Databased Modelling Price Variance in Hybrid LCA

Challenges and possibilities.

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Swiss National Science Foundation

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Sustainable Economy
National Research Programme

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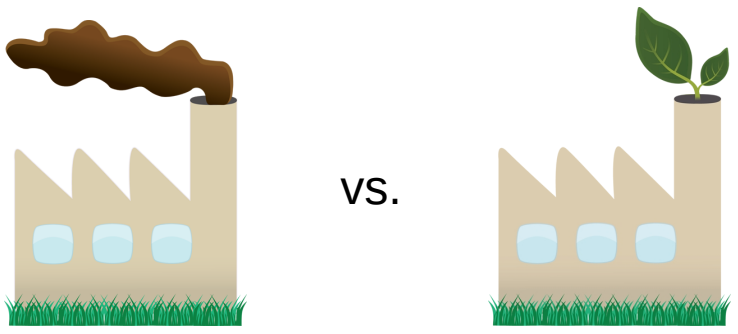
Process LCA



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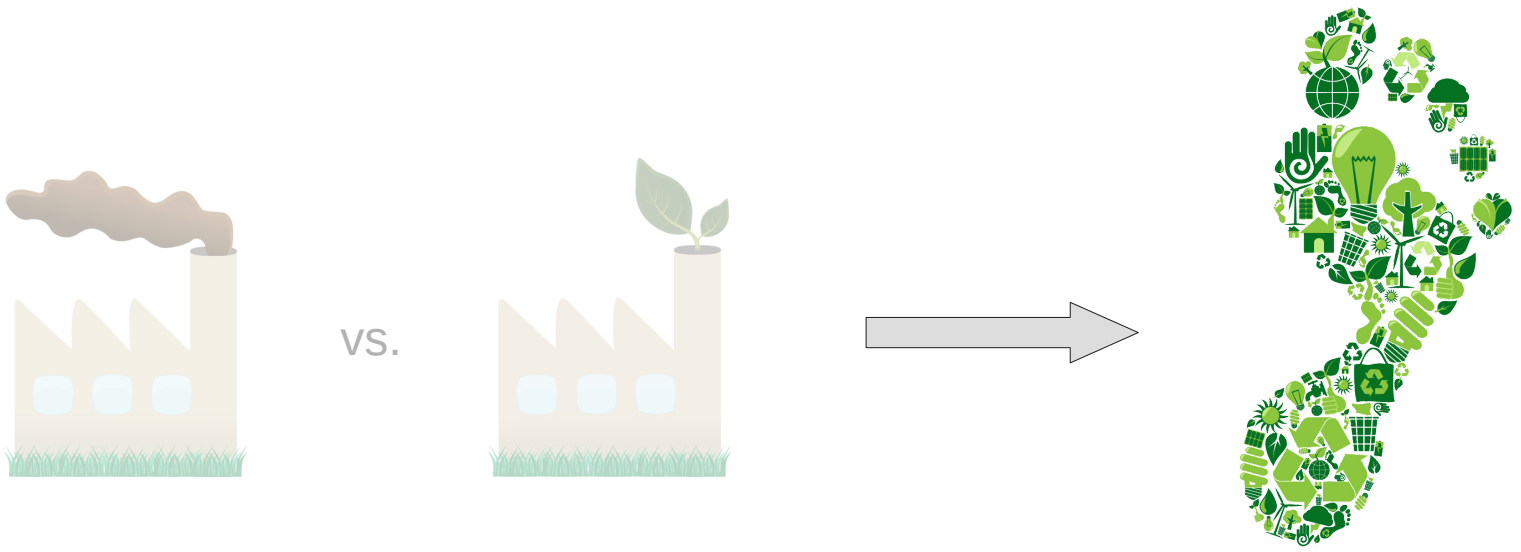

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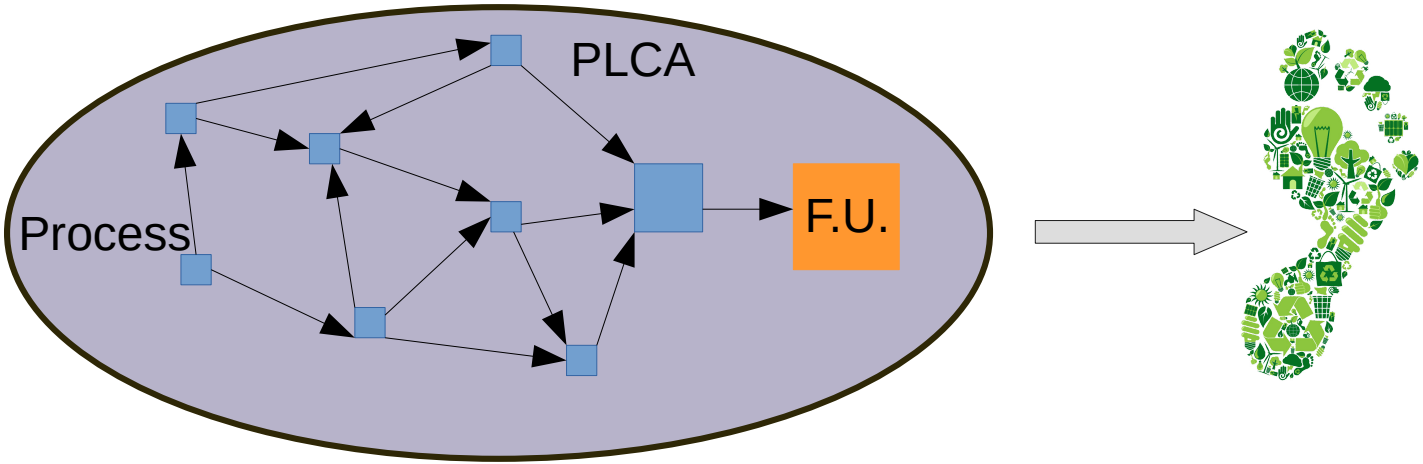
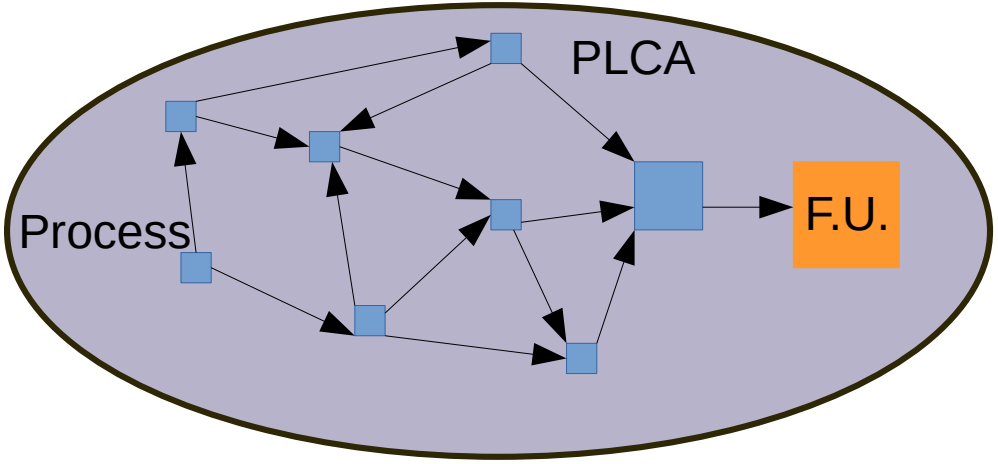


Precision vs Accuracy

~10% GHG



System Boundary

Agez et al. 2021 DOI: 10.1111/jiec.13132 (earth.org)

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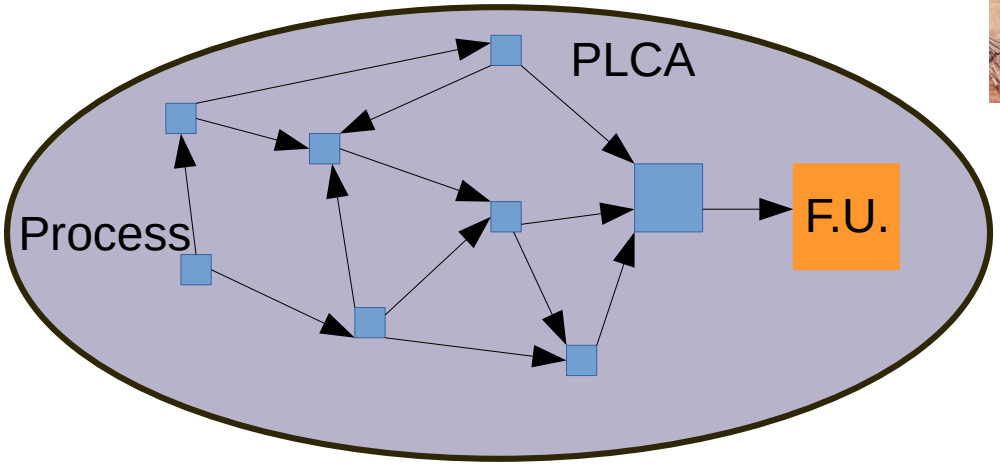


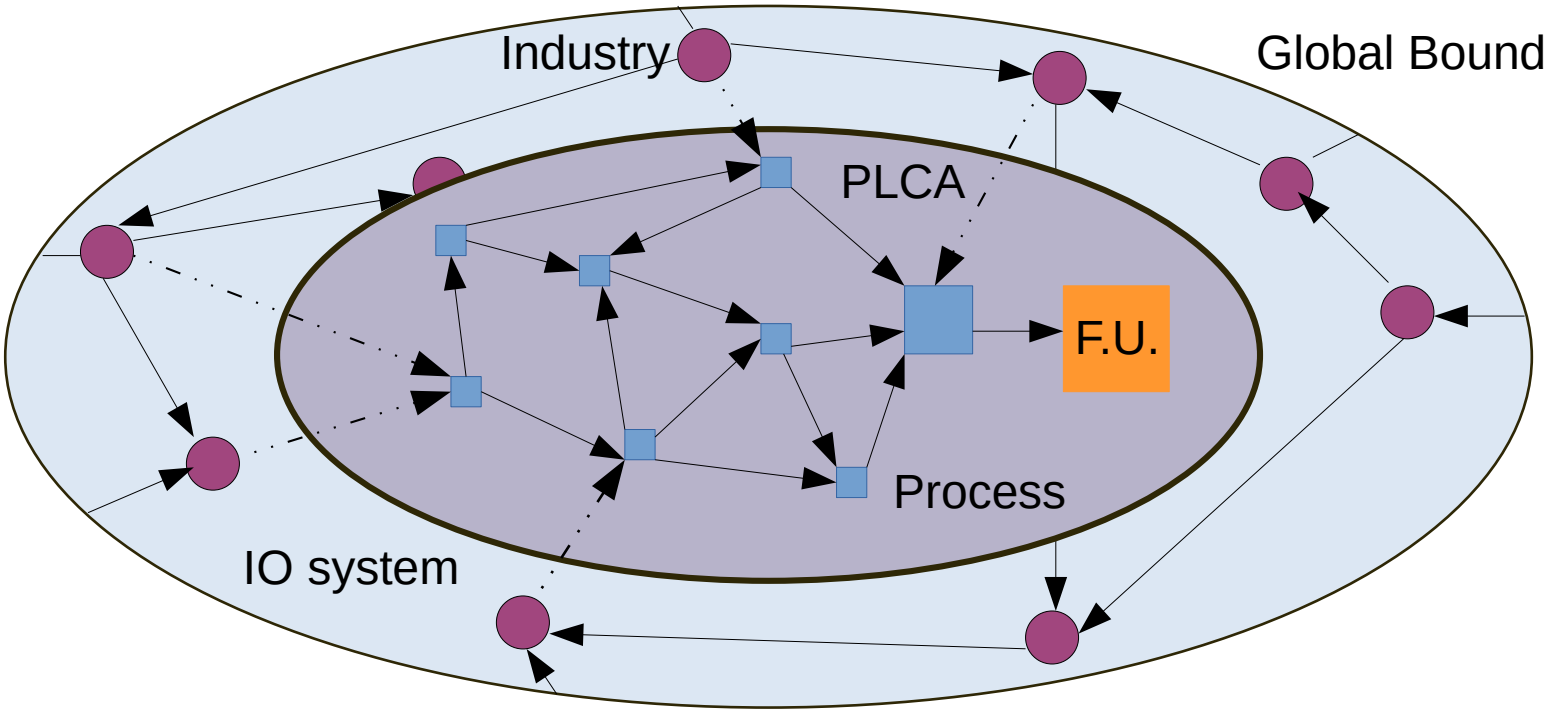
System Boundary

~200% Land Use

Agez et al. 2021 DOI: 10.1111/jiec.13132

(earth.org)

Hybrid LCA



Prices in Hybrid LCA

- Physical vs. Monetary Units (kg ↔ euro)

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  - Linear relationship with IO inputs

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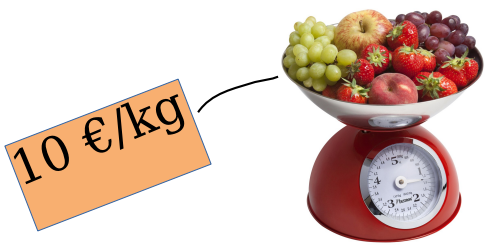
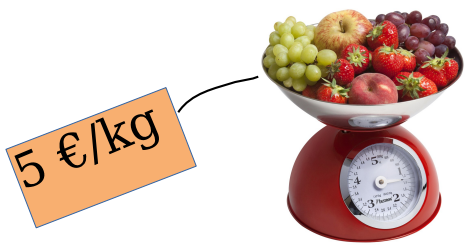




Prices in Hybrid LCA

- Physical vs. Monetary Units (kg ↔ euro)
- Variance: Different buyer seller relations
- Variance: Market dynamics

(cityam.com)

Effect of price variance in HLCA

- Linear relation IO Inputs
- One study:
  - Fixed price data + theor. normal distributions
  - Relatively small effect +/- ~5%
- Can we get a better, databased estimate?

Price data in LCA data

- Ecoinvent: prices for most commodities
  - Fixed (no uncertainty)
  - Mixed sources (only basic consistency)
  - No temporal information

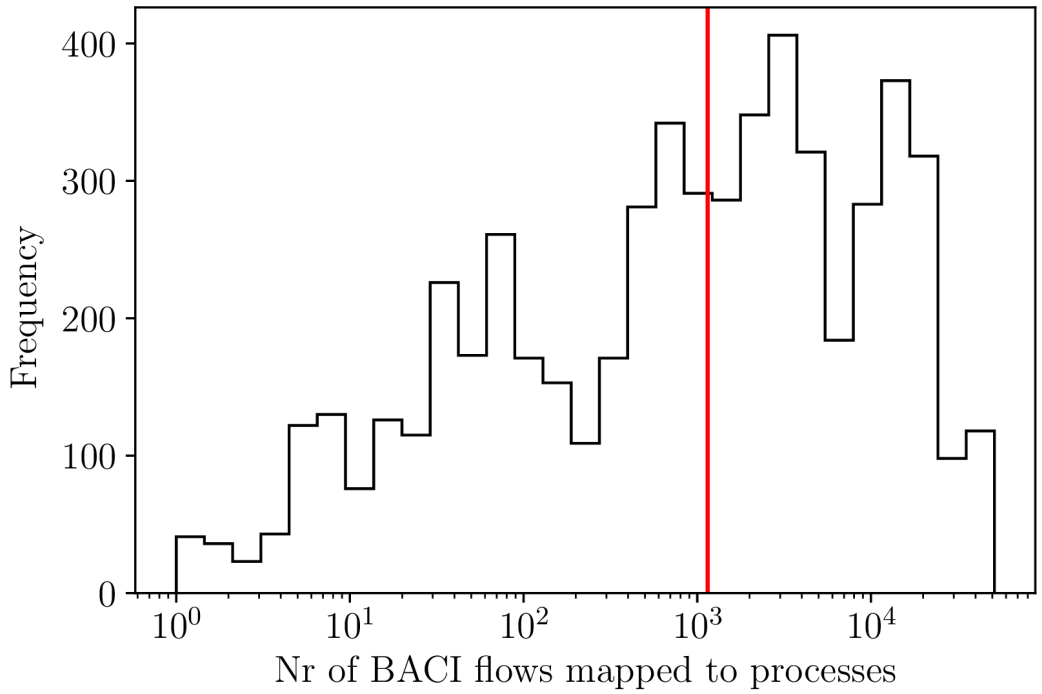
BACI Trade database

- UN COMTRADE
- Trade Data between 221 countries
- 5199 commodity groups
- Monetary and physical flows → Prices
- Annual statistic

Baci flows to price distribution

- Volume weighted distribution of export prices
  - Example:
    - **Process**: steel production in DE
    - **Price distribution**: steel export DE to world

Baci flows to price distribution



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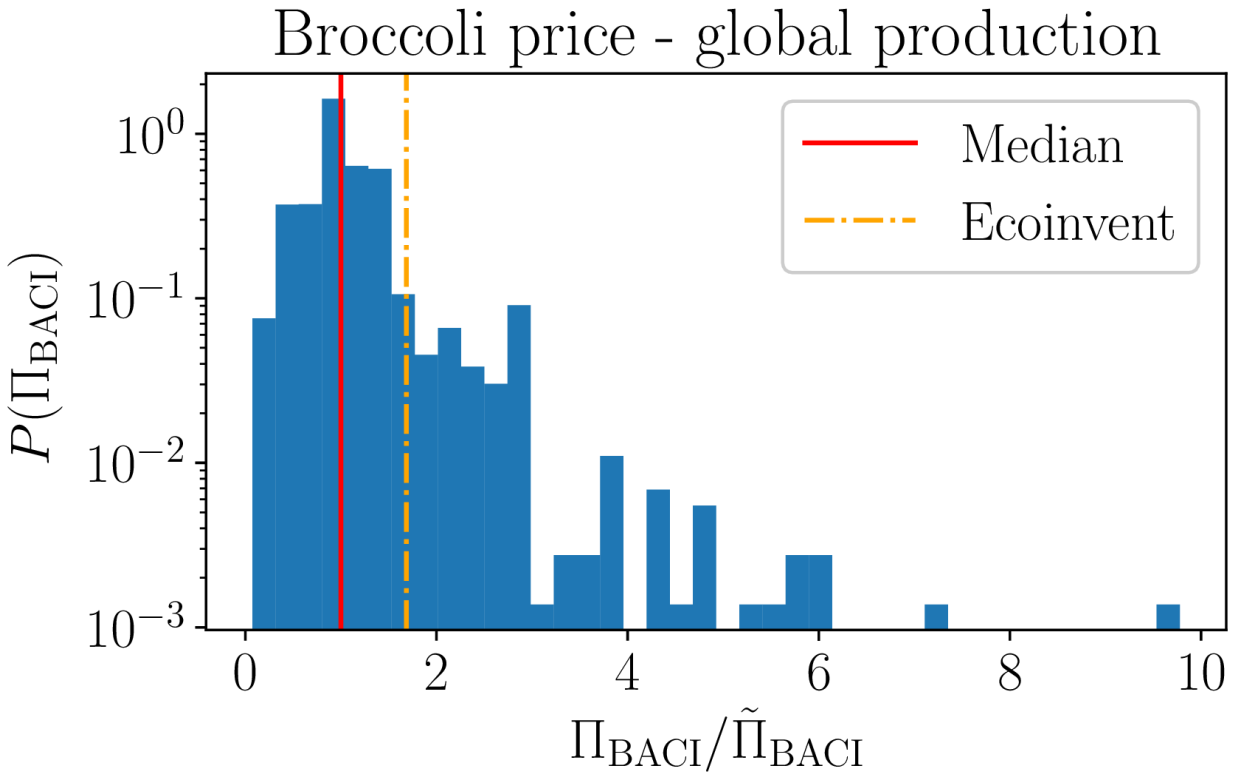

Modelling choices and assumptions

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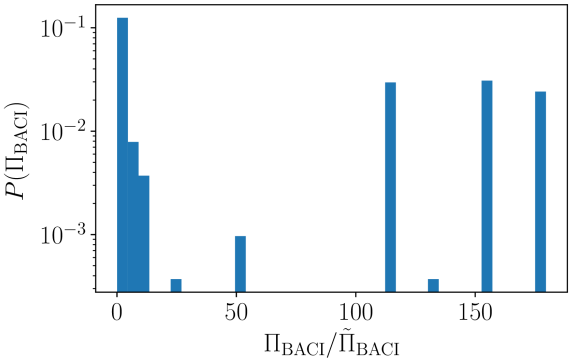
- Only map commodities same units

Prices unavailable in BACI

- Services, Electricity, Transport, ...
- Lognormal on ecoinvent price
- Variance based on proxy data
  - E.g.: oil price variance for transport

Modelling choices and assumptions

- Only map commodities with mass unit
- Direct sampling of trade prices
  - No distribution was fitted



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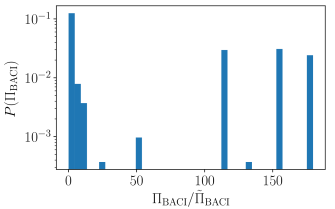

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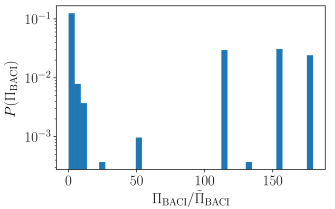


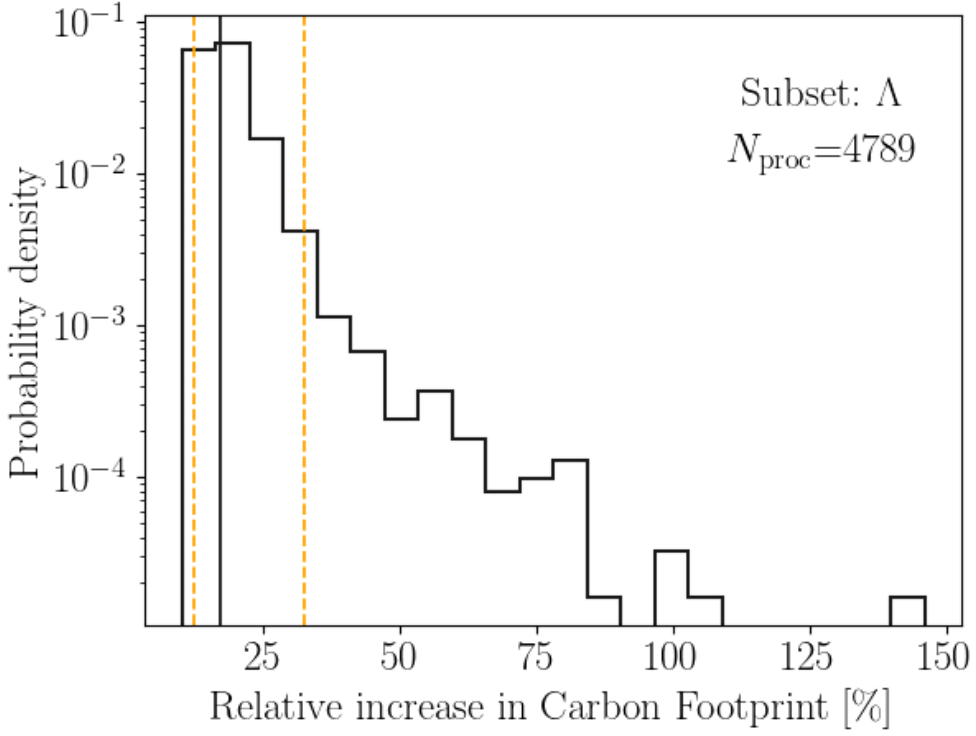
- Export price distribution captures domestic markets
- No correlation information available: independent sampling

Case study

- CH Household consumption footprint
- Based on consumer expenditure survey
- Modelled to ecoinvent/Exiobase (Froemelt et al. 2018)
- Hybrid analysis
  - MC sampling over prices

Froemelt et al. 2018 DOI: 10.1021/acs.est.8b01452

Result: CH Household Consumption



Relative uncertainty of Hybrid impact:

(-28%, +90%)!!!

95% interval (dashed lines)

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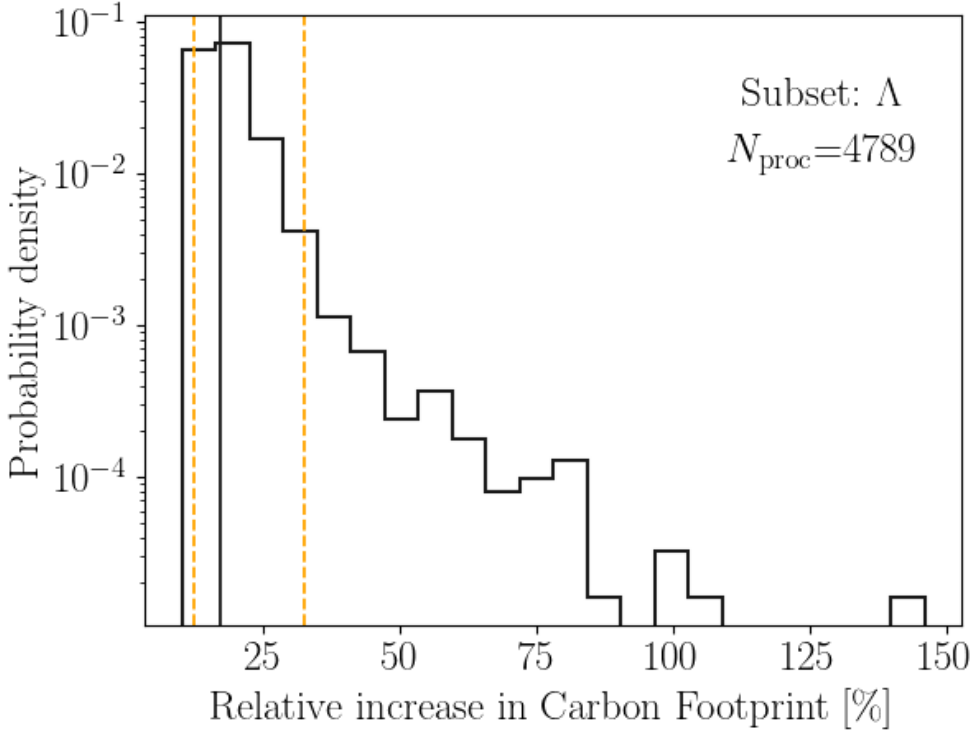

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Data provides different picture than pure theoretical model.

Need for data based uncertainty

Limitations and questions

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- Correlations!
  - How to deal with known unknowns?

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- How to communicate uncertainty in IE?

Thank you!

- Correlations!
  - How to deal with known unknowns?
- How to communicate uncertainty in IE?

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DOI: 10.3389/frsus.2021.666209

https://github.com/jakobsarthur/Price_Uncertainty_HLCA

Prices in Hybrid LCA

- Physical vs. Monetary Units (kg ↔ euro)

	Pump (unit)	Stainless steel (kg)	Plastics (kg)	Machinery (€)	Steel (€)	Fabricated metal (€)	Plastic (€)	Diesel (€)	Lubricant (€)	Other (€)
Pump (unit)	0	0	0	0	0	0	0	0	0	0
Stainless steel (kg)	1	0	0	0	0	0	0	0	0	0
Plastics (kg)	0	0	0	0	0	0	0	0	0	0
Machinery (€)	0.84	0	0	0.07	0.02	0.01	0.01	0.003	0.003	0.01
Steel (€)	0.36	0	0	0.03	0.2	0.1	0	0	0	0.006
Fabricated metal (€)	0.84	0	0	0.07	0.02	0.085	0.01	0.004	0.004	0.01
Plastic (€)	0.012		0	0.001	0	0.001	0.001	0	0	0.01
Diesel (€)	0.012			0.001	0	0	0	0	0	0
Lubricant (€)	0.012		0	0.001	0.002	0	0	0	0	0
Other (€)	4.8036	0	0	0.4003	0.4755	0.5583	0.7922	0.7022	0.7098	0.621
Added value (€)	5.1324	0	0	0.4577	0.2825	0.2457	0.1868	0.2908	0.2832	0.343
CO_2 (kg)	0.1	0	0	-	-	-	-	-	-	-
	0.768	0	0	0.064	1.651	0.073	0.063	1.018	0.984	0.356

$Price_{pump}$ = 12€/unit

Up stream Cut-off Matrix

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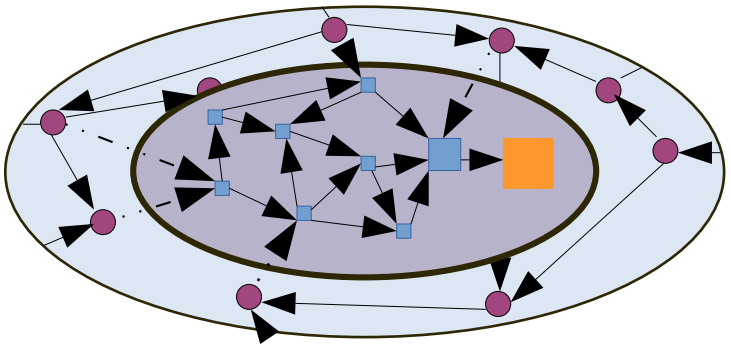
Challenges in Hybrid LCA

- Double Counting correction
- Unit Conversion (prices)
- Aggregation error



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