ENERGY EFFICIENCY POLICIES FOR DIFFERENT FIRM SIZES: CHALLENGING CURRENT POLICIES WITH EMPIRICAL DATA

Patrick Plötz & Tobias Fleiter

Fraunhofer Institute for Systems and
Innovation Research ISI, Karlsruhe

ECEEE Industrial Summer Study – Arnhem, The Netherlands, 2012

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Motivation:
Efficiency Policies and Firm Sizes?

- Firms differ in energy consumption → There is large heterogeneity, but many estimates focus on “average firms/payback rates/consumptions”

  See e.g.: Rohdin et al.: Energy Policy **35**, p. 672 (2007).; Schleich: Ecological Economics **68**, p. 2150 (2009).
  Stoneman: The economics of technological diffusion, Oxford: Blackwell (2002).

- Different policies have been designed to increase energy efficiency in industry, often with focus on
  - ✓ energy intensive industry
  - ✓ Small and medium enterprises

- Goals of the present talk:
  - ✓ Quantify heterogeneity in energy consumption → be careful with averages
  - ✓ Check effect of firm size on decision to adopt energy efficiency measures
  - ✓ Derive suggestions for policy improvement

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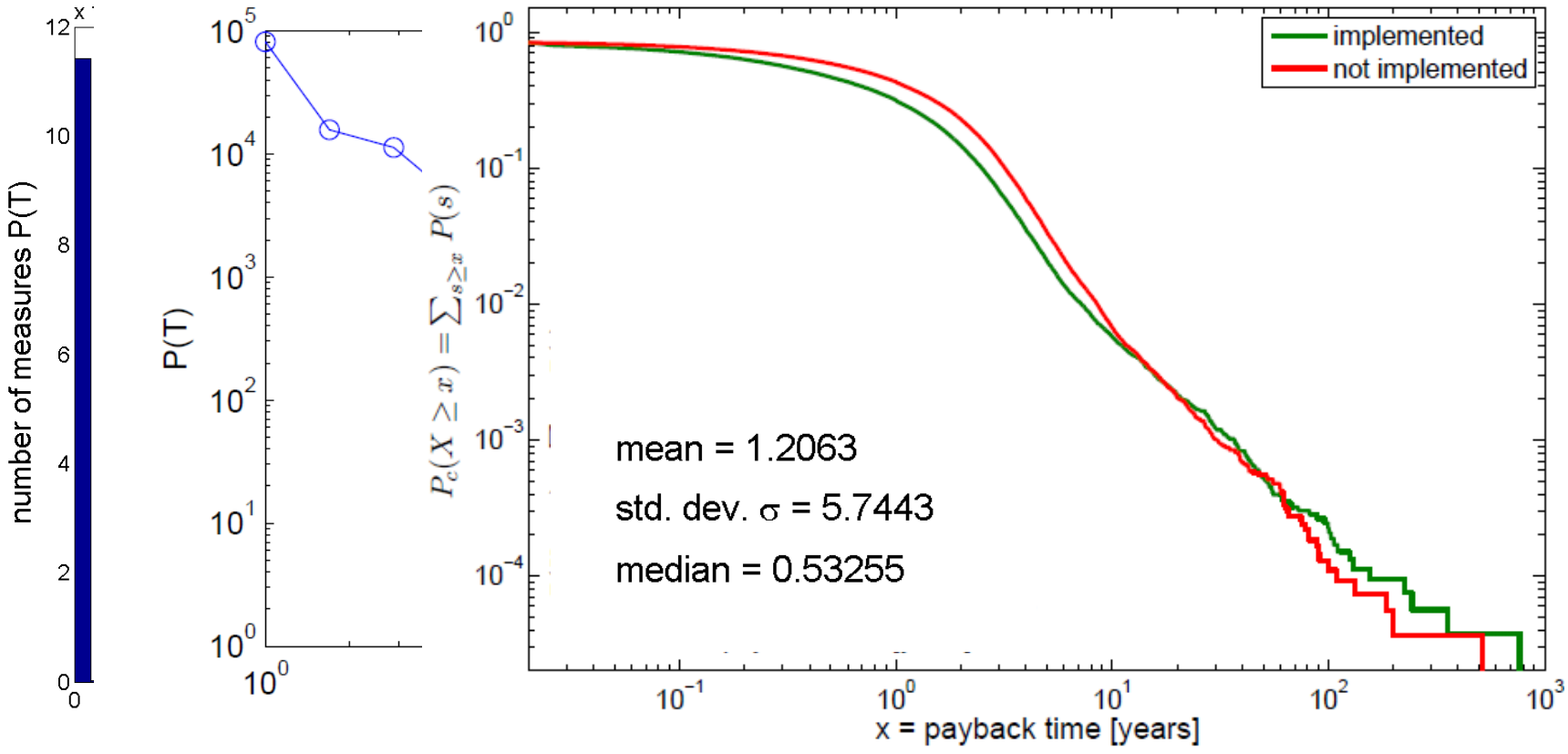
Data: SMEs from the US and Germany

- US Industrial Assessment Center: http://iac.rutgers.edu/ data publicly available
  (has also been analysed by Anderson and Newell (2004))
- German federal program “Sonderfonds Energieeffizienz” for SMEs
- Summary statistics:

Data set and variable	Min	Max	Median	Std. Dev.
German data ***N = 2670 measures***				
Number of employees	1	550	25	59
Annual energy consumption [MWh]	1.66	115,460	460.4	96,414
Annual energy costs [10^3 Euro]	1.606	7,274.7	44.30	904.52
US IAC data ***N = 114,548 measures***				
Number of employees	0	5800	130	193.5
Annual electricity consumption [MWh]	0	1,200,000	3,400.0	25,772.5
Annual energy costs [10^3 USD]	1.0	190,000	295.5	2,516.3

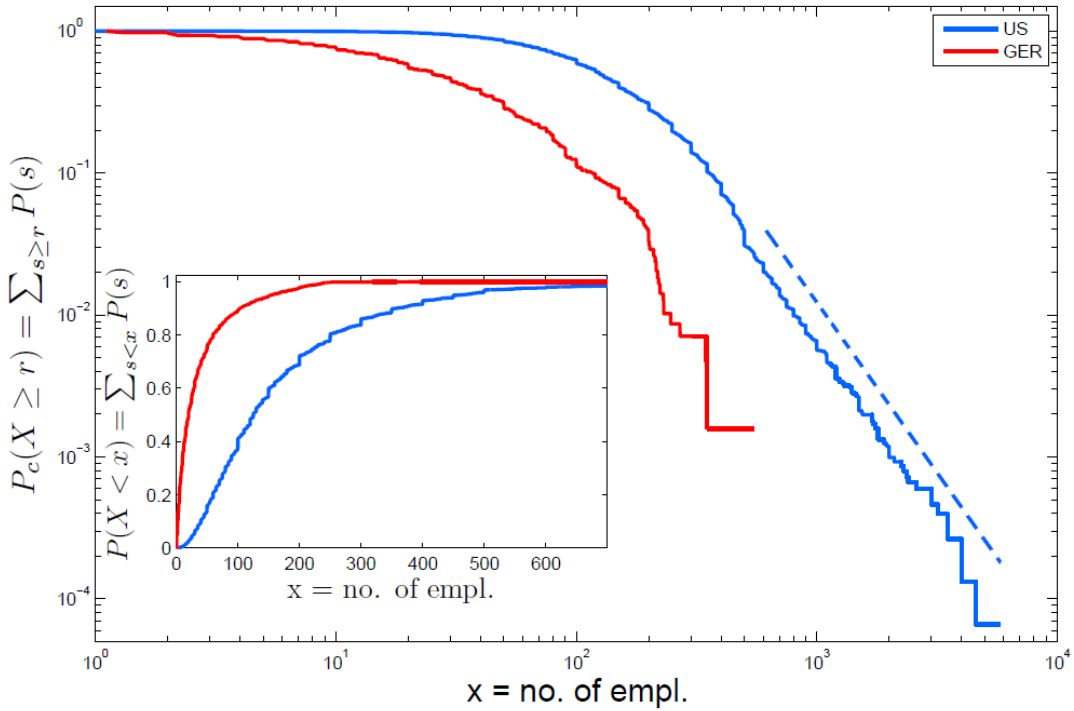
Methodological issues – Distribution of payback times and averages

- Payback time distribution shows heavy tail → this "ruins" averages



Empirical distributions:
firm size & energy consumption

- Firm size distribution of sample (complementary CDF):



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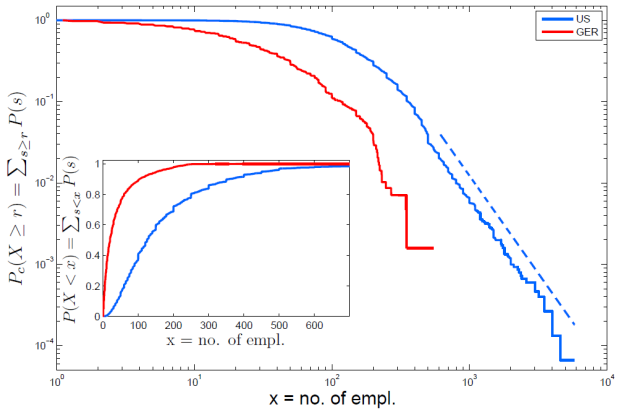
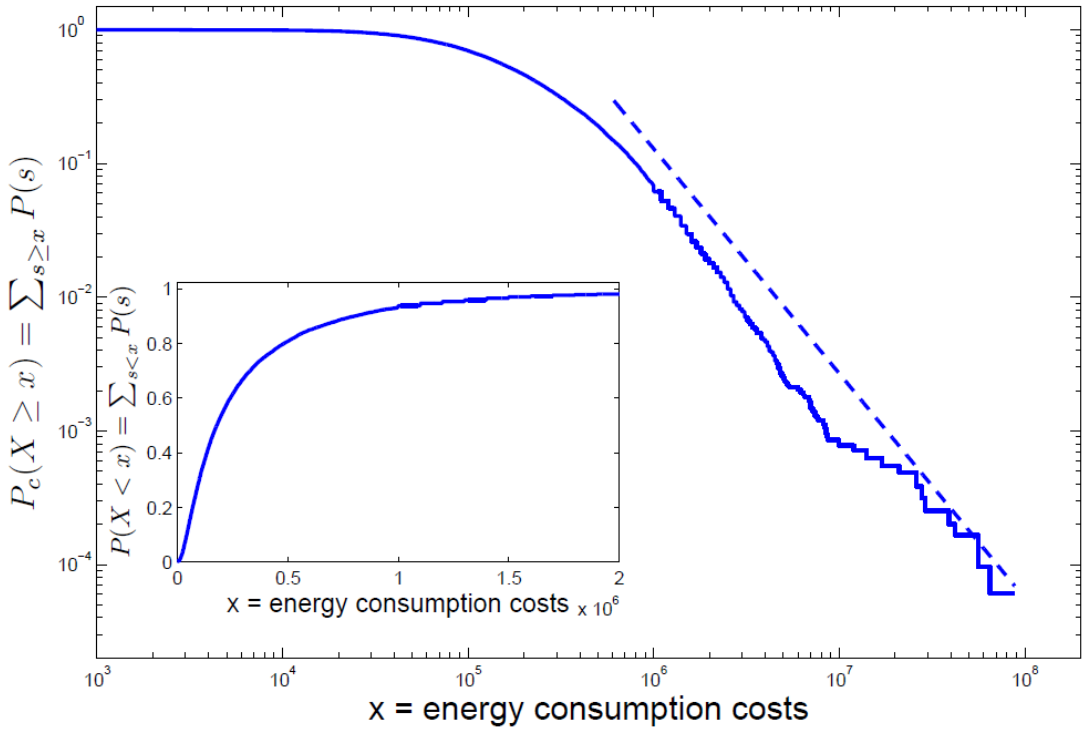


- Energy consumption distribution (complementary CDF):



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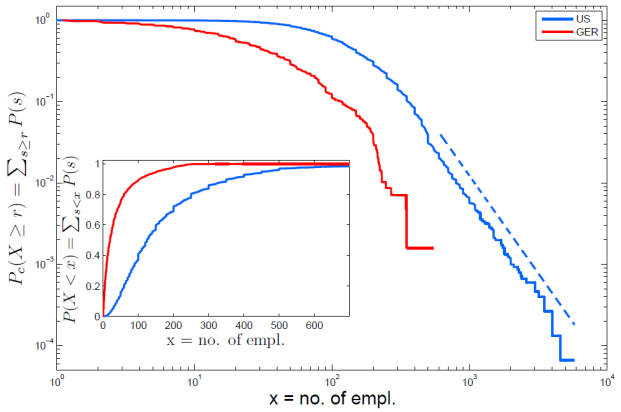

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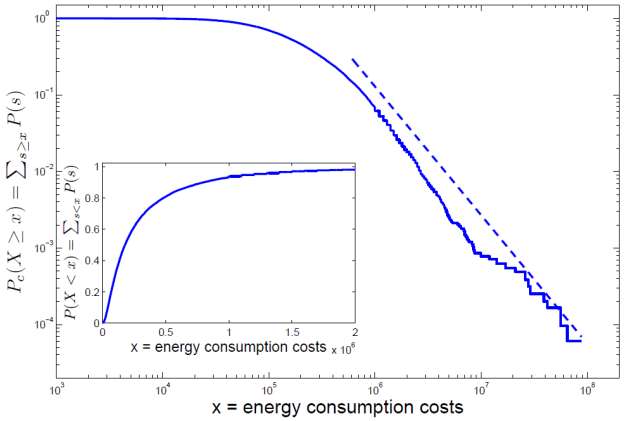

- Firm size distribution heavy tailed (Zipf's law)
- distribution of **energy consumption** per firm also heavy tailed → **no averages!**
- Use firm size as proxy for energy consumption?

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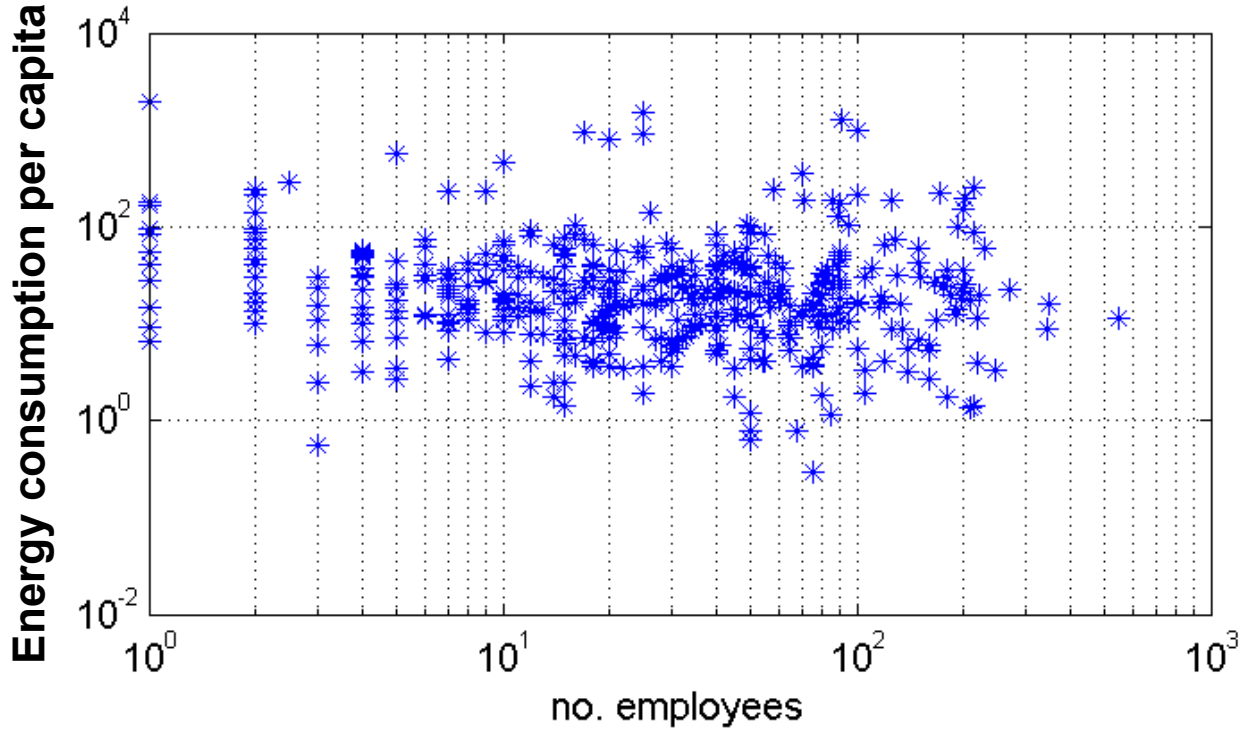
Empirical distributions:
energy consumption per employee

- Energy consumption per employee for different firms:



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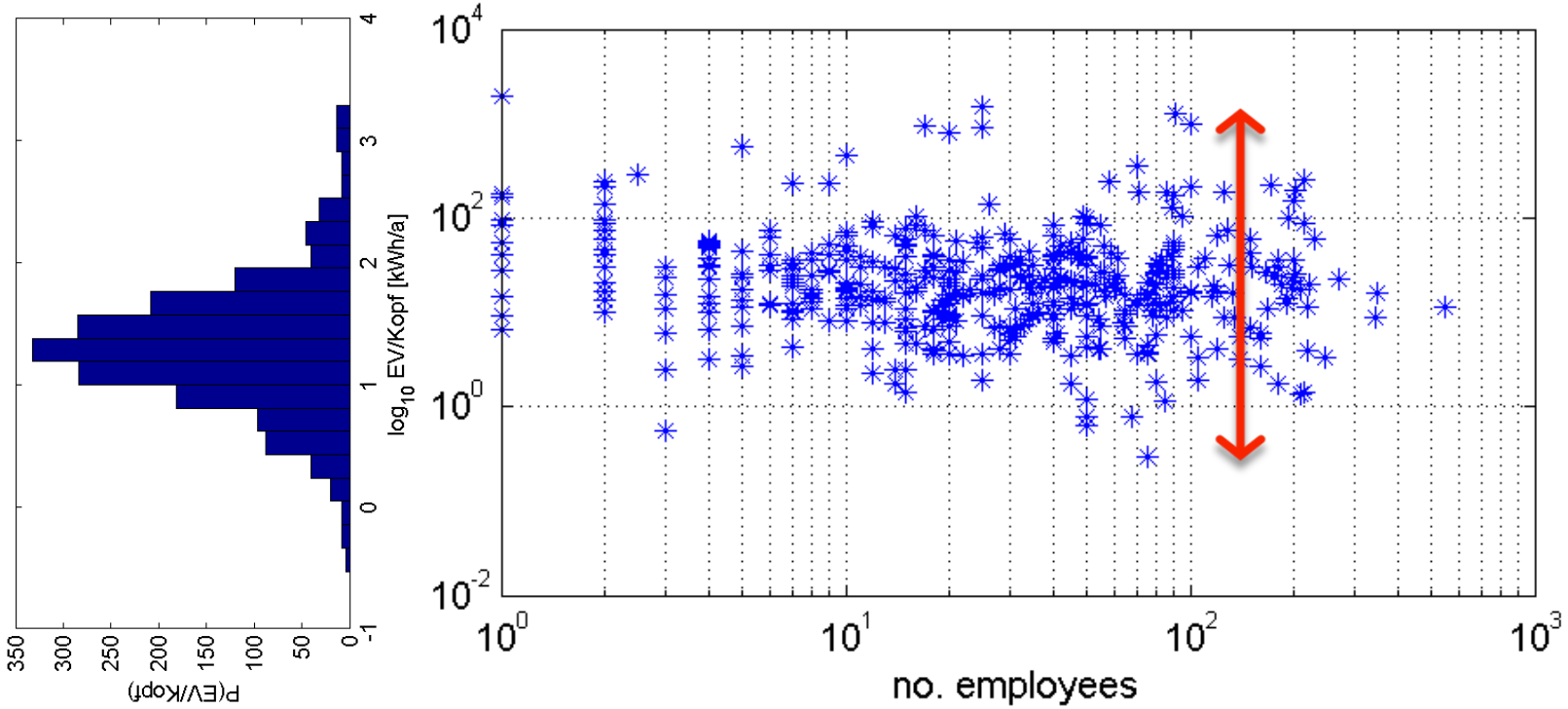

- Energy consumption per employee differs over several orders of magnitude

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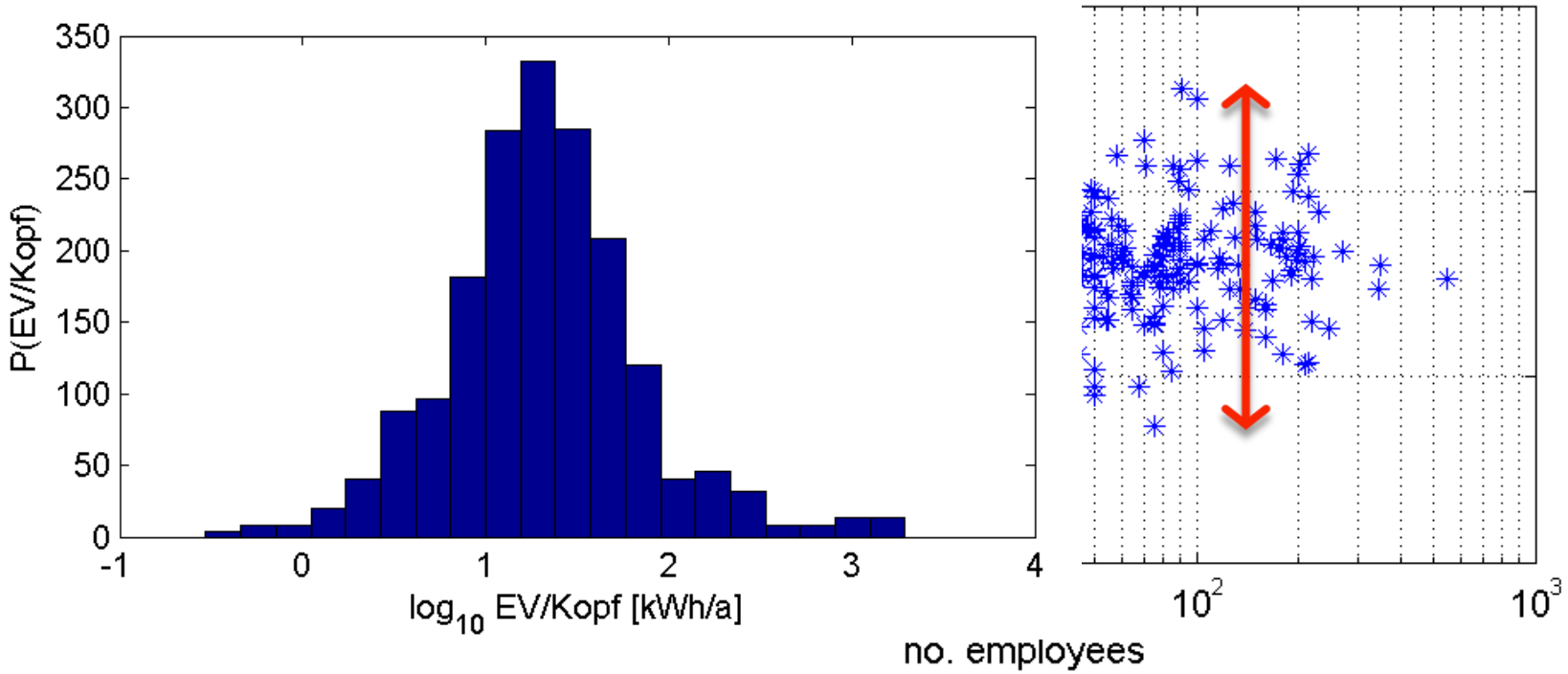

- Energy consumption per employee differs over several orders of magnitude
- Distribution not Gaussian but log-normal → averages not useful

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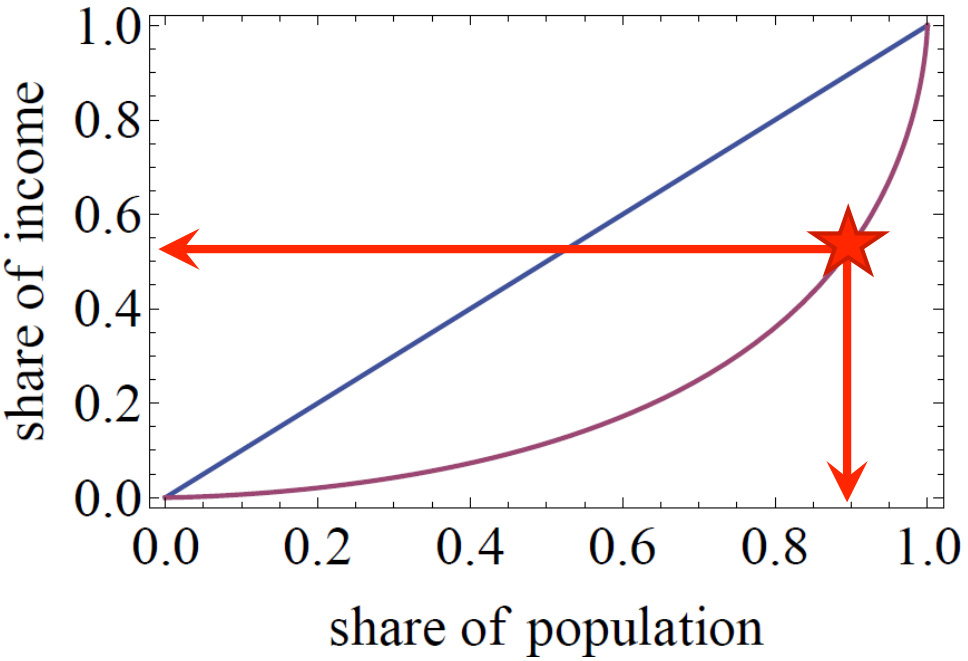
Displaying inequality: Lorenz curves

- Definition of **Lorenz curve** for given (normalised) probability density $P(s)$:

$$x(r) = \int_0^r P(s)\mathrm{d}s, \quad y(r) = \frac{\int_0^r sP(s)\mathrm{d}s}{\int_0^\infty sP(s)\mathrm{d}s}$$



- Example interpretation:

10% of the population have 50% of the total income

- Useful **way to display inequality** for different distribution functions

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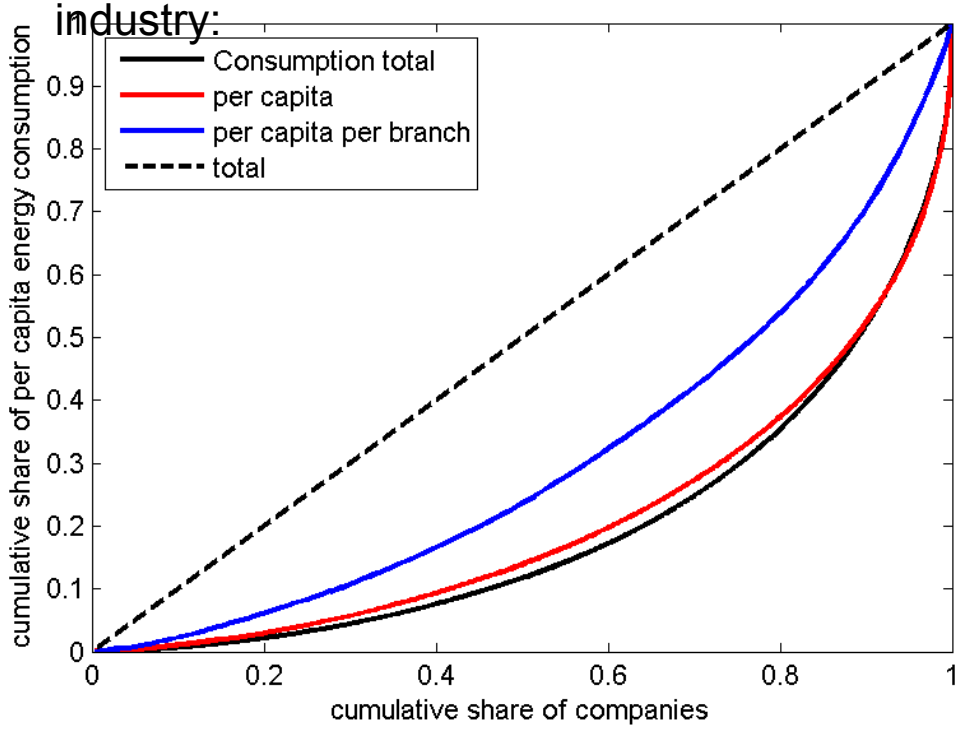
Inequality in industrial energy consumption

- **Lorenz curve** for energy consumption in industry:



- Inequality in industrial energy consumption:
  - Inequality per capita is smaller than total inequality in consumption
  - Inequality prevails even within industrial segments

- **Large heterogeneity in energy consumption in industry remains**
- **Form of heterogeneity may be universal**

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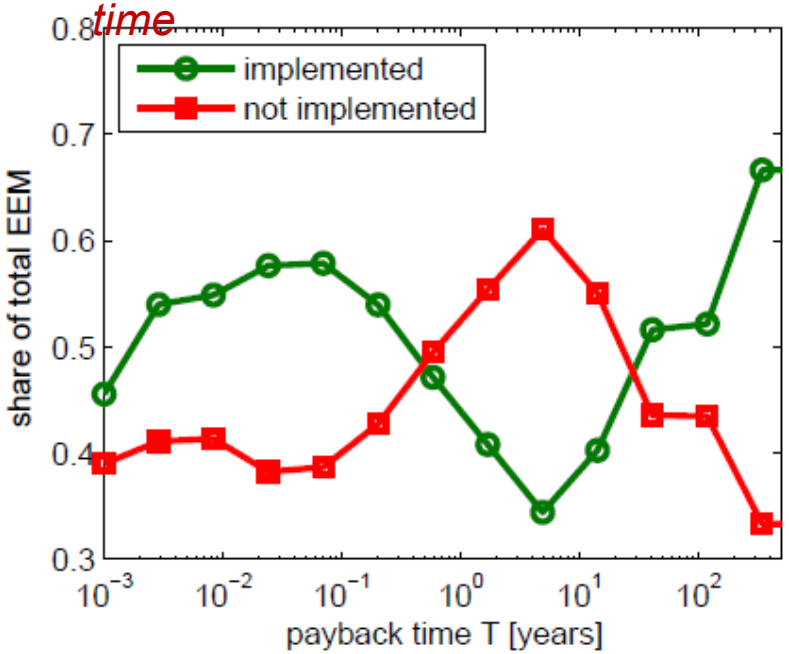
Rationality in Adoption decision?

- Adoption of energy efficiency measures depends on *payback time*



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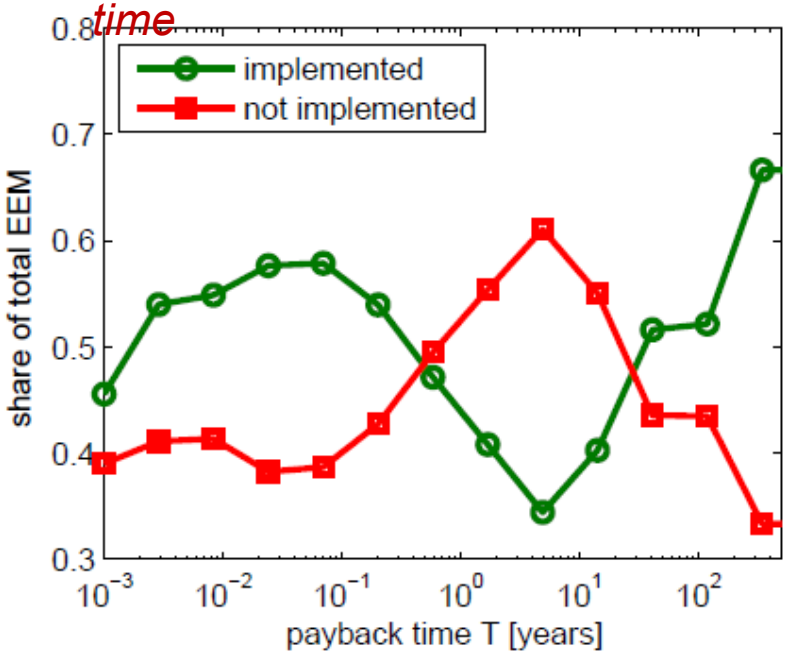
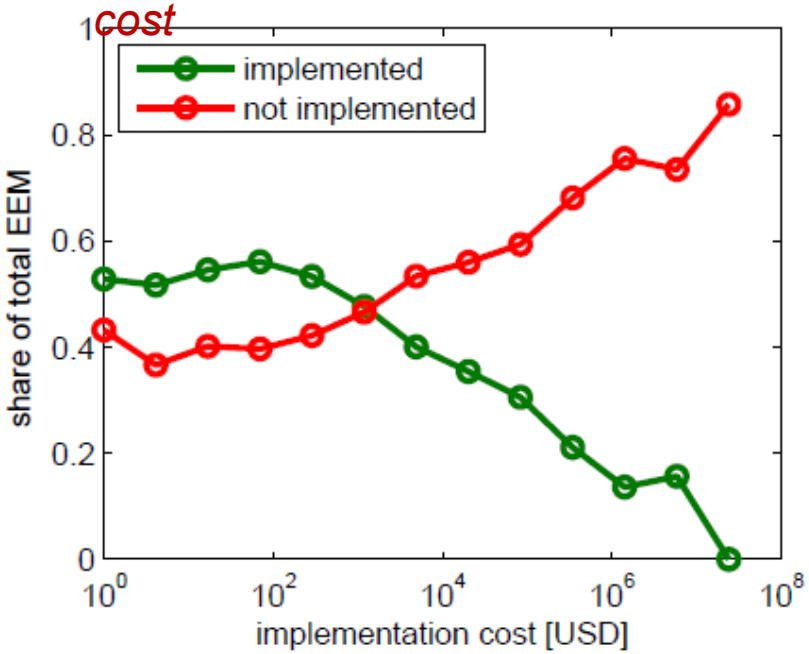


- Adoption of energy efficiency measures depends on *implementation cost*



- Payback time and implementation cost affect adoption decision

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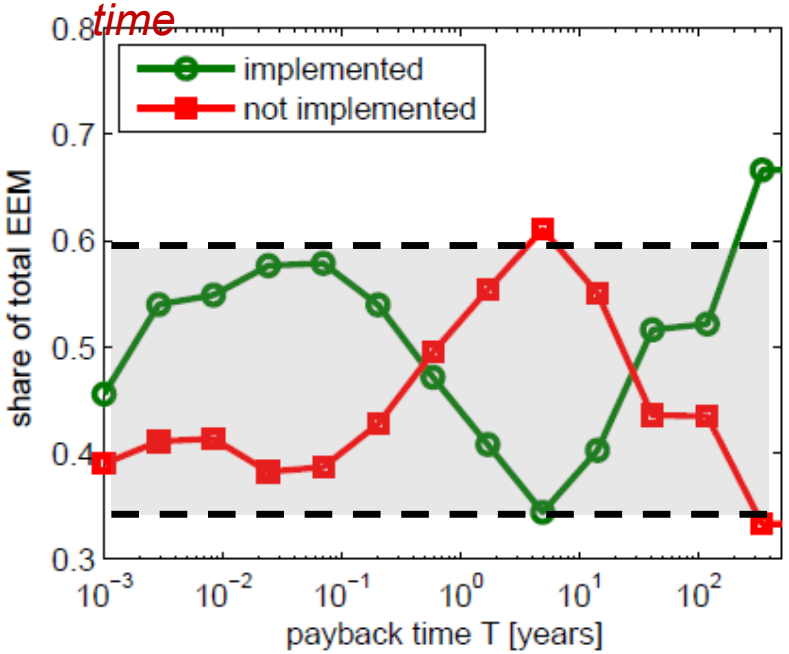

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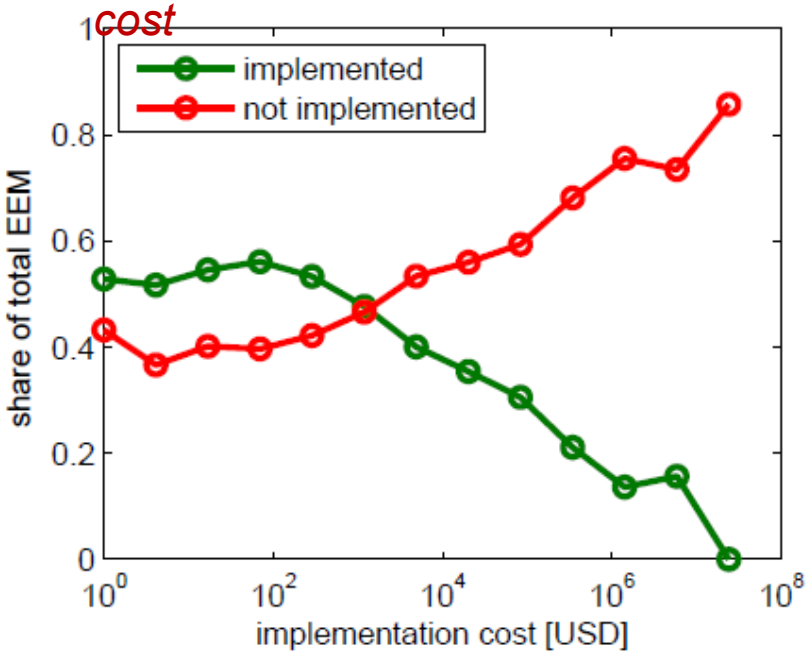

- Payback time and implementation cost affect adoption decision
- **Profitability alone explains small part of adoption decision**

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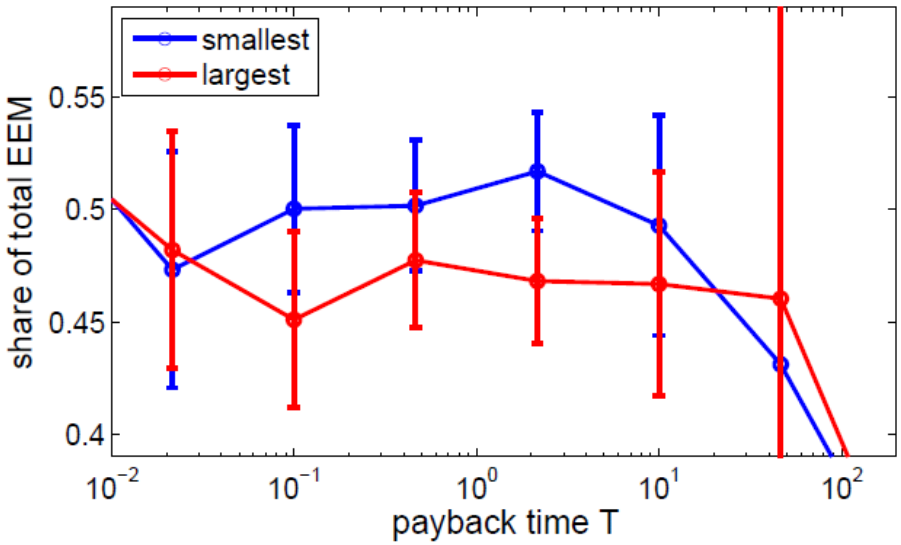
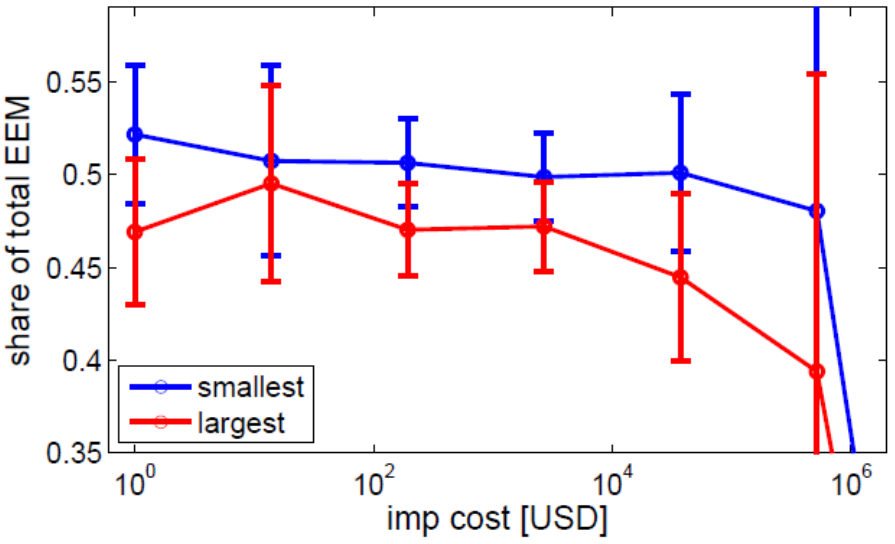
Effect of Firm Size on Adoption decision?

- Measures of energy efficiency implemented by **smallest 10% and largest 10%** of all companies

Adoption rate vs. *payback time*



Adoption rate vs. *implementation cost*



- **Small or no effect of firm size on adoption decision** when considering payback time and implementation cost
- Larger companies might already have energy management

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Conclusions and possible policy implications

1	**Empirical distributions**	▪ Energy consumption and energy efficiency measures have heavy tailed distributions → **averages not useful!** ▪ Avoid "average firm/payback time/saving"
2	**Adoption decision & firm size**	▪ Adoption of energy efficiency measures partly influenced by profitability and strongly by implementation cost ▪ Influence of firm size unclear → empirical evidence for focus on SMEs?
	Possible policy suggestions	**Treat "sickest" patient first, instead of all similarly:** ➢ **Two step process: first audits, then energy efficiency consultation** ➢ **White certificates: best for companies with large potentials**

Thank you for listening!

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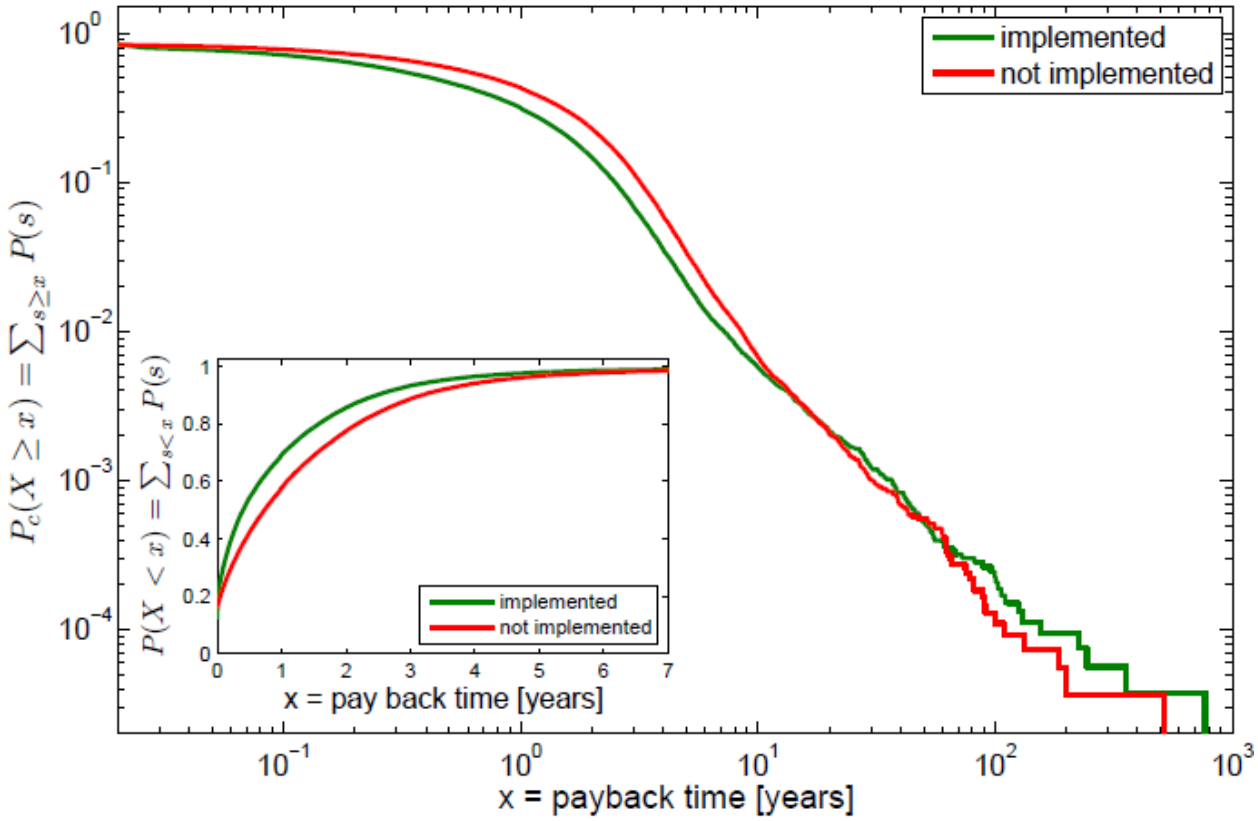
Distribution of payback times

- Payback time distribution shows heavy tail:



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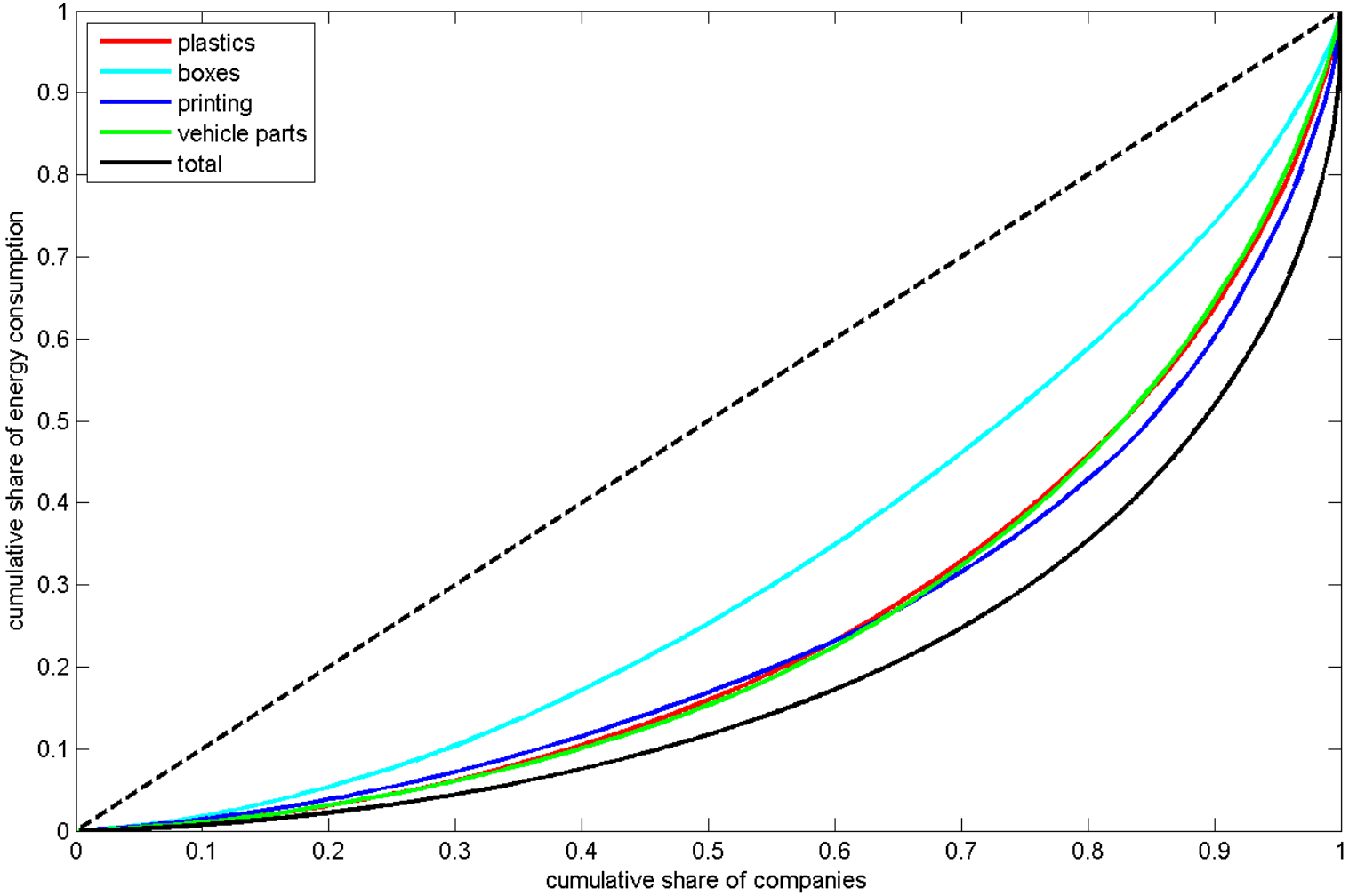
Lorenz diagrams for different industrial branches



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