



System dynamics as a tool for economic analysis

Using examples of using systems dynamics to explore the connection between resources, society, politics and the economy in the service of preparing for the policies of tomorrow

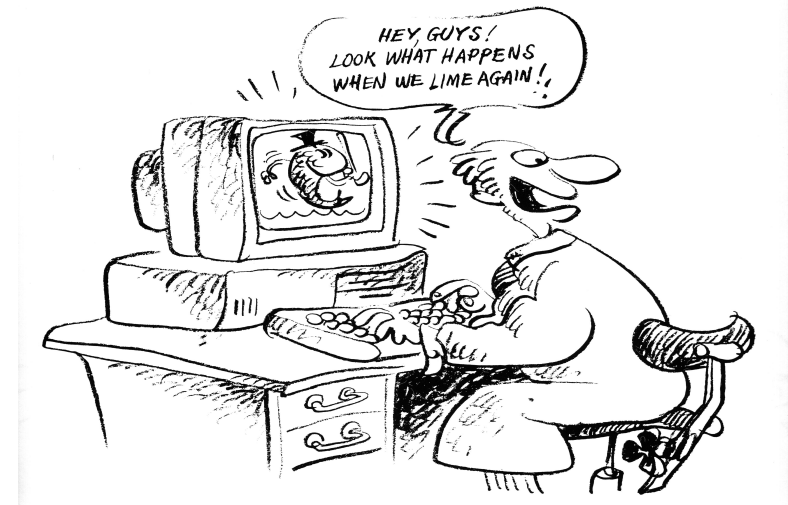
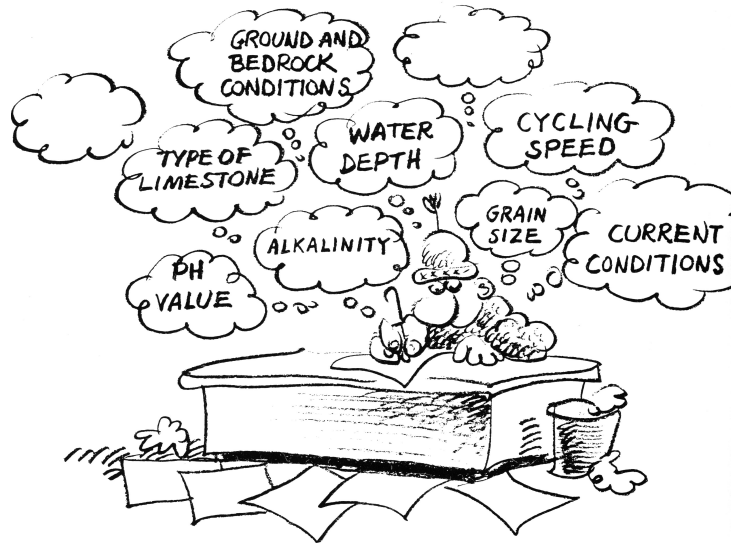


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Thinking is
modelling





- We need to find out what is going on....
- We can use systems analysis to understand
- We can use systems dynamics to predict

Approaches

- *Adaptive management* methods for model and product development and design
- Utilisation of *systems analysis* and *group modelling* as tools to systematise existing knowledge and synthesise the integrated knowledge-based know-how needed
- *Interdisciplinary approach*, combining political science, physical world modelling and modelling of social systems and interpersonal interactions
- *Process-oriented* integrated dynamic simulations engines
- Modelling of morality, norms, internal and external doctrines and social standards in *social dynamics*

The context of what we are doing

- International Resource Panel, United Nations Environmental Program, UN/UNEP-IRP
- Balaton Group – Future society think-tank
- Club of Rome – Limits to growth studies
- EU CONVERGE Project 2010-2013
- The SIMRESS project: Assists developing a German Resource policy strategy for 2050.

The SIMRESS goals

Globally and regionally applicable scenario-engine with better quality and performance than those existing for strategic analysis with the Great Powers with respect to national economy, strategic aspects of economy, long term environment, strategic resource use, national security, negotiation tactics and developments towards a more sustainable society



German future goals

- Climate
 - A climate-neutral base industry
 - Energy and heat production system
 - Metal production from recycling, ore and smelting
 - Cement and building material system
 - Manufacturing of consumer goods
 - A climate neutral society
 - Consumption
 - Transportation and logistics
 - Basic public services provision
 - Waste generation
- Food sufficiency and security:
 - Self-sufficient for subsistence food supply to the German population.
 - A climate neutral agro-food production system.
- Sustainable resource-base for supplying the industry with key raw materials
 - Metals supply security
 - Polymers and fibres availability
 - Energy sufficiency
 - Water sufficiency
 - Food production resource sufficiency and security
- Environmental protection (The Environmental goals of Germany)
 - Preservation of all significant ecosystems: Marine, aquatic, eolian and terrestrial: Atmospheric deposition or sulphur, nitrogen, ground-level ozone, heavy metals and persistent organic pollutants below the critical loads and levels for 95% of the final receptors. No systematic build-up of toxic substances in ecosystems, long term sustainable ecosystem service harvests.
 - Eutrophication prevention, protection of aquatic ecosystems and water quality
 - Eliminate endocrine disruptors and low-dose physiologically active pollution
 - Protect, develop and conserve natural habitats
- A sustainable society, based on a participatory democratic state, supported by a culture of tolerance, transparency, honesty and accountability and a sufficiency of basic public services provision.

Die drei wenden Deutschlands:

(The three turn-arounds of Germany)

- Energie-wende
- Ressource-wende
- Nachhaltigkeits-wende

Remember the old style (1960)
birthday parties?

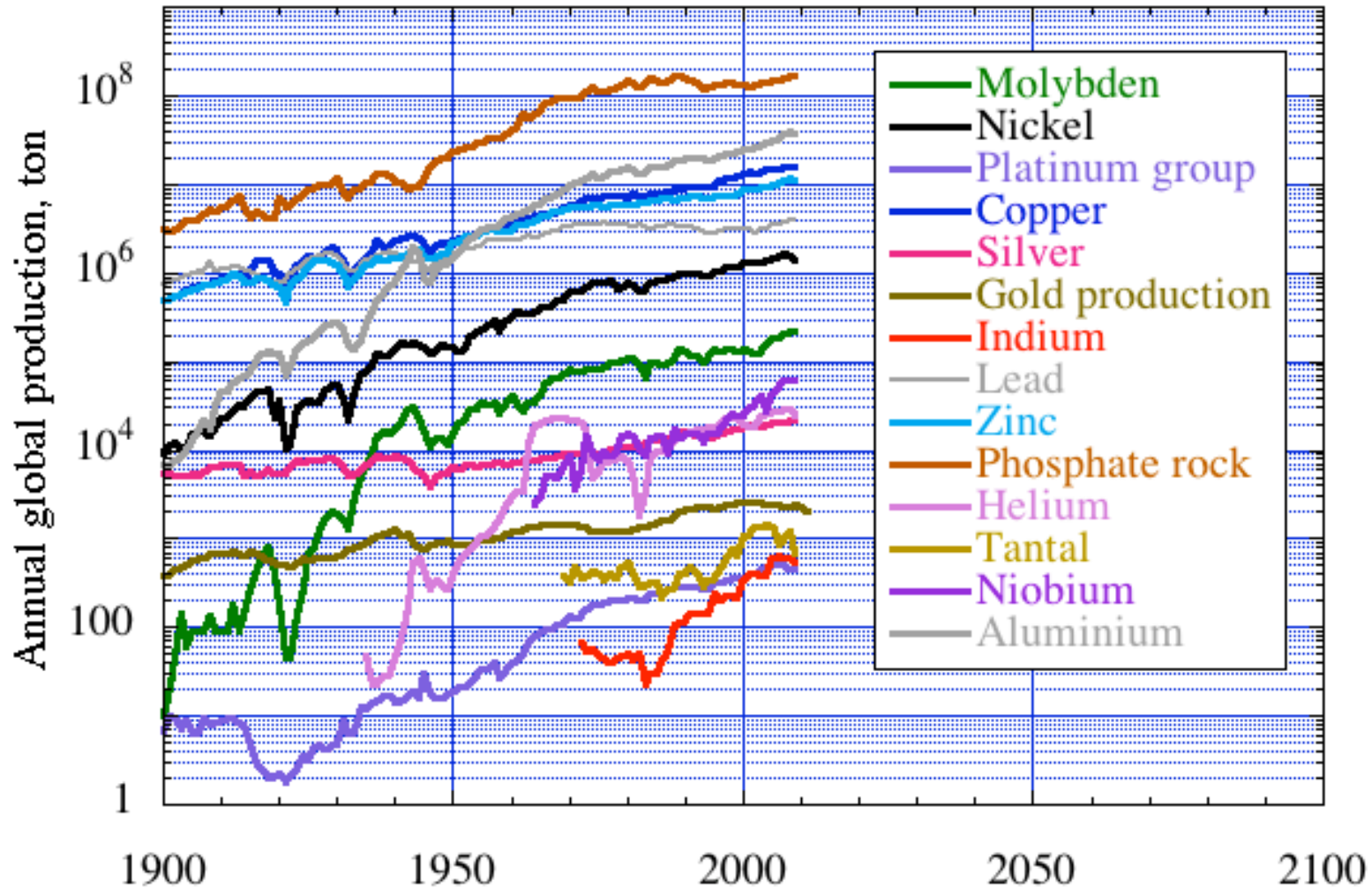


Mine always ended up like this

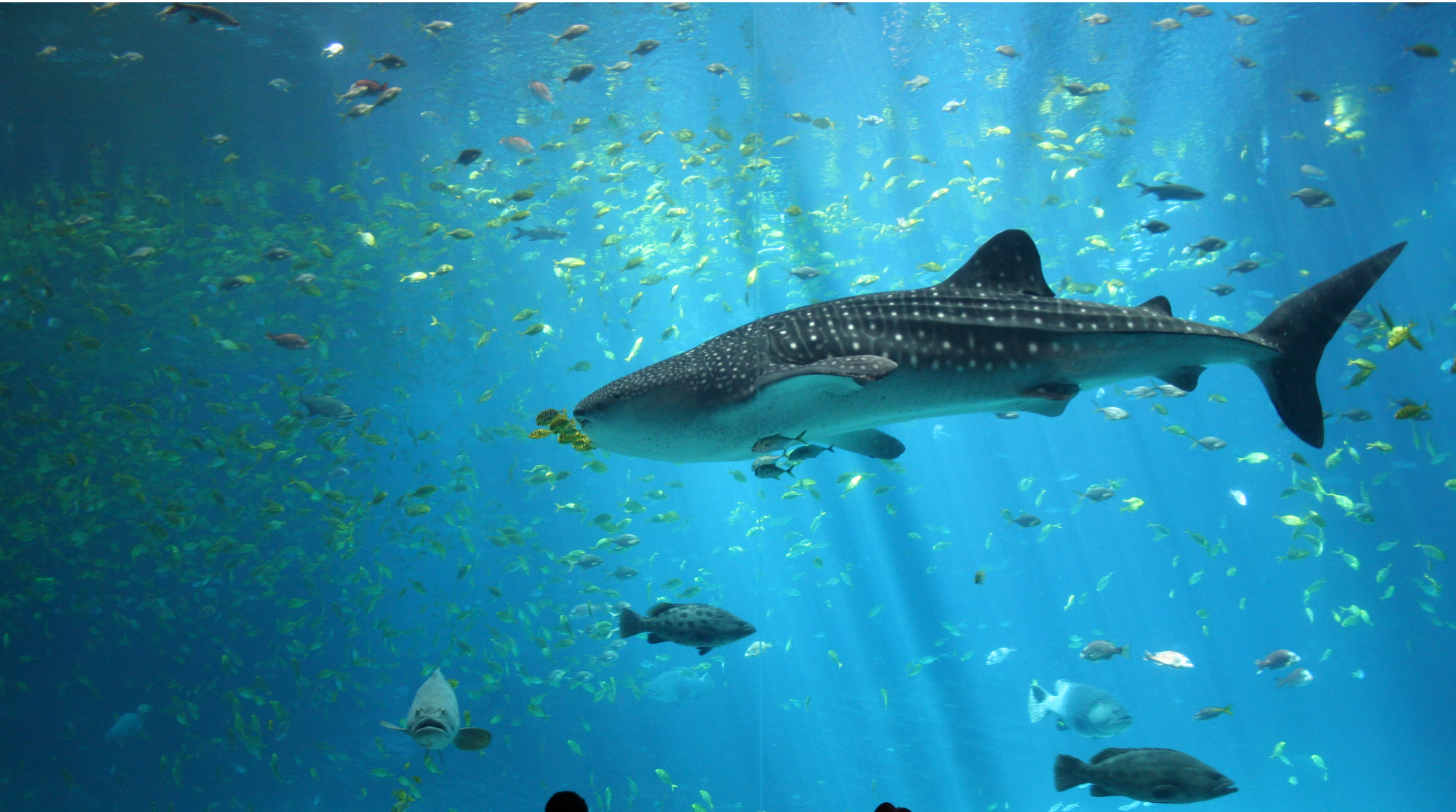




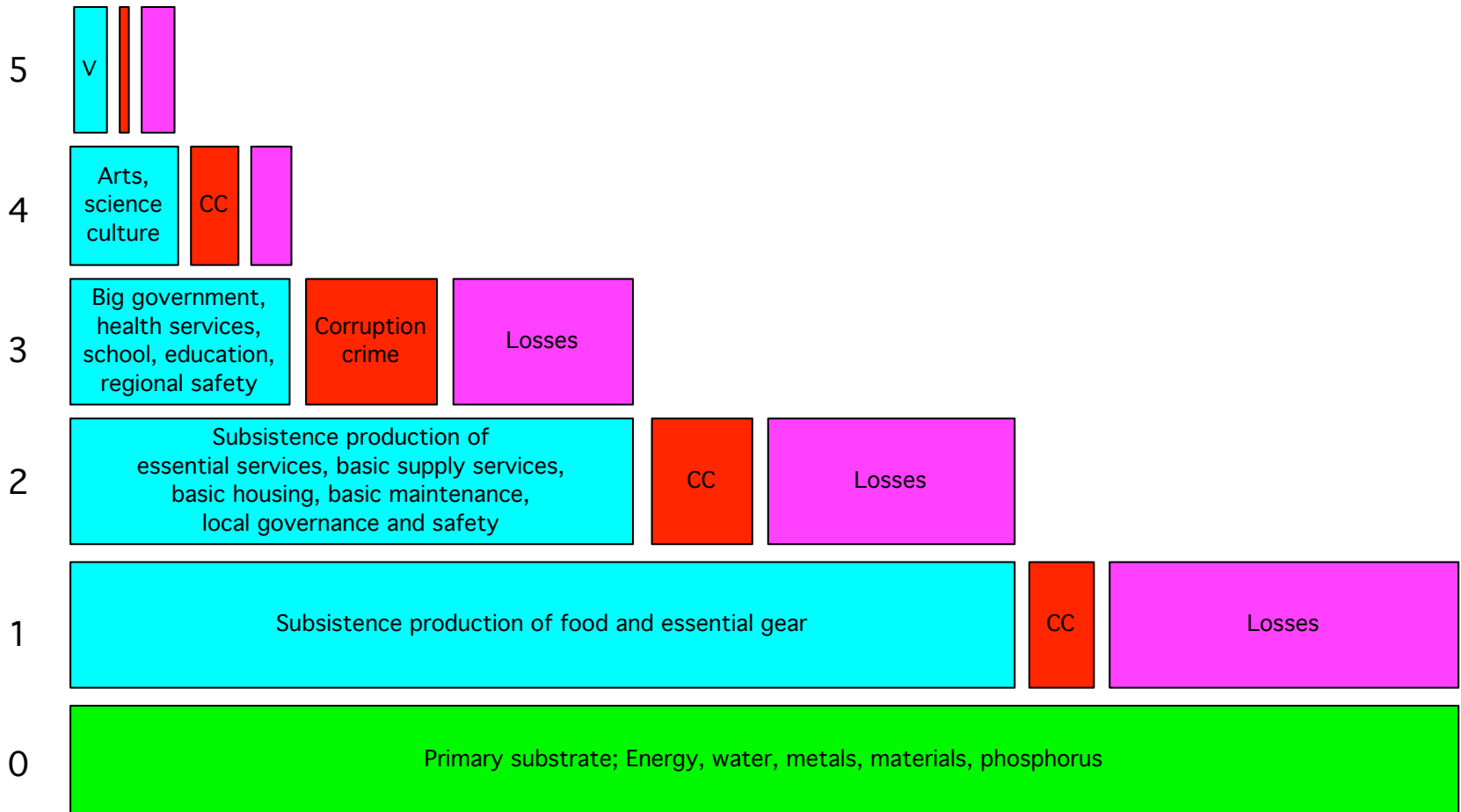
Exponential growth ?



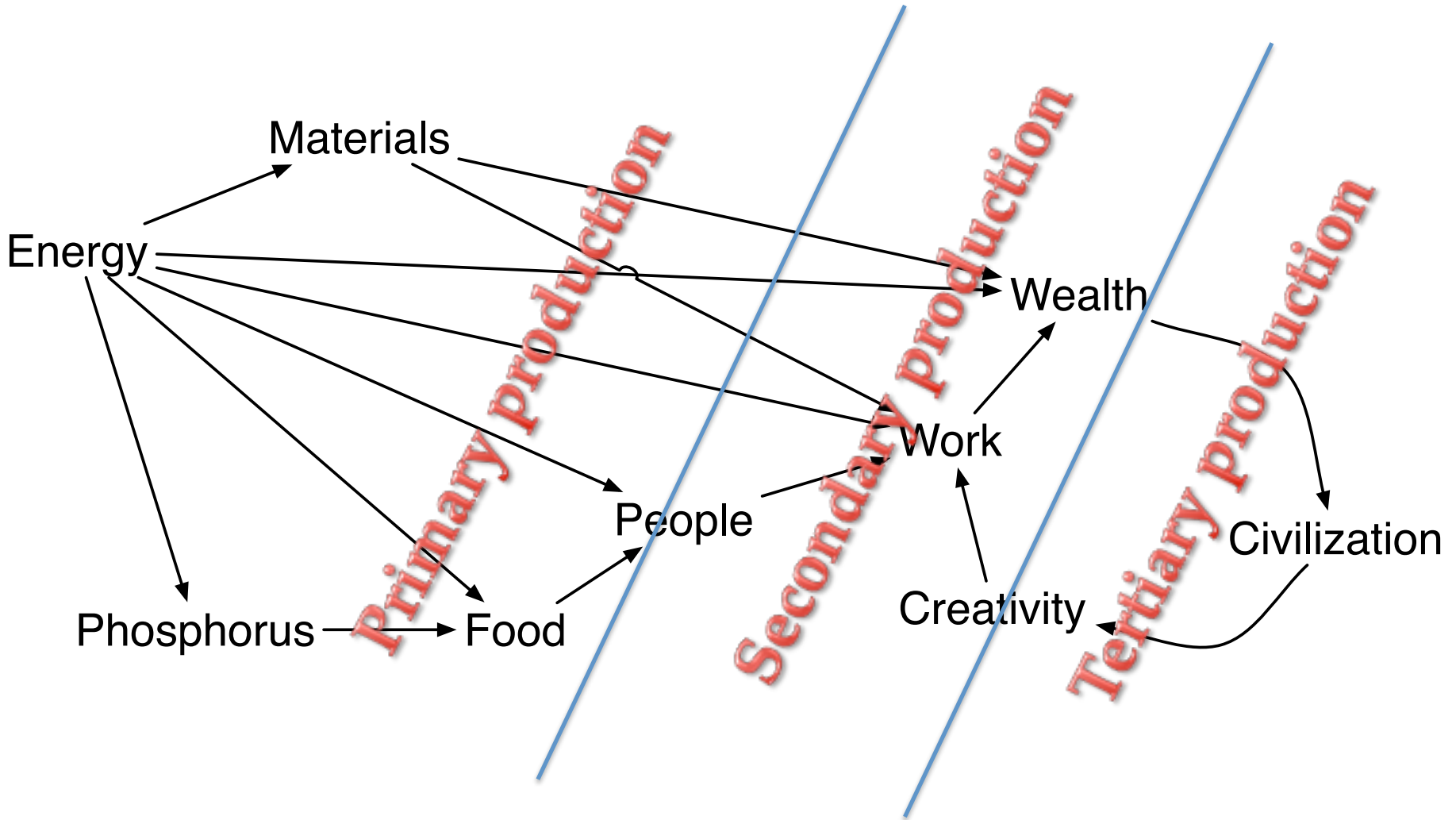
Modelling Germany in the world



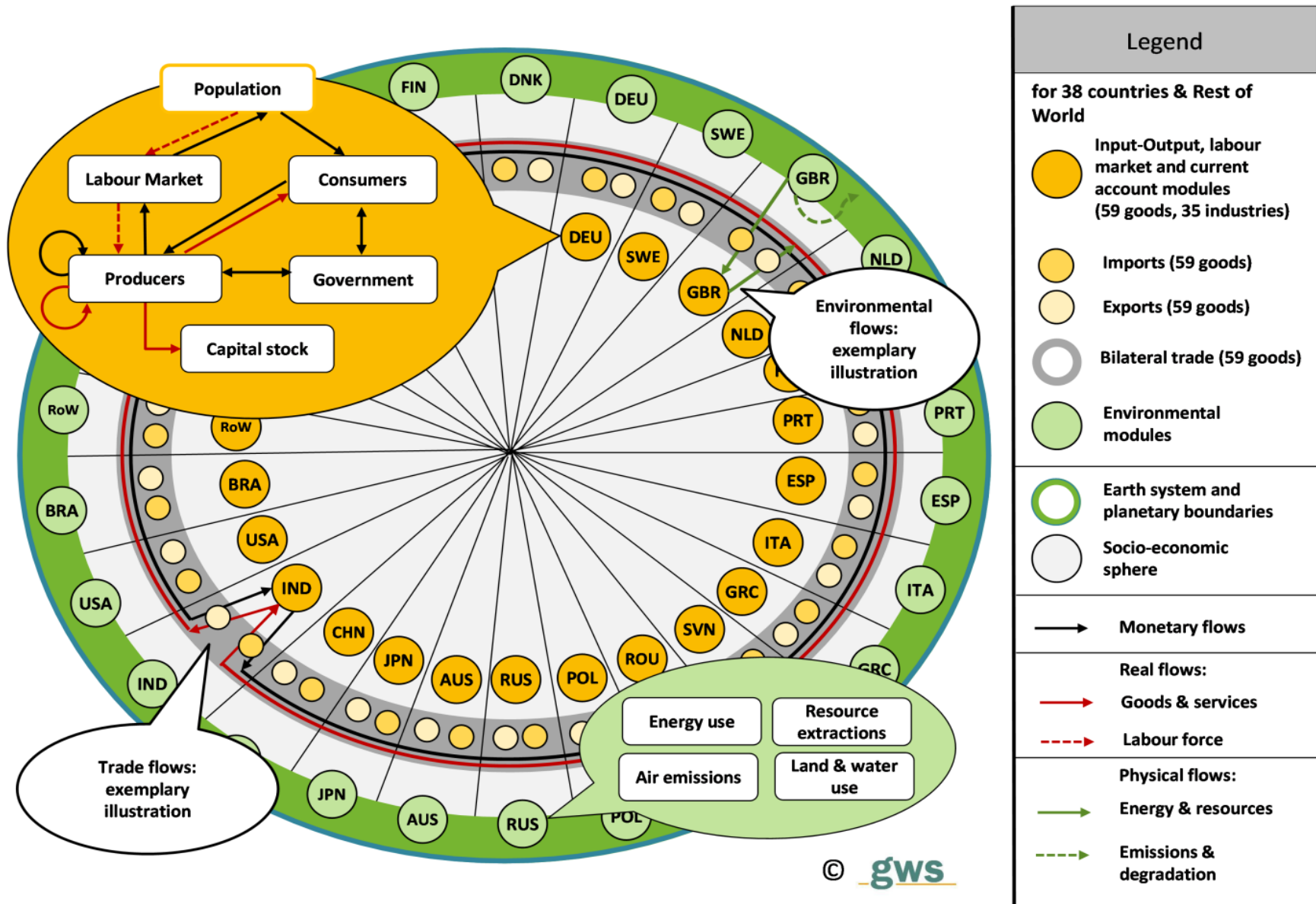
Society is an ecosystem



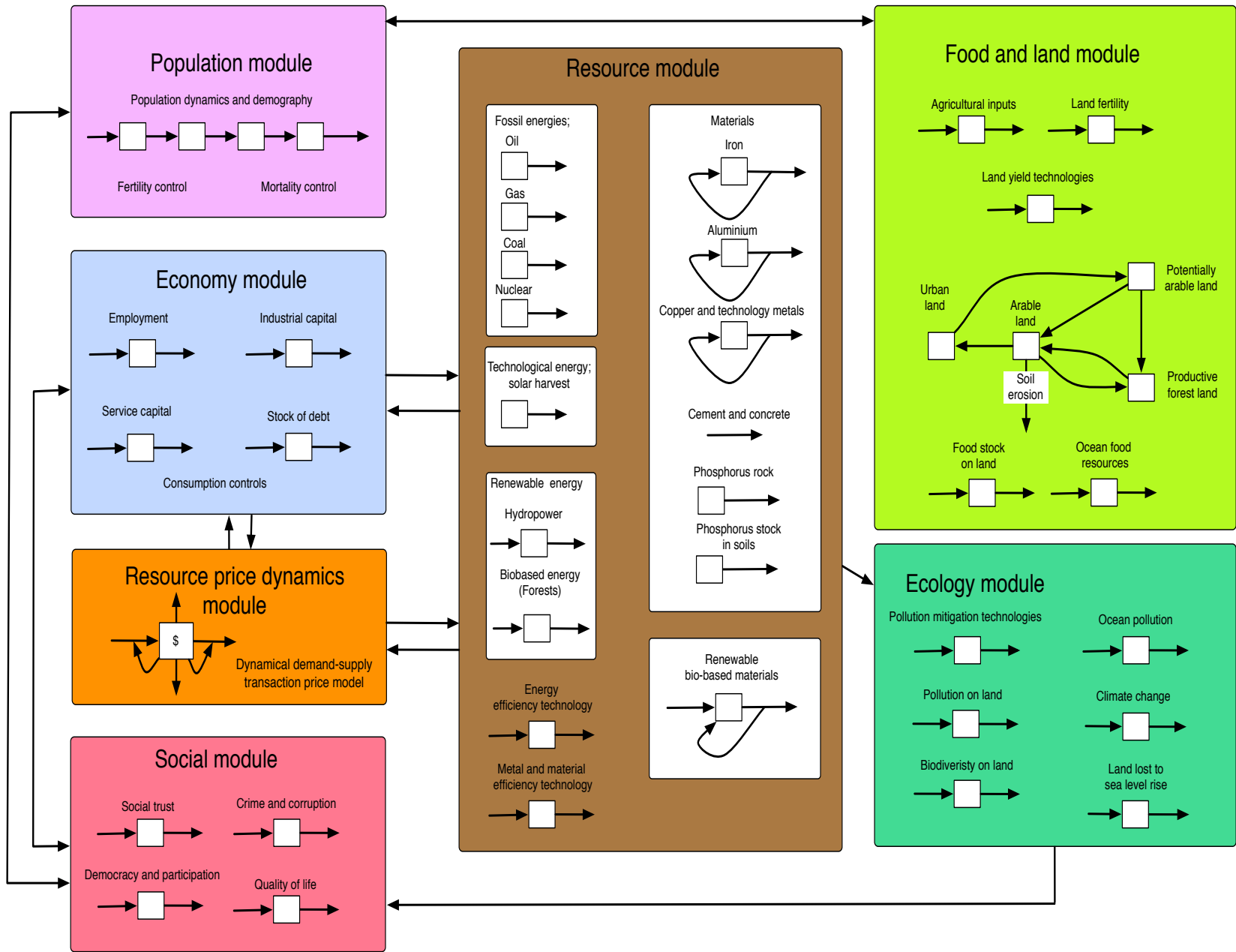
Where does wealth come from?



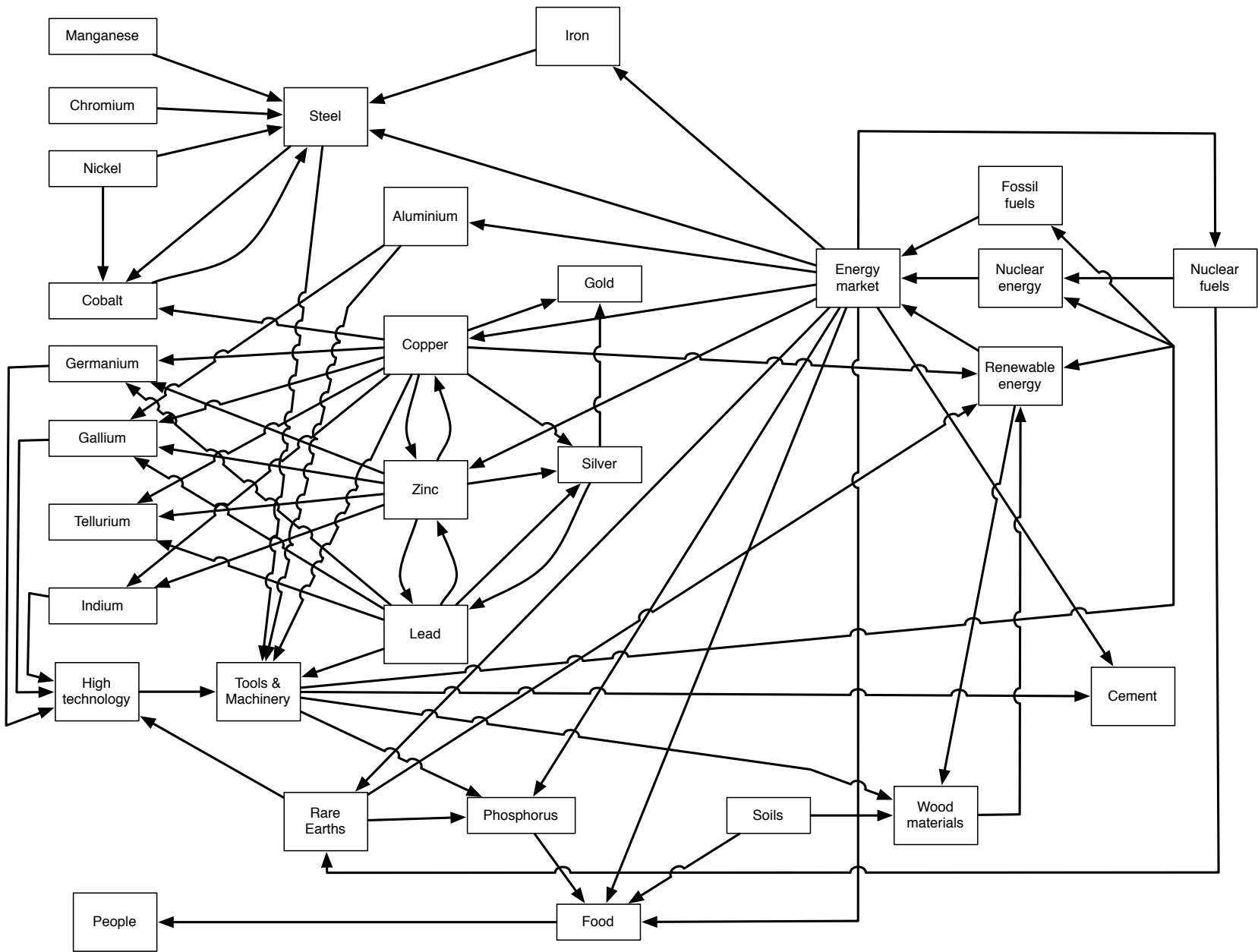
GINFORS model for demand



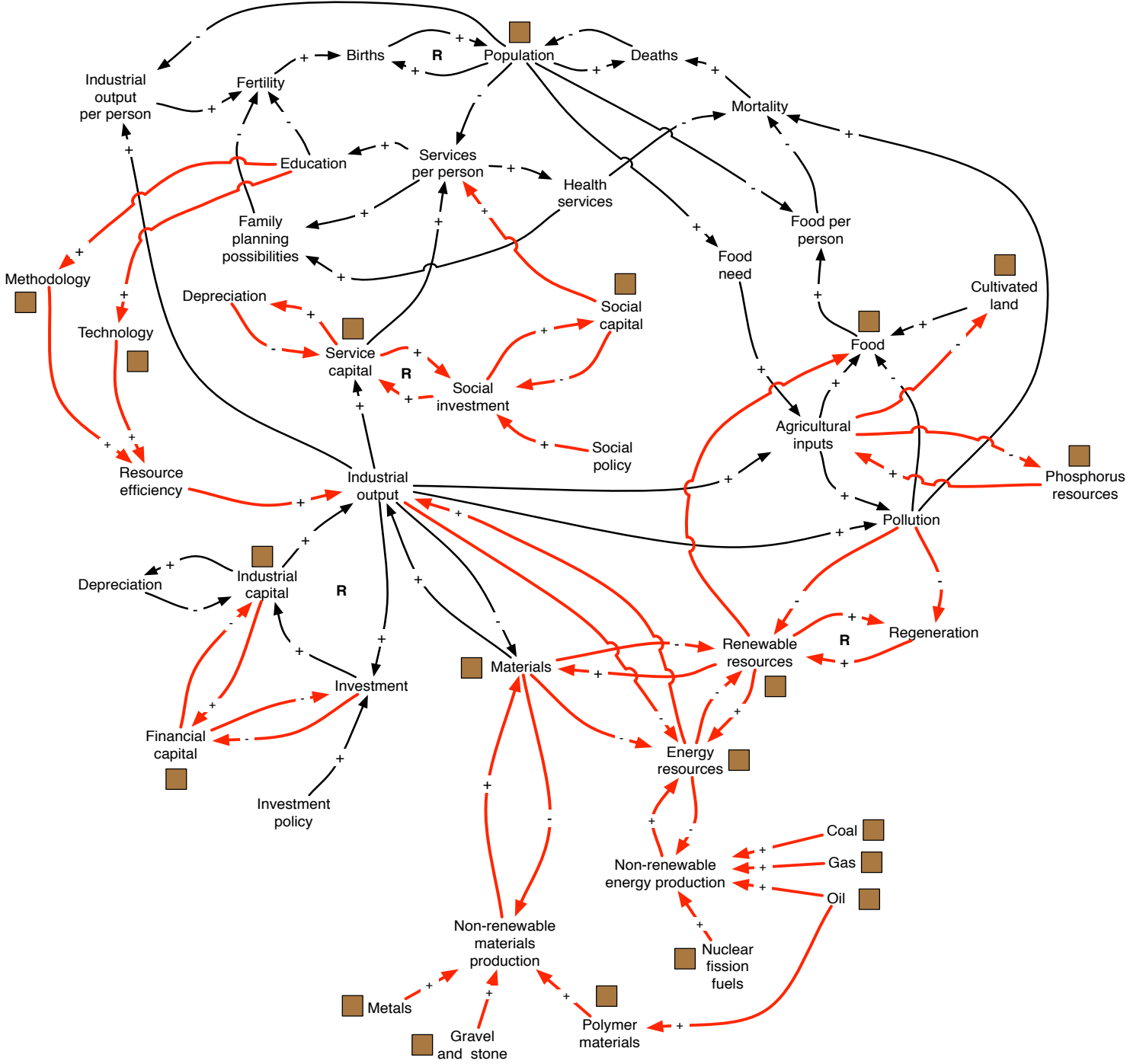
Legend	
for 38 countries & Rest of World	
	Input-Output, labour market and current account modules (59 goods, 35 industries)
	Imports (59 goods)
	Exports (59 goods)
	Bilateral trade (59 goods)
	Environmental modules
	Earth system and planetary boundaries
	Socio-economic sphere
	Monetary flows
Real flows:	
	Goods & services
	Labour force
Physical flows:	
	Energy & resources
	Emissions & degradation



The WORLD model

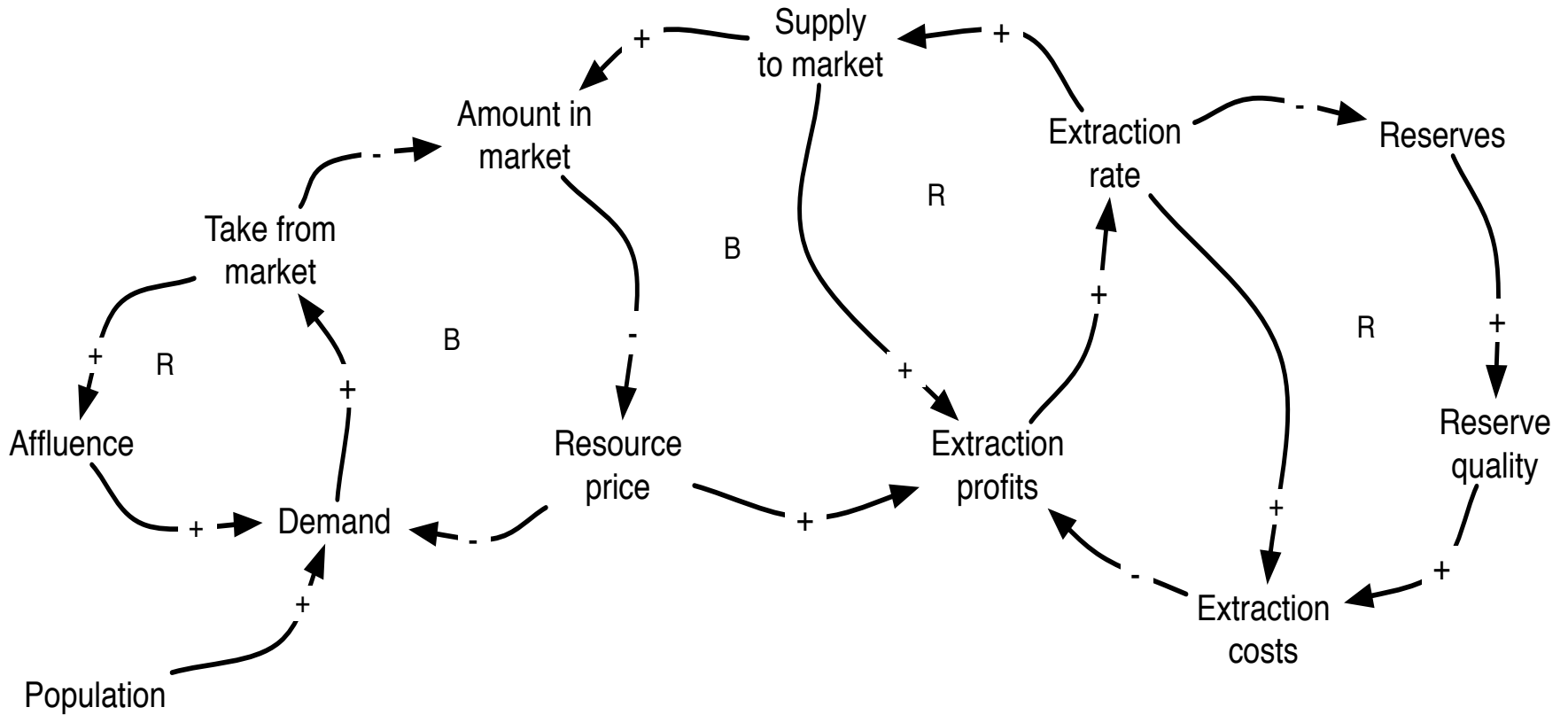


WORLD model resource flows

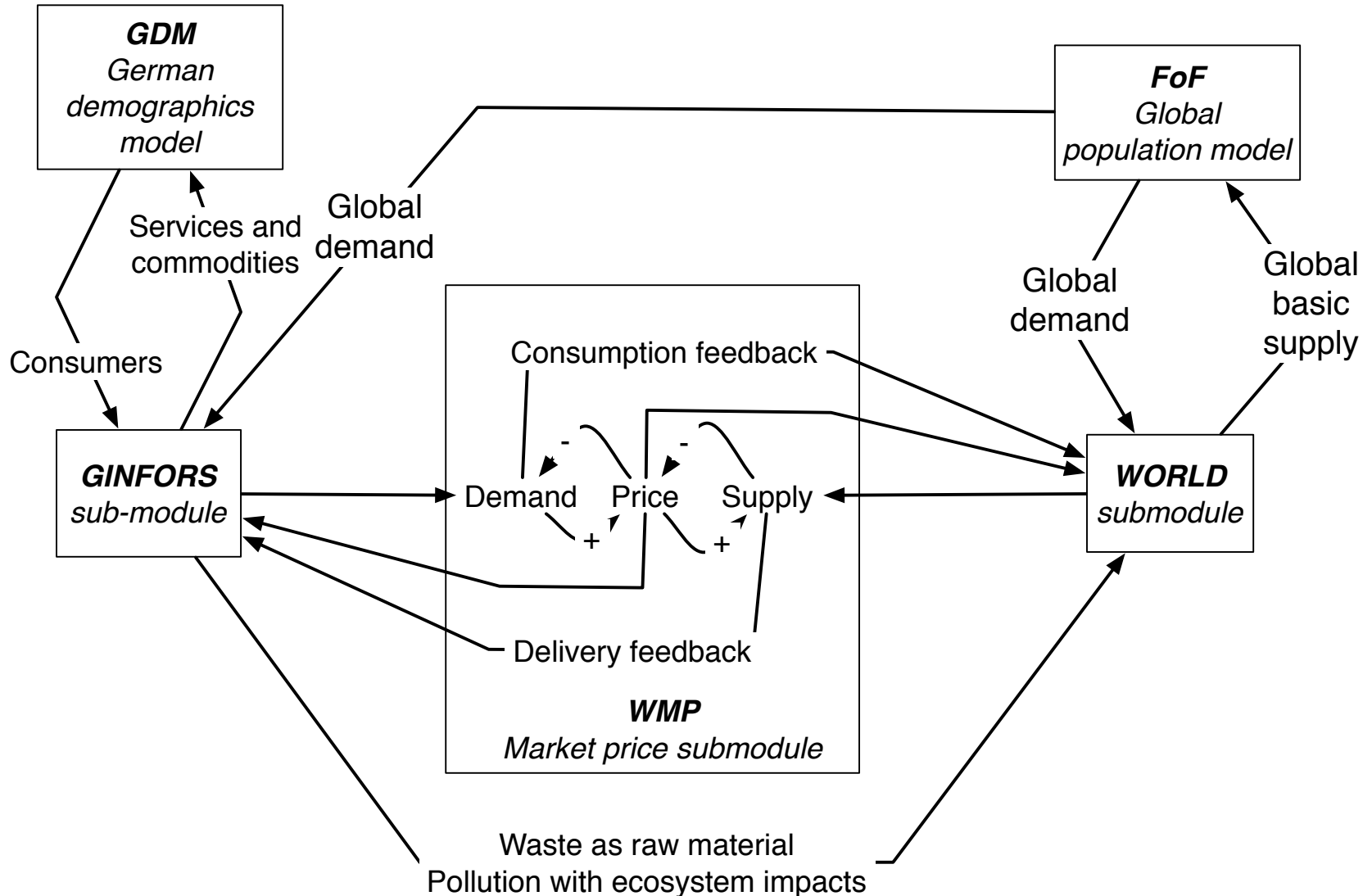


The WORLD model

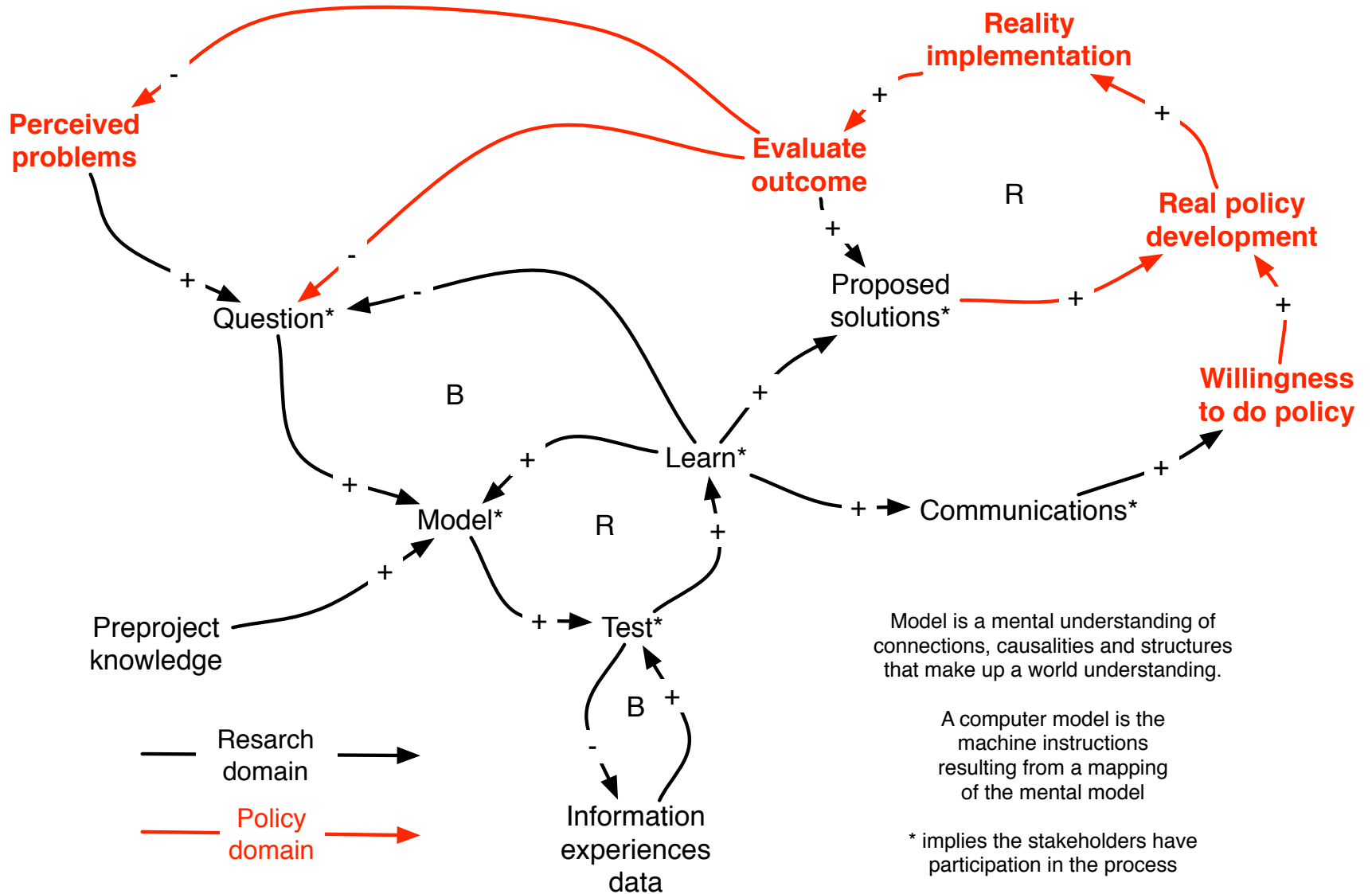
Market price, supply and demand



Supply and demand driven systems dynamics global economy modelling



The connection to policy



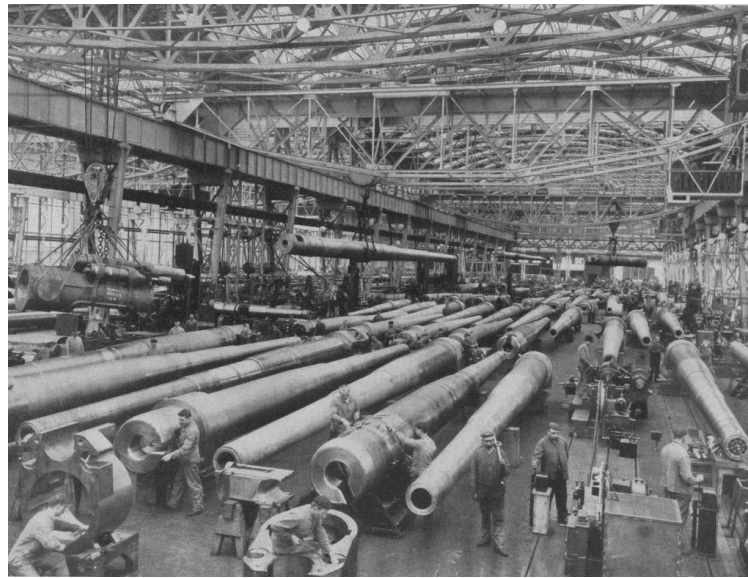
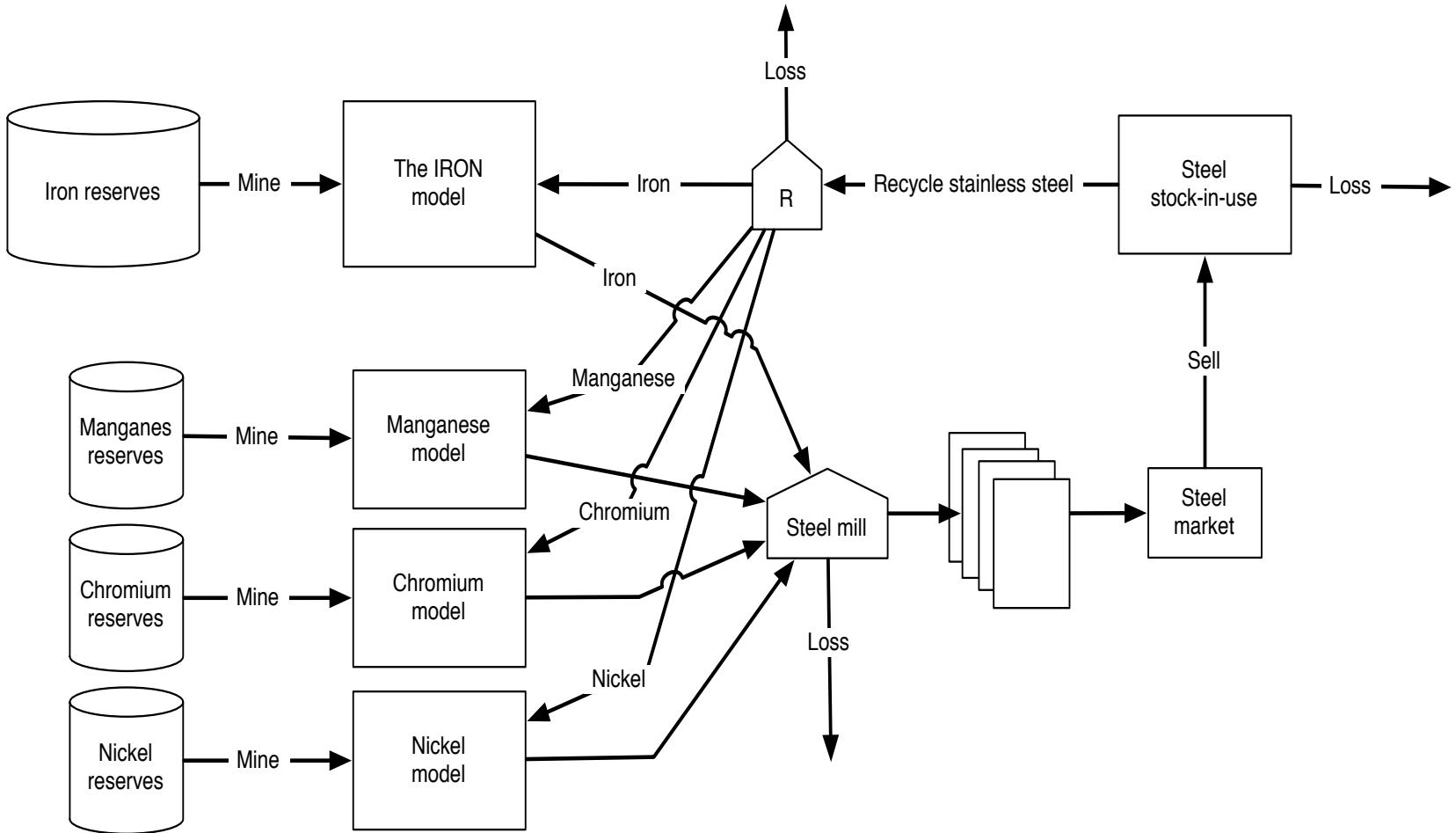


Figure 2. Alfred Krupp invented modern steel, steel alloyed into toughness, hardness, heat tolerance and corrosion resistance with molybdenum, vanadium, chromium and cobalt. Krupp was pioneering the development of stainless steel that would not corrode. Beside a picture of A. Krupp, we see the inside of one of his cannon factories about 1914. The Krupp company went on to become one of the world's largest steel corporation before WWII. Kitchenware is often made in stainless steel, found in most homes. Stainless steel is a relatively valuable metal and is recycled in significant amounts, compressed stainless steel scrap is seen in the picture bottom right.

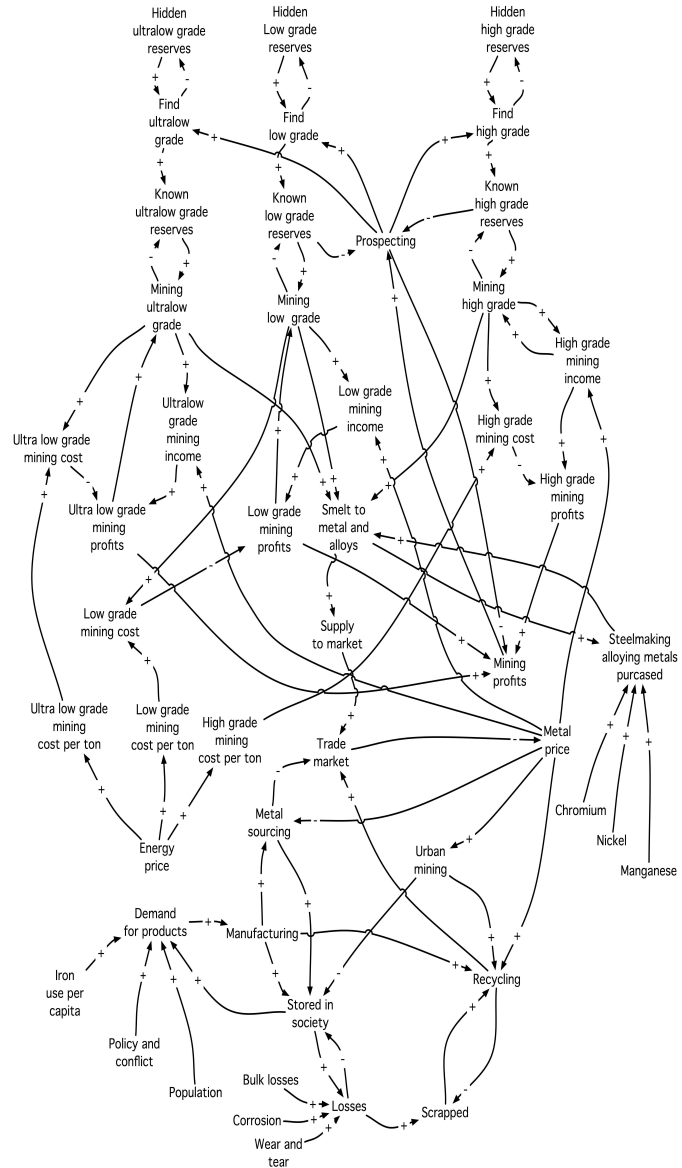
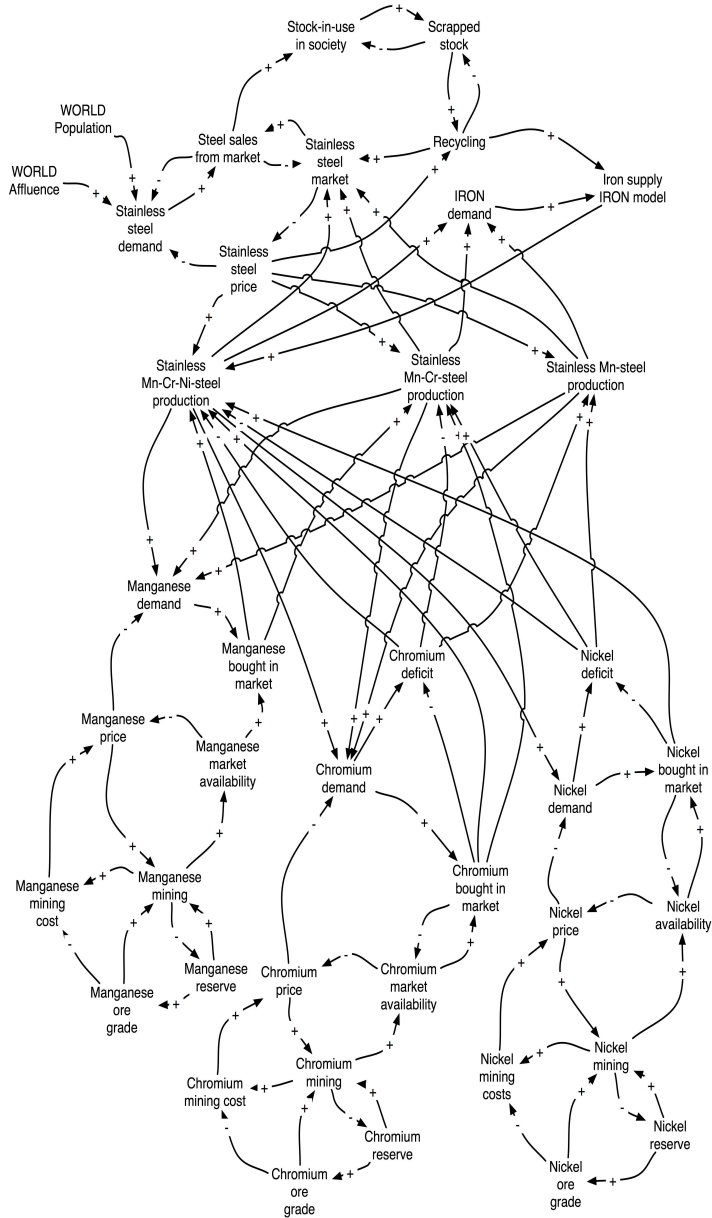
The stainless steel system

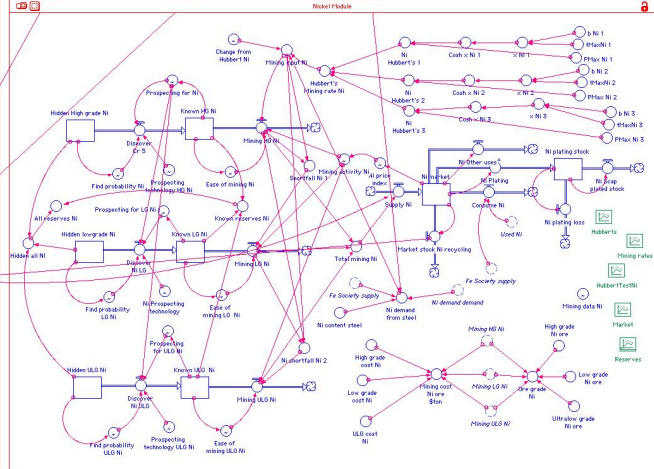
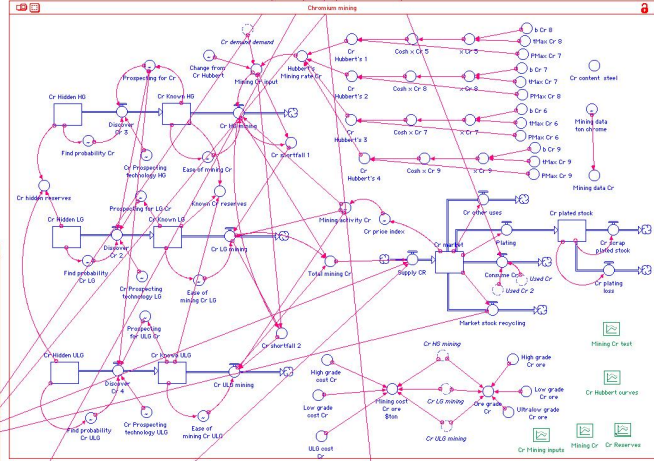
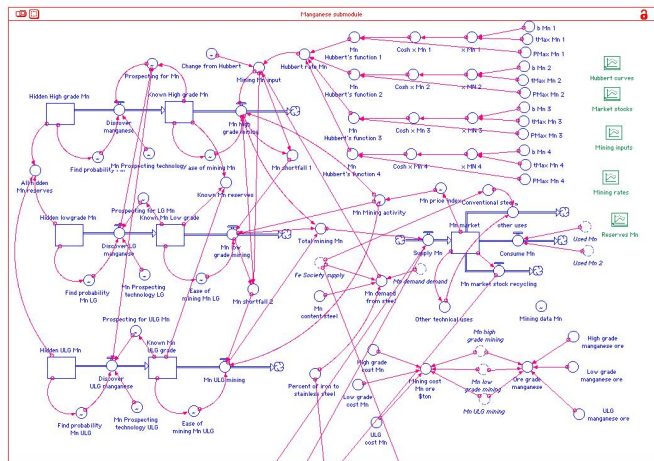
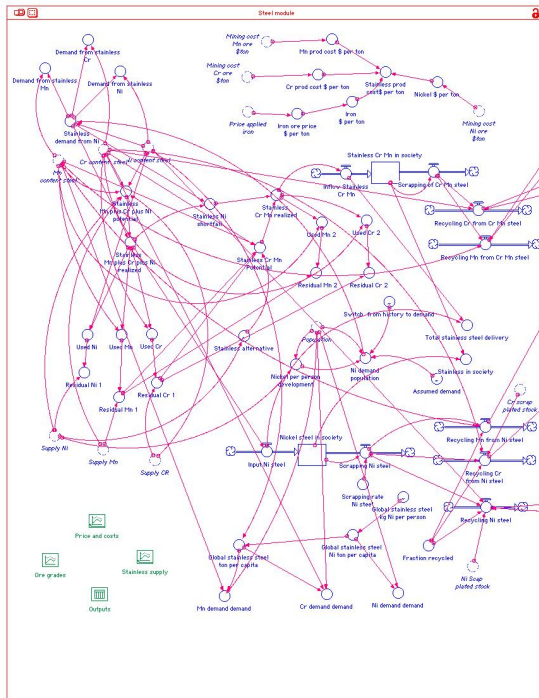
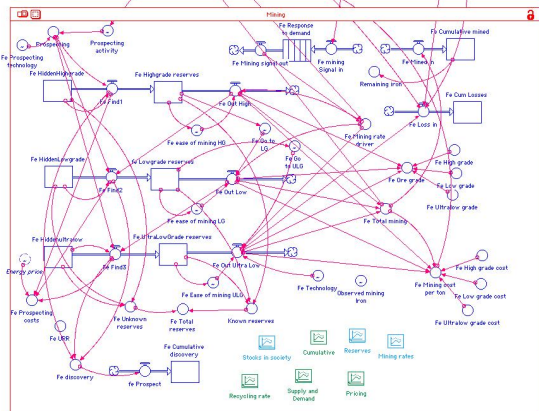
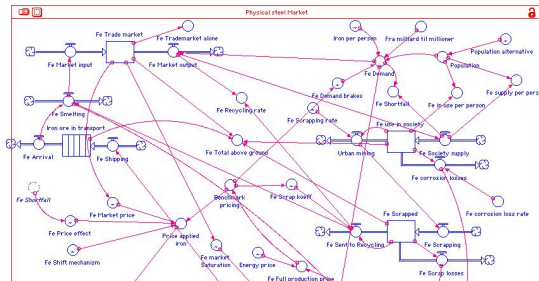


The stainless steel system

Do the causal loop mapping of the system

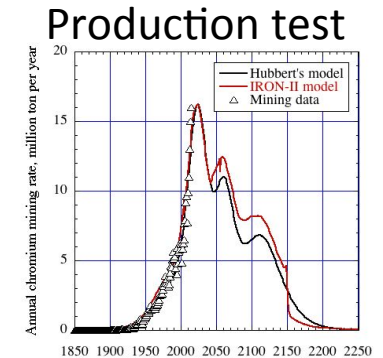
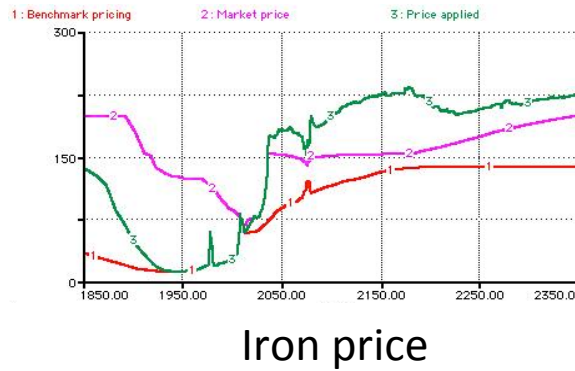
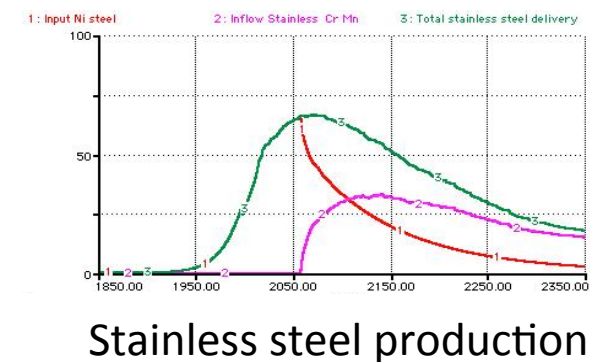
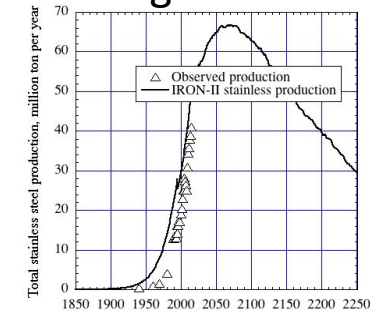
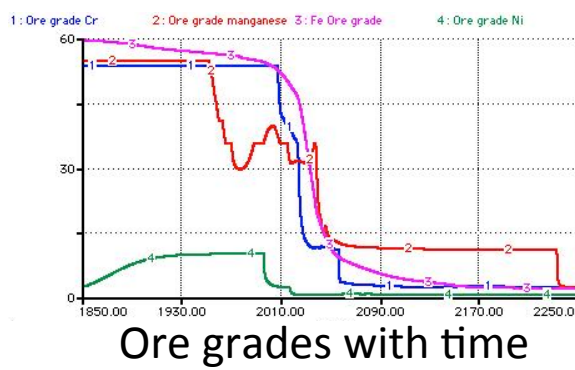
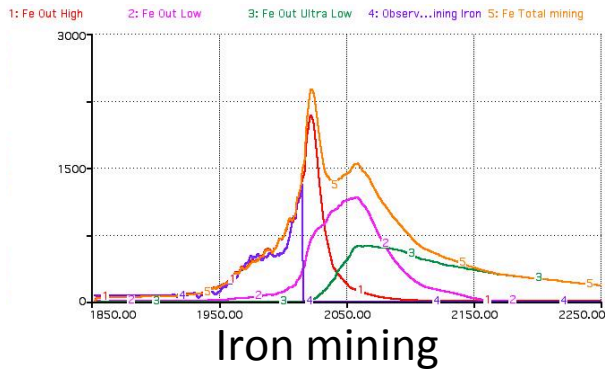
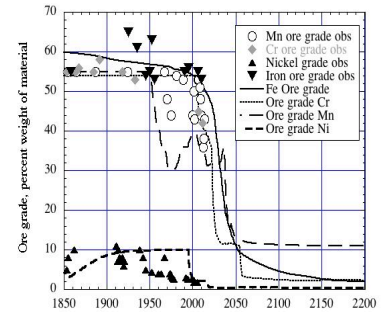
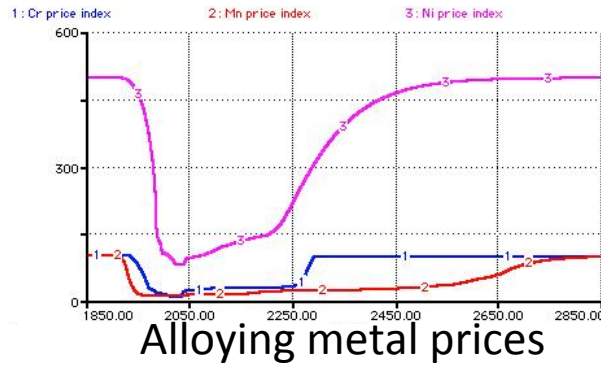
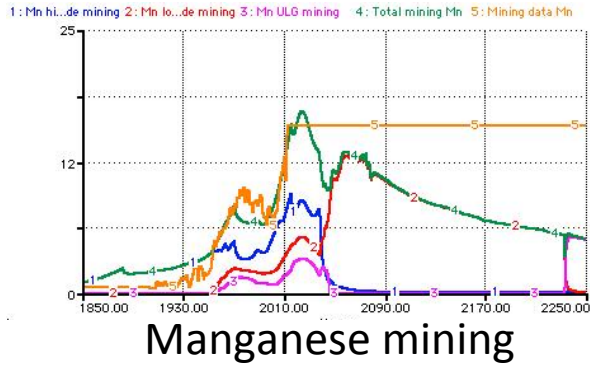
The stainless steel system



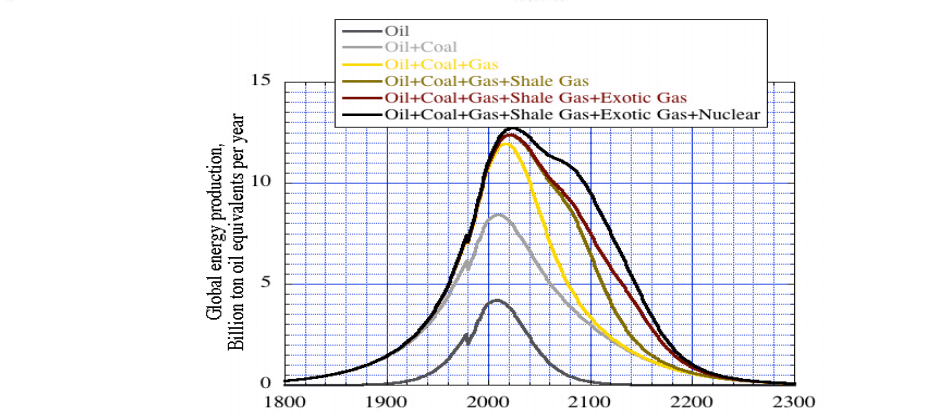
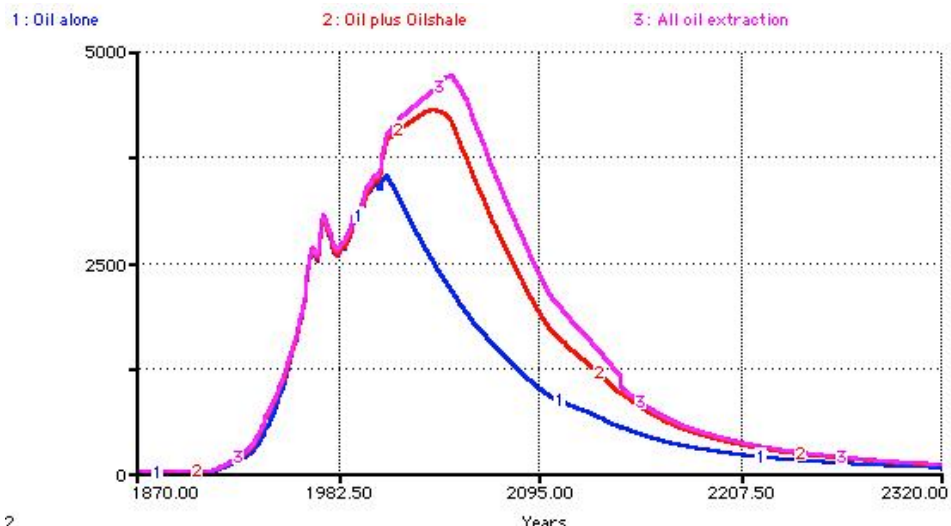
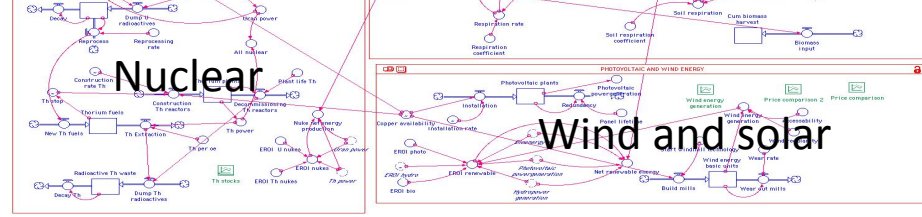
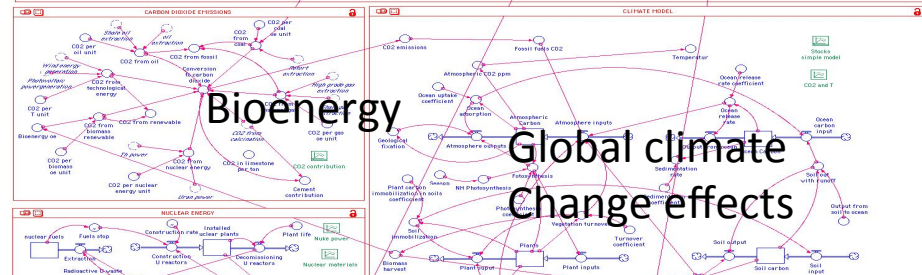
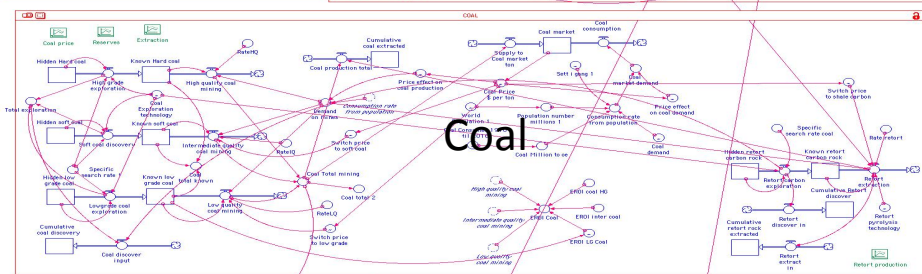
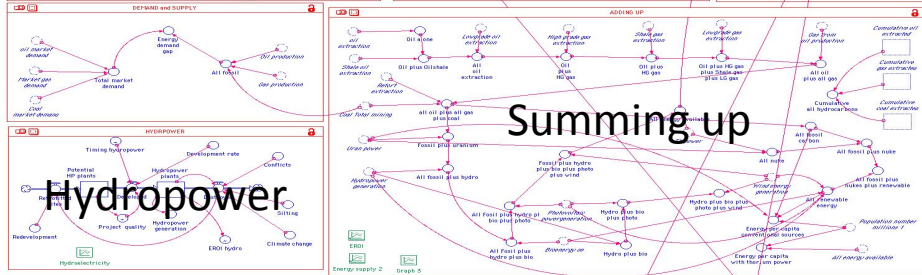
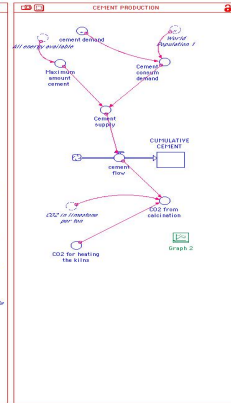
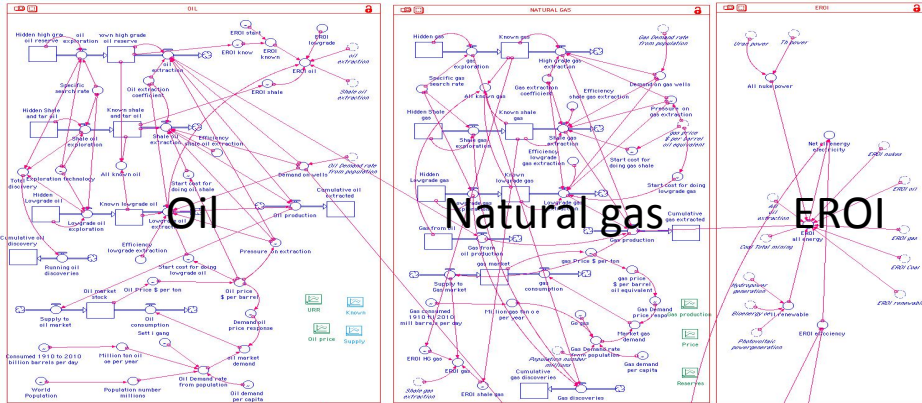


The
STEEL
 computer
 model
 in
 the
STELLA
 modelling
 tool

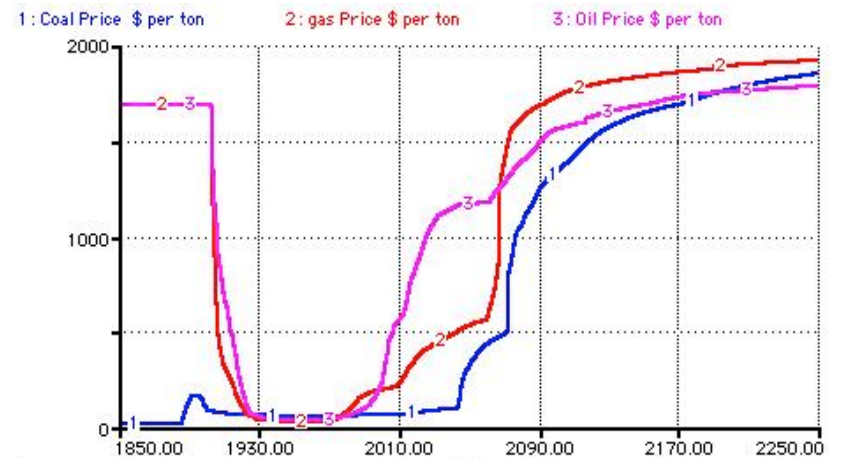
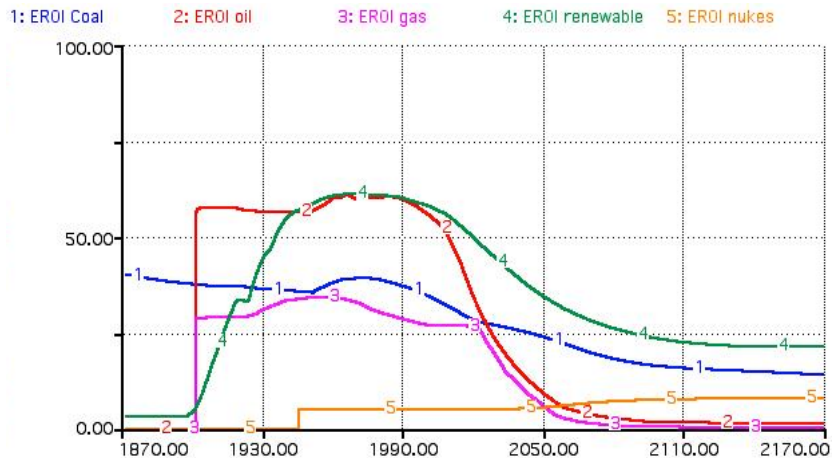
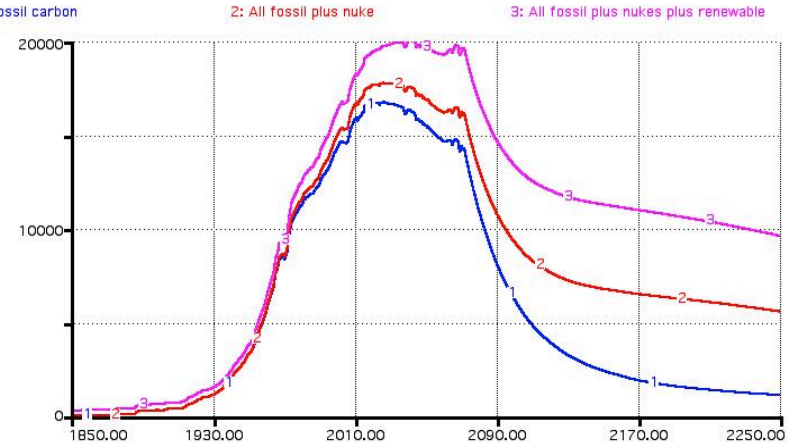
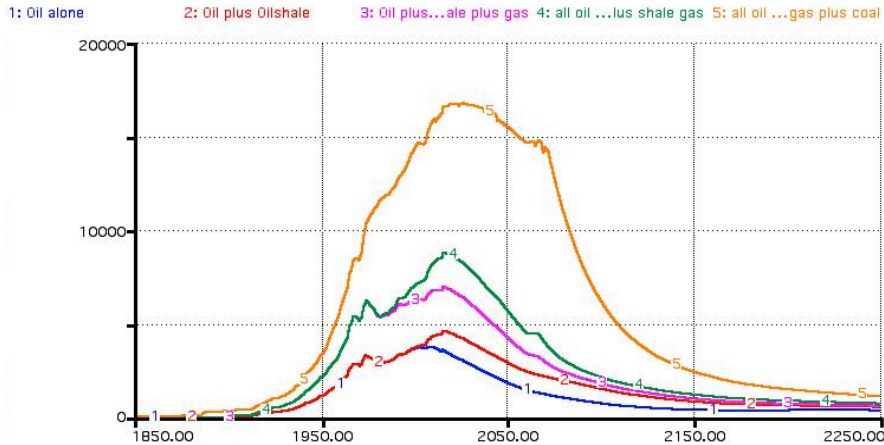
STEEL model outputs



The global ENERGY submodule



The ENERGY submodule



Peak moments of our times

- ***Already passed the peak***; conventional oil, hard coal, platinum, ocean fish, agricultural soil, gold, helium, tantal.
- ***Coming soon***; within the next 20 years: copper, zinc, lead, indium, silver, palladium, soft coal, low quality coal, natural gas, phosphorus, shale gas, tar sands,
- ***Takes a little while***; Within the next 100 years; iron, aluminium, nickel, manganese, lithium, germanium, niobium, wolfram, molybdenum, zirconium, yttrium, uranium, antimony, tin, selenium.....

The kings of Lydia invented money



Gyges
716-678 BC



Ardys II
678-629 BC



Sadyattes
629-619 BC



Alyattes II
619-560 BC

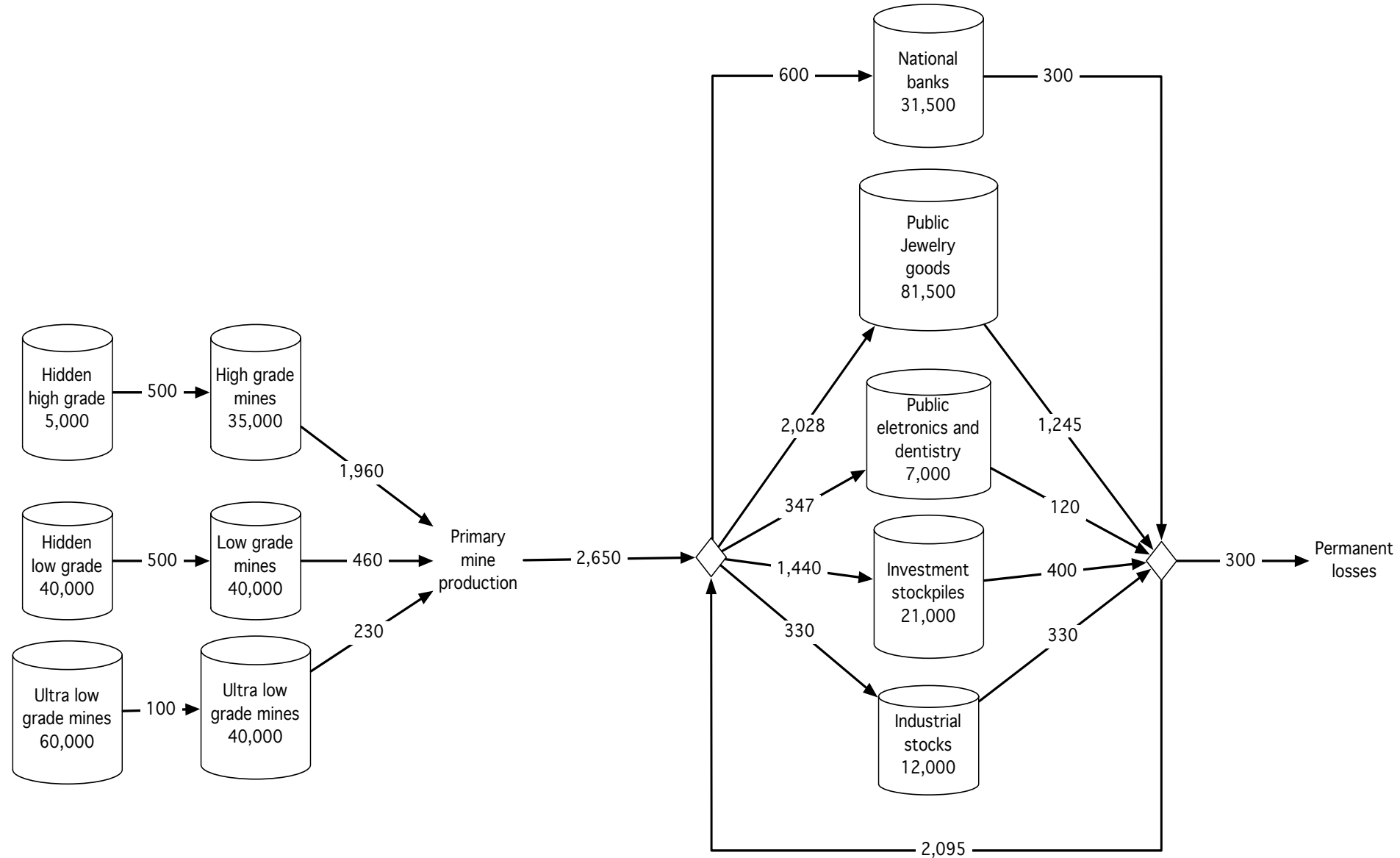


Kroisos
560-547 BC

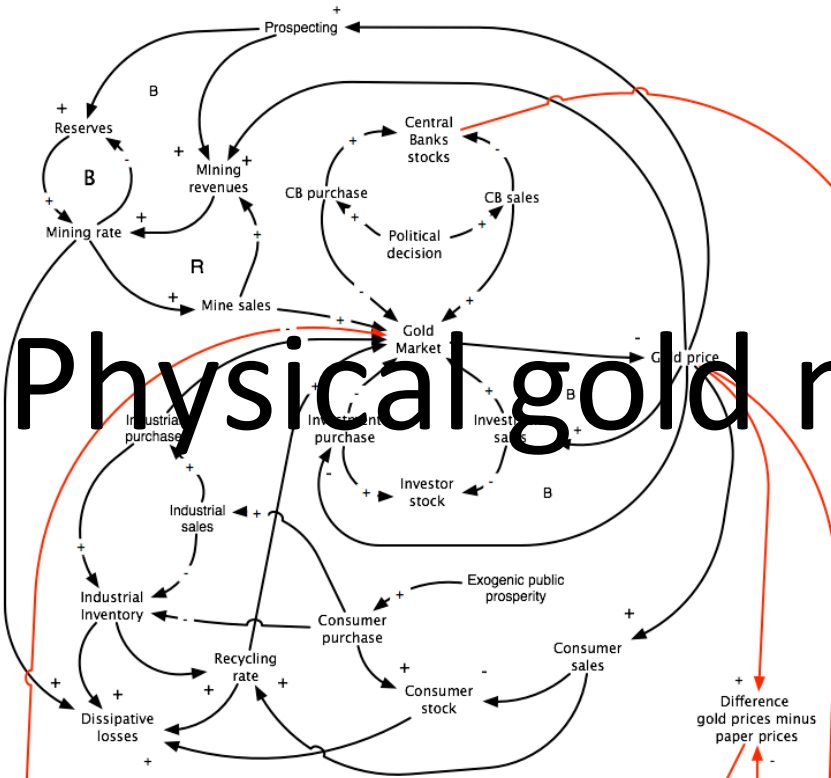
Enough to fill this



World gold flow in ton

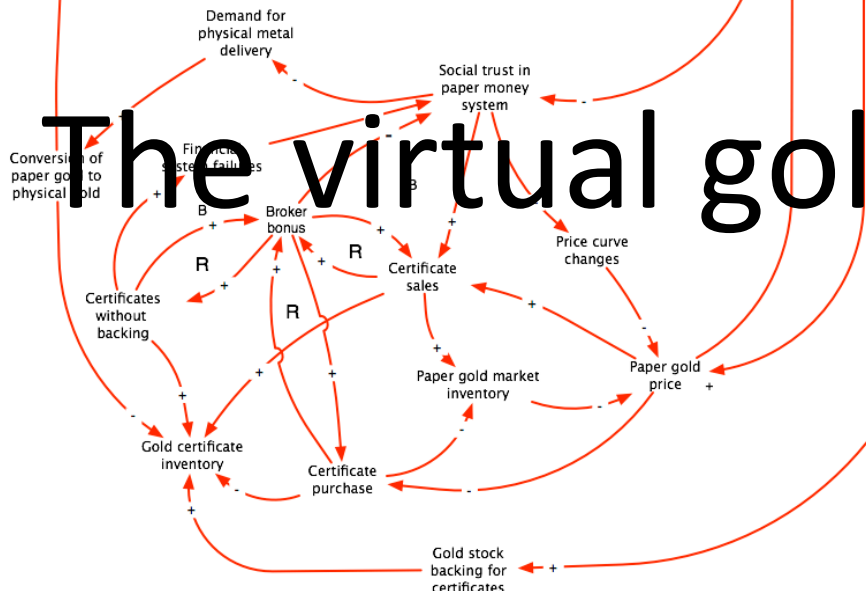


Physical gold market

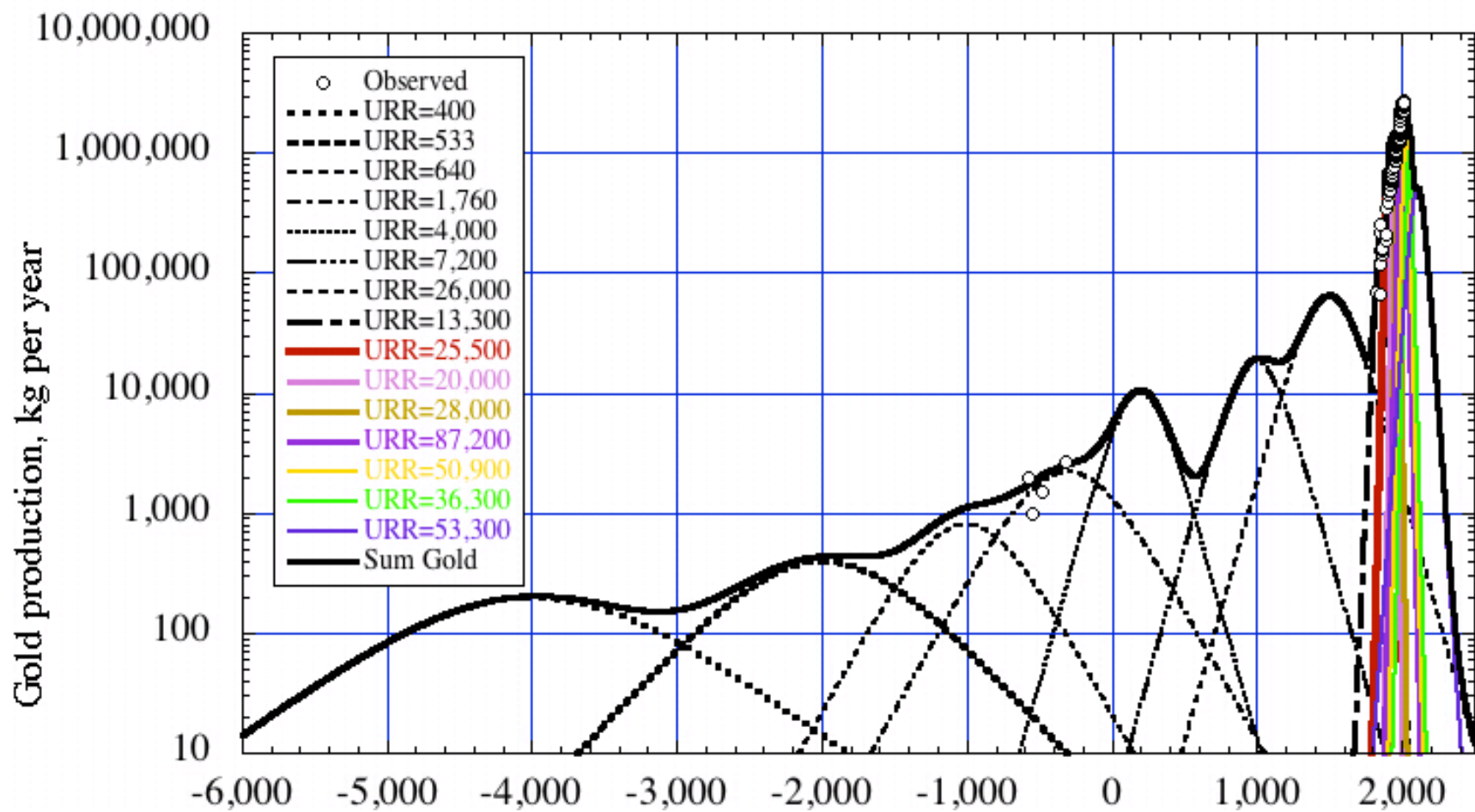


10,000 ton of free market gold

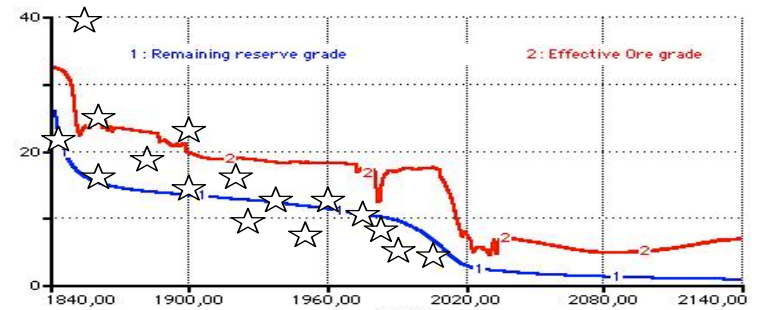
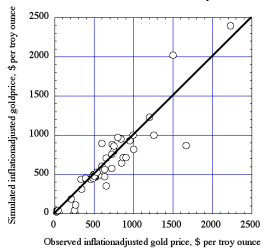
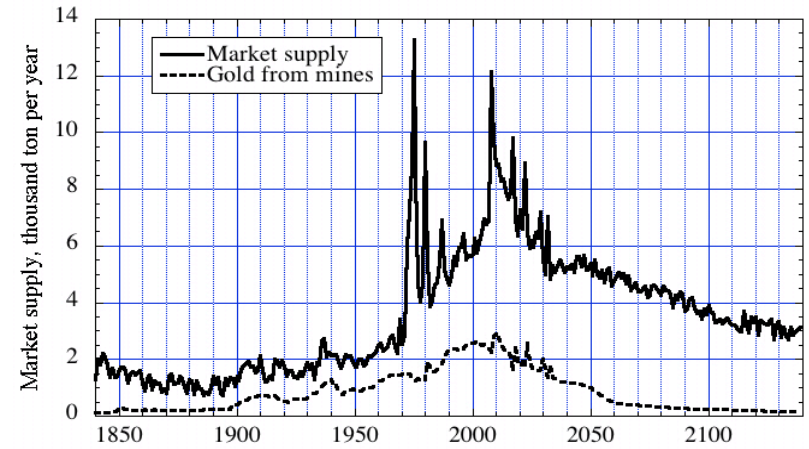
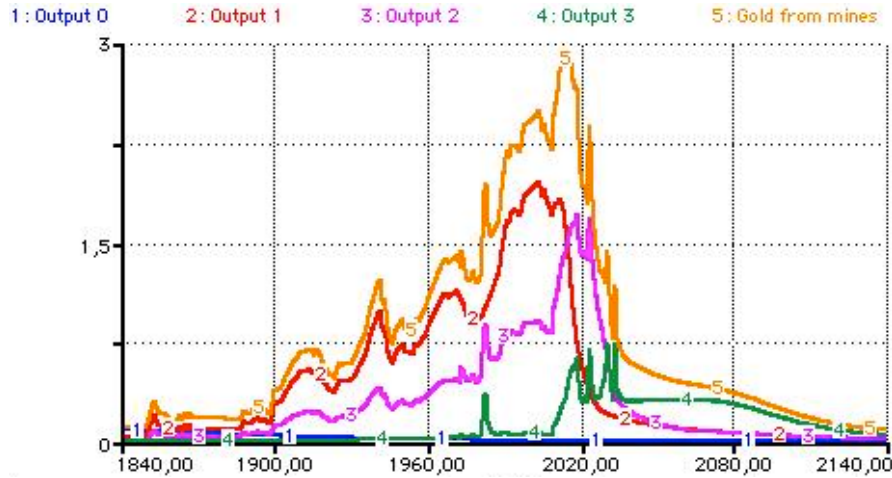
The virtual gold market



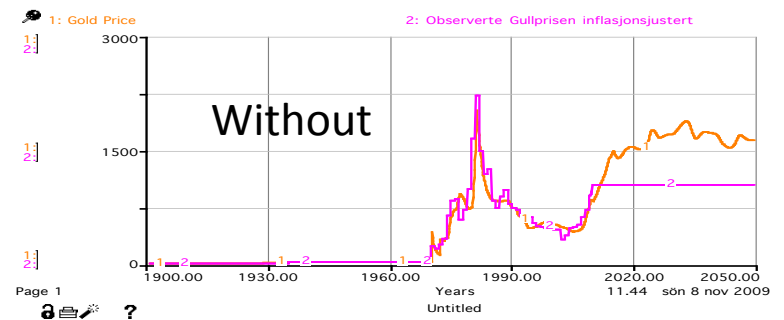
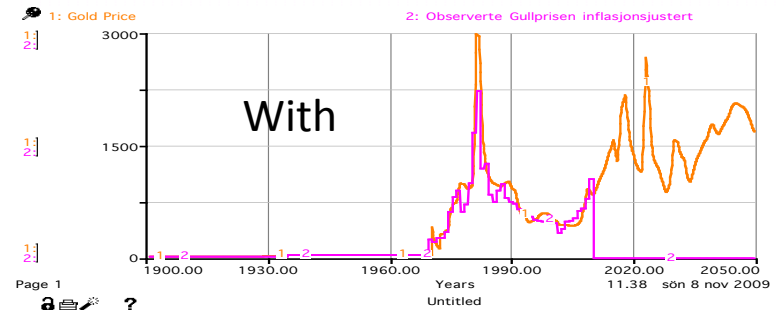
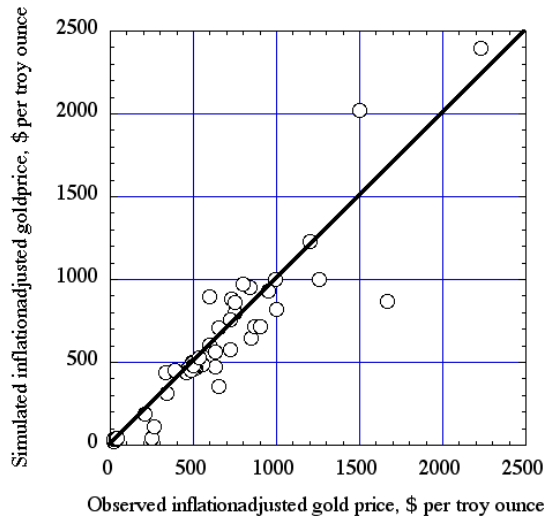
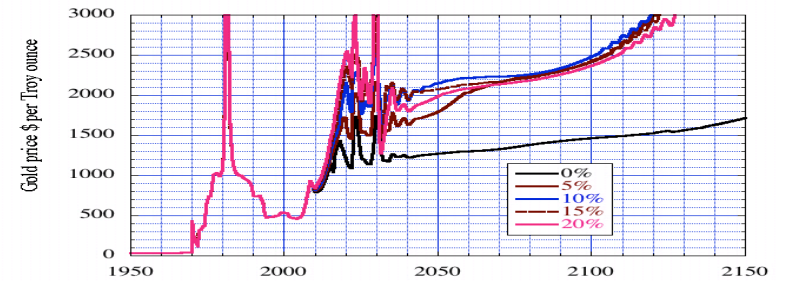
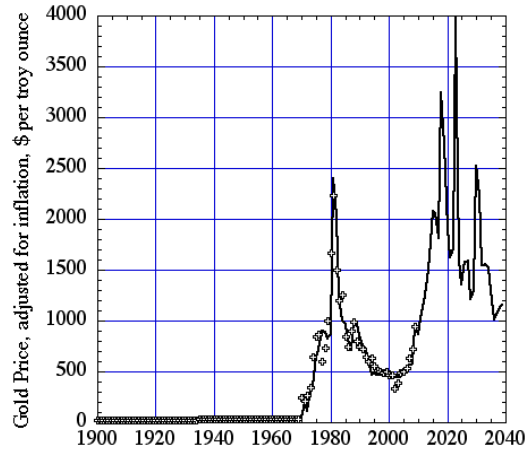
95,000 ton of "paper-gold"



GOLD model outputs



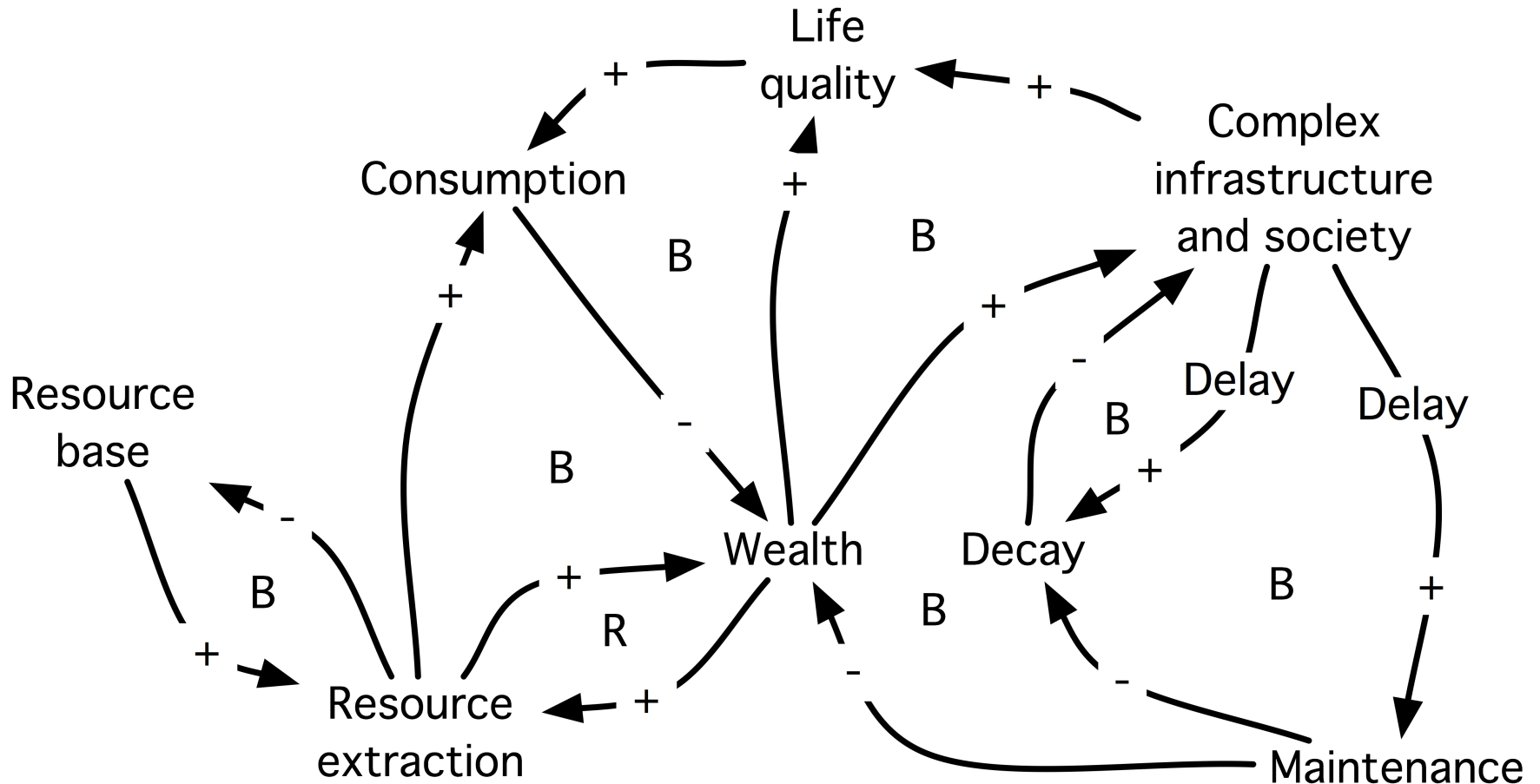
The real test: gold price prediction

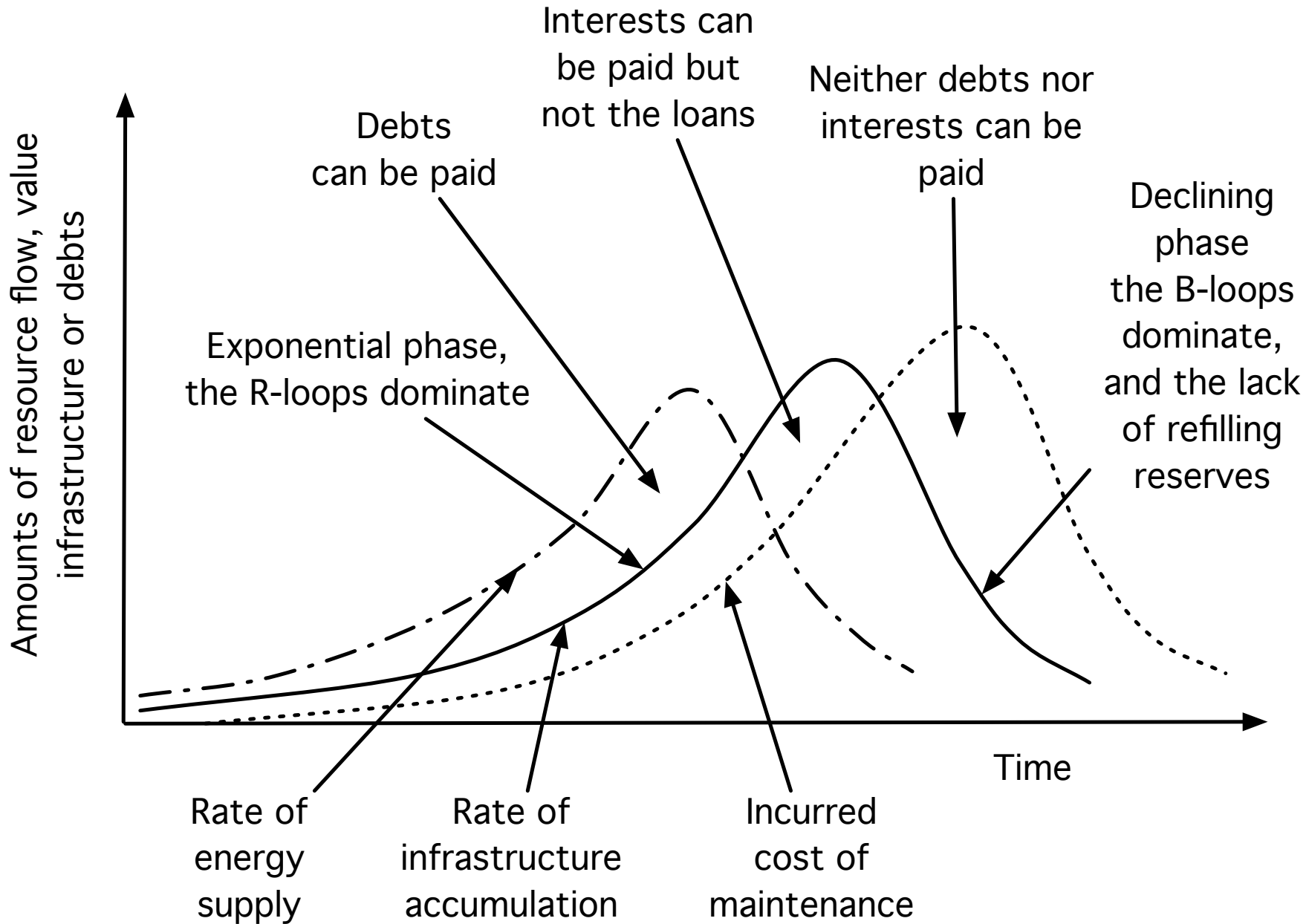


Troy ounce = 31.1 g

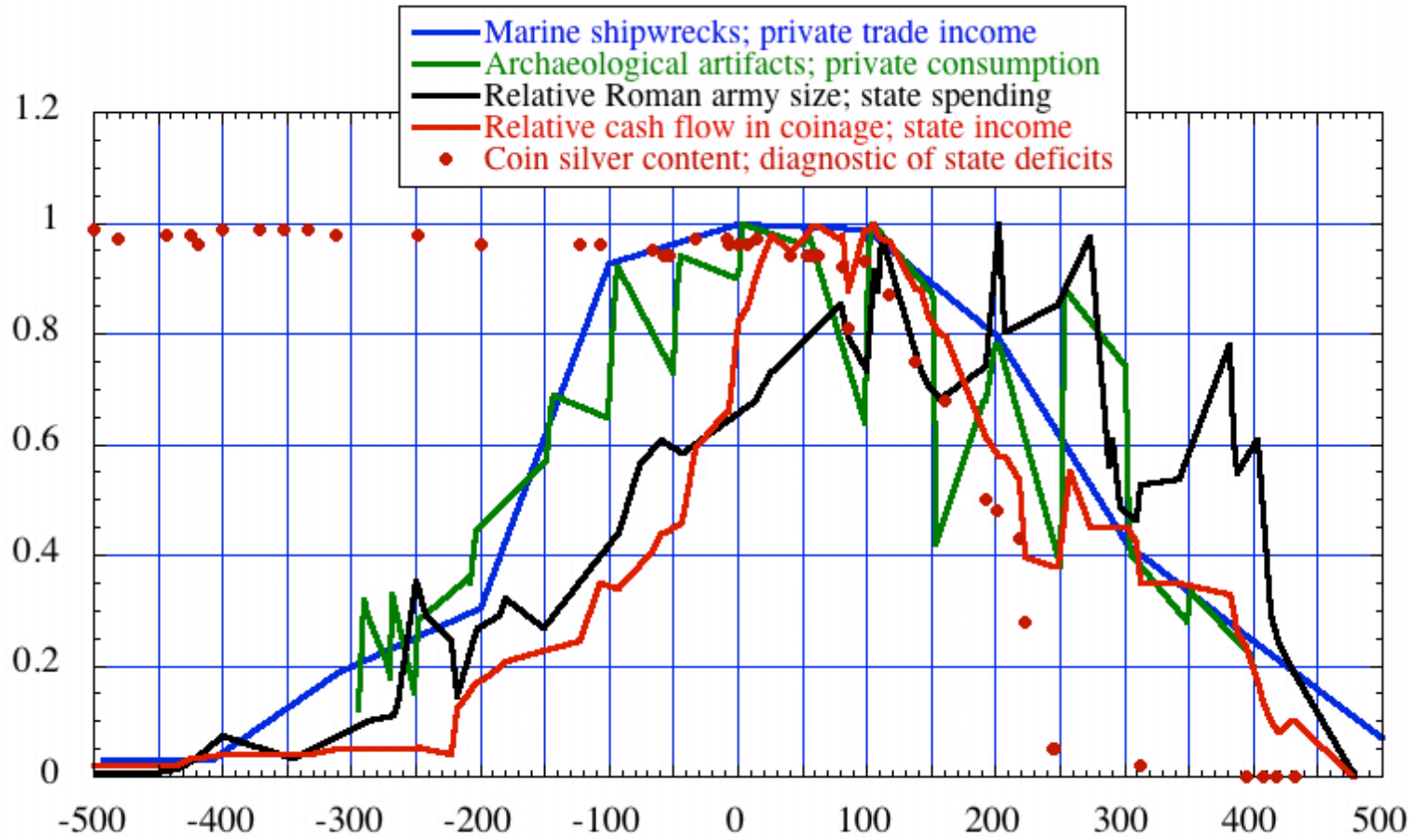
With = with "paper" gold
 Without = physical gold only

Tainter's principle: Resources lead to more complexity and increasing permanent costs





The Roman Empire



It happend in the Roman Empire

- Maximum resource outputs:
 - Fuel max occurred in 250 AD
 - Grain max occurred in 280 AD
 - Metals max occurred in 220 AD
 - Land max occurred in 320 AD
- Maximum wealth
 - occured 15 years later 335-340 AD
- Cost outrun Wealth;
 - occured 15-20 years later 290-300 AD
 - The Roman Empire collapsed 370 AD

Challenges and unknowns ahead

- Many key resources will reach peak supply during the next two decades
- A contracting resource base will impose new and very strong challenges on economic thinking, policy and behaviour
- Old solutions and old thinking will become redundant
- We need to develop new thinking, new governance, new economic policies which we do not yet know what are
- Systems analysis and systems dynamics can help do inputs for these developments