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MEASURING THE EFFECTS OF ENERGY TRANSITION:

A Structural Decomposition Analysis of the Change in Renewable Energy Use between 2000 and 2014

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Starting point:

Renewable energy (RE) use changed over time
How come? Measure the contribution of the drivers

Standard answer:

More consumption per person
More people
More efficient ***renewable energy*** use
…… and several smaller drivers

Calculate how much each driver contributes

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Starting point:

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This paper's approach:

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Energy transition
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Calculate how much each driver contributes

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Why do we need to do that?

Standard approach:

More consumption per person	↑
More people	↑
More efficient renewable energy use	↓
…… and several smaller drivers	

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This paper's approach:

More consumption per person ↑
More people ↑
More efficient energy use ↓
Energy transition ↑
…… and several smaller drivers

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Not much going on

Why do we need to do that?

Standard approach:

		%
More consumption per person	↑	75
More people	↑	30
More efficient renewable energy use	↓	-10
…… and several smaller drivers		5

This paper's approach:

More consumption per person	↑
More people	↑
More efficient energy use	↓
Energy transition	↑
…… and several smaller drivers	

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Excellent job!

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This paper's approach:

More consumption per person	↑	75
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More efficient energy use	↓	***-50***
Energy transition	↑	***40***
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Why do we need to do that?

Devastating!!

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Methodology: structural decomposition analysis

In an input-output framework
split the change in the endogenous variable into
the changes in its drivers
(exogenous variables and parameters)

Example: $y = x_1 x_2 x_3$

matrices/vectors/scalars

then: $\Delta y = (\Delta x_1) x_2 x_3 + x_1 (\Delta x_2) x_3 + x_1 x_2 (\Delta x_3)$

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Endogenous variable: y = global renewable energy (RE) use

RE use consists of two components:

- RE used directly by households
- RE used by *n* industries in production processes

household RE: 4 drivers
production RE: 8 drivers
  together: 10 different drivers

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Results are presented for 5 combined drivers

- Technological changes (energy per dollar of production, energy per dollar of consumption, changes in technical input coefficients)
- Changes in trade structure (imports shares of intermediate inputs, import shares of final products)
- Changes in consumption bundle (incl investments and government expenditures, i.e. use of final products) per capita (affluence)
- Changes in population
- Energy transition (share of RE in total energy use for production and for households)

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Data: WIOD (World Input-Output Database)
available free of charge at www.wiod.org

- Global multiregional input-output tables (GMRIO tables)
  deliveries from industry *i* in country *R* (agriculture in France) to industry *j* in country *S* (food processing in Germany)
- 44 countries: 28 EU countries, 15 other (Brazil, Russia, India, Indonesia, China, US, Japan, Taiwan, South Korea, Canada, Australia, Turkey, Mexico, Norway, Switzerland), Rest-of-the-World
- Underlying data: 56 industries
- Annual tables for 2000-2014
- Energy data from Kulionis (2018)

- Problem: only current prices!

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Environmental satellite accounts: 26 energy sources

RE sources:

- Biogas
- Biogasoline
- Biodiesel
- Geothermal heat
- Waste combustion
- Solar energy
- Wind energy
- Hydroelectric energy
- Other renewables

Descriptive statistics

		2000	2014	Change
RE Households	Use in EJ	31.8	36.8	5.0
	% of RE	54.9	46.0	−8.9
RE Production	Use in EJ	26.1	43.2	17.1
	% of RE	45.1	54.0	8.9
Total RE	Use in EJ	57.8	79.9	22.1
	% of all	9.5	10.2	0.7
All energy	Use in EJ	608.2	780.1	172.5
	% Growth	2000-2007	2007-2014	2000-2014
RE Households		1.4	0.7	1.1
RE Production		3.0	4.4	3.7
Total RE		2.1	2.5	2.3
All energy		2.4	1.2	1.8

- Yellow: growth and annual %growth, all energy
- Green: RE approximately 10% of all energy use
- Red: some energy transition (2.3 > 1.8)

A more nuanced picture when looking at the details

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- Red: some energy transition (2.3 > 1.8)
- Yellow: RE industries growth is more than 3 times the growth of RE households
- Green: hence the share of RE households in RE drops

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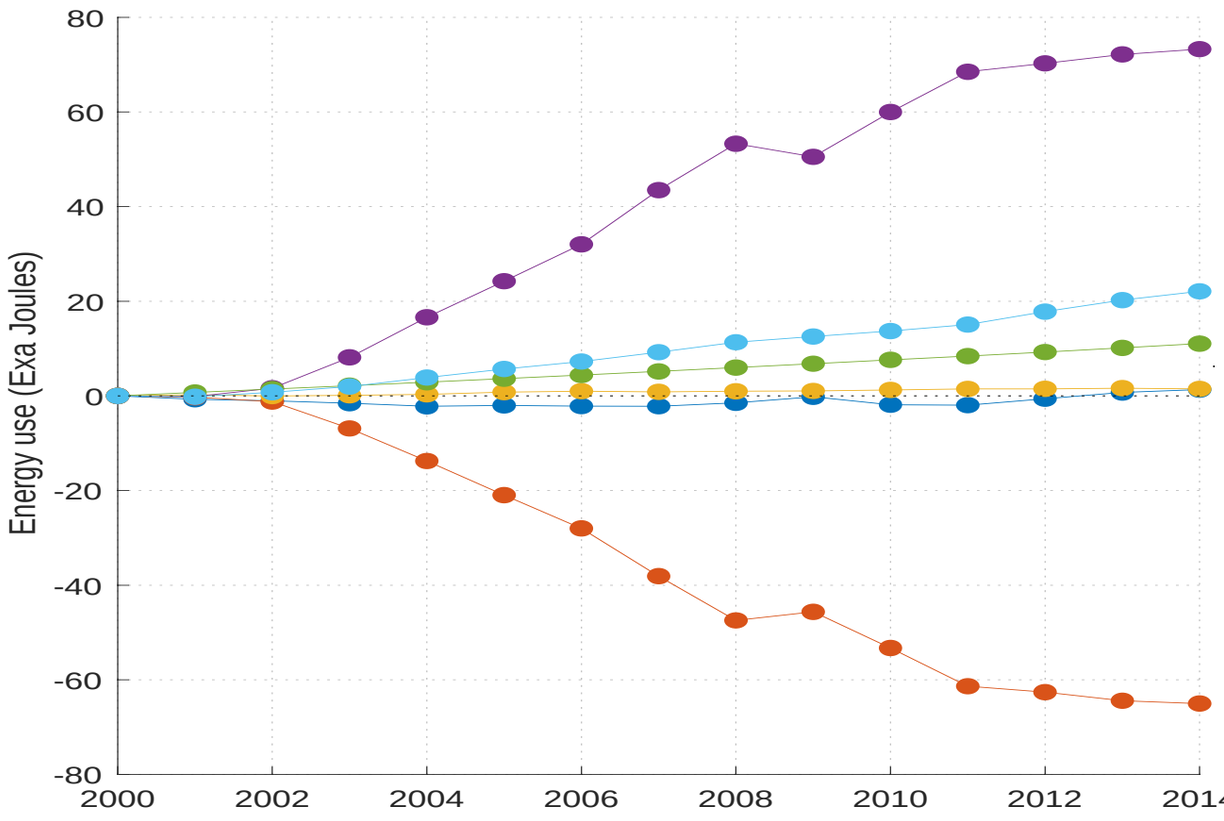
- Bottom panel (grey): changes before/after 2007
- Yellow: Divergence RE Households/RE production acelerated

- Red: little reversed transition 2000-07
- Green: strong transition 2007-14

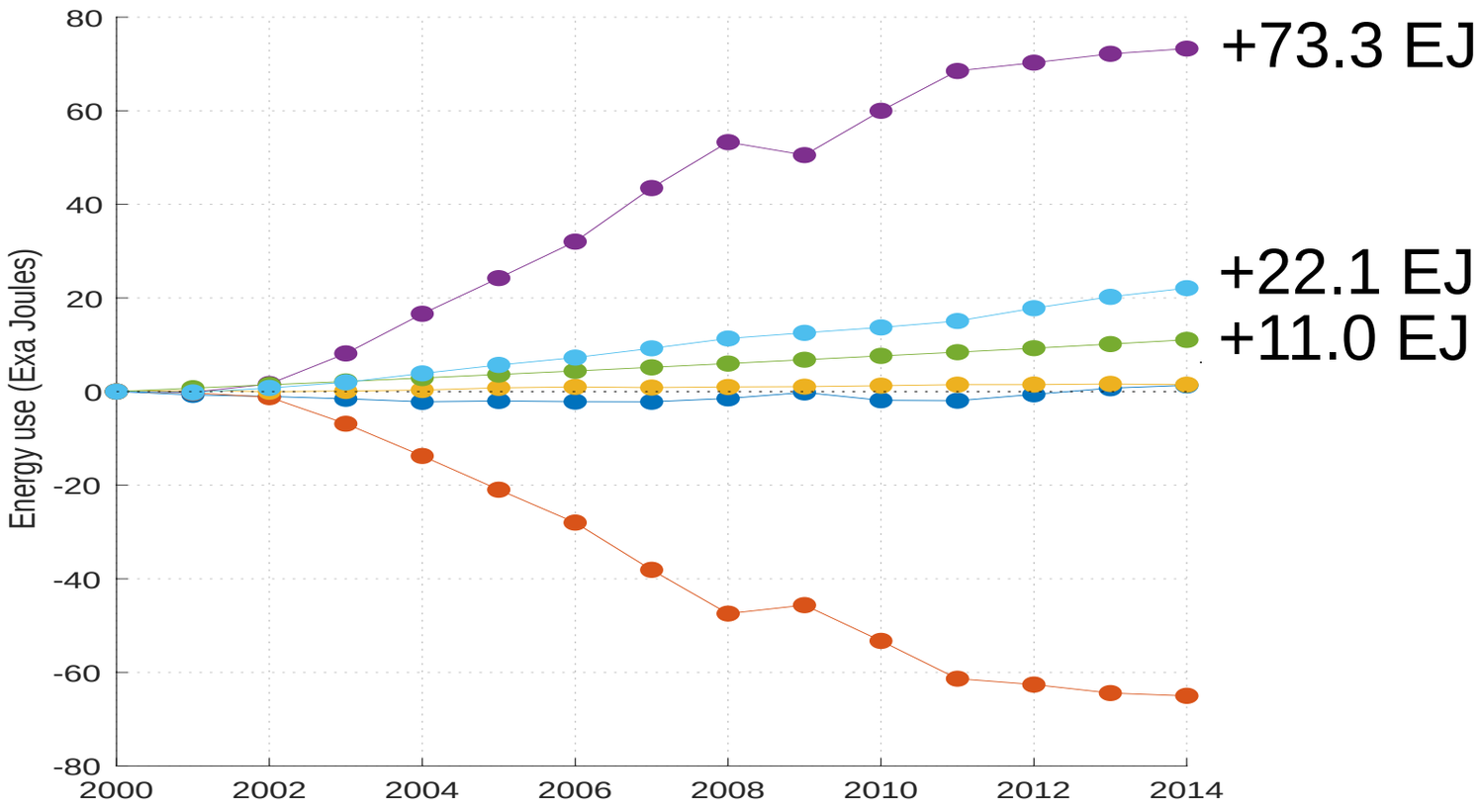
Drivers of RE use at the global level



+22.1 EJ

- Light blue: global RE use increased by 22.1 EJ

Drivers of RE use at the global level



- Purple: affluence (consumption per capita) +73.3 EJ
- The increase if only we would *have* "eaten more"
- Green: population +11.0 EJ

- Consumption: +84.3 EJ
  (more than four times actual increase in RE use)

Drivers of RE use at the global level

- Red: technology -65.0 EJ (reduction in energy intensities!)

- Dark blue: modest energy transition +1.3 EJ
- Yellow: trade effect +1.5 EJ
  imports and exports cancel out
  despite increase in trade volume
  trade has little effect on *global* RE use
  (it matters what and how much, not where it was made)

Drivers of RE use at the global level

- Consumption per capita (purple) & technology (red)
  Started in 2003 and had setback in 2009 (financial crisis)

- Results are biased by price effects
  Growth in consumption per capita: overestimated
  Decrease in energy intensities: also overestimated
  both effects in SDA: too strong (net effect: +8.3 EJ)

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Robustness check

- 2016CURR 2000-2014 # countries, industry class.
- 2013CURR 1995-2009
- 2013PYP 1996-2009 in ‘constant’ prices

all three datasets available for 2000-2009

compare

2016CURR and 2013CURR
effects of different data sets

20013CUR and 2013PYP
consequences of not eliminating prices effects

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Problem: eliminate price effects

Energy coefficients =
energy use (in EJ) per m$ of output in an industry

Energy coefficients decrease:
(a) because of a price rise of the output
(physically nothing changes)
(b) because less energy is used for the same output
(physical changes occur)

Eliminate (a), it is not a “real” change

Use tables in previous year’s prices and “chain the results”

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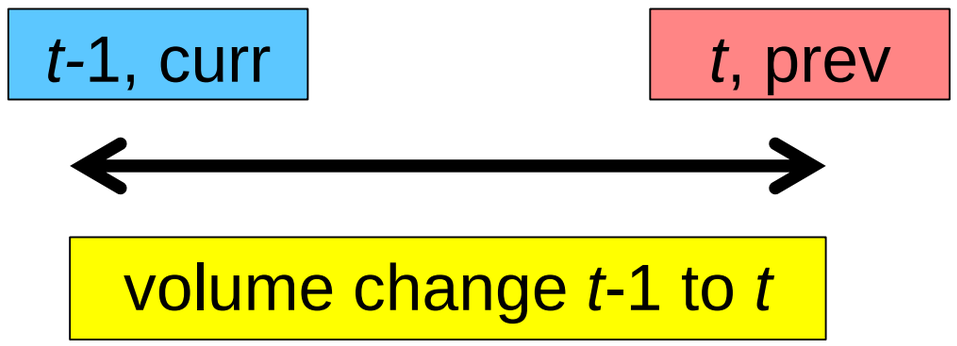

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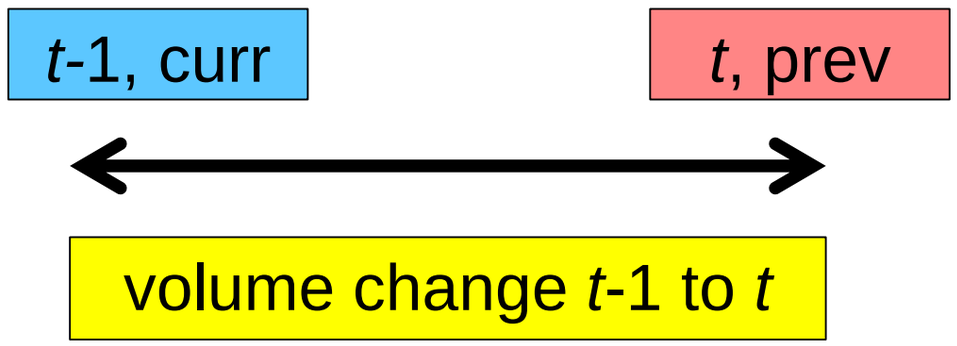

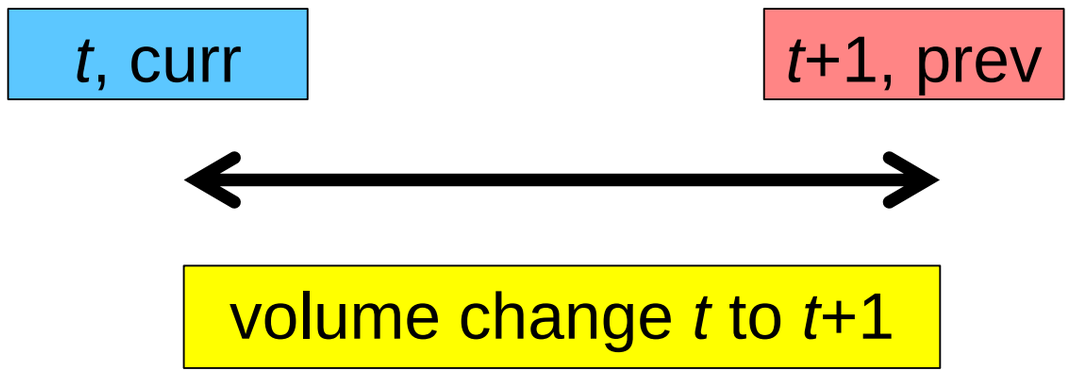

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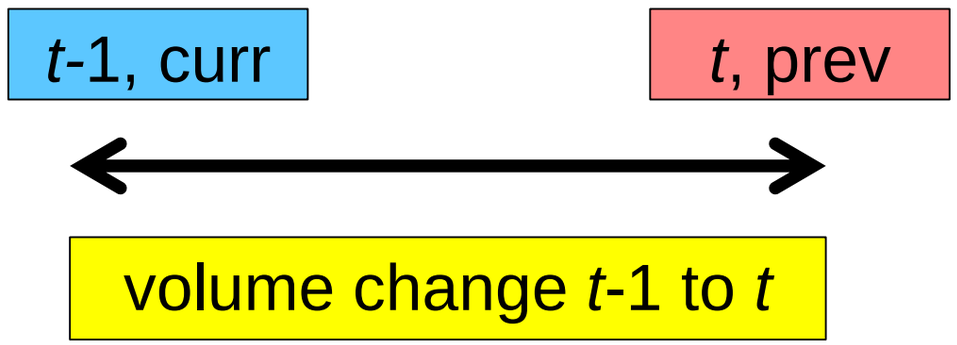
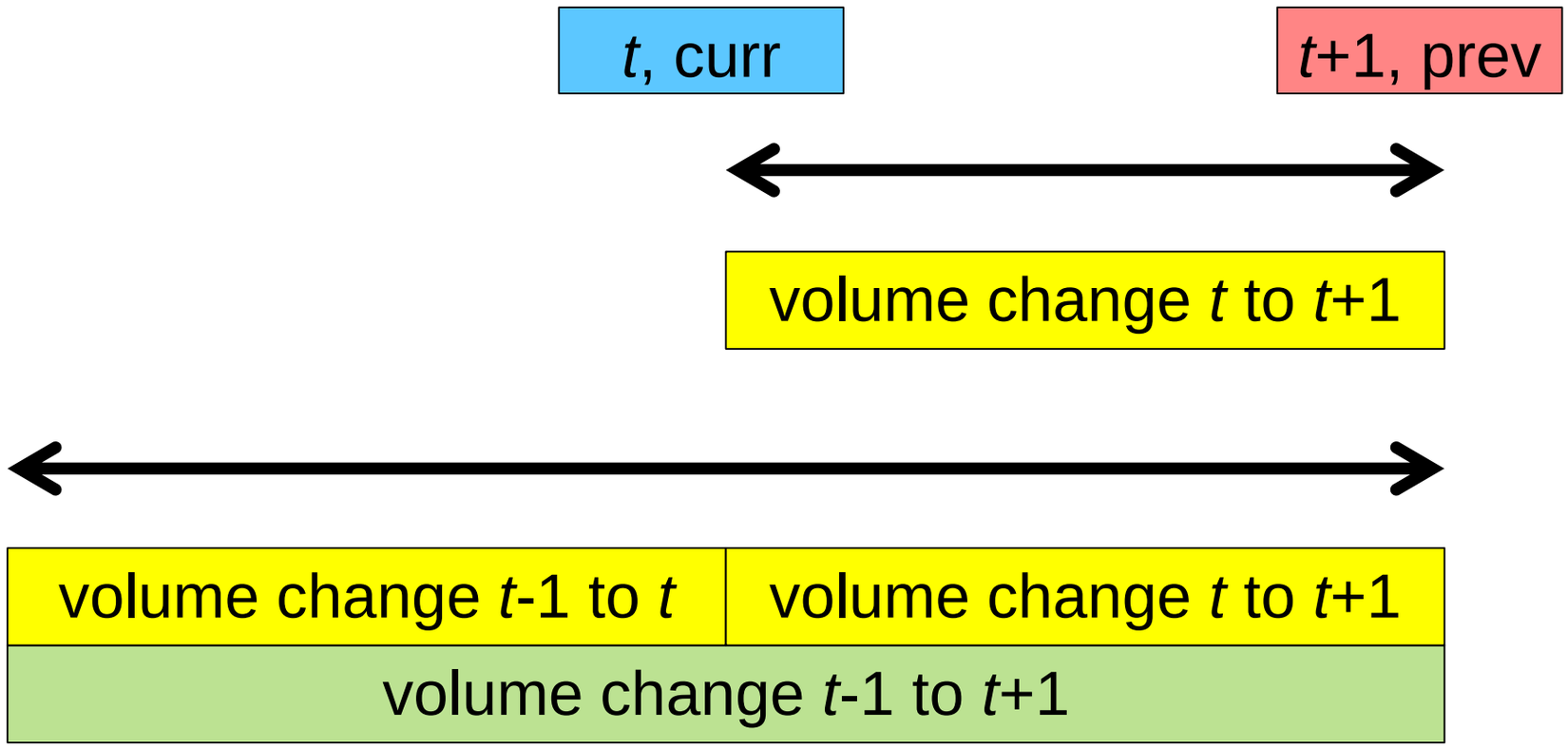
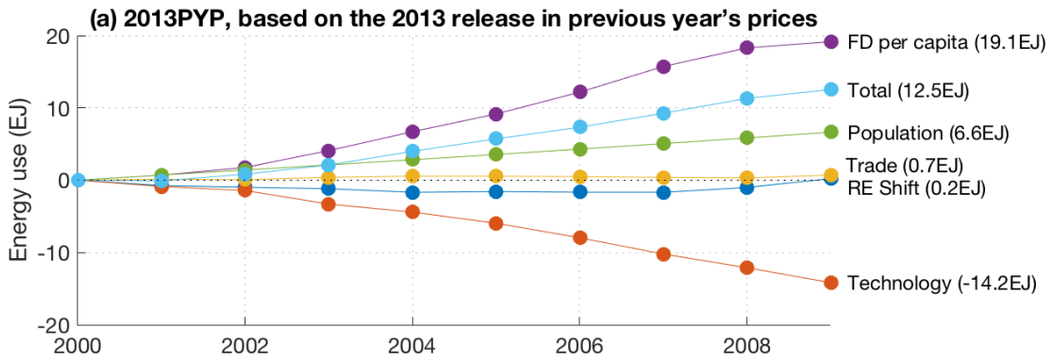
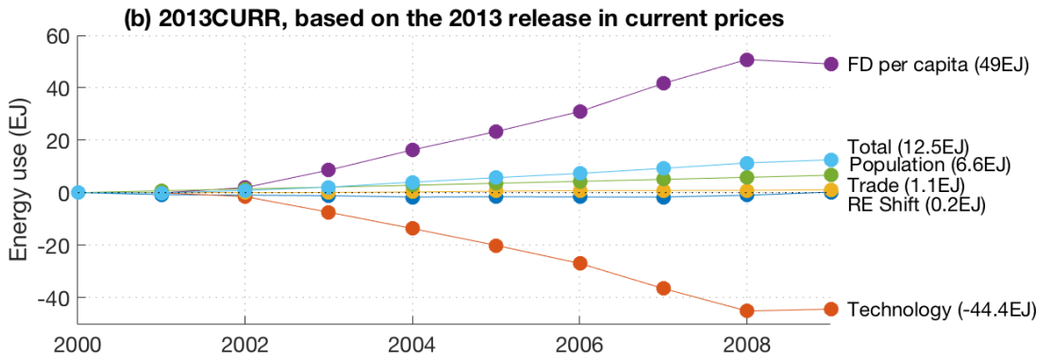
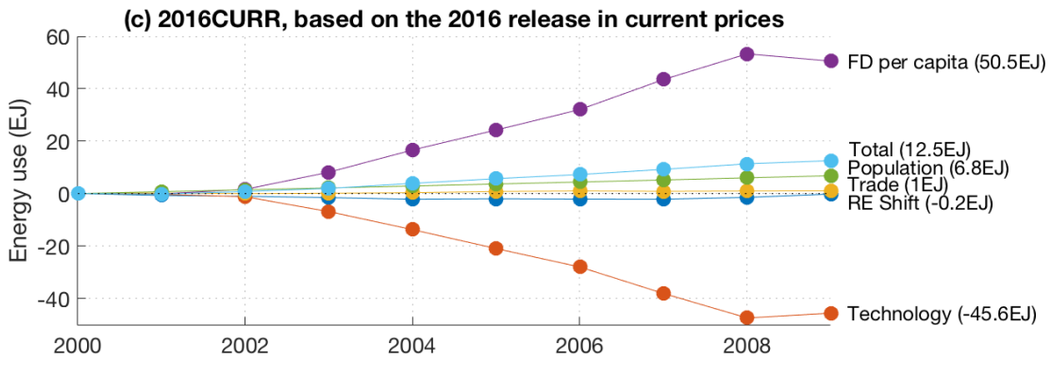




Robustness check

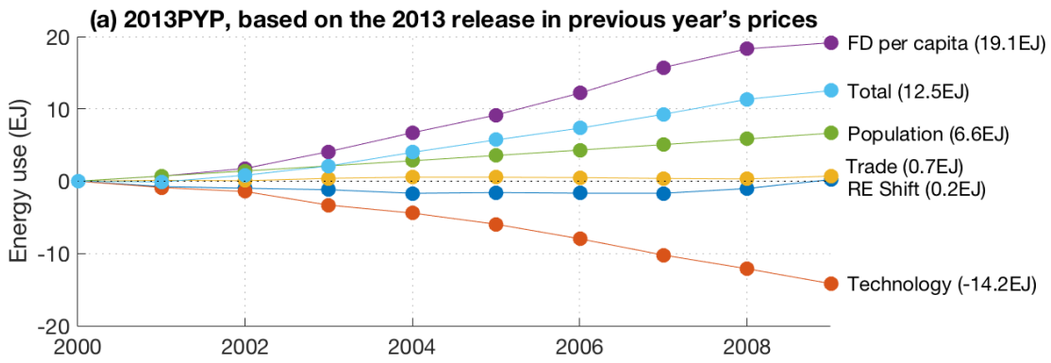


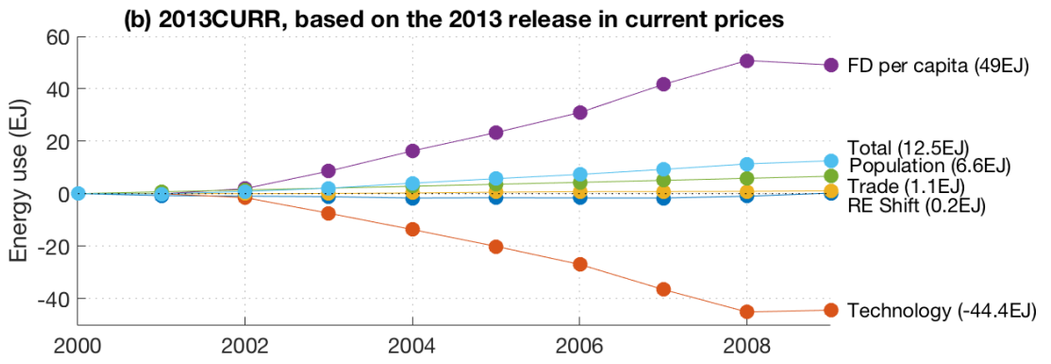


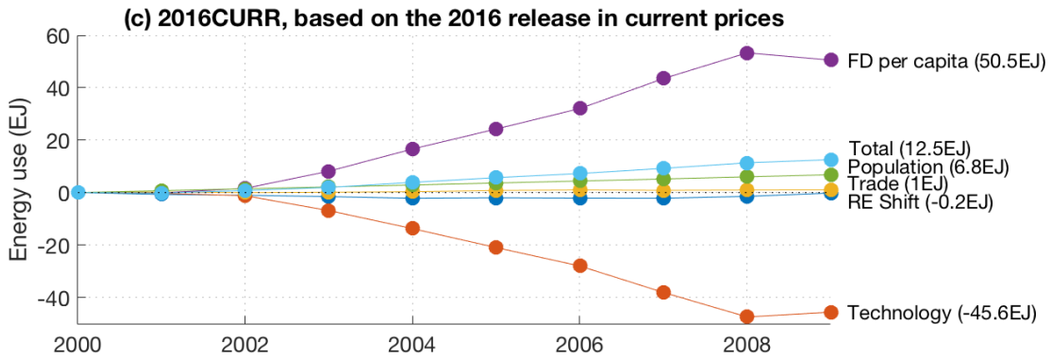


- Only marginal differences
- Data seem very comparable for effects at *global* level

Robustness check



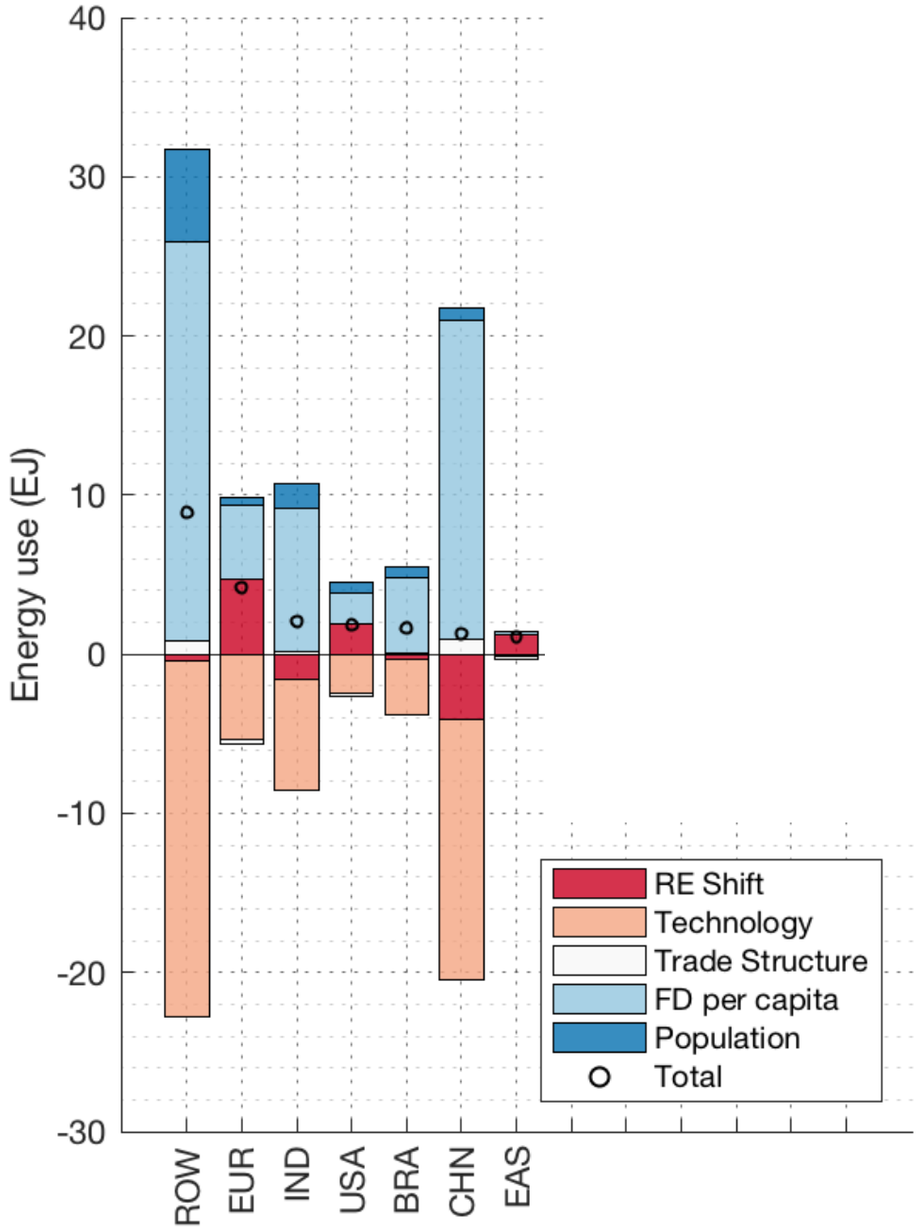




- Observe different scales
- Large differences in size
  for cons/cap and technology
- Overestimations (as expected)
- Net effects (cons/cap + technol)
  +4.9 for 2013PYP
  +4.6 for 2013CURR
- Growth 2009: continues 2013PYP
  reversed for 2013CURR

- Only marginal differences
- Data seem very comparable
  for effects at *global* level

Global drivers of RE use at the country level



RoW: terr RE use +8.9 EJ (dot)
global cons/cap +25.0, technol -22.4
overestimates

Red bars: transition
although global, largest effects local
positive: EUR, US, EAS
negative: CHN, IND, RoW

Population growth: RoW, IND

Trade structure:
positive effects CHN, RoW
producers and consumers move away
EUR and US towards CHN and RoW

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Conclusions

- Methodology to measure the effect of energy transition
- RE use:
  - grows at 1.8% per year in 2000-2014
- Growth slows down for households after 2007
  but accelerates for RE use in production
- Energy transition:
  - slightly negative for 2000-07
  - clearly positive 2007-14

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Conclusions

- Energy transition:
  - small but positive effect on global RE use
  - positive effect on RE use in EUR, US and EAS
  - negative effect on RE use in China and India
- Changes in trade structure:
  - small, positive effect on global RE use
  - positive effect in China and RoW (supply more inputs)
  - negative effect in USA and EU27 (supply less inputs)
- Major drivers are usual suspects:
  - affluence (consumption per capita)
  - population
  - technology (incl efficiency in energy use)

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Thank you for your attention!!!

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