The Systems Science Framework

The Economy as a System

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Outline

- Motivation – both biophysical and ecological economics draw heavily upon concepts from **systems ecology**
- General systems science provides a structured framework for thinking about the economy as a system
- Principles of Systems Science provide a basis
- Applications of the principles to economics

Motivation

- The Systems Ecology heritage
  - Howard T. Odum (https://en.wikipedia.org/wiki/Howard_T._Odum)
- Ecological Economics – focus on the Ecos and its economic value in terms of life support
- Biophysical Economics – energy flow through the system and the support of economic work

The ‘Systems’ in Systems Ecology

- Systems ‘thinking’ – a necessary but not sufficient condition for ***understanding*** the world and how it works.
- Formal systems theories
  - Ludwig von Bertalanffy’s General Systems Theory (GST https://en.wikipedia.org/wiki/Ludwig_von_Bertalanffy)
  - Cybernetics and information theory
  - Energetics & thermodynamics extended
- Applications like system dynamics modeling, e.g. *Limits to Growth*, Meadows et al.

The ‘Problems’ with Systems Theory

- Has developed into disparate fields since the 1950s (control engineering, information theory, system dynamics, complexity science, etc.) – minimal integration
  - Typical evolution into academic silos
  - Each discipline tries to ‘explain’ phenomena in terms of their own focus
  - Competition for priority of mind space (and funding)
  - Abuse of terminologies (‘emergence’, ‘adaptive’, etc.)
- Non-unified perspective or way to understand the nature of systems

The ‘Systems Intuition’ in Heterodox Economics

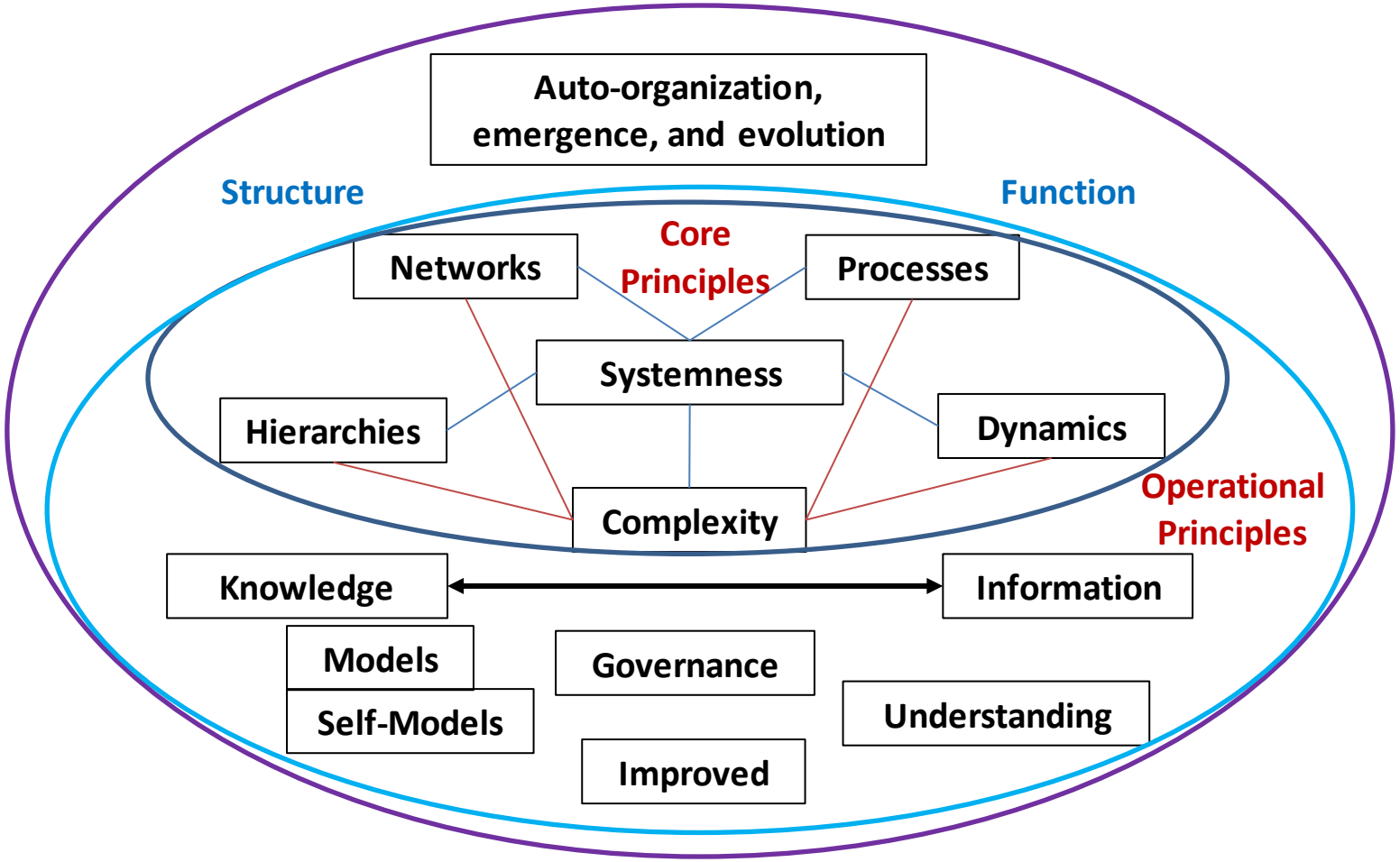
- **Open systems** concepts used in EE and BPE
- Neoclassical Economics treats the economy as a **closed system**, which is to say not a real system
- EE and BPE considering open systems and finite, non-renewable resources – take the larger meta-system of the ***Ecos*** into account

Ecos: Derived from Greek – Home. The planet Earth as a system with the human social system as a subsystem.

Principles of Systems Science*

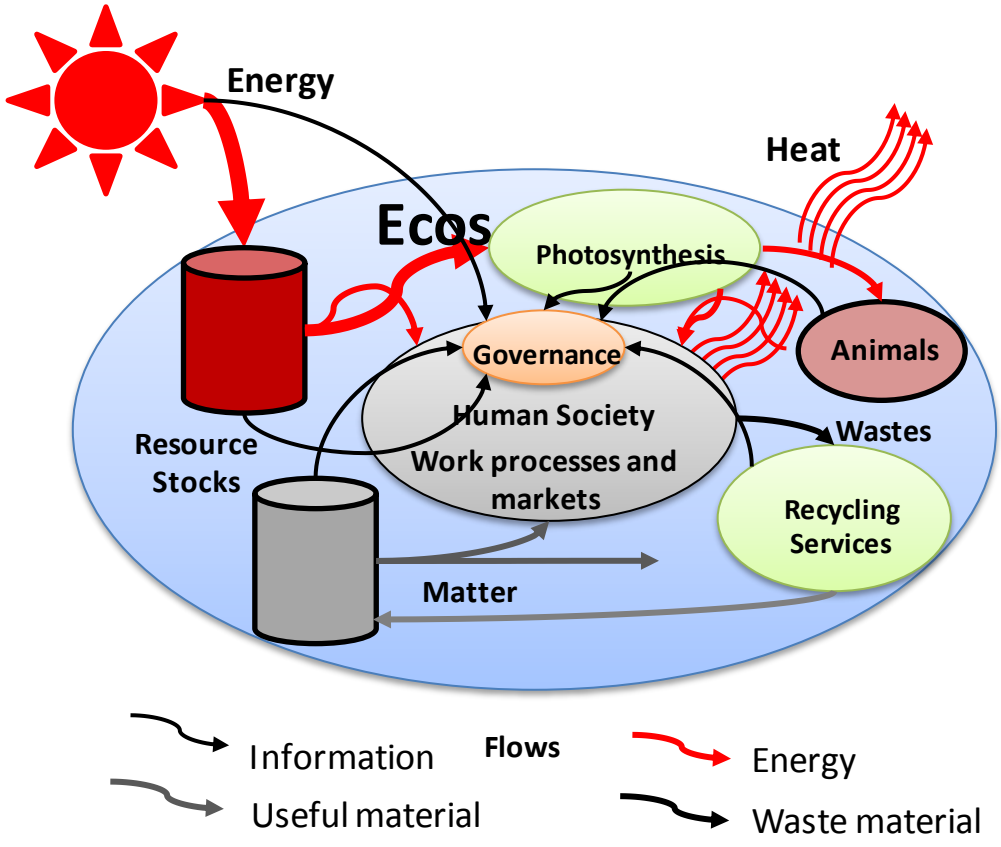
1. ***Systemness*:** Bounded networks of relations among parts constitute a holistic unit. Systems *interact* with other systems, forming yet larger systems. The universe is composed of systems of systems.
2. Systems are ***processes*** organized in *structural and functional hierarchies.*
3. Systems are themselves, and can be represented abstractly as, ***networks of relations*** between components.
4. Systems are ***dynamic*** on multiple time scales.
5. Systems exhibit various kinds and levels of ***complexity***.
6. Systems ***evolve*** to accommodate long-term changes in their environments.
7. Systems encode ***knowledge*** and receive and send ***information***.
8. Systems have ***governance*** subsystems to achieve stability.
9. Systems contain ***models*** of other systems (e.g. simple built-in protocols for interaction with other systems and up to complex anticipatory models).
10. Sufficiently *complex adaptive & evolvable* systems can contain ***self models***.
11. Systems can be ***understood*** (a corollary of #9) – Science.
12. Systems can be ***improved*** (a corollary of #6) – Engineering.

Principles Concept Map

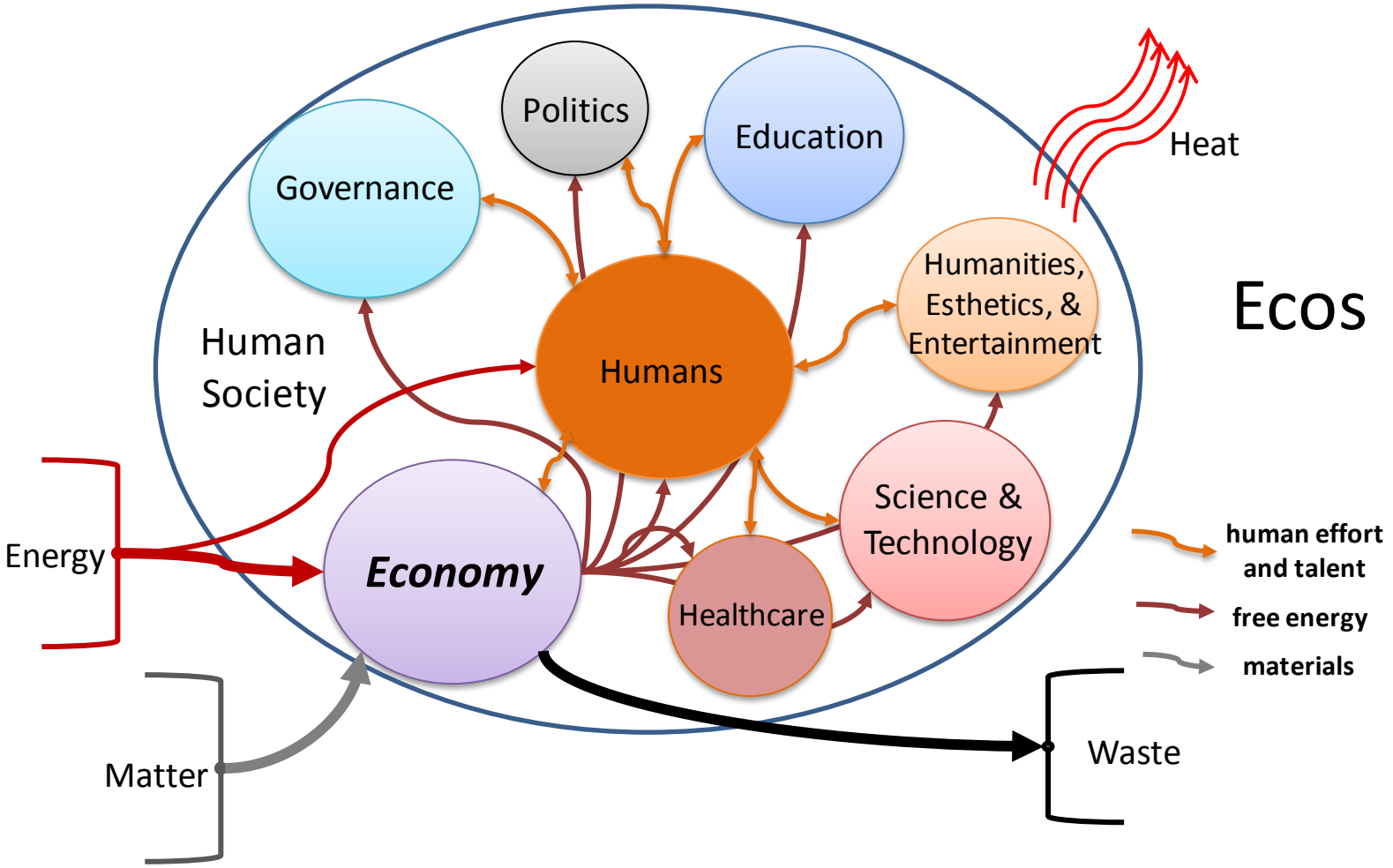


Principles Applied to Economics

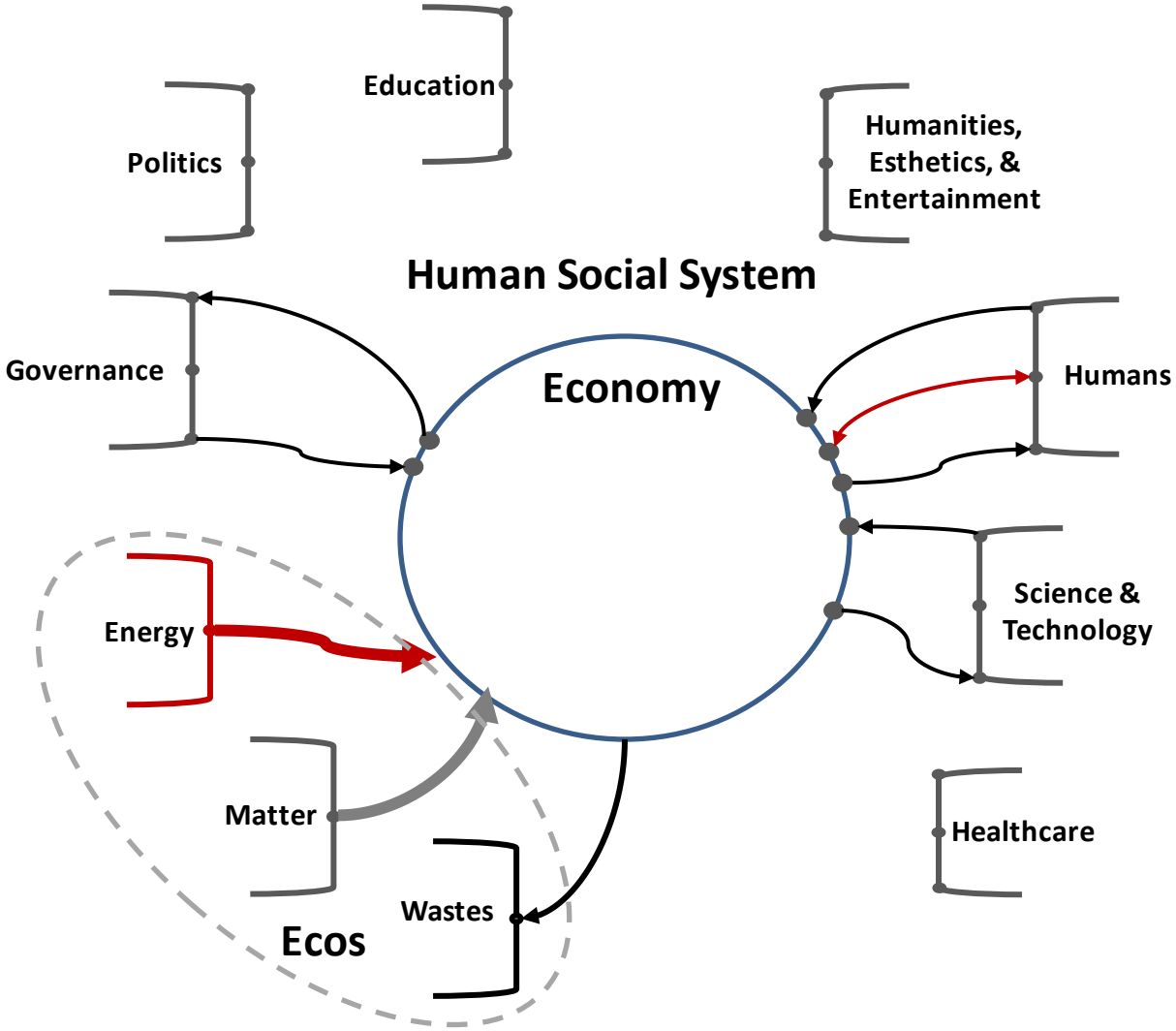
- The Economic System in context of the Human Social System and the greater Ecos



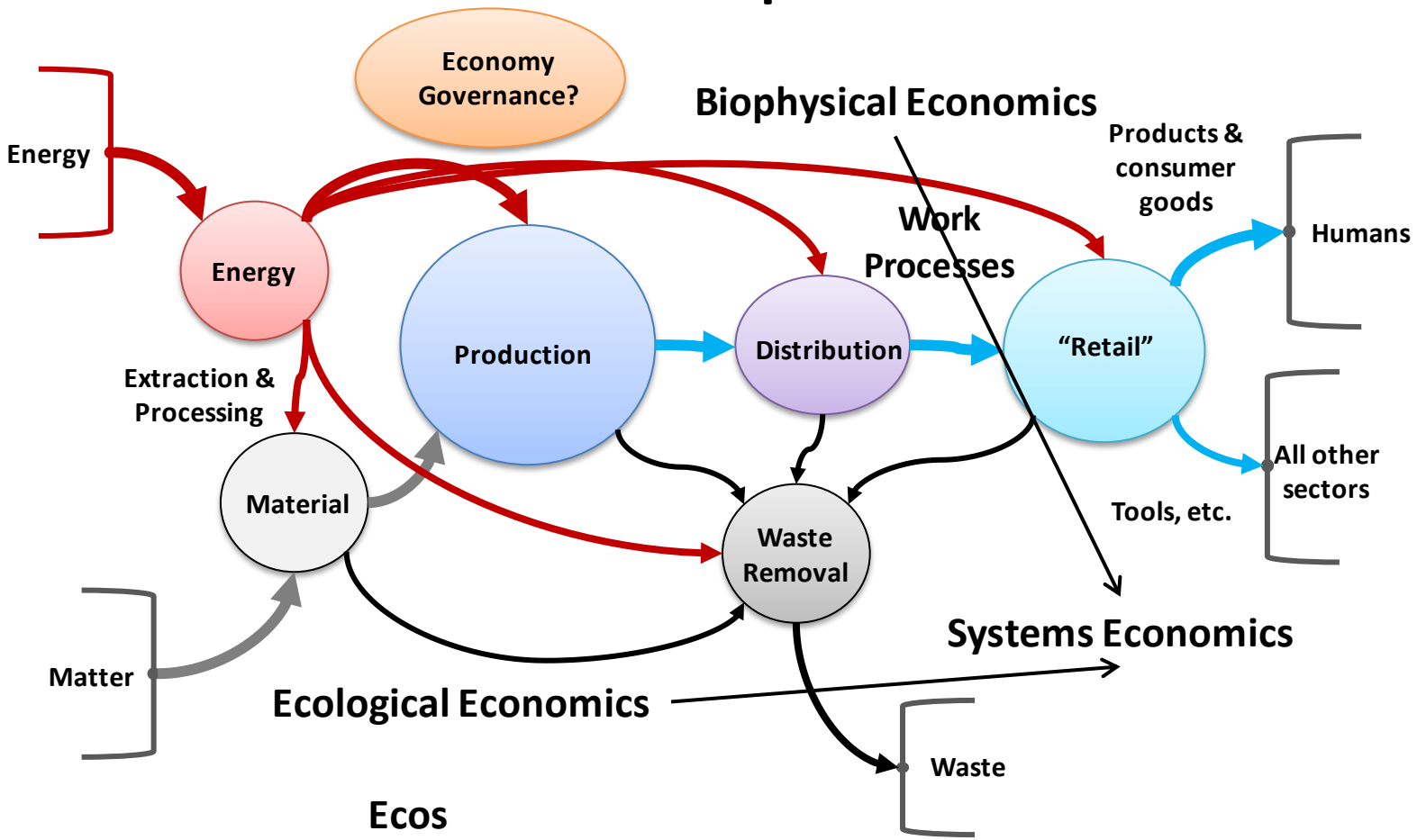
The Human Social System (HSS) Subsystems



The Economy Subsystem as System of Interest (SOI)

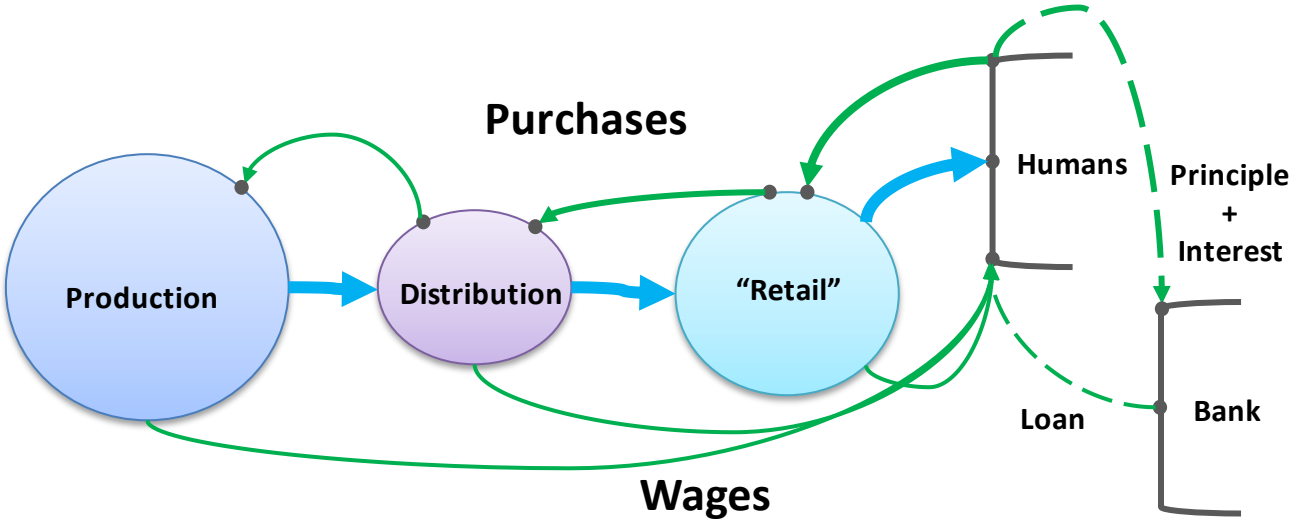


The Economy Subsystem (Cartoon) Decomposed



Role of Money – Information to Regulate Flows

- Money is a token in a message flow system used to convey information to control the flows of matter and energy
- Used to ‘buy’ goods and services
- Used to ‘buy’ physical and mental labor
- Markets as 1st order (primitive) governance



Systems Economics and Governance

- The markets provide a basic web of low-level information
- Various 2nd order regulatory processes
  - Government rules
  - Fourth estate feedback and impact
- Nebulous structures and functions
  - Usually developed ad hoc in response to crisis
  - Not organized (yet) according to hierarchical cybernetic principles
  - Example: debt financing in response to diminishing EROI of fossil fuels

Governance Subsystems in Nature

- Many examples of naturally evolved governance subsystems (esp. living systems)
- All such systems are hierarchical cybernetic systems (feedback and feedforward, etc.)
  - Operational management at lowest level
  - Coordination management just above operations
    - Logistical – coordinating internal operational processes
    - Tactical – coordinating whole system with its environment
  - ***Complex adaptive & evolvable systems*** (CAES, like the HSS, organizations, and the human brain) have a strategic management layer over the others

HSS & Economy Governance

- In the process of evolving and showing the *outlined structure of a hierarchical system*
- Added complexity of ***evolvability*** at a very immature stage (ability to learn new behaviors)
- Operational level governance reasonably well understood (e.g. corporate management)
- Coordination level poorly understood (let the market solve all problems!)
- Strategic level not understood at all (deadlock in congress, shared governance in academia!)

Understanding the Economy

- Decomposing the economy in this fashion exposes deviations from proven systems structures and functions and violations of principles
- Examination of the various information flows and hierarchy of governance mechanisms expose the flaws in standard economic theories
- The systems framework provides causal models of what is going on – needed for real prediction/anticipation

Notes, etc.

- * From Mobus & Kalton (2014). *Principles of Systems Science*, Springer, New York. Chapter 1