CO_2 intensity and GDP per capita

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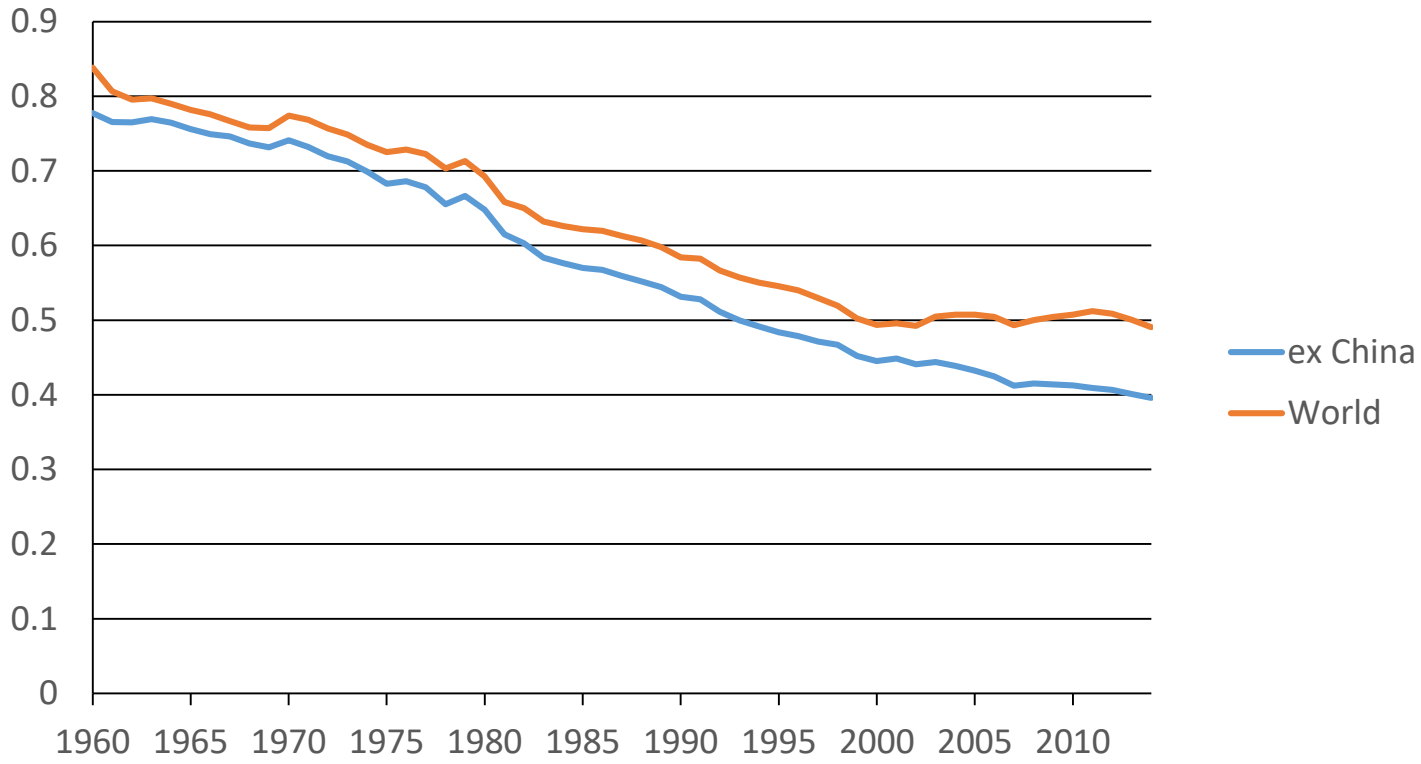
Emissions of CO2 (kg per 2010 US$ of GDP). Data from World Bank



Do emissions fall at a diminishing rate as countries get richer?

What has happened in individual countries?

- For the 36 richest countries (2014), CO_2 intensity has fallen
- The rest?
  - 69: rising CO_2 intensity
  - 58: falling CO_2 intensity
  - 28: no significant trend

Does CO_2 intensity increase with GDP initially and then fall?

Does it fall at a diminshing rate?

Relationship between CO_2 intensity and GDP per capita

Negative	Positive	Insignificant
94	48	48

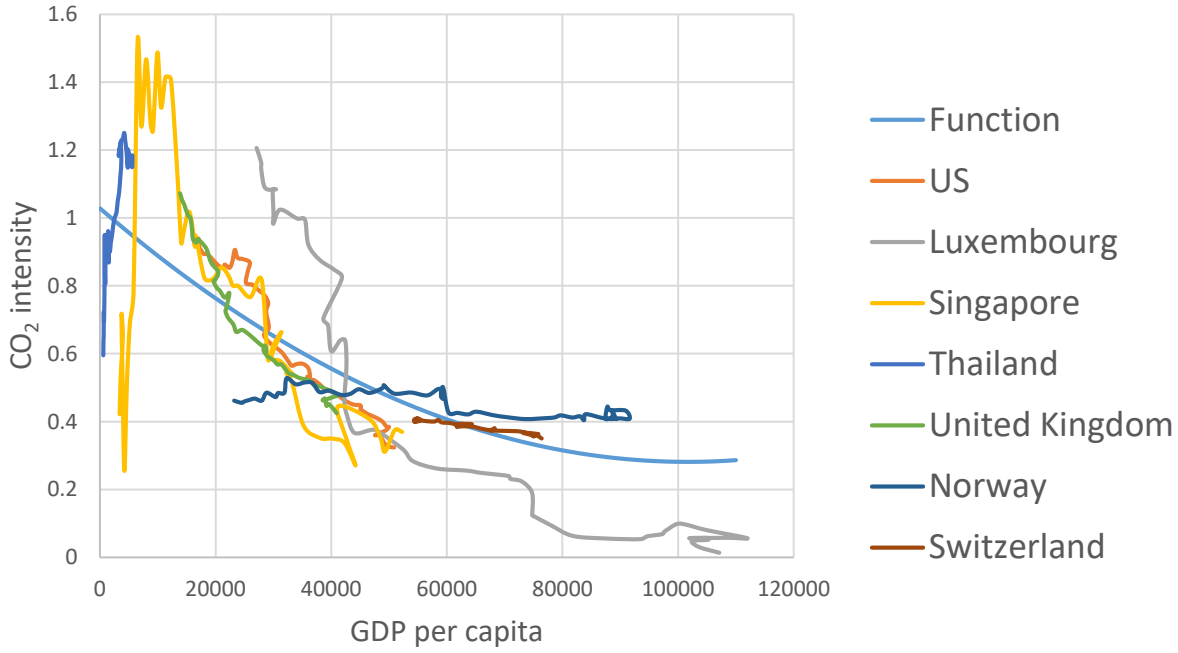
Negative correlation for the 36 richest countries (except 3)

Positive correlation about as prominent for the poorer countries,

but becomes increasingly frequent as GDP per capita drops

Does CO_2 intensity fall as GDP increases but at a diminishing rate?

$y = a + bx + cx^2$, y = CO_2 intensity, x = GDP per capita, estimated for the entire panel with country dummies



$b < 0, c > 0$

Regressions for individual countries

$y = a + bx + cx^2$, y = CO_2 intensity, x = GDP per capita, for the 94 countries with negative correlation

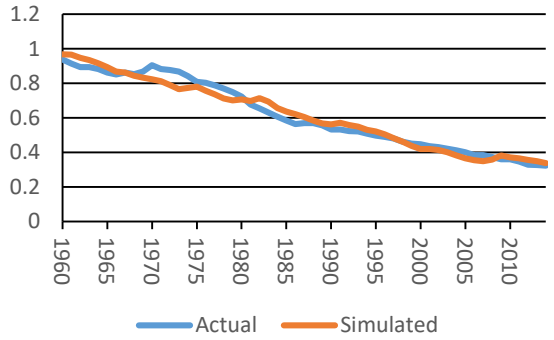
63 countries: $b < 0$, $c > 0$, but c not significant for 28

21 countries: $b > 0$, $c < 0$; i.e., rising CO_2 intensity initially and then falling

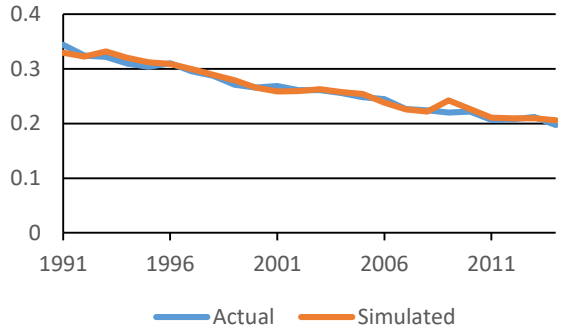
Consider $y = a + bx + cx^2 + dx^3$

13 countries: $b > 0$, $c < 0$, $d > 0$, i.e., CO_2 intensity falls at a diminishing rate

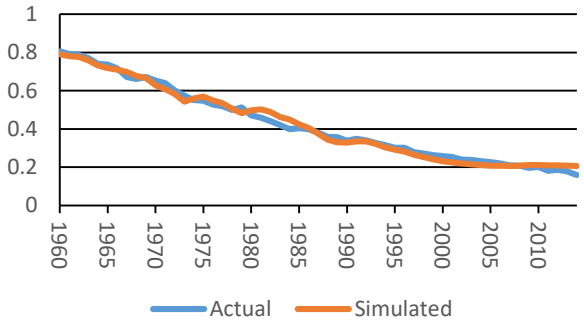
United States



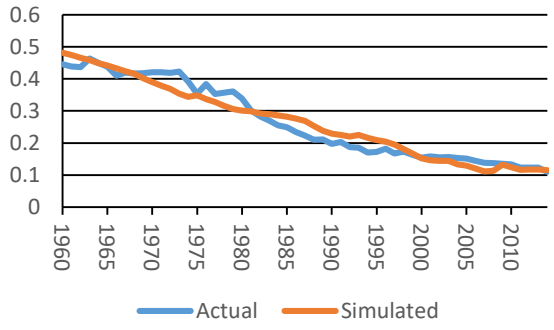
Germany



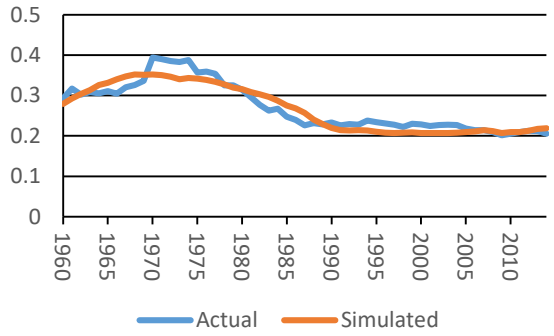
United Kingdom



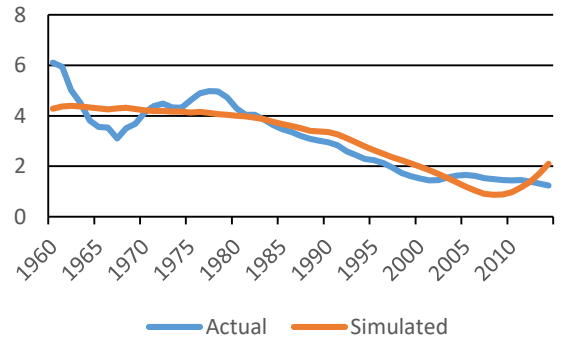
France



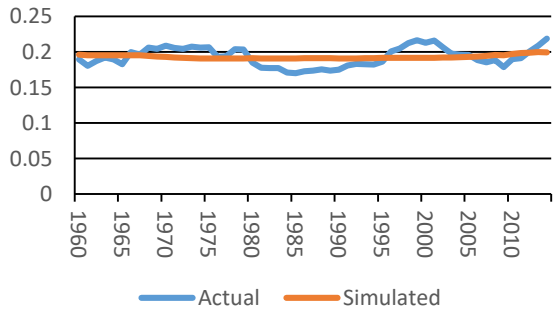
Japan



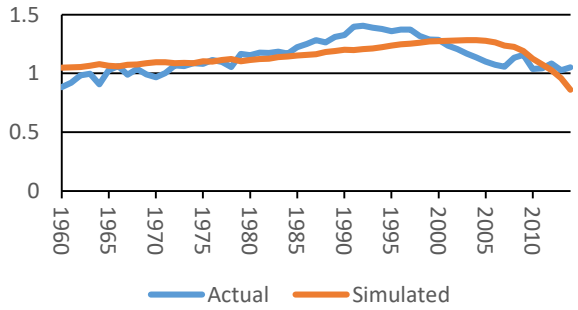
China



Brazil



India



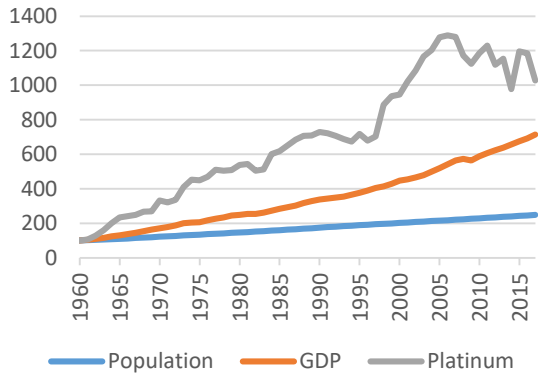
Is the world GDP becoming less material intensive?

Consider extraction of 11 industrial minerals

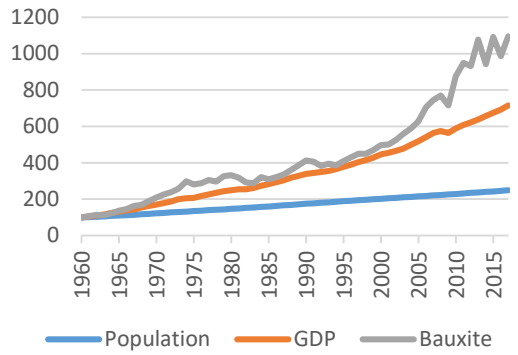
Growth of extraction 1960-2015

Faster than GDP	Slower than GDP, but faster than population	Slower than population
5	4	2

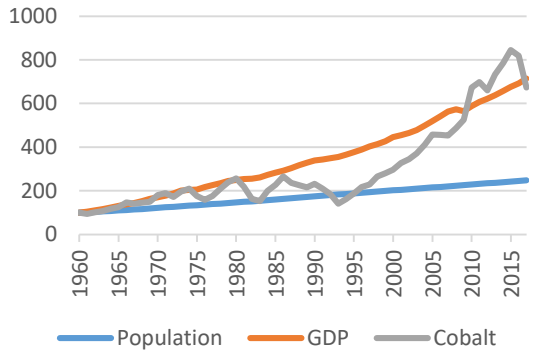
Platinum



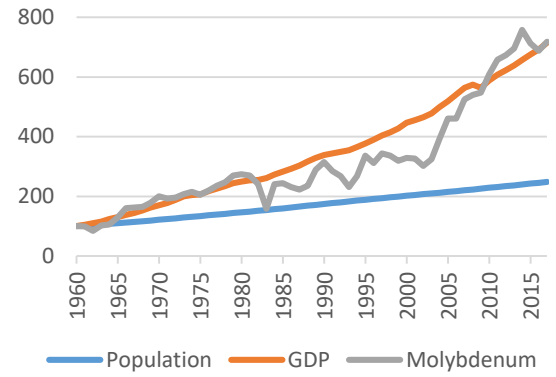
Bauxite



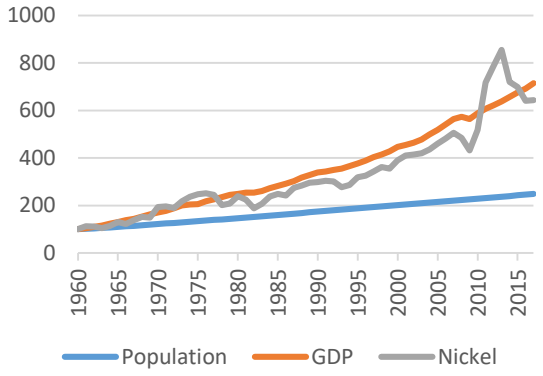
Cobalt



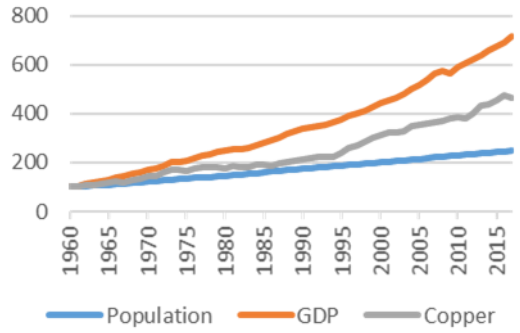
Molybdenum



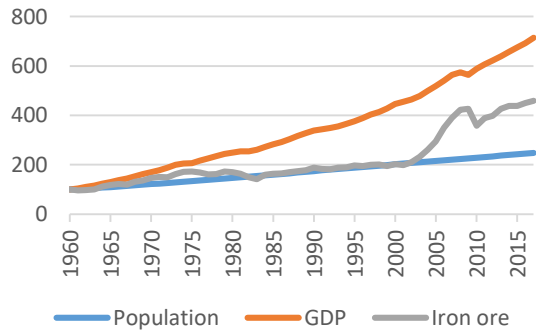
Nickel



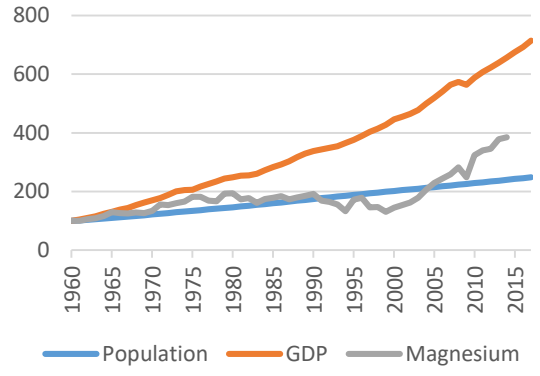
Copper



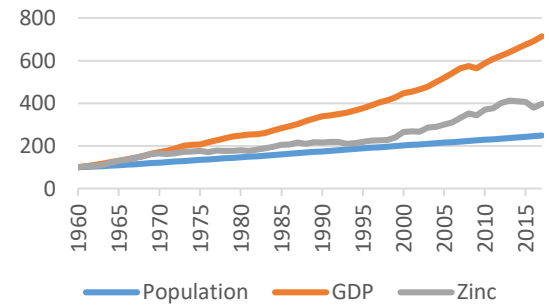
Iron ore



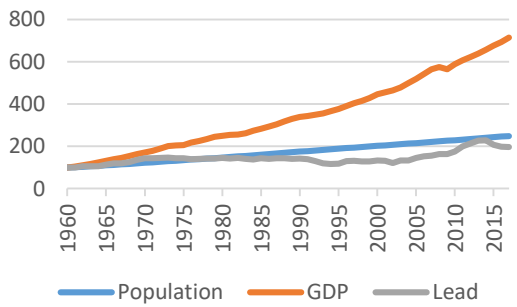
Magnesium



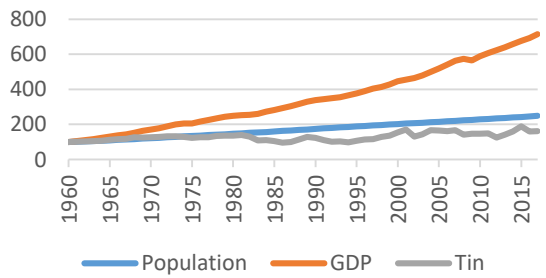
Zinc



Lead



Tin



Conclusion

Limited help in economic growth as a solution to decarbonization

- CO_2 emissions fall with GDP per capita at a dimishing rate
- CO_2 emissions may rise as countries initially grow out of poverty
- The world economy is not becoming less material intensive

New energy technologies are needed, but will they deliver?