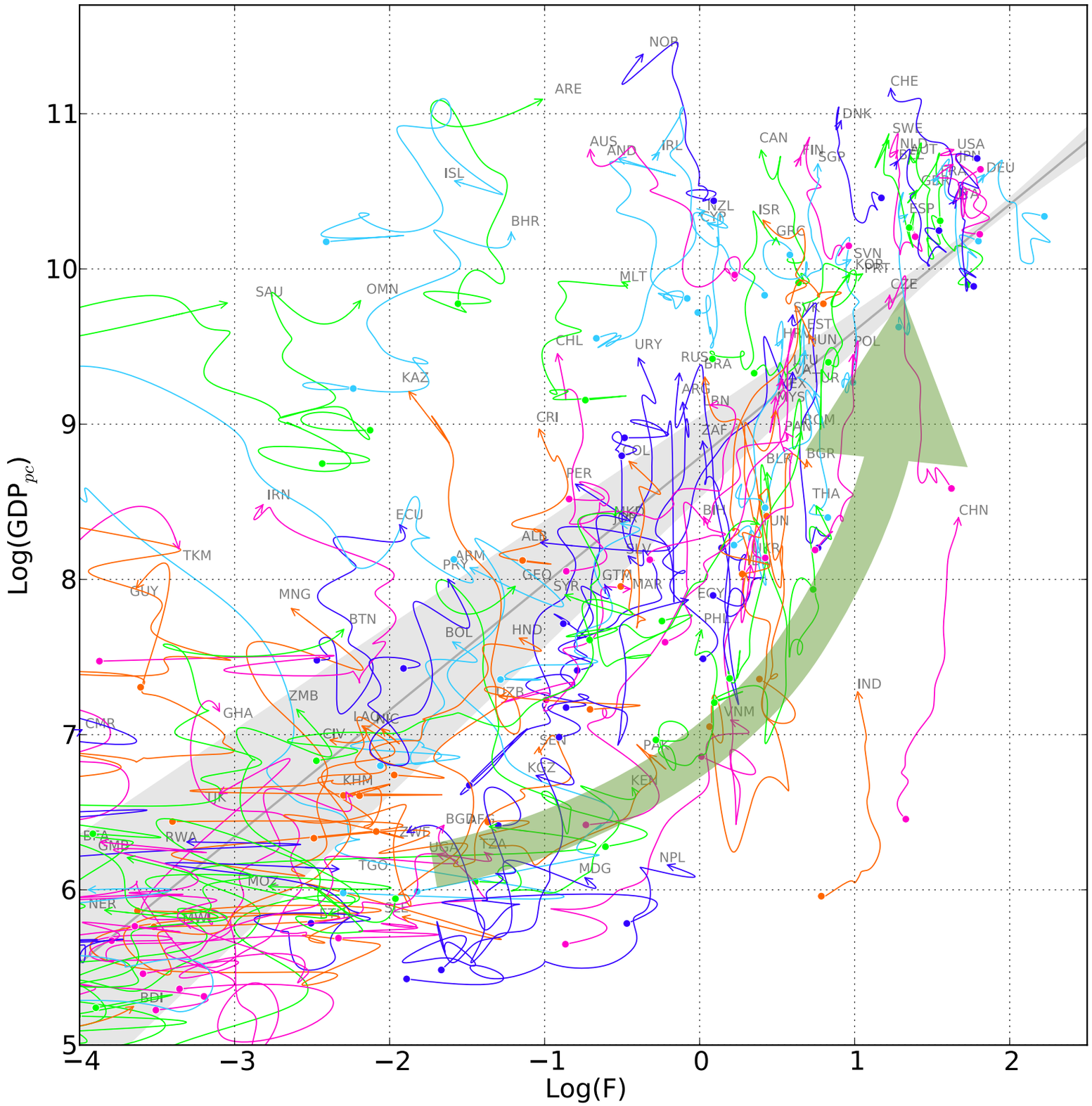
FITNESS vs GDP$_{pc}$

Red Line: average trend, NOT a regression

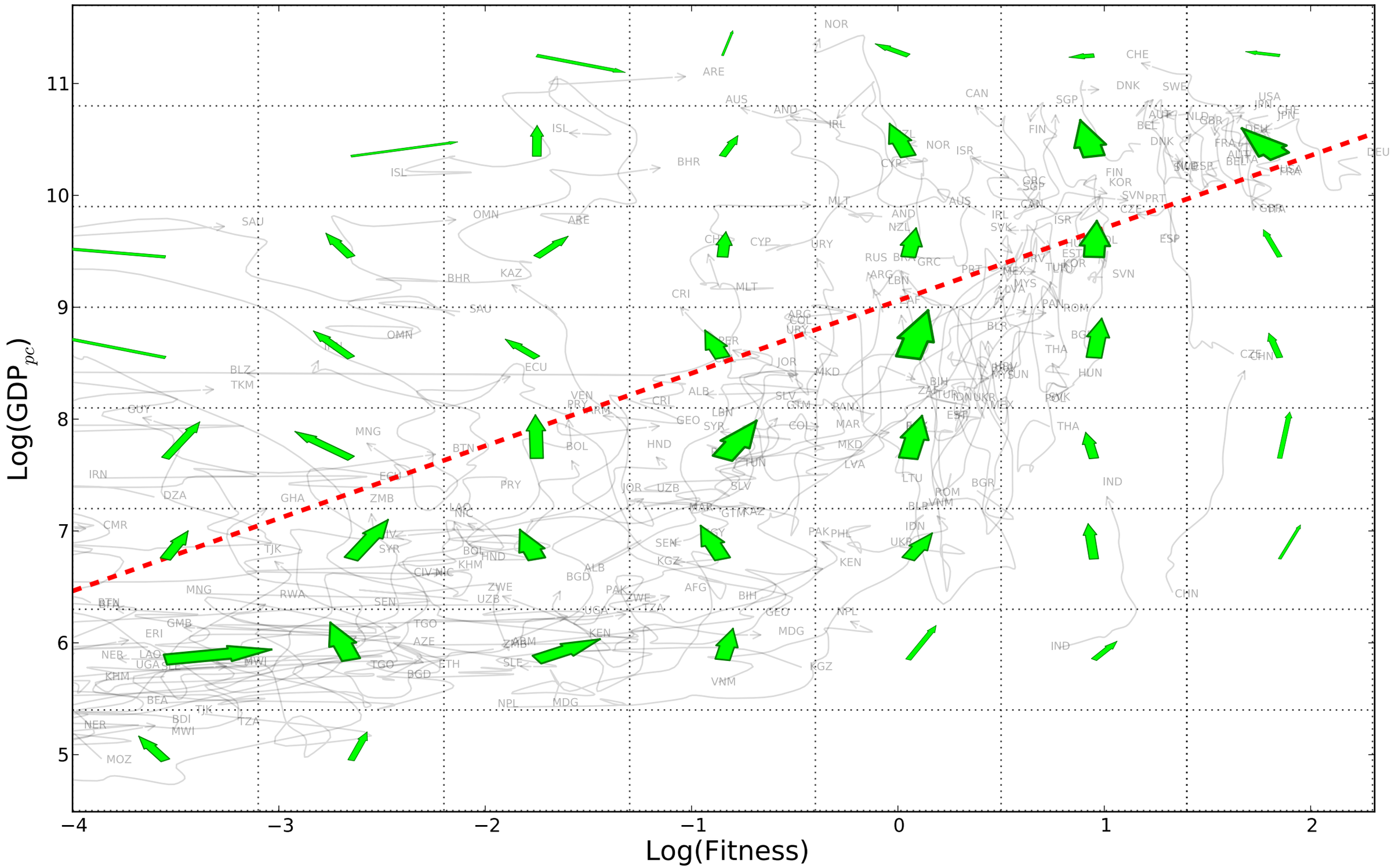


“HOW GOOD YOU ARE”

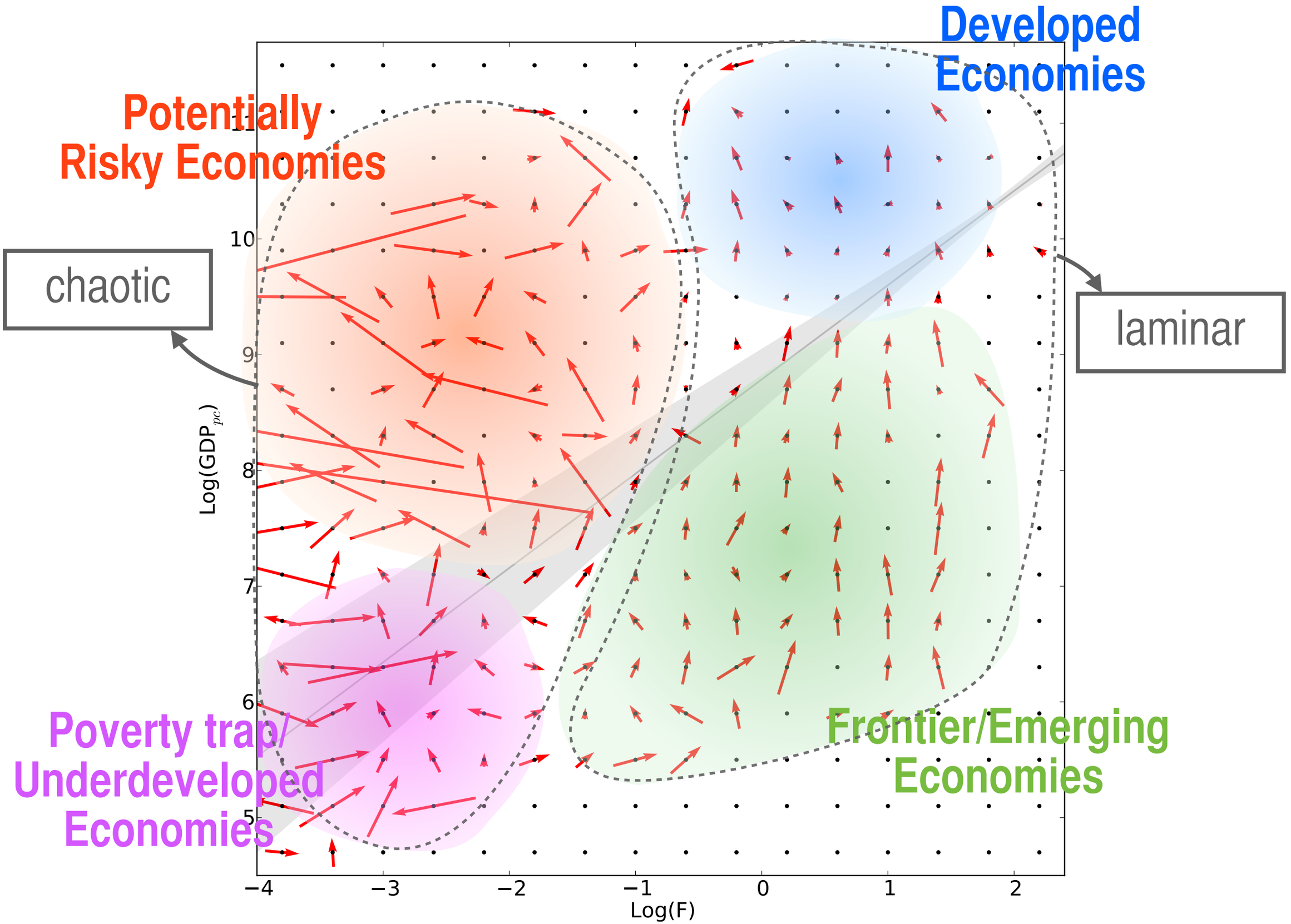
Collective dynamics ... a mess but not everywhere



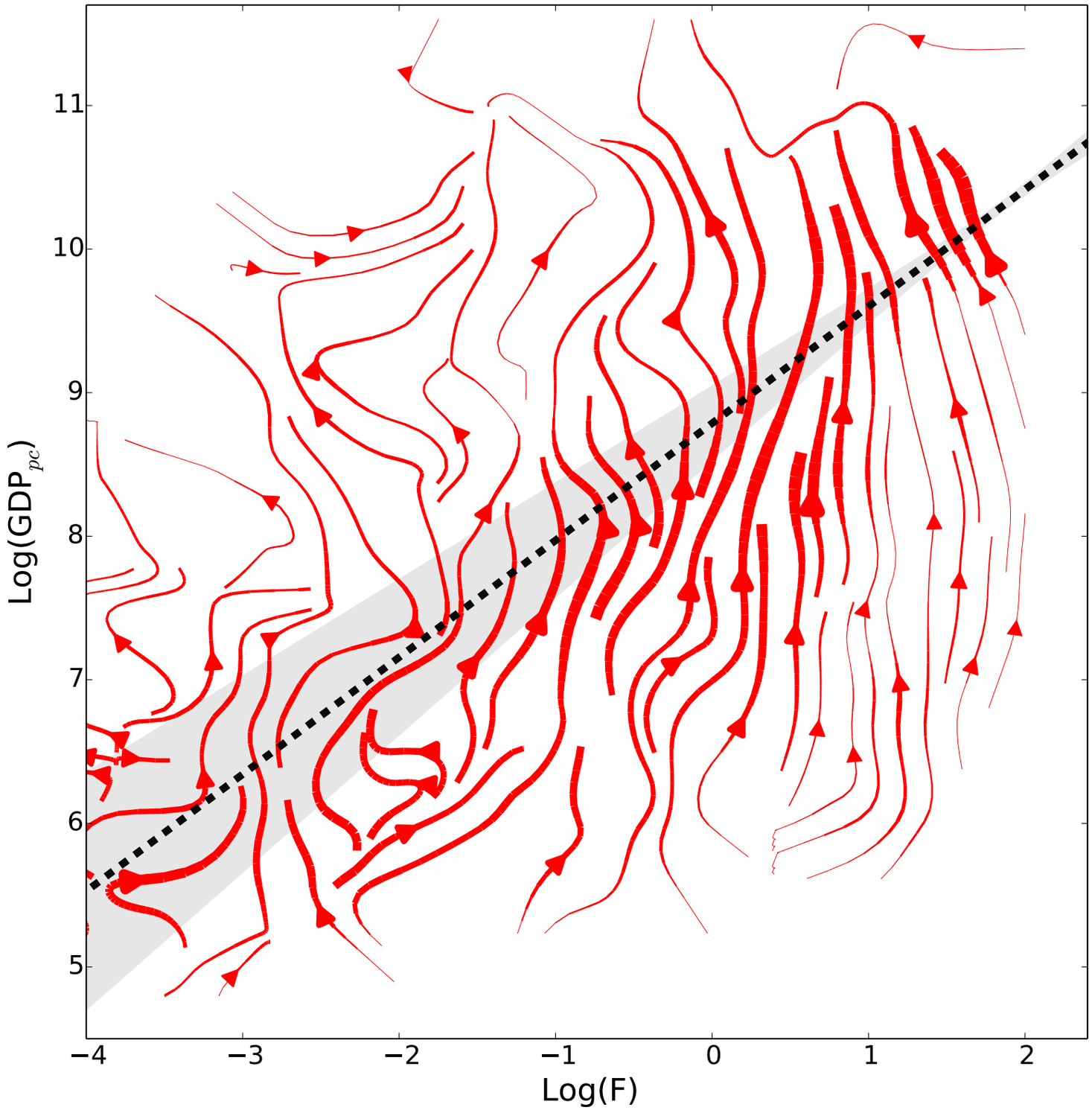
Weather-like forecast



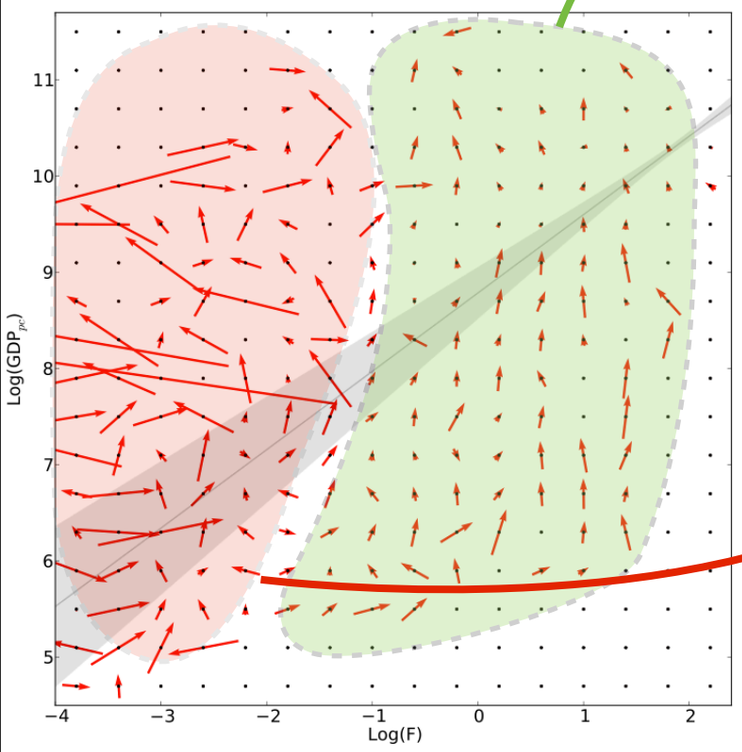
Weather-like forecast: Heterogeneous dynamics



Weather-like forecast: Heterogeneous dynamics



Borrowing concepts from dynamical systems



Laminar regime

Low effective dimension ($d_e \approx 2$)

Fitness is the relevant and driving variable for the economic dynamics in this regime

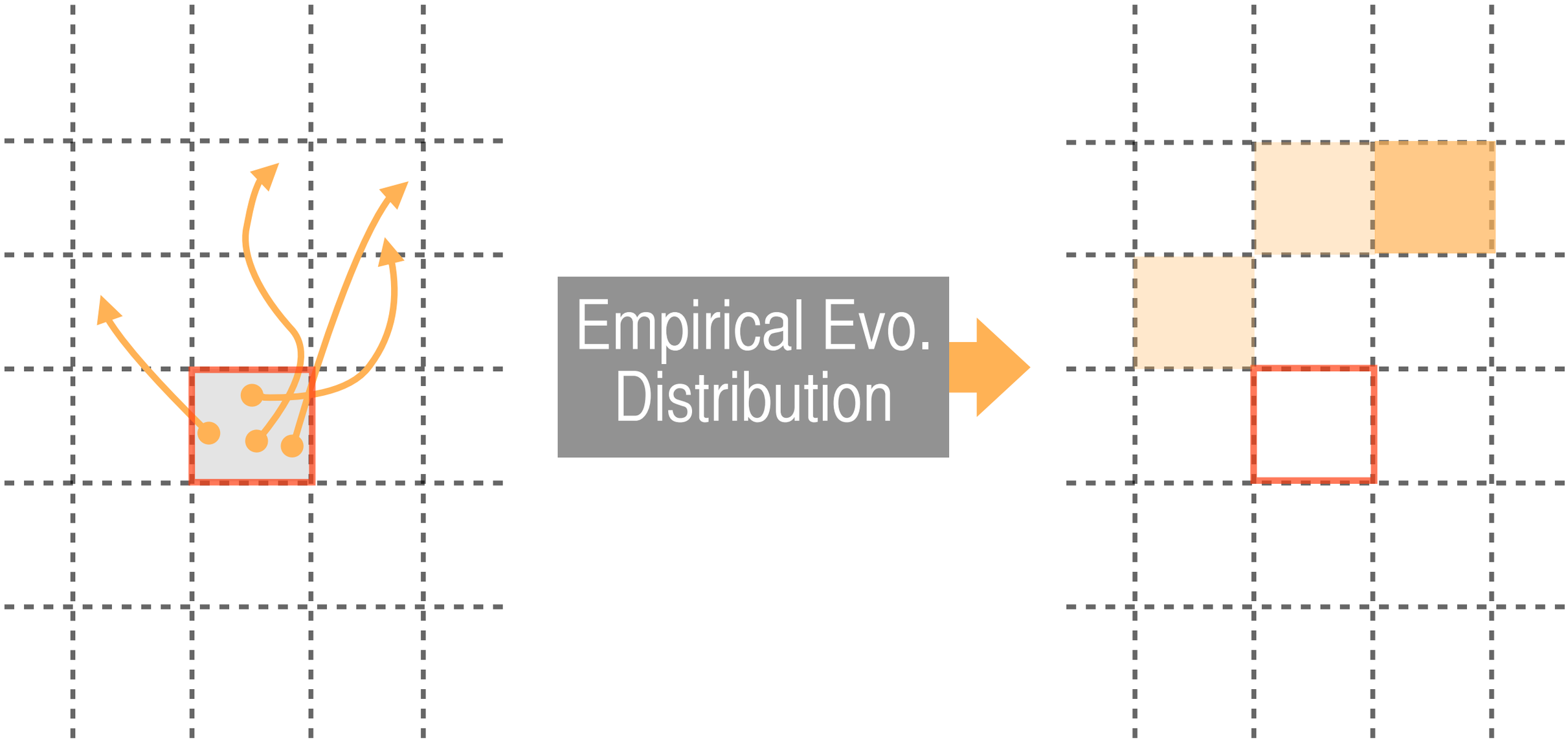
Chaotic regime

Chaotic dynamics OR $d_e \gg 2$

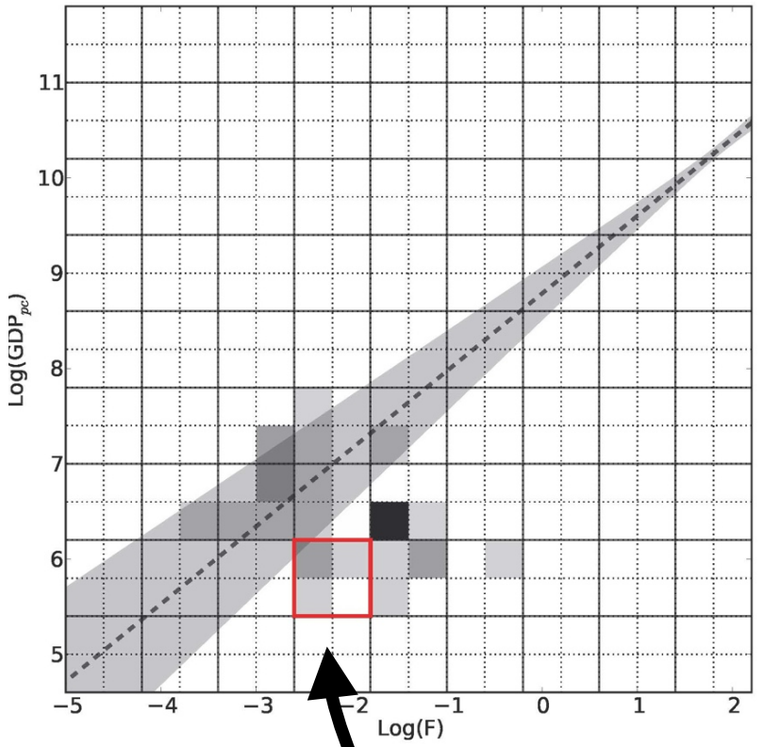
Dynamics is ruled by several other exogenous factors competing with Fitness

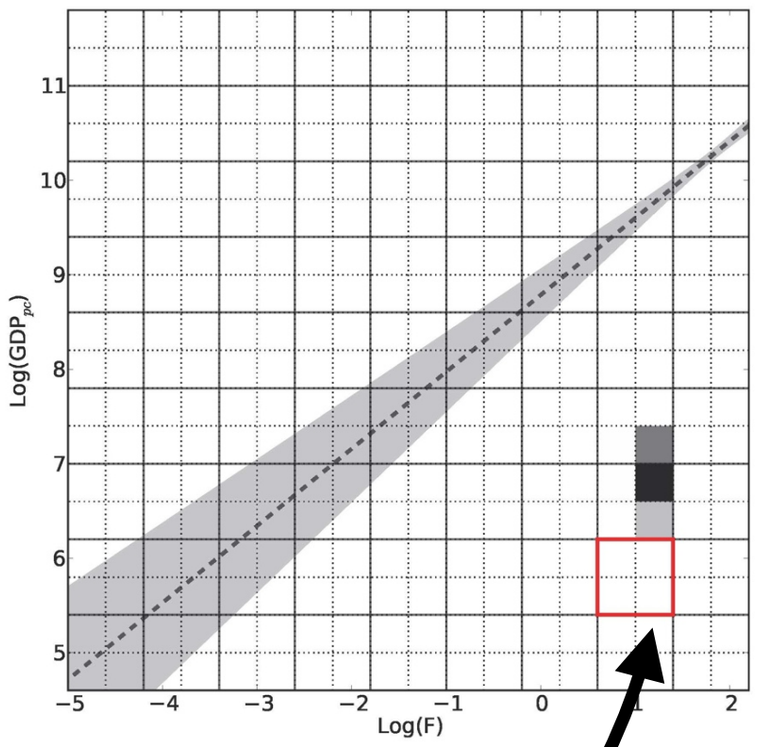
SELECTIVE PREDICTABILITY

Method of Analogs: forecasting the future by the knowledge of the past



the *Selective Predictability* Scheme





$$\mathcal{C} = \frac{n_{\text{boxes}}^{(i)}}{N^{(i)}} - \frac{1}{N^{(i)}}$$

NB: $N^{(i)} \geq 10$

SCIENTIFIC REPORTS

A New Metrics for Countries' Fitness and Products' Complexity

Andrea Tacchella[1,2], Matthieu Cristelli[2,1], Guido Caldarelli[3,2,4], Andrea Gabrielli[2,3] & Luciano Pietronero[1,2,4]

PLOS | ONE

Measuring the Intangibles: a Metrics for the Economic Complexity of Countries and Products

M. Cristelli, A. Tacchella, A. Gabrielli, G. Caldarelli, L. Pietronero

PLOS | ONE

A Network Analysis of Countries' Export Flows: Firm Grounds for the Building Blocks of the Economy

Guido Caldarelli[1,2,3], Matthieu Cristelli[2,4]*, Andrea Gabrielli[2,3], Luciano Pietronero[2,4,3], Antonio Scala[2,3], Andrea Tacchella[4,2]

JEDC

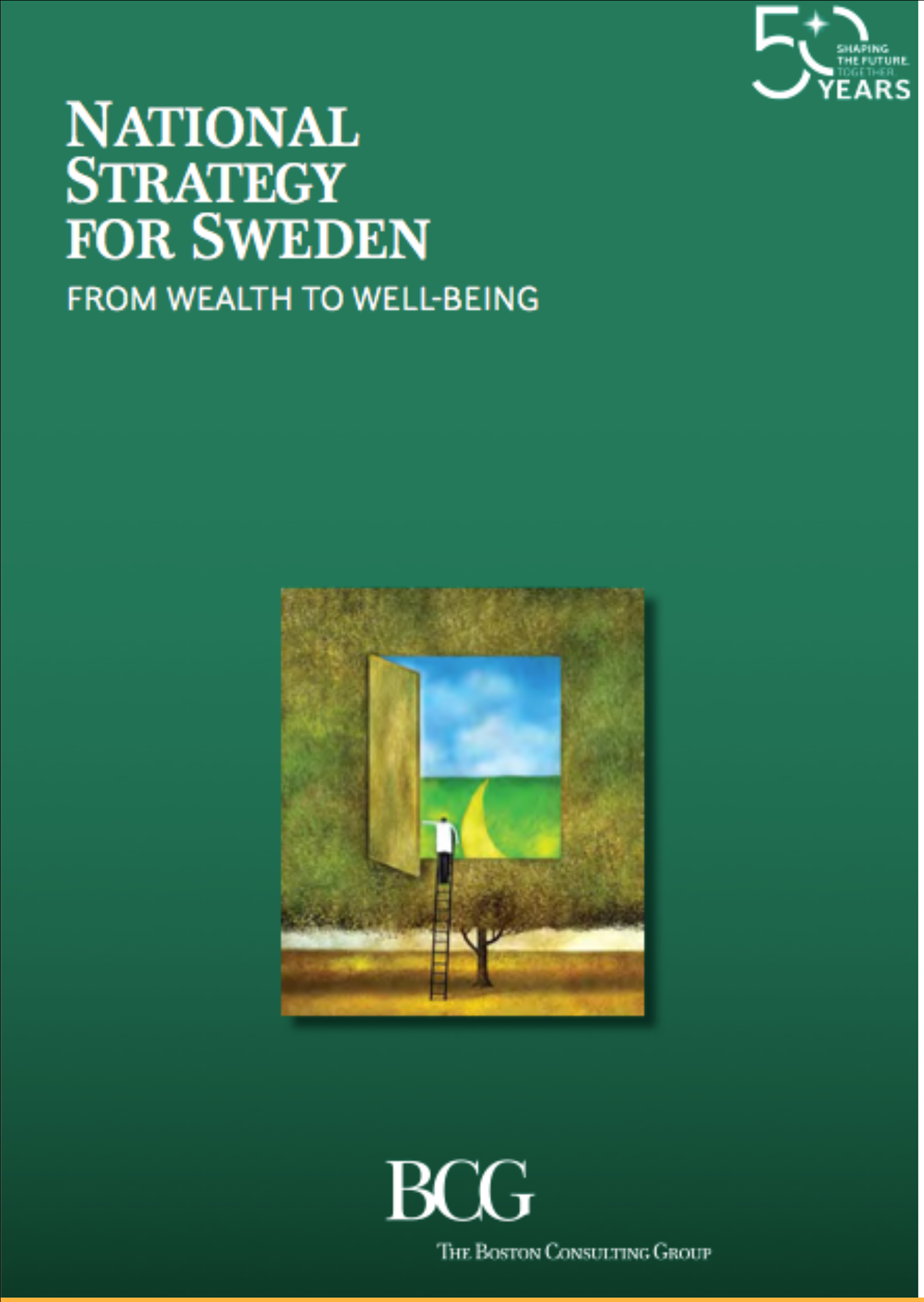
Economic complexity: Conceptual grounding of a new metrics for global competitiveness

A. Tacchella[a], M. Cristelli[b], G. Caldarelli[b, d, e], A. Gabrielli[c, d], L. Pietronero[a, c, d]

further information

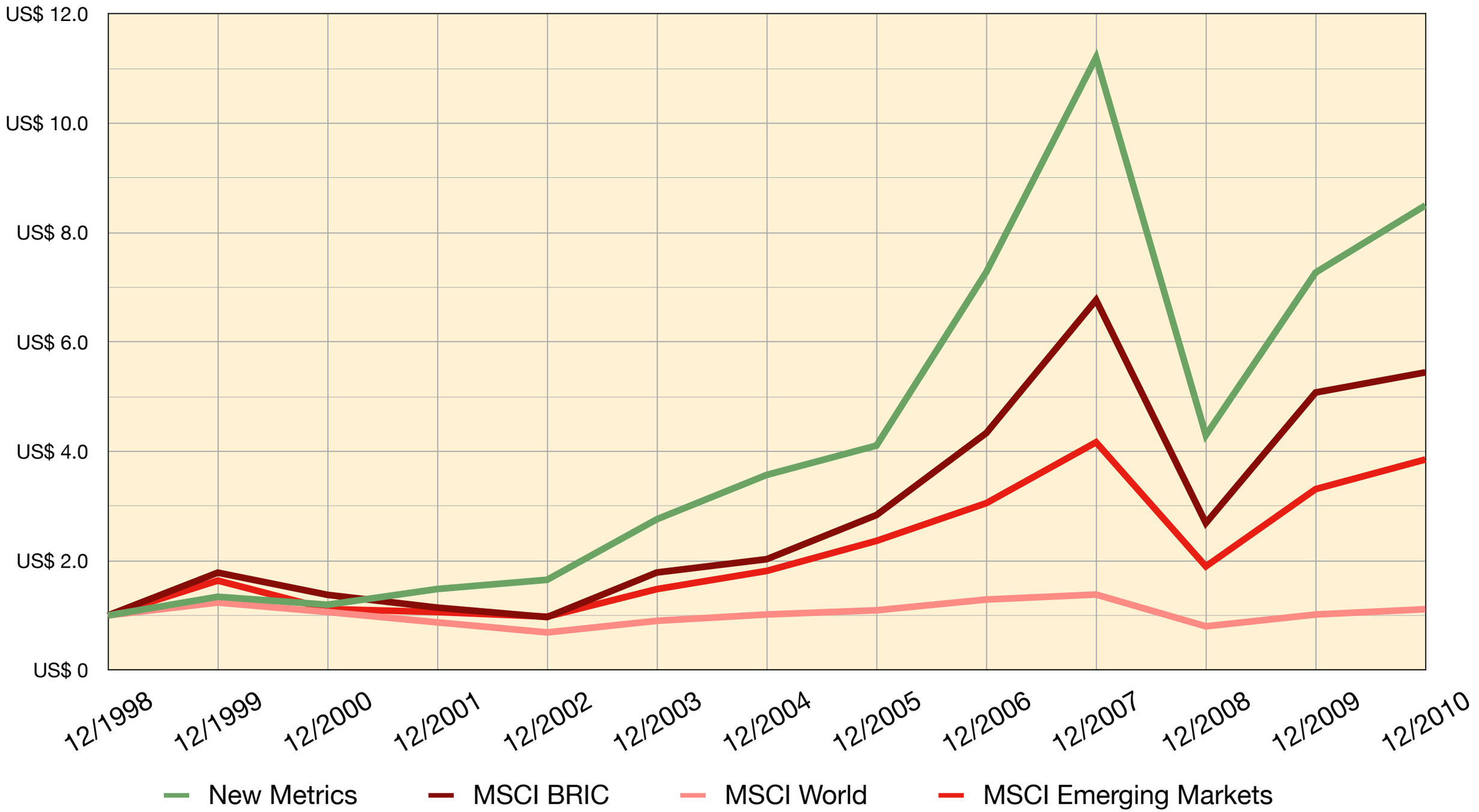
http://pilhd.phys.uniroma1.it/PILgroup_Economic_Complexity/Home.html

http://sites.google.com/site/matthieucristelli/



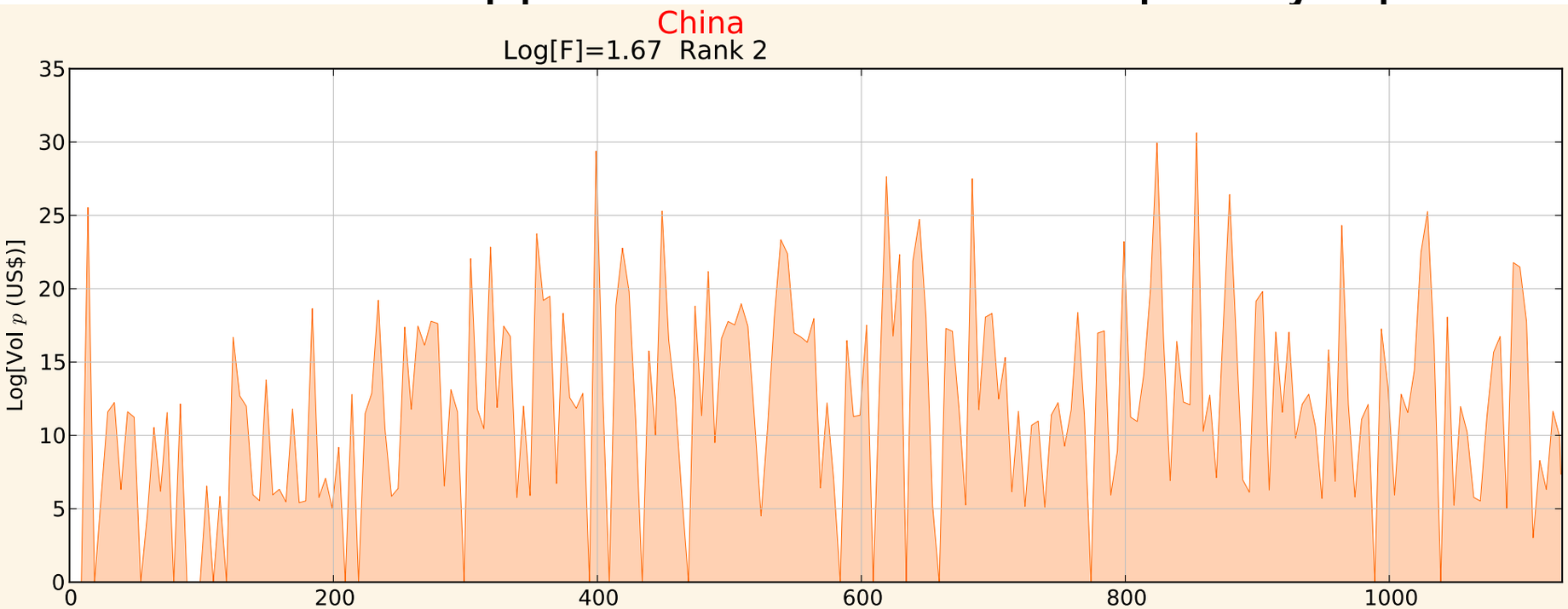
BCG report for Sweden Government (2013)

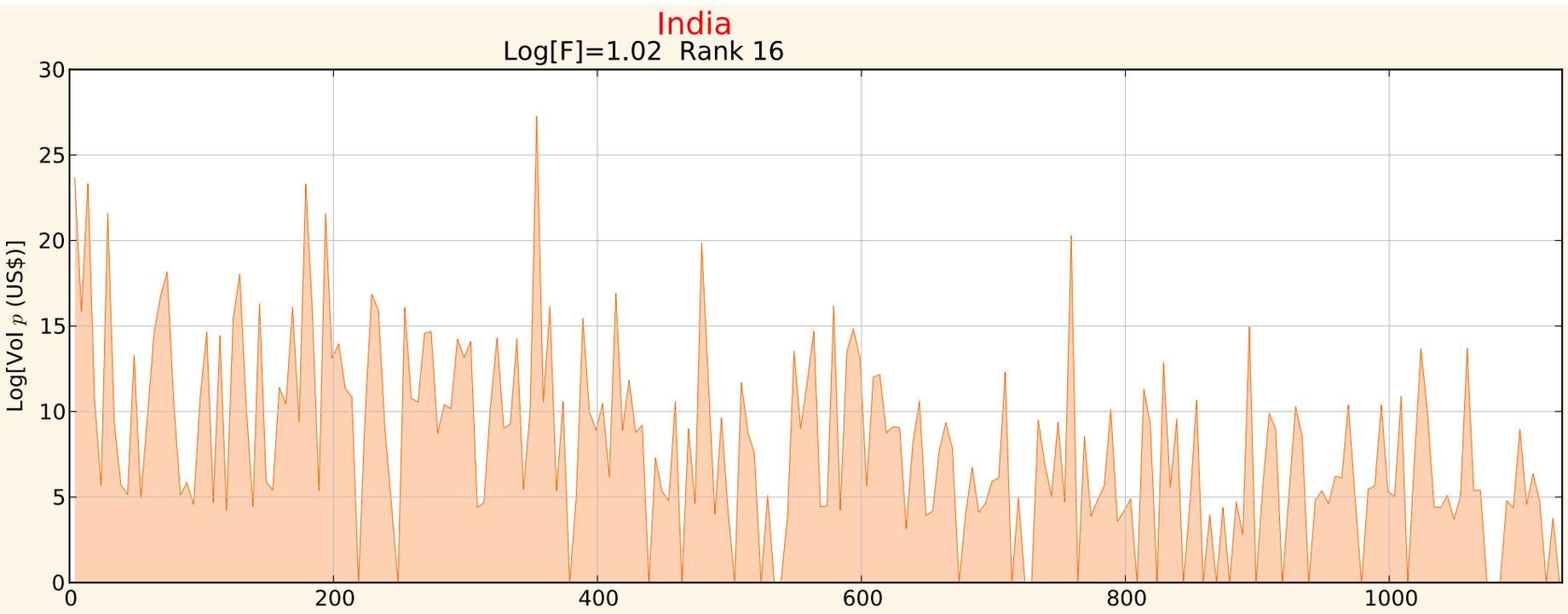
Similar analysis for UK in preparation

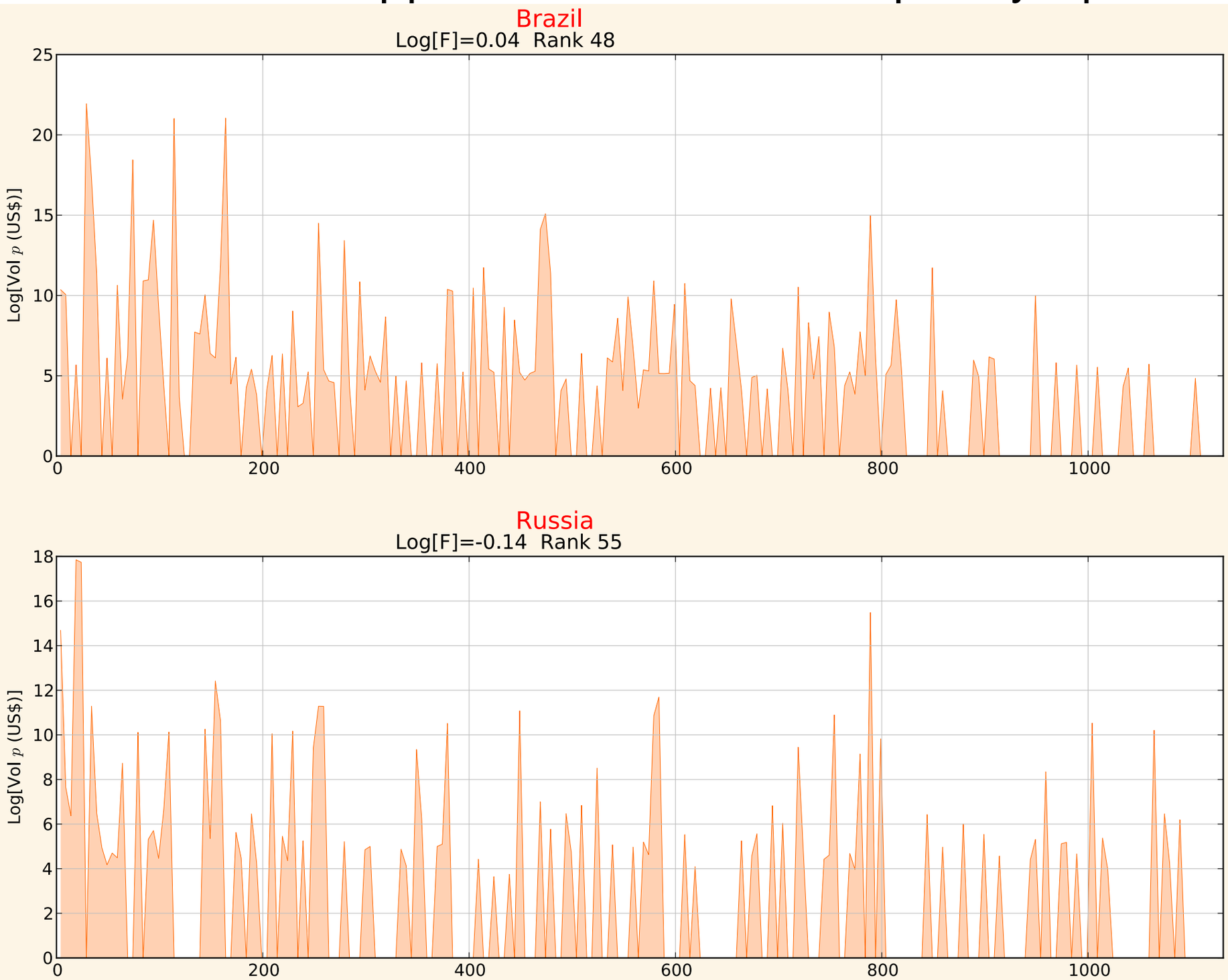

US$ 12.0
US$ 10.0
US$ 8.0
US$ 6.0
US$ 4.0
US$ 2.0
US$ 0
12/1998
12/1999
12/2000
12/2001
12/2002
12/2003
12/2004
12/2005
12/2006
12/2007
12/2008
12/2009
12/2010
New Metrics
MSCI BRIC
MSCI World
MSCI Emerging Markets

Country *spectroscopy*

Products appear clustered in Complexity Space





Country *spectroscopy*

Products appear clustered in Complexity Space