

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

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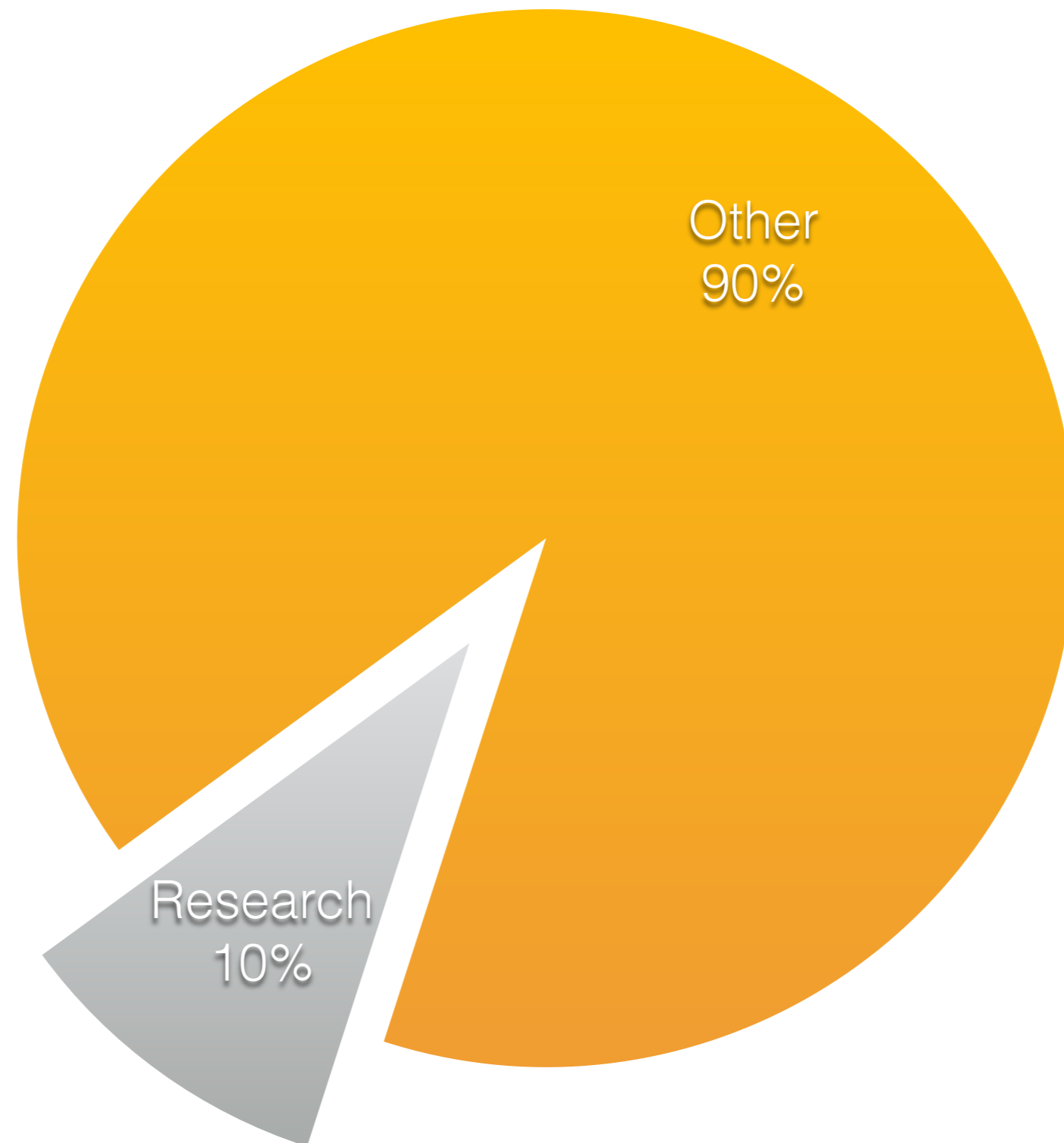


ANFeA
Stati Generali 2 – Professione Fisico
13 Dicembre 2013



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What do physicists do?



Series: ... on science

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

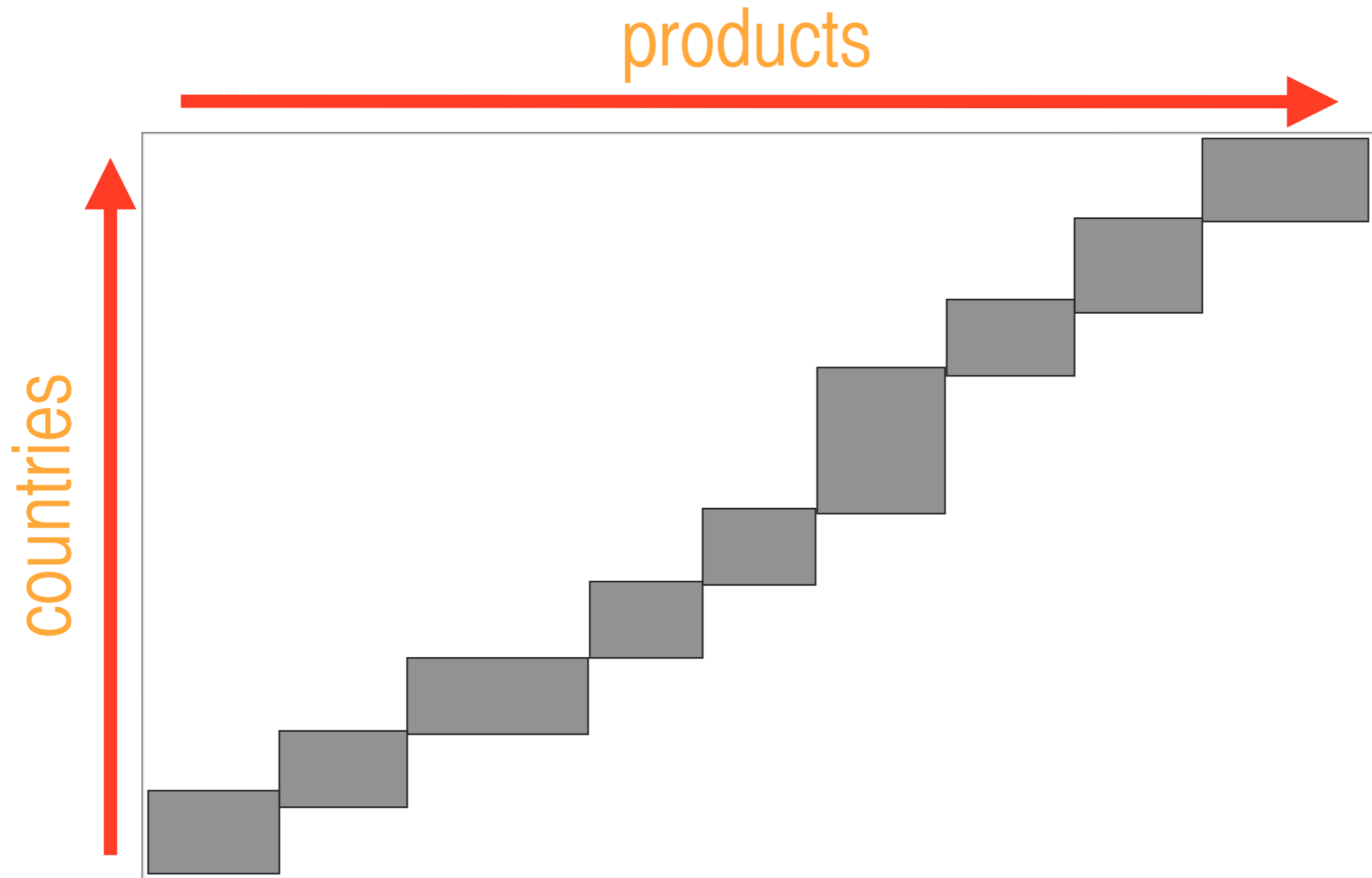


Economic Complexity

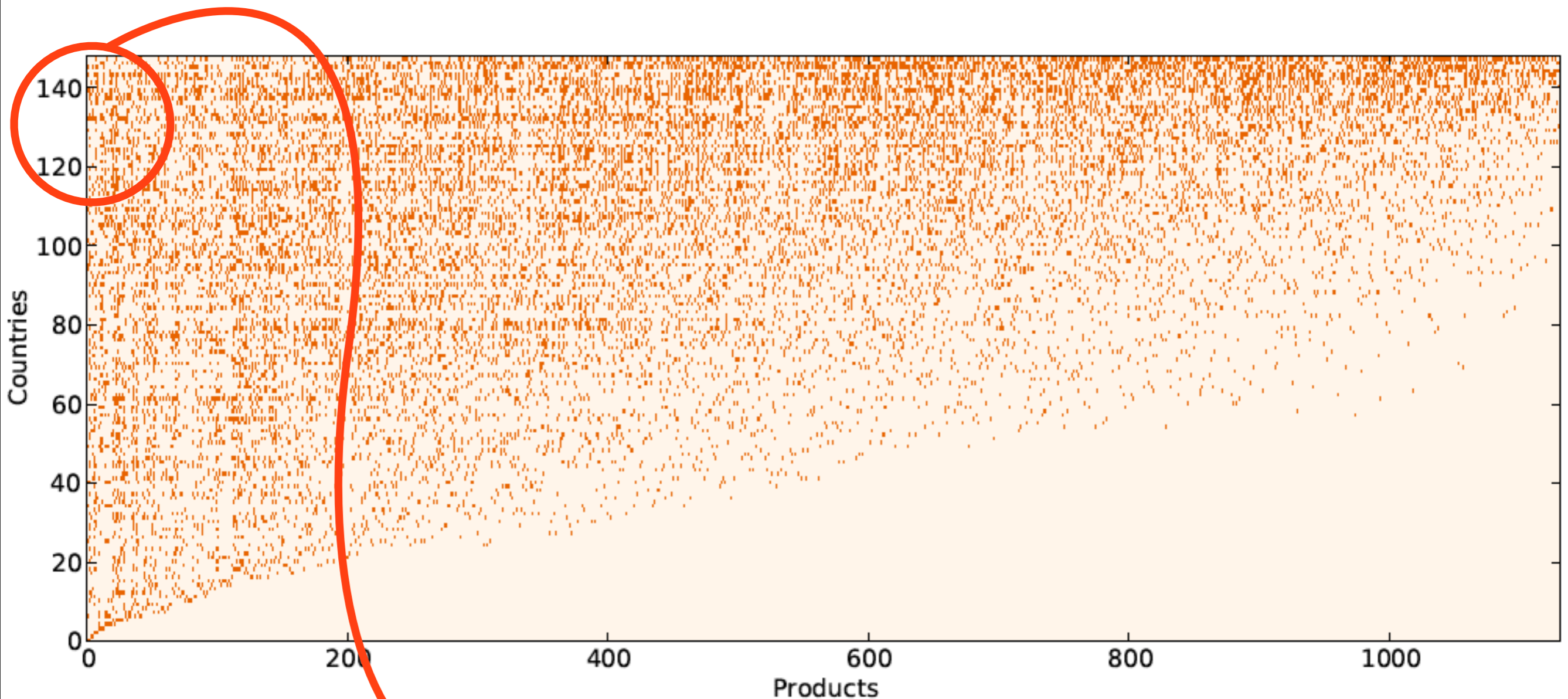
*“It is the great multiplication of the productions of all the different arts, in consequence of the **division of labour**, which occasions, in a well-governed society, that universal opulence which extends itself to the lowest ranks of the people.”*

Adam Smith – The Wealth of Nations

Classic Theories (Smith, Ricardo) Efficiency and Specialization



Most diversified countries are the most competitive countries!



Germany, USA, China, Italy, UK,
France, Spain, India, Japan, ...

Database COMTRADE
Year 2010

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

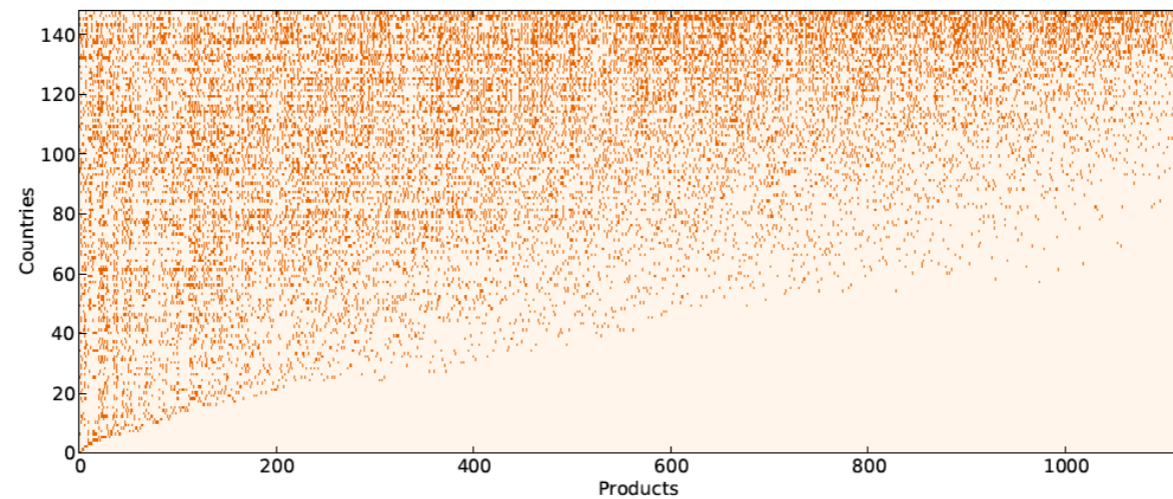


BIO: Adaptation, Ecosystems, Evolvability

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

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

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

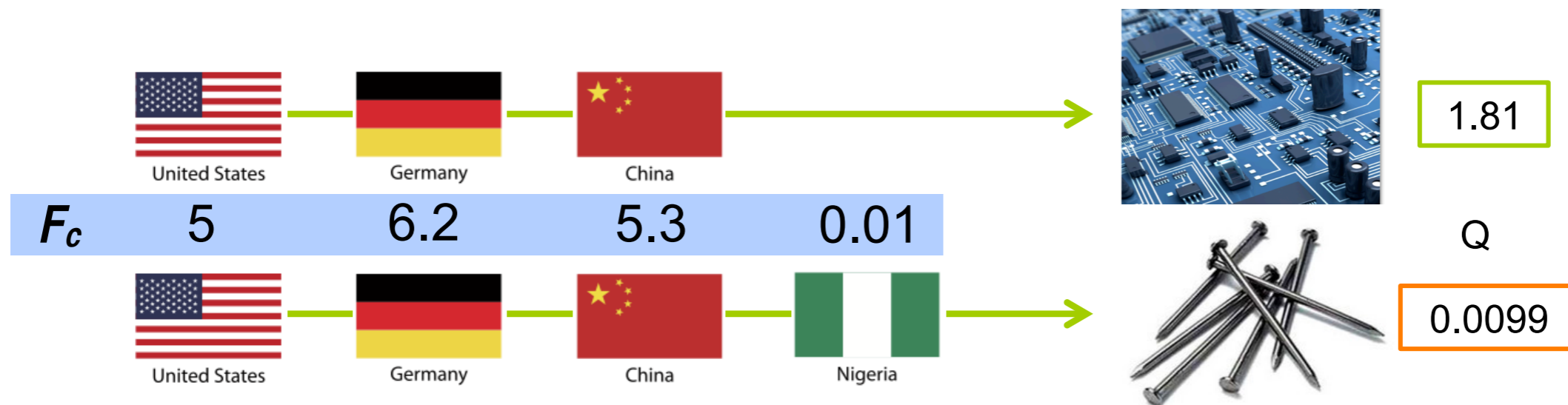
F_c : diversification weighted by complexity

Complexity

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

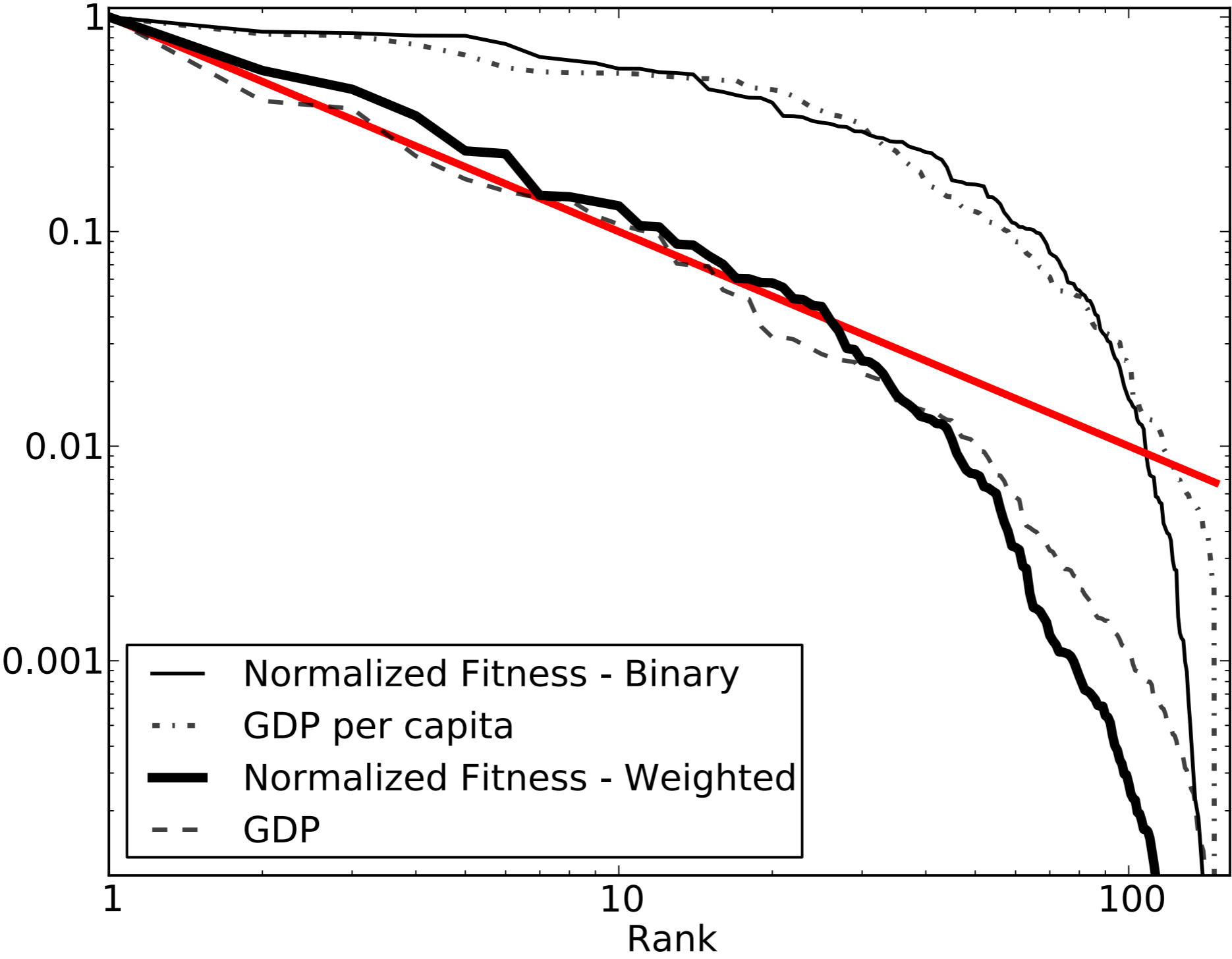
$$Q_p^{(n)} = \frac{\tilde{Q}_p^{(n)}}{\langle \tilde{Q}_p^{(n)} \rangle_p}$$

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



Intensive definition correlates with **intensive** measure of wealth

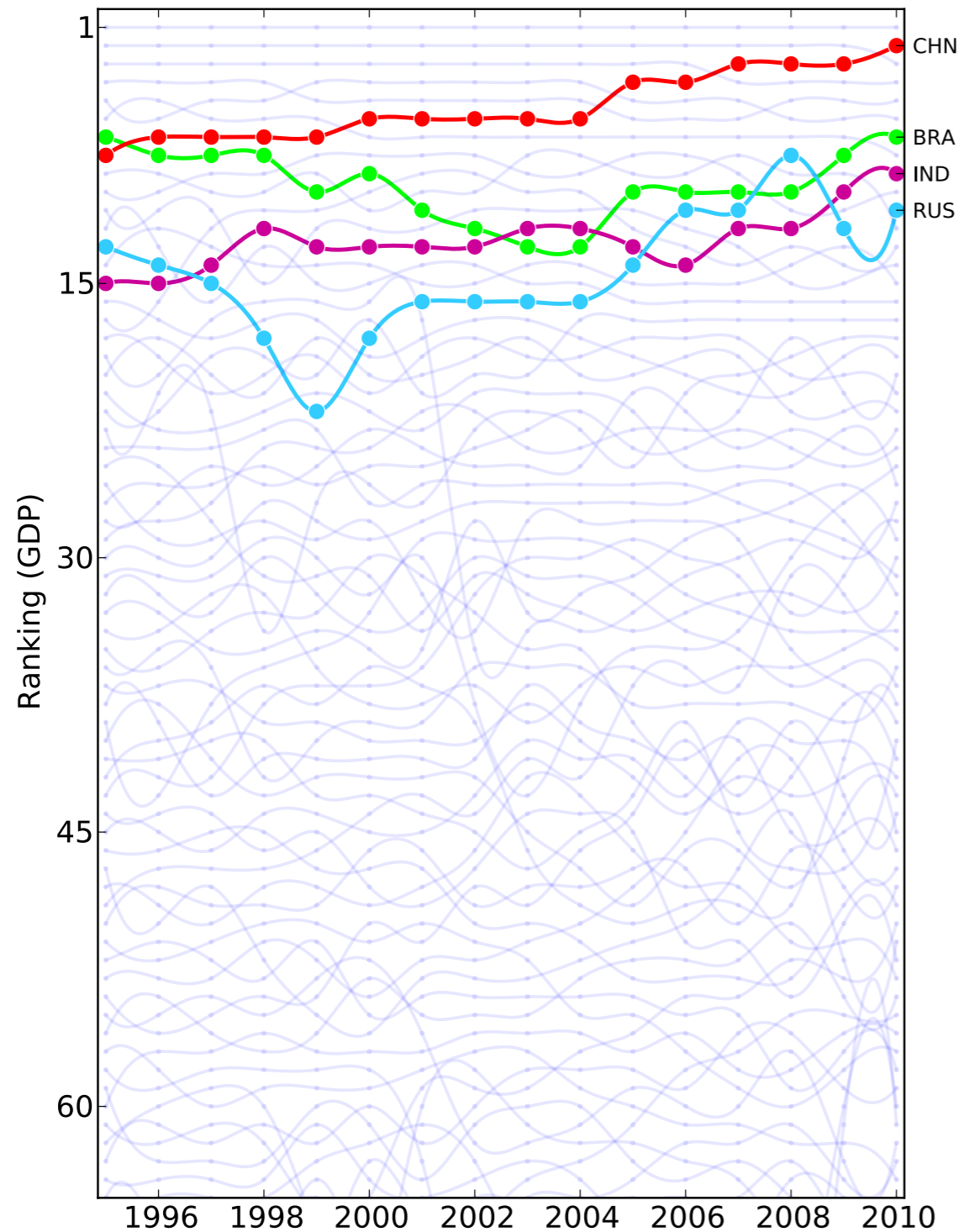
Extensive definition correlates with **extensive** measure of wealth



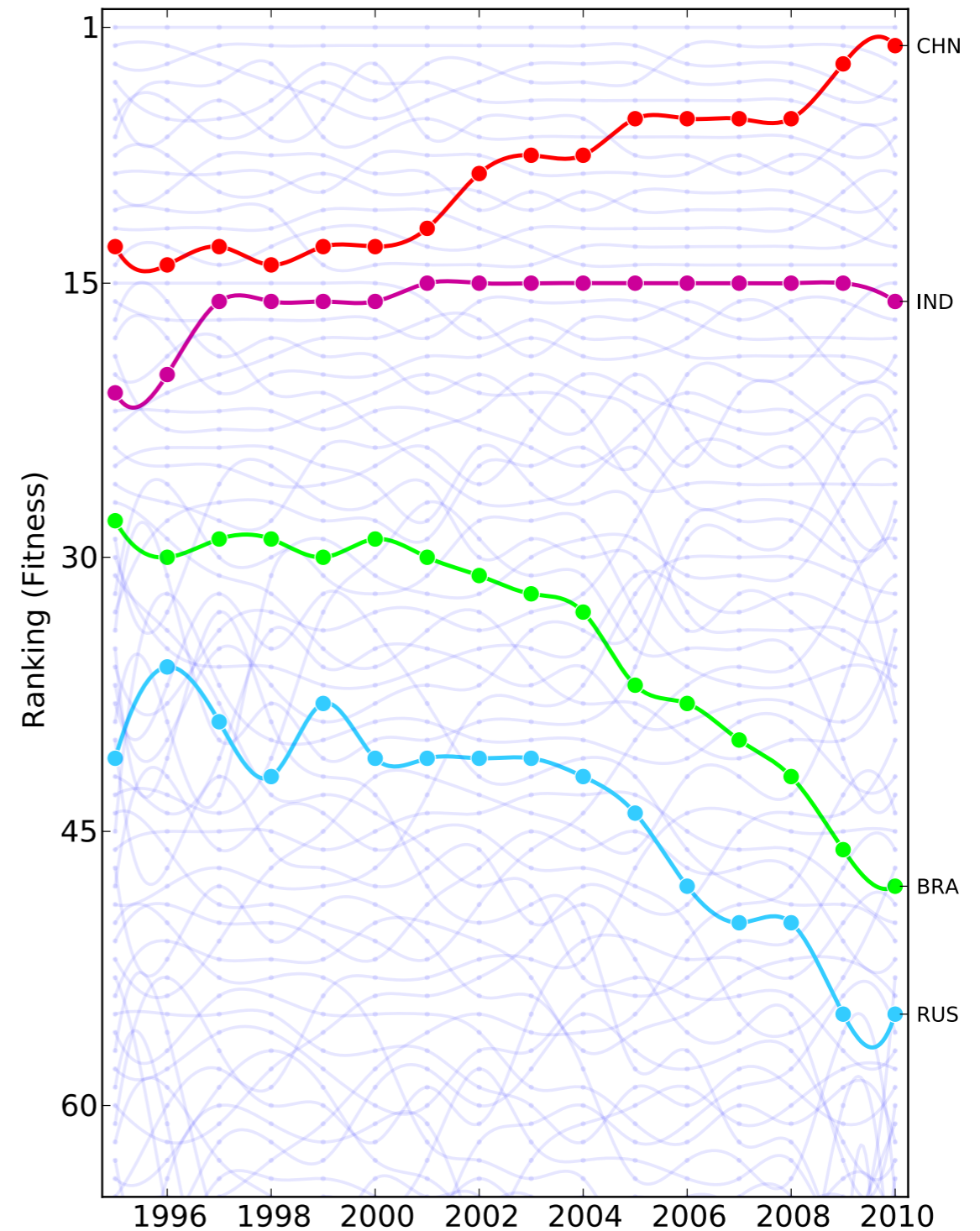
BRIC – Time Evolution (1995–2010)

GDP is not enough

GDP



Fitness



Key challenge 2

how to forecast
economic growth

**SCIENTIFIC GROUNDING OF ECONOMIC
PREDICTION**

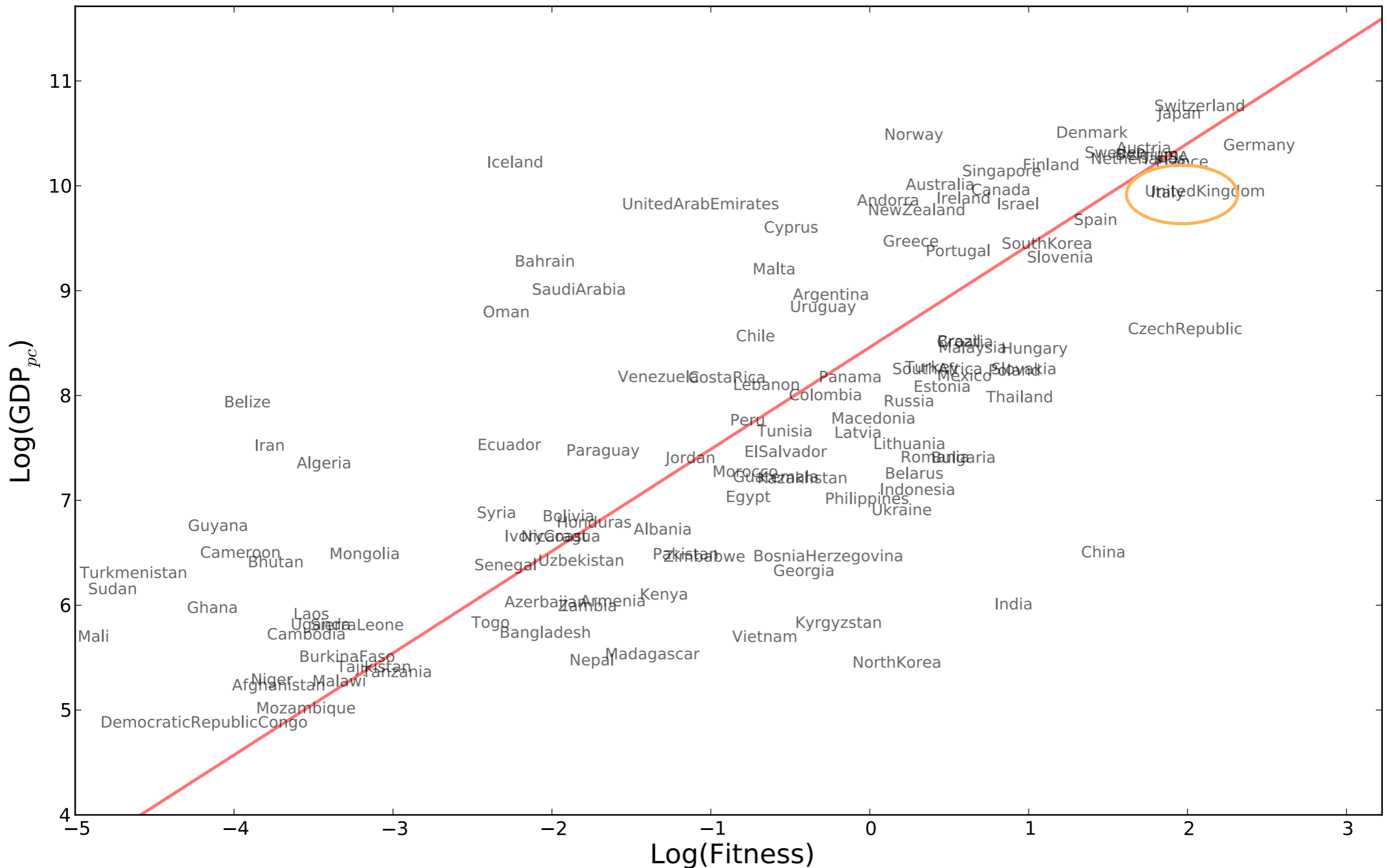
(beyond std tools and Reinhart and Rogoff excel-gate)

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

FITNESS vs GDP_{pc}

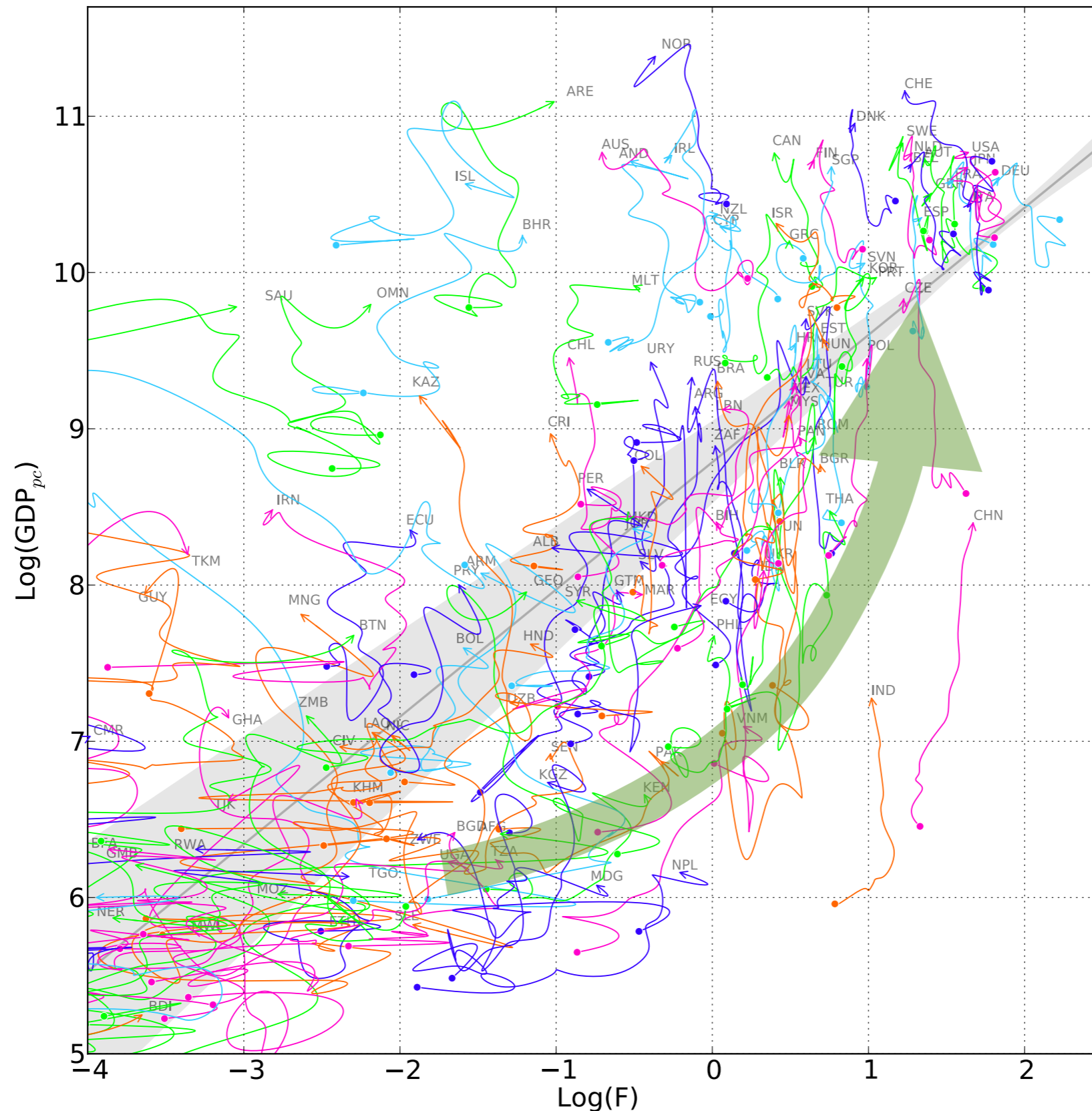
Red Line: average trend, NOT a regression

“HOW MUCH YOU EARN”

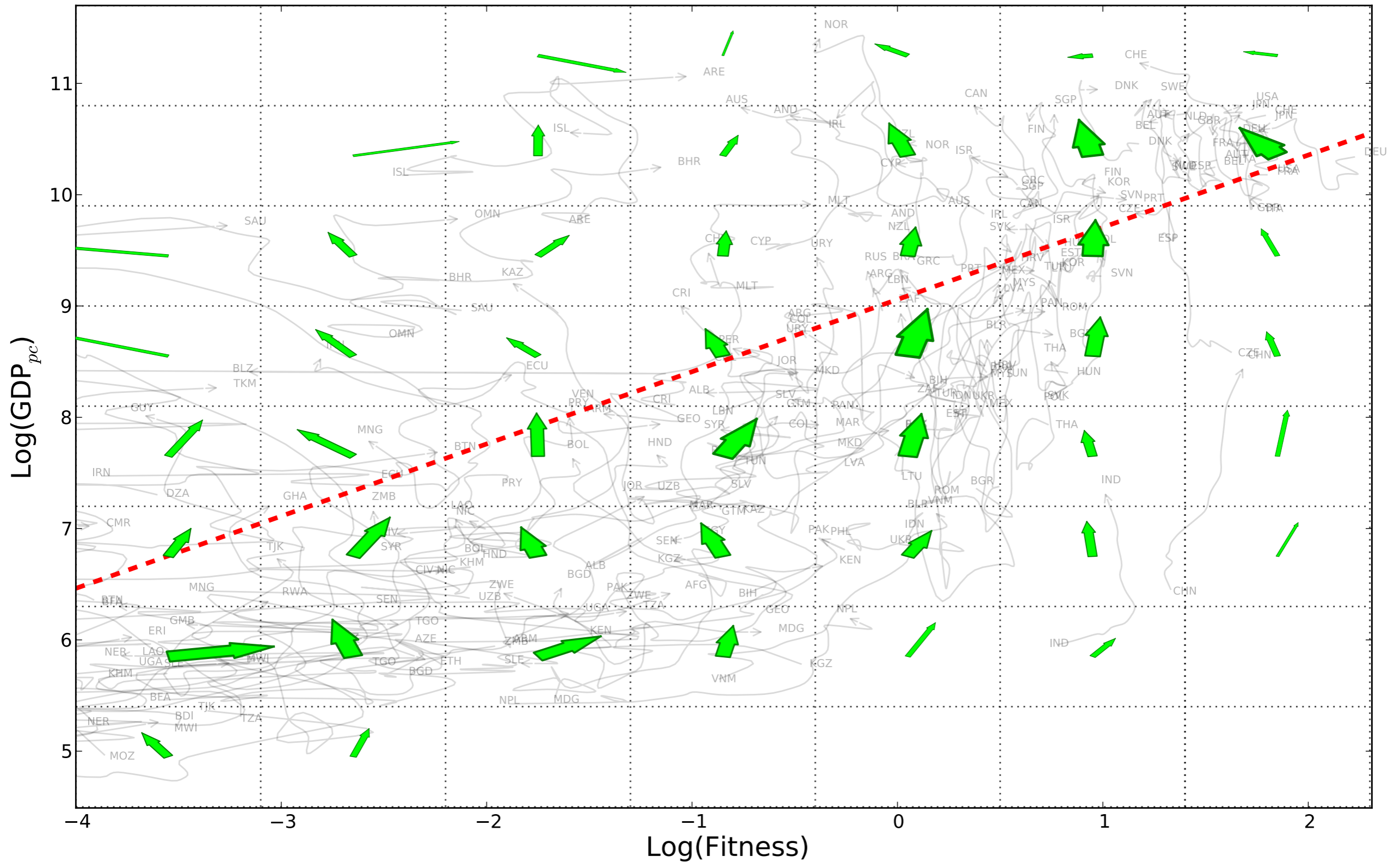


“HOW GOOD YOU ARE”

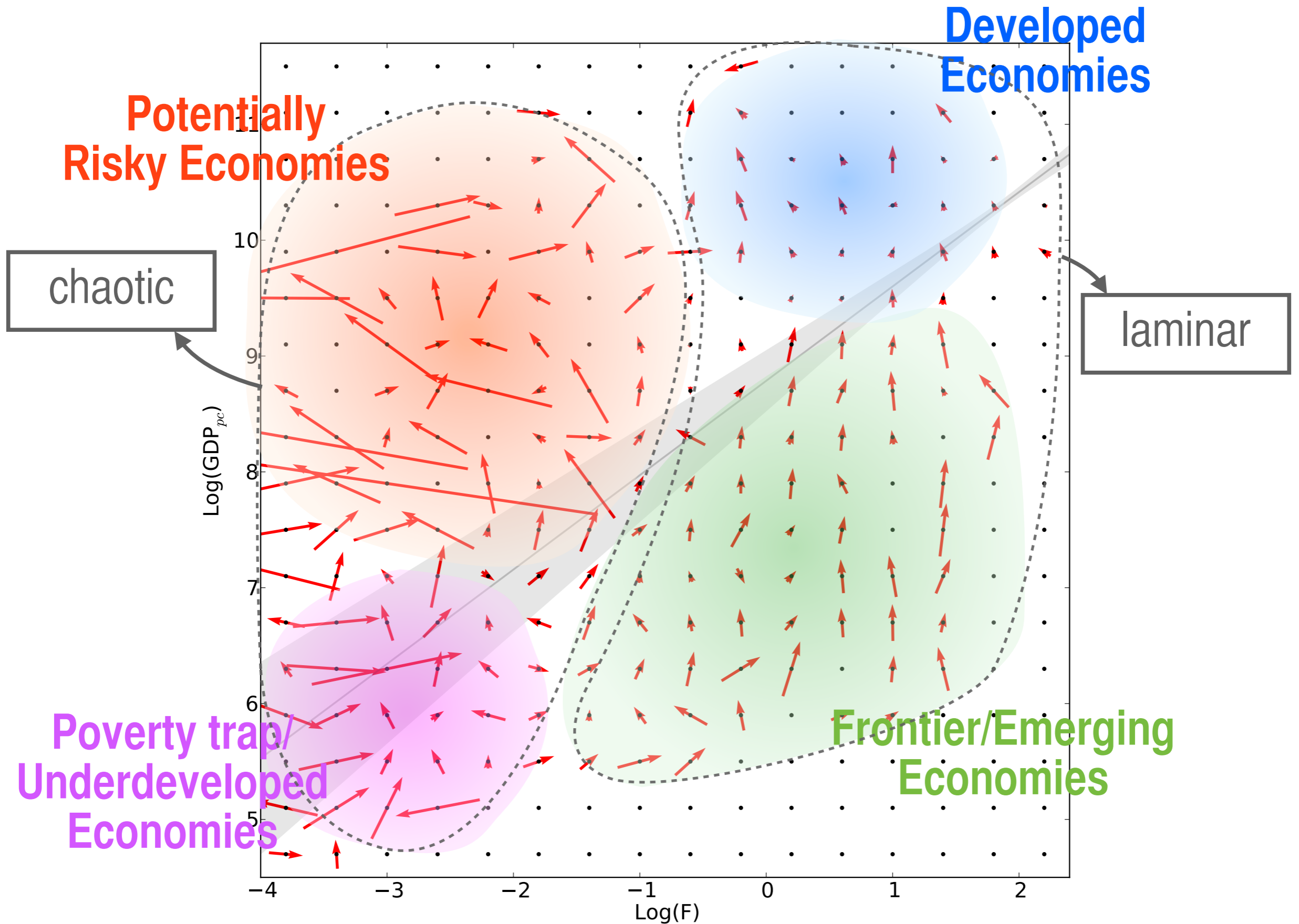
Collective dynamics ... a mess but not everywhere



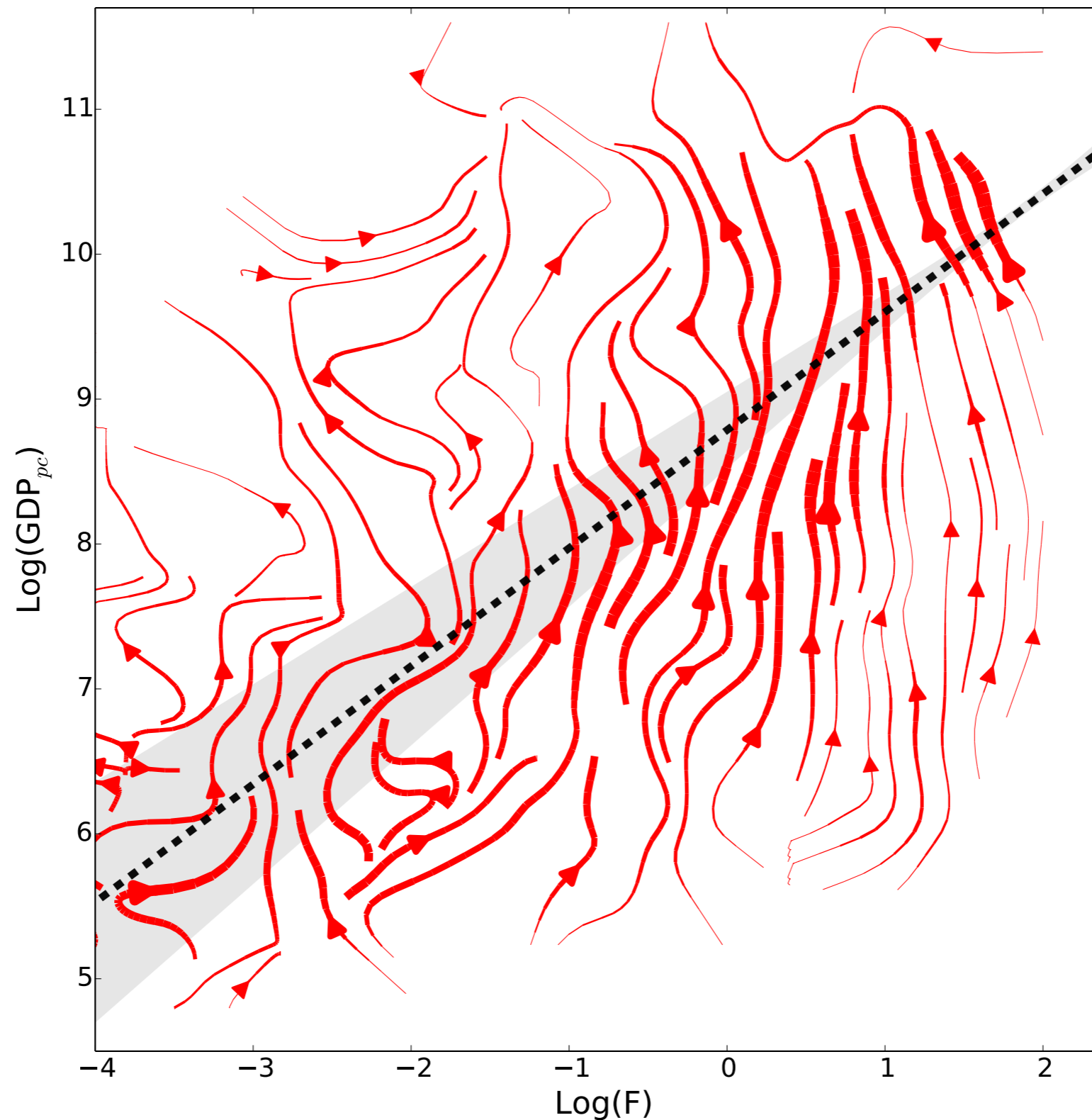
Weather-like forecast



Weather-like forecast: Heterogeneous dynamics



Weather-like forecast: Heterogeneous dynamics



Borrowing concepts from dynamical systems

Laminar regime

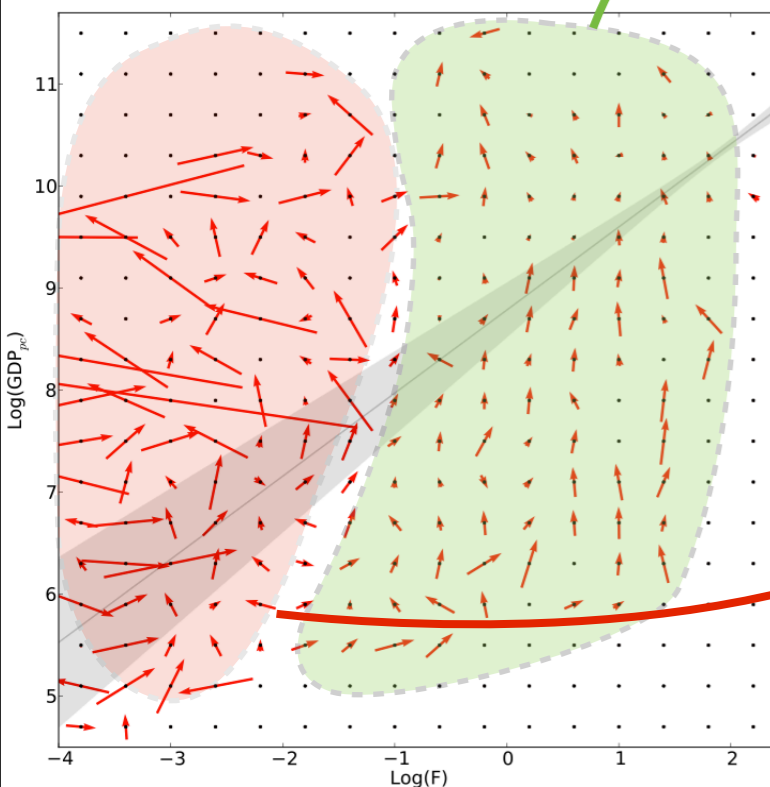
Low effective dimension ($d_e \approx 2$)

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

Chaotic regime

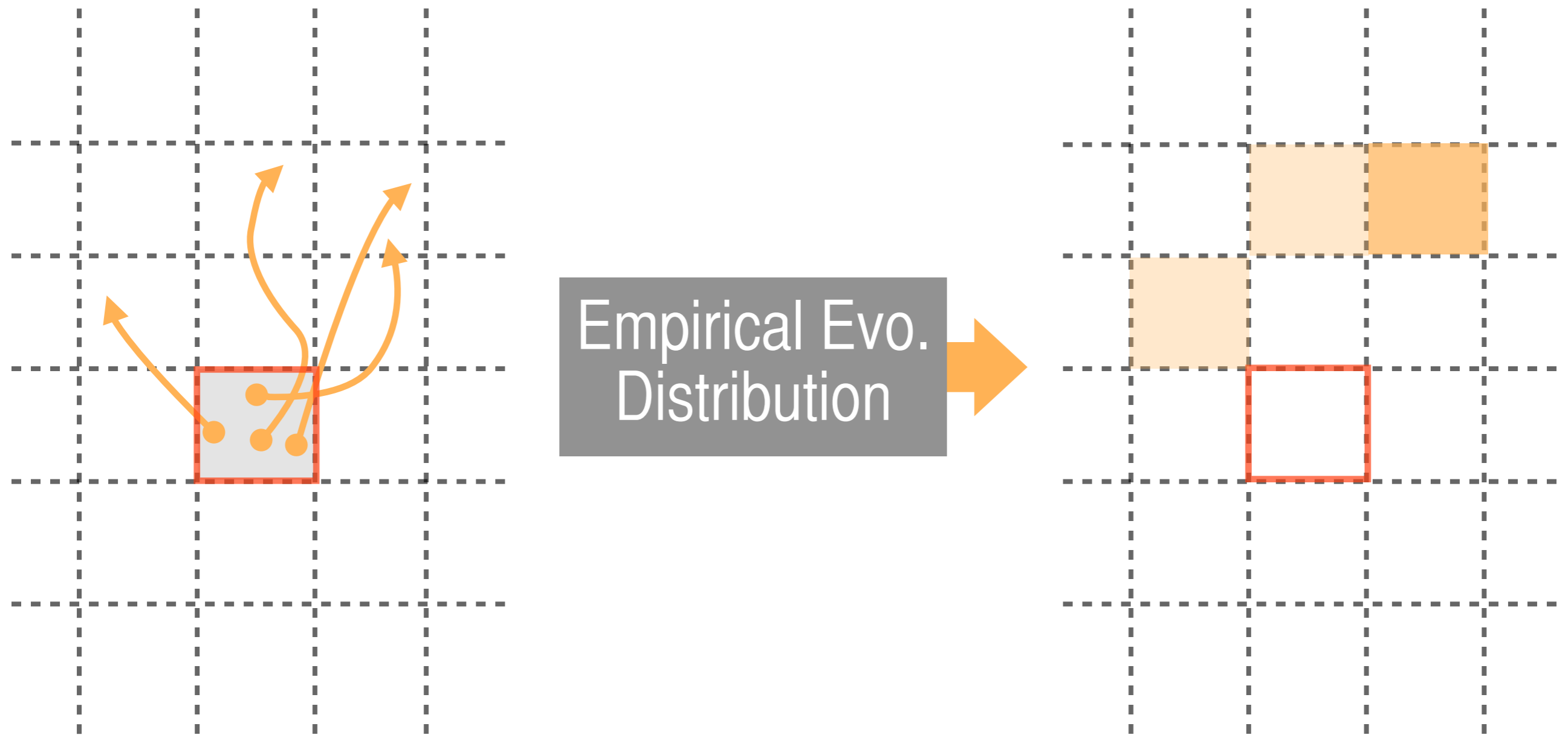
Chaotic dynamics OR $d_e \gg 2$

Dynamics is ruled by several other exogenous factors competing with Fitness

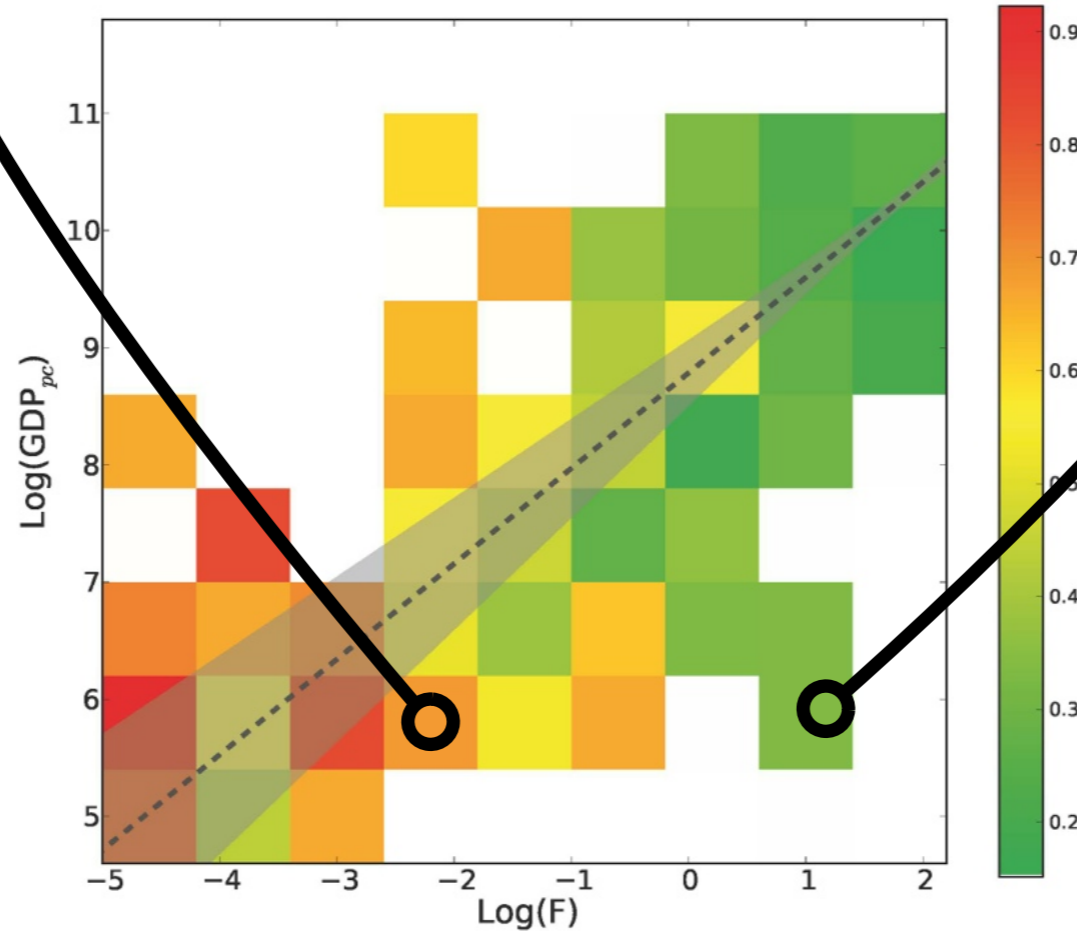
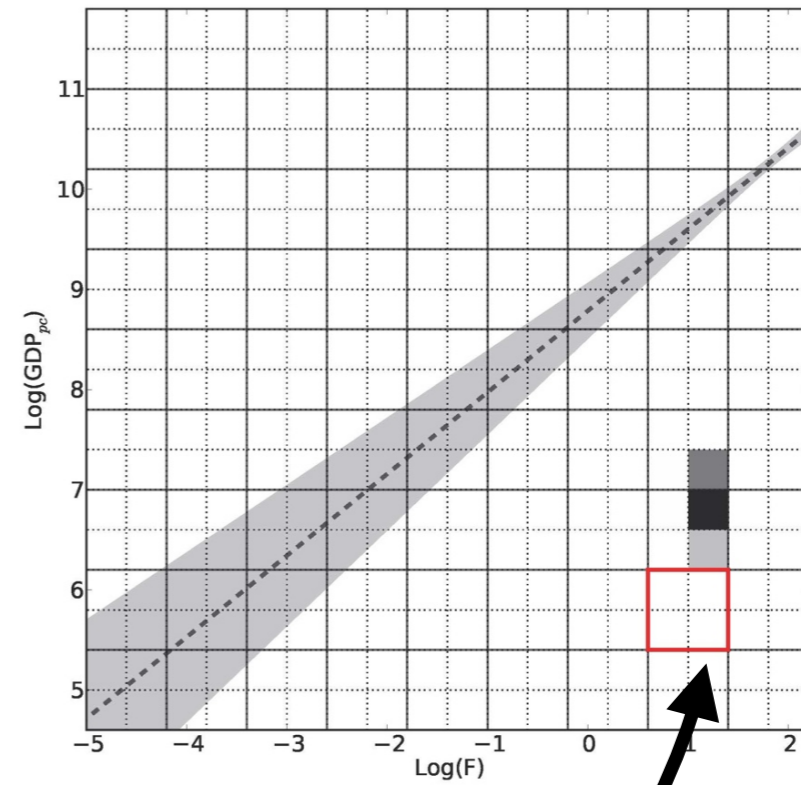
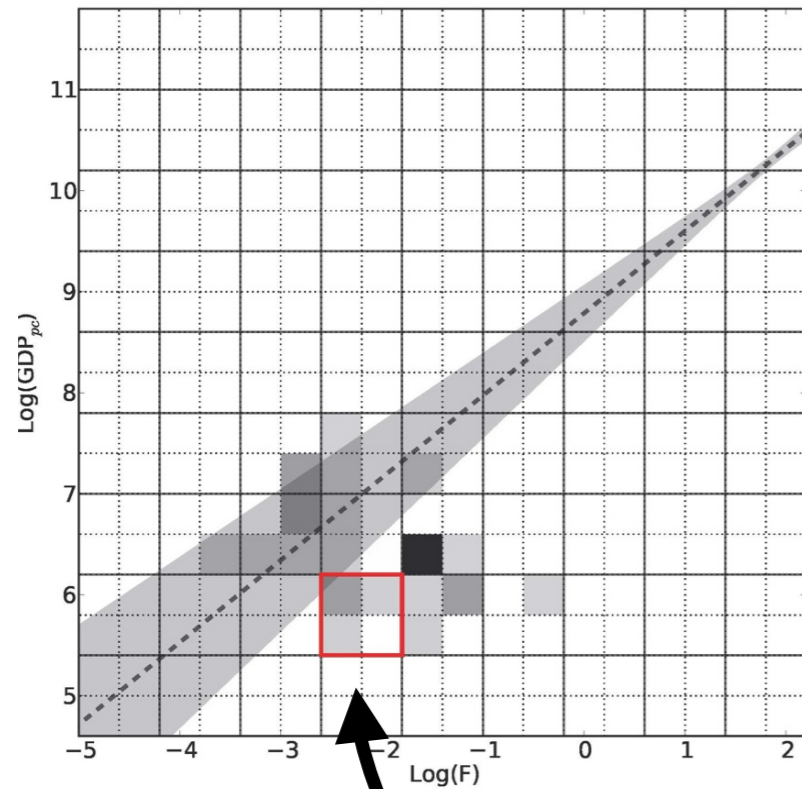


SELECTIVE PREDICTABILITY

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



the *Selective Predictability* Scheme



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

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



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}



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

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



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/PIgroup_Economic_Complexity/Home.html

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

NATIONAL STRATEGY FOR SWEDEN

FROM WEALTH TO WELL-BEING

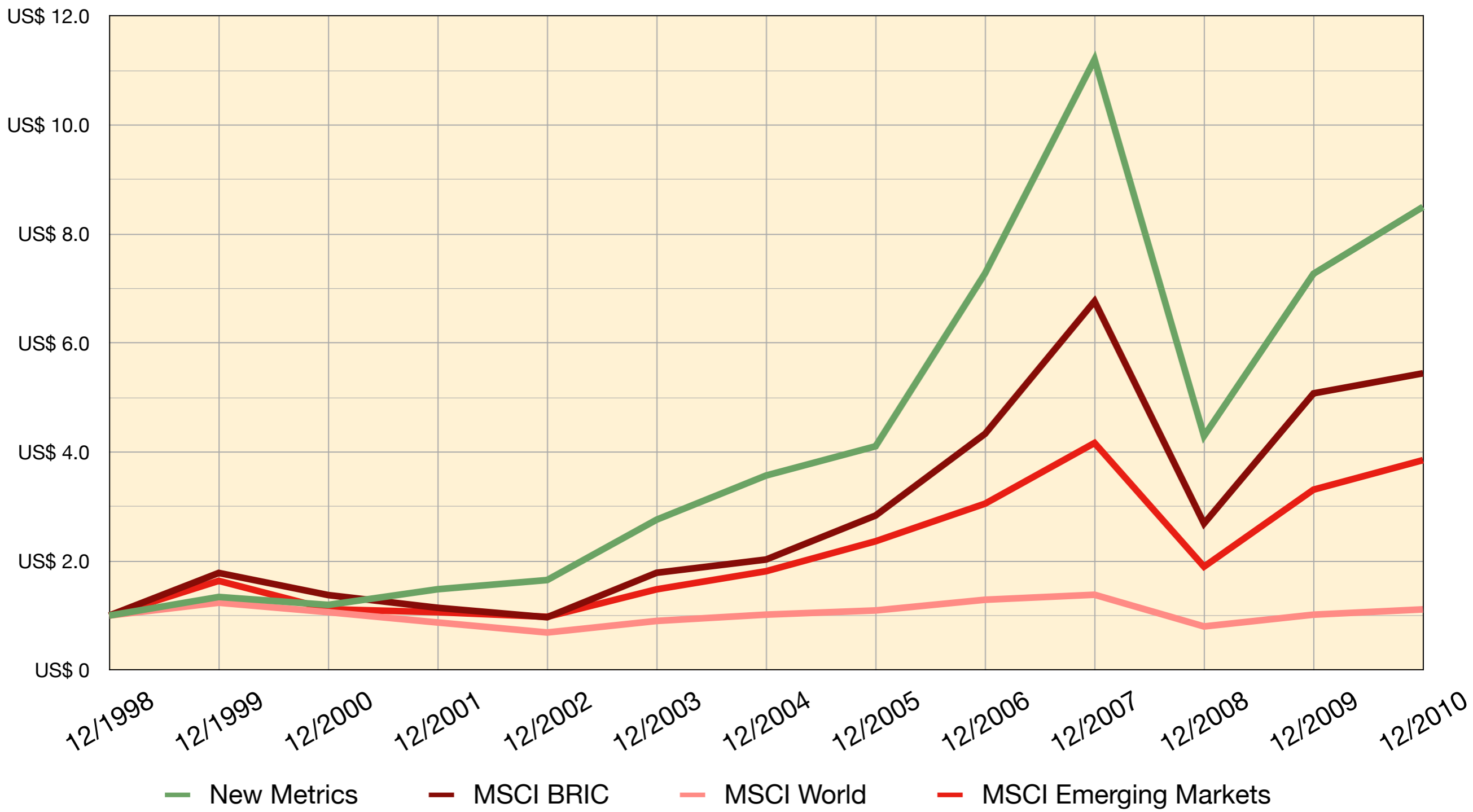


BCG

THE BOSTON CONSULTING GROUP

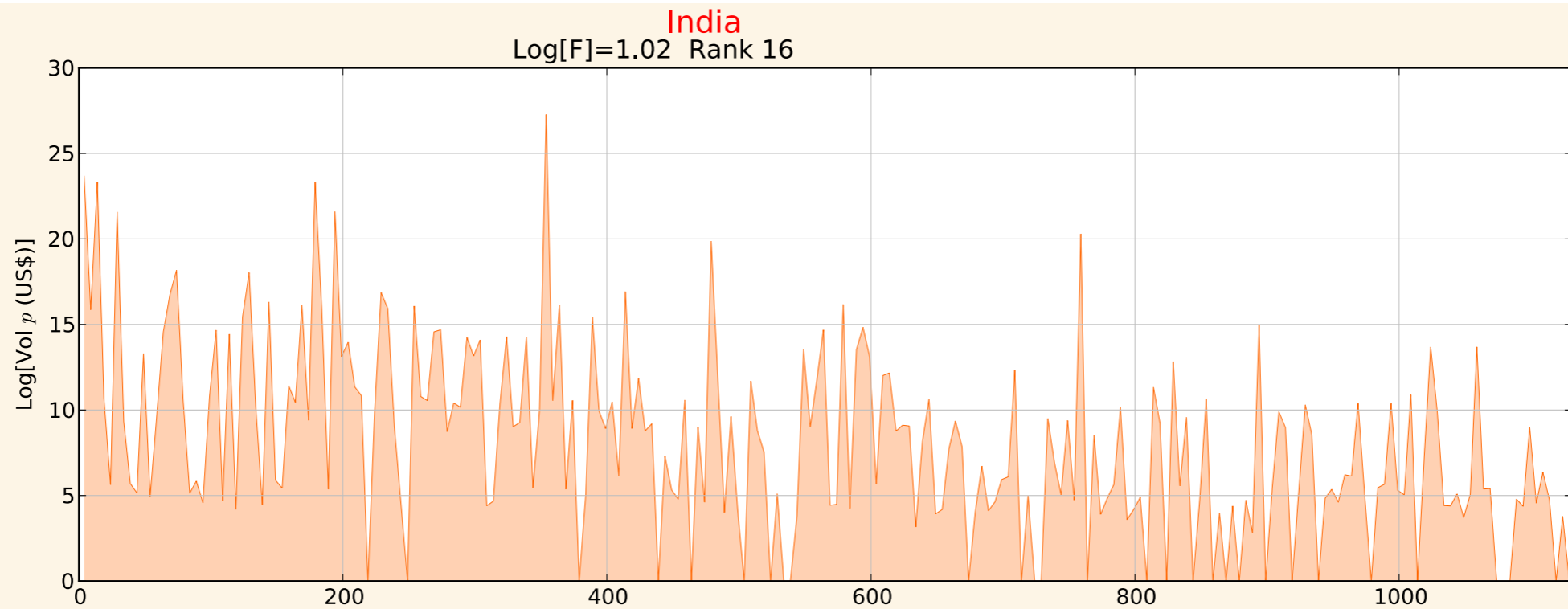
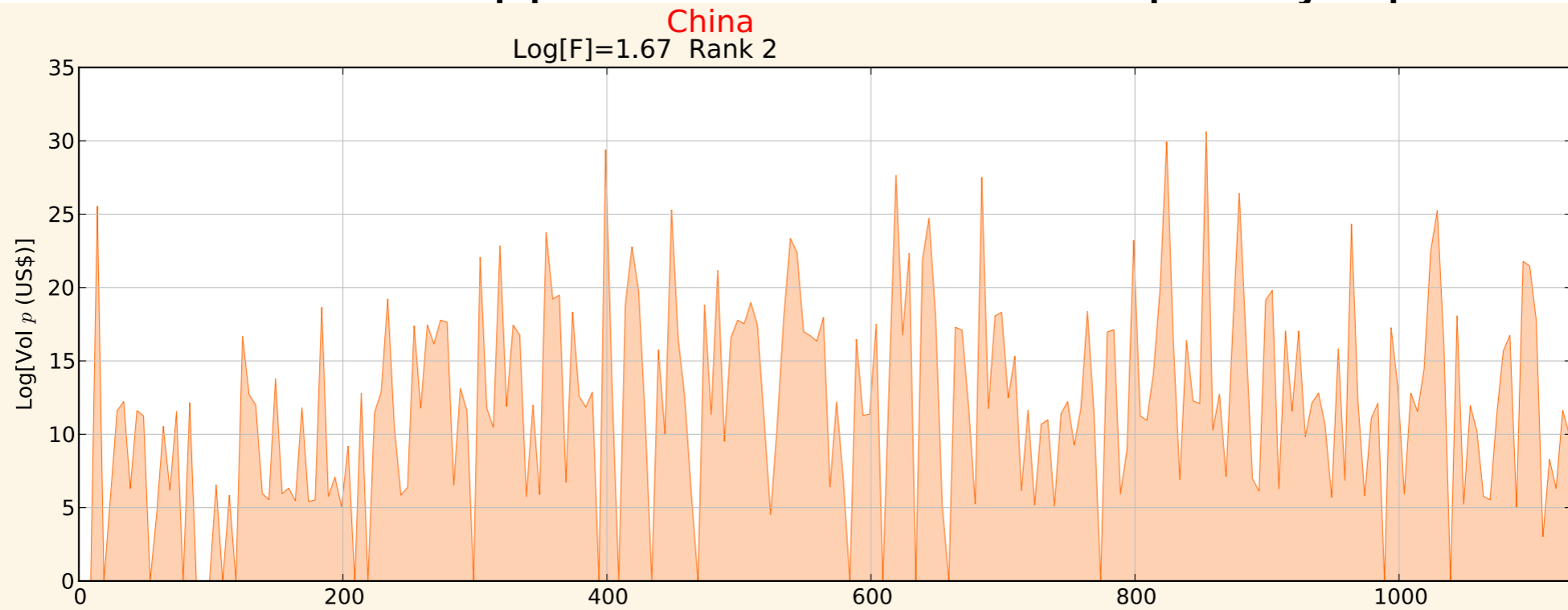
BCG report for Sweden Government (2013)

*Similar analysis for UK
in preparation*



Country *spectroscopy*

Products appear clustered in Complexity Space



Country *spectroscopy*

Products appear clustered in Complexity Space

