RESOURCE EFFICIENCY AND CIRCULAR ECONOMY POLICIES: MACROECONOMIC IMPACTS & IMPLICATIONS FOR LABOUR MARKETS

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Environmental impacts from extraction and processing will more than double

In 2060:
- 12% of total GHG emissions associated with 7 key metals
- 12% of total GHG emissions associated with concrete
- 50Gt CO₂eq emissions associated with materials cycle

Source: Global Material Resources Outlook to 2060 (OECD, 2019)
Outline

• Methodology & description of the scenarios
• Results: macroeconomic impacts, material use and environment
• Focus on labour market impacts
• Conclusions & future research
METHODOLOGY
Modelling material resources in a nutshell

- Global assessment (12 large economies + 13 regions)
- 2040 time horizon
- 50+ economic sectors
- 60 materials
- ENV-Linkages baseline from “Global Material Resources Outlook to 2060” (OECD, 2019)
- Model enhanced with
  - Material extraction data from UNEP (2017) linked to IO
  - Recycling sector and primary / secondary metal processing technologies (sectors split in GTAP)
  - Environmental impacts (Leiden U, ecoinvent database)
Description of the Material Fiscal Reform scenario

<table>
<thead>
<tr>
<th>Instrument</th>
<th>Description</th>
<th>Target (2040)</th>
</tr>
</thead>
</table>
| Material tax                        | Tax on primary metals and non-metallic minerals                              | • 10 $/t of iron ores  
• 50 $/t of aluminium ores  
• 20 $/t of copper ores  
• 15 $/t of other metals ores  
• 5 $/t of non-metallic minerals |
| Subsidy to secondary metal production | Production subsidy to secondary metal production                            | 75% subsidy rate on the purchasing price of the recycling commodity          |
| Subsidy to recycling                | Subsidy for recycling input uses                                            | 25% subsidy rate on the producer (selling) price of secondary metal          |

- All these fiscal instruments are implemented from 2018 to gradually reach their target in 2040
- Extra government revenues are used to reduce labour taxation
THE MATERIAL FISCAL REFORM SCENARIO

IMPACTS ON MATERIAL USE AND THE ENVIRONMENT
Impacts of MFR are small and the use of extra tax revenues matters

Global variation in 2040 w.r.t. central baseline scenario
Tax on metals and minerals scenario

-0.8%  -0.6%  -0.4%  -0.2%  0.0%  0.2%  0.4%

- Gross wage rate
- Net-of-tax wage rate
- GDP
- Household consumption
- Employment

Preliminary results from ENV-Linkages model, do not cite
The MFR boosts secondary shares and reduces primary output

Evolution of sector output relative to baseline in 2040

Evolution of share in output compared to baseline in 2040

Preliminary results from ENV-Linkages model, do not cite
The brunt of materials use reduction in Gt is borne by BRIICS

Materials use in Gt relative to baseline in 2040

Preliminary results from ENV-Linkages model, do not cite
The material fiscal reform reduces environmental impacts linked to materials use.

Global variation in 2040 w.r.t. central baseline scenario

- Aluminium
- Copper
- Iron
- Other metals (Pb, Mn, Ni, Zn)
- Concrete
- Total change

Preliminary results from ENV-Linkages model, do not cite
Trade is an important mechanism of material use reduction

Variation of material use in 2040 w.r.t. central baseline scenario

- Scale effect
- Efficiency effect
- Trade effect

Aluminium  Copper  Iron and steel  Other non-ferrous metals  Non-metallic minerals

Draft report: “The consequences of a more resource efficient and circular economy for international trade patterns” (Dellink et al., forthcoming)

Preliminary results from ENV-Linkages model, do not cite
THE MATERIAL FISCAL REFORM SCENARIO

EMPLOYMENT CONSEQUENCES
Baseline to 2040: Employment changes go beyond employment growth

- Because of structural change there are job reallocations across sectors that are higher than projected changes in total employment.
- Reallocation of jobs are higher in BRIICS and countries that are in phase of transition towards mature economies.
- In other developing economies employment growth is the main driver of labour markets dynamics.

Source: OECD ENV-Linkages Model. All variables in the Table are expressed in % of total employment. Changes are cumulative across the period 2017-2040.

<table>
<thead>
<tr>
<th></th>
<th>Net employment growth</th>
<th>Excess worker reallocation</th>
<th>Job creations</th>
<th>Job destructions</th>
<th>Total job reallocations</th>
</tr>
</thead>
<tbody>
<tr>
<td>OECD</td>
<td>0.3%</td>
<td>0.4%</td>
<td>0.5%</td>
<td>0.2%</td>
<td>0.7%</td>
</tr>
<tr>
<td>BRIICS</td>
<td>0.2%</td>
<td>0.7%</td>
<td>0.6%</td>
<td>0.4%</td>
<td>1.0%</td>
</tr>
<tr>
<td>Rest of the world</td>
<td>1.6%</td>
<td>0.1%</td>
<td>1.7%</td>
<td>0.1%</td>
<td>1.8%</td>
</tr>
</tbody>
</table>

Preliminary results from ENV-Linkages model, do not cite.
Expected sectoral changes

Preliminary results from ENV-Linkages model, do not cite
MRF: Workers reallocation in 2040

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Net employment growth</th>
<th>Excess worker reallocation</th>
<th>Job creations</th>
<th>Job destructions</th>
<th>Total job reallocation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>OECD</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Material taxes</td>
<td>-0.1%</td>
<td>0.1%</td>
<td>0.1%</td>
<td>0.2%</td>
<td>0.2%</td>
</tr>
<tr>
<td>MFR</td>
<td>0.0%</td>
<td>0.6%</td>
<td>0.3%</td>
<td>0.3%</td>
<td>0.6%</td>
</tr>
<tr>
<td><strong>BRIICS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Material taxes</td>
<td>-0.2%</td>
<td>0.7%</td>
<td>0.3%</td>
<td>0.6%</td>
<td>0.9%</td>
</tr>
<tr>
<td>MFR</td>
<td>0.1%</td>
<td>0.9%</td>
<td>0.5%</td>
<td>0.4%</td>
<td>0.9%</td>
</tr>
<tr>
<td><strong>Rest of the World</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Material taxes</td>
<td>-0.3%</td>
<td>0.5%</td>
<td>0.2%</td>
<td>0.6%</td>
<td>0.8%</td>
</tr>
<tr>
<td>MFR</td>
<td>0.1%</td>
<td>0.6%</td>
<td>0.4%</td>
<td>0.3%</td>
<td>0.7%</td>
</tr>
</tbody>
</table>

Source: OECD ENV-Linkages Model. All variables in the Table are expressed as difference to baseline values in 2040 as % of total employment.

- The impact of material tax policies on total employment is very limited.
- Labour markets dynamic is characterized by shifts of employment across sectors.
- MFR implies large labour shifts across sectors for limited impacts on GDP.

Preliminary results from ENV-Linkages model, do not cite
Job creations and destructions are limited to few sectors

Global variation in 2040 w.r.t. central baseline scenario

Global Employment
(millions of jobs)

Production
(millions of 2011 USD)

Preliminary results from ENV-Linkages model, do not cite
CONCLUSIONS & FUTURE STEPS
Conclusions and future steps

Conclusions
• A combination of material taxes and subsidies to recycling and secondary metal production achieves a significant increase in circularity, at very low GDP costs and no loss of consumption
• Using the extra tax revenue to reduce labour taxation is a way to alleviate those costs
• The implications for net employment are small but mask large disparities across sectors and countries
• The material fiscal reform scenario leads to significant reduction in environmental impacts

Future steps
• Investing in material efficiency technologies
• Transition to low carbon economies
• Other megatrends
  (digitalization, servitisation, sharing economy ...
THANK YOU!

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Greenhouse gas emissions related to materials management will more than double

12% of total GHG emissions associated with 7 key metals
12% of total GHG emissions associated with concrete
50Gt CO₂ eq emissions associated with materials cycle
The ENV-Linkages model

• Computable General Equilibrium (CGE) model
  – Multi-regional, multi-sectoral (details in next presentation)
  – Full description of economies
  – All economic activity is part of a closed, linked system
  – Simultaneous equilibrium on all markets
  – Structural trends, no business cycles

• Dynamics
  – Solved iteratively over time (recursive-dynamic)
  – Capital vintages

• Link from economy to environment
  – Greenhouse gas emissions linked to economic activity
  – Other pollutants forthcoming...
Overview of the articulation of models and assumptions

External Modules
- Population Prospects
- Employment: Labour Force Participation + Unemployment scenarios
- Human Capital
- Additional Assumptions:
  - Public debt Stabilisation (OECD only)
  - Government Savings

Long-Term Models
- ECO Dpt. LTB Model
  - 42 countries
- ENV-Growth Model
  - Rest of the World (140 additional countries)

Structural CGE Model
- Real GDP
- Employment Investment
- Current-accounts
- Public savings
- Population
- ENV-Linkages Baseline
- CGE Model:
  - 25 Regions
  - 33 Goods

Additional Features and Trends to be reproduced:
- Energy Demands, Supplies, prices (IEA WEO 2013)
- Agricultural Yields (IIASA/OECD-TAD)
- World Trade Scenario (OECD-ECO/CEPII)
- Sector Specific Labour Productivity
- Convergence in preferences/technology
Splitting relevant sectors in GTAP

**Initial GTAP database**
- Iron and steel
- Fabricated metal products
- Nonferrous metals
- Other manufacturing

**Split GTAP database using Exiobase**
- Iron and steel processing - primary
- Iron and steel processing - secondary
- Iron and steel casting
- Fabricated metal products
- Nonferrous metal casting
  - Aluminium processing - primary
  - Aluminium processing - secondary
  - Copper processing - primary
  - Copper processing - secondary
  - Other metal processing - primary
  - Other metal processing - secondary
- Other manufacturing
- Recycling

**Final ENV-Linkages database with recycling**
- Iron and steel processing - primary
- Iron and steel processing - secondary
- Fabricated metal products and casting
- Nonferrous metal casting
  - Aluminium processing - primary
  - Aluminium processing - secondary
  - Copper processing - primary
  - Copper processing - secondary
  - Other metal processing - primary
  - Other metal processing - secondary
- Other manufacturing
- Recycling
<table>
<thead>
<tr>
<th>Category</th>
<th>Sector</th>
<th>Material</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fossil fuels</strong></td>
<td>Coal extraction</td>
<td>Anthracite; Other Bituminous Coal; Peat</td>
</tr>
<tr>
<td></td>
<td>Gas extraction</td>
<td>Natural gas; Natural gas liquids</td>
</tr>
<tr>
<td></td>
<td>Oil extraction</td>
<td>Crude oil; Oil shale and tar sands</td>
</tr>
<tr>
<td>Livestock (cows, other)</td>
<td>Grazed biomass; Other crop residues (sugar and fodder beet leaves etc); Straw</td>
<td></td>
</tr>
<tr>
<td>Sugar cane, sugar beet</td>
<td>Sugar crops</td>
<td></td>
</tr>
<tr>
<td>Forestry</td>
<td>Timber (Industrial round wood); Wood fuel and other extraction</td>
<td></td>
</tr>
<tr>
<td>Fishing</td>
<td>All other aquatic animals; Aquatic plants; Wild fish catch</td>
<td></td>
</tr>
<tr>
<td>Vegetables, fruit, nuts</td>
<td>Fruits; Nuts; Vegetables</td>
<td></td>
</tr>
<tr>
<td>Oil seeds</td>
<td>Oil bearing crops</td>
<td></td>
</tr>
<tr>
<td>Plant-based fibers</td>
<td>Fibres</td>
<td></td>
</tr>
<tr>
<td>Wheat</td>
<td>Wheat</td>
<td></td>
</tr>
<tr>
<td>Paddy rice</td>
<td>Rice</td>
<td></td>
</tr>
<tr>
<td>Cereal grains nec</td>
<td>Cereals n.e.c.</td>
<td></td>
</tr>
<tr>
<td>Crops nec</td>
<td>Other crops n.e.c; Pulses; Roots and tubers; Spice - beverage - pharmaceutical crops; Tobacco</td>
<td></td>
</tr>
</tbody>
</table>
## Materials following input flow from one sector to another

<table>
<thead>
<tr>
<th>Category</th>
<th>Input from this extraction sector</th>
<th>Into this processing sector</th>
<th>Materials</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fossil fuels</strong></td>
<td>Coal extraction</td>
<td>Coal power</td>
<td>Lignite (brown coal); Other Sub-Bituminous Coal</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Iron and steel</td>
<td>Coking Coal</td>
</tr>
<tr>
<td><strong>Non-metallic minerals</strong></td>
<td>Non-metallic Minerals*</td>
<td>Construction</td>
<td>Gypsum; Limestone; Sand gravel and crushed rock for construction; Structural clays</td>
</tr>
<tr>
<td></td>
<td>Mining (other than fossil fuels)</td>
<td>Construction</td>
<td>Ornamental or building stone</td>
</tr>
<tr>
<td></td>
<td>Chemicals, rubber, plastics</td>
<td>Chemical minerals n.e.c.; Fertilizer minerals n.e.c.; Salt</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Non-metallic minerals</td>
<td>Chalk; Dolomite; Industrial minerals n.e.c.; Industrial sand and gravel; Other non-metallic minerals n.e.c.; Specialty clays</td>
<td></td>
</tr>
<tr>
<td><strong>Metals</strong></td>
<td>Iron and steel</td>
<td>Iron ores</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Non-ferrous metals</td>
<td>Bauxite and other aluminum ores; Chromium ores; Copper ores; Gold ores; Lead ores; Manganese ores; Nickel ores; Platinum group metal ores; Silver ores; Tin ores; Titanium ores; Zinc ores; Other metal ores</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Refining</td>
<td>Uranium ores</td>
<td></td>
</tr>
</tbody>
</table>
## Linking materials use to economic activity: metals

<table>
<thead>
<tr>
<th>Materials</th>
<th>Corresponding economic flow</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iron ores</td>
<td>Mining inputs used in iron and steel production</td>
</tr>
<tr>
<td>Bauxite and other aluminium ores</td>
<td>Mining inputs used in aluminium production</td>
</tr>
<tr>
<td>Copper ores</td>
<td>Mining inputs used in copper production</td>
</tr>
<tr>
<td>Chromium ores, Gold ores, Lead ores, Manganese ores, Nickel ores, Other metal ores, Platinum group metal ores, Silver ores, Tin ores, Titanium ores, Zinc ores</td>
<td>Mining inputs used in other non-ferrous metals production</td>
</tr>
</tbody>
</table>
## Linking materials use to economic activity: non-metallic minerals

<table>
<thead>
<tr>
<th>Materials</th>
<th>Corresponding economic flow</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gypsum, Limestone, Sand gravel and crushed rock, Structural clays</td>
<td>Non-metallic minerals used in construction</td>
</tr>
<tr>
<td>Ornamental or building stone</td>
<td>Mining inputs used in construction</td>
</tr>
<tr>
<td>Chemical minerals n.e.c., Fertiliser minerals n.e.c., Salt</td>
<td>Mining inputs used in chemicals production</td>
</tr>
<tr>
<td>Chalk, Dolomite, Industrial minerals n.e.c., Industrial sand and gravel,</td>
<td>Mining inputs used in non-met. minerals production</td>
</tr>
<tr>
<td>Other non-metallic minerals n.e.c., Specialty clays</td>
<td></td>
</tr>
</tbody>
</table>
Coefficients that link material flows to the corresponding specific economic flows
- e.g. iron ores in volumes as linked to the input of the ‘Mining’ sector to the ‘Iron and Steel’ sectors in values

Coefficients calculated on the base year and kept constant through time

Implicit assumption
- No physical decoupling, i.e. no changes in the efficiency of extraction and treatment of materials or in ore grades
Impacts on key indicators of an incremental implementation of MFR

Global variation in 2040 w.r.t. central baseline scenario

-0.5%  -0.4%  -0.3%  -0.2%  -0.1%  0.0%

GDP

-40.0%  -30.0%  -20.0%  -10.0%  0.0%

Metals

Minerals

- Tax on metals with lumpsum transfer to households
- Tax on metals and minerals with lumpsum transfer to households
- Tax on metals and minerals with extra revenues to reduce labour taxation
- Material fiscal reform scenario

Preliminary results from ENV-Linkages model, do not cite
Mechanisms and drivers of labour implications

- Job creation
- Job destruction
- Job substitution
- Job redefinition

- Changes in demand patterns
- Aggregate income and macroeconomic conditions
- Changes in production modes
- Trade and competitiveness
Job creations and destructions vary across countries

Global variation in 2040 w.r.t. central baseline scenario, million jobs

Preliminary results from ENV-Linkages model, do not cite