

Impact of science on Estonian economy: From inevitable expenses to lucrative investment

Tarmo Soomere

Estonian Academy of Sciences

Laboratory of Wave Engineering
Department of Cybernetics
School of Science, Tallinn University of Technology

Instead of introduction

Small is beautiful
source for unicorns

A unicorn:

- A business
- with a goal to develop and launch an innovative and repeatable business model with great global growth potential;
- that has a valuation of at least \$1Billion confirmed by a major international news outlet



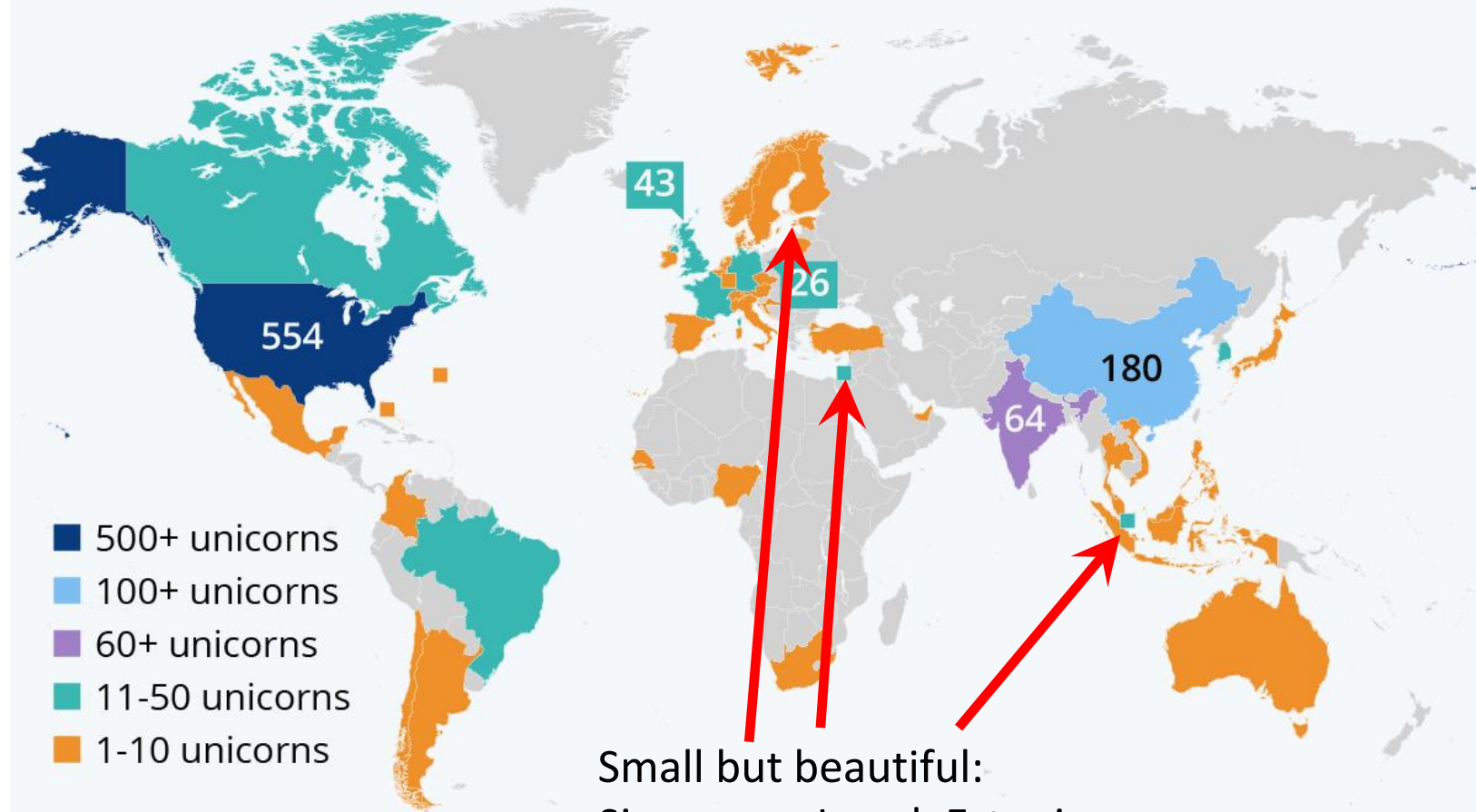
There are many unicorns in the world (2022):

Source: CB Insights // Statista

Global Unicorn Herd Now Counts 1,000+ Companies



Number of privately held, up-and-coming companies with a valuation of \$1 billion or more, per country



- 500+ unicorns
- 100+ unicorns
- 60+ unicorns
- 11-50 unicorns
- 1-10 unicorns

As of March 30, 2022

Source: CB Insights

Small but beautiful:
Singapore, Israel, Estonia

Unicorns
per M capita

Skype.com 2003 // 2005

Playtech.com 1999 // 2007

Wise.com 2010 // 2015

Bolt 2013 // 2018

Pipedrive.com 2010//2020

Zego.com 2016 // 2021

ID.me 2010 // 2021

Gelato 2006 // 2021

Veriff 2015 // 2022

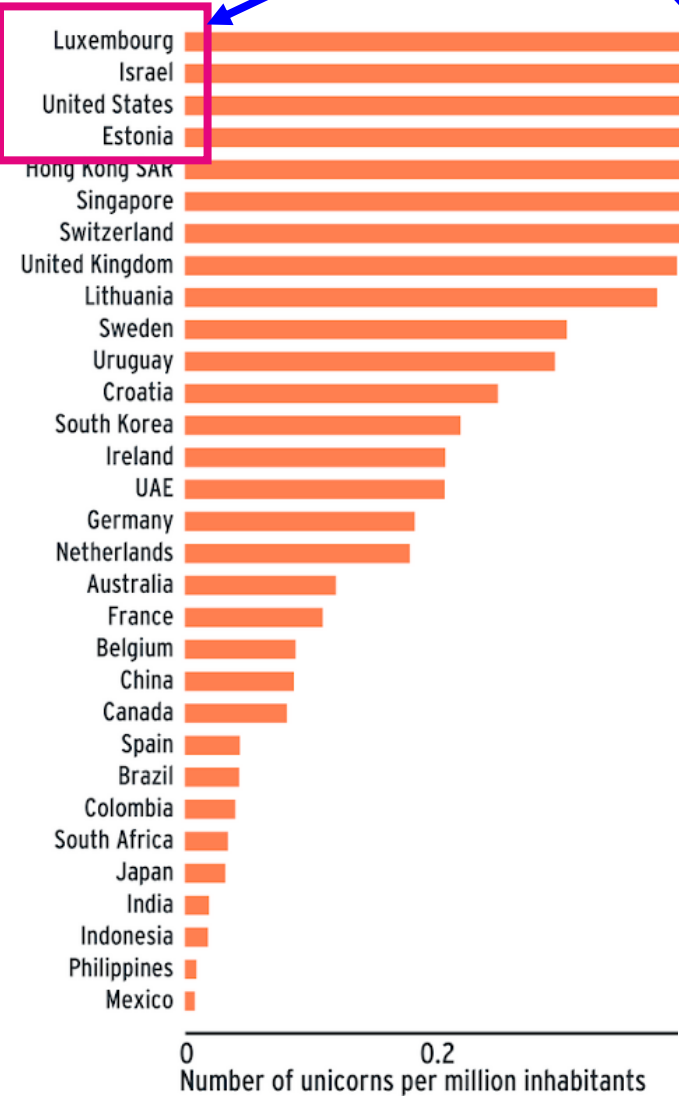
Glia / 2022

Just numbers

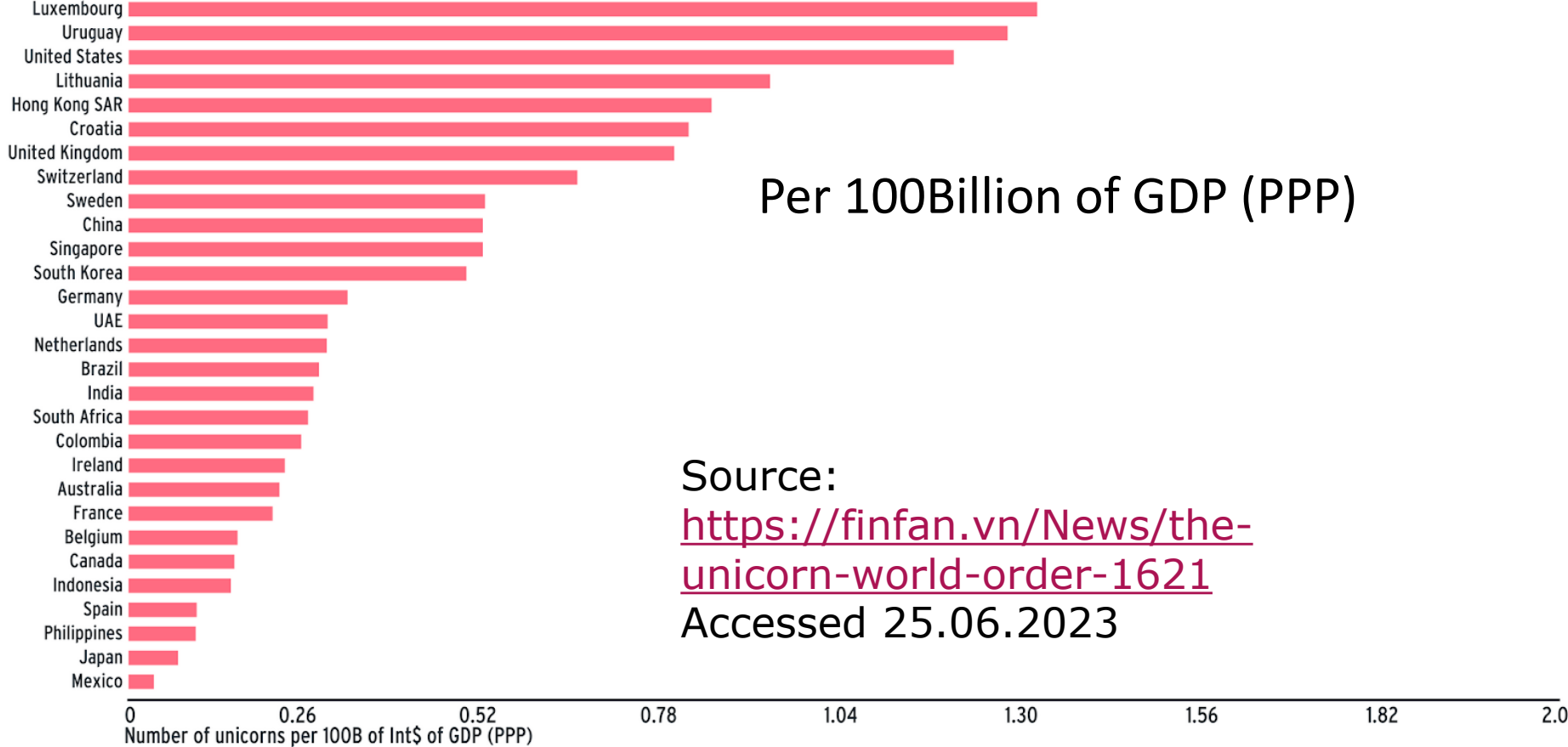
Estonia

Per million inhabitants

Per 100 Billion of GDP (PPP)



Israel
Estonia



Source:
<https://finfan.vn/News/the-unicorn-world-order-1621>
 Accessed 25.06.2023

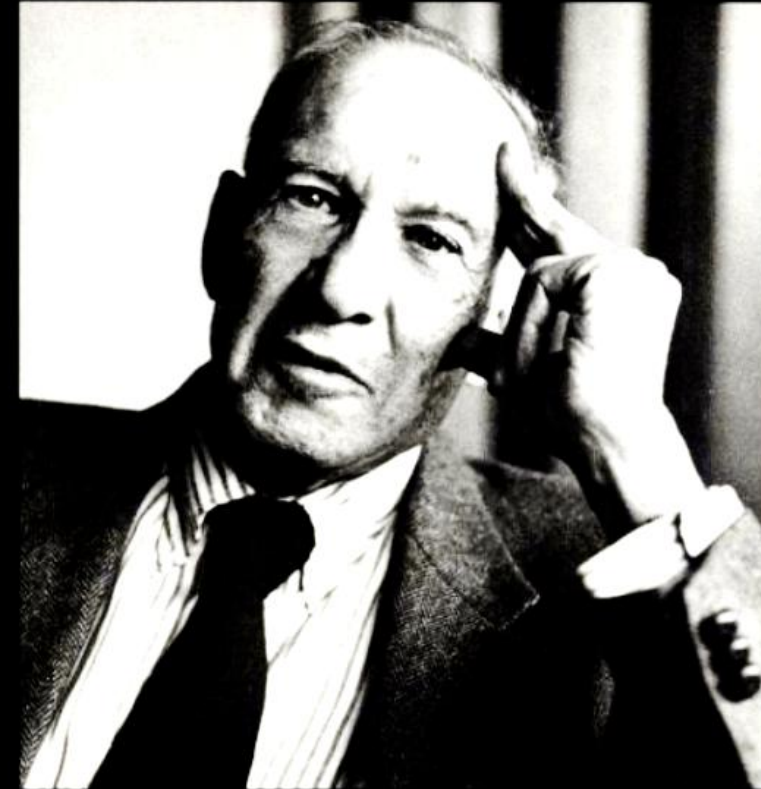
Back to basics or Great minds have great thoughts

A unicorn,
by definition, is an
innovative adventure

But what is
innovation?

How different it is
from, e.g., more
effective production?

*Knowledge is the
source of wealth.
Applied to tasks we
already know, it
becomes
productivity.
Applied to tasks that
are new it becomes
innovation.*



Peter Drucker

A simple corollary:

- New knowledge is needed for innovation

A conjecture:

- New knowledge is the food for unicorns

Combining this with the definition of science:

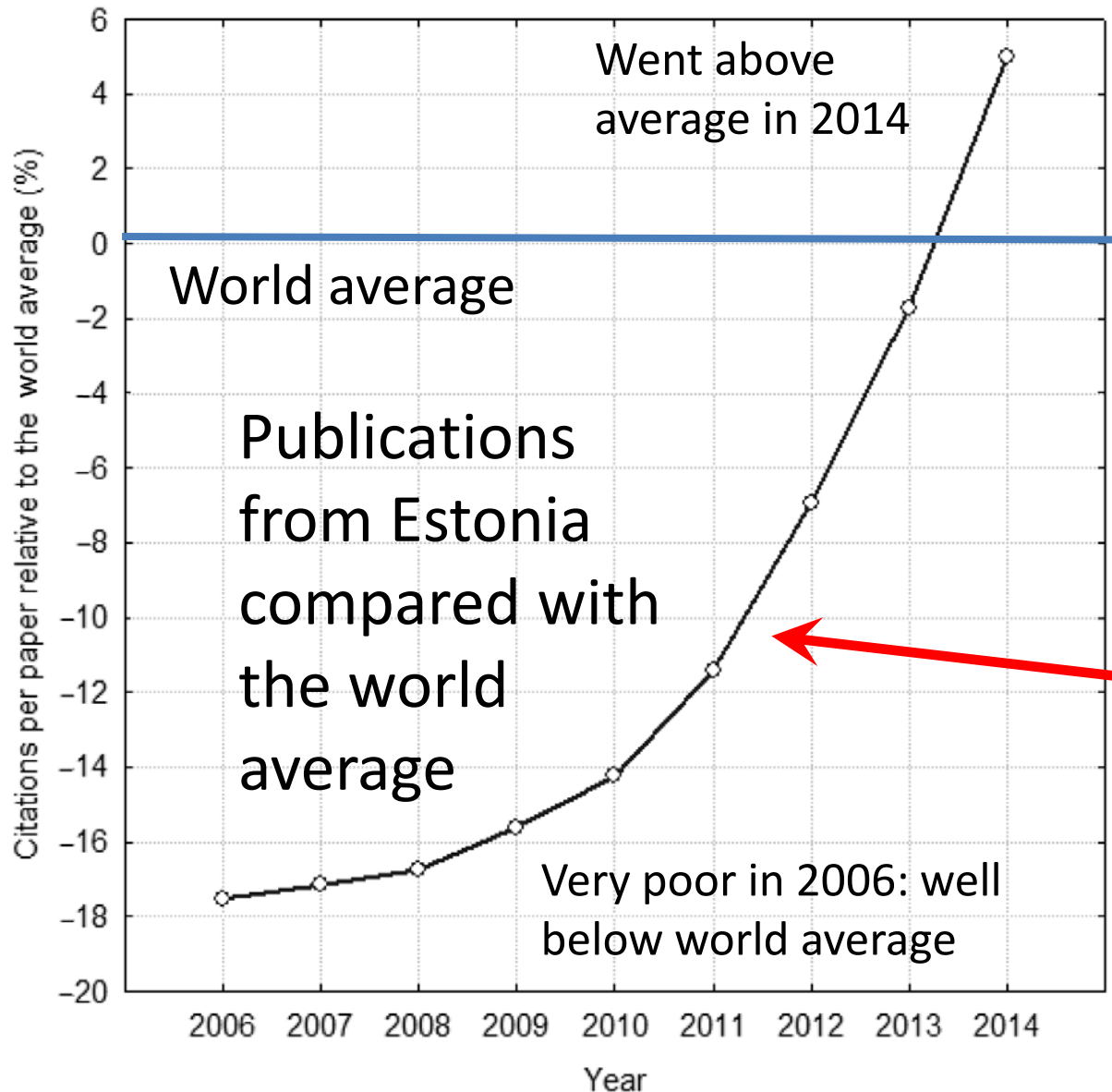
- Excellent science is generally THE precondition for the growth of unicorns

Science in Estonia is:

- Small in numbers
- In rapid transition
 - Currently strong part of the EU science system
- Funded controversially
- Concentrated in a few centres
 - Unbalanced between research fields
- Extensively communicated to society

Most importantly:
aiming at excellence

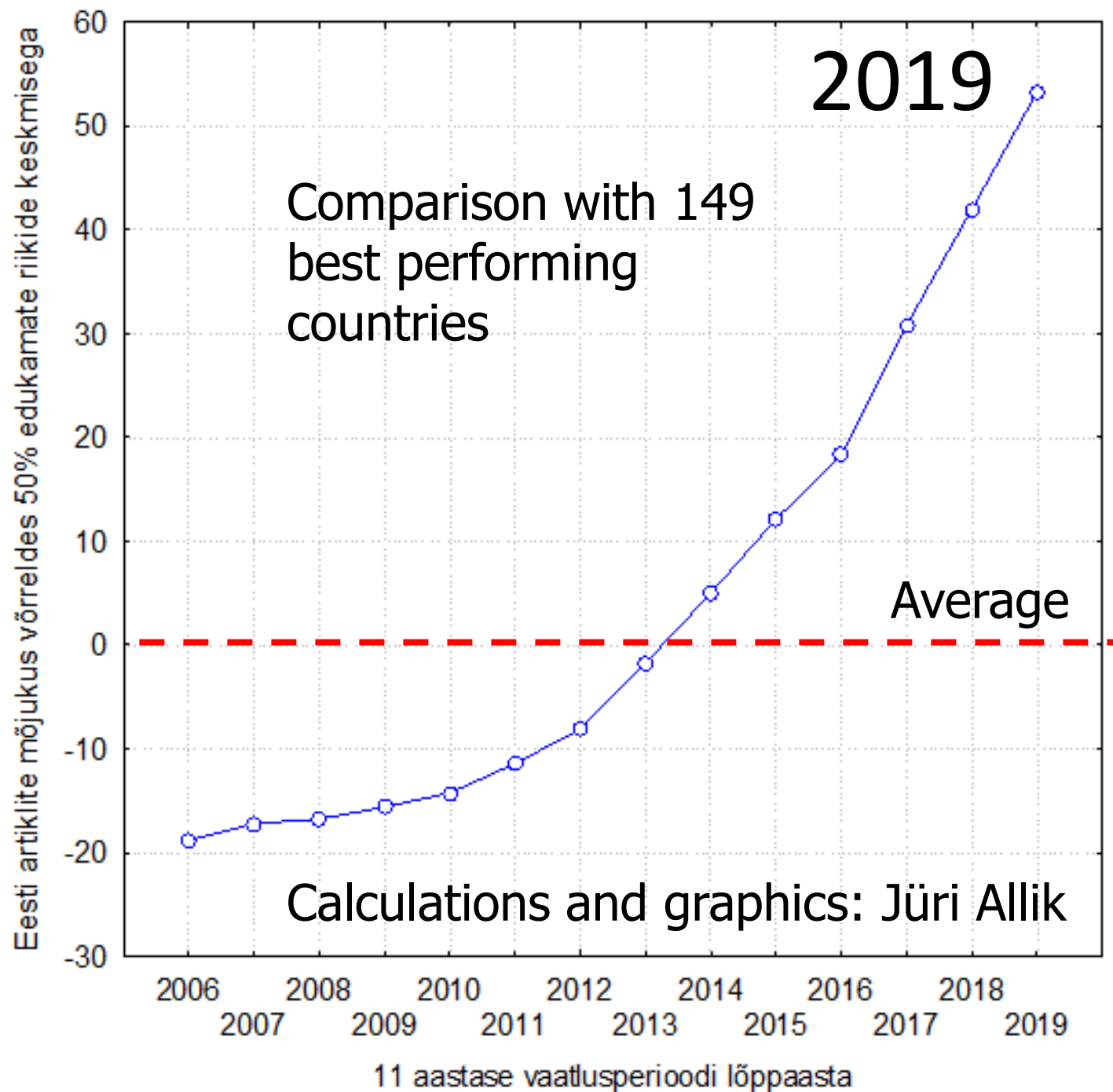
Aiming at excellence



- Not easy to measure quality of science
- To some extent: looking how much others use/rely on your results
- Estimated by looking at citations
 - Not perfect but does have decent content if applied for large groups
- The Baltic States started together in 1991
- A break of trend around 2010
- 2014: Estonia ranked as 27th in the world: Each paper cited on average 12,17 times in 10 years, Latvia: 8,32 times, Lithuania 6,37 times

Allik, J. 2015, Proceedings of the Estonian Academy of Sciences, based on Thomson Reuters Essential Science Indicators (Web of Science)

The growth continued and continued:



Breaking news: reaching the top 2023

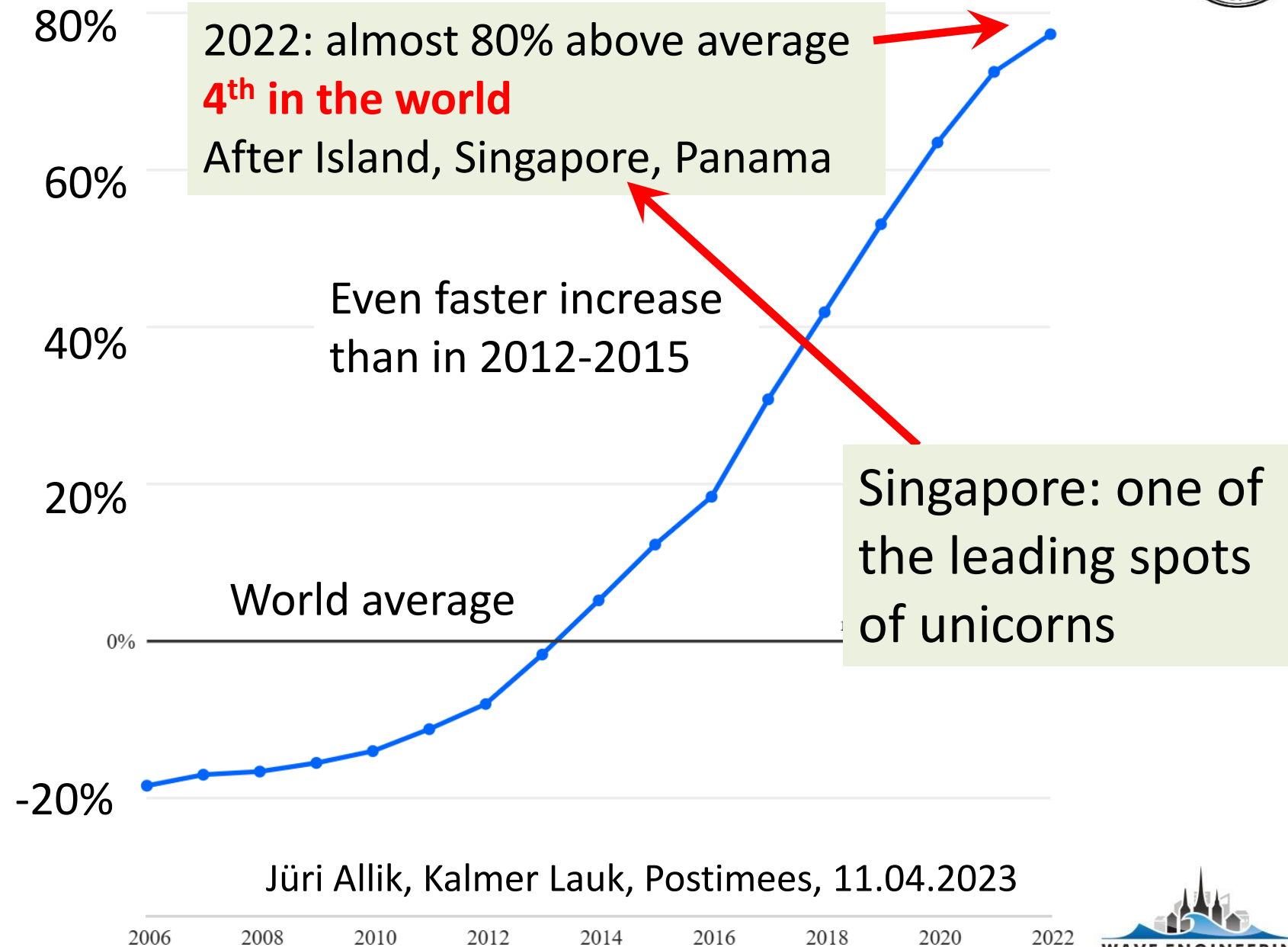
Number of citations per article (%), compared to the average of top countries

Mystery or miracle?

- We (Baltic States) started together 1991

Now

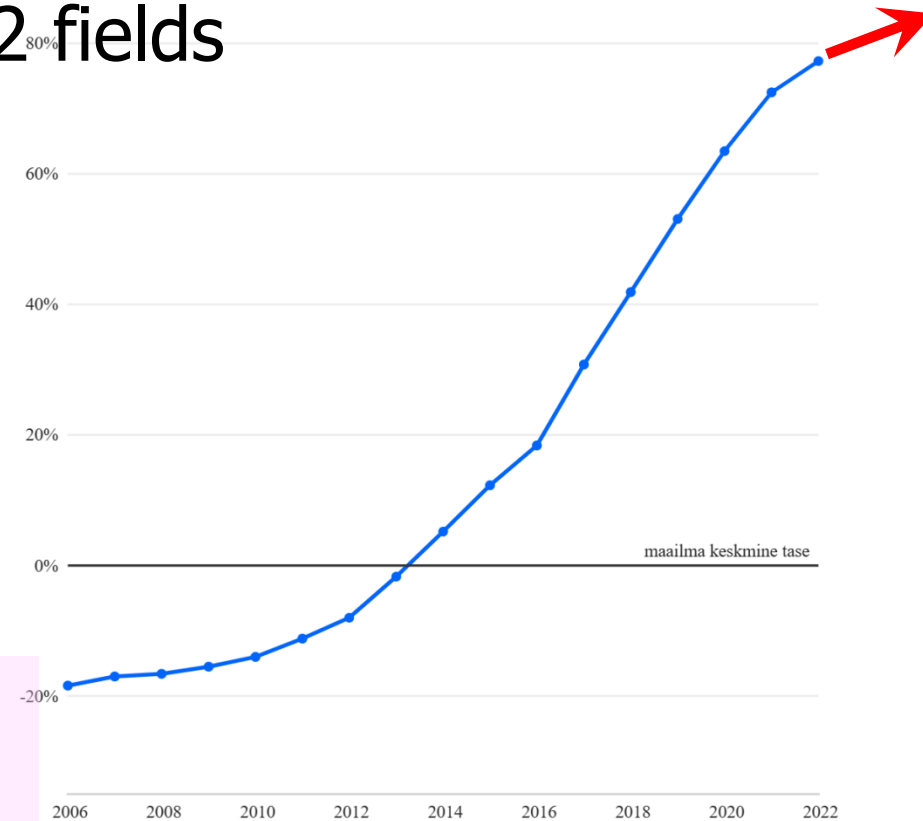
- Latvia = 53rd
- Lithuania = 84th
- Finland = 23rd
- Sweden = 16th



A small country cannot be excellent everywhere

Web of Science / Essential Science Indicators 22 fields

- Science in Estonia above average: 15 fields
- Slightly below average 6 fields
 - Strongly below average: economy and finances



Forerunners

- Medicine
- Genetics
- Biology
- Ecology
- Physics

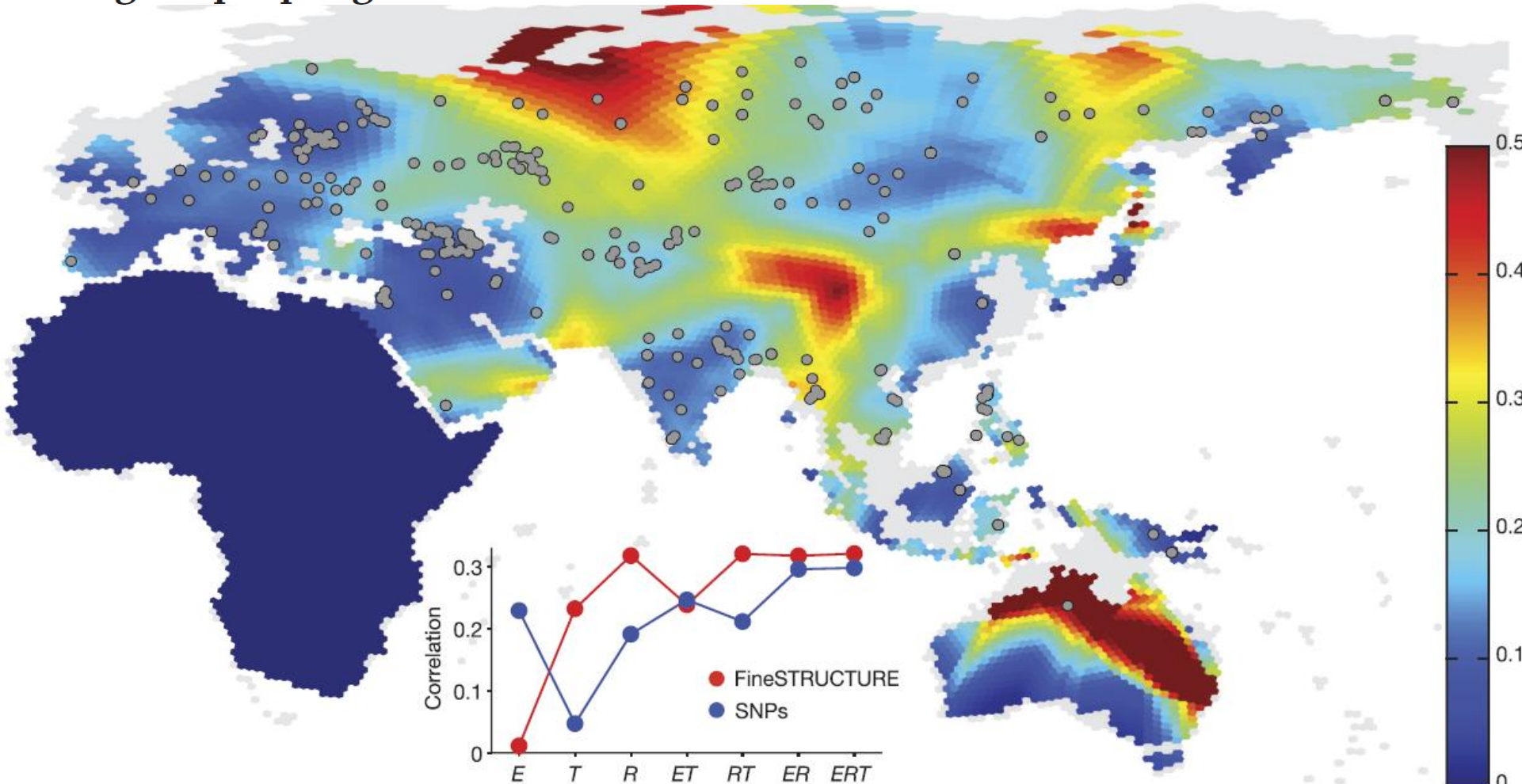
The cost of one good publication

- Finland = 455,000 €
- Estonia = 128,000 €

World highlights

doi:10.1038/nature19792

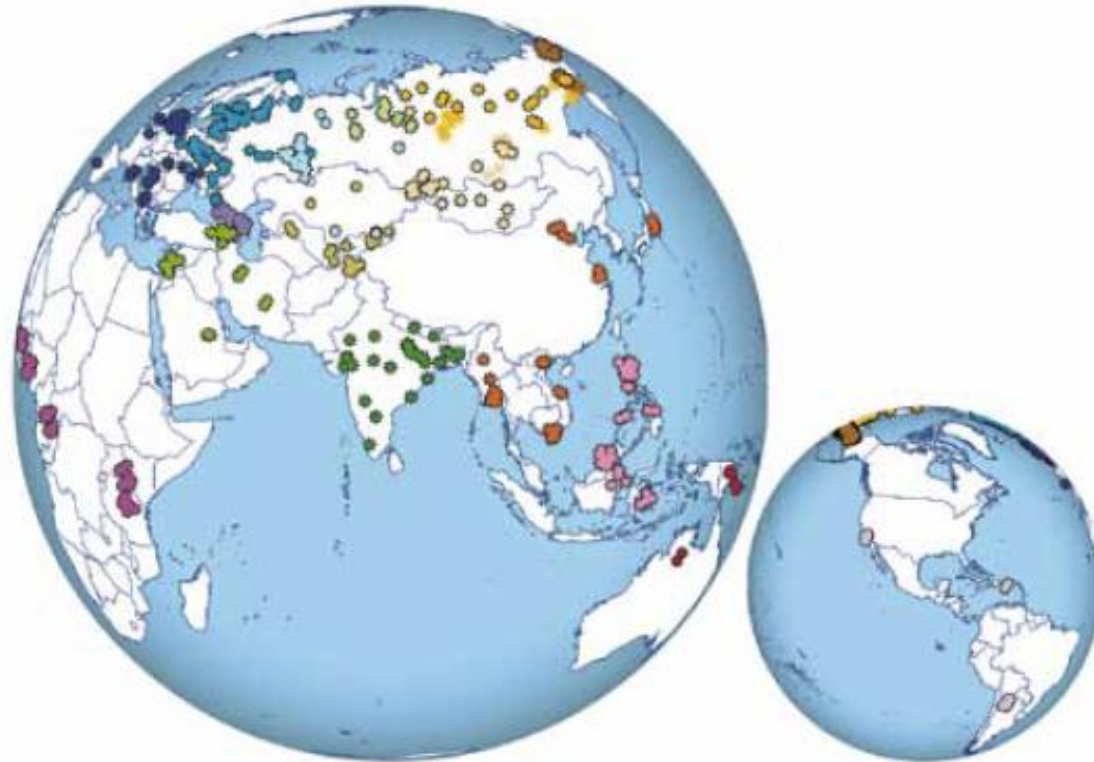
Genomic analyses inform on migration events during the peopling of Eurasia



The team of Estonian Biocentre: three publications in Nature, 13 Oct 2016

Strong sides

Chemistry and molecular biology
Population genetics, Estonian Biocentre

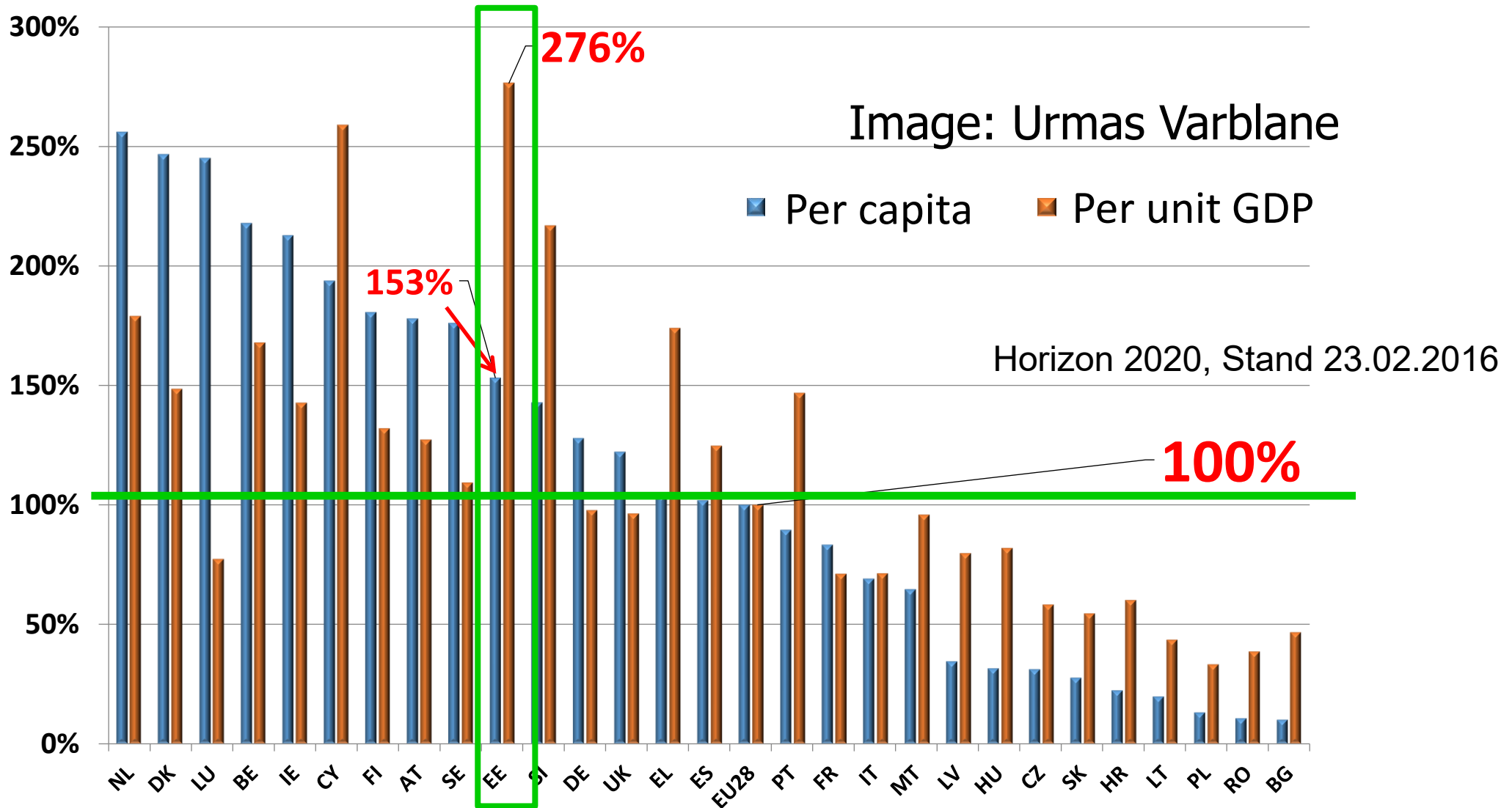


- How *homo sapiens* was spreading over the Earth: several waves
- **Among ten most influential discoveries in 2016/2017 by Science**

A selection of highlights

- Estonian Biocentre among 15 most influential developments by Science magazine in 2016/2017
- Science video based on the discovery of Academy Member Hillar Aben (secret of Prince Rupert tears) – most popular video of Science magazine in 2017
- Academy Member Andres Metspalu – chair of the Programme Committee of European Science Open Forum 2018 (Toulouse)
- 7 scientists among the world top ~3600 in 2018
 - This flow continues every year, 5-9 scientists
- >50 scientists among 1% of most cited researchers (Web of Science)
- 56/62 scientists among most influential 160,000 (2021/2022, <https://research.com/>; based on population should be 22-23)

Excellent in bringing money home



How we did that

or the steps from Soviet science system to our world

Science in Estonia in the 1980s

- **A powerful**, well-manned (~10,000 staff) and well-equipped system
- **but largely inefficient:**
 - Academy of Sciences: >20 institutes, some 4,000 staff
 - Research institutes at different ministries and institutions
 - Research at universities: high quality but much less people, focus on teaching)
- Tuned according to the viewpoint of Moscow & needs of the entire Soviet Union
 - to a large extent financed by and serving the military system

Managing **the collapse of the 1990s**

- Almost total collapse at the beginning of the 1990s.
 - The reason: No correlation of assets & competence with the needs of Estonia
- **Three decisions 30 years ago**
 - The unnecessary and not successful research fields must go
 - High-quality and/or necessary for Estonia fields must remain
 - Research and higher education must be bridged
- The target: contemporary universities by Wilhelm von Humboldt
 - top researchers should teach and professors must do science

Step 1 into today

Inventory with the help of Swedish Academy of Sciences

- so-called Swedish evaluation.
- All research units and groups in Estonia evaluated in terms of:
 - demonstrated results, existing competence (PhD degrees)
 - assets (labs), position in the world science
 - how far are they from the cutting edge

Step 2: **Structuring** the research landscape

- Moving major research institutes from the Academy of Sciences and ministries to universities
 - not an easy task, with quite high emotions
- The result:
 - several strong research centres in universities
 - 5–7 research areas basically closed
- Academy of Sciences reshaped

Step 3: **Structuring** finances

Financing according to quality and importance for Estonia

- Establishing targeted financing scheme + research grants from 1997
 - Research groups of reasonable size
 - Minimum performance threshold for each supported group member
 - Funds totally under control of the group itself
- The targets:
 - detaching financing from the local (faculty, department) level
 - ensuring regular quality assurance
- A guarantee: Every group above threshold was were financed

Step 4: More **balanced institutional funding**

- From 2012: establishing more balanced institutional funding by merging the two existing schemes.
 - Clear quality principles have been worked out and established in practice, such as regular institutional evaluation of research and teaching
- The staff in research institutes: decreased from ~10,000 to ~4,000

Step 5 or almost there

Two mechanisms:

- Quality-based research grants
- Massive increase of “base financing” of universities and research institutes
 - For driving research but with almost no prescription how
- Why this was possible? -
 - The previous steps have cleaned, ordered and structured the research landscape, and created a decent quality assurance system.

Not only formal steps

- In parallel: the Academy of Sciences was radically reshaped
 - It was kind of ministry of science before 1995, and less a parallel to Max Planck Society
- The core decision: academy should support the country differently, not via running a large system of distributing funds
 - The country needs independent advice
 - that is not connected with science funding and definitely not affected by political aspects
 - Like the French Academy of Sciences of the National Academies in the USA

The content is most important

A crucial point: organization of connections between research landscape and governance system of the country

- There are at least four connecting points.
 - Some should advice
 - Some should lobby for science
 - Some should distribute money
 - Some other should be ready to organize a protest if something goes wrong.

- These roles cannot be combined, even not pairwise
 - E.g., the advisor must not lobby.

The missing link: Estonian Young Academy of Sciences

Founded 2017; up to 33 members, up to 41 yrs old



The content is most important

- By 2017, we have distributed the relevant roles between institutions.
 - The Academy has a national mandate to advice the country
 - Estonian Research Council distributes the funds & organizes evaluation
 - Estonian Young Academy of Sciences became an effective lobby group
 - A NGO Estonian Scientists' Board took lead of protests
- The result: stakeholders and policy-makers know to whom they are talking. This makes the entire system transparent.
 - This was highly successful
- **Result: an agreement about an increase in the national funds for science to 1% of the GDP in December 2018, and started to work in 2021.**
 - A sign of mutual trust, a recognition for three decades of shaping the research landscape in Estonia

An eternal challenge: bridging the gap

Returning to Peter Drucker: innovation == (new) knowledge + new tasks

- Another dimension: time
 - The winner is who takes the market first
- The new knowledge must emerge close to the production
- **We need excellent research in the private sector**
 - This is in the best interest of academic community!
 - Information retrieved from publications has been used by others
- **THE challenge: excellent scientists' minds in private companies**

A simple summary:

- (i) Excellent science is THE food for unicorns (and economy in general)
- (ii) -- if driven systematically for decades
- (iii) It must be present & driven specifically where the production is



Facta non solum verba

Thank you for your attention!