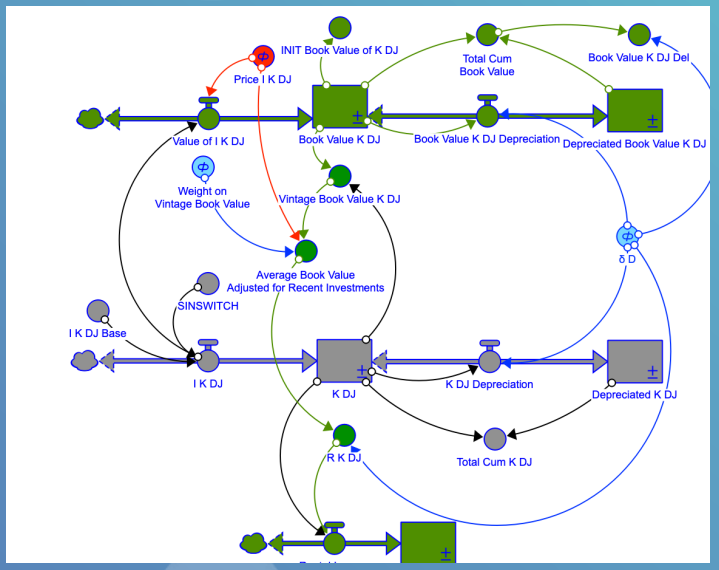
POLYTRoPOS

The implementation of the system dynamics version of the POLYvalent model for TRansformative Policy Scenarios



Pål I. Davidsen

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pal.davidsen@uib.no

+47 91 17 28 19

European Commission

A dynamic model of the economy represents

Accumulation processes

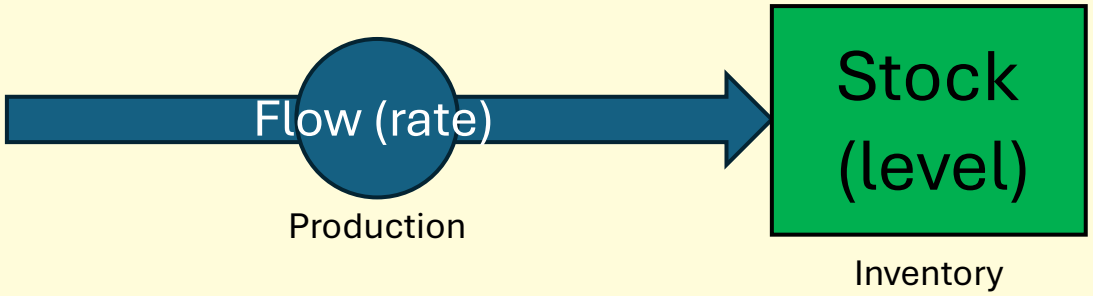
Feedback

Non-linearities

Stochasticity

Accumulation processes

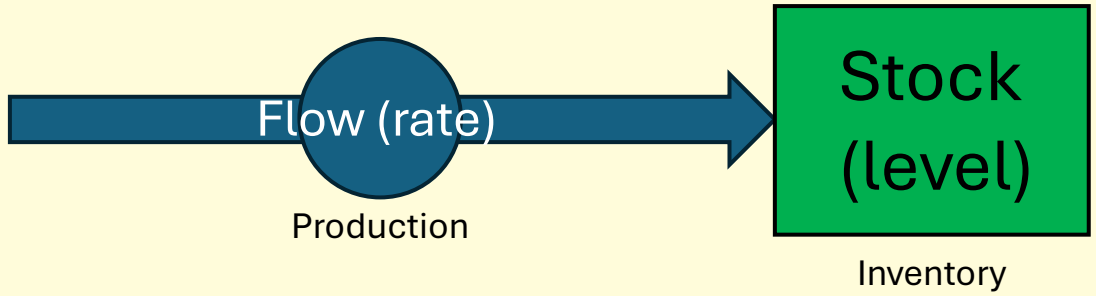
S & F



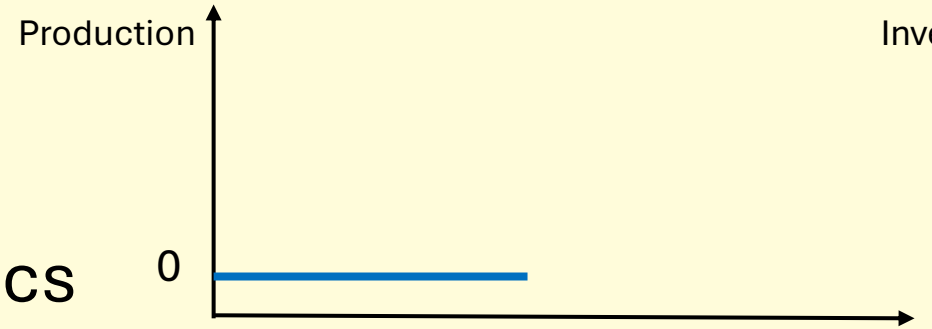
CLD

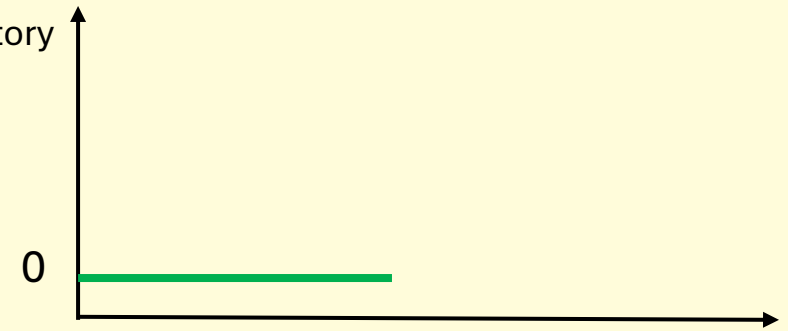
Accumulation processes

Structure

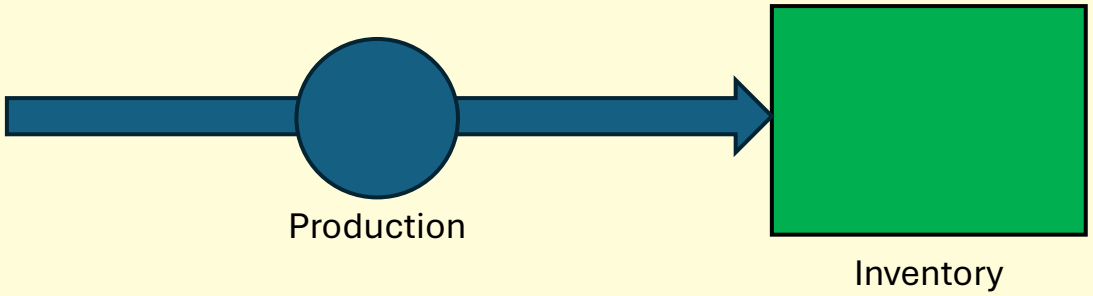


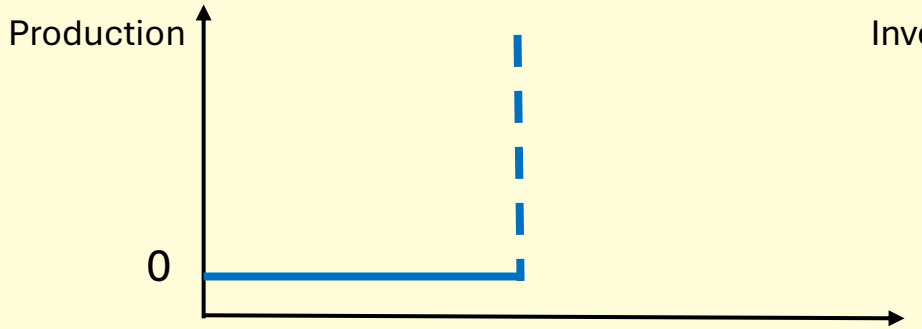
Dynamics

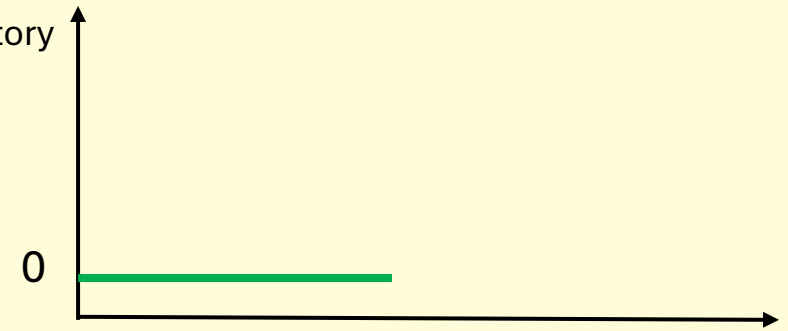




Accumulation processes

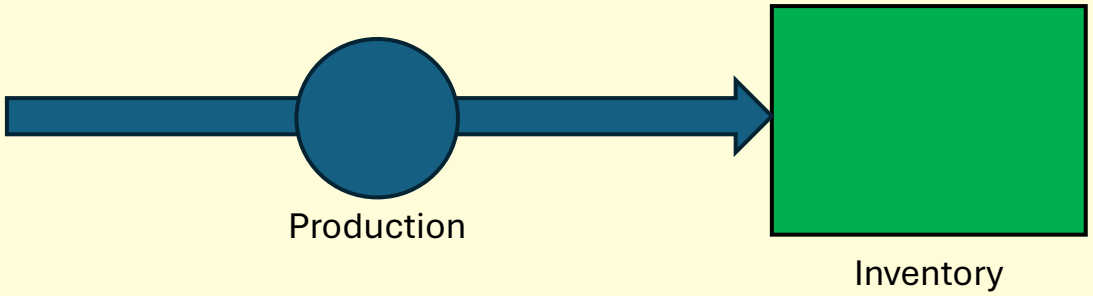




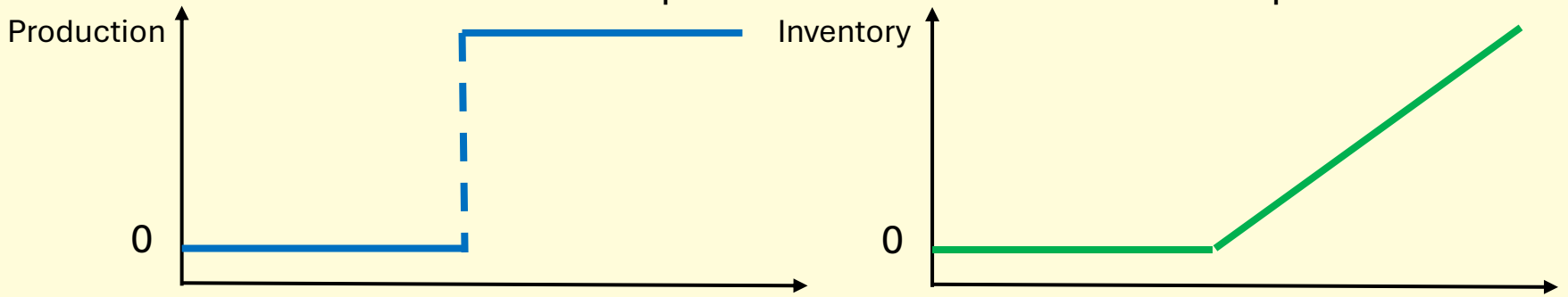


Accumulation processes

Time consuming processes

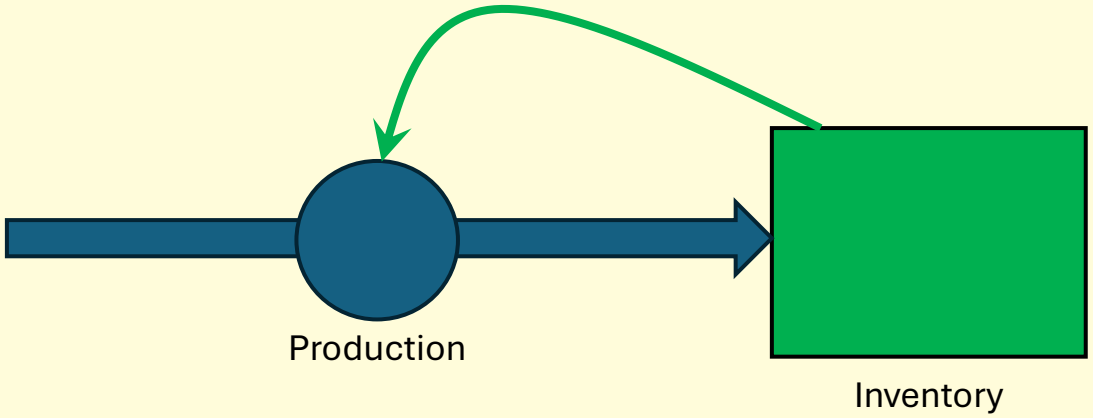


Time must pass for an accumulation to take place:

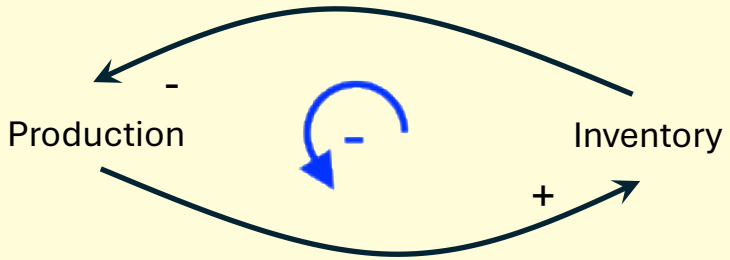


Accumulation processes with feedback

S & F

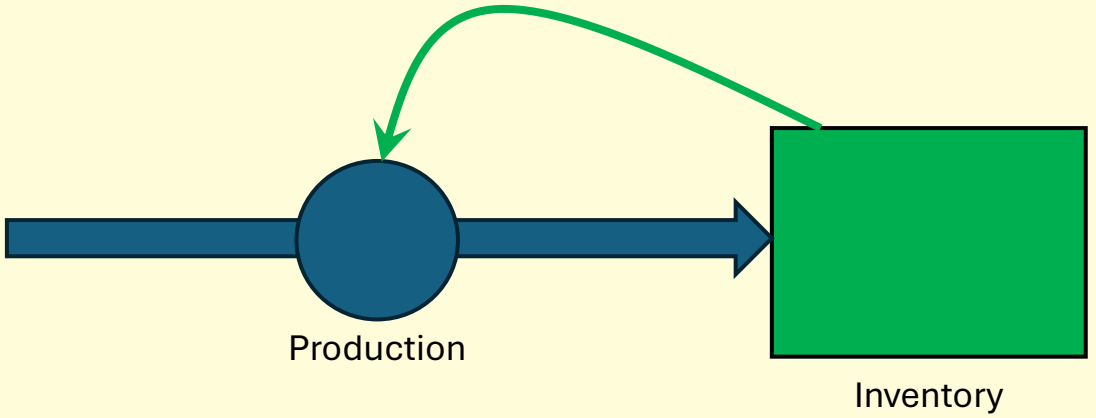


CLD

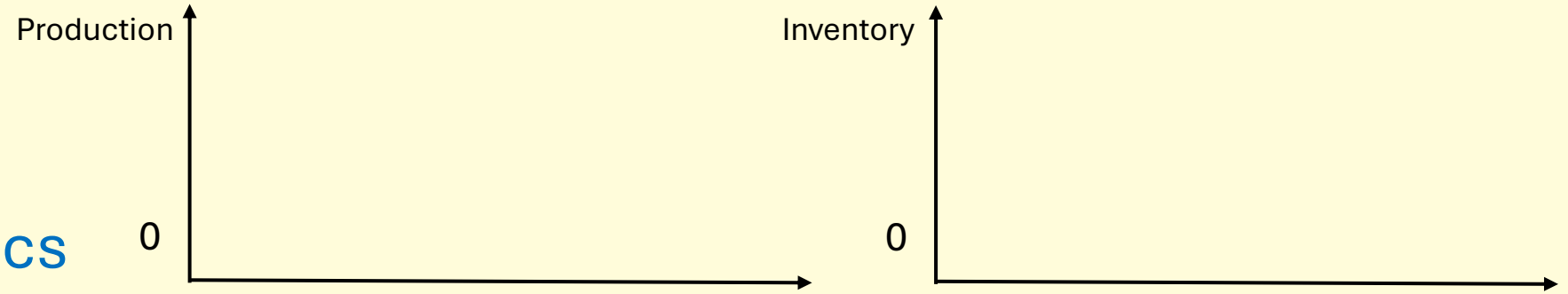


Accumulation processes with feedback

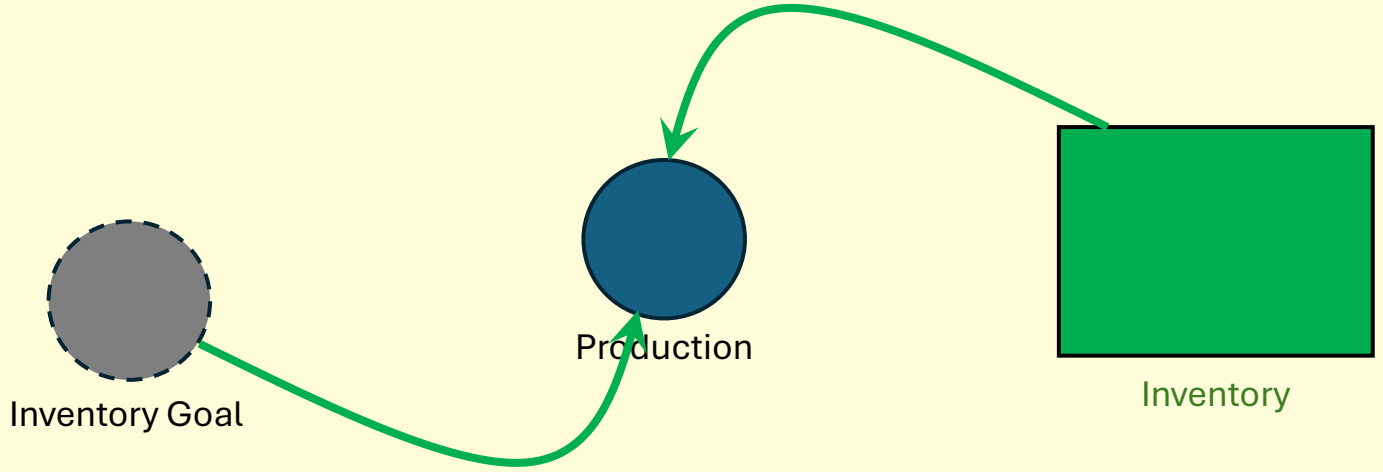
Structure

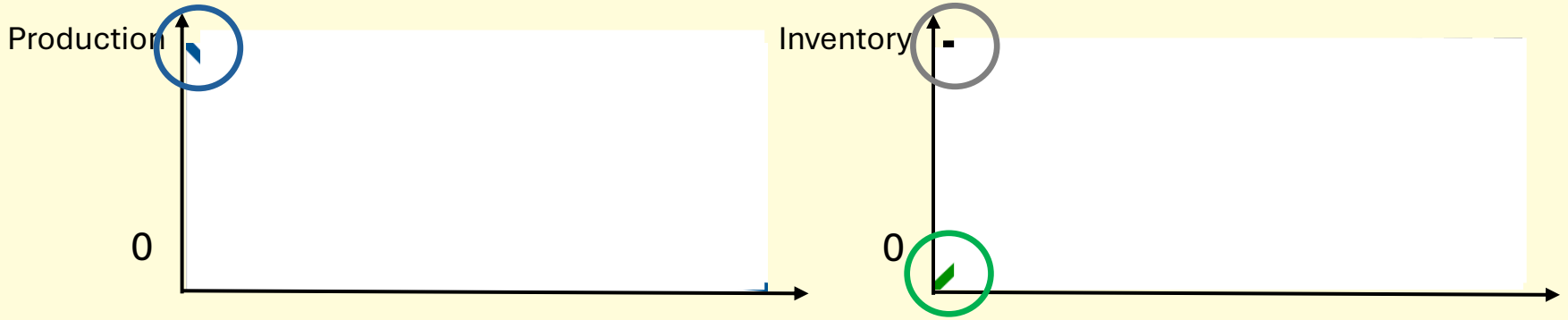


Dynamics

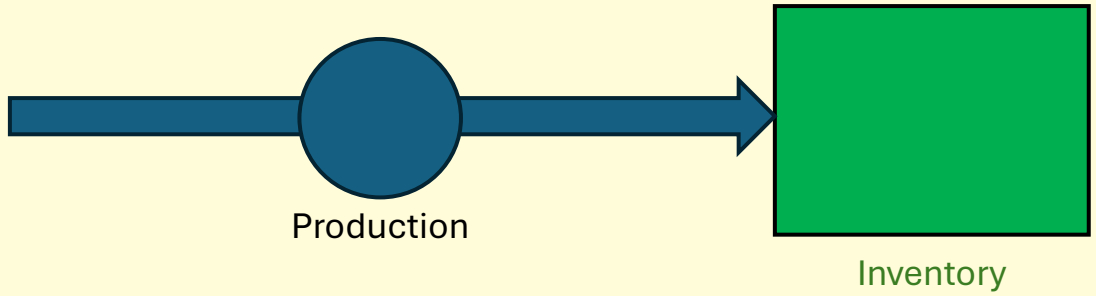


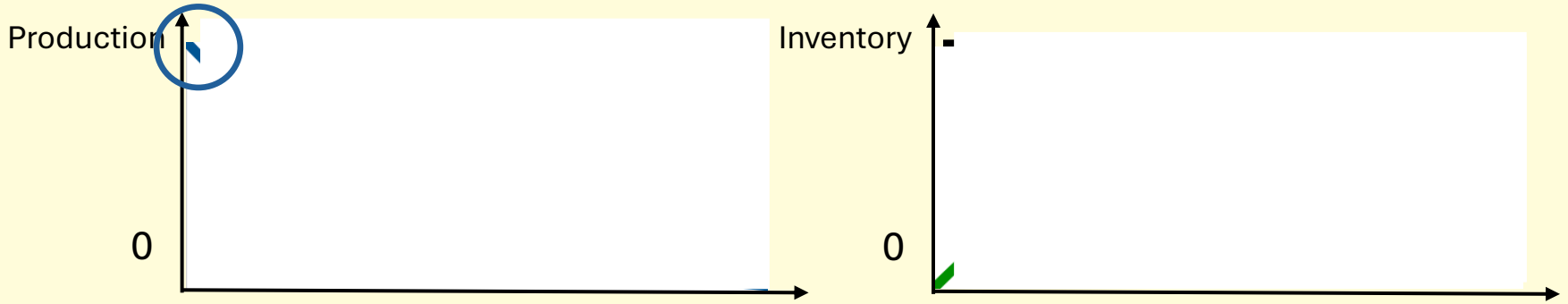
Accumulation processes with feedback (Rate Calculation)



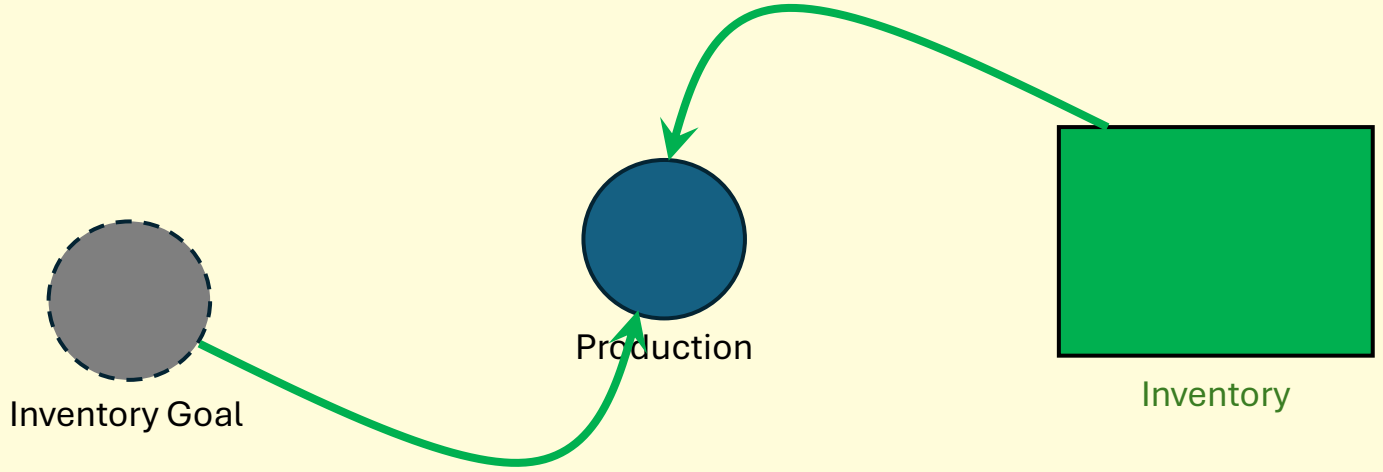


Accumulation processes with feedback (Integration)

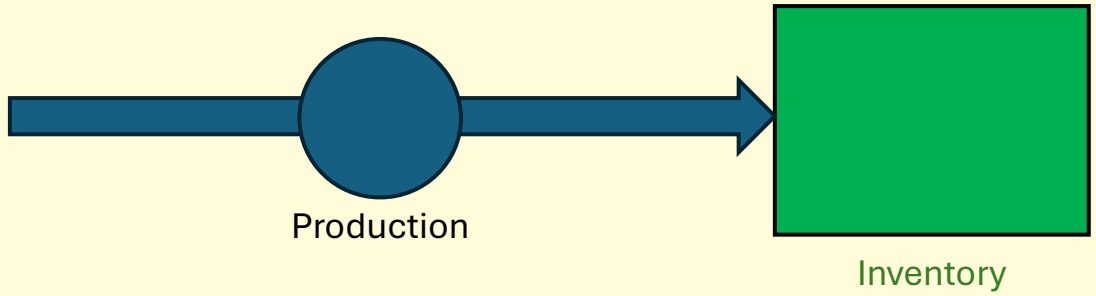


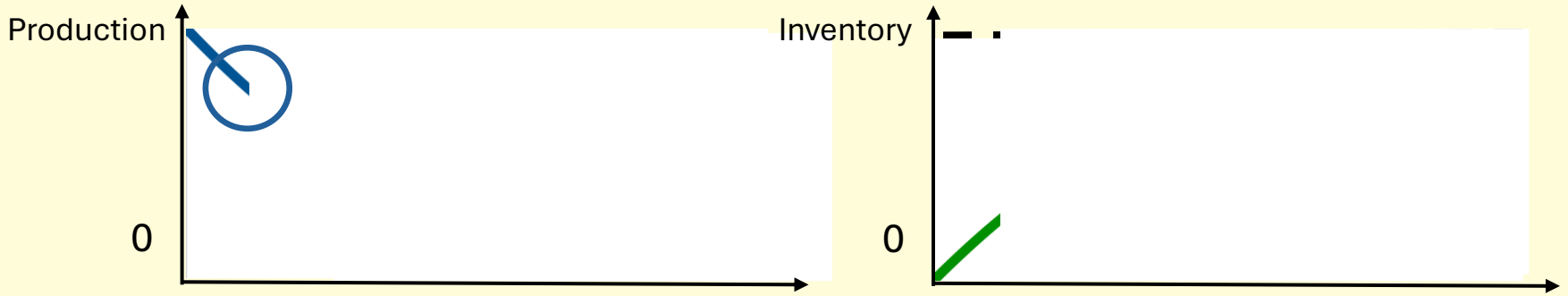


Accumulation processes with feedback (Rate Calculation)

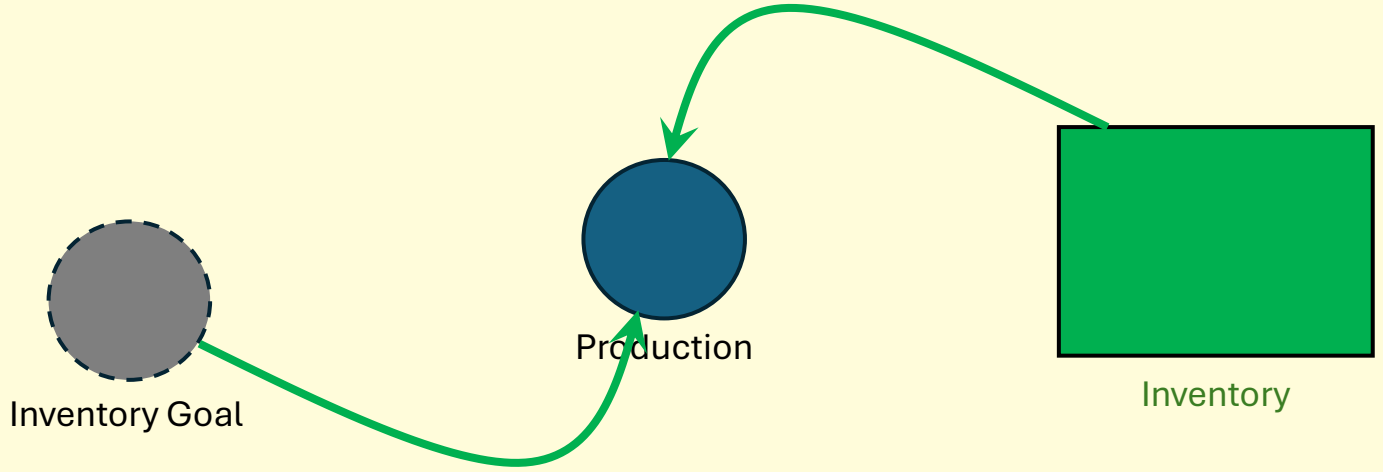


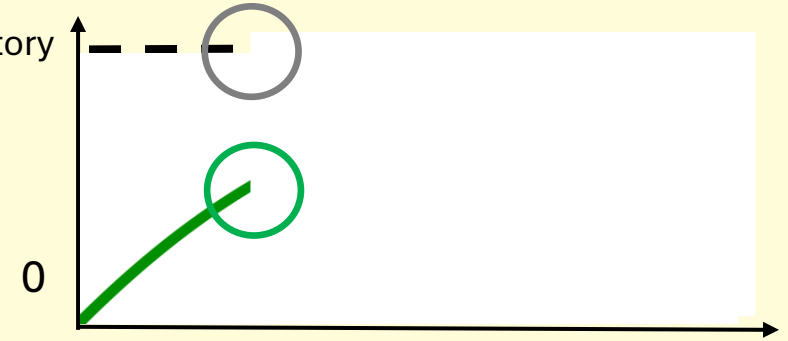
Accumulation processes with feedback (Integration)



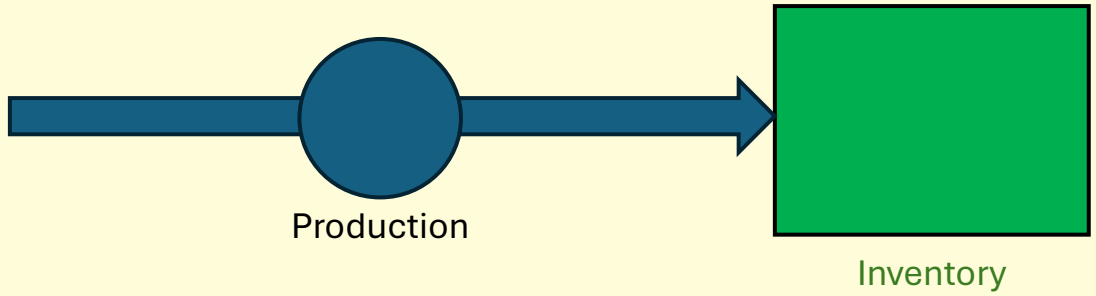


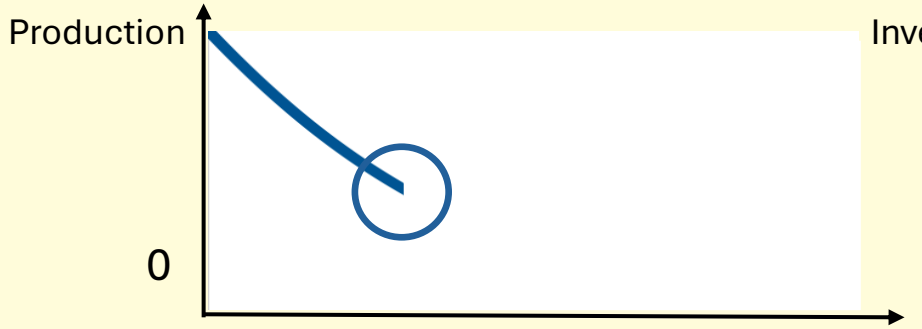
Accumulation processes with feedback (Rate Calculation)

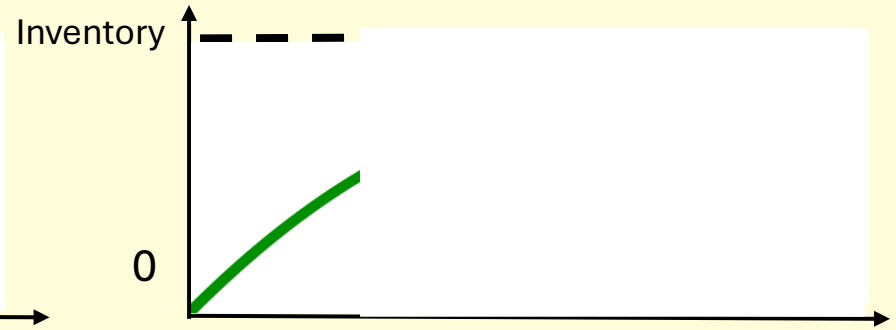




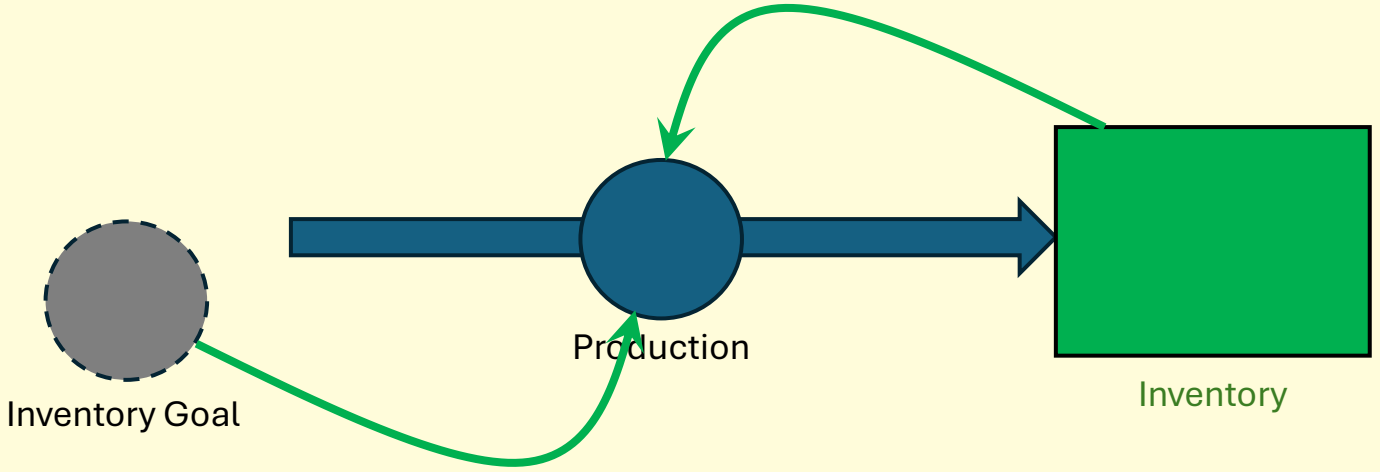
Accumulation processes with feedback (Integration)

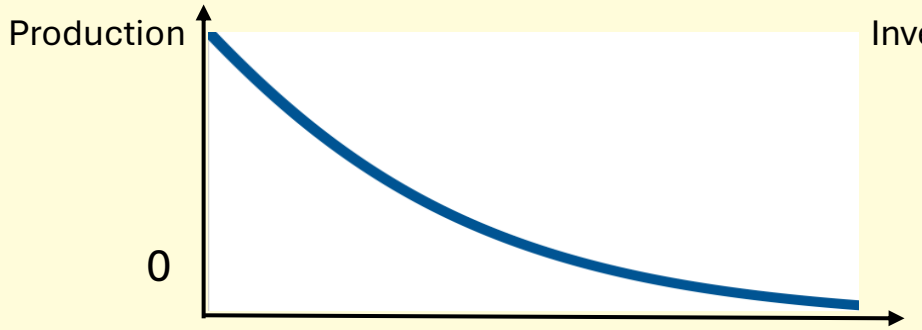


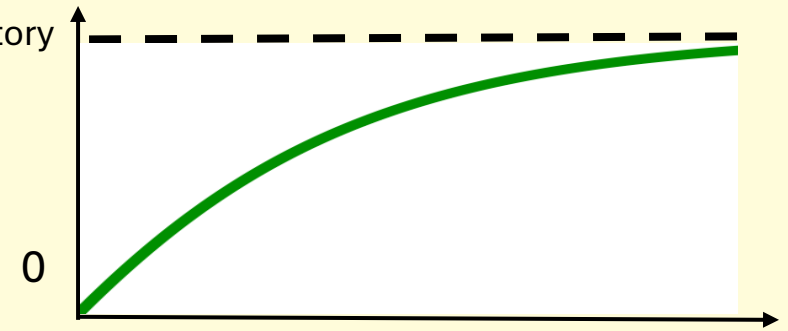




Accumulation processes with feedback (Rate calculation & Integration)







Accumulation processes with feedback

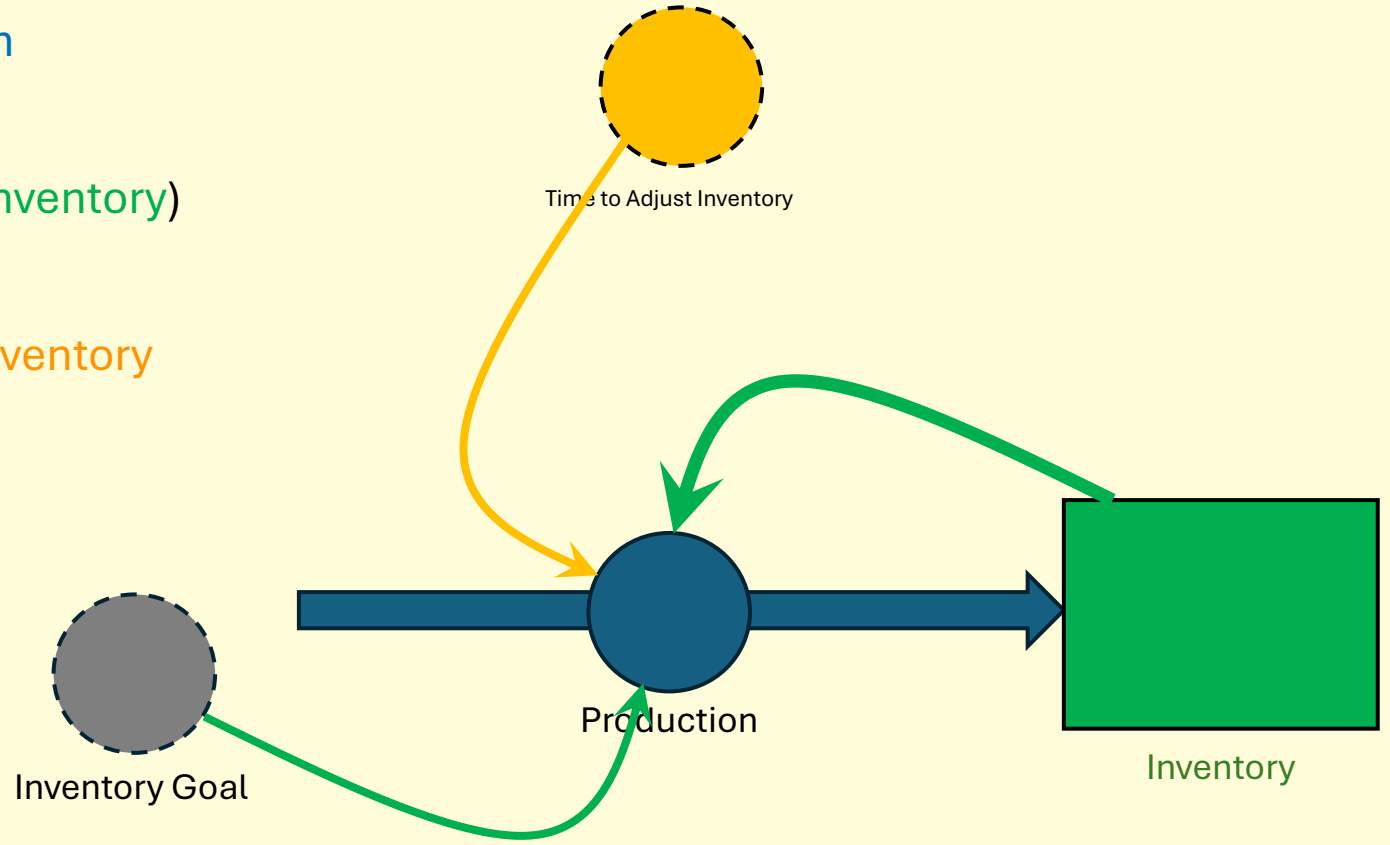
Production

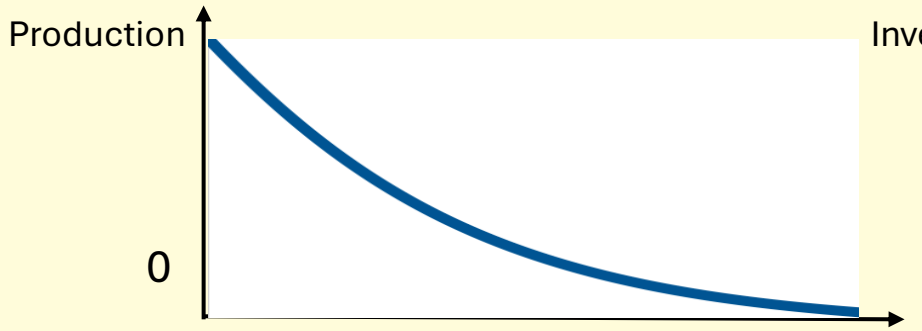
=

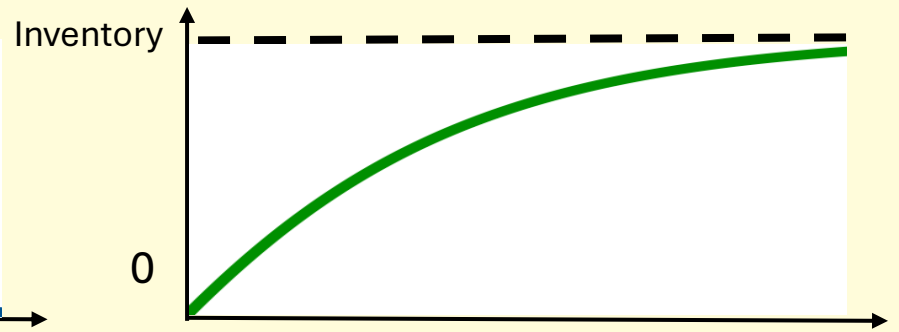
(Inventory Goal – Inventory)

/

Time to Adjust Inventory







Accumulation processes with non-linear feedback

Production

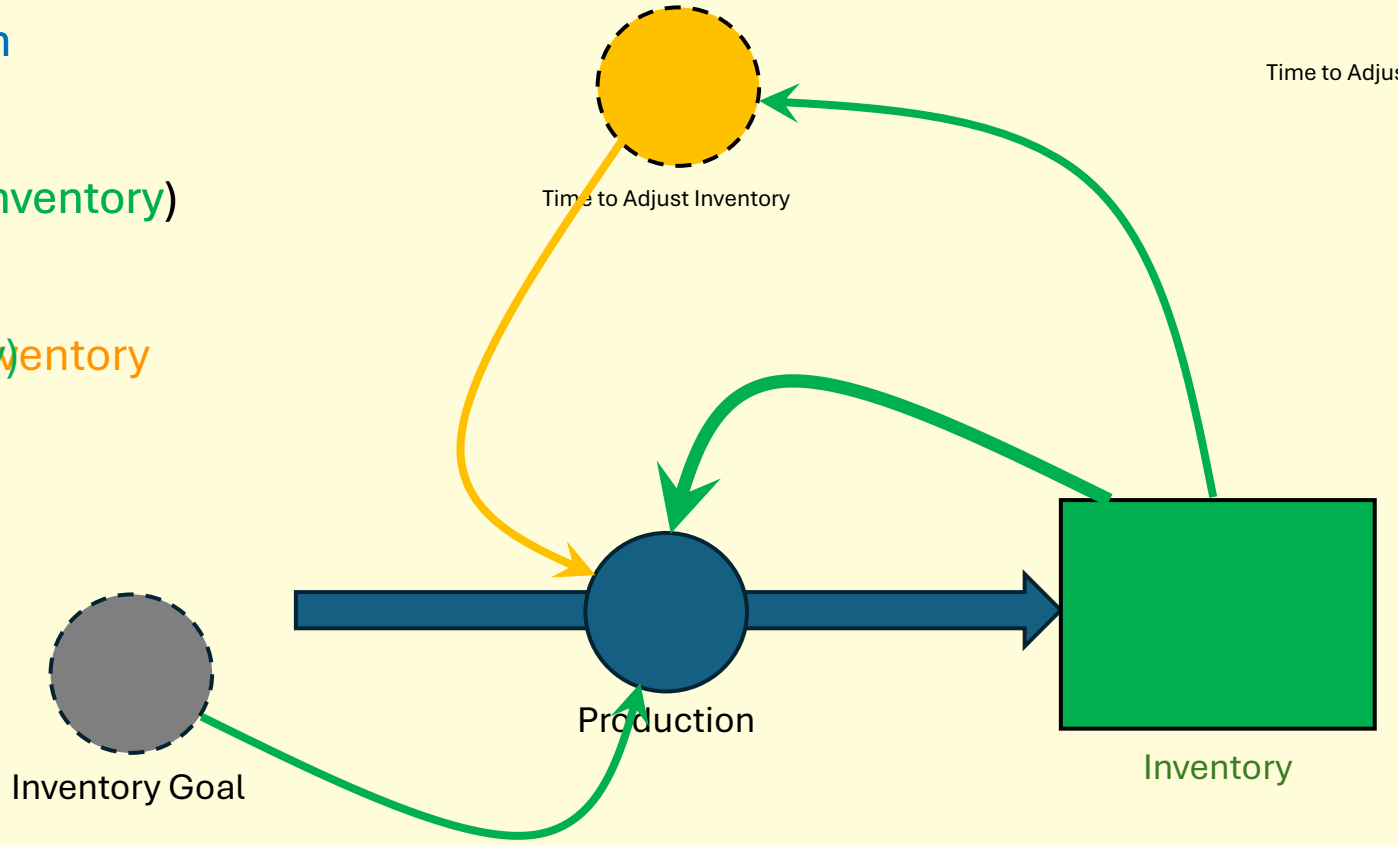
=

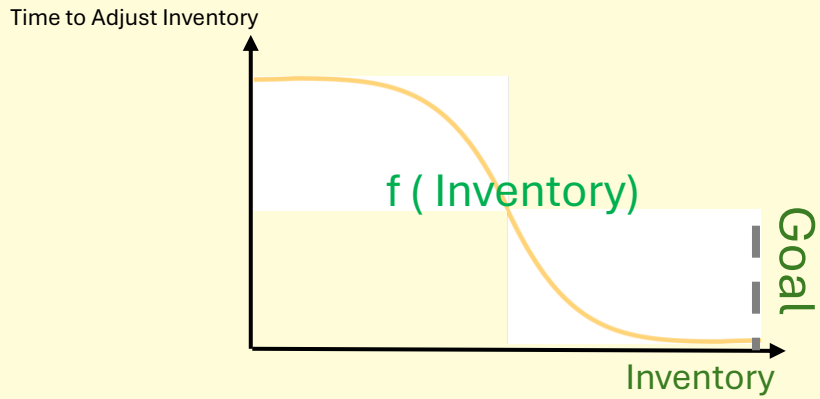
(Inventory Goal – Inventory)

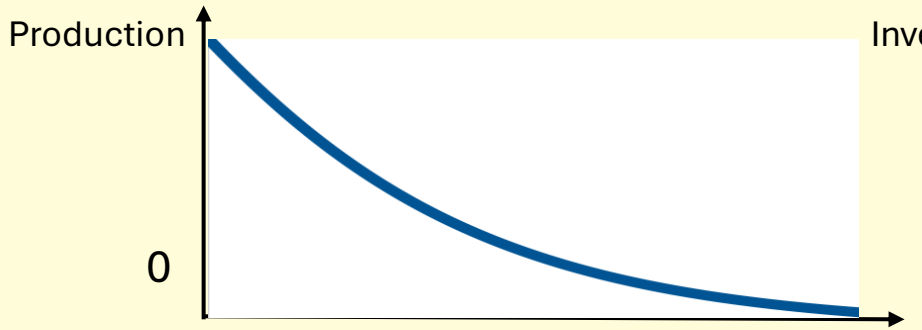
/

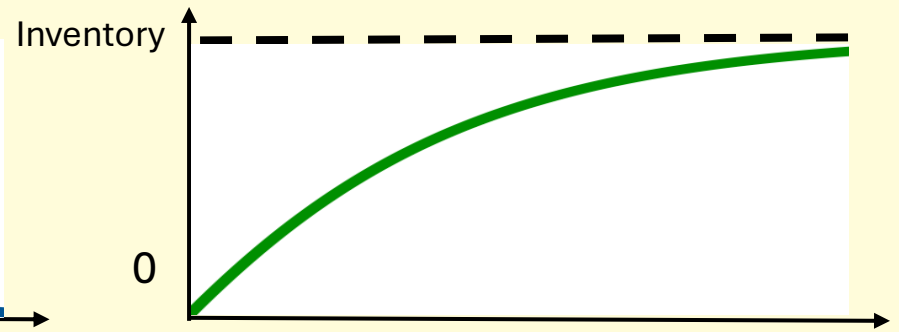
Time to Adjust Inventory

f (Inventory)









Accumulation processes with non-linear feedback

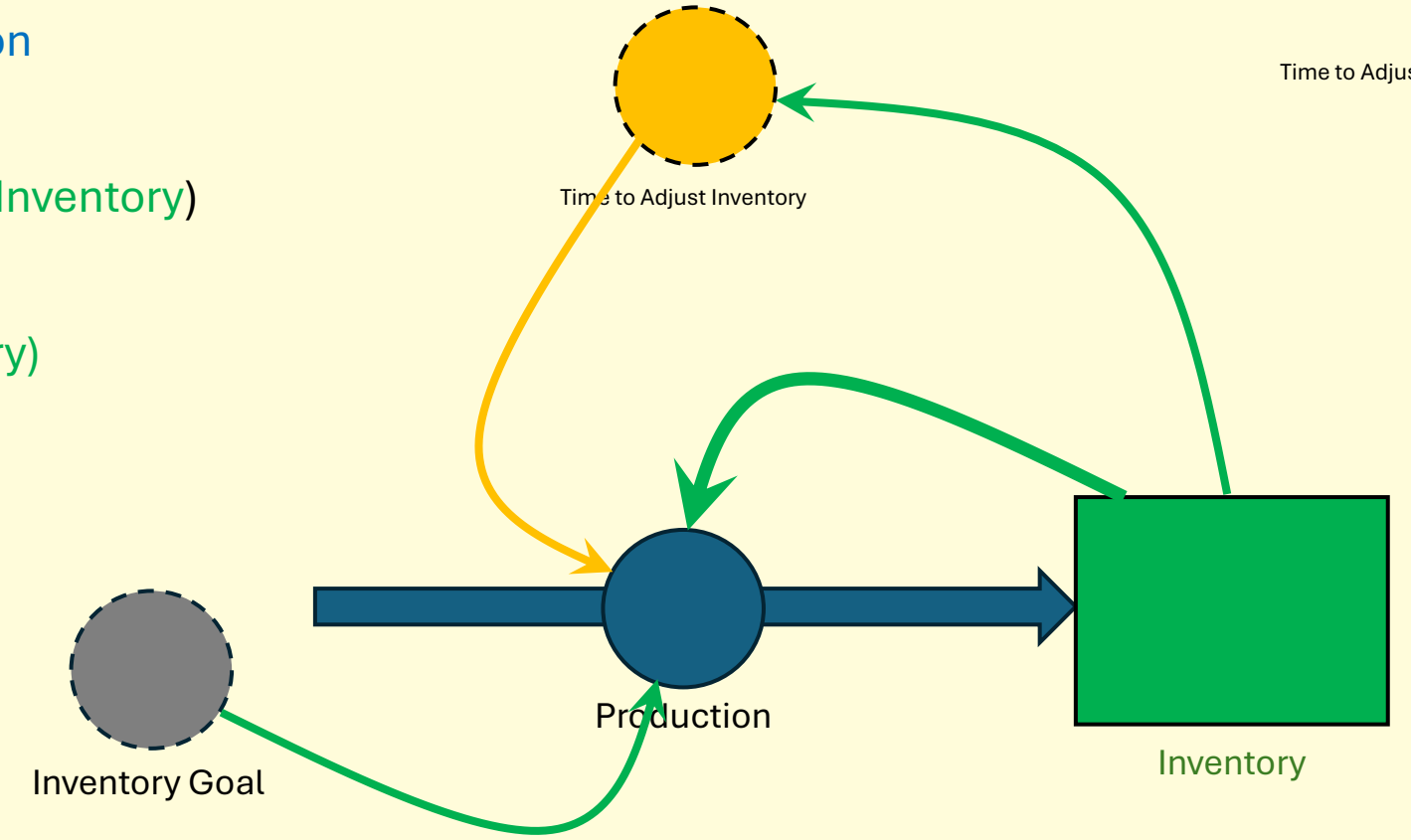
Production

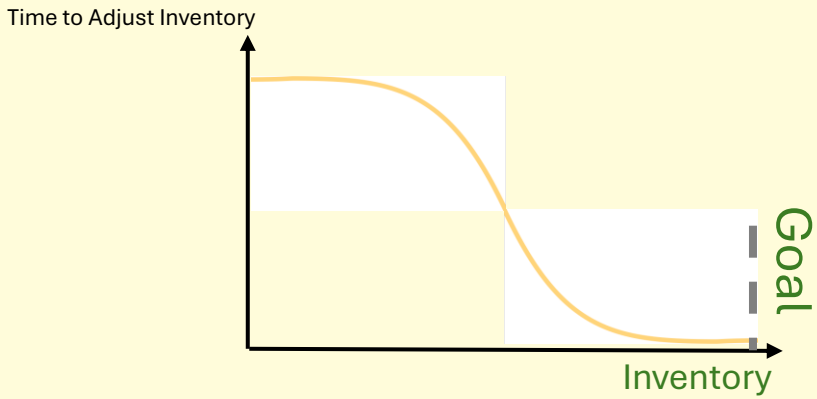
=

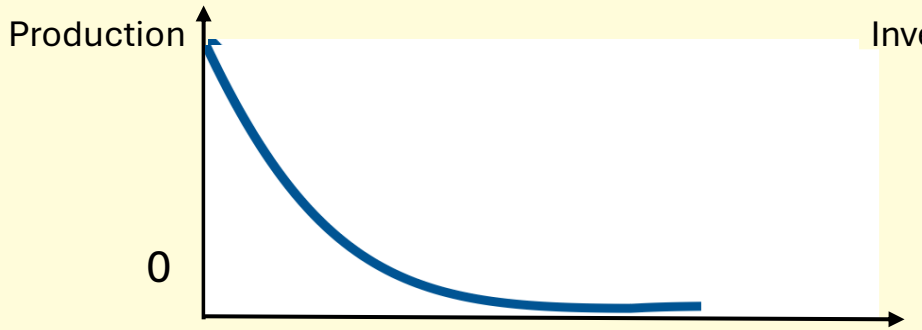
(Inventory Goal – Inventory)

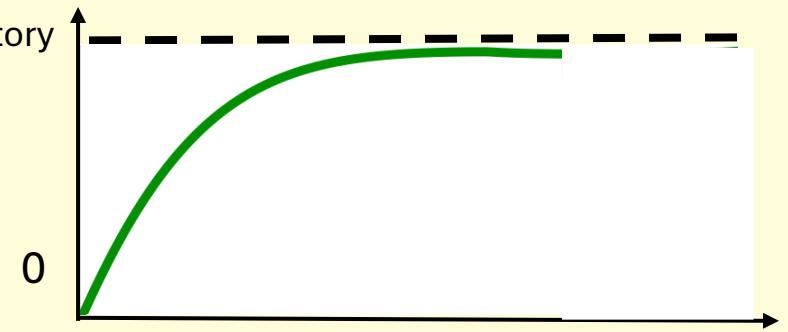
/

f(Inventory)





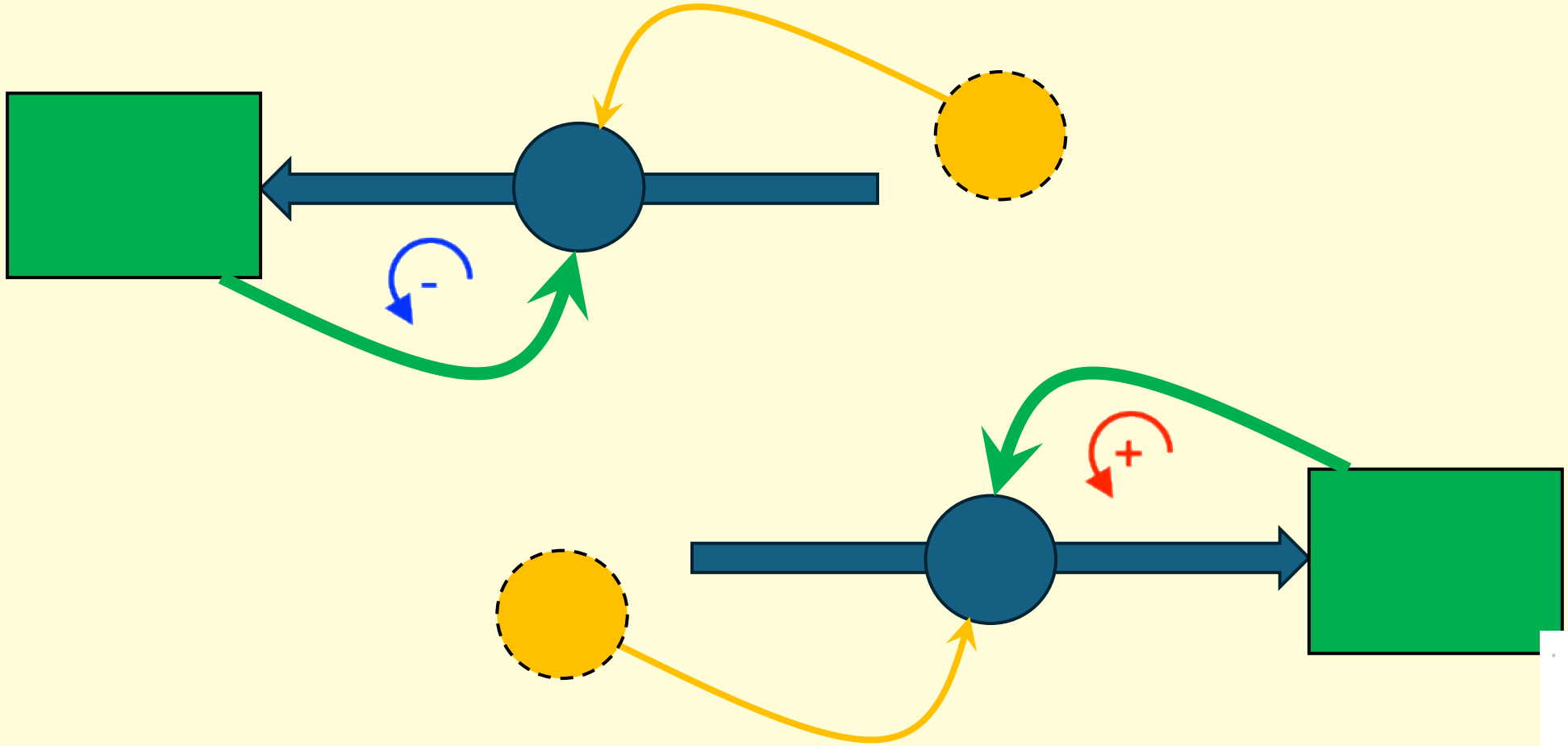




Structure produces dynamics

and

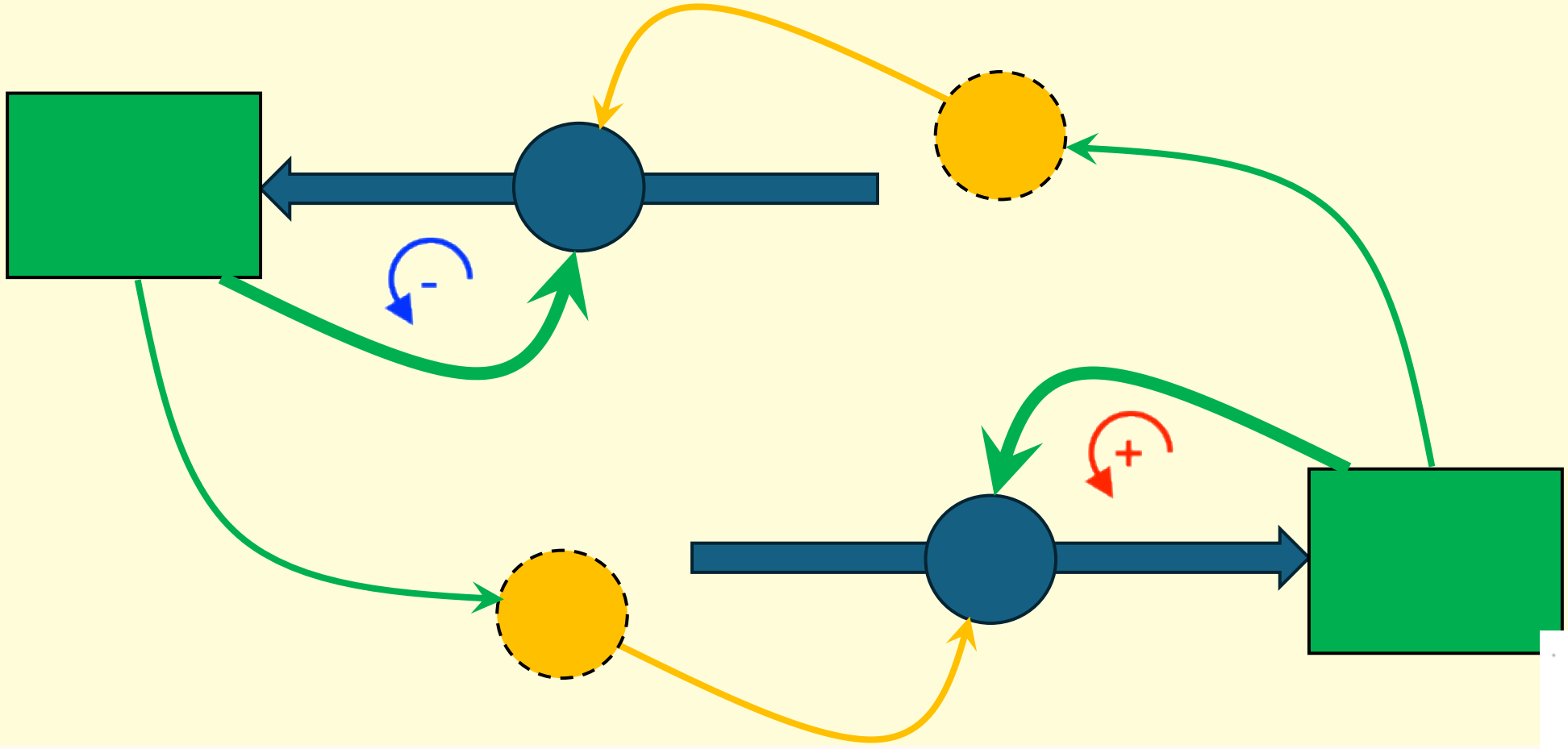
...



Structure produces dynamics

and

...

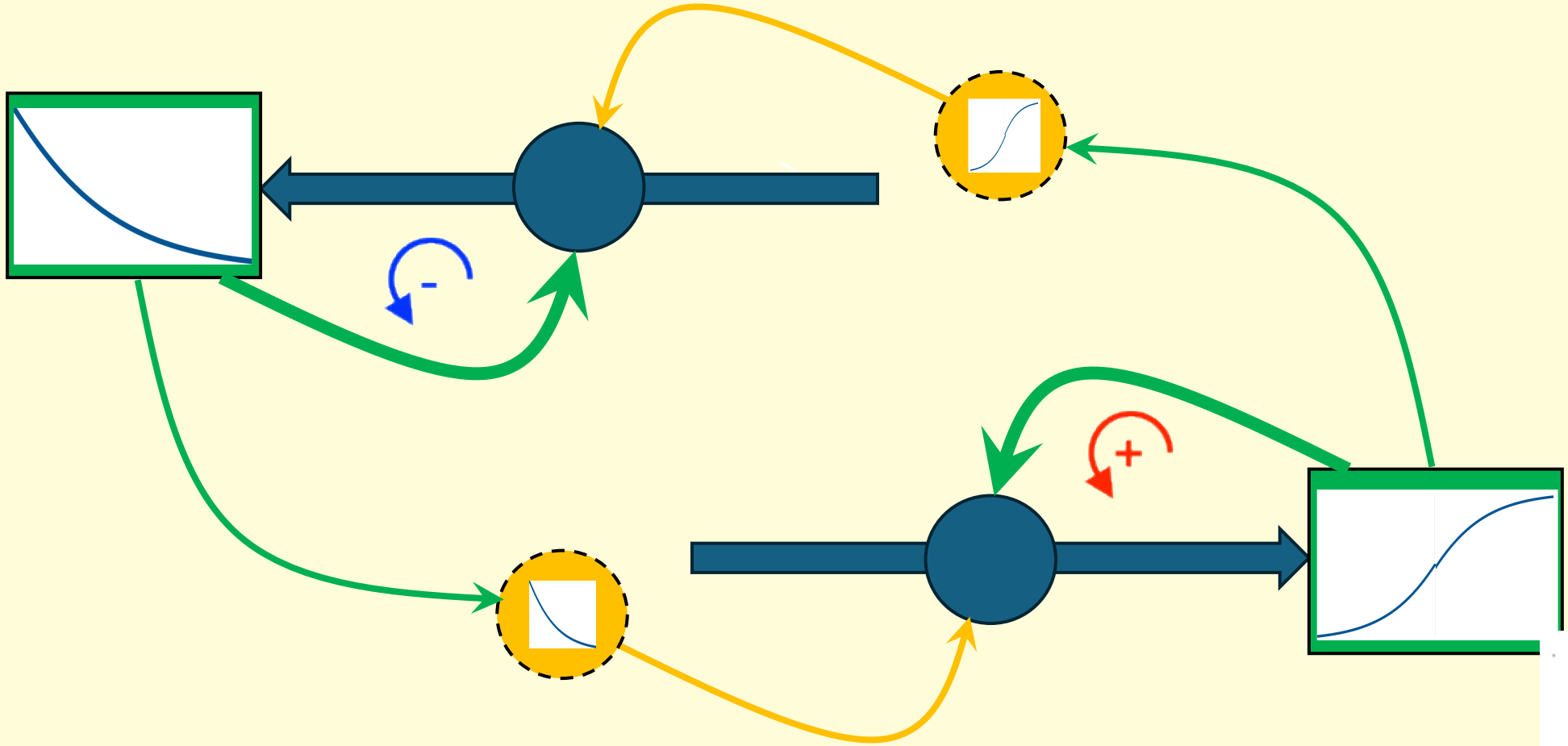


Structure produces dynamics

and

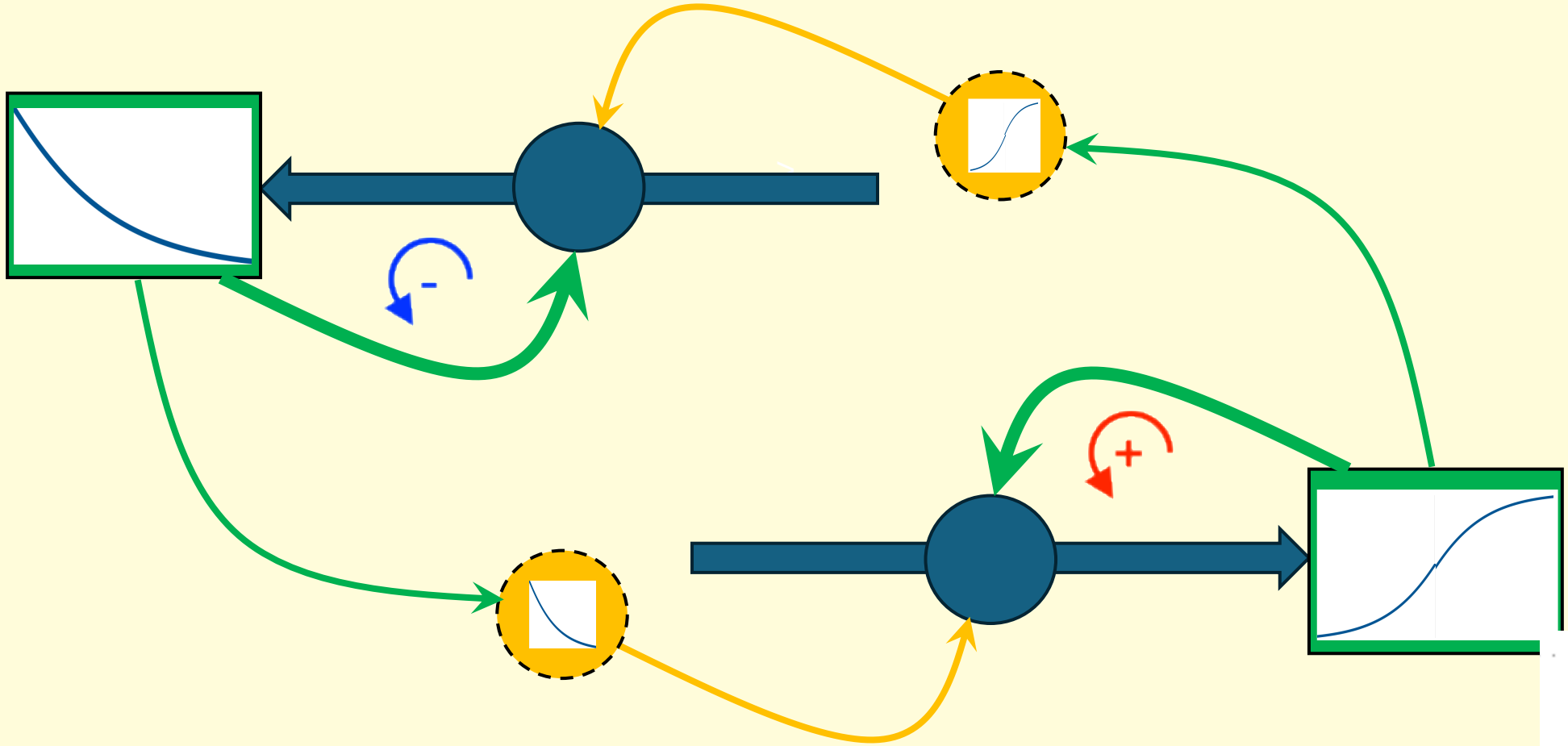
the dynamics produced changes the structure

(i.e. the relative significance of structural components)

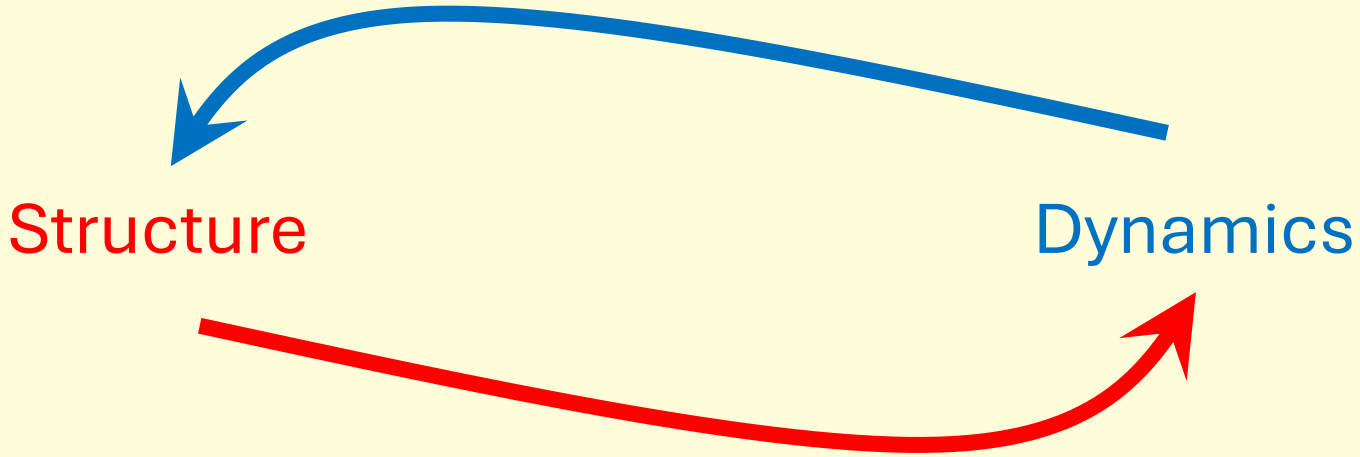


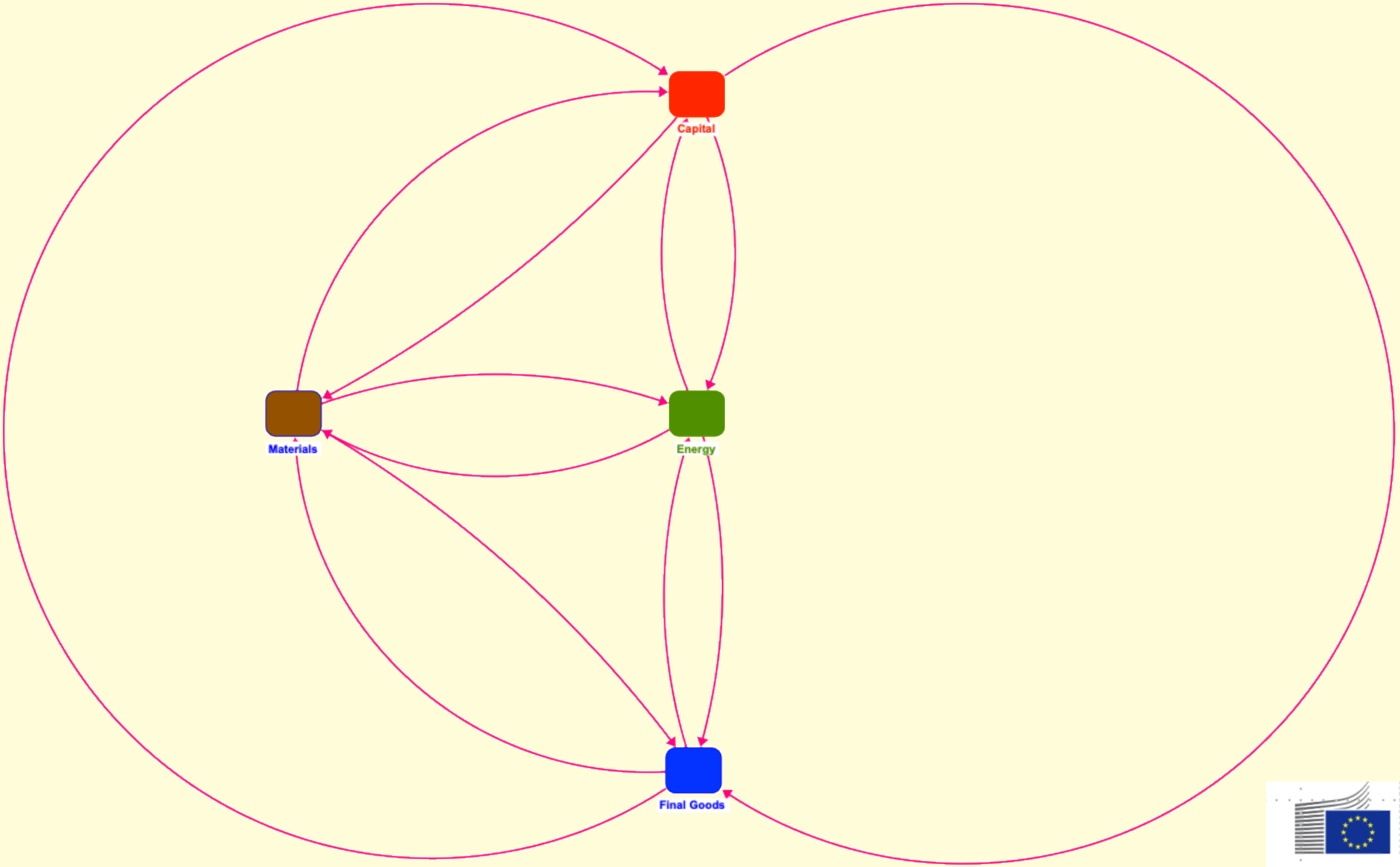
Rationale for a holistic systems approach:

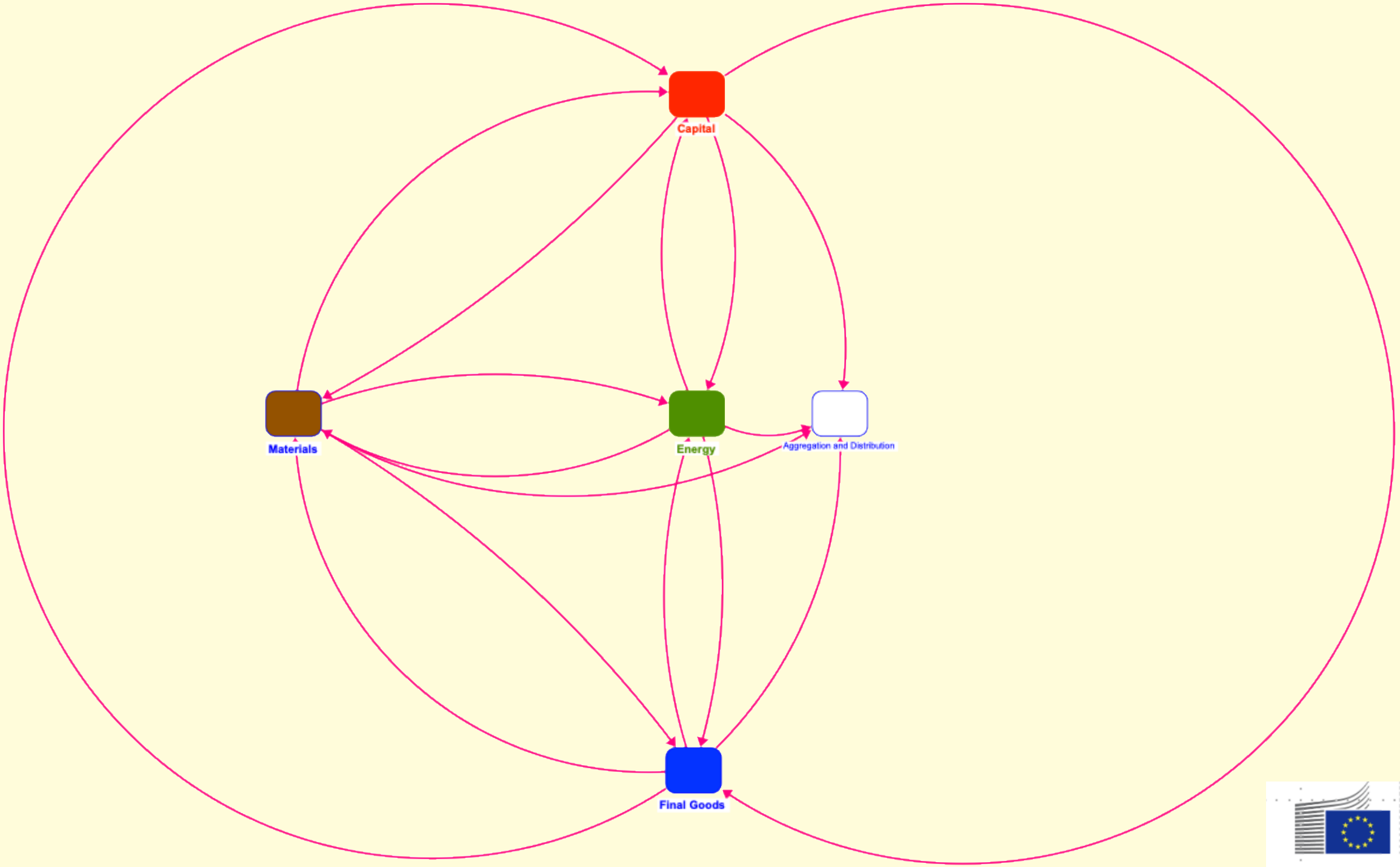
System components synergize
(cooperate / compete)
in the production of a total dynamic development over time
!

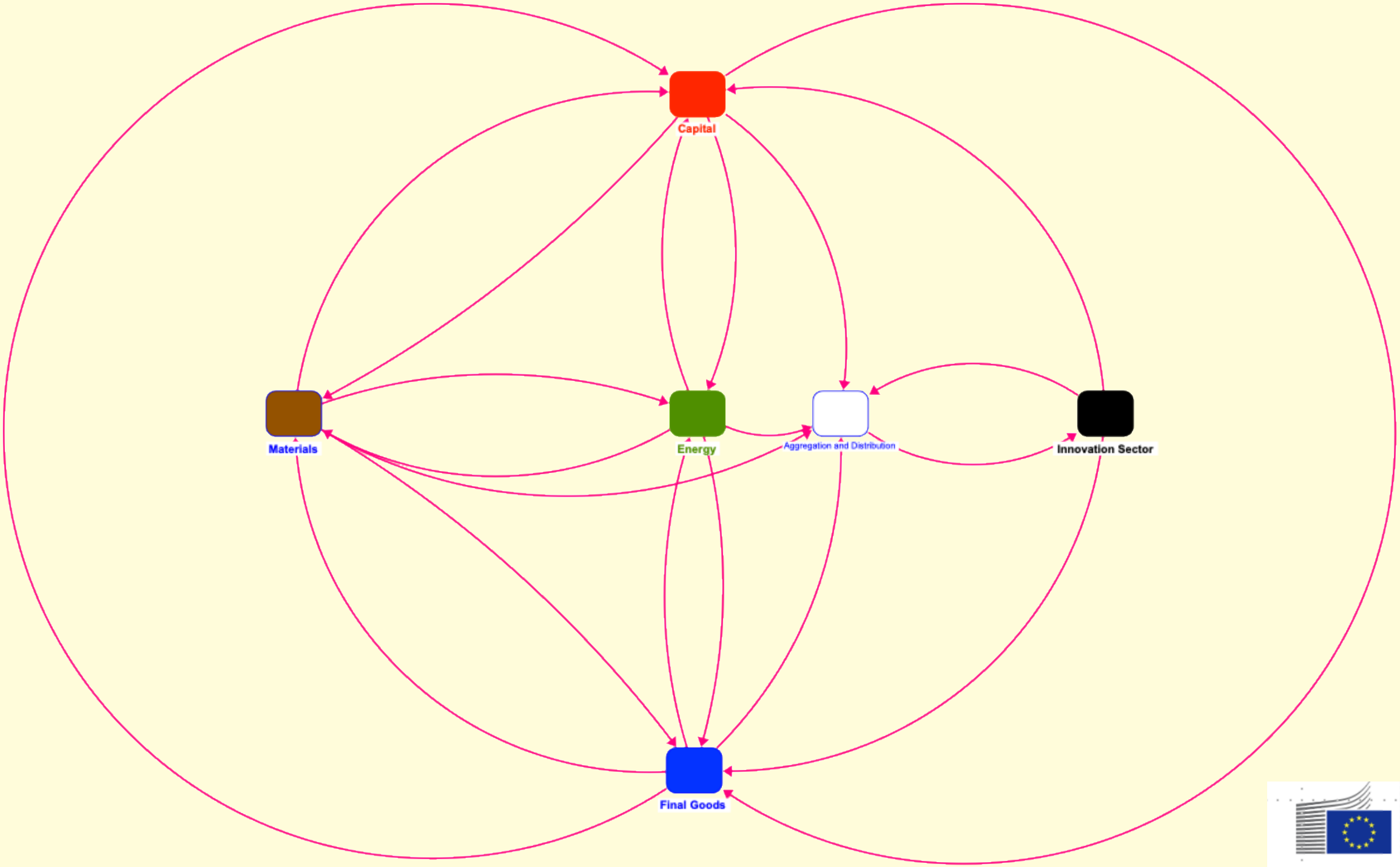


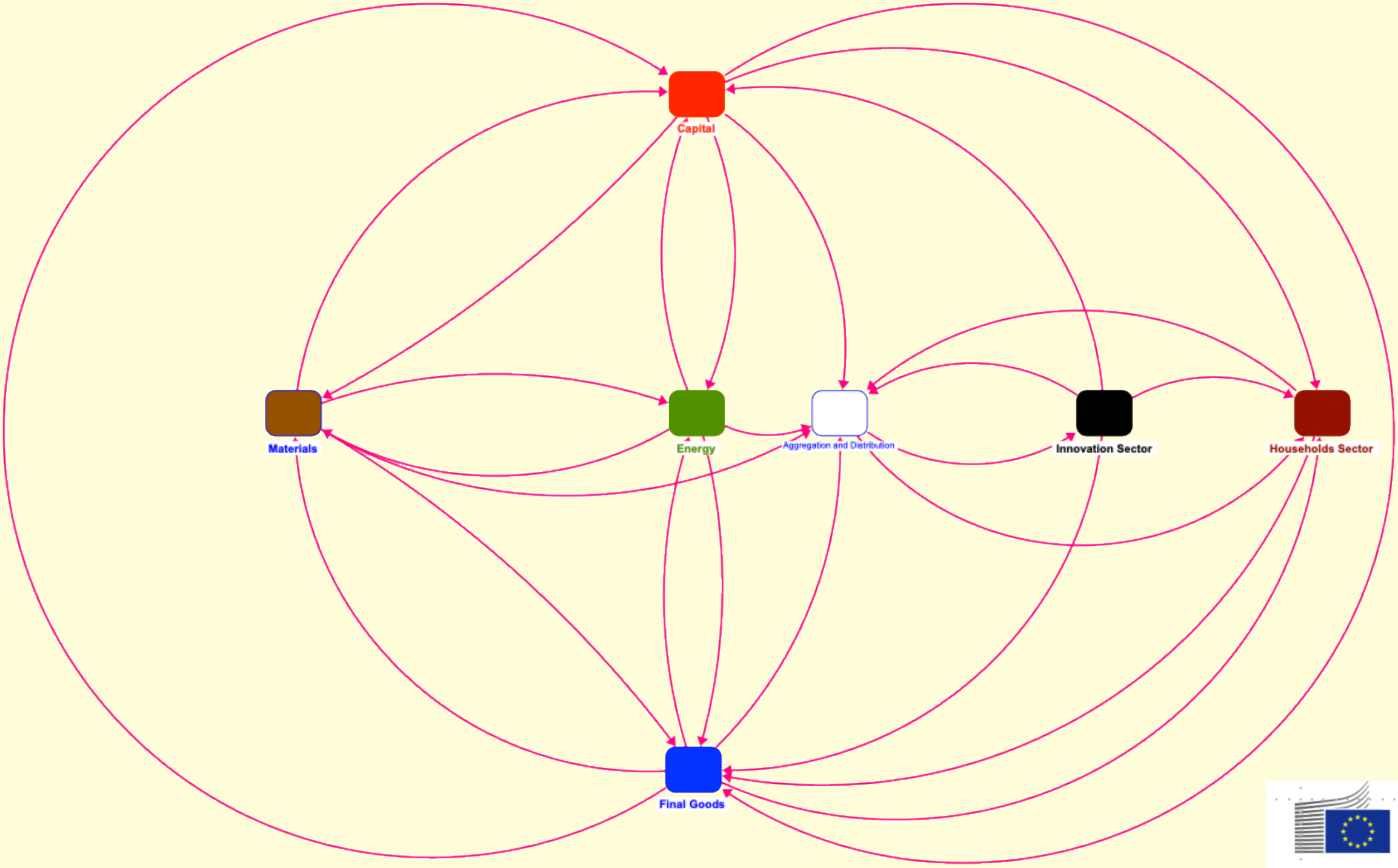
In non-linear feedback systems

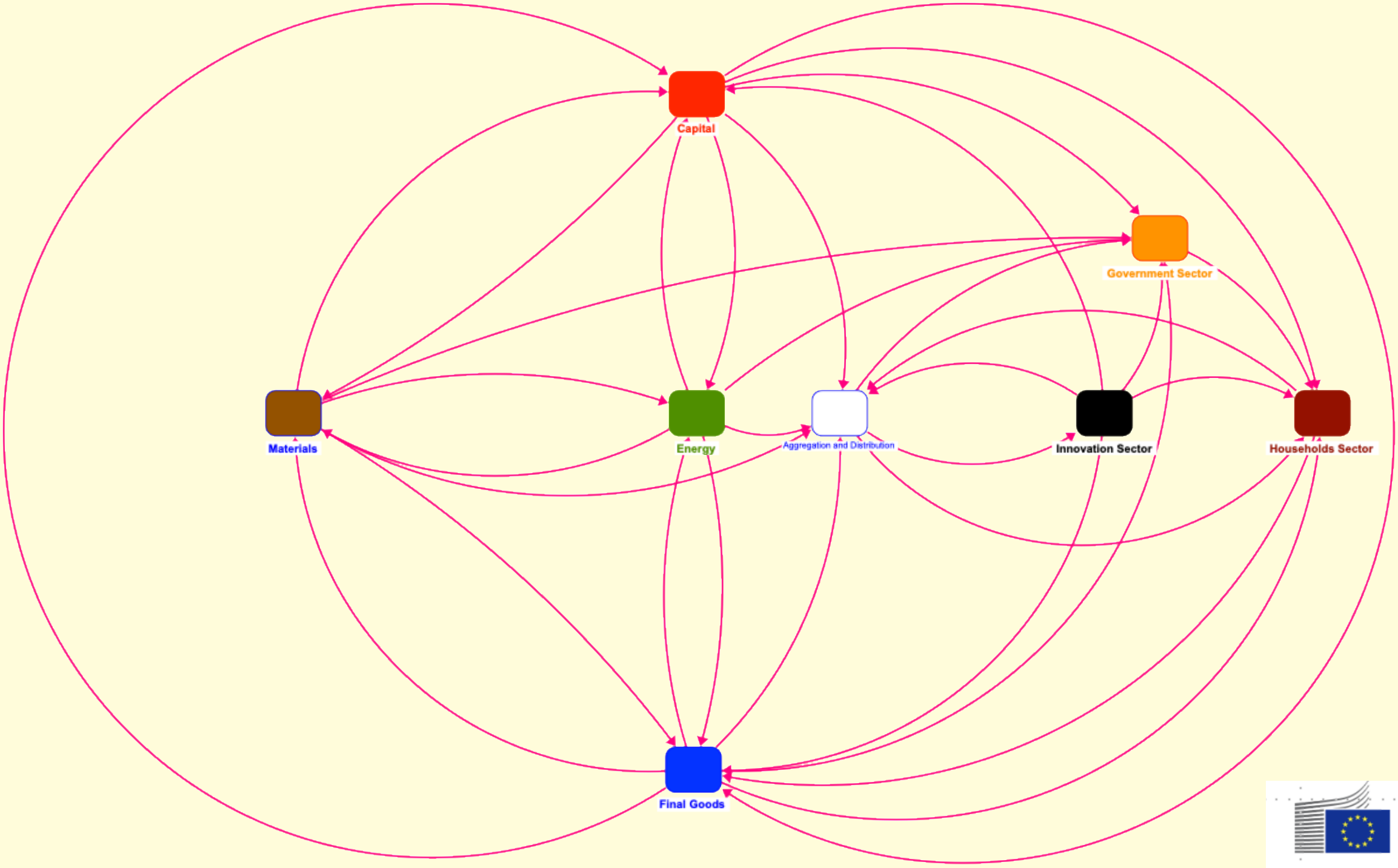


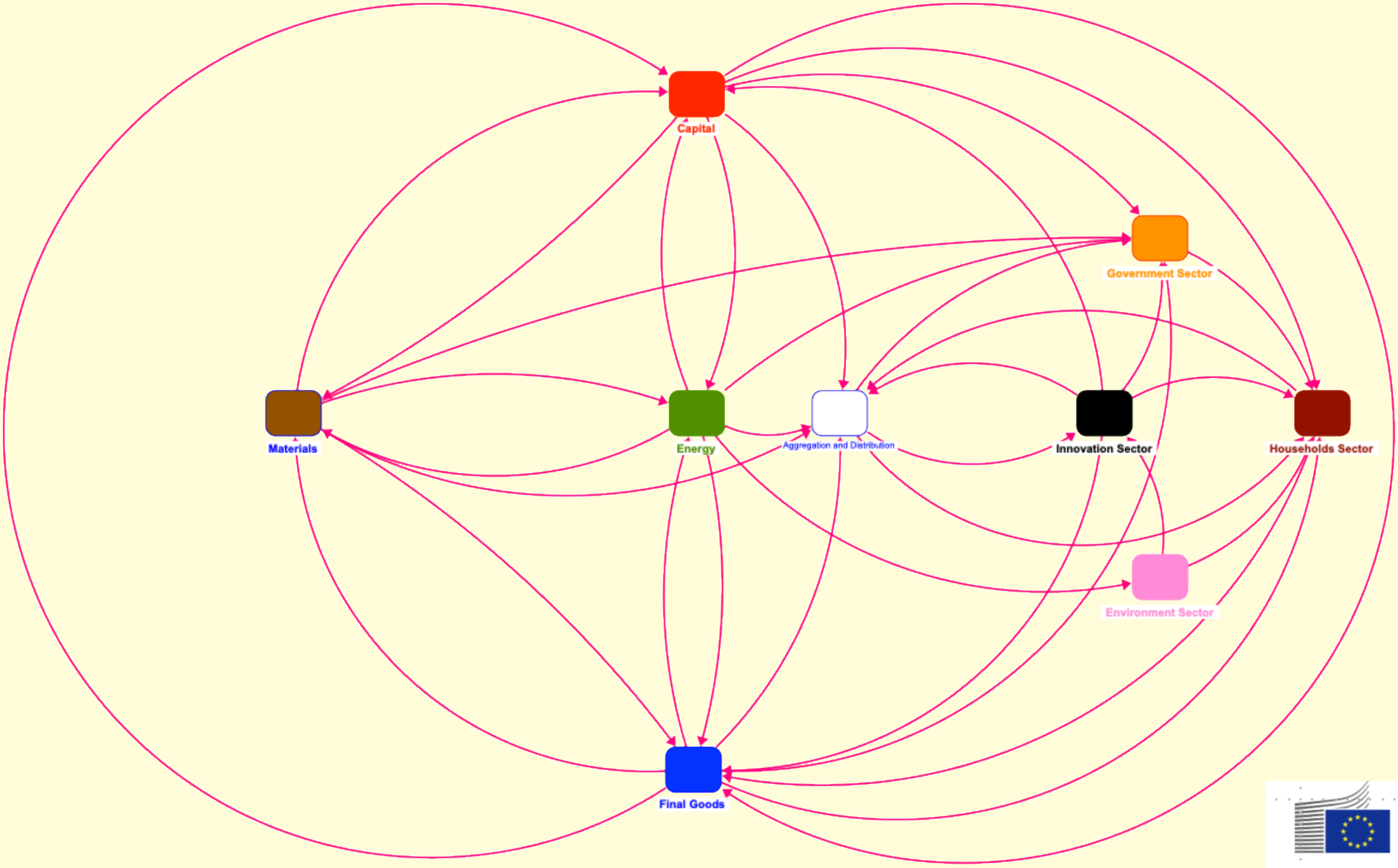

Capital
Materials
Energy
Final Goods


Capital
Materials
Energy
Aggregation and Distribution
Final Goods


Capital
Materials
Energy
Aggregation and Distribution
Innovation Sector
Final Goods


Capital
Materials
Energy
Aggregation and Distribution
Innovation Sector
Households Sector
Final Goods


Capital
Government Sector
Materials
Energy
Aggregation and Distribution
Innovation Sector
Households Sector
Final Goods


Capital
Government Sector
Materials
Energy
Aggregation and Distribution
Innovation Sector
Households Sector
Environment Sector
Final Goods

Products and factors of production

Two kinds of Energy sources

Renewable

Non-renewable

Two kinds of Energy factors

Electricity

Fuel

Two kinds of Final Goods

Old

New

Two kinds of Capital

Traditional

Novel

One kind of Material

Several kinds of Labor

(competence / capability)

Innovation and technology

Energy sources

Efficiency

Energy factors

Efficiency

Final Goods

Utility

Total Factor Productivity +

Capital

Productivity

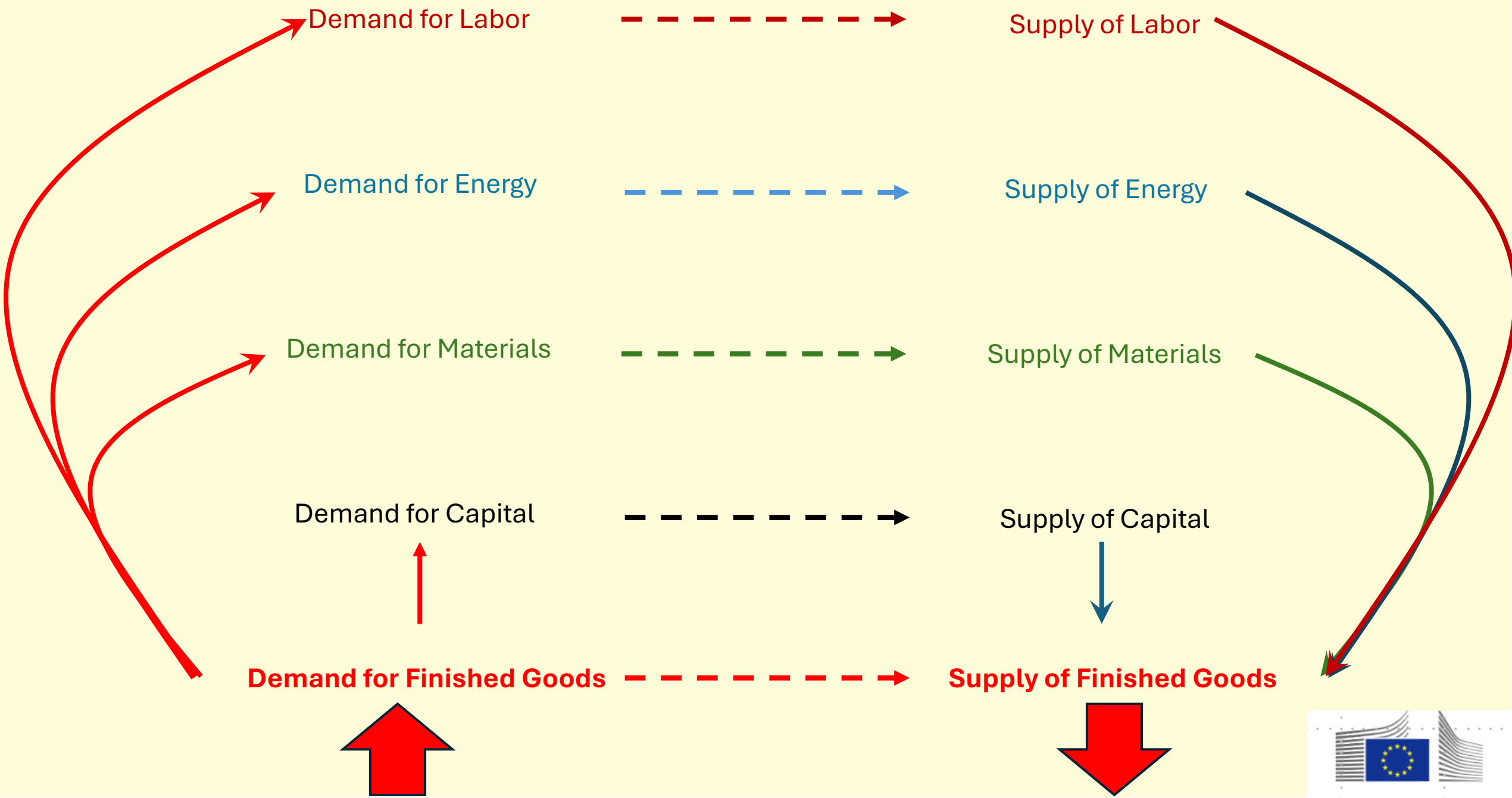
Materials

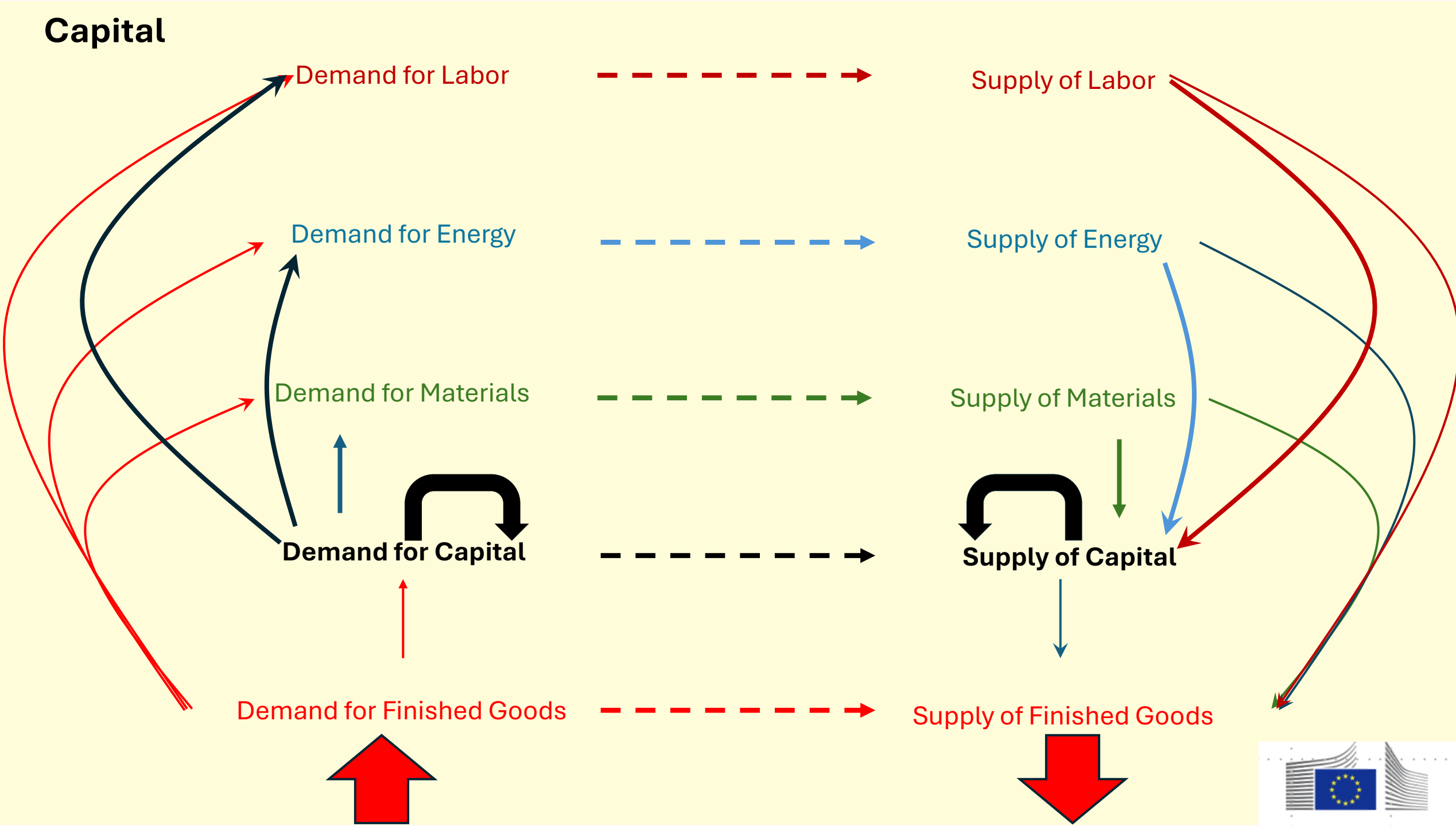
Effectiveness

Labor

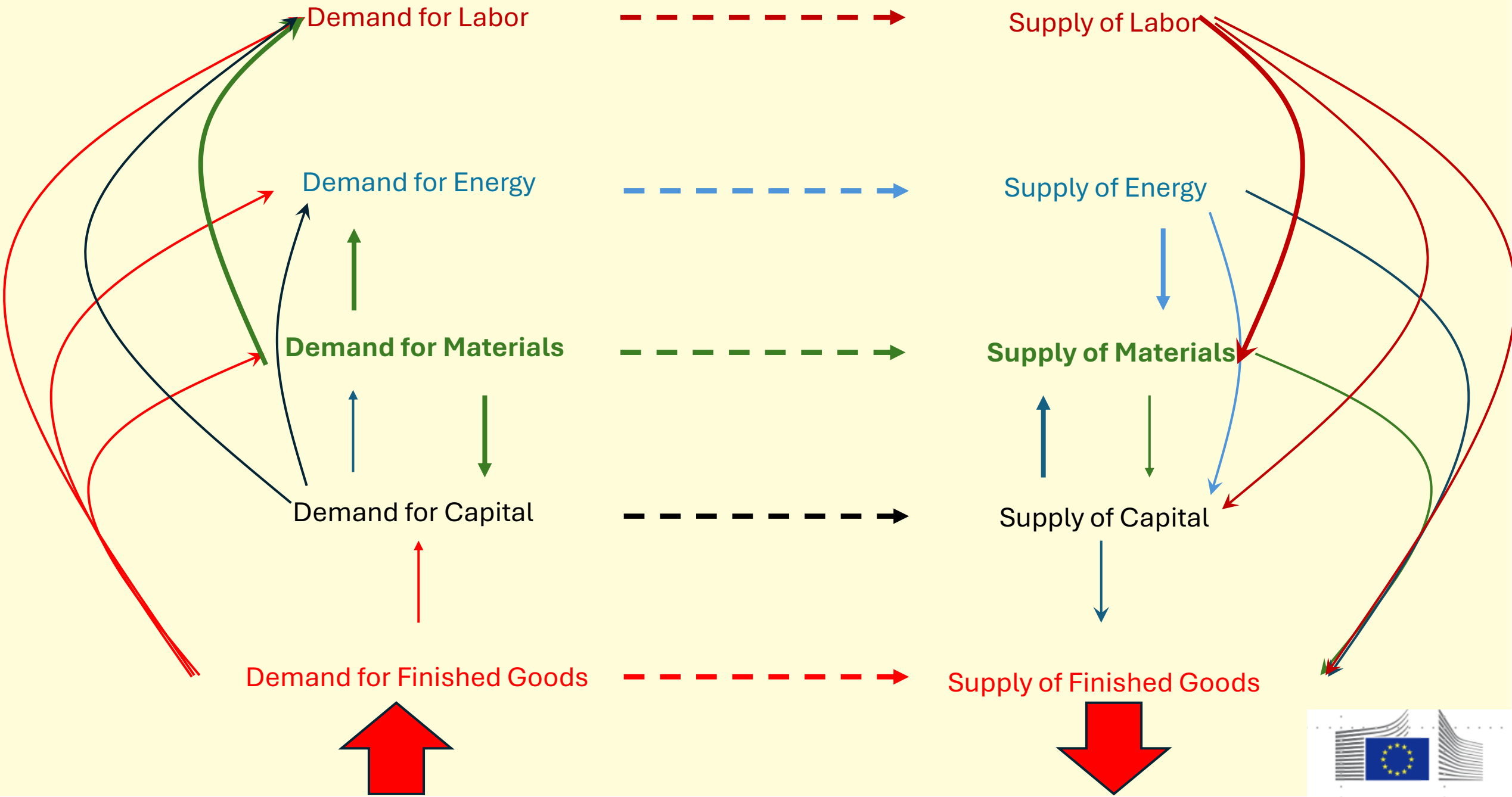
Productivity

Finished Goods

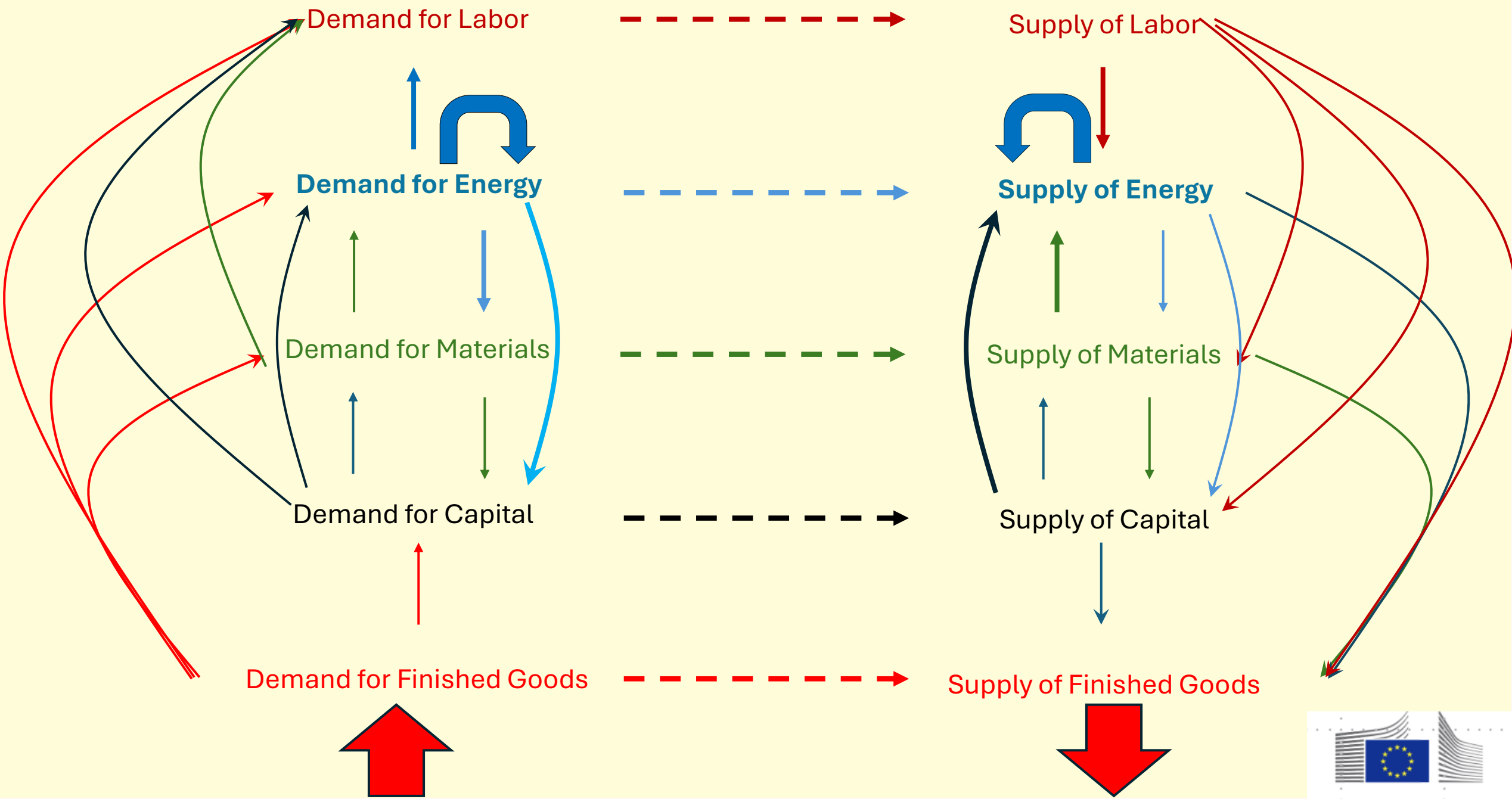



Capital
Demand for Labor
Supply of Labor
Demand for Energy
Supply of Energy
Demand for Materials
Supply of Materials
Demand for Capital
Supply of Capital
Demand for Finished Goods
Supply of Finished Goods

Materials


Demand for Labor
Supply of Labor
Demand for Energy
Supply of Energy
Demand for Materials
Supply of Materials
Demand for Capital
Supply of Capital
Demand for Finished Goods
Supply of Finished Goods

Energy


Demand for Labor
Supply of Labor
Demand for Energy
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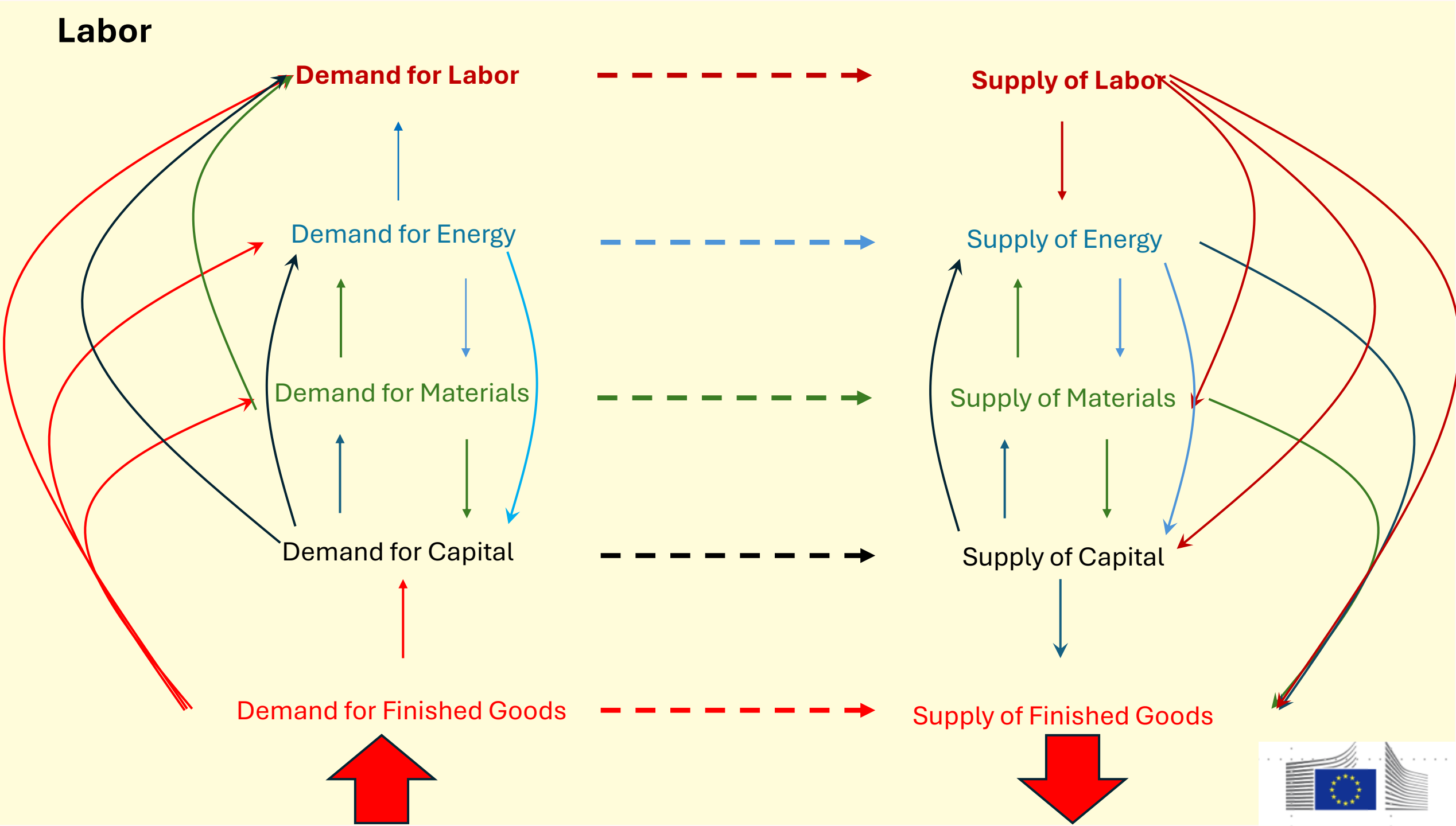
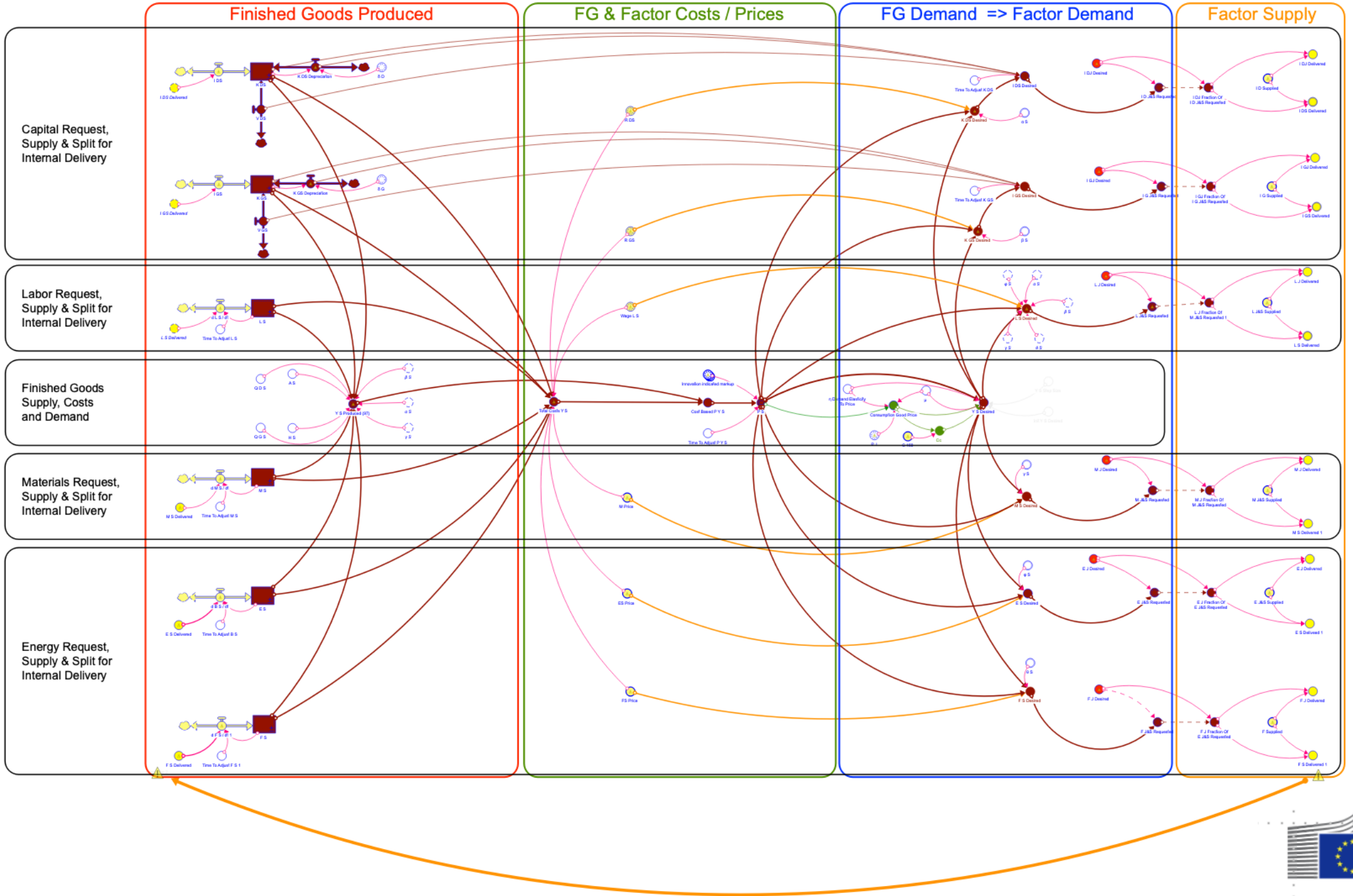
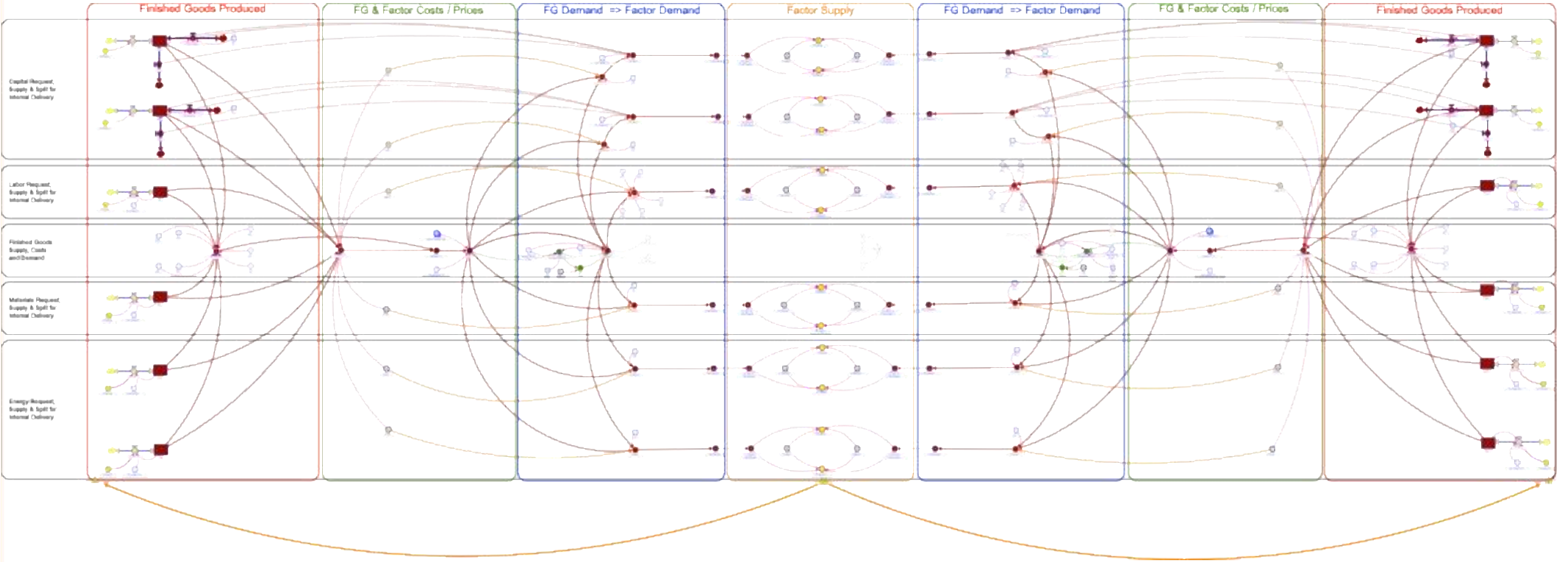
Demand for Materials
Supply of Materials
Demand for Capital
Supply of Capital
Demand for Finished Goods
Supply of Finished Goods


Labor
Demand for Labor
Supply of Labor
Demand for Energy
Supply of Energy
Demand for Materials
Supply of Materials
Demand for Capital
Supply of Capital
Demand for Finished Goods
Supply of Finished Goods


Finished Goods Produced
FG & Factor Costs / Prices
FG Demand => Factor Demand
Factor Supply
Capital Request, Supply & Split for Internal Delivery
Labor Request, Supply & Split for Internal Delivery
Finished Goods Supply, Costs and Demand
Materials Request, Supply & Split for Internal Delivery
Energy Request, Supply & Split for Internal Delivery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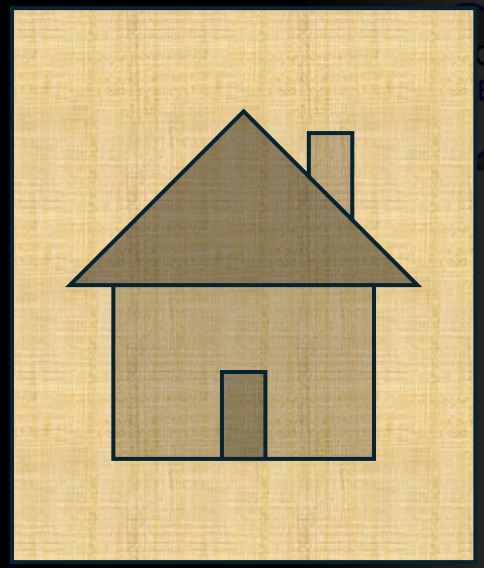
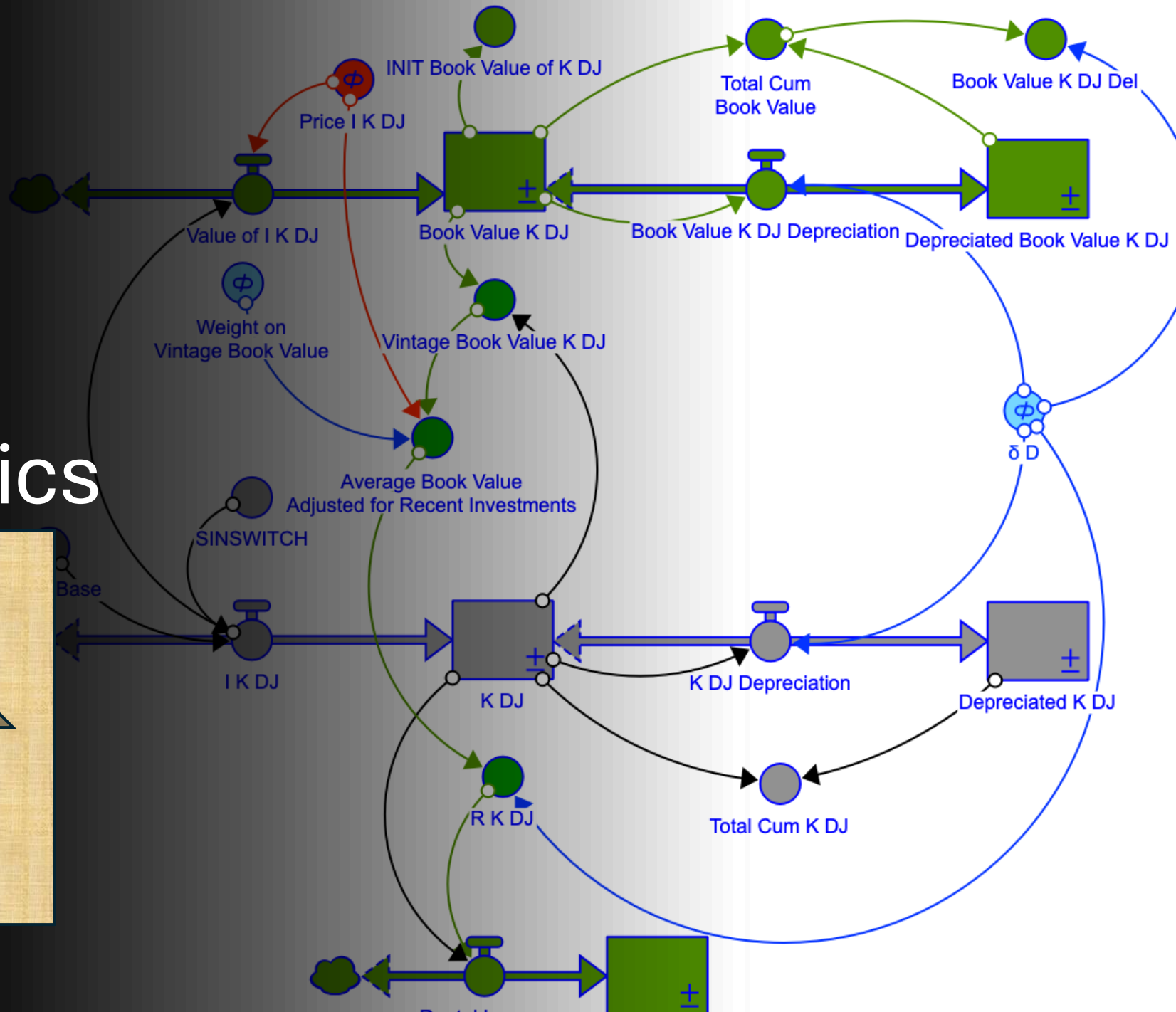
Capital Request, Supply & Split for Internal Delivery
Labor Request, Supply & Split for Internal Delivery
Finished Goods Supply, Costs and Demand
Materials Request, Supply & Split for Internal Delivery
Energy Request, Supply & Split for Internal Delivery

POLYTRoPOS System Dynamics Model:



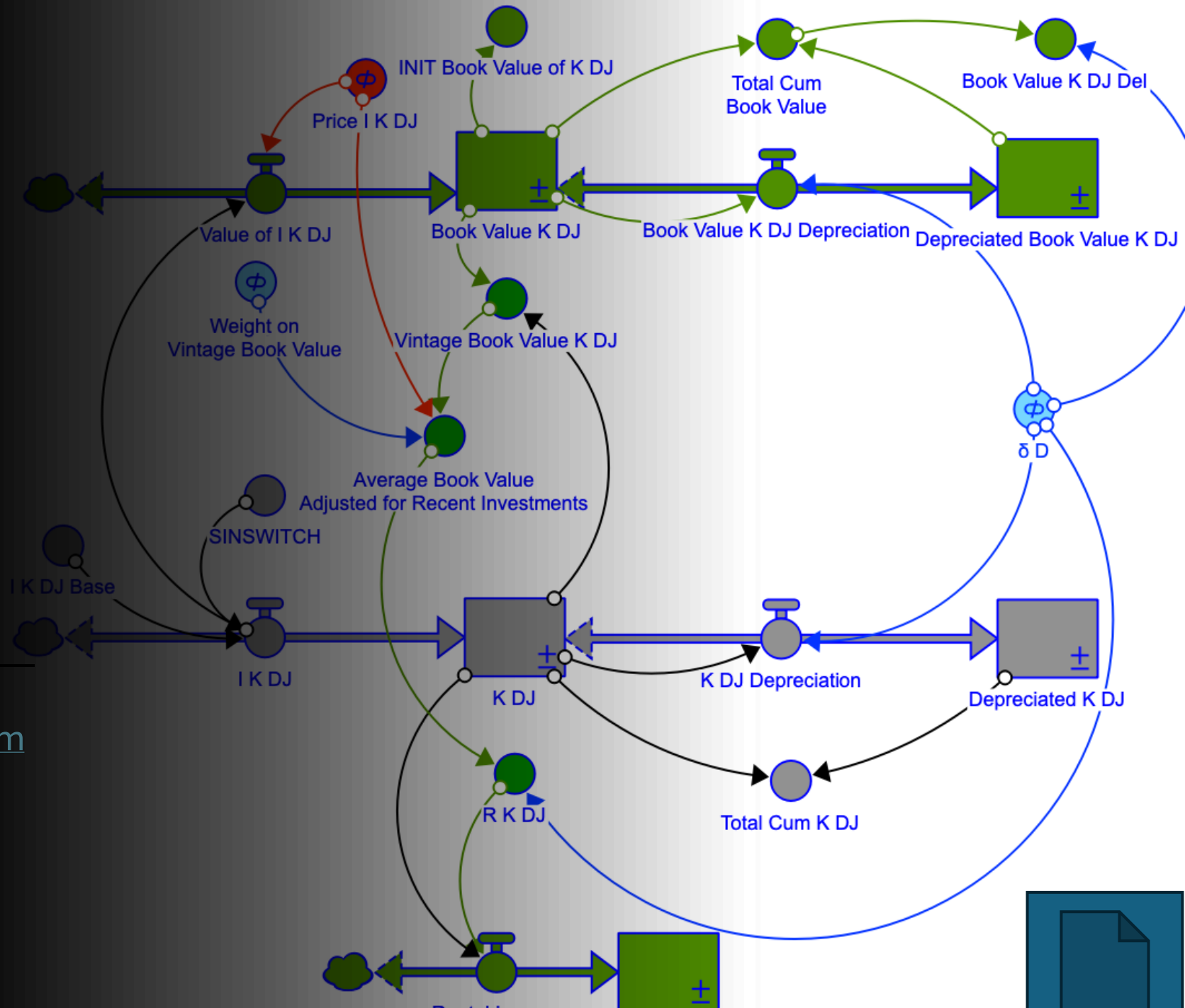


Remaining to be done … :

- Finalization of current model;
  - Elaboration of policy relevant relationships between sectors
    - Tax
    - Subsidies
    - Import / Export
  - Elaboration of;
    - Innovation – impact on factors of production in various sectors)
    - The environment – Impact on productivities, efficiencies & effectiveness
  - Introduction of;
    - Supply lines;
    - Markets with imperfections
    - Financial sector
  - Unit consistency checking
  - Calibration case by case (parameter estimation)
  - Calibration for all 27 EU member states (NUTS0) vs Rest of the world

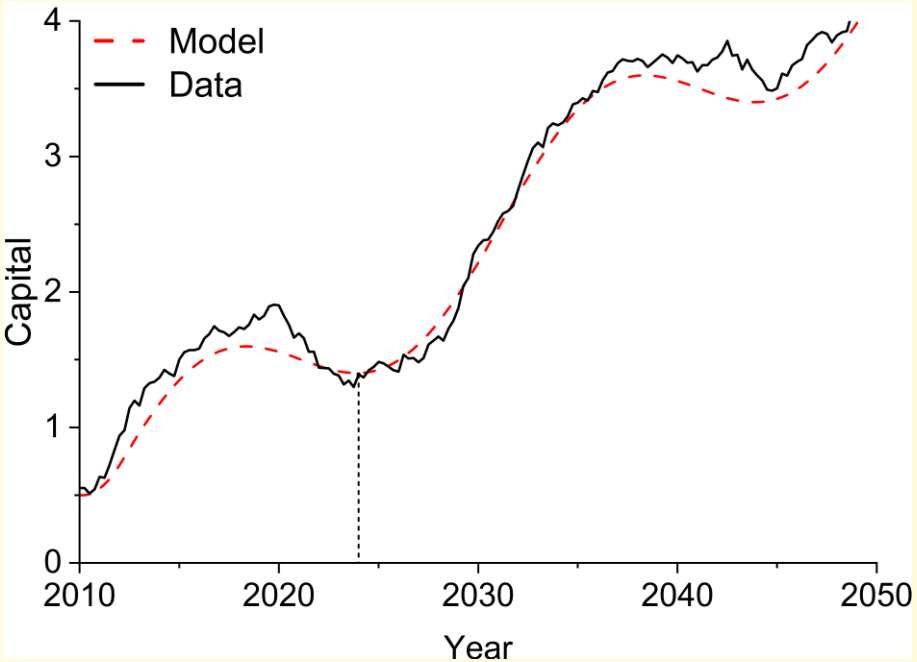
POLYTRoPOS Capital Rent Calculations

https://exchange.iseesystems.com/public/pid/capital-rent



Data used by POLYTRoPOS *)

1. Time series to compare against key variables across the different sectors (mostly stocks)
2. Initial conditions for stocks
3. Parameters established in literature and empirical econometric/statistical regression analyses
4. Parameter ranges established in literature/regressions, which define the space for calibration



*) **NOTE:** As a general rule, we do NOT use data to "drive" the model, but to calibrate and make time series comparisons

Calibration (fit) of POLYTRoPOS

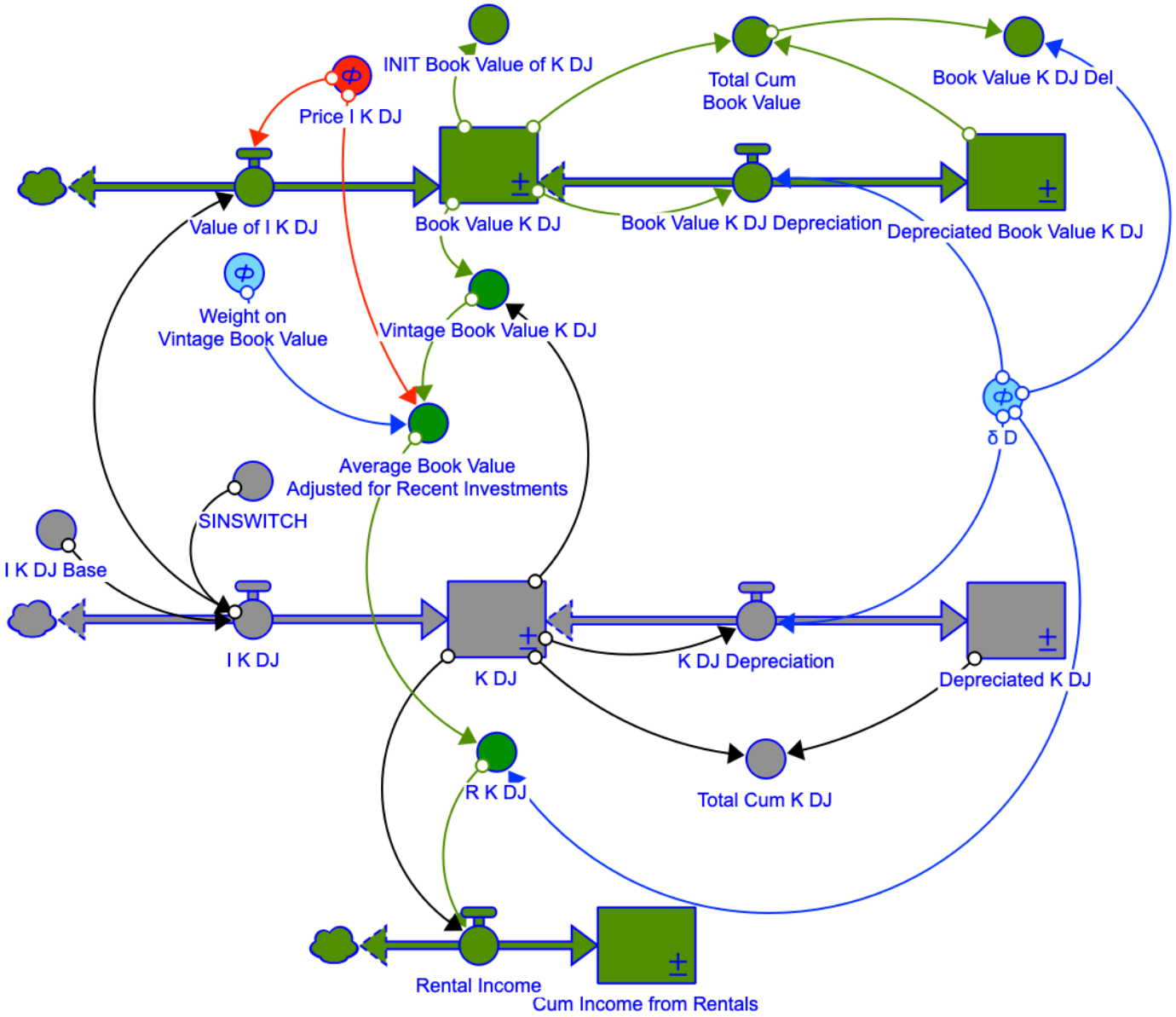
1. Define payoffs (key variables for which we aim to minimize error)
2. Define parameters that can vary (weights, elasticities…) and their respective ranges
3. Perform local (sector-specific) calibration (Oliva 2003) using Differential Evolution (Storn & Price 1997) and Powell (1964) algorithms
4. Perform global (whole model) automated calibration with the same algorithms
5. Iterate as necessary

(Synthetic) Data generated by POLYTRoPOS

1. Ex-post and ongoing evaluation of policy instruments and instrument mixes.
    - Counterfactuals
        - 2010-present (what would have happened if…)
        - 2010-future (what could happen if we didn’t have polices X,Y,Z…)
2. Ex-ante comparative impact assessment of policy options.
    - Simulation horizon to 2050 (what may happen if…)
3. Net Zero Industry Act – background to anticipated model application

Thank you for your attention
!

Capital Rent Calculations



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