

The Heterogeneous Dynamics of Economic Complexity

Quantitative macro economic scenarios for long term country growth

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Which will be the growth of China, USA, and Vietnam in next 3, 5 or 10 years?

Despite this kind of question has a large societal impact and an extreme value for economic policy making, how to provide a scientific basis for economic predictability is still a very challenging problem.



Shanghai 1990



Bangkok 1988



Shanghai 2010



Bangkok 2007



Sub Saharan Africa



Russia



Italy



USA

Is a **linear fit** the right tool?

$$\text{Growth} = c + aX_1 + bX_2 + cX_3 + \dots$$

“If you don't like the **weather** in New England
now, just wait a few minutes”

– Mark Twain

Wind map

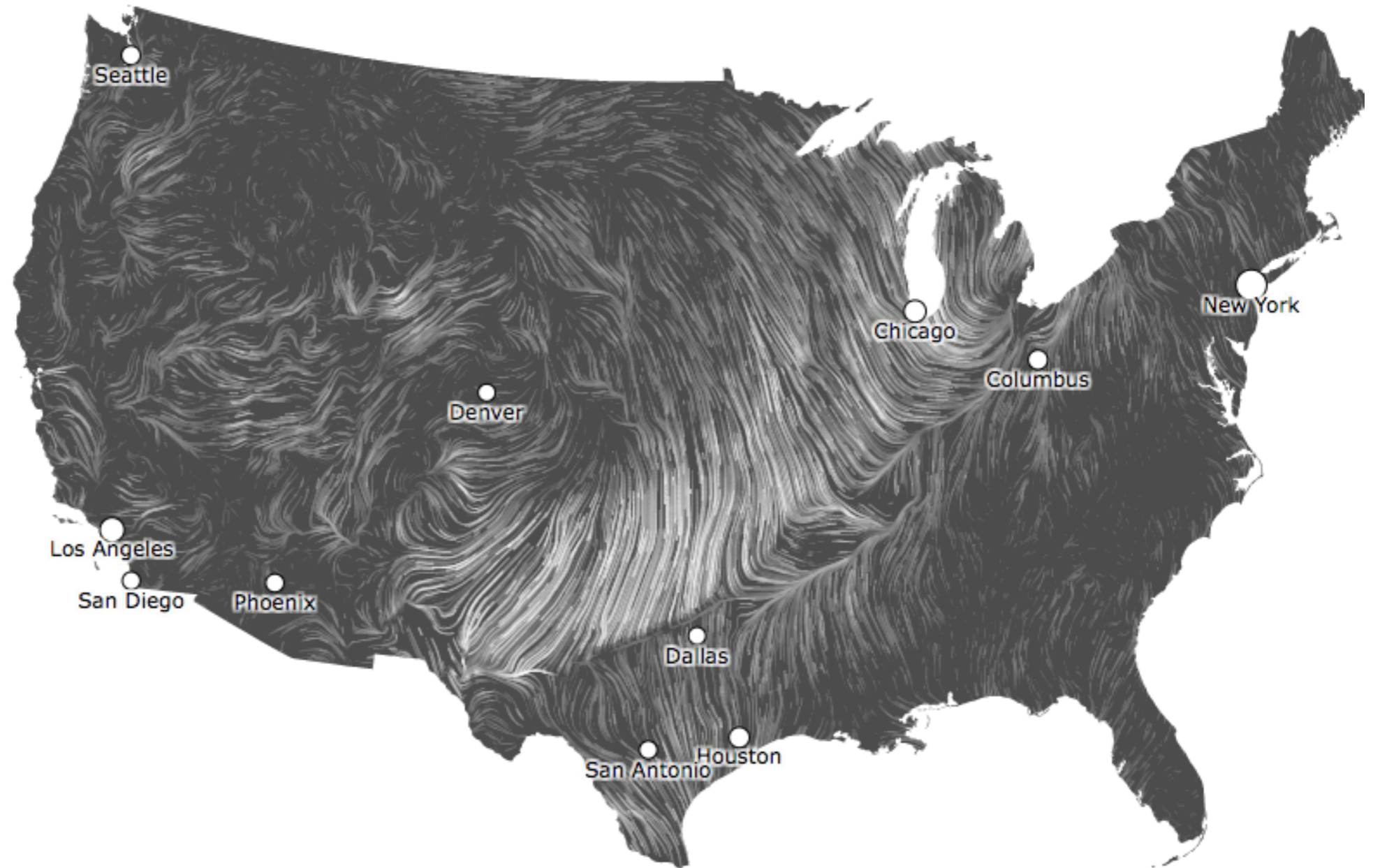
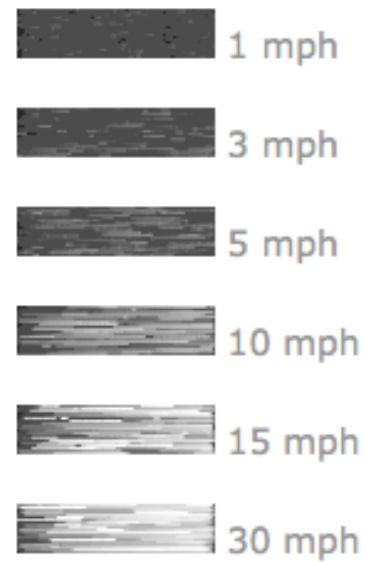
Sept. 7, 2012

8:59 pm EST

(time of forecast download)

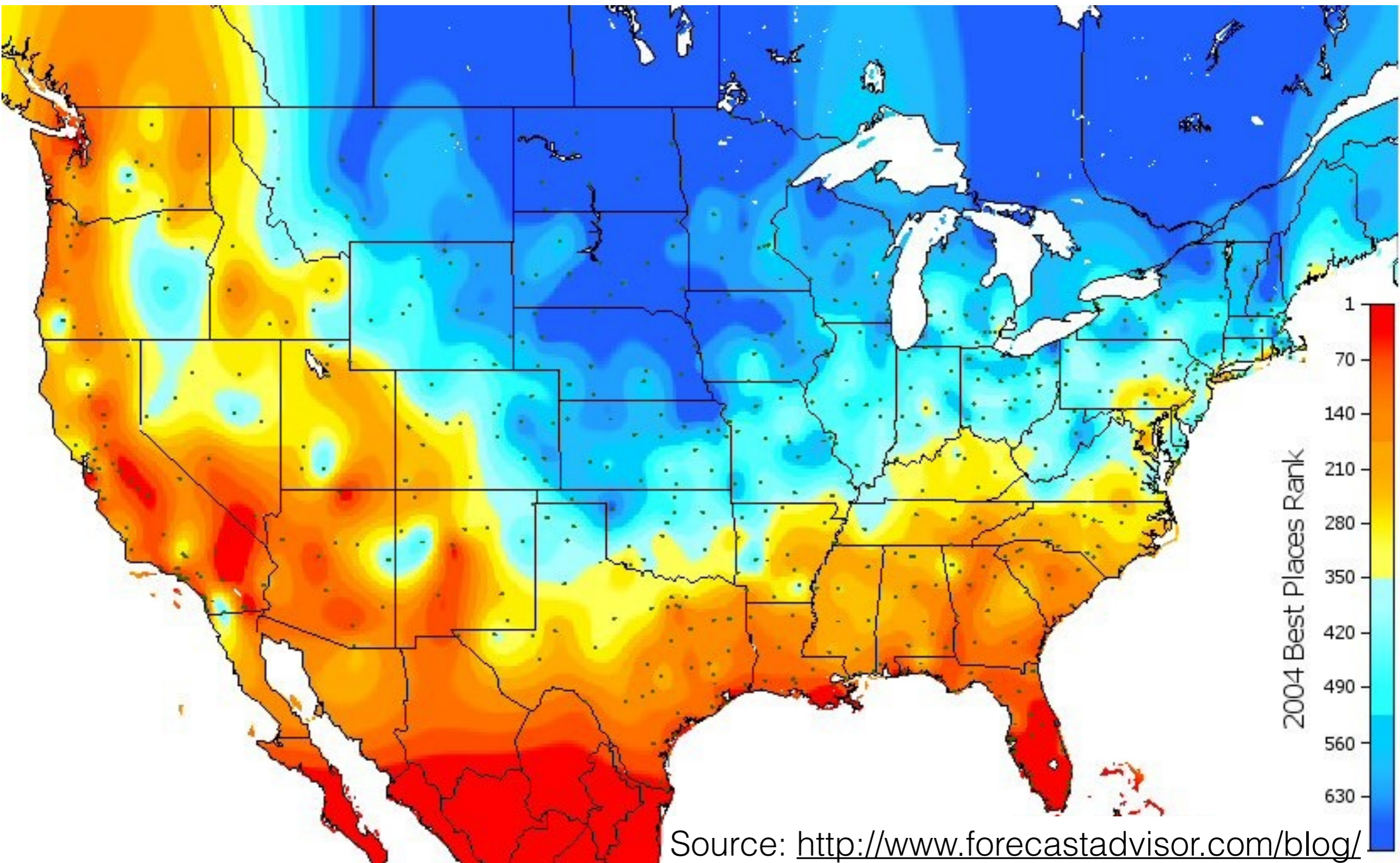
top speed: **26.2 mph**

average: **5.7 mph**



Source: <http://hint.fm/wind/index.html>

How reliable is weather forecasting ?

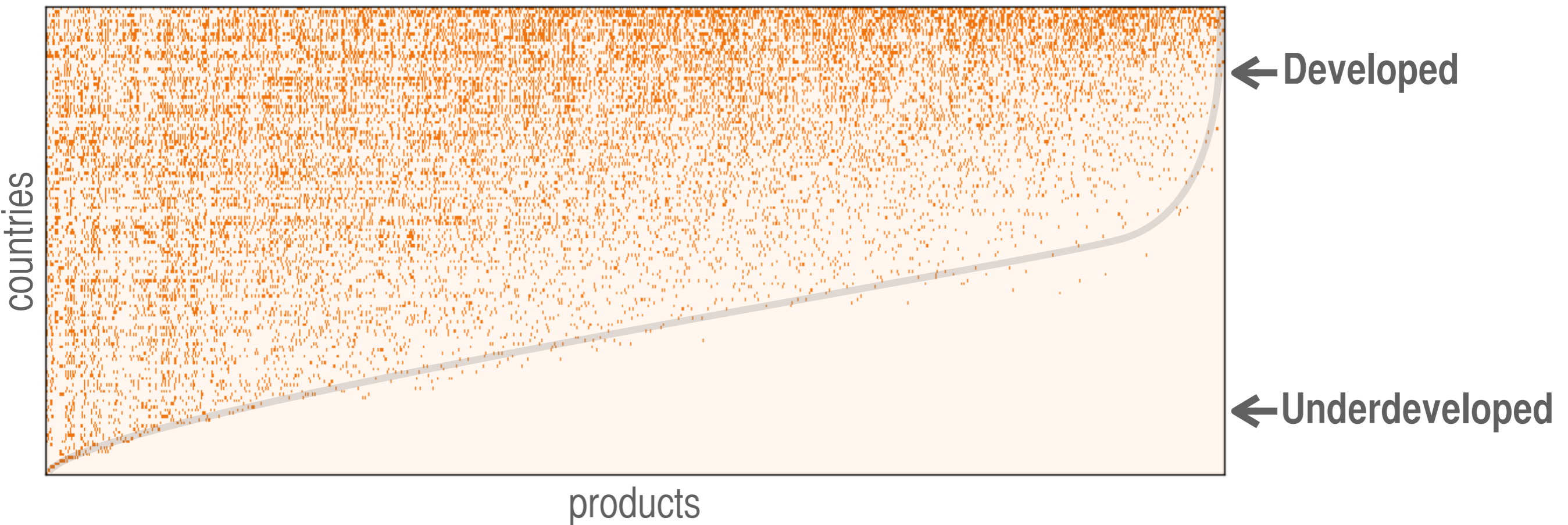


Source: <http://www.forecastadvisor.com/blog/>

“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*

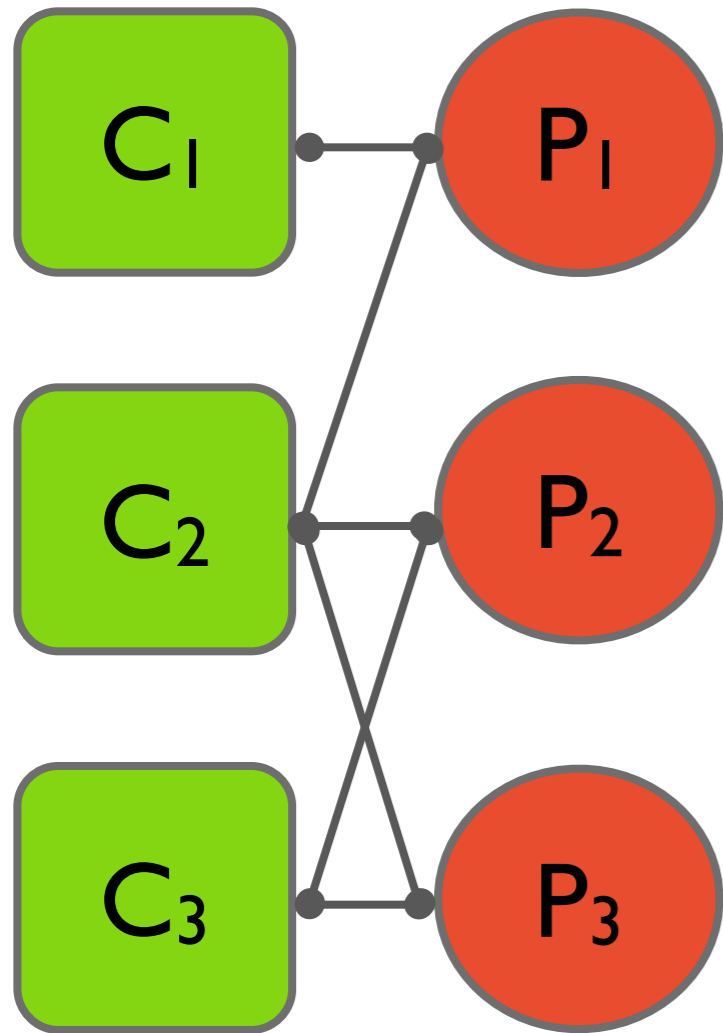
Most diversified countries are the most competitive countries!



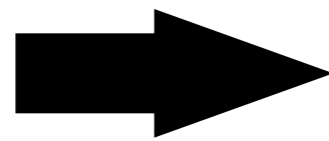
Products **discount** the information stored in country capabilities

Countries

Products



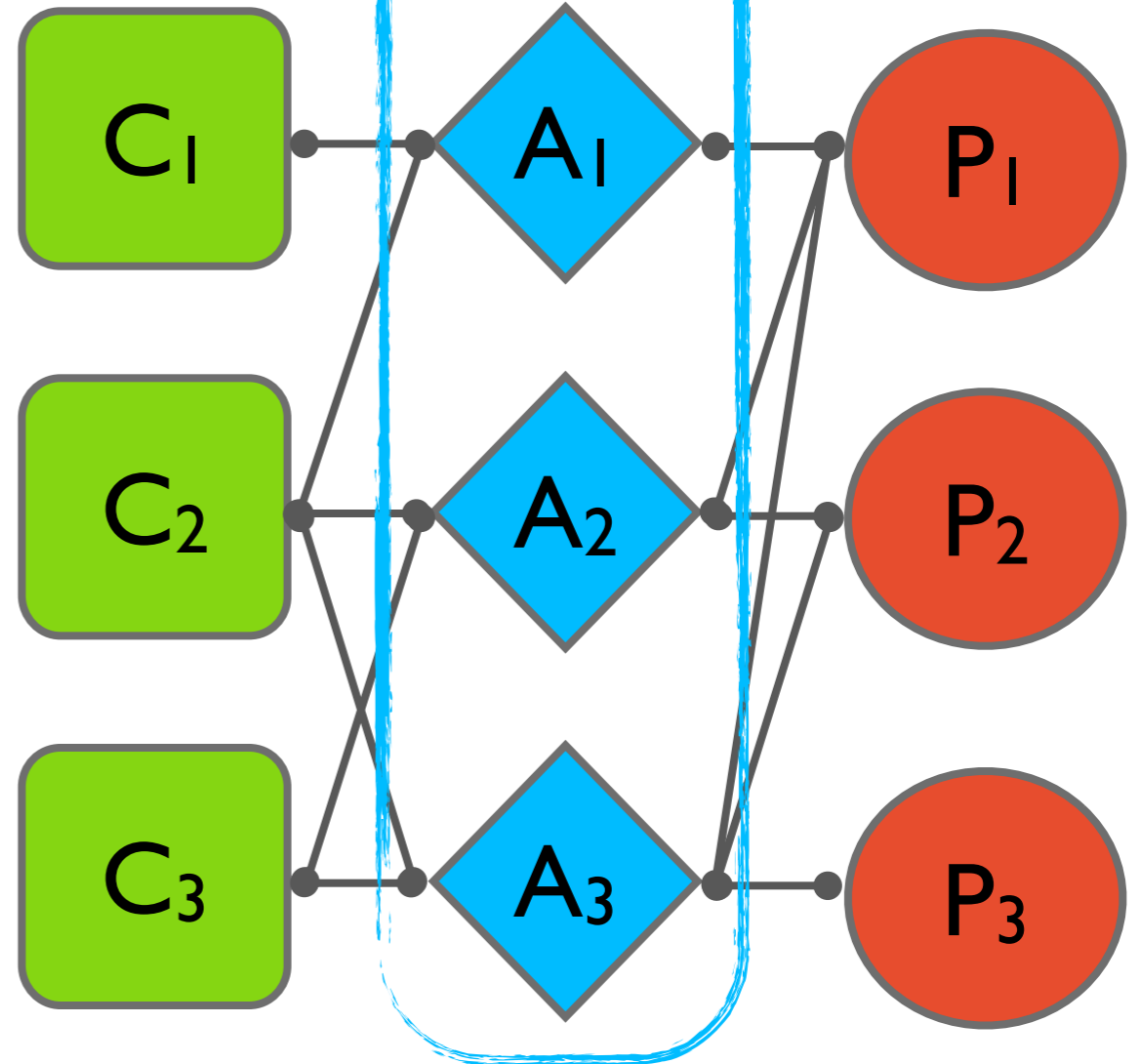
Available Data



Countries

Capabilities

Products



Model

MEASURING INTANGIBLE PROPERTIES

New metrics for **Fitness** of countries and **Complexity** of products

Fitness

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

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

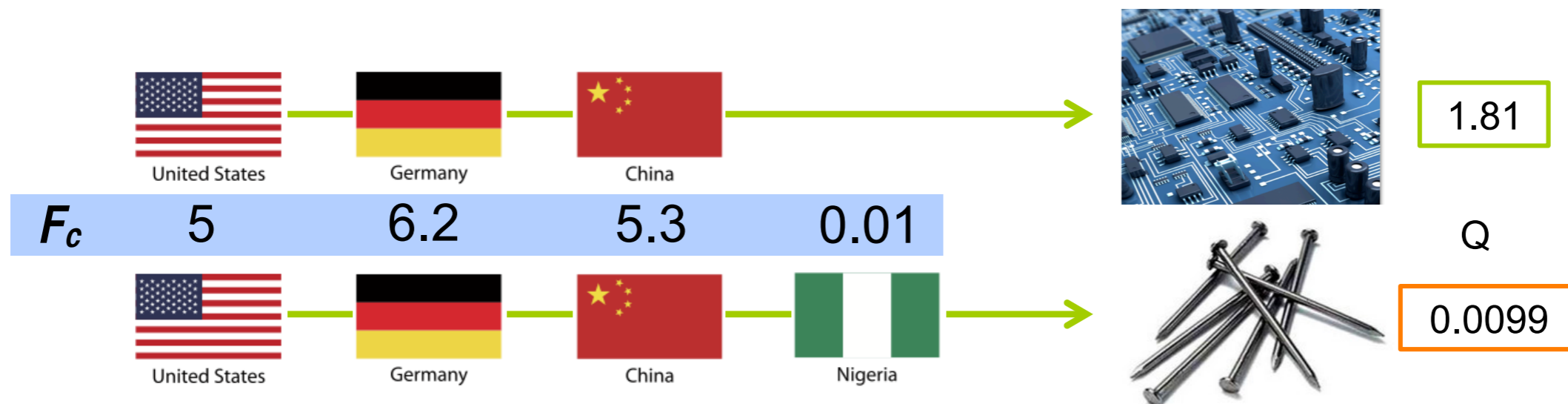
Complexity

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

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

F_c : diversification weighted by complexity

Q_p : Extremal non-linear complexity of products
a single low fitness producer implies low complexity

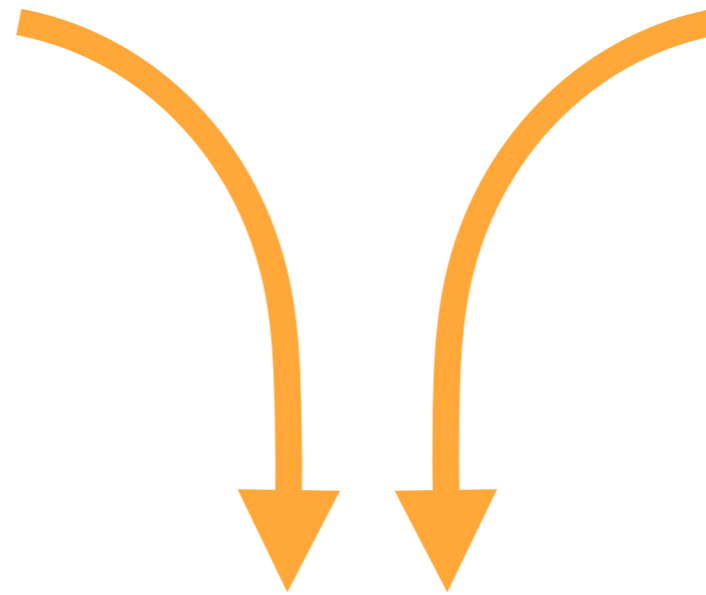


Measuring the intangibles, but what for?

These metrics can provide a fundamental
analysis of the hidden potential of growth
for countries

Monetary measures

Metrics for intangibles



NEW INFORMATION

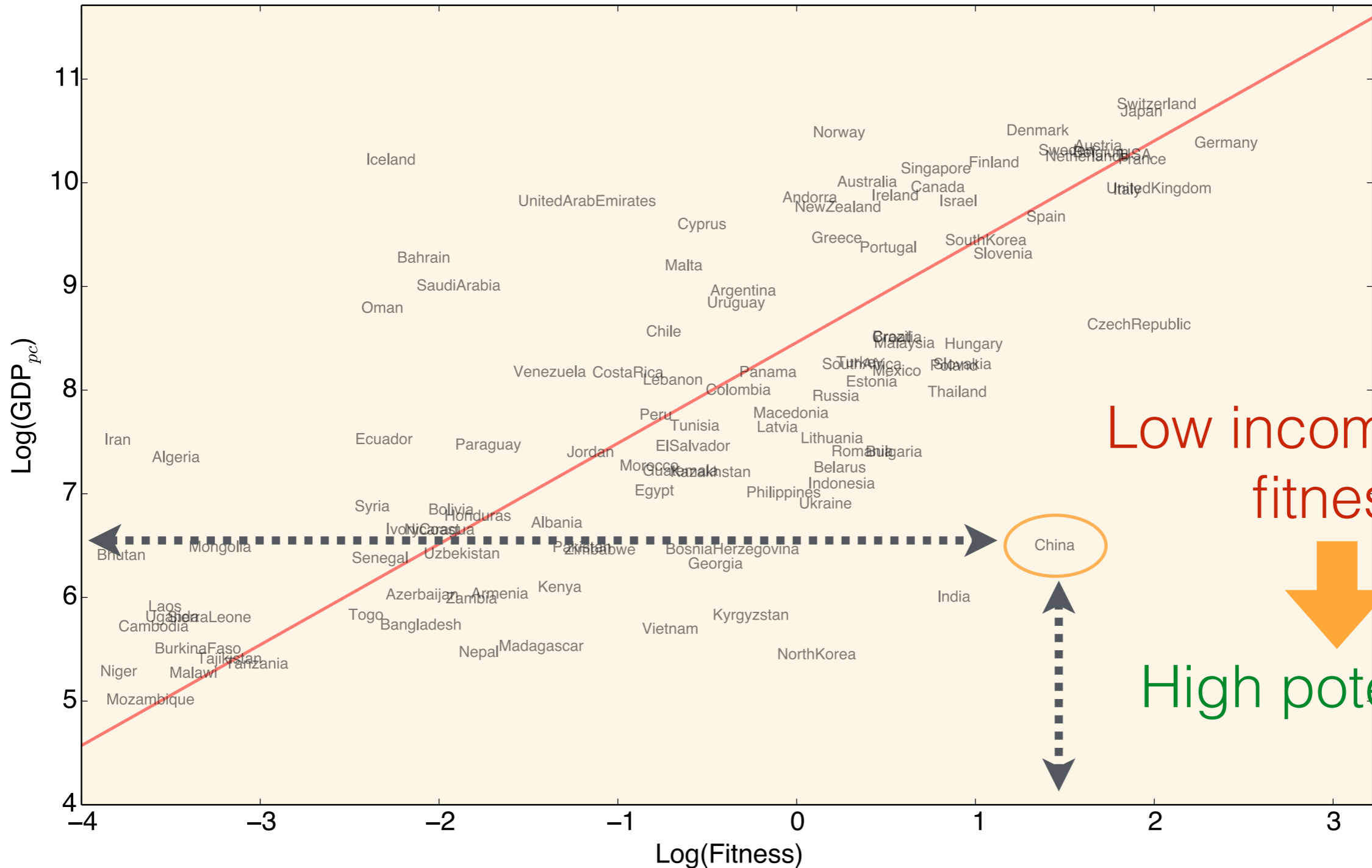
M. Cristelli, A. Tacchella, L. Pietronero, The Heterogenous Dynamics of Economic Complexity (under review)

M. Cristelli, A. Tacchella, L. Pietronero, Economic Complexity: Measuring the Intangibles (ebook)

FITNESS vs GDP_{pc} - 1995

Red Line: average trend, NOT a regression

“HOW MUCH YOU EARN”

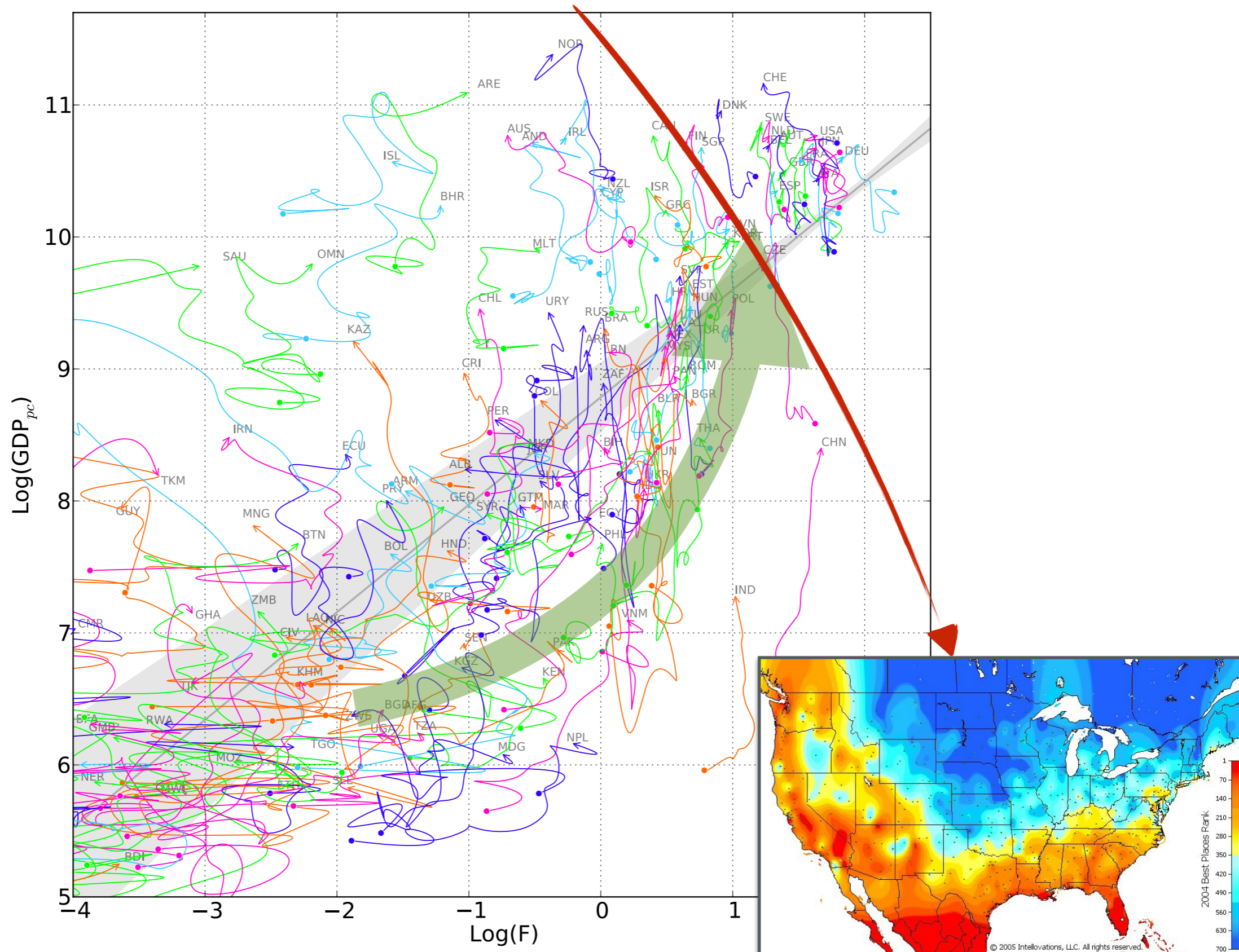


Low income, high fitness

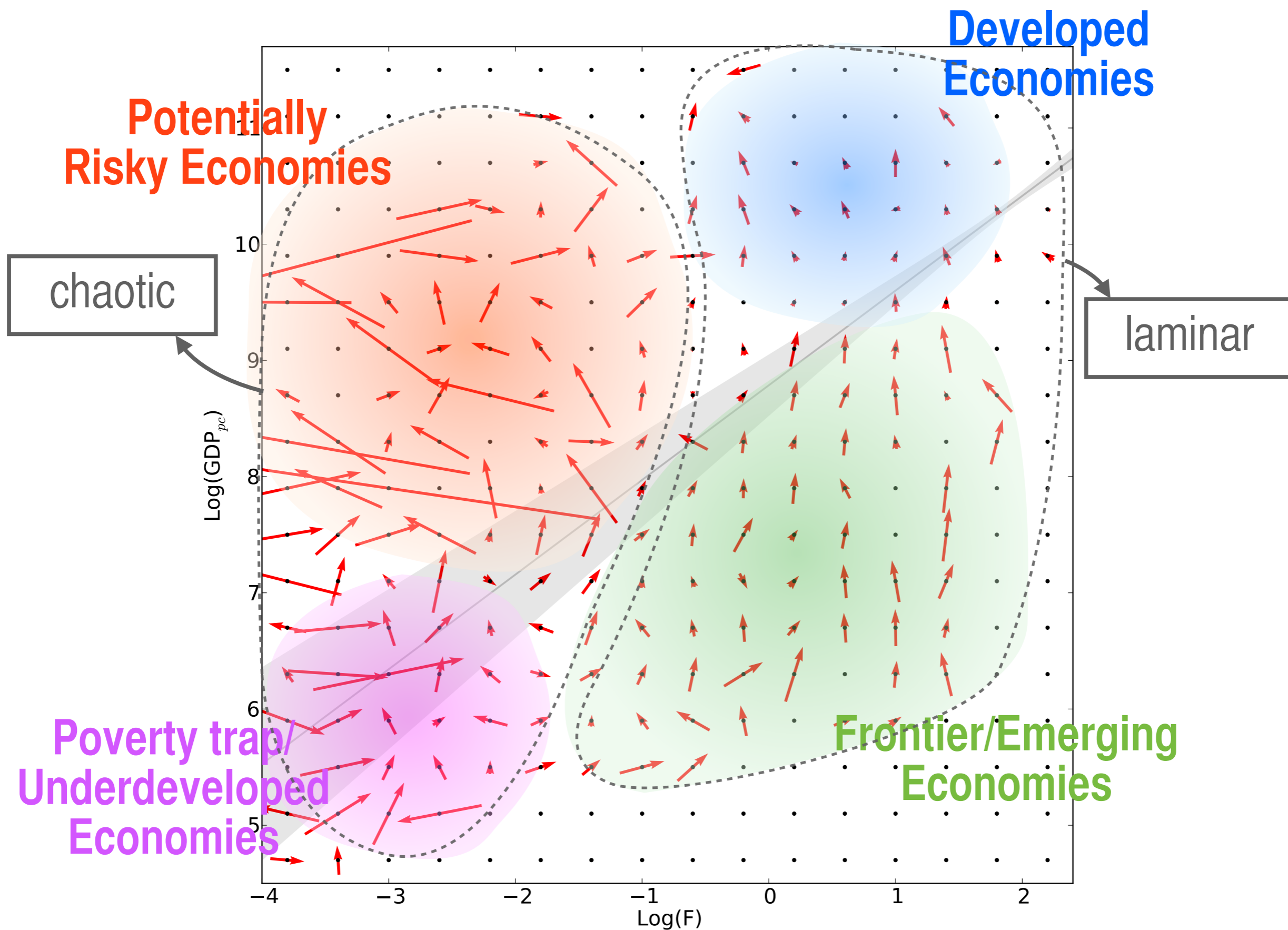
High potential?

“HOW GOOD YOU ARE”

Collective dynamics ... apparently a mess but not everywhere



Weather-like forecast: **Heterogeneous dynamics**



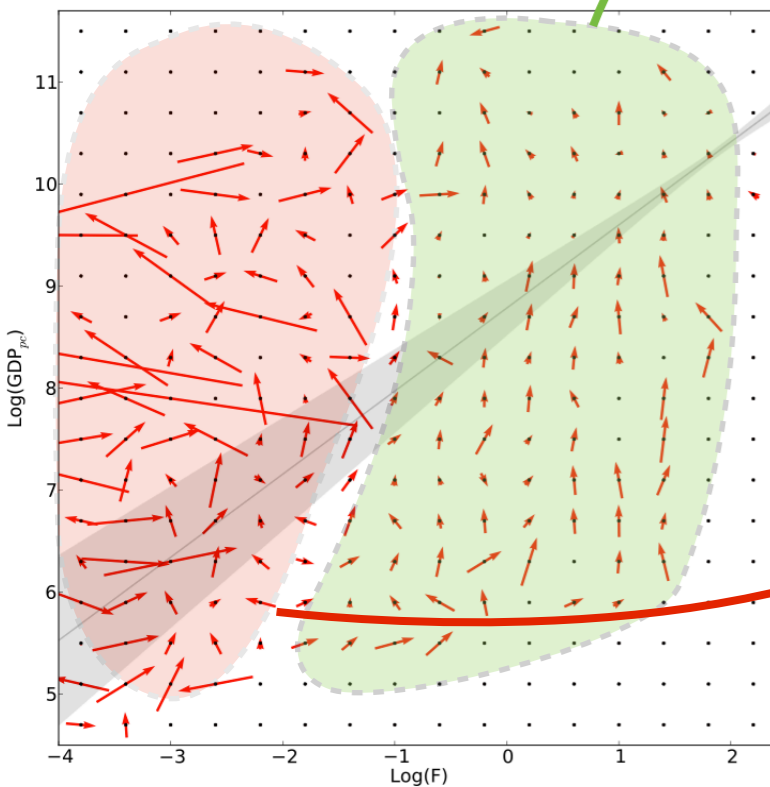
Forecasting country growth faces issues which are very close to the **problem of forecasting the evolution of dynamical systems** (i.e. atmosphere, climate, wind, ocean dynamics, weather, etc) when **the law of motions are unknown**

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

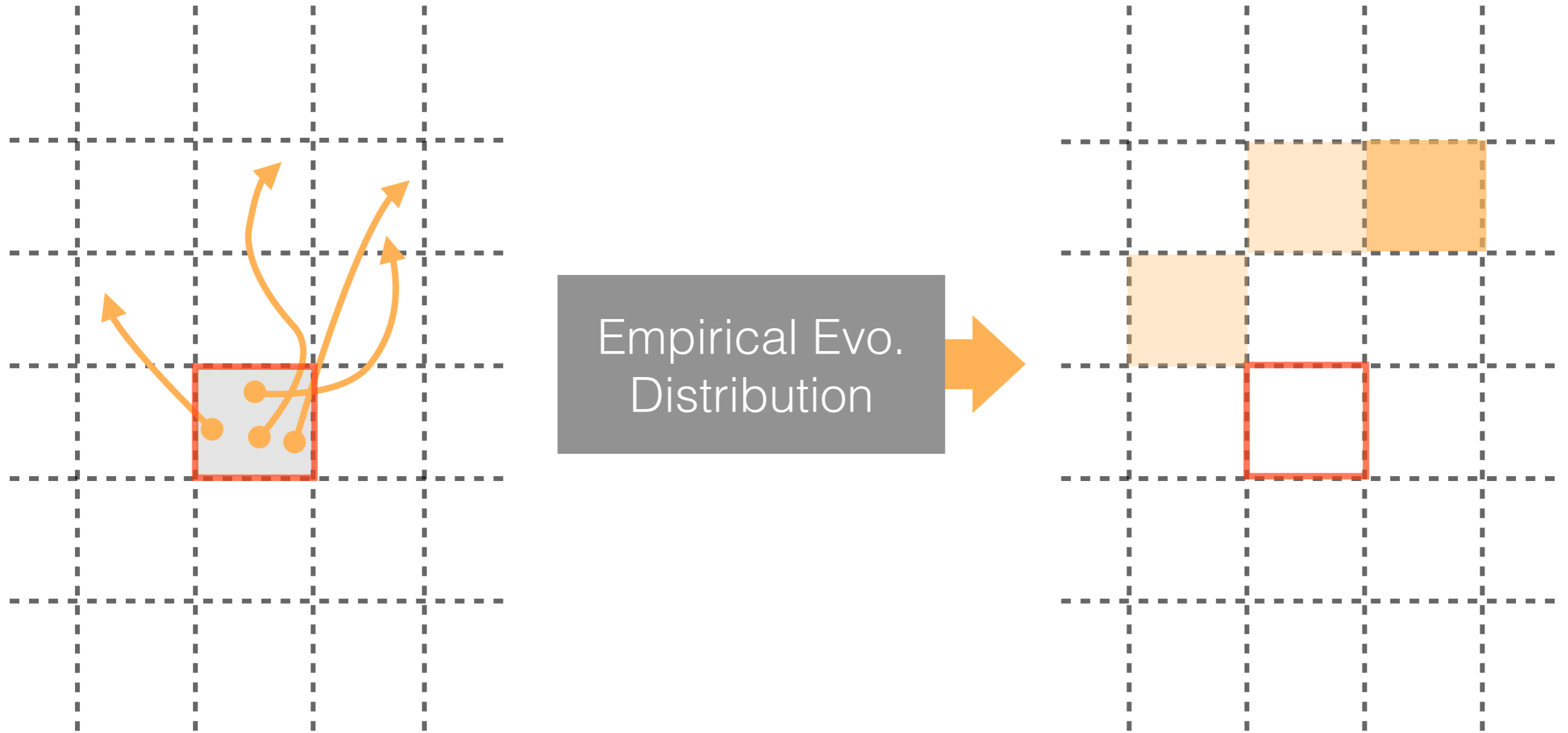
Chaotic dynamics OR $d_e \gg 2$

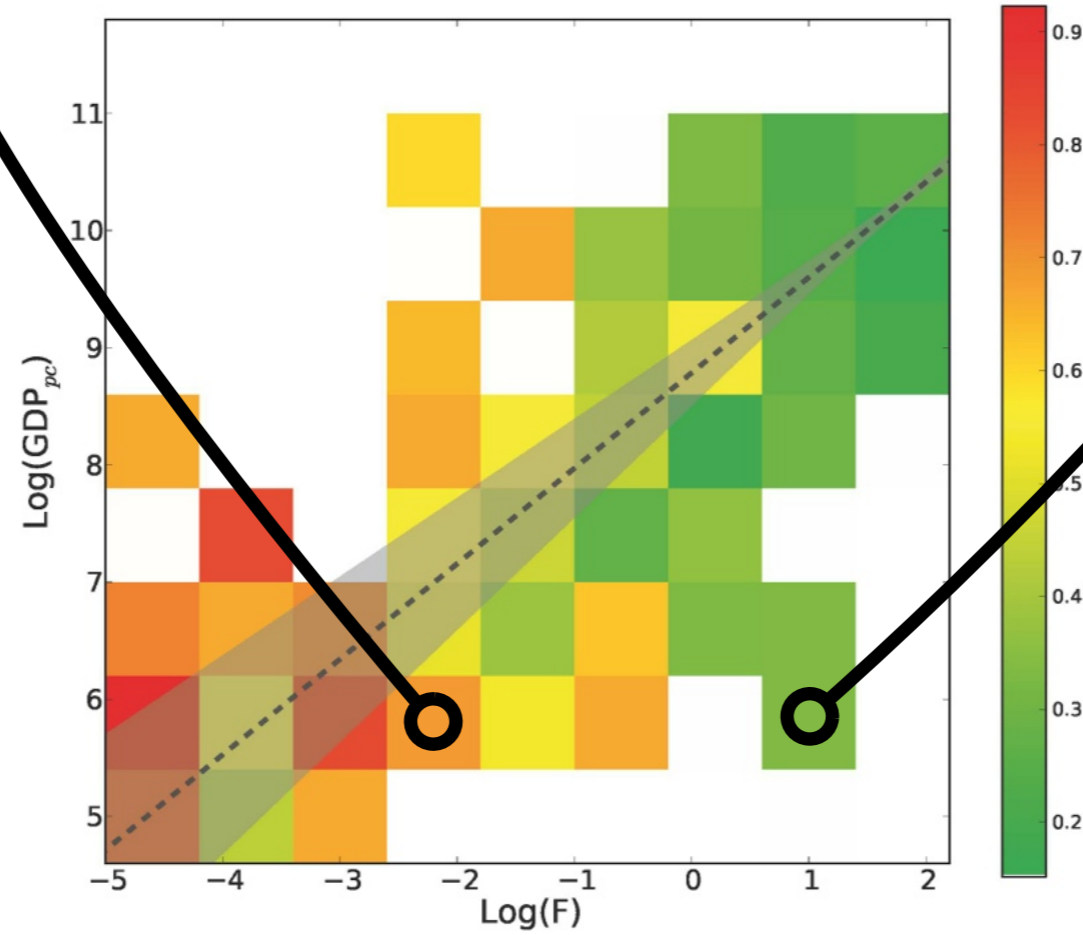
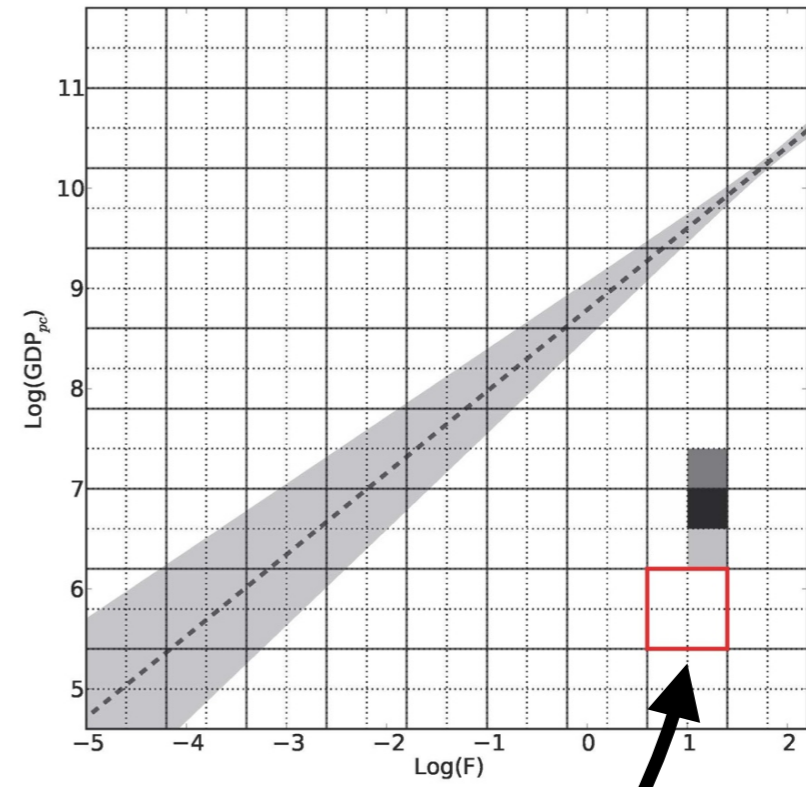
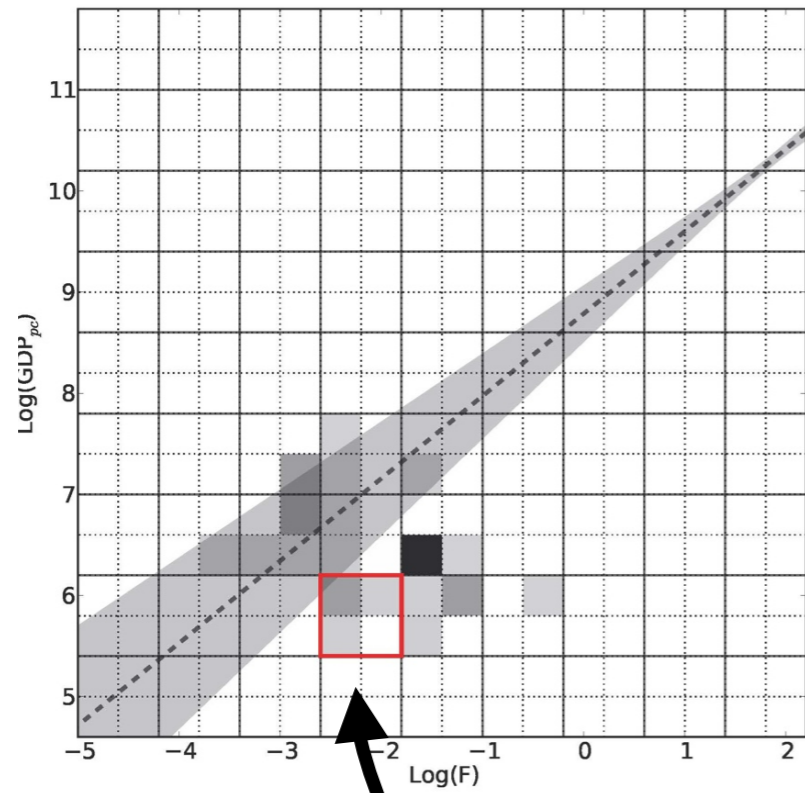
Dynamics is ruled by several other exogenous factors competing with Fitness

SELECTIVE PREDICTABILITY

Method of Analogues

forecasting the future by the knowledge of the past





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

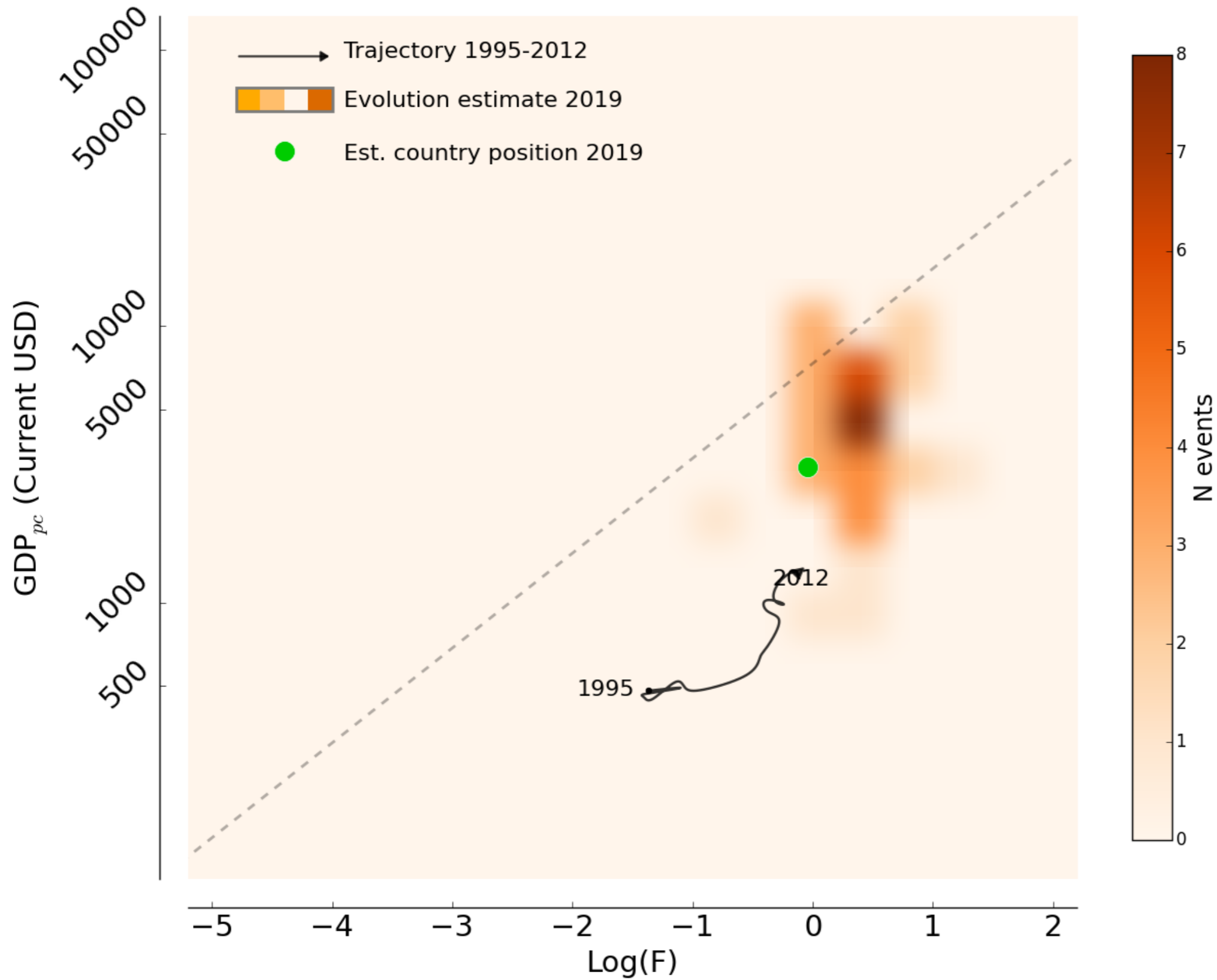
NB: $N^{(i)} \geq 10$

Country 1

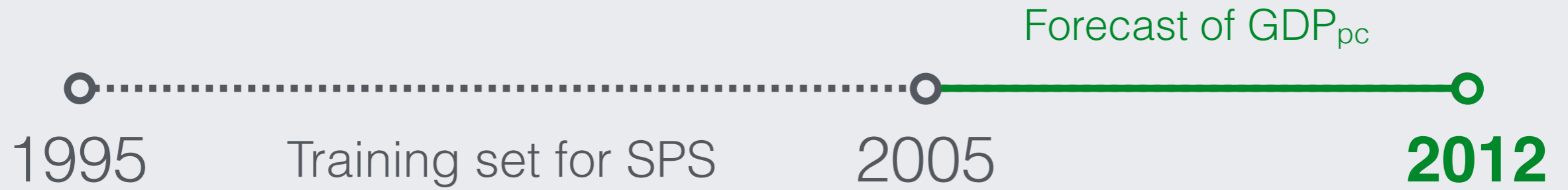
Predictability 0.667

Fitness 0.887 (2012)

GDP_{pc} 1255 Current USD (2012)

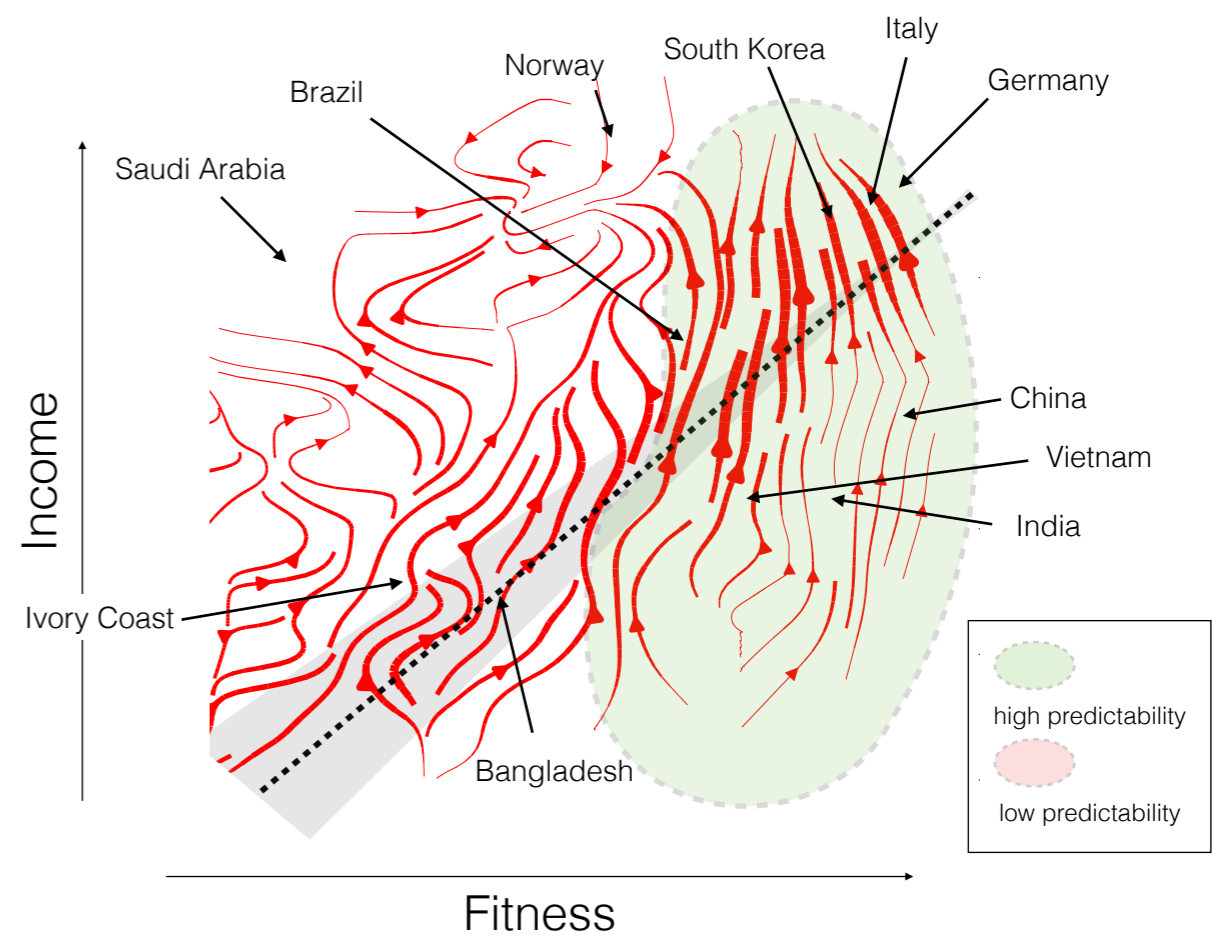
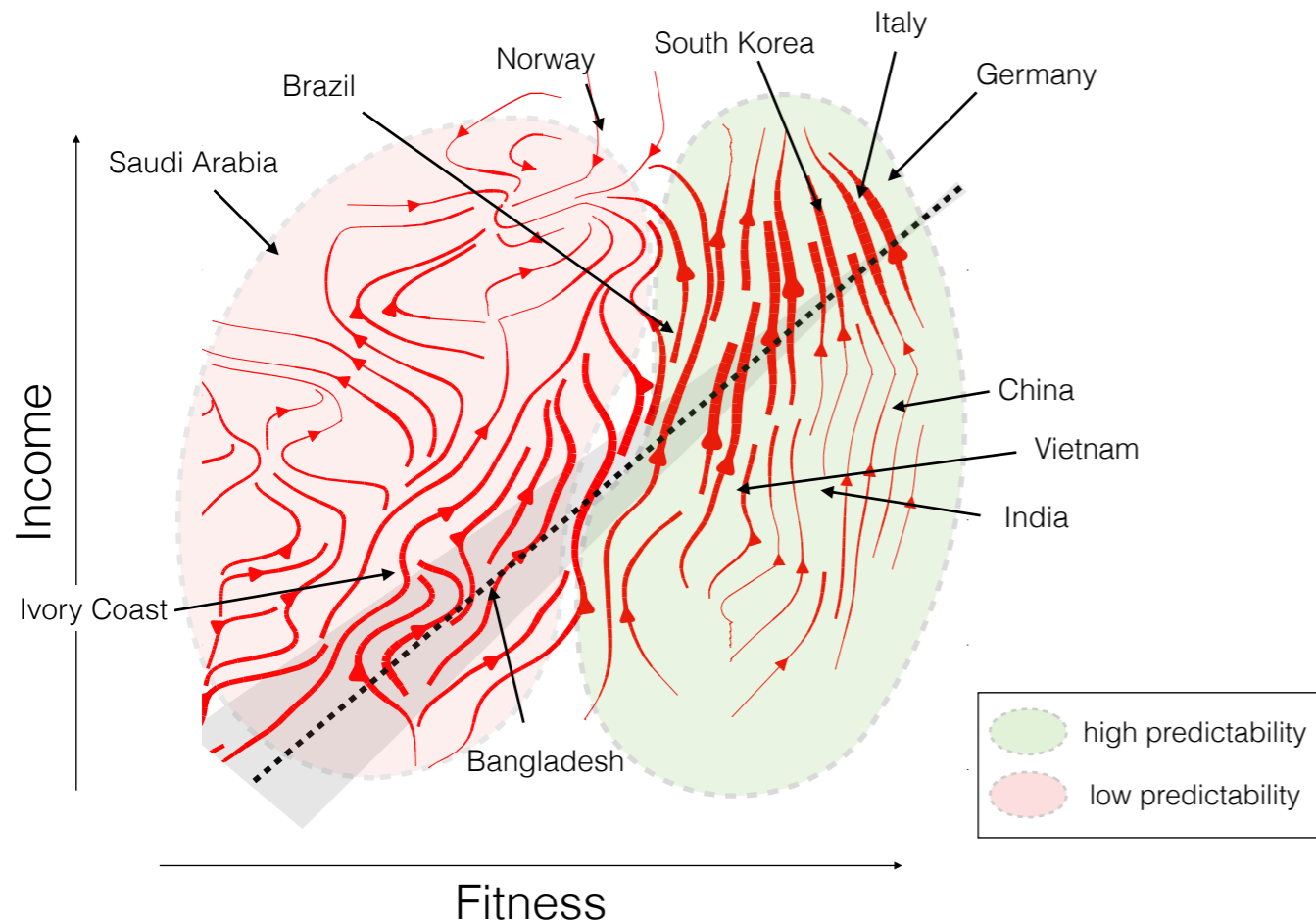


Backtesting

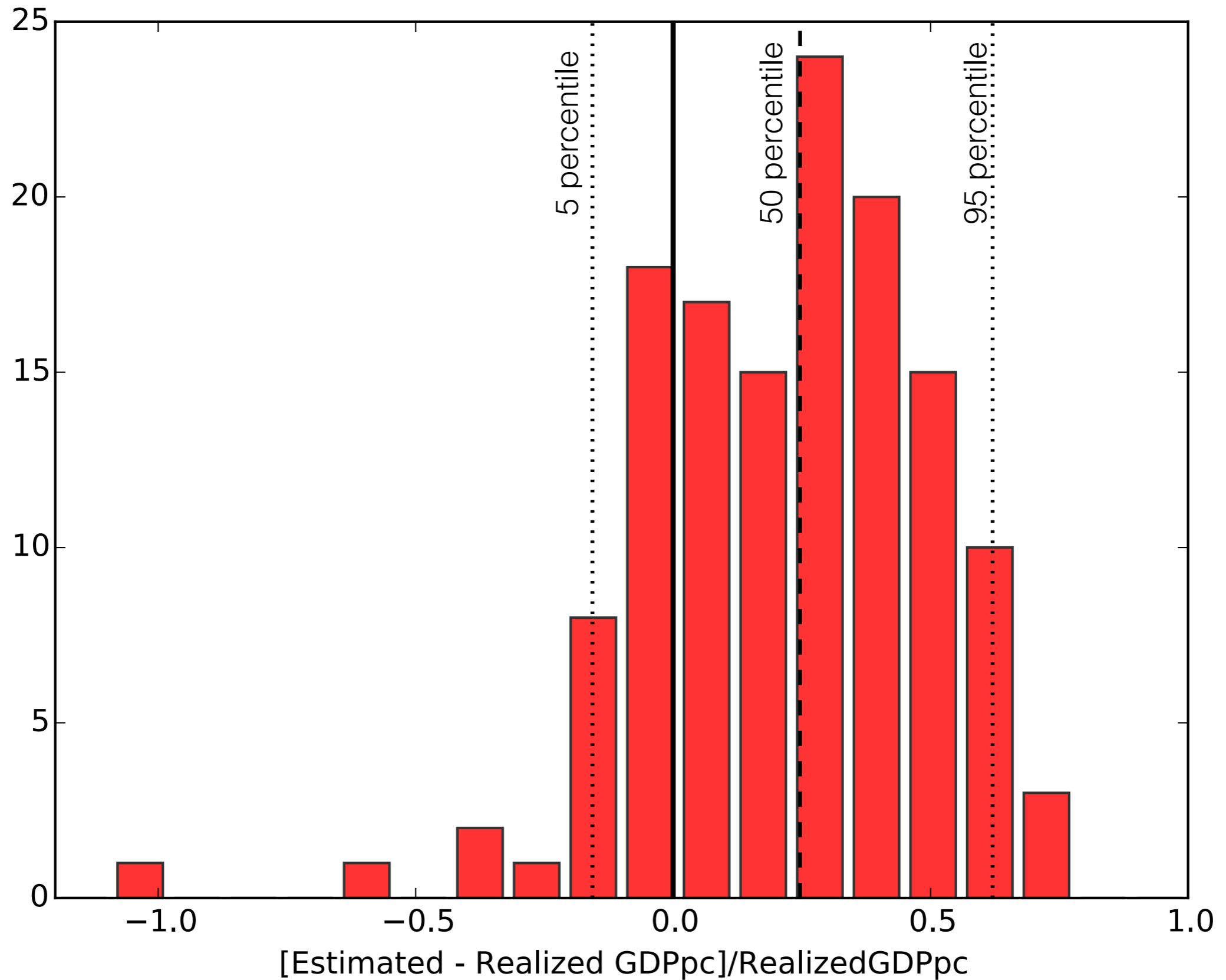


Case 1: red and green areas, laminar and chaotic regime

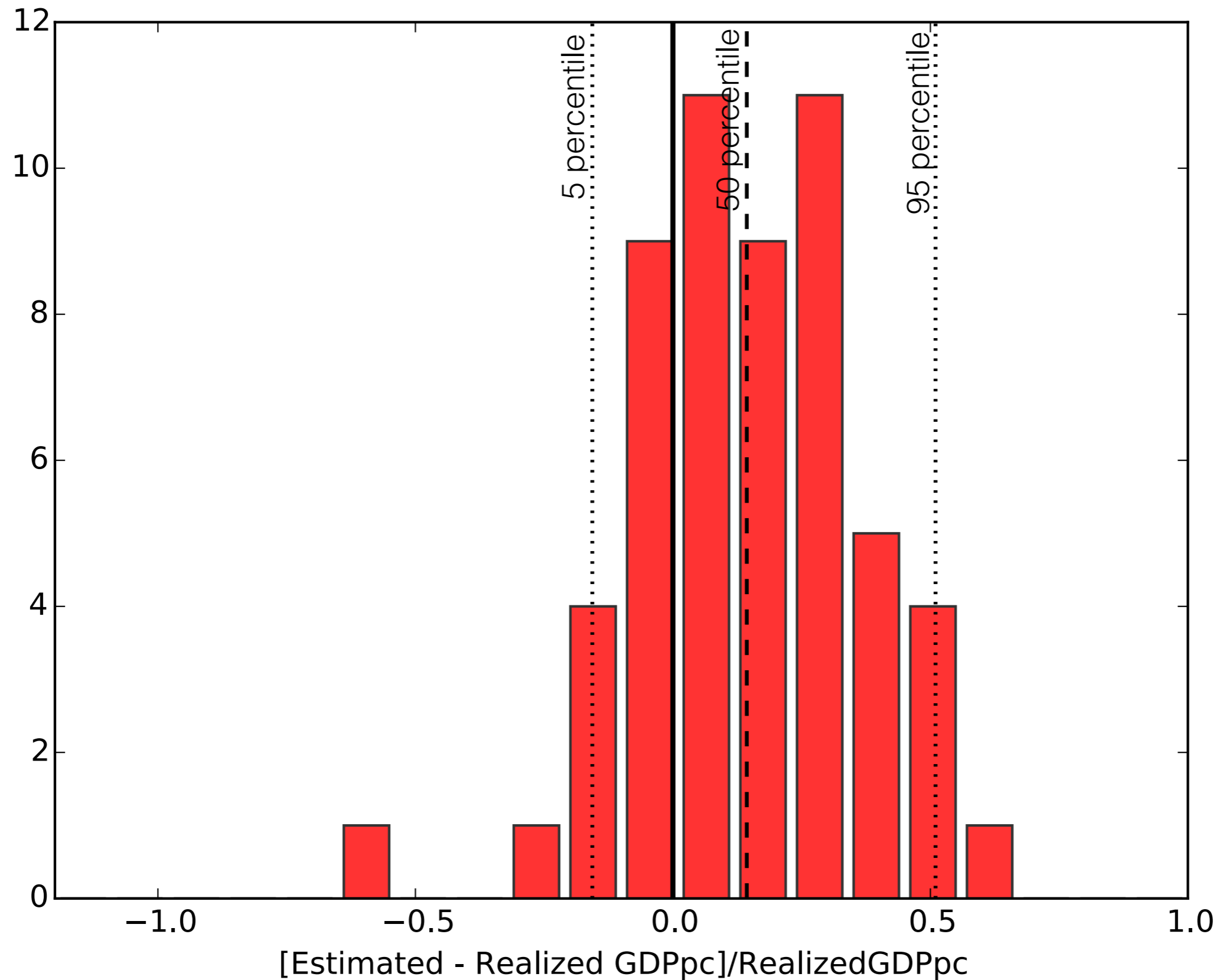
Case 2: green area, only laminar regime



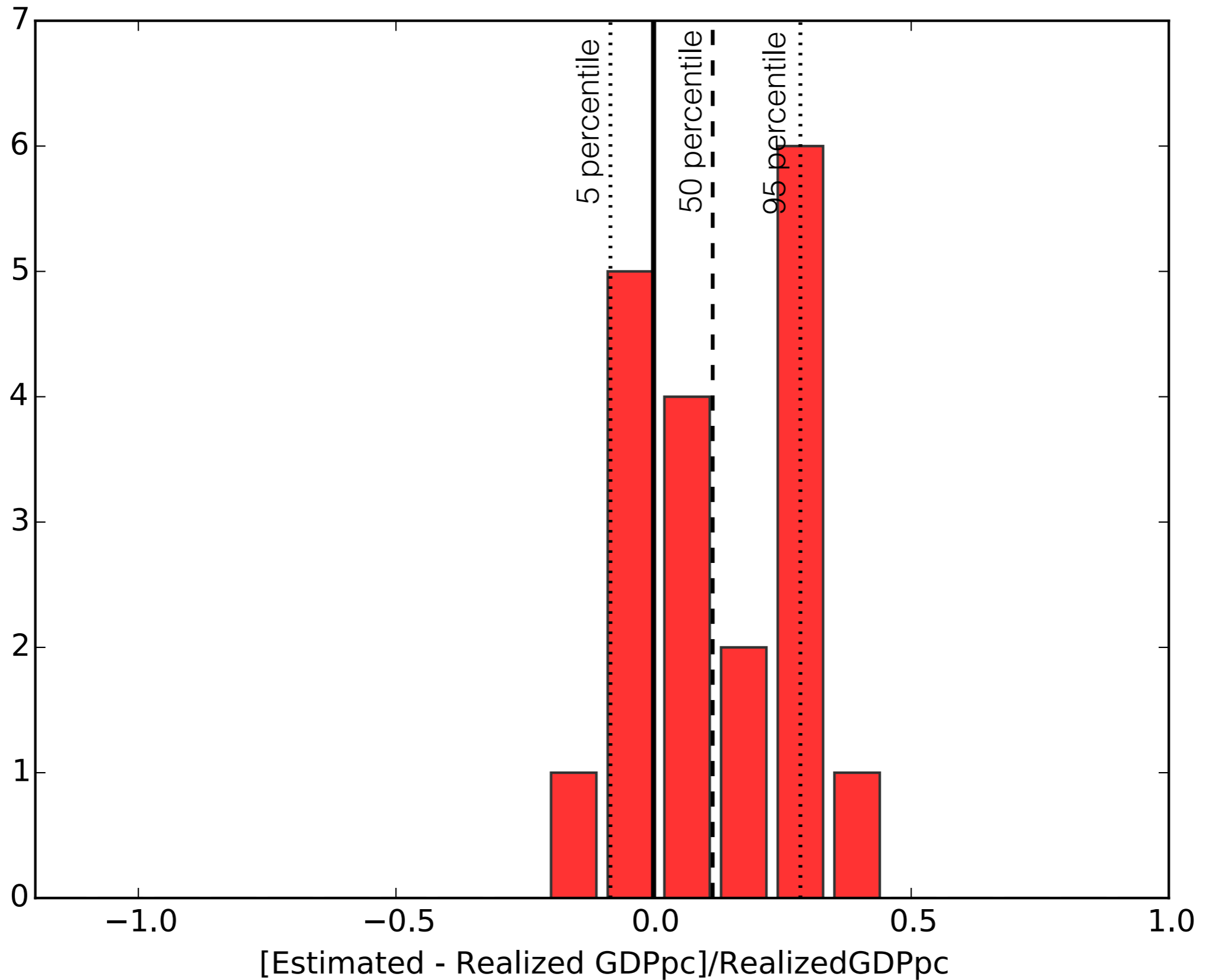
Case 1: laminar and chaotic regime (135 countries)



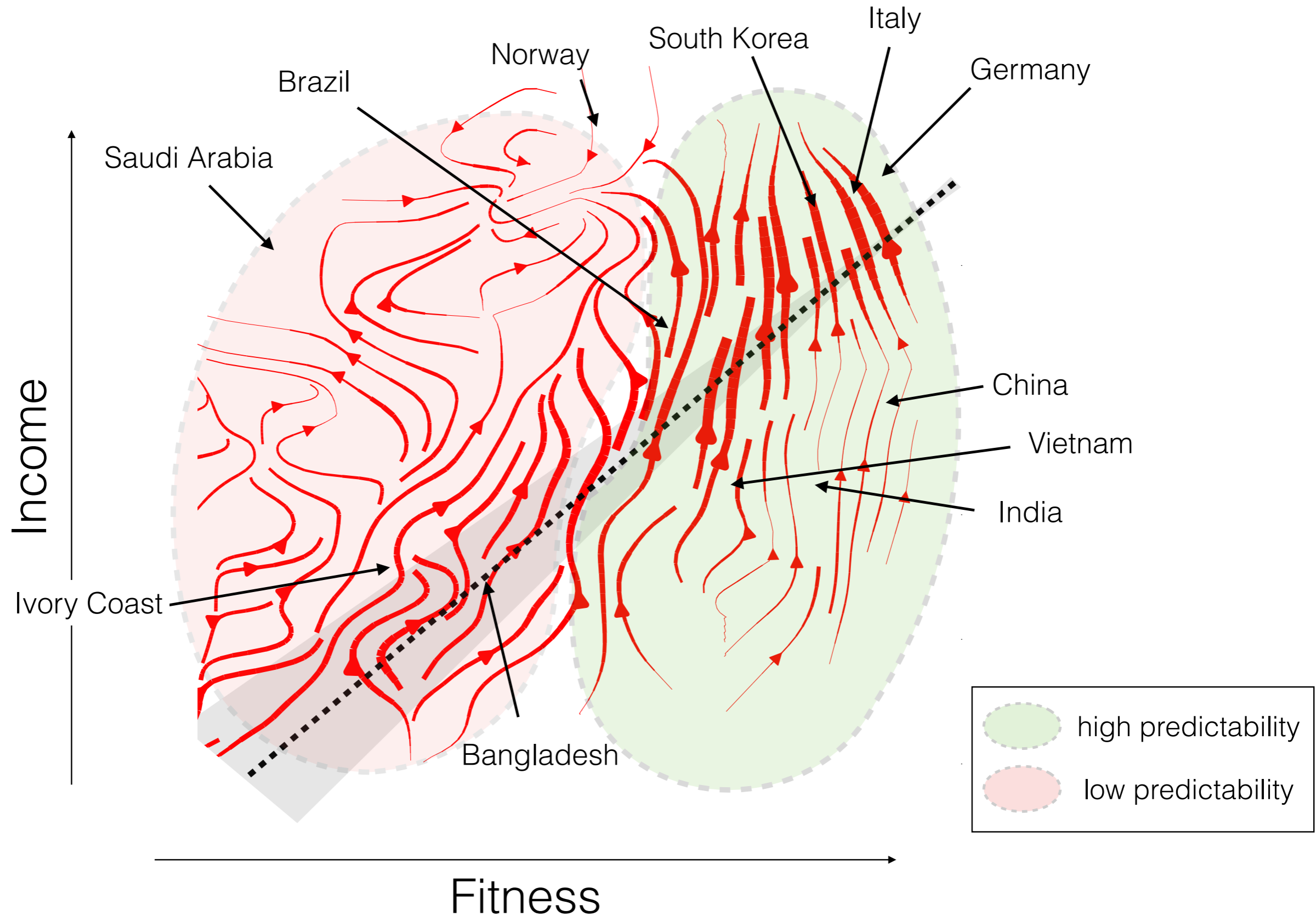
Case 2: laminar regime (56 countries)



Case 2bis: laminar optimized (19 countries)



Take home message



Country positions are referring to 2010 — Red lines are averages of country trajectories
Income is measured by Gross Domestic Product *per capita*, PPP (current international \$)

Complexity Economics

Complexity, Crises & Choices

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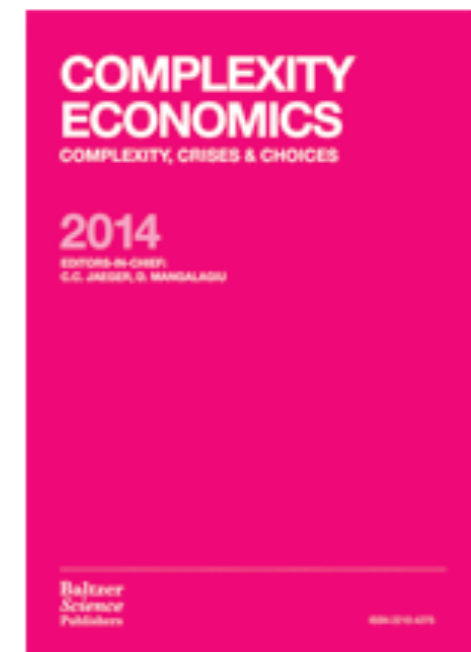
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Perspectives

- Economy-Economics-Finance
- Forecast sectorial development of countries
- Relation between fitness and macroeconomic variables
- New dimensions = larger laminar region?
- Financial portfolios



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>

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

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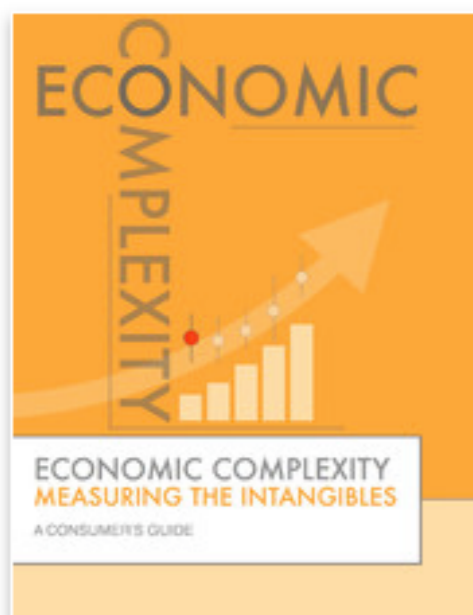
Economic Complexity: Measuring the Intangibles

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A consumer's guide

Matthieu Cristelli and Others

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Description

New economic theories must be strongly data-driven in order to provide a more concrete scientific grounding for Economics.

In this perspective, we discuss two metrics for measuring intangible properties of the complexity of products and competitiveness of countries. The comparison of these measures with monetary figures, as the Gross Domestic Products or the Income per capita, uncovers new information to assess the hidden potential of growth and development of countries

This work is intended as an introduction to both the scientific activity and business-oriented applications of the framework and methodologies presented.

Economic complexity permits to acknowledge that Finance and Economics are two highly connected aspects of the same general problem and provides a framework to discuss, both from a conceptual and practical point of view, this

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PDF



http://pilhd.phys.uniroma1.it/PILgroup_Economic_Complexity/Home_files/economic_complexity_flyer%20_v2.1_1.pdf

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*



Report for Royal Dutch Shell on South Africa