

Nestedness-Triangularity is a general property of all the data For Products, Patents and Technologies and Scientific Activity

## Bipartite Nested Networks: FITNESS ALGORITHM

This leads to the **Fitness of countries** (intangibles) and the **Complexity of products** with an iterative for the bipartite country-product network but also for the **Technology and Science Networks** (Non linear and different from Google)

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

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

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

## Fitness

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## Complexity

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**The FITNESS is the Diversification weighted by the Complexity of the Products**  
**Diversification: Resilience, stability**  
**Complexity: Value Added, Wealth**

**\*\*\* INTERESTING RELATION WITH THE MATHEMATICAL PROBLEM OF “OPTIMAL TRANSPORT”; SINKHORN SOLUTION \*\*\***

Previous attempt: Hidalgo&Hausmann 2009 ECI index (in our language)  
Directly inspired to linear **Google algorithm**

$F_c = \langle Q_p \rangle_c$       Fitness of a country is given by the average  
Complexity of its products

$Q_p = \langle F_c \rangle_p$       Complexity of a product is given by the average  
Fitness of the countries that can make it

Problem 1: In ECI the Fitness is totally independent on the diversification, only the average matters. If a country makes all possible products it is inferior to one that makes a single product with Complexity just above the average

Problem 2: The Complexity of raw materials like crude Oil acquires large Contributions by the fact that high Fitness countries like US, UK etc happen by chance to produce Oil. Nonlinearity is needed to properly consider these problems

# ECI and fitness: theory

- **Averaging:** the matrix is triangular, diversification is lost
- **Linearity:** crude oil is pushed up by USA, Norway etc.

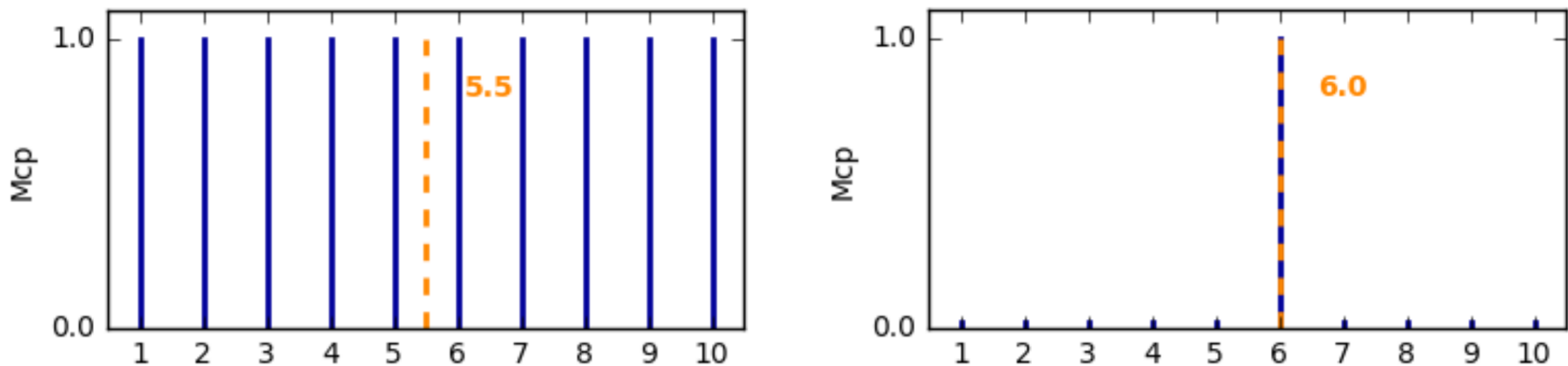
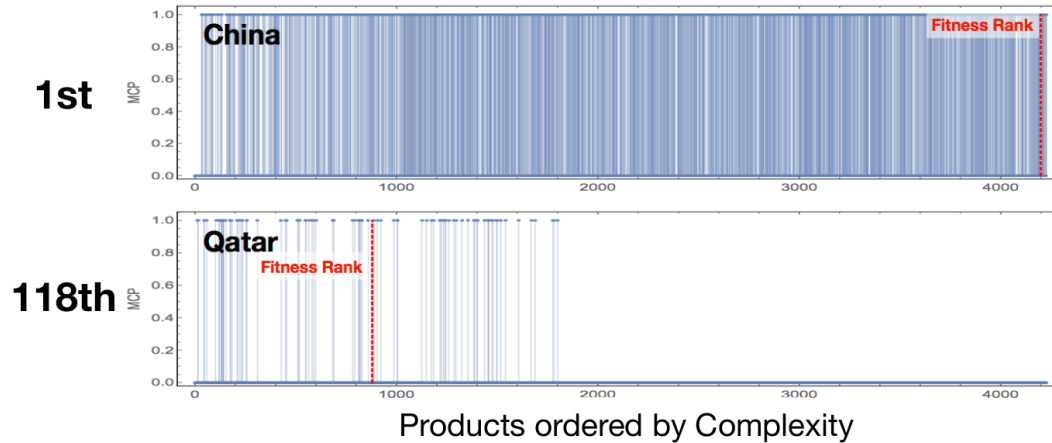


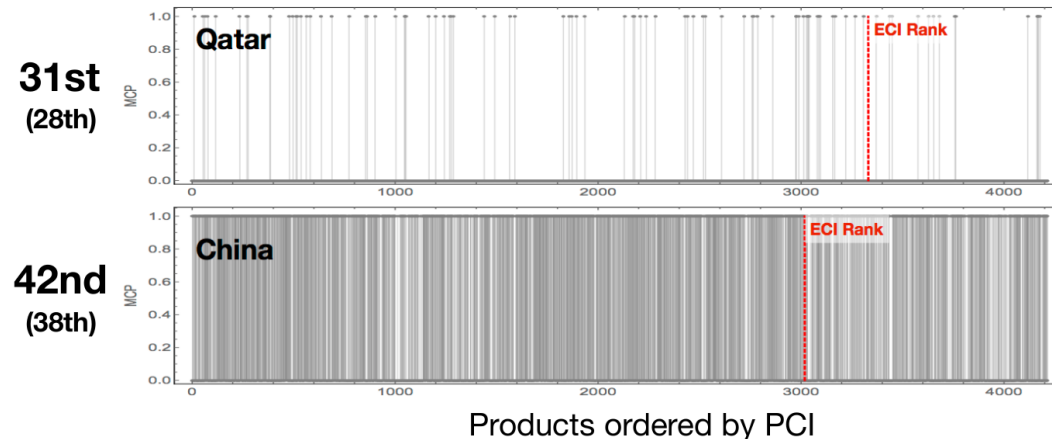
Figure 1: Example of a two-countries model: Country *A* (left) exports 10 products whose Complexity values range from 1 to 10, while country *B* (right) exports a single product of Complexity 6. According to ECI the Fitness of *A* is less than that of *B*, which is clearly a crucial inconsistency in the light of the nested structure of the matrix  $M_{cp}$ . This is due to the fact that ECI is based only on averages and diversification has zero effect.

# ECI and fitness: in practice

Fitness World (2015)



ECI World (2015)


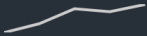



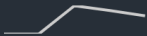











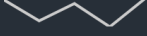


Averaging: the matrix is triangular, diversification is lost

Linearity: crude oil is pushed up by USA, Norway etc.

L Pietronero et al.  
arXiv:1709.05272

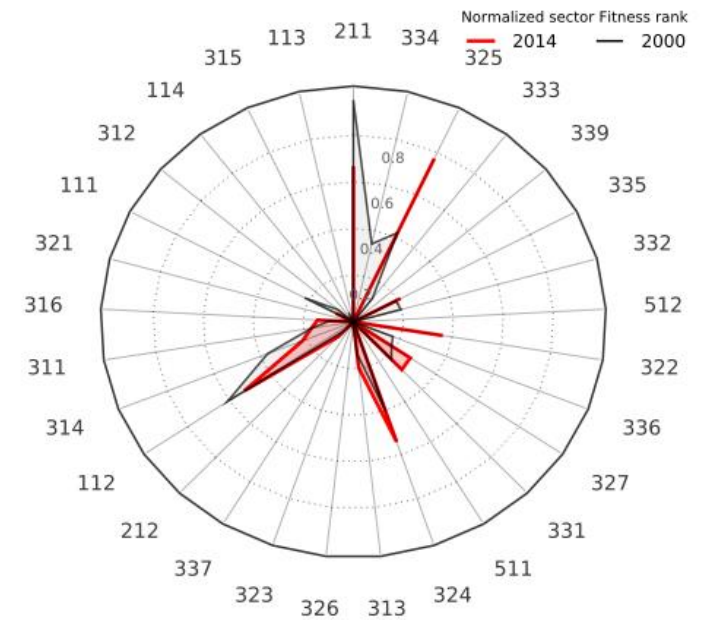
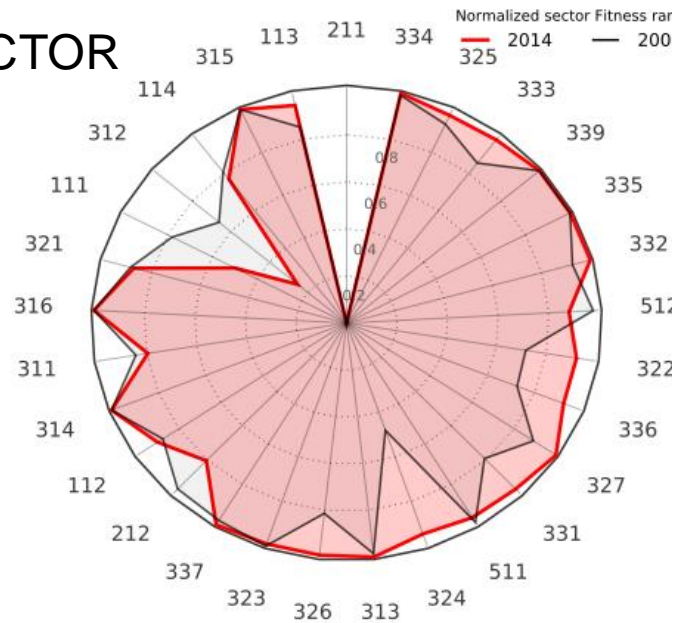
# SCREENSHOT FROM THE MIT ECI ATLAS: INCREDIBLE RESULT

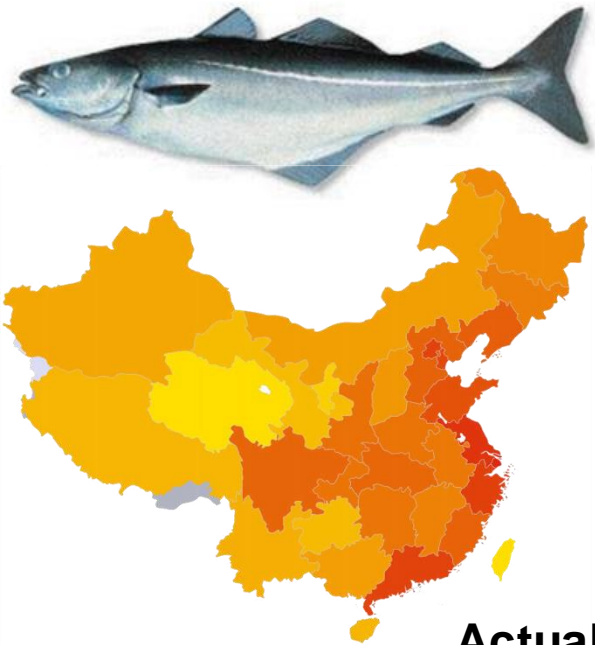
26	 Estonia	0.68394	0.752262	0.86561	0.843983	0.898422	
27	 Russia	0.048022	0.008439	0.855036	0.8547	0.852045	
28	 Spain	0.700457	0.701443	0.820536	0.80013	0.777415	
29	 Saudi Arabia	-0.462099	-0.369927	0.870754	0.819673	0.747155	
30	 Belarus	0.689295	0.731427	0.836874	0.743585	0.743075	
31	 Romania	0.751166	0.787654	0.561038	0.620618	0.713669	
32	 Thailand	0.87724	0.955651	0.590169	0.650521	0.711704	
33	 China	1.04036	1.16379	0.60941	0.642376	0.691307	
34	 Lithuania	0.673455	0.63807	0.667051	0.627923	0.675449	

China

Saudi Arabia

INDUSTRIAL SECTOR  
FITNESS:





**BREAKING NEWS:**  
**ECI INDUSTRIAL PLANNING FOR CHINA**  
**SUGGESTS TO CLOSE ALL INDUSTRIES**  
**AND PRODUCE ONLY COALFISH**  
**A SUGGESTION TO Xi Jinping from**  
**HARVARD (HAUSMANN), MIT (HIDALGO)**  
and with the special support of INET-OXFORD  
(FARMER AND BEINHOCKER)

Actual industrial production  
of China (including Coalfish)

But if China would close all  
Industries and produce  
**ONLY COALFISH**

**ECI Ranking**  
(Harvard + MIT + INET-OXFORD)

40th →

**4th !!**

But for those who are doubtful about this fantastic “scientific” result:

**FITNESS Ranking**  
(Fermi Center + Sapienza + ISC CNR)

1st →

169th



# A Better Way to Make Economic Forecasts

Try looking at what a country knows how to produce.

By [Mark Buchanan](#)

4 2 ottobre 2017, 00:00 GMT+2

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New research has demonstrated that [the "fitness" technique systematically outperforms standard methods](#), despite requiring much less data. This has helped attract the interest of the International Monetary Fund and the World Bank's International Finance Corporation, signalling what could be a major shift in perspective. Instead of encouraging countries to focus on those areas where they have a comparative advantage, economists might start seeing an economy as more like a living ecosystem, its resilience dependent on its diversity.



# A FUNNY DEBATE: ECI vs FITNESS

**July 2017:** Hidalgo's group announces the **discovery of ECI+**, a novel algorithm which is supposed to be the best of all. <https://arxiv.org/abs/1707.05826>

His regressions «show» that ECI+ is best, then comes ECI and last is our Fitness.

BUT two weeks later we post a note in which we show that **ECI+ is mathematically identical to the Fitness!** <https://arxiv.org/abs/1708.01161>

Hidalgo et al accept that ECI+ is nothing but the Fitness, however, then they conclude that after all these algorithms are all alike. <https://arxiv.org/abs/1708.04107>

They do not explain how is it possible from their magic regressions that the same Algorithm works well or not depending on the name you give to it.

Then we summarize this funny story: <https://arxiv.org/abs/1709.05272>

**January 2019:** Hausmann and collaborators put a paper in the Archive in which The main conclusion is that the key indicator for country growth is:

**Complexity Weighted Diversification.** <https://arxiv.org/pdf/1812.03534.pdf>

BUT they forget to mention that **this is precisely the definition of the Fitness.**

In this paper also the 2D country flow is rediscovered etc.

I wrote to them and they seem to agree and said they will revise the paper but, as of today, no revision has appeared.

In summary both Hidalgo and Hausmann seem to really appreciate our papers but....in a very peculiar way.