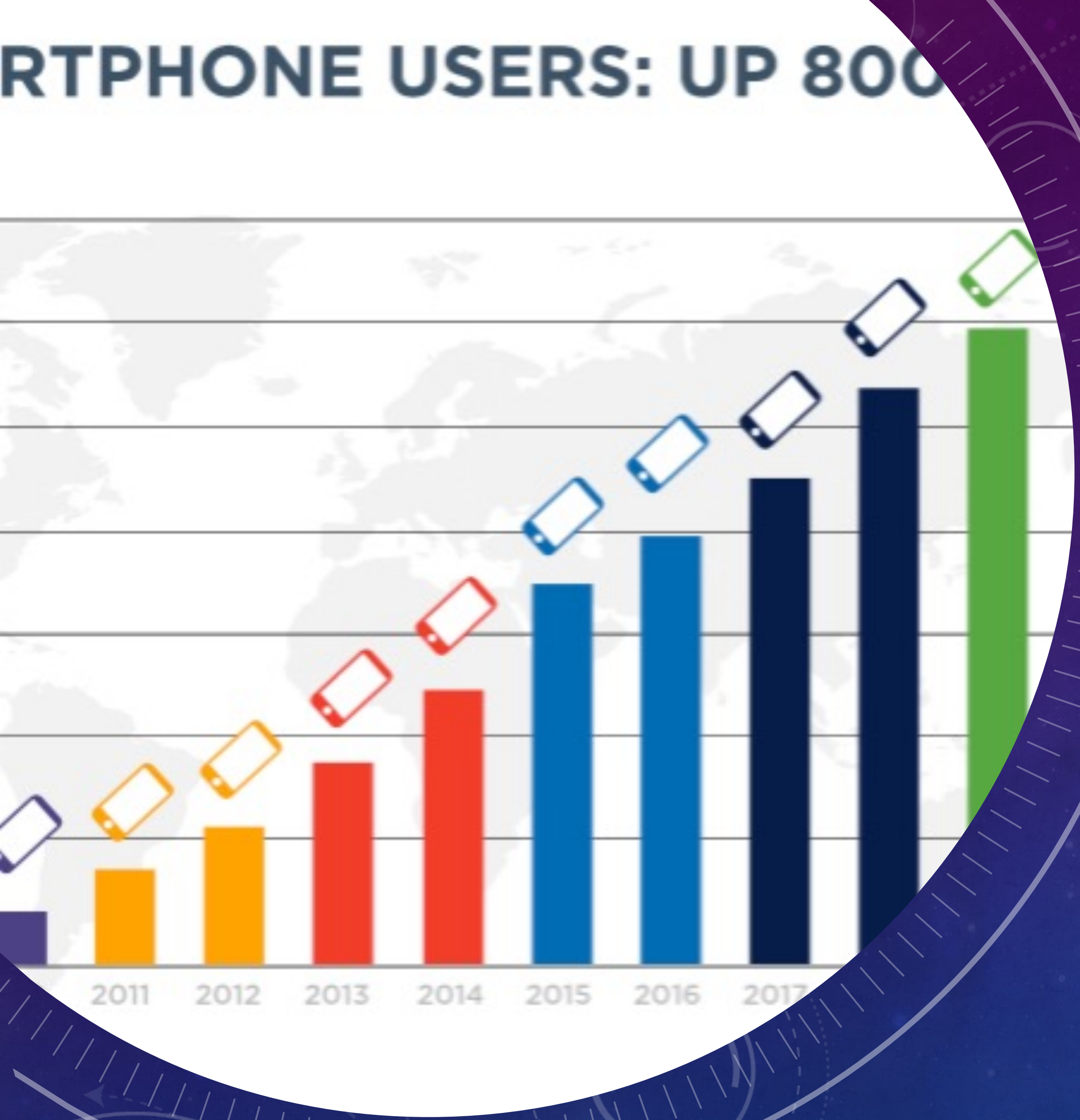
GLOBAL SYSTEMIC RISK

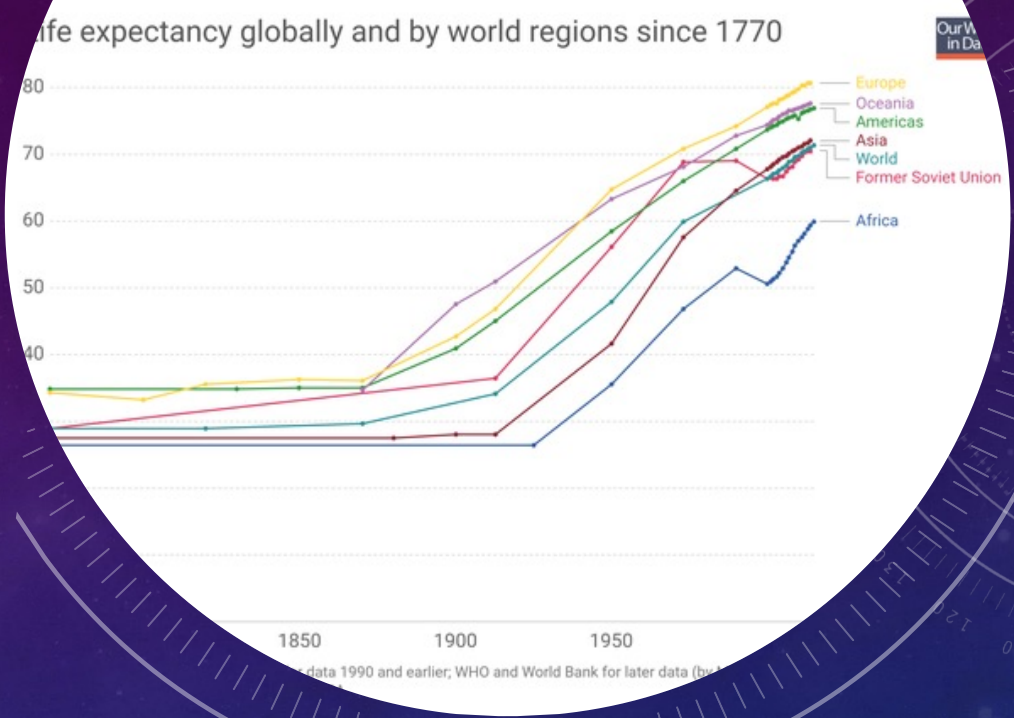
COLLOQIUM ON SYSTEMIC RISK
OCTOBER 27, 2022

AGENDA

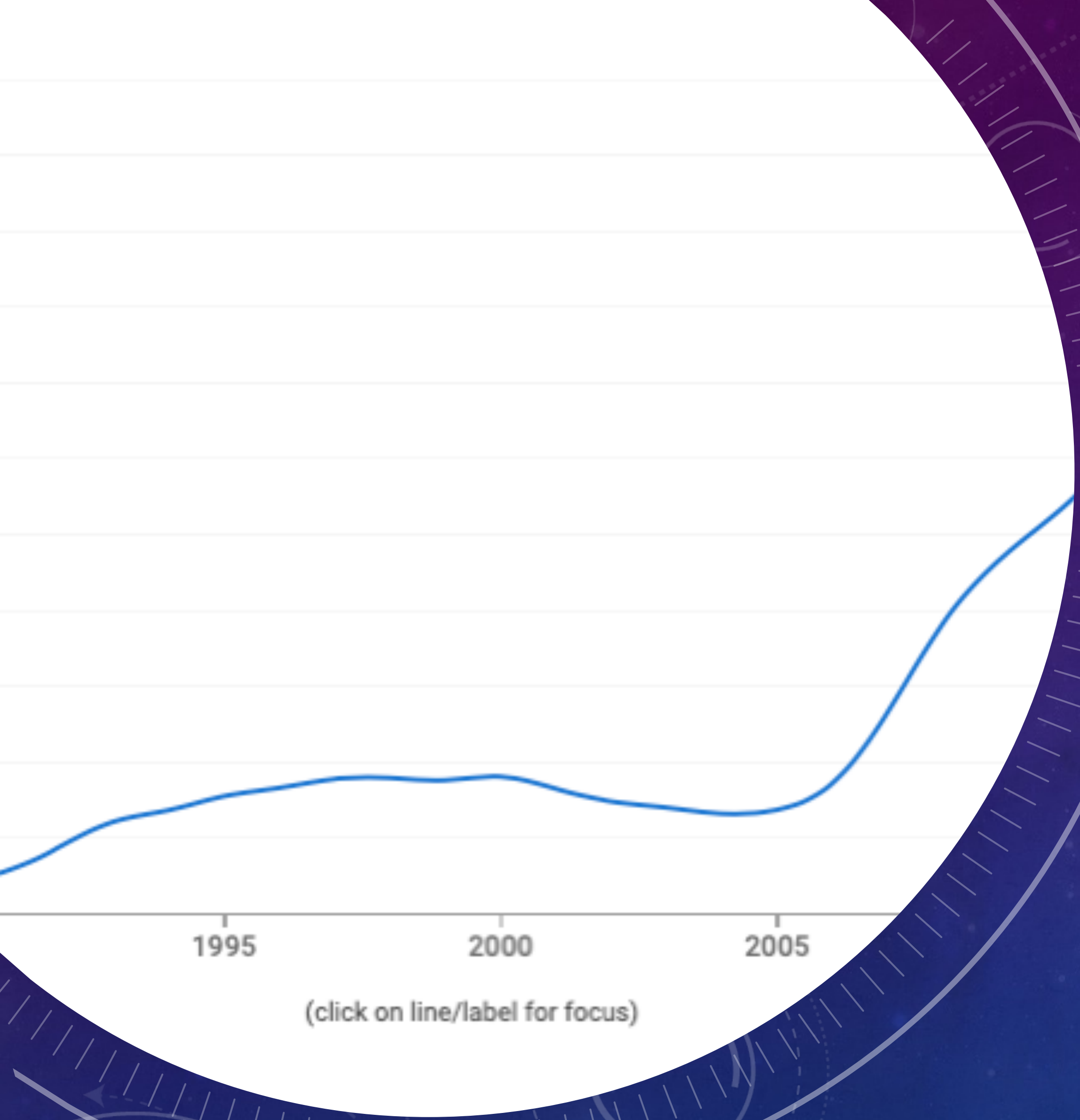
- Motivation
- Systems and Networks
- Global Systemic Risk
- Mechanisms of Risk
- Ukraine War as GSR
- Governance Solutions?

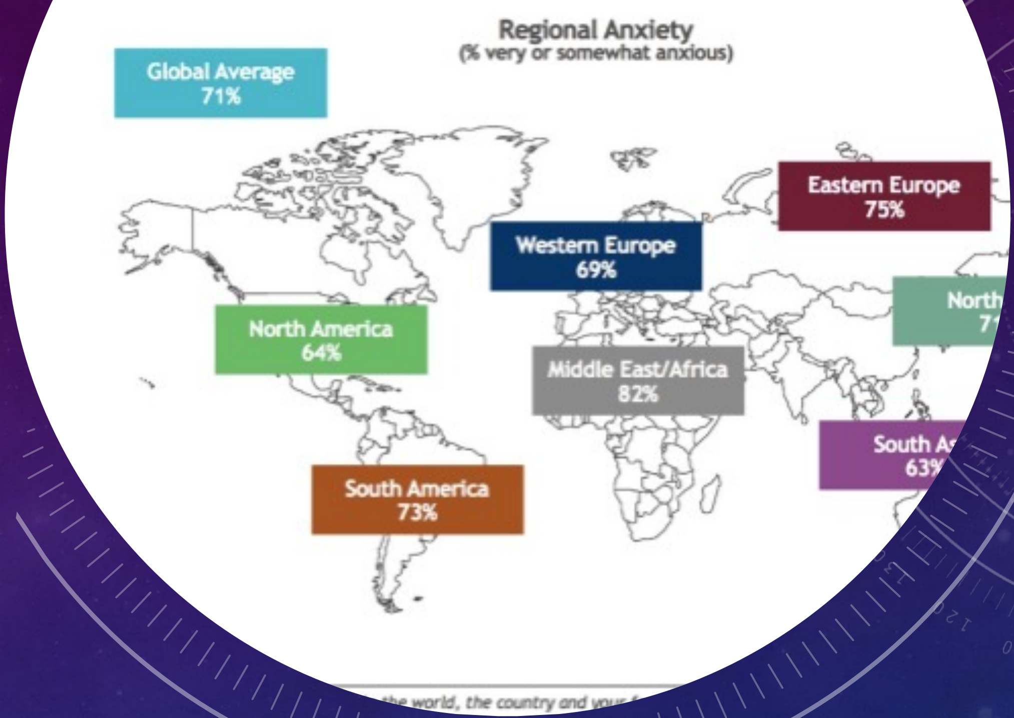
MOTIVATION





WE ARE TORN BETWEEN PLENTY AND….


1995
2000
2005
(click on line/label for focus)


Regional Anxiety
(% very or somewhat anxious)
Global Average 71%
Eastern Europe 75%
Western Europe 69%
North America 64%
Middle East/Africa 82%
South America 73%

…AND ANXIETY

AND THEN.....POLYCRISIS

HUBRIS

WHAT IS GSR?

RISK.PRINCETON.EDU

- Peter Callahan
- Miguel Centeno
- Paul Larcey
- Thayer Patterson

GLOBAL SYSTEMIC RISK

The global system is the set of tightly coupled interactions that together allow for the continued flow of information, money, goods, services, and people.

Though these connections are not in themselves new, the level of interdependence, the tight couplings between many of these domains, and the speed and scale of interactions have created new configurations of opportunity and risk.

We investigate the causes and consequences of global systemic risk (GSR) through the analysis of human-made networks and the robustness or fragility of these structures to endogenous forces and exogenous shocks.

Investigate the theoretical and methodological approaches to analyzing the construction and dynamics of complex systems and their inherent robustness and fragility.

COMPLEX ADAPTIVE SYSTEMS

Complex adaptive systems arise endogenously out of the interactions of components, and have collective behaviors that cannot be reduced to those of their components

The complex interactions of components create new dynamics that cannot be explained solely by the behavior of constituents, whether intended or not

Such systems can often give the appearance of stability even as their fragility increases

This fragility is due to the fact that complex systems may gradually become susceptible to small perturbations that have catastrophic results.

GLOBALIZATION AS A COMPLEX SYSTEM

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Modern systems are built to exploit the benefits and efficiencies resulting from specialization of labor, economies of scale, collective knowledge and information sharing.

These same systems that underwrite our way of life also create expose us to catastrophic outcomes that may derive from the characteristics of the relationships themselves.

EDGE OF CHAOS

Systems that reach this threshold at the “edge of chaos” are particularly prone to sudden, nonlinear transitions from one state to another.

↓

Such critical transitions can be the result of either external perturbations or the endogenous functioning of the system itself, and are both difficult to forecast and potentially irreversible

↓

Systems that are both complex and densely interconnected are especially prone to “complexity catastrophe”

SYSTEMIC AND EMERGENT RISK

- Systemic risk is risk to the “system” that is posed by the interconnections or network of its constituent parts.
  - About connections, cascades and thresholds; it is about how local risk scales up to and develops as global risk.
- Emergent risk arises from how individual parts are connected to form the whole, but – and this is the distinguishing point from systemic risk – *it is not reducible to the individual components.*

SYSTEMIC RISKS AND COLLAPSE

We define "**systemic risk**" as the risk that a given system will experience a systemic collapse, driven primarily by endogenous forces, such that it can no longer fulfill its critical function through damage that is not easily undone.

A **systemic collapse** has taken place when 1) an event critically impairs the system's ability to perform its core function, 2) the collapse demonstrates hysteresis, and 3) although potentially triggered by an external shock, the main cause of the systemic collapse is endogenous systemic factors.

NO EXIT

- CAS may also provide a heuristic for the new level analysis required by a globalized world.
- We are living with a new and unprecedented level of aggregation of social space.
- The sheer quantity and breadth of interactions may require a shift in our analysis of interdependence.
- Such interdependence has produce a myriad of benefits, but potential instability may be an endogenous characteristic of a system as complex as what we have created.
- Not enough time for “market solutions”

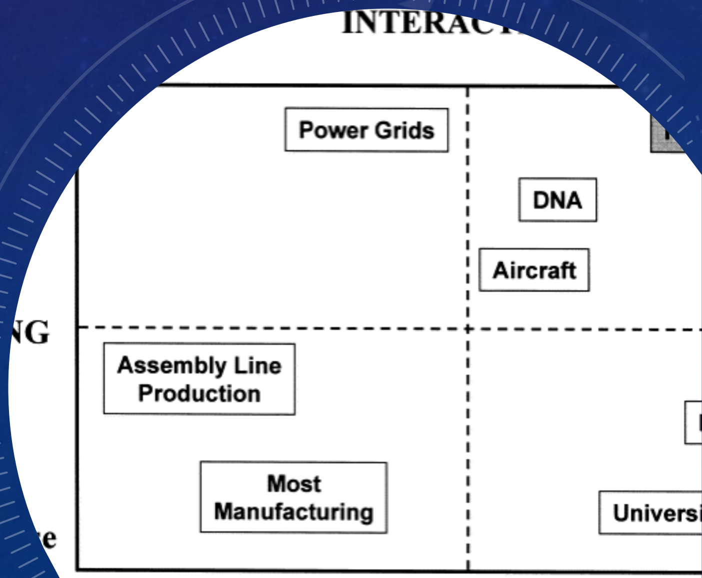
EFFICIENCY VS. FRAGILITY

- An increasing emphasis on efficiency in these global systems has given rise to advances like just-in-time inventory and the elimination of redundancy, which has increased productivity and enabled tremendous gains in the profitability of these systems worldwide.
- These changes, however, make the systems operate at tighter tolerances with increasing dependence on technology, which makes them less resilient and heightens the potential of a costly systemic event.

MECHANISMS OF GSR

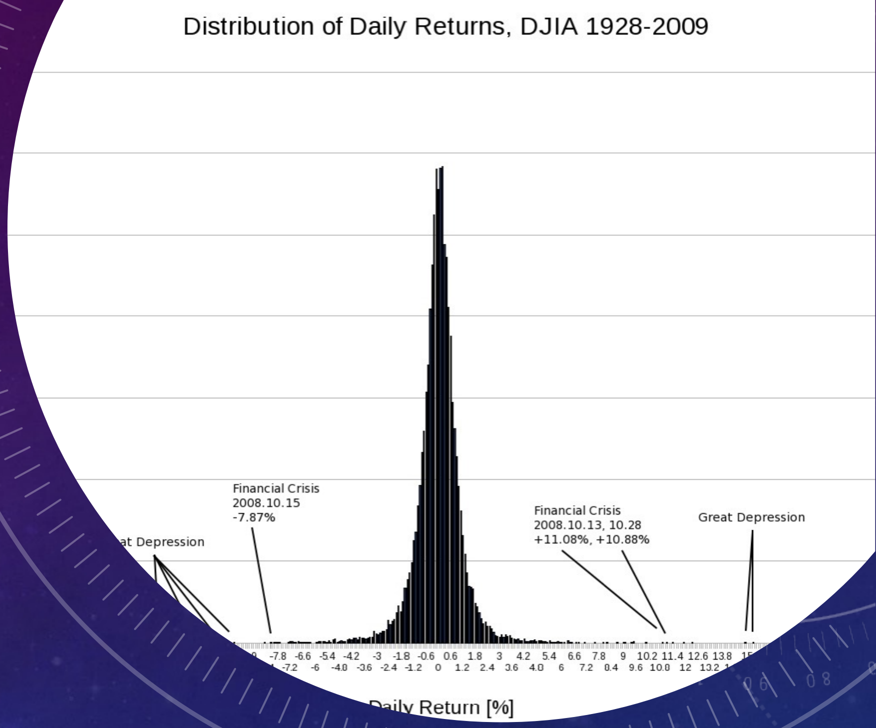
NORMAL ACCIDENTS

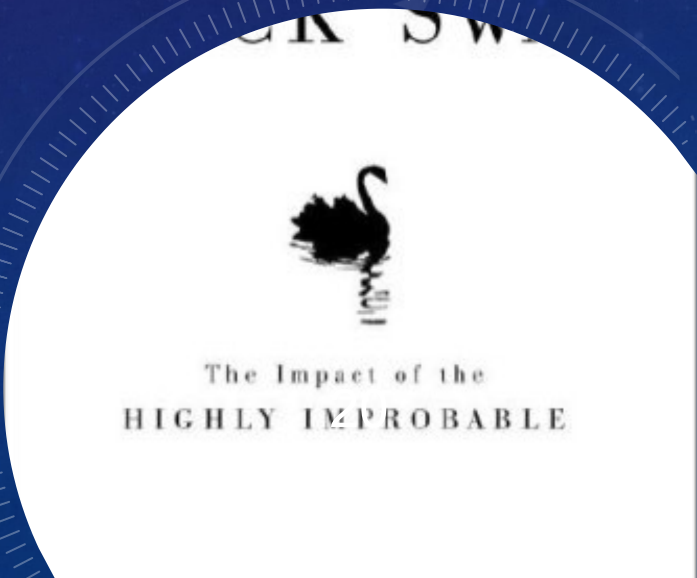
- Inherent unpredictability of complex and tightly coupled interactions



BLACK SWANS

- With any event there are “tails” to the probability distribution that make the non-probable possible.
- The number and complexity of transactions and interactions makes any kind of conventional description or analysis arguably impossible to compute or comprehend. Mathematical combinatorics shows us that with just 100 agents or actors in a system, there are 2^{100} (1.3×10^{30}) possible combinations or groups of these agents, there are 100- factorial (9.3×101^{57}) possible ways for 100 agents to be ranked or ordered, and as you linearly increase a system with *n* agents by adding one more agent, the number of pairwise links in the system increases by *n*—the larger the system, the faster its potential complexity grows with each additional element.



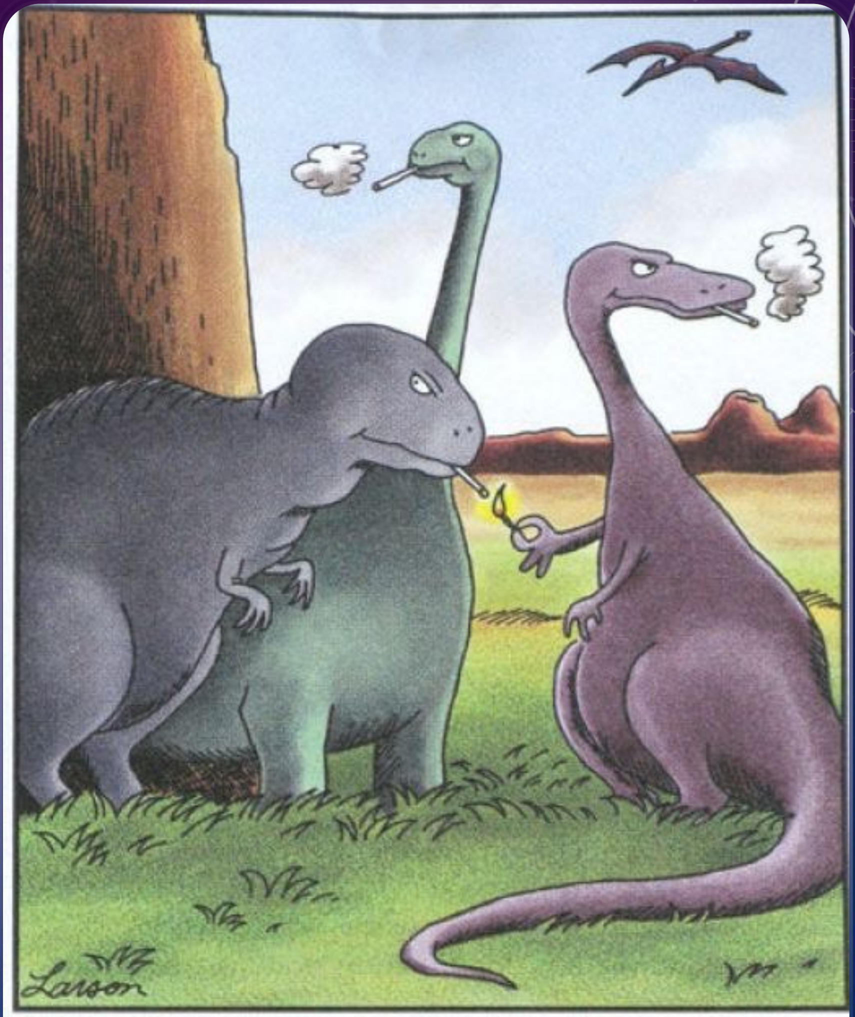


EXOGENOUS

- Conquest
- Disease
- Climate shift (not self induced)
- Alien lizards
- Bad luck

ENDOGENOUS

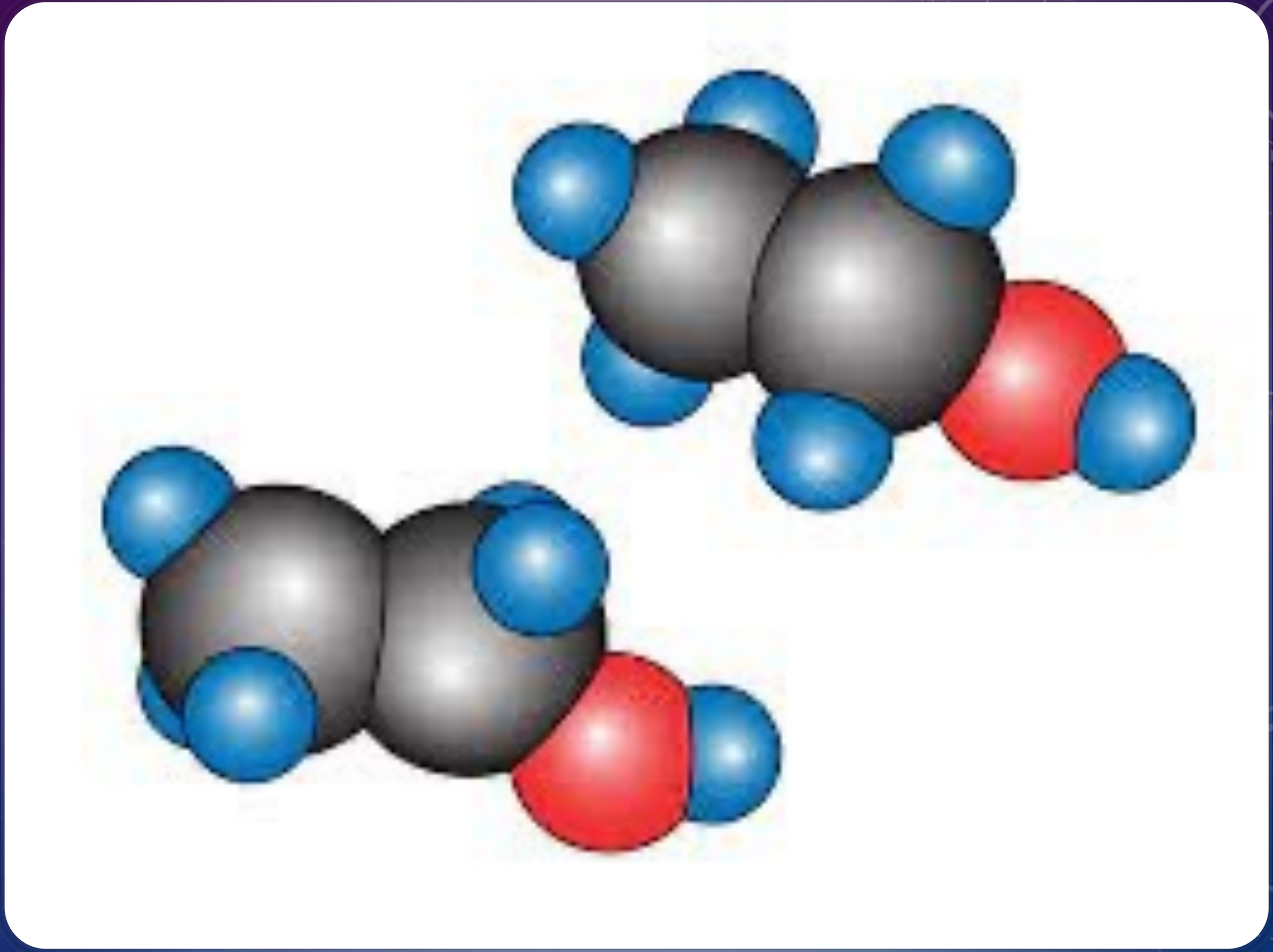
- Loss of legitimacy
- Unsustainable inequality
- Elite splits
- Normal accident
- Emergent properties
- Hyperbolic discounting
- Overuse of resources
- Fear itself?



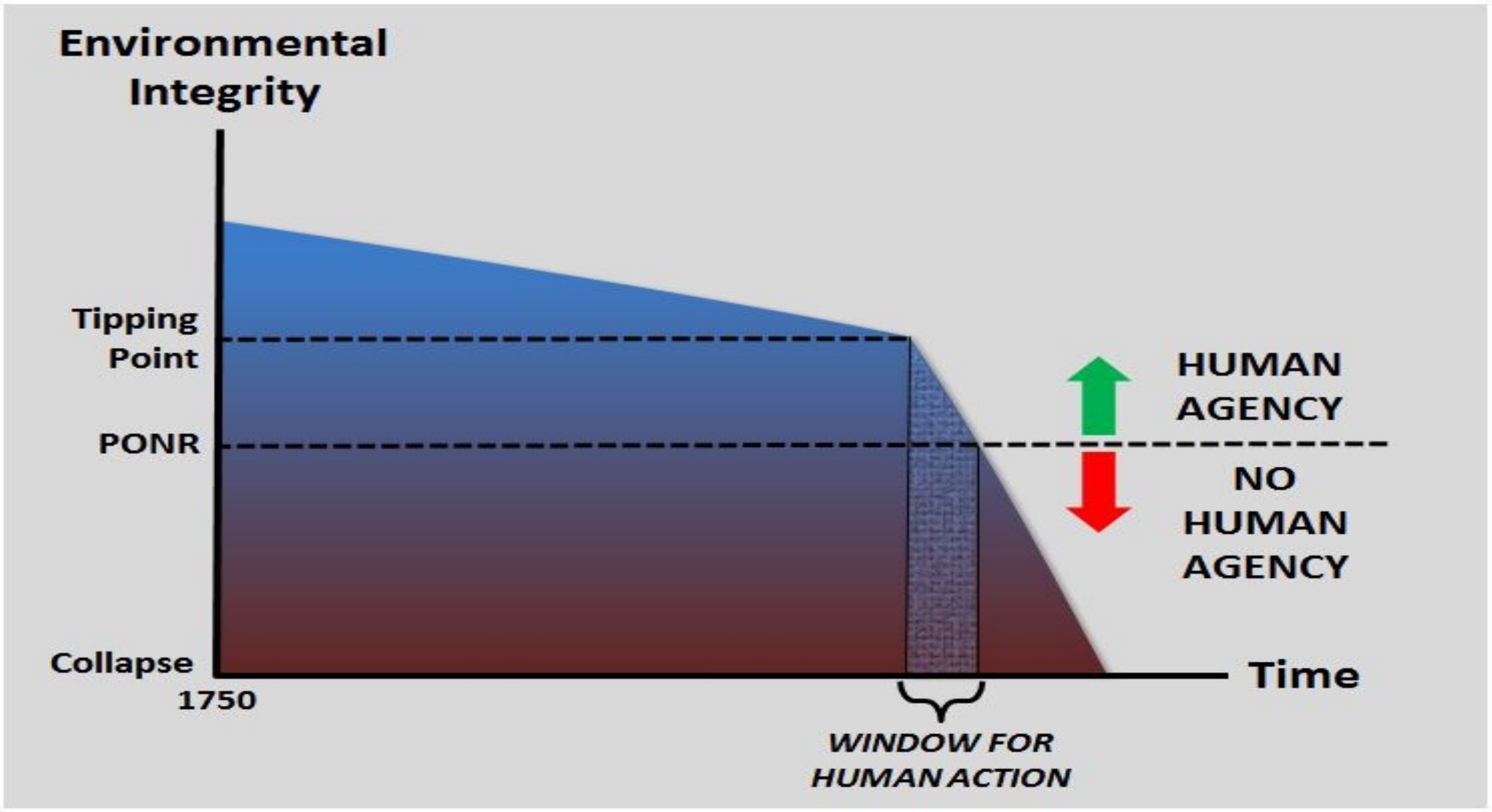
The real reason dinosaurs became extinct

INTERACTION EFFECTS

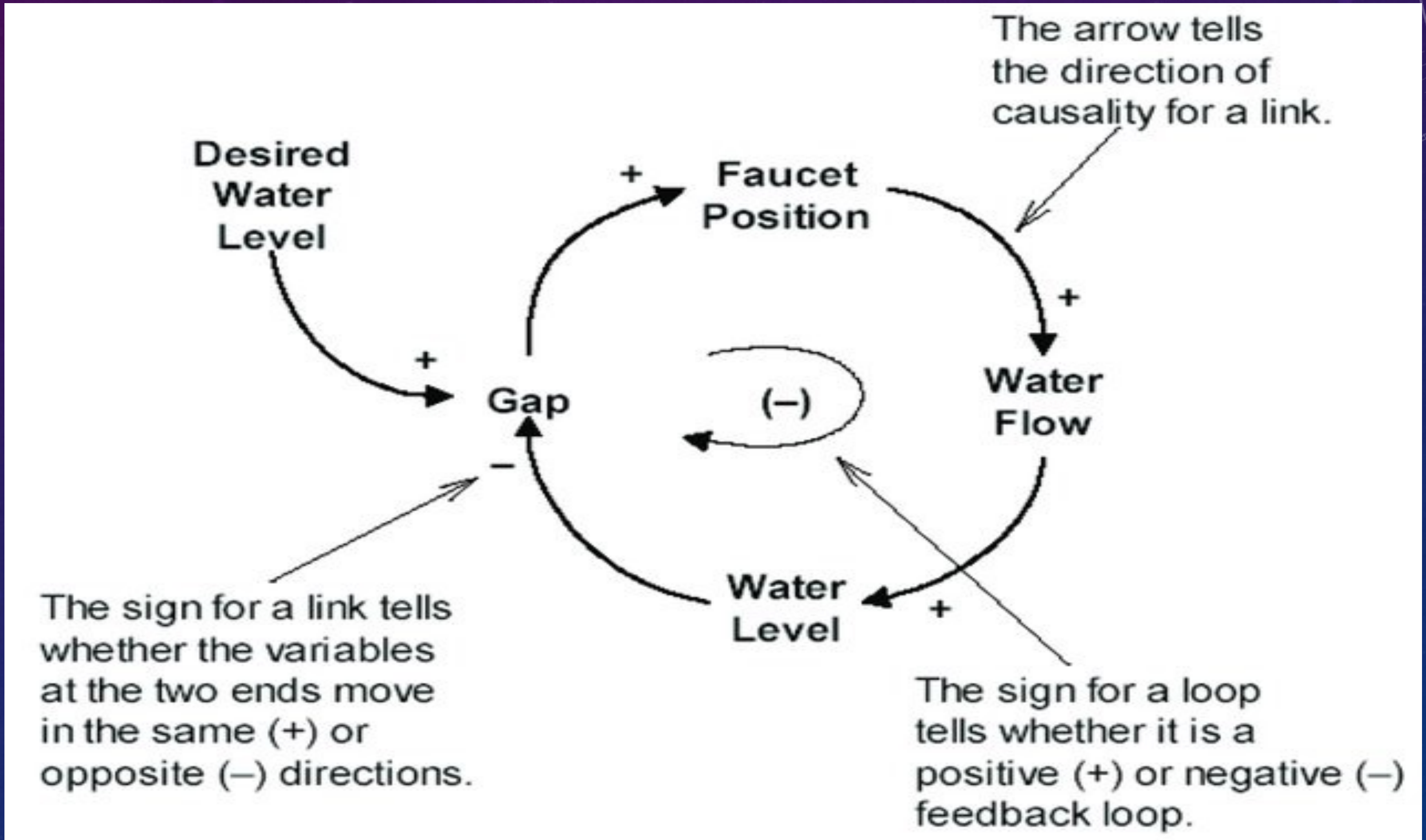
- *"The most interesting causes of collapse may not be the specific factors that initiate the process, but the structure that allows perturbation to amplify through the system."*
  -



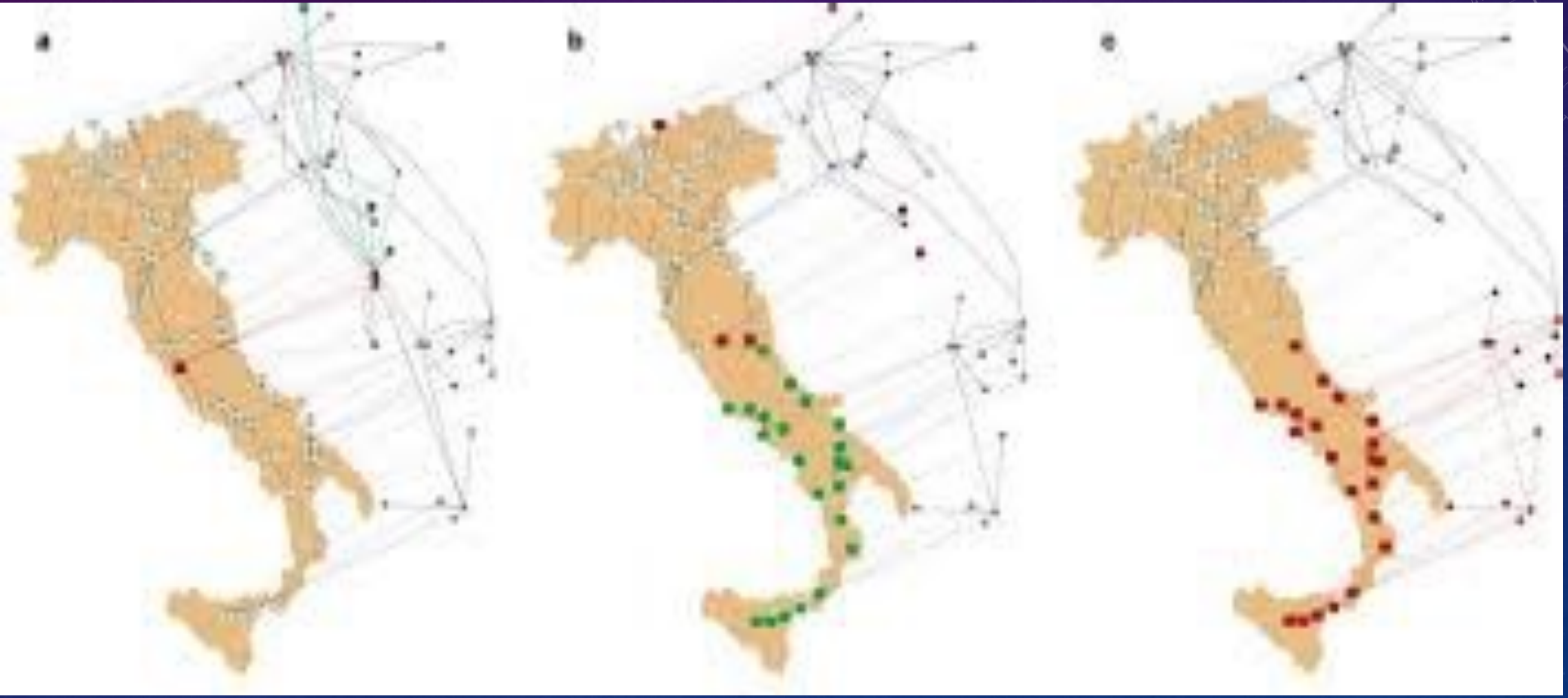
TIPPING POINTS



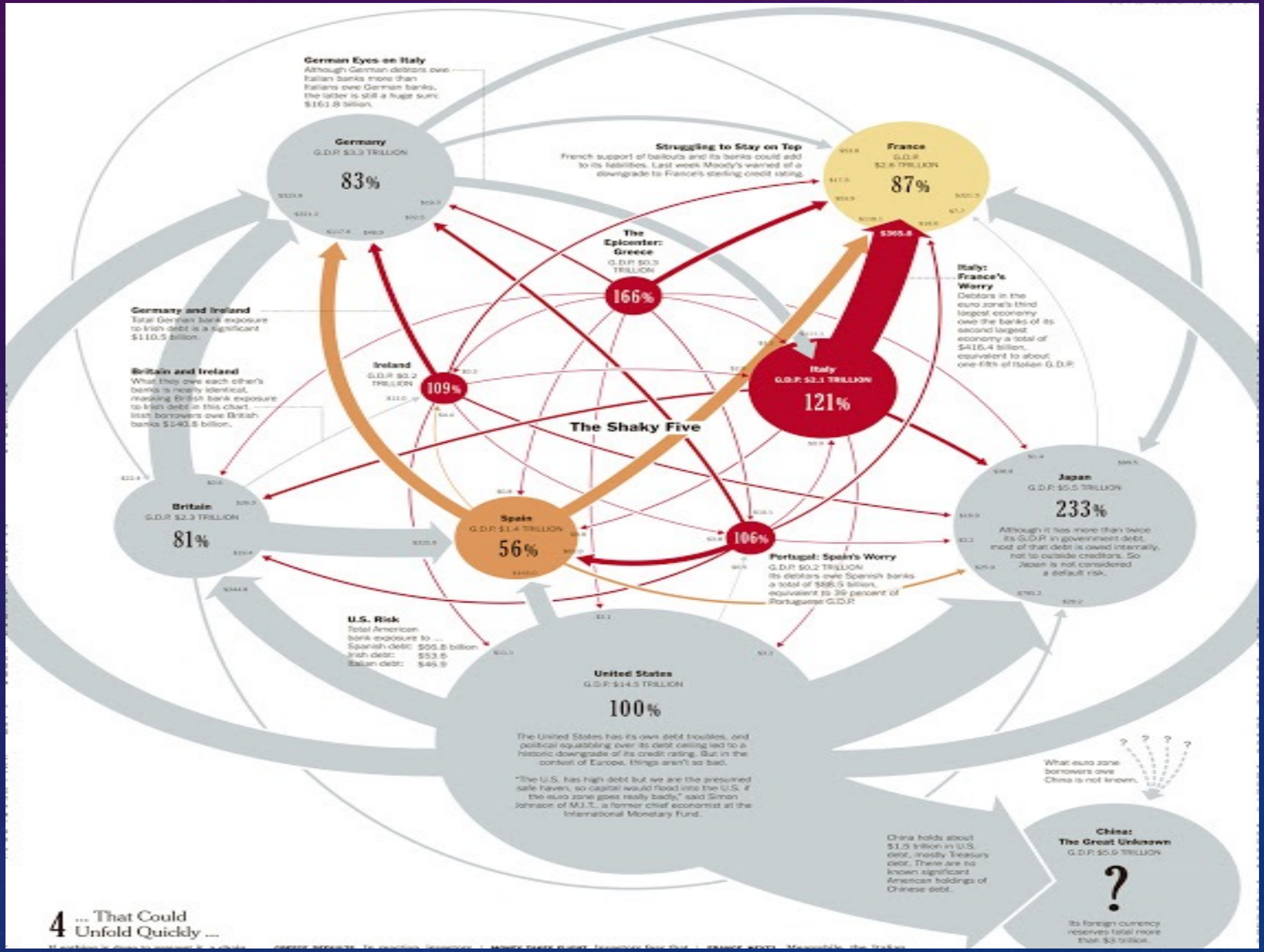
FEEDBACK LOOPS



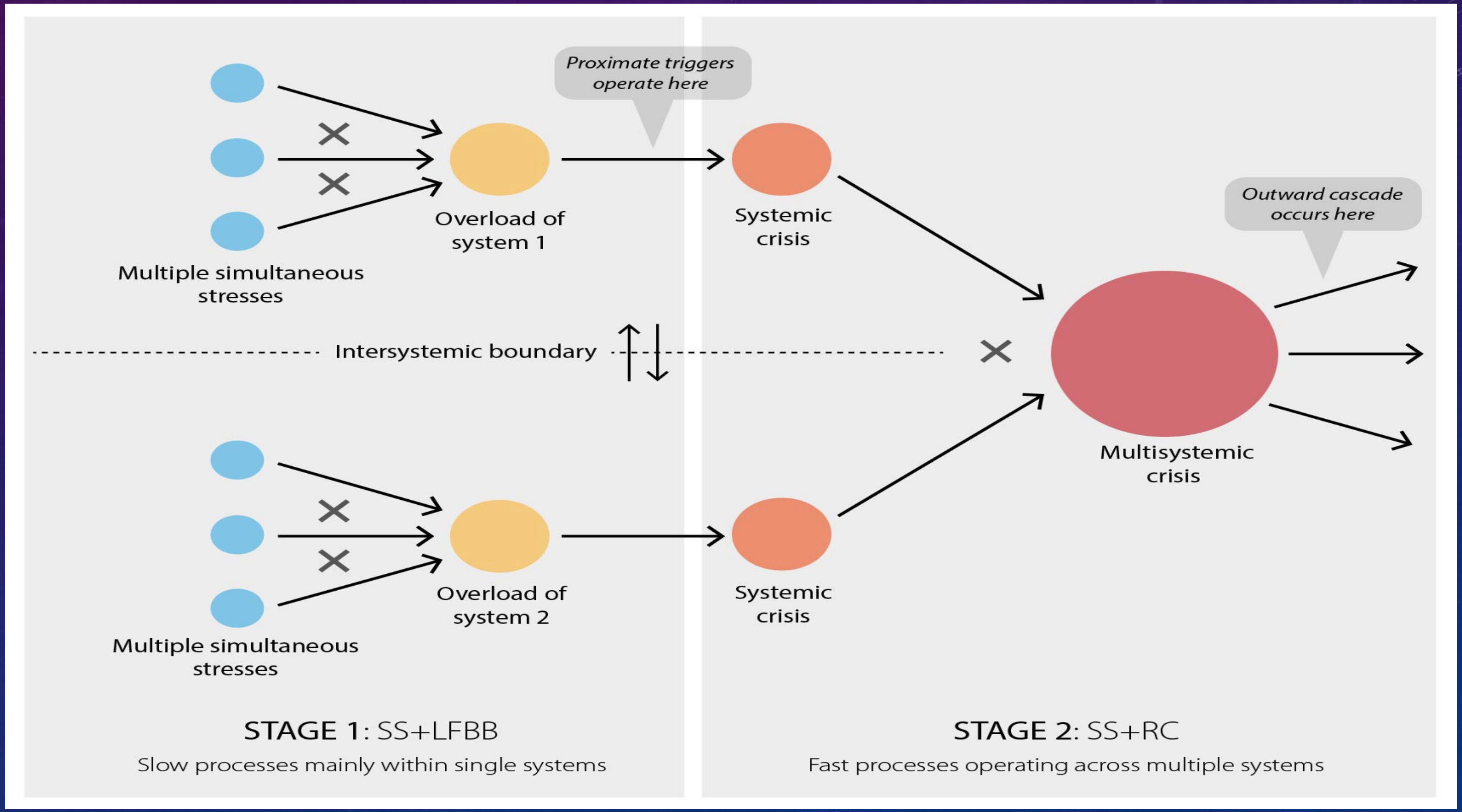
CASCADE FAILURE



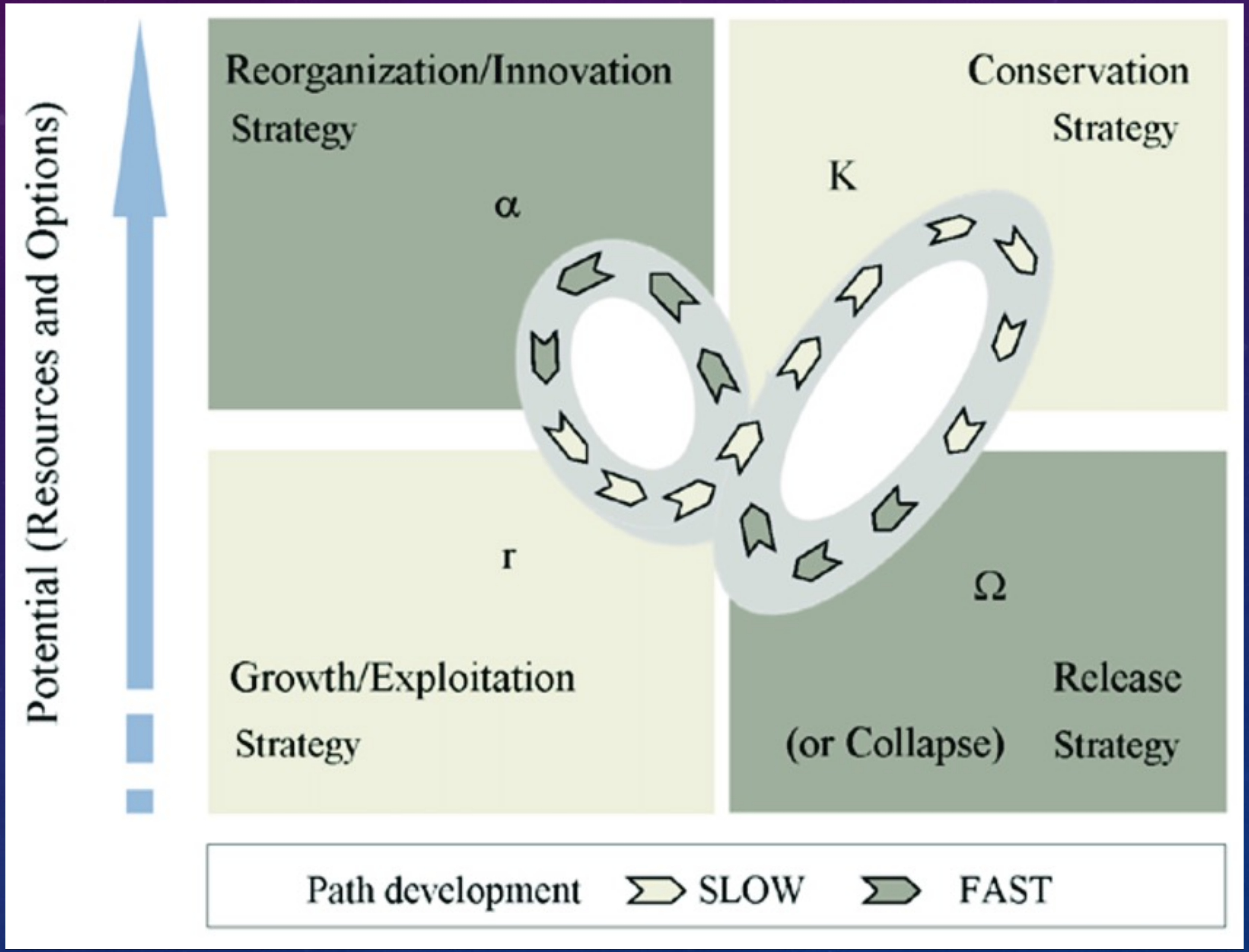
CONTAGION


German Eyes on Italy
Although German debtors owe Italian banks more than Italians owe German banks, the latter is still a huge sum: $161.8 billion.
Germany
G.D.P. $3.3 TRILLION
83%
Struggling to Stay on Top
French support of bailouts and its banks could add to its liabilities. Last week Moody's warned of a downgrade to France's sterling credit rating.
France
G.D.P. $2.6 TRILLION
87%
$365.8
The Epicenter: Greece
G.D.P. $0.3 TRILLION
166%
Italy: France's Worry
Debtors in the euro zone's third largest economy owe the banks of its second largest economy a total of $416.4 billion, equivalent to about one-fifth of Italian G.D.P.
Germany and Ireland
Total German bank exposure to Irish debt is a significant $110.5 billion.
Britain and Ireland
What they owe each other's banks is nearly identical, masking British bank exposure to Irish debt in this chart. Irish borrowers owe British banks $140.8 billion.
Ireland
G.D.P. $0.2 TRILLION
109%
Italy
G.D.P. $2.1 TRILLION
121%
The Shaky Five
Japan
G.D.P. $5.5 TRILLION
233%
Although it has more than twice its G.D.P. in government debt, most of that debt is owed internally, not to outside creditors. So Japan is not considered a default risk.
Britain
G.D.P. $2.3 TRILLION
81%
Spain
G.D.P. $1.4 TRILLION
56%
106%
Portugal: Spain's Worry
G.D.P. $0.2 TRILLION
Its debtors owe Spanish banks a total of $88.5 billion, equivalent to 39 percent of Portuguese G.D.P.
U.S. Risk
Total American bank exposure to ...
Spanish debt: $66.8 billion
Irish debt: $53.6
Italian debt: $46.9
United States
G.D.P. $14.5 TRILLION
100%
The United States has its own debt troubles, and political squabbling over its debt ceiling led to a historic downgrade of its credit rating. But in the context of Europe, things aren't so bad.
"The U.S. has high debt but we are the presumed safe haven, so capital would flood into the U.S. if the euro zone goes really badly," said Simon Johnson of M.I.T., a former chief economist at the International Monetary Fund.
What euro zone borrowers owe China is not known.
China holds about $1.5 trillion in U.S. debt, mostly Treasury debt. There are no known significant American holdings of Chinese debt.
China: The Great Unknown
G.D.P. $5.9 TRILLION
?
Its foreign currency reserves total more than $3 trillion.
4 ... That Could Unfold Quickly ...

SYNCHRONOUS FAILURE



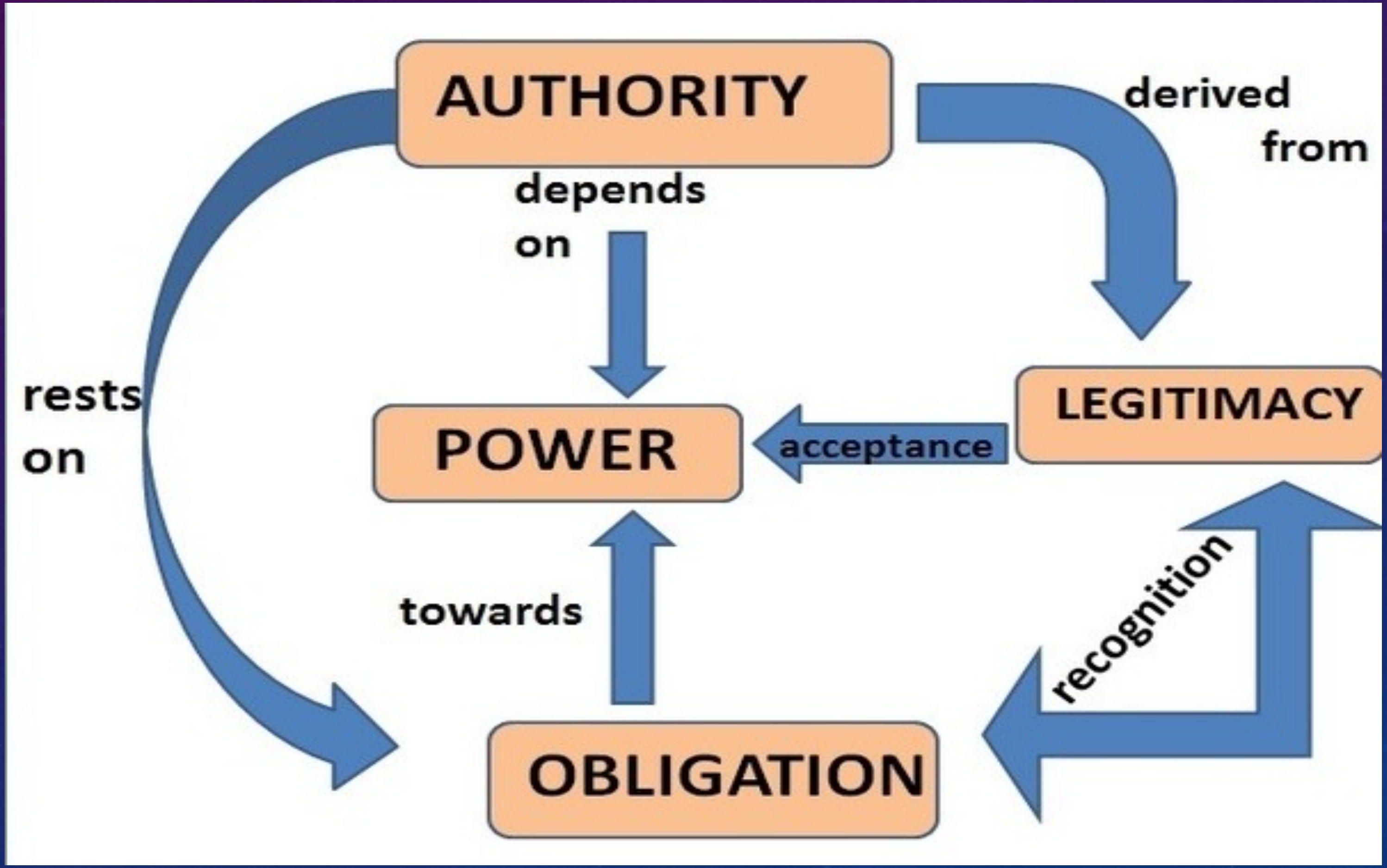
CYCLES



Potential (Resources and Options)
Reorganization/Innovation
Strategy
α
Conservation
Strategy
K
r
Growth/Exploitation
Strategy
Ω
Release
(or Collapse)
Strategy
Path development
SLOW
FAST

TECHNOLOGY

LEGITIMACY


AUTHORITY
derived
from
depends
on
rests
on
POWER
acceptance
LEGITIMACY
towards
recognition
OBLIGATION

UKRAINE AND GSR

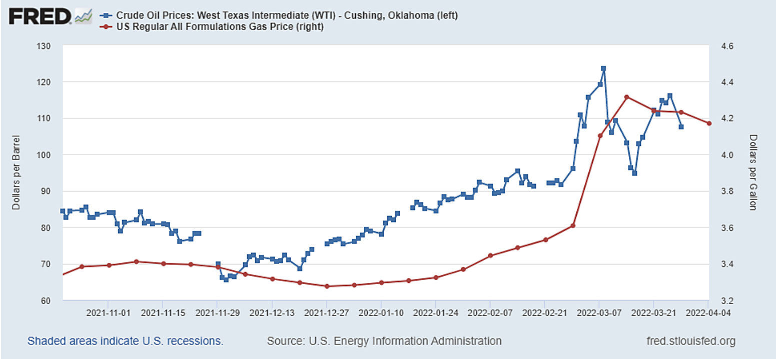
NOT A NEW ISSUE

UKRAINE AND FLOWS

ENERGY AVAILABILITY

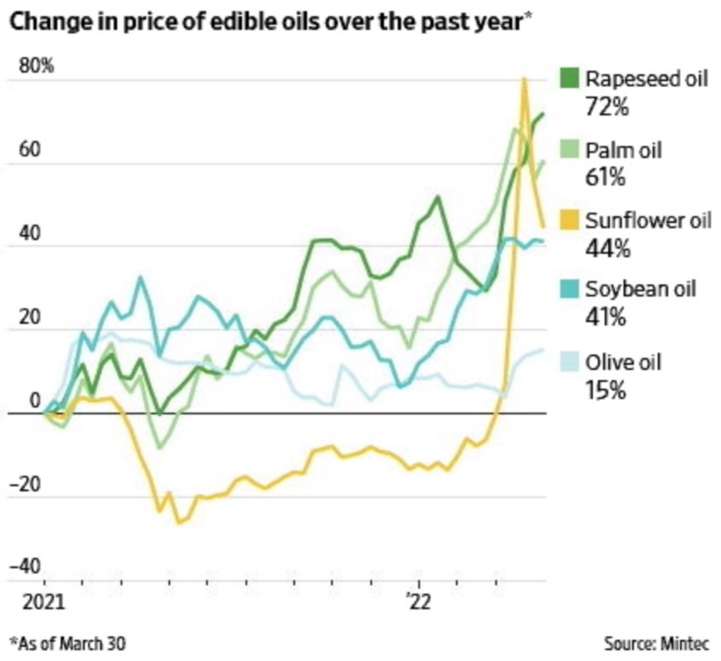
UKRAINE AND FLOWS

OIL PRICES



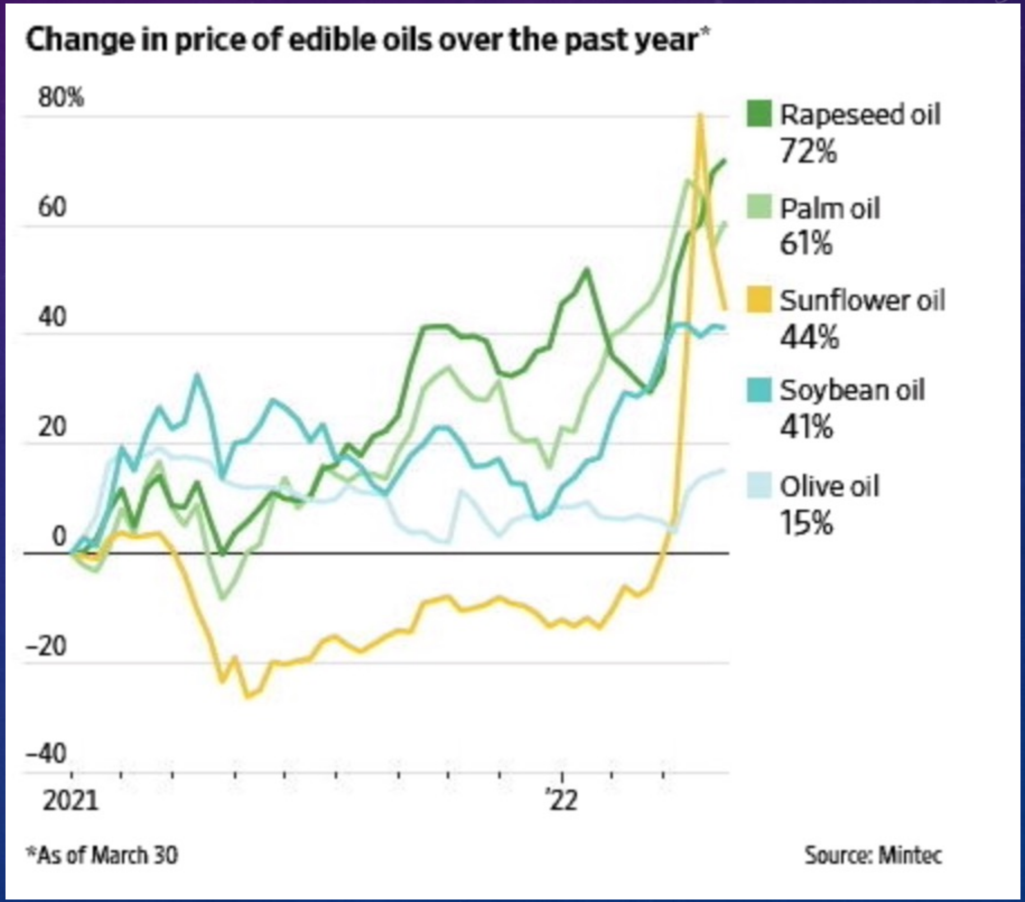
UKRAINE AND FLOWS

COOKING OIL



UKRAINE AND FLOWS

- COOKING OIL



UKRAINE AND FLOWS

CEREALS

UKRAINE AND FLOWS

FERTILIZER

UKRAINE AND FLOWS

PEOPLE

UKRAINE AND FLOWS

MONEY

UKRAINE AND STRUCTURES

BORDERS

UKRAINE AND STRUCTURES

ENVIRONMENT

UKRAINE AND STRUCTURES

RADIATION

THE ULTIMATE DANGER

HOW TO GOVERN WITH GSR

DEFINING THE PROBLEM I: EFFICIENCY VS. FRAGILITY

Institutional and systemic bias	• Growth and efficiency
Optimization of operating systems	• Just in time
Complexity of interactions	• Emergence
Reliance on non-sustainable resources	• Climate change will bring more instability

DEFINING THE PROBLEM II: GLOBAL VS. TERRITORY

DEFINING THE PROBLEM: WE ARE WHO WE ARE

- Selfish
- Opportunism (“self seeking behavior with guile”)
- Bounded Rationality
- Biases
- Mystery of collective behavior

STRATEGY I: WALLS VS. RESERVES

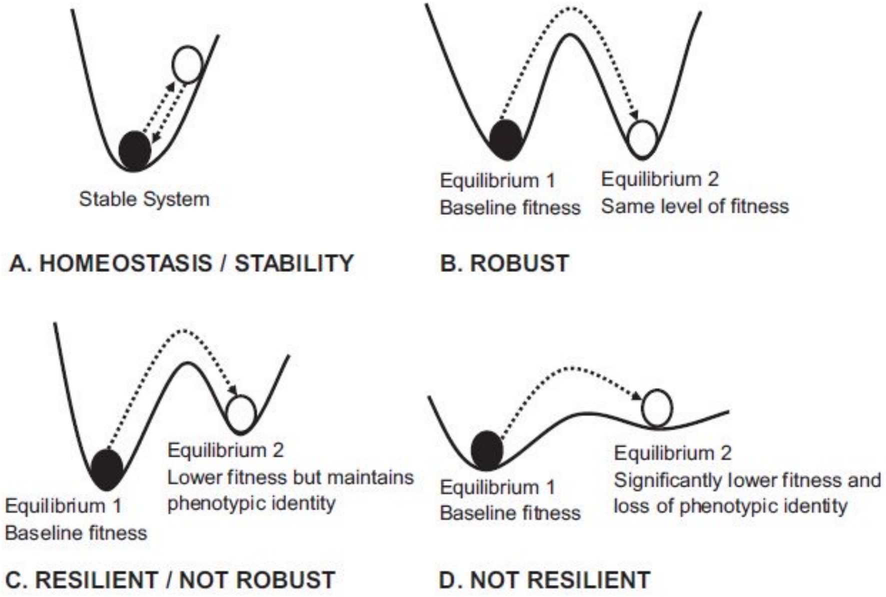
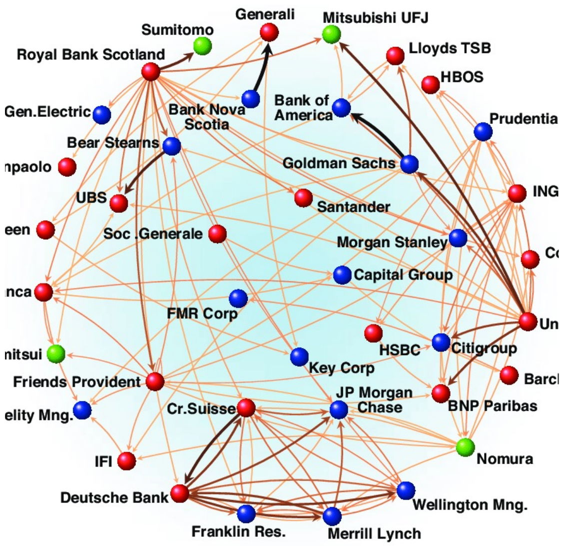


Figure 1. Hypothetical, abstract representation of possible responses of a physiological system to a clinical stressor. The solid circle represents the state of a physiological system. (a) Under small perturbations, the system establishes homeostasis and is stable. When perturbed by a stressor of sufficiently large magnitude, the system is displaced from its original state and establishes another equilibrium state. (b) The system is robust when it maintains its functionality intact under the new equilibrium. (c) The system is resilient when it maintains its essential functionality under the new equilibrium. (d) The system is nonresilient when it loses its essential functionality under the new equilibrium.



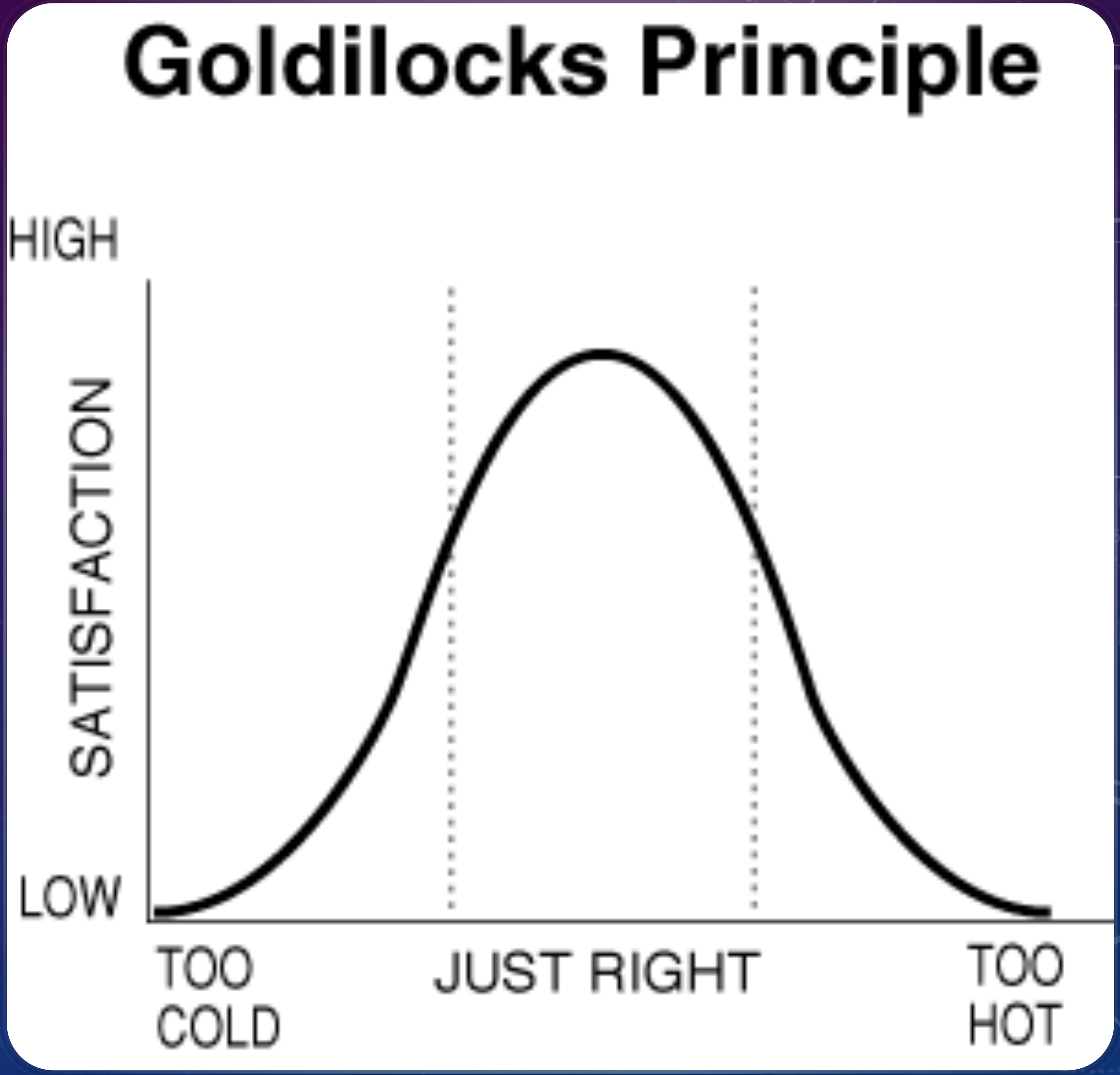
STRATEGY II: WHOM TO GOVERN

STRATEGY III: DEFINING WHO WINS AND WHO LOSES

OSTROM'S LAW:

- "A resource arrangement that works in practice can work in theory"
- Self organized governance
- Trust and (enforced) reciprocity

GETTING IT RIGHT?



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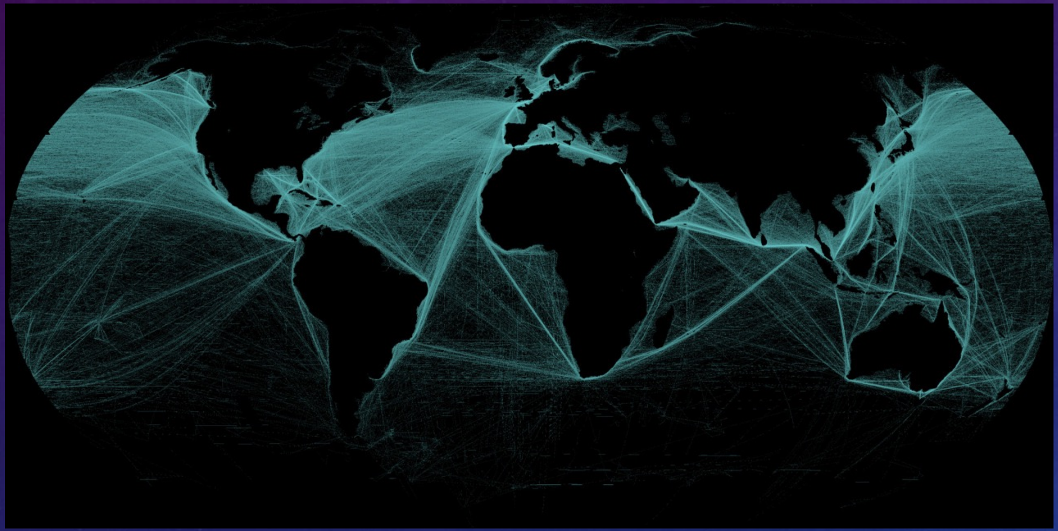

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