Sessão de apresentação

"Estudo sobre matérias-primas críticas
e estratégicas e economia circular em Portugal - *eMaPriCE*"

Beyond resource productivity – critical raw materials

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IN+ CENTER for INNOVATION, TECHNOLOGY and POLICY RESEARCH

LARSyS Laboratory of Robotics and Engineering Systems

TÉCNICO LISBOA

Context

Most human activities are supported by material flows.

SHELTER

FOOD

CLOTHING

TRANSPORTATION

Since 1970…

2 x Population

X 4.7 GDP

X 3.4

Resource extraction

Growing concern over sustainable development

ipcc
INTERGOVERNMENTAL PANEL ON climate change
WMO UNEP

The European Green Deal

SUSTAINABLE DEVELOPMENT GOALS

12 RESPONSIBLE CONSUMPTION AND PRODUCTION

The scientific community has been studying material flows across the economy to tackle the sustainable development problem.

Development drivers

Drivers based on previous work from a variety of authors

- GDP and income per year
- Population and population density
- Economic structure (services and construction)
- Technological advancement
- Wars, recessions and other significant events
- Materials in the economy
- Trade, energy, climate

Compilation of PIOTs

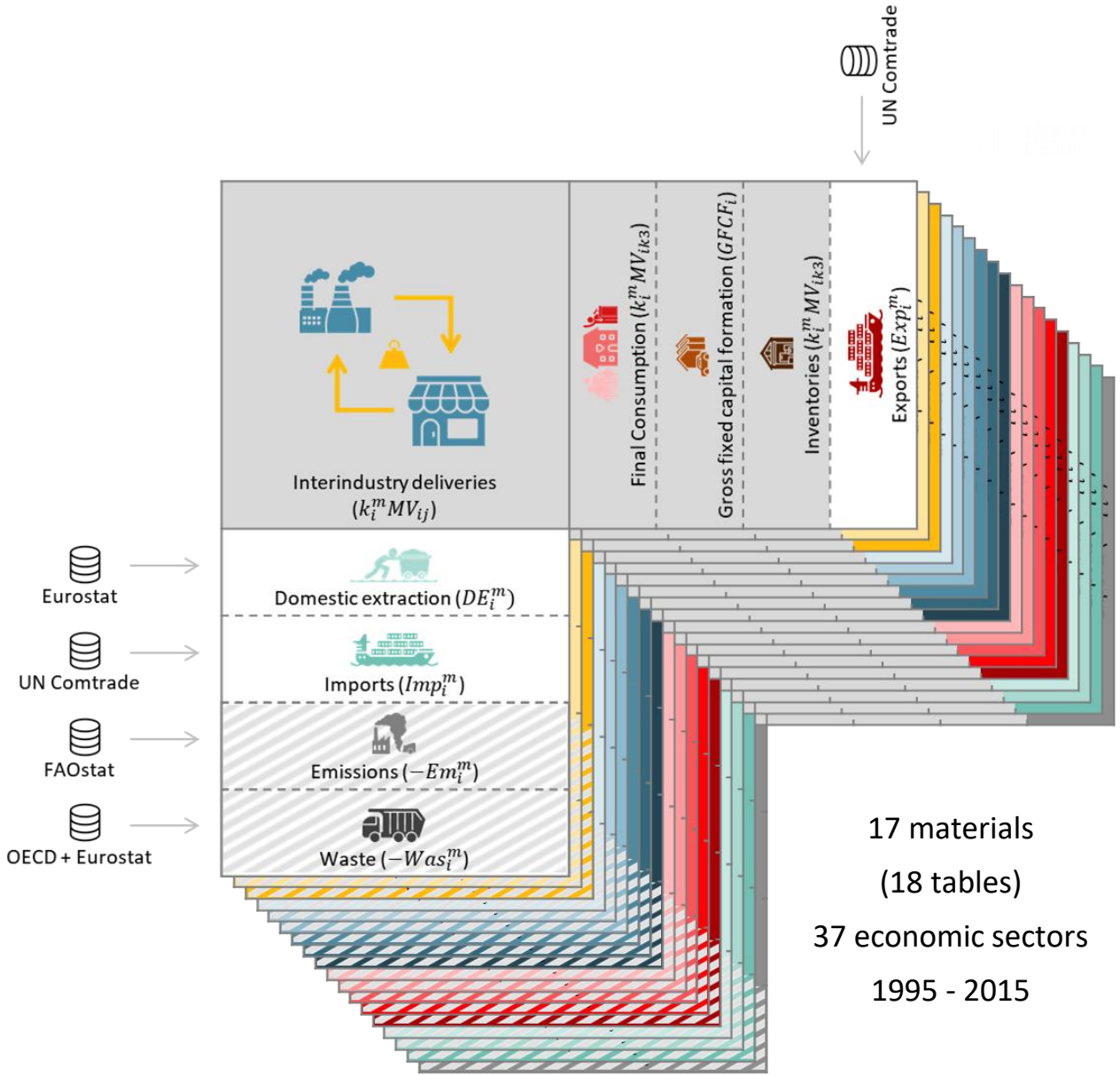
Method steps

PART I : Known flows (white)

Collect data for known flows and add it to the tables, by disaggregating the flows per sector and material

PART II : Unknown flows (grey)

Calculate the material flows that satisfy the mass balance at the sector and material level, based on the homogeneous price assumption.



17 materials

(18 tables)

37 economic sectors

1995 - 2015

python™

4-step Framework

To analyze the socioeconomic metabolism of an economy

I. Analysis of the economic development and resource use (key years)

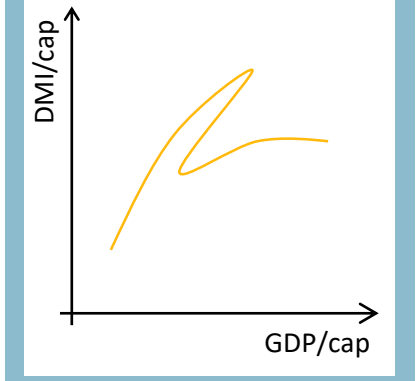
II. Distribution of the materials in the economy

III. Economic structure (material use, value-added and resource productivity by sector)

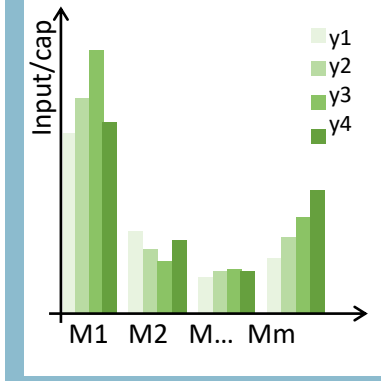
IV. Analysis of the flows of the SEM

Step 3 and 4 are enabled by the PIOTs and are the innovative steps

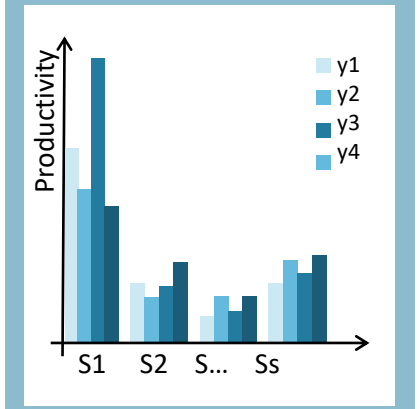
1 DMI vs GDP



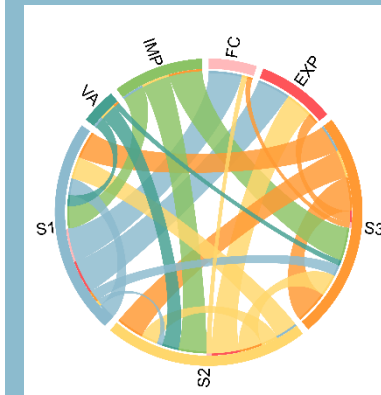
2 Materials in the economy



3 Economic structure



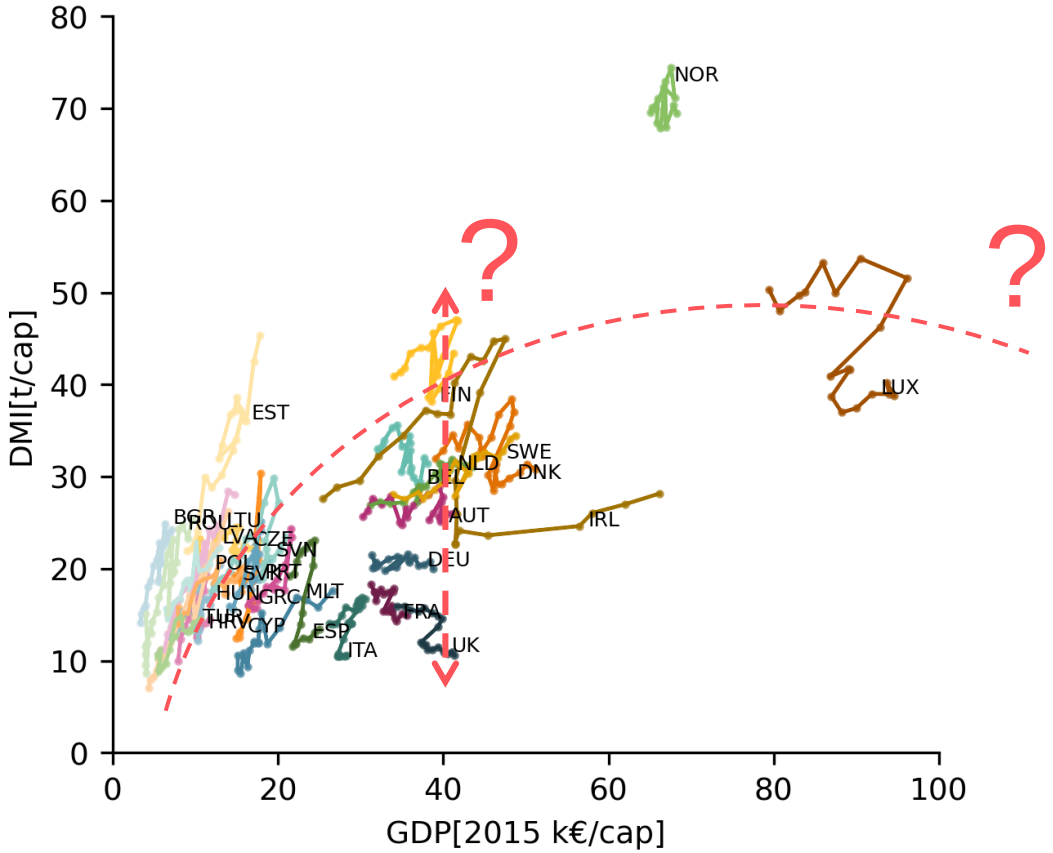
4 Socioeconomic metabolism



European economic development

Will European countries decouple?

- Various development trends
- There are countries with different DMI/cap for the same level of GDP/cap



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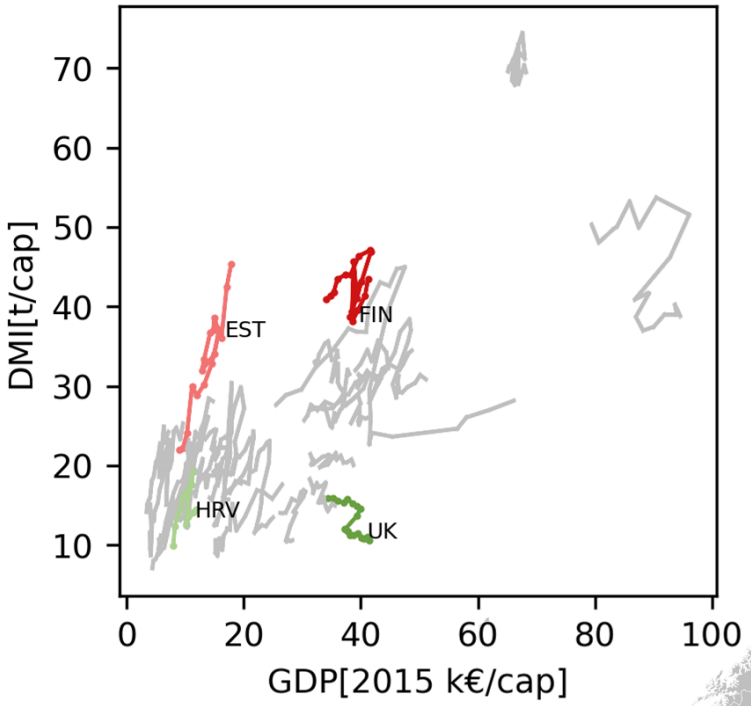
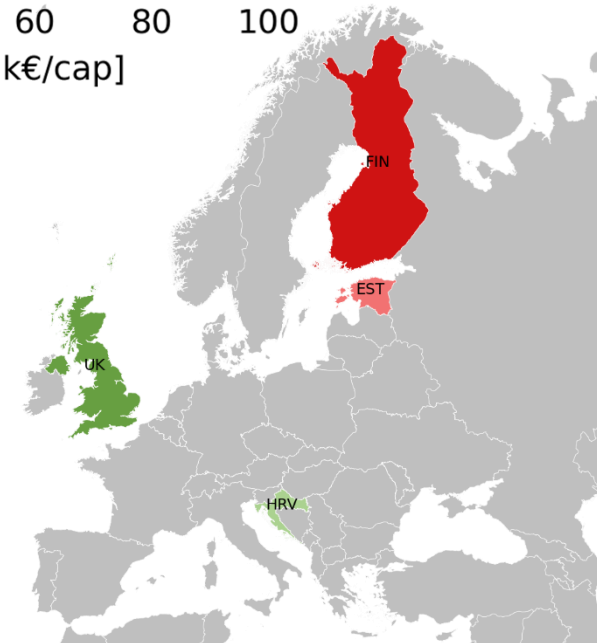
Country selection

Four selected countries

- 2 Different GDP/cap levels for 2 different DMI/cap levels
- Different decoupling levels
- The SEM of some of these countries have been studied before

	Low GDP/cap	High GDP/cap
High DMI/cap	Estonia (EST) Coupled	Finland (FIN) Recession
Low DMI/cap	Croatia (HRV) Decoupled	United Kingdom (UK) Decoupled





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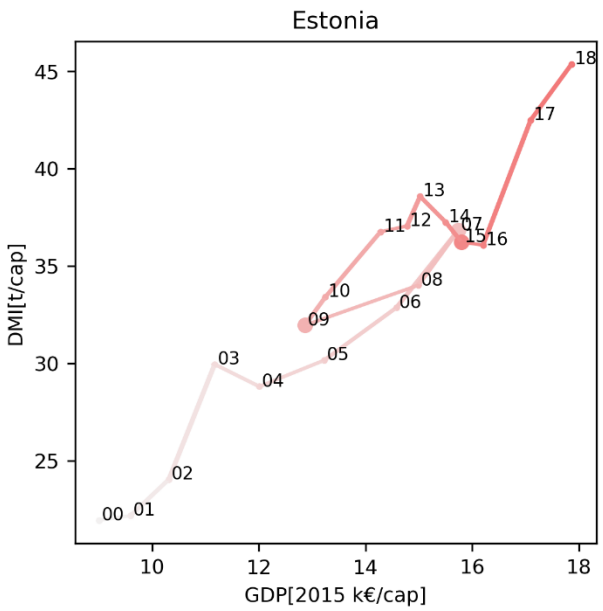
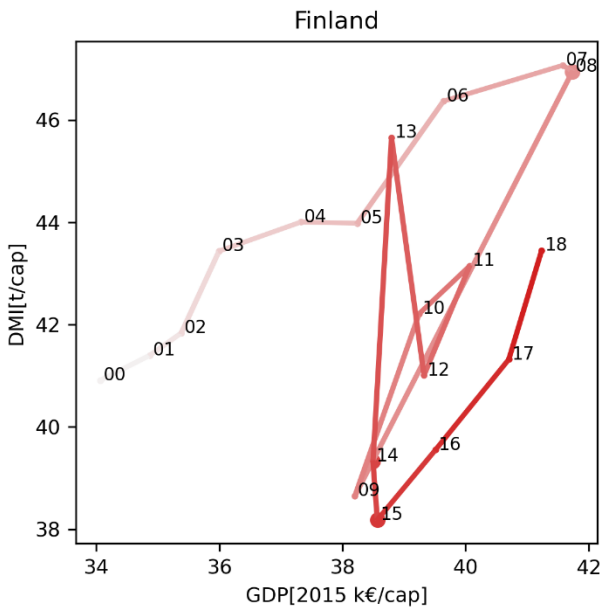
Socioeconomic development

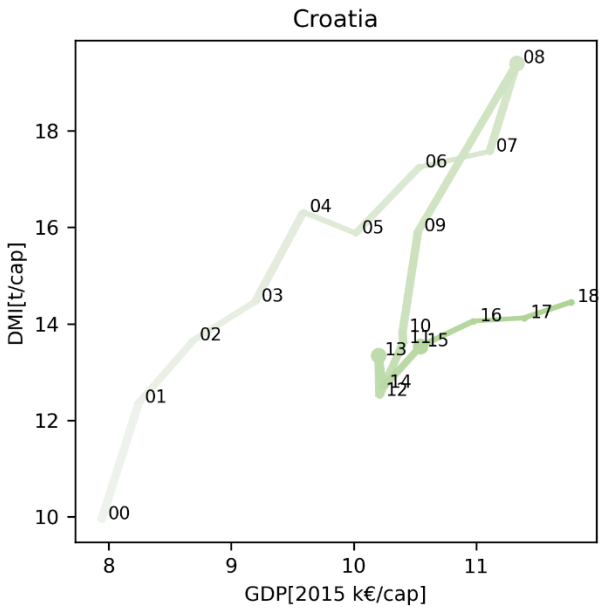
DMI vs GDP

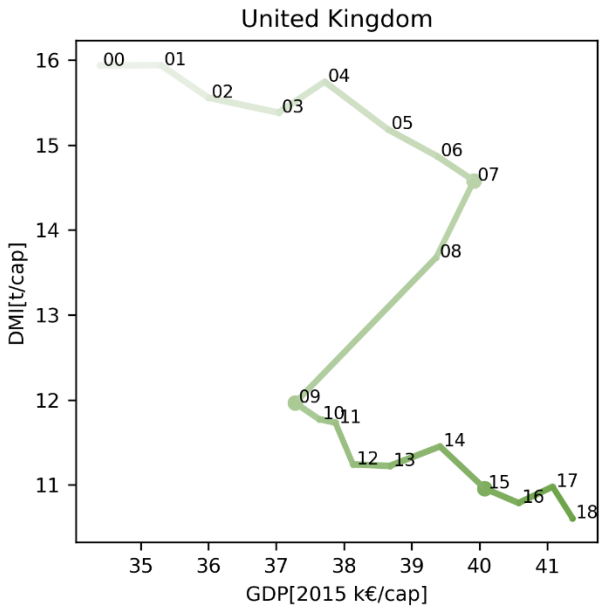
The DMI/cap vs. GDP/cap curves clearly show the differences between the evolution of the RP of the countries and support the previous results.

ESTONIA	**FINLAND**
After the economic recession, the country reverted to previous trend, maintaining the same resource productivity	In 2018, hadn't recovered to 2008 GDP/cap, no significant changes in resource productivity
CROATIA	**UK**
Improved resource productivity after the economic crisis	GDP/cap had already shown signs of absolute decoupling before the economic crisis, same trend after but at a lower level of DMI/cap





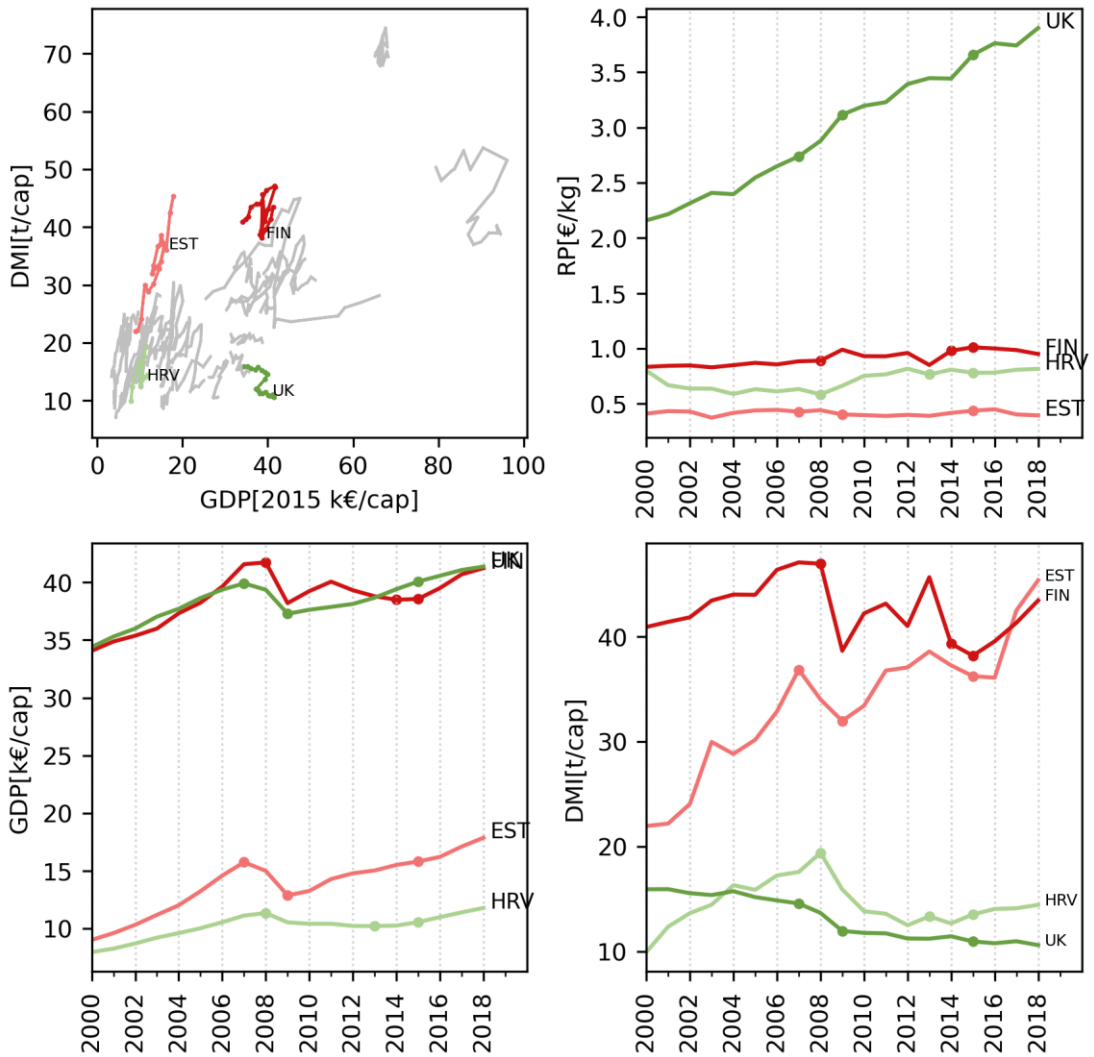




Socioeconomic development

DMI, GDP and Resource productivity

- 2 GDP/cap and 2DMI/cap levels.
- The RP of the UK is significantly higher than the RP of the other countries.
- The RP of the low DMI/cap countries improved
- The RP of the high DMI/cap doesn't show significant/lasting improvements.
- The economic recession impacted the DMI/cap of the four countries differently.



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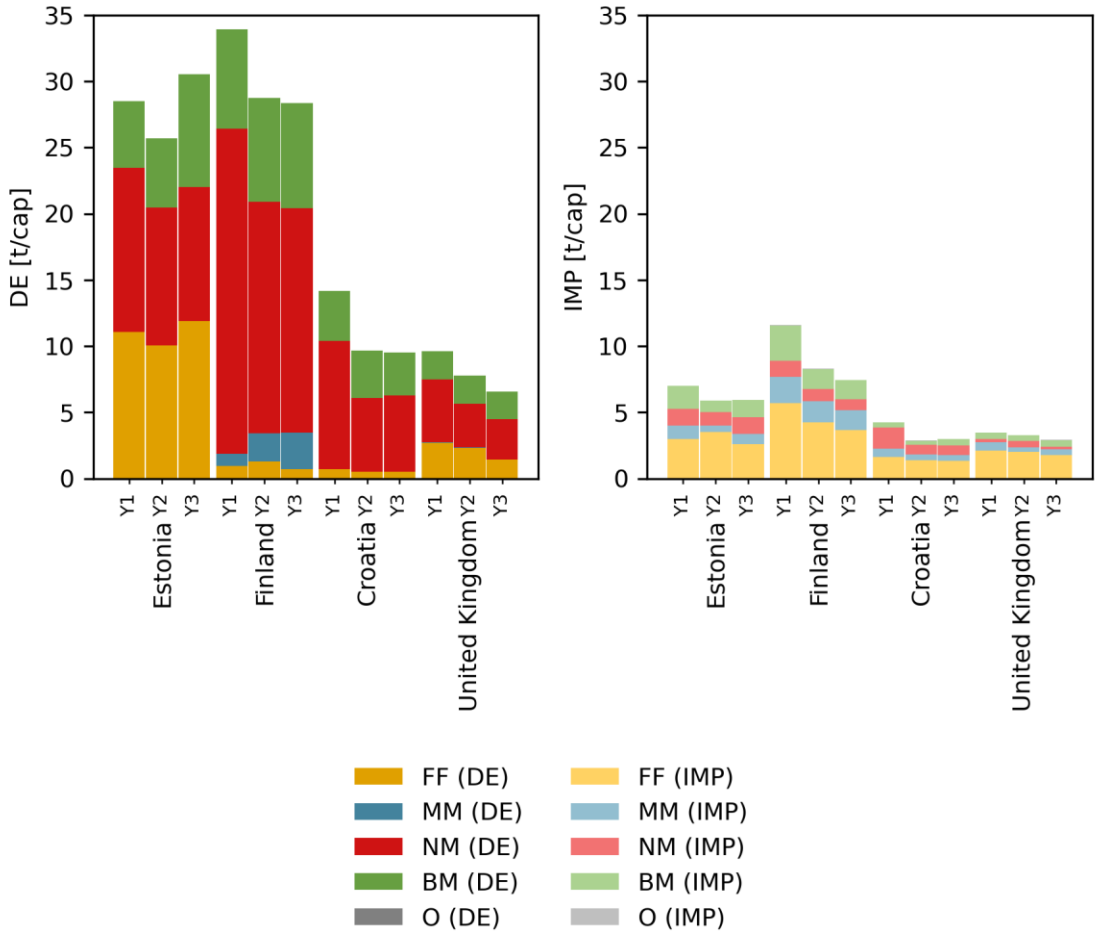
Materials

What is extracted and what is imported

- Estonia has a high DE of FF and BM
- Finland has a very high DE of NM (pop. density)
- Finland has a high DE of MM and BM
- The UK has some DE of FF

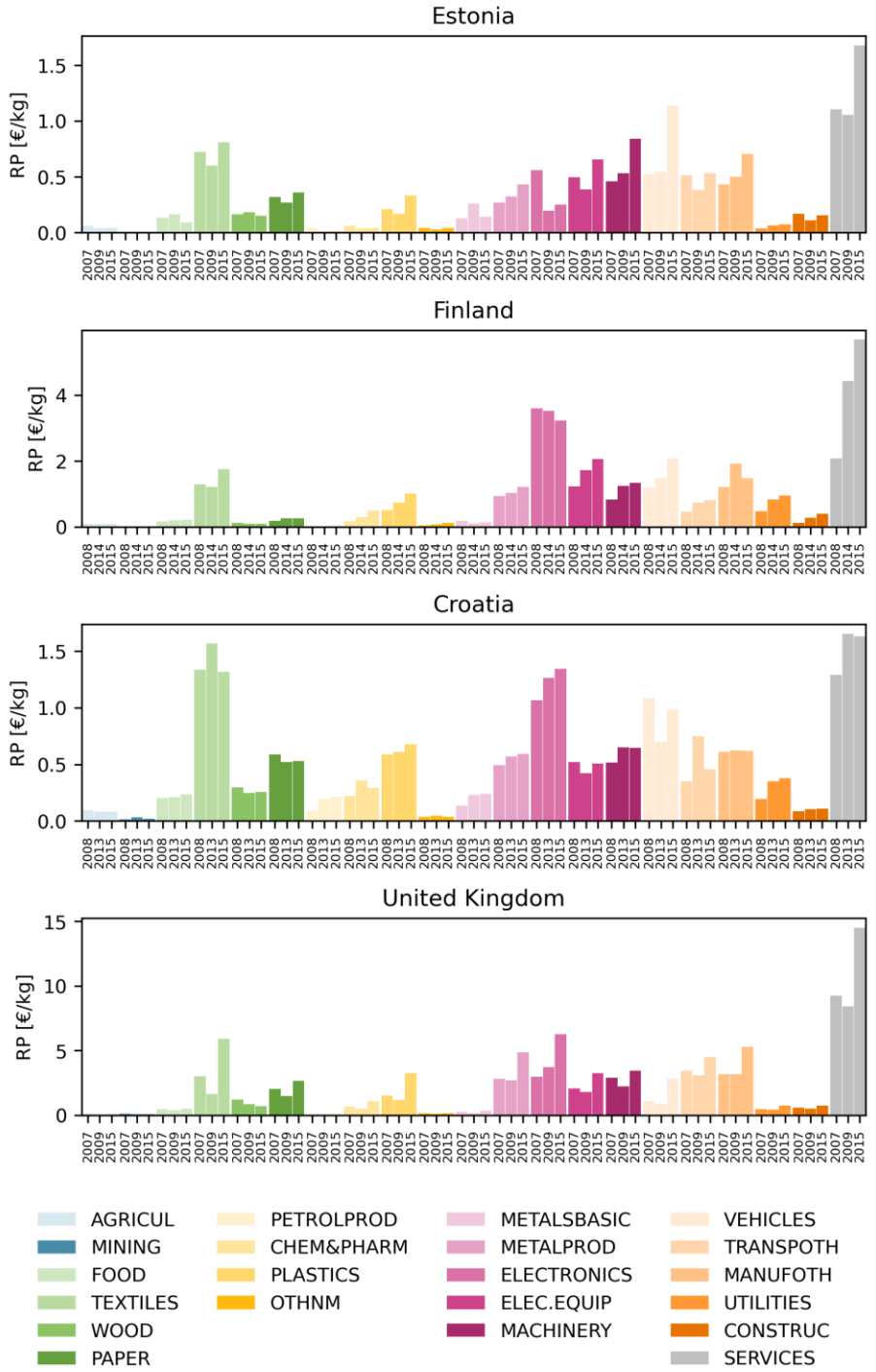
In the high DMI/cap countries DE of key natural resources increased after the recession, the same did not happen in the low DMI/cap countries.



Economic structure

Resource productivity

- Services have the highest RP in all countries.
- The RP of services increased after the economic recession in all countries.
- The RP of services is significantly higher in the UK.

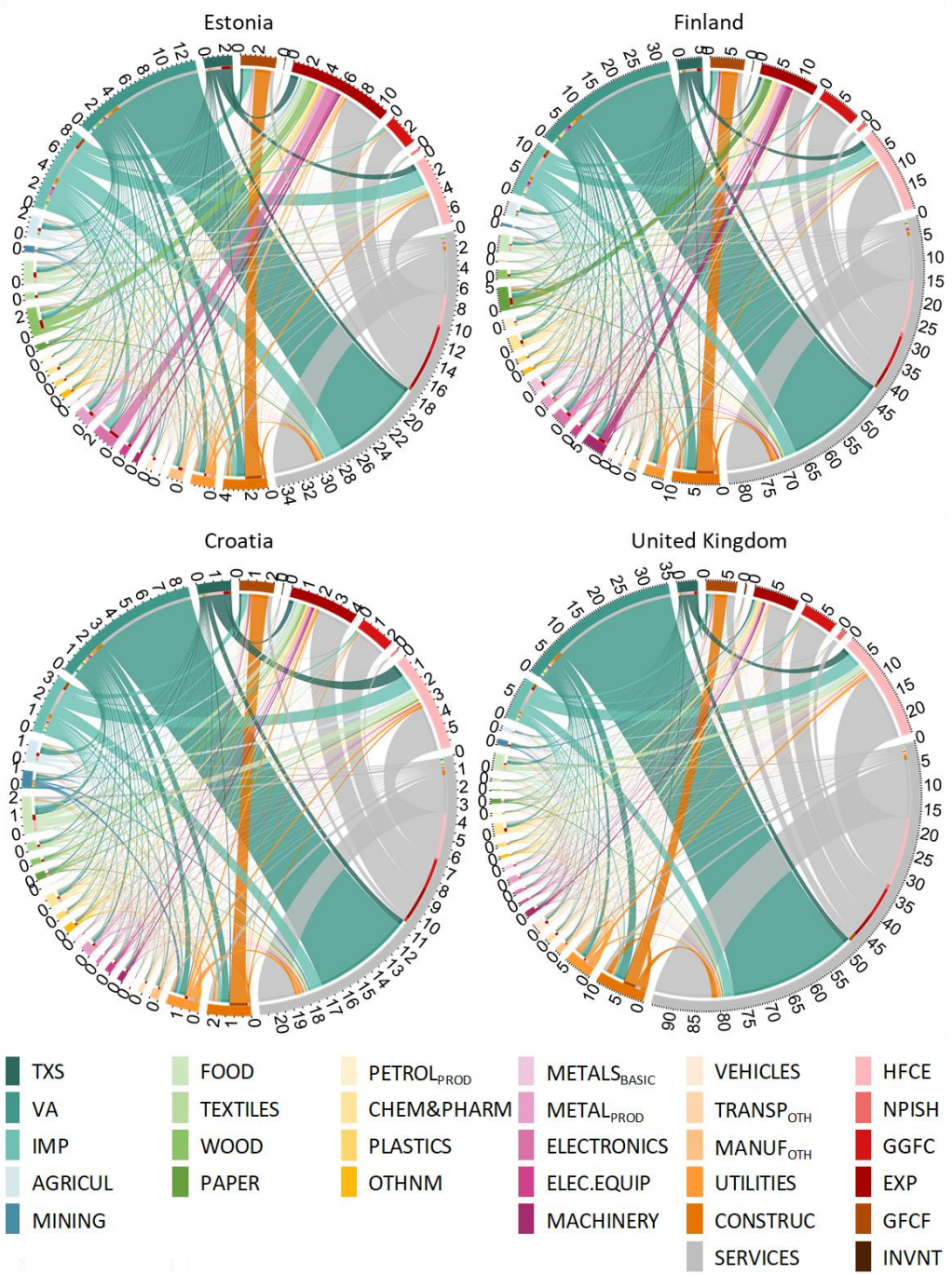


Socioeconomic metabolism

Monetary flows in 2015

No immediate significant difference in the monetary flows. But there are some:

- Services have the largest contribution to VA/cap, especially in the UK.
- Larger exports in high DMI/cap countries.



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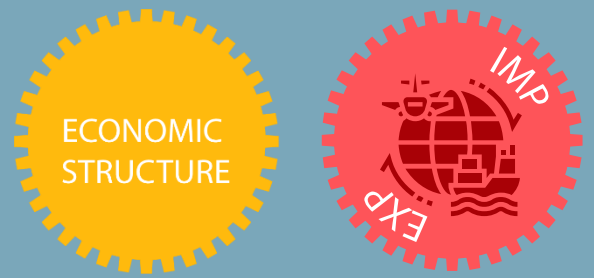
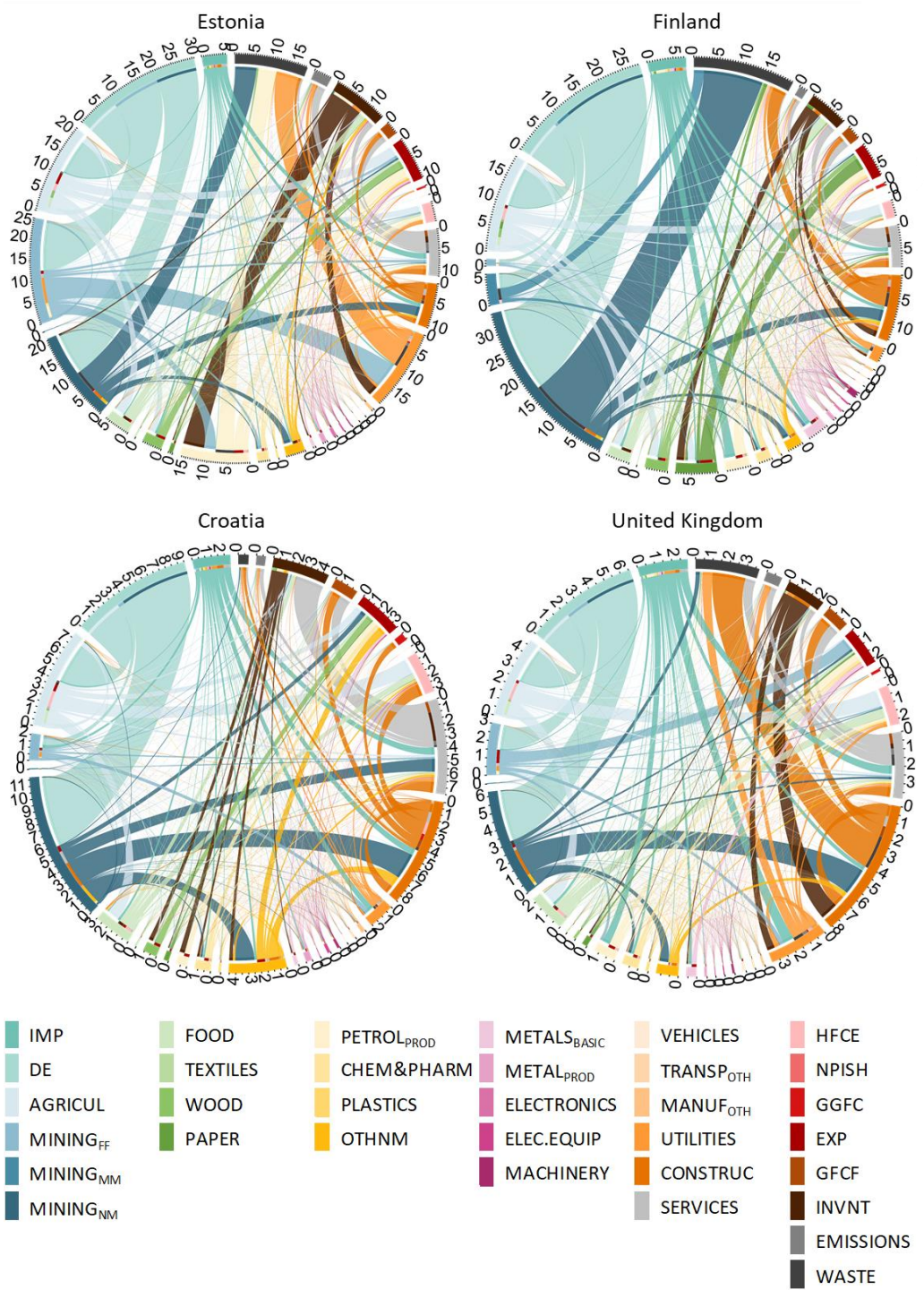
Socioeconomic metabolism

Physical flows in 2015

The differences in the SEMs clearer in the PIOTs

- Flows associated with industrial sectors are more significant in high DMI/cap countries.
- In low DMI/cap most flows are linked to food, housing, and transportation.
- Services account for the largest share of the demand for construction.





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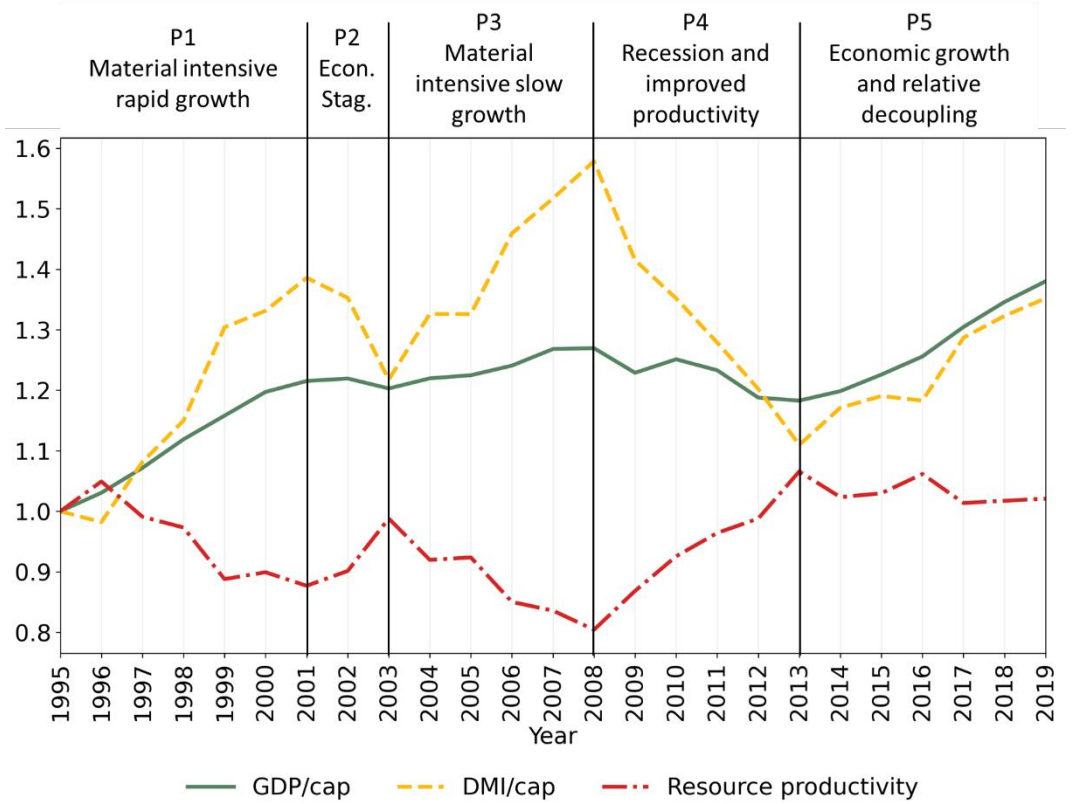
PORTUGAL

Evolution of economic development and resource use

$$resource\ productivity = \frac{GDP}{DMI}$$

$$DMI = domestic\ extraction + imports$$

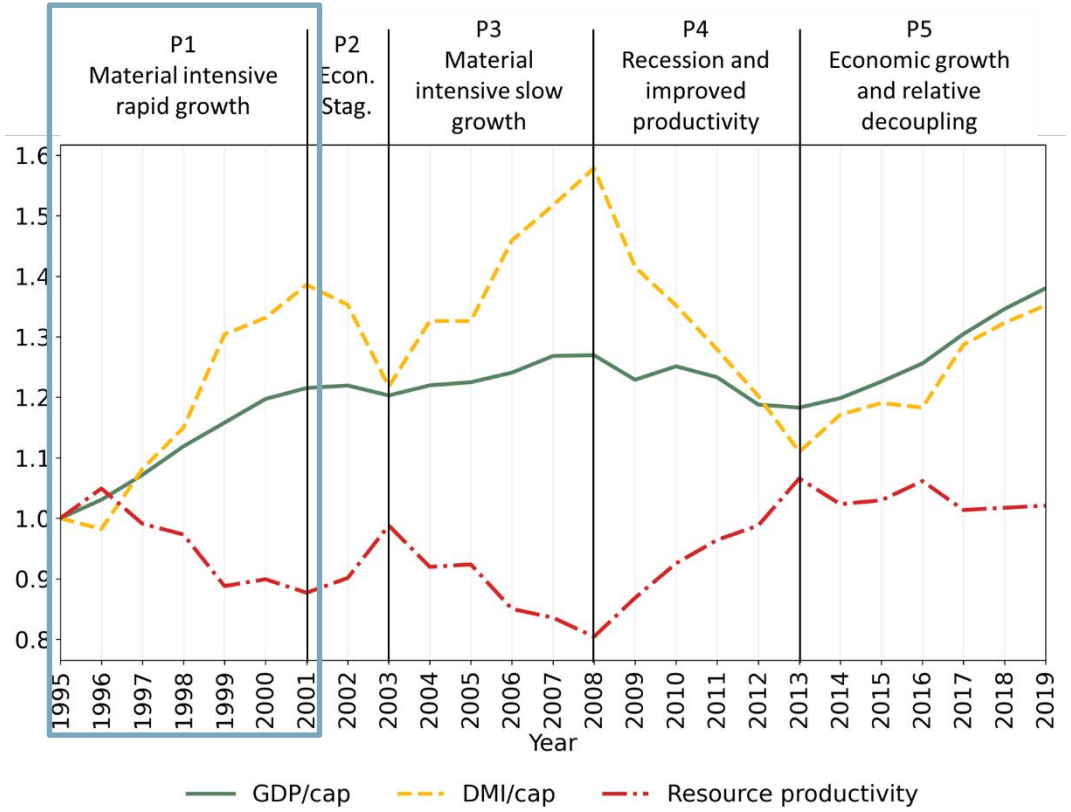


Key years

Economic development and resource use

P1 – Material intensive, rapid economic growth

- Dictatorship 1933-1974
- PT joins the EU in 1986
- Despite initial policy efforts towards sustainable development, productivity decreased 12%

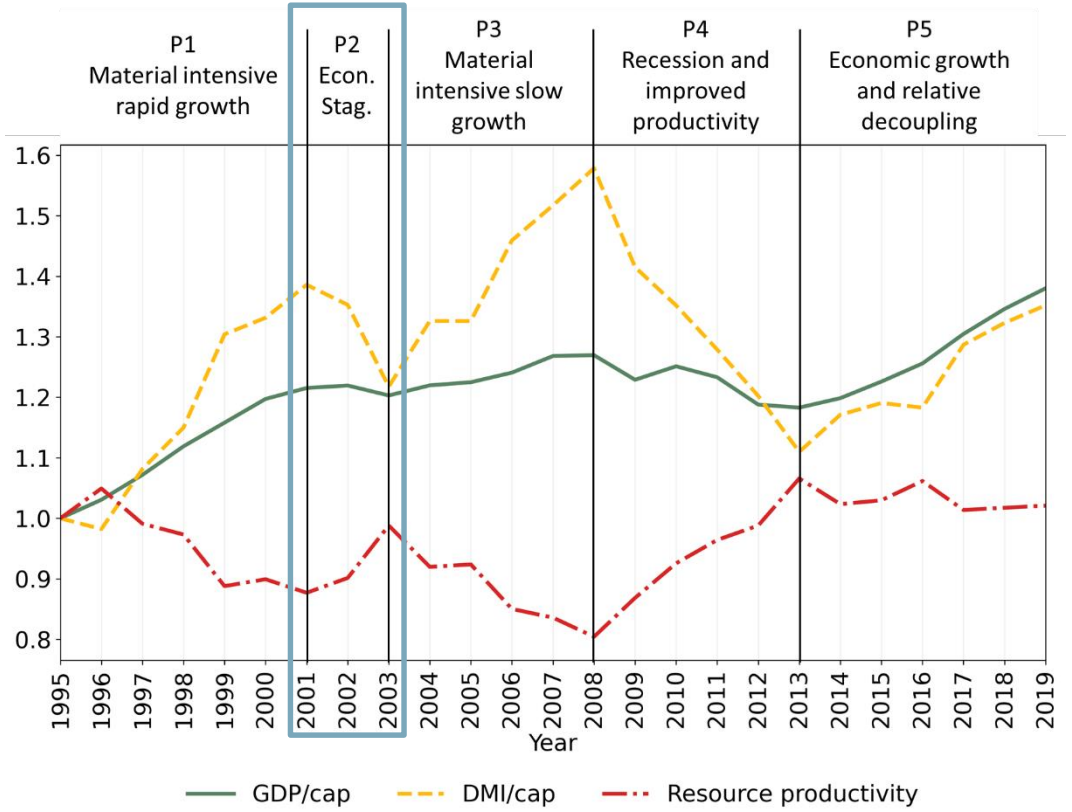


Key years

Economic development and resource use

P2 – Economic stagnation

- First signs of change
- Economic growth slowed and decreased
- Thought as a cyclical correction, that should not affect the convergence with more developed EU countries, whose development path Portugal could follow at smaller cost

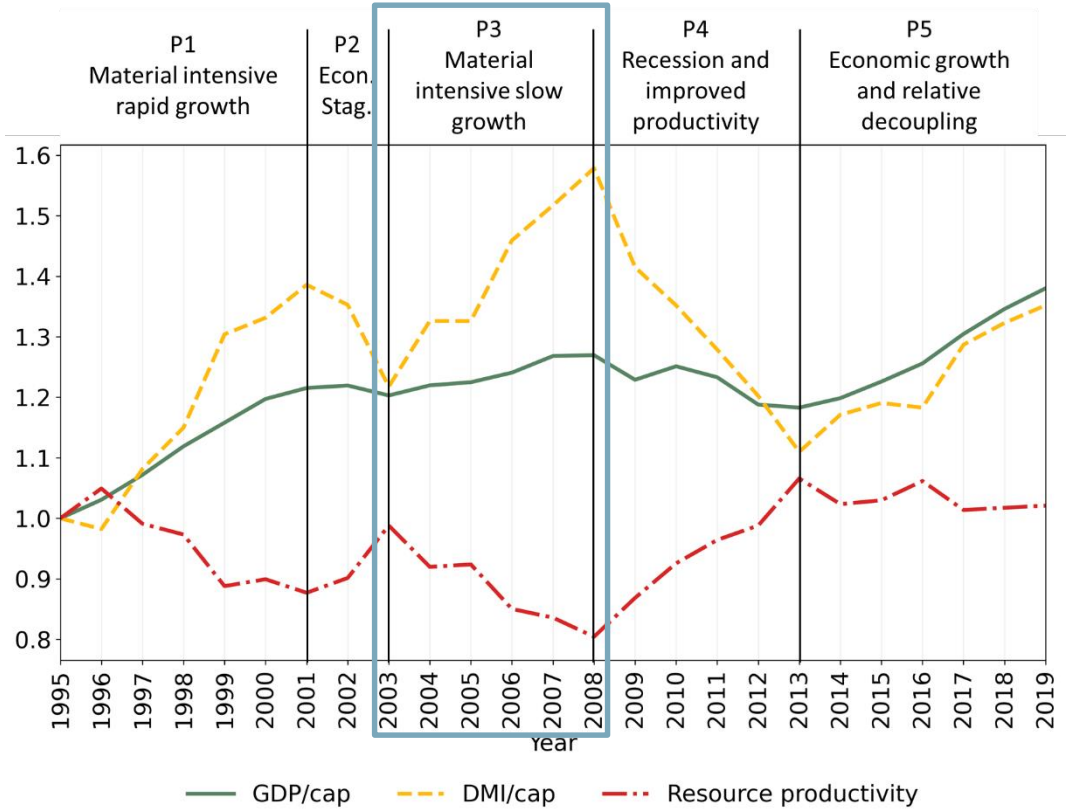


Key years

Economic development and resource use

P3 – Material intensive, slow economic growth

- The economy continued to grow at a slower rate
- Material use increased significantly, until 2008 when a minimum productivity is reached (0.71€/kg)
- Non-tradable goods and economic inefficiencies from monopolies

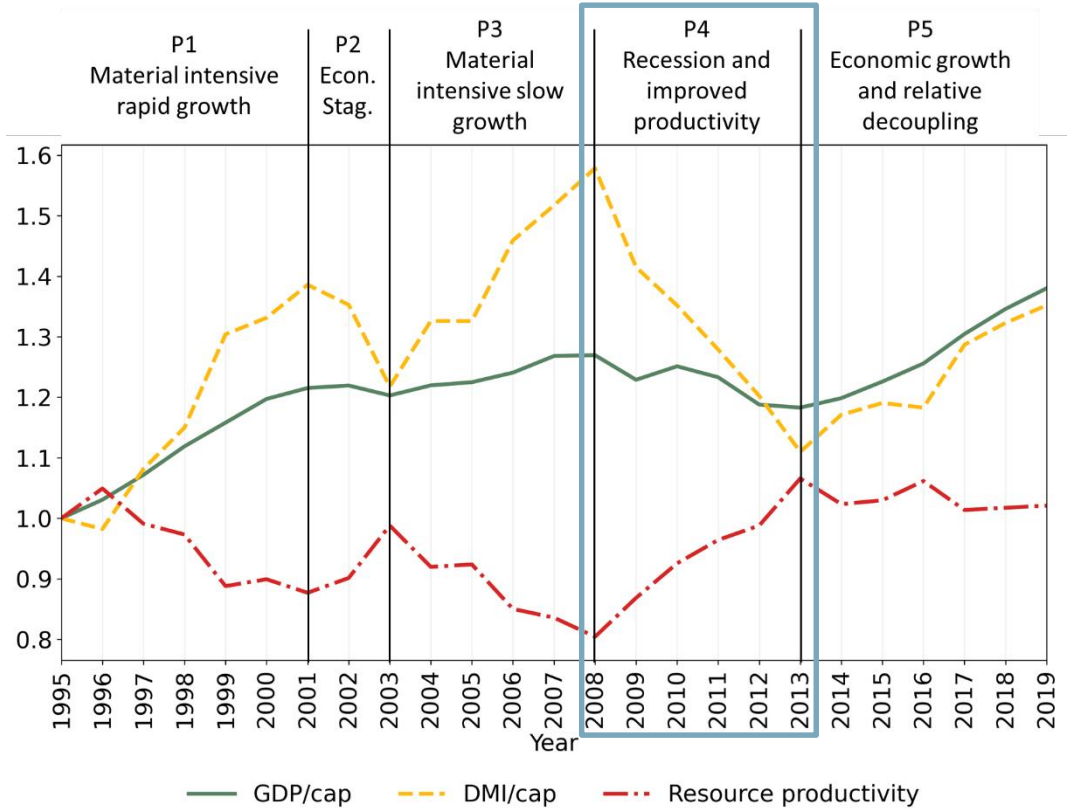


Key years

Economic development and resource use

P4 – Economic recession and improved productivity

- During the international economic crisis, Portugal entered a state of recessions, during which material use decreased and productivity increased.
- Period of absolute decoupling between resource use and economic development.

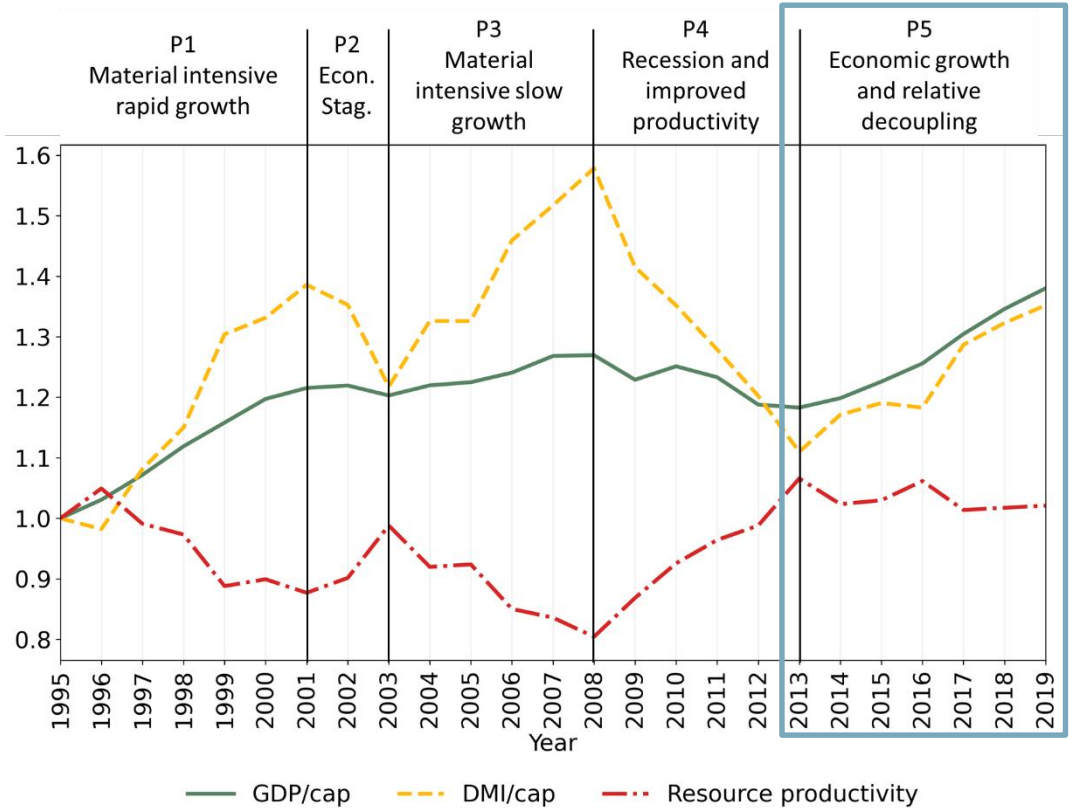


Key years

Economic development and resource use

P5 – Economic recovery and relative decoupling

- Economic recovery, without major material use increase
- In 2016 there was absolute decoupling between material use and economic development, without GDP decrease
- The economy grew at a somewhat constant productivity, comparable to that of 1995



Key years

Economic development and resource use

P1 – Material intensive, rapid economic growth

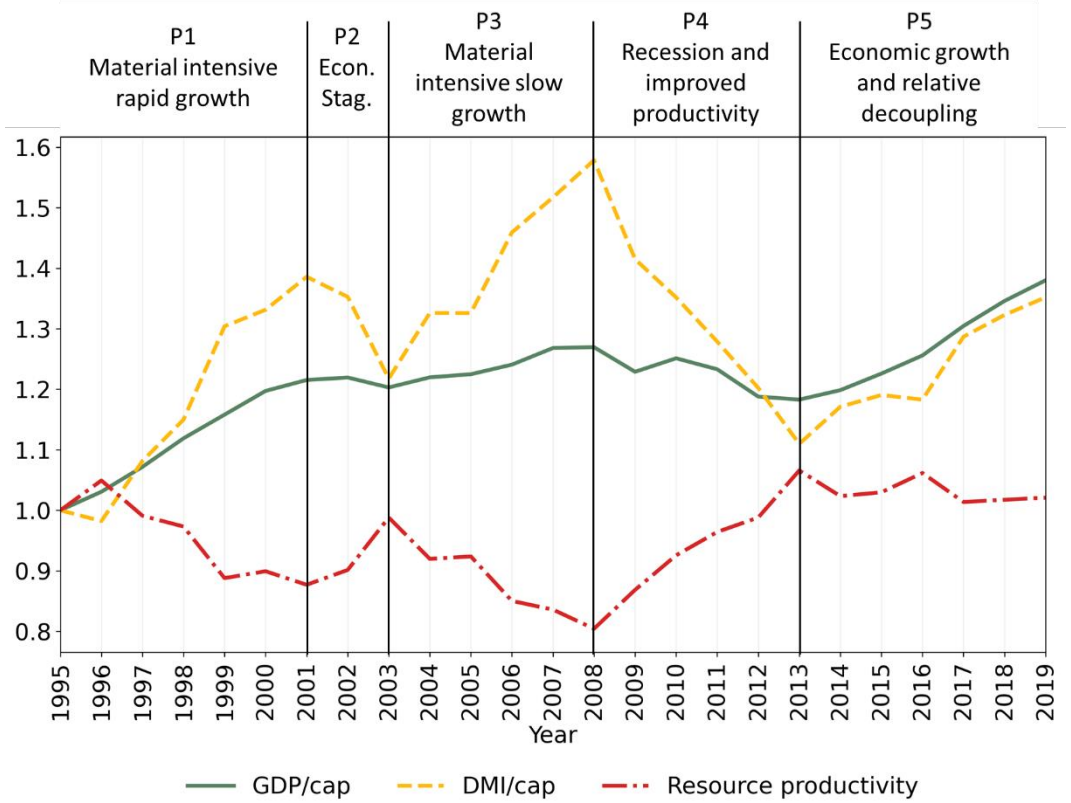
P2 – Economic stagnation

P3 – Material intensive, slow economic growth

P4 – Economic recessions and improved productivity

P5 – Economic recovery and relative decoupling

These changes suggest that Portugal has gone through structural changes.



Materials in the economy

Types of materials in the economy for key years

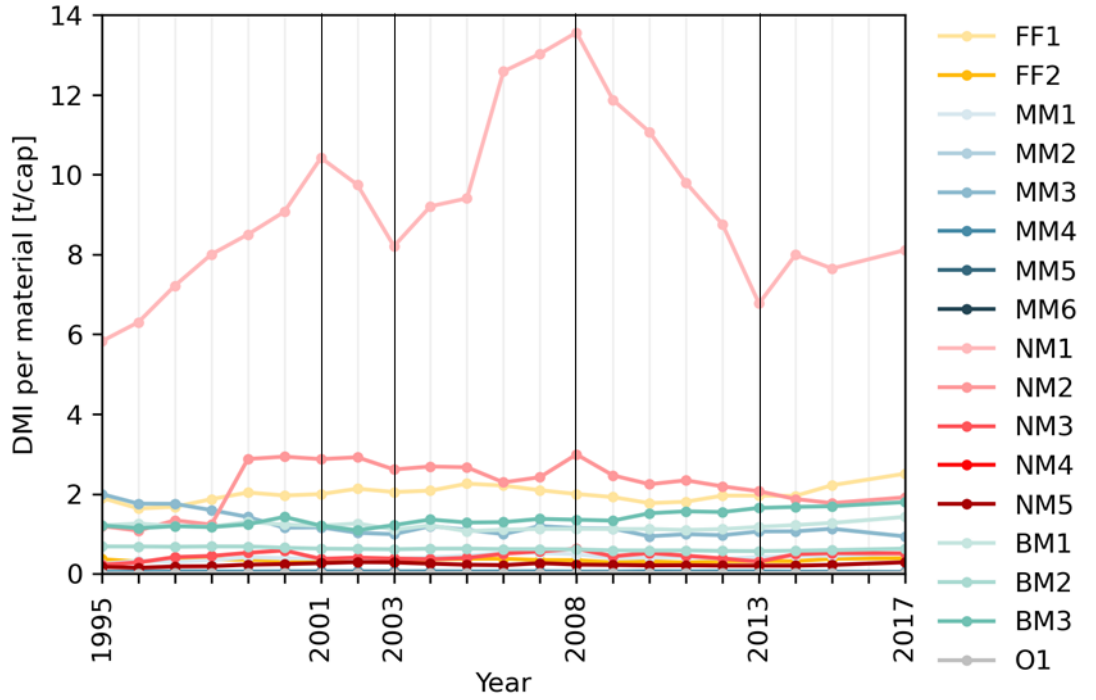
Non-metallic minerals: 49% - 71%

Biomass: 13% - 21%

Fossil fuels: 10% - 15%

Metallic minerals: 8% - 15%

- Correlation between the use of construction materials and GDP/cap varies.

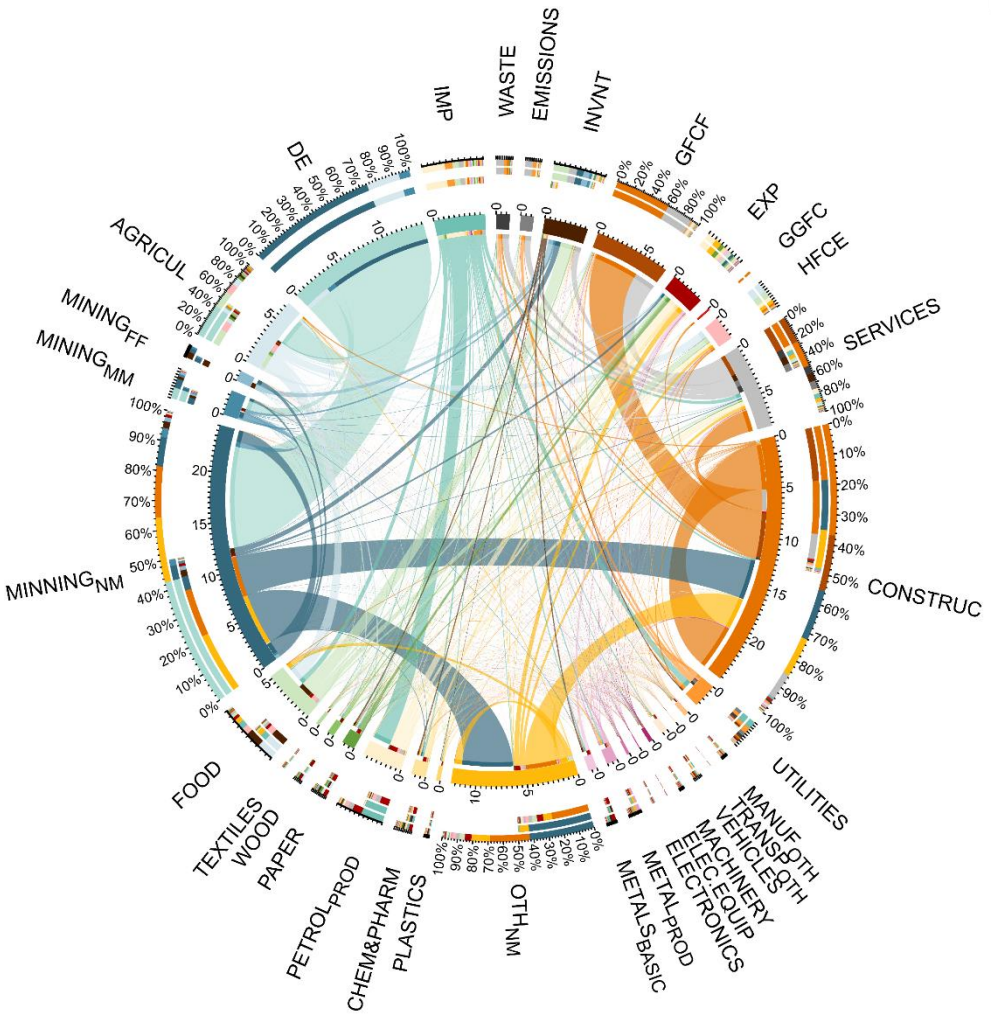


Material group	Description
FF1	Low ash fuels
FF2	High ash fuels
MM1	Iron and steel alloying metals
MM2	Light metals
MM3	Non-ferrous heavy metals
MM4	Special metals
MM5	Nuclear fuels
MM6	Precious metals

Material group	Description
NM1	Stone (including sand)
NM2	Cement and limestone
NM3	Clay
NM4	Precious non-metallic minerals
NM5	Other (fibers, salt, inorganic parts of animals)
BM1	Agricultural biomass
BM2	Animal biomass (including feed)
BM3	Wood
O1	Non-specified

Socioeconomic metabolism

How to read a chord diagram

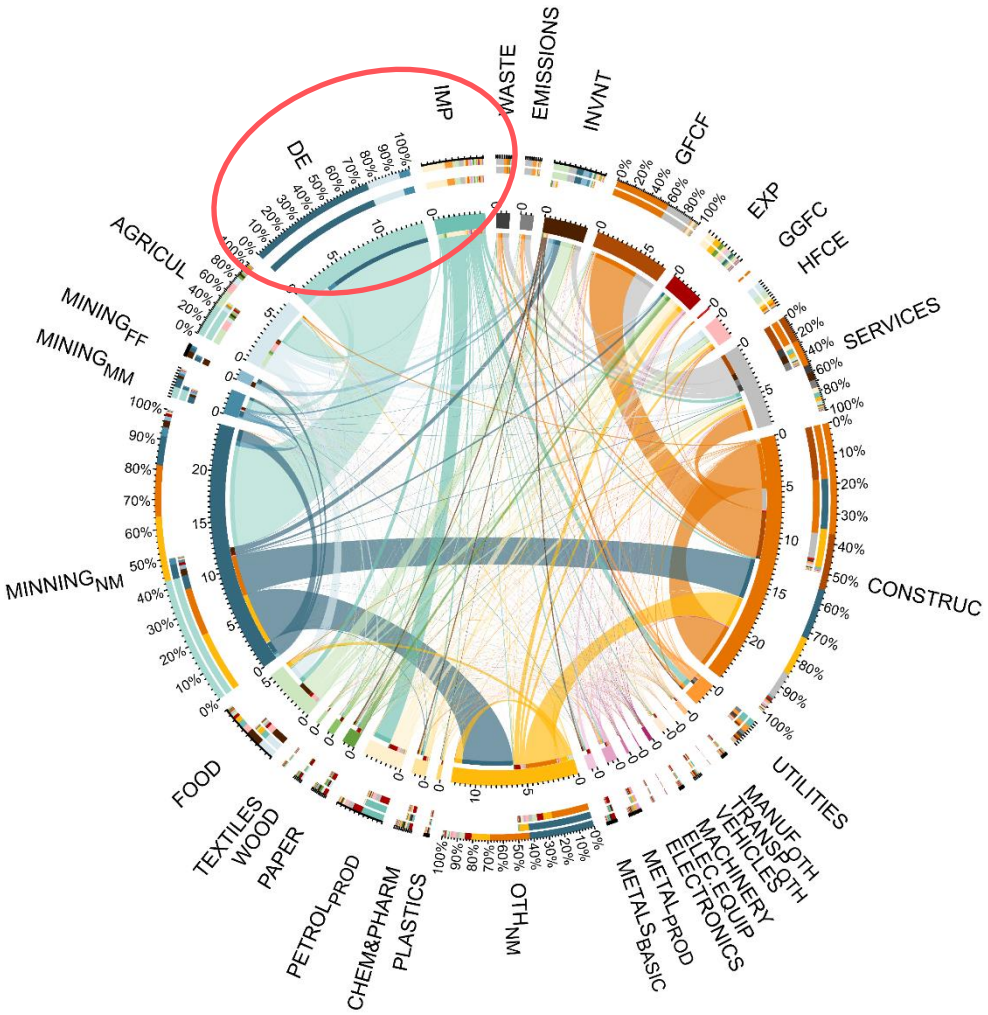


PIOT 2017 [t/cap]

Socioeconomic metabolism

How to read a chord diagram

1 . Most of the material enter the economy through domestic extraction



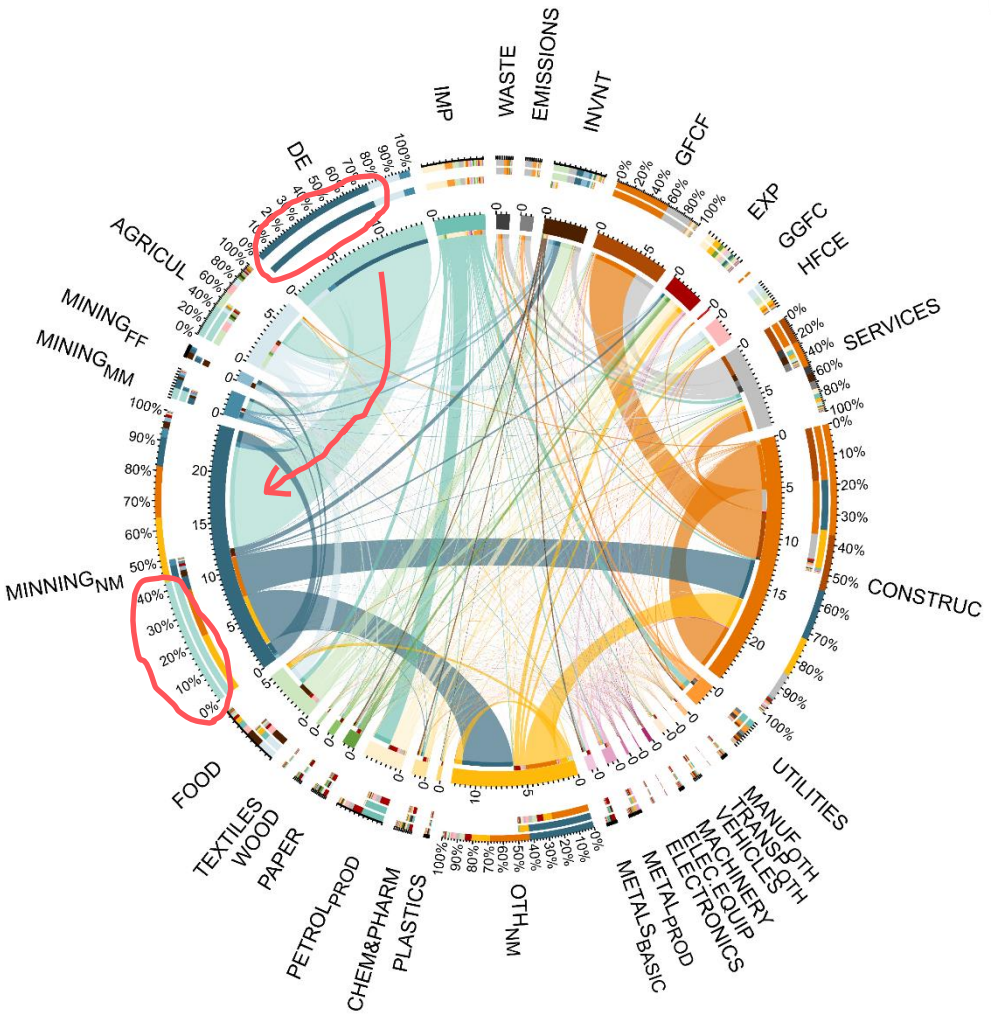
PIOT 2017 [t/cap]

Socioeconomic metabolism

How to read a chord diagram

1 . Most of the material enter the economy through domestic extraction

2. Of that, most enter through mining of non-metallic minerals ($MINING_{NM}$)



PIOT 2017 [t/cap]

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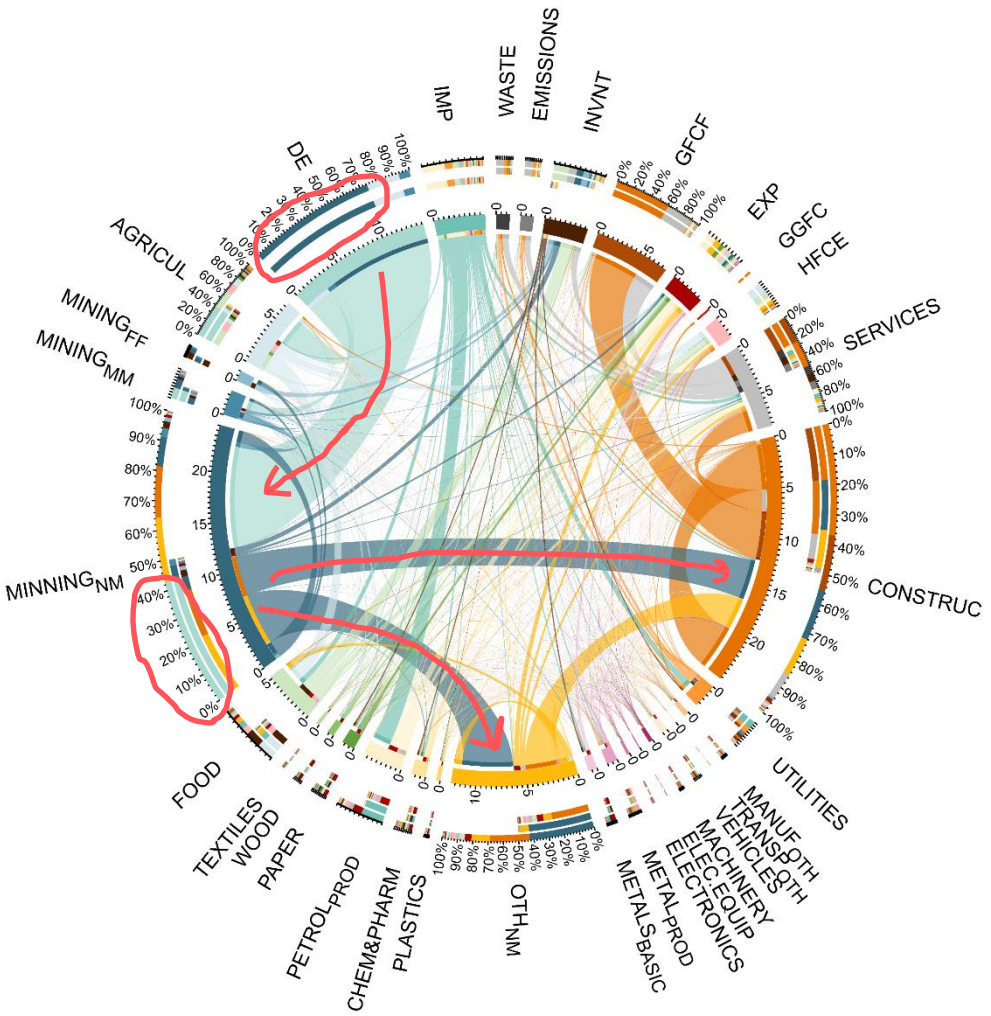
3. That is then distributed between OTH_{NM} and CONSTRUC)



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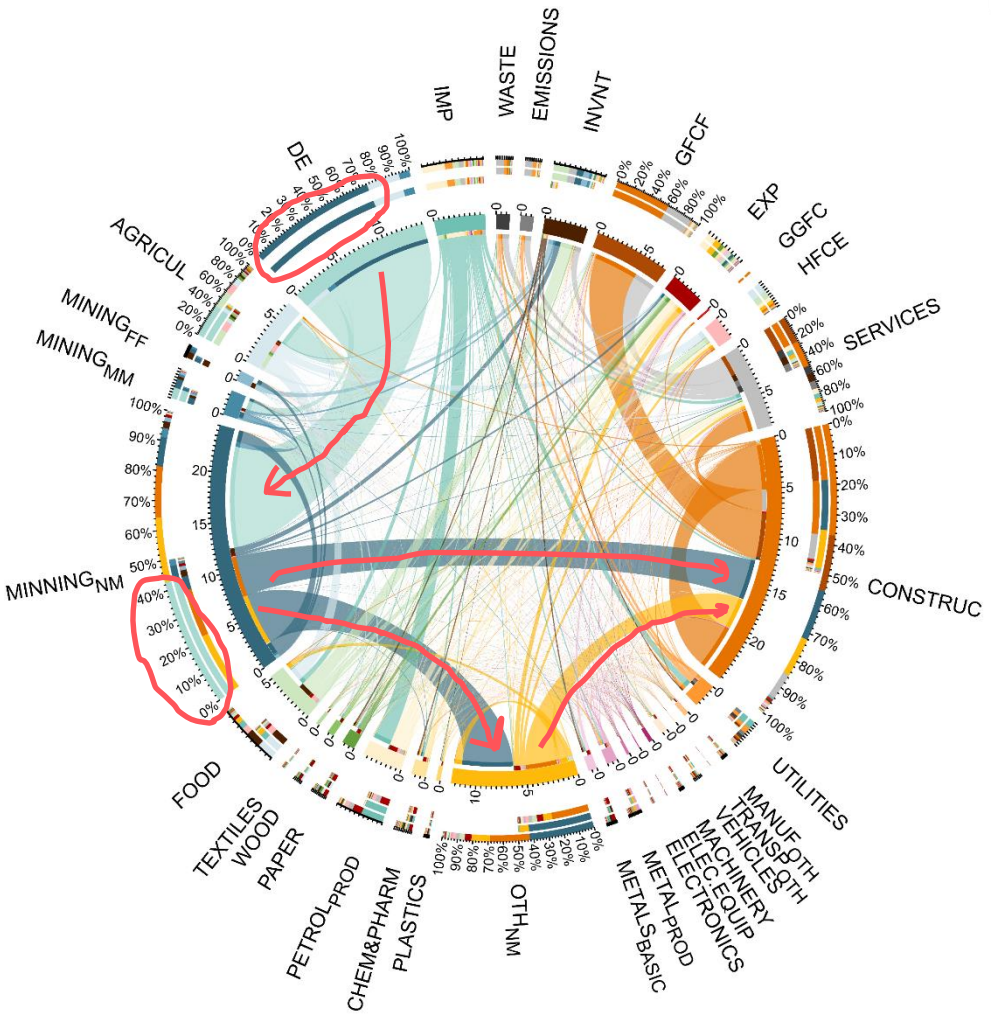
3. That is then distributed between OTH_{NM} and CONSTRUC)

4 . Most of the products from OTH_{NM} are also sold to CONSTRUC.

5. The materials in construction will either stay as the sectors GFCF, or be sold to services, only a small share is sold to final consumption.



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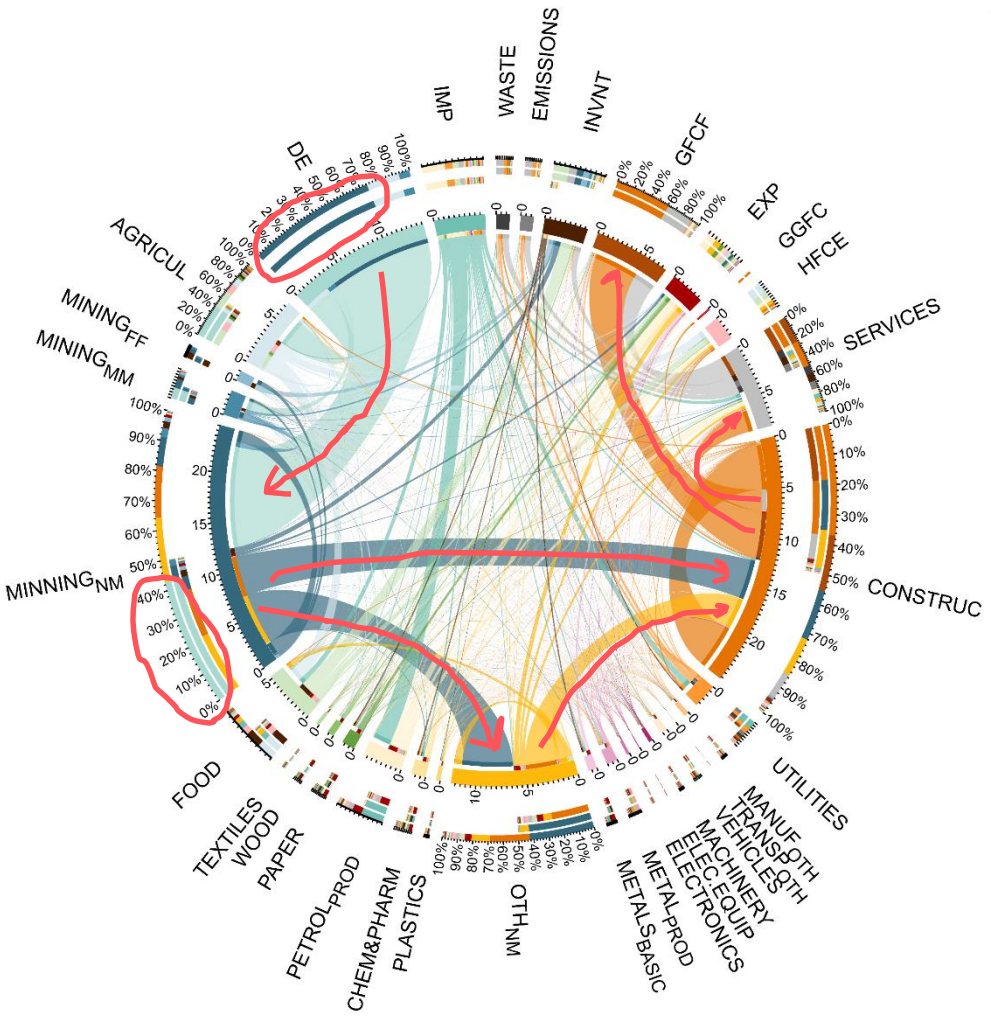
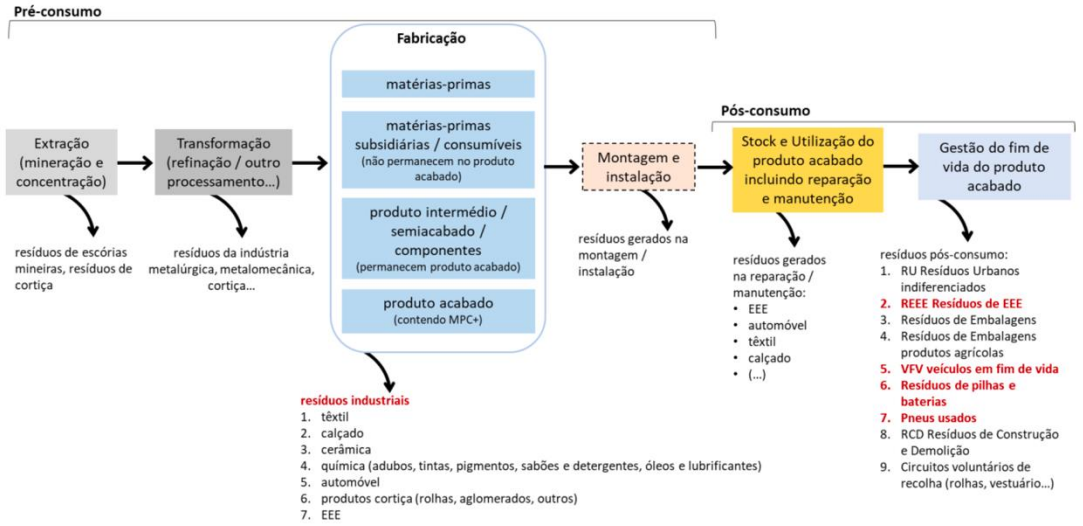


PIOT 2017 [t/cap]

Critical Raw Materials

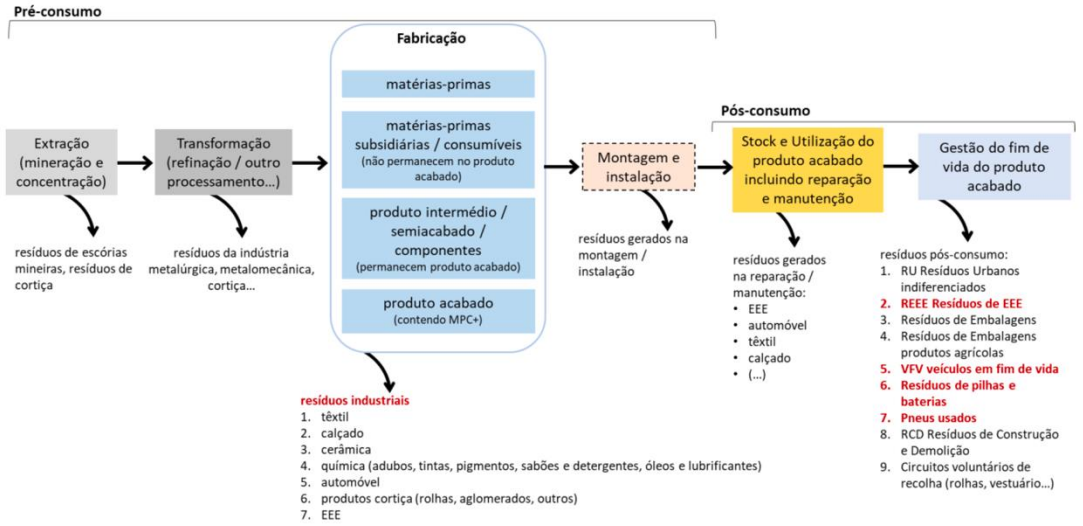
1. The flows of materials across sectors and its incorporation into products adds complexity to their potential recovery.
2. Critical raw materials are incorporated in complex products, as very well depicted in the EmaPrice study
3. Waste management strategies should be designed to improve critical materials recycling
4. As always there are barriers and opportunities



Critical Raw Materials

Barriers

1. The need for dedicated collection flows, respecting some specificities of the products
2. Citizen engagement in best practices of EOL Product Management
3. The need for critical mass and adequate regulations to enable its economics
4. Lack of certification schemes for adequate EOL processing, to guarantee best practices



Critical Raw Materials

Opportunities

1. To develop digital product passports to better inform both green public procurement, individual choice and adequate processing at the end of life
2. Establish new industries, that can add value to the economy. - requires critical mass, for example, battery recycling technologies, particularly for Lithium
3. R&D for the substitution of critical materials in product design
4. Design new business models to promote Circular Economy in practice
5. PROMOTE ECODESIGN