Rebound Effects

Digitalization and the Rebound Effect - Seminar HS2019

Martin Blapp
Greenhouse gas abatement potential for Switzerland in 2025

Hilty, University of Zurich Research Report, 2017
Historical Perspective

The Rebound Effect

How to estimate

Energy Efficiency

Digitalization
Jevons’ Paradox

Jevons observed in 1865:

If efficiency of coal usage increases, coal consumption will increase, not decrease.

Some assumed improving technology would reduce coal consumption

Alcott, Ecological Economics, 2005
Jevons’ Paradox

Savery steam engine (1702)  
https://wikipedia.org/

Watt steam engine (~1775)  
https://fotolibra.com
Global fossil fuel consumption

Global primary energy consumption by fossil fuel source, measured in terawatt-hours (TWh).

OurWorldInData.org/fossil-fuels/ • CC BY-SA
Historical Perspective

The Rebound Effect

How to estimate

Energy Efficiency

Digitalization
Rebound Effect

"... the rebound effect describes increases in resource or energy efficiency that do not result in corresponding decrease in energy or resource use"

Binswanger, Ecological Economics, 2001
Rebound Effect

- Zero rebound ($RE = 0$)
- Partial rebound ($0 < RE < 1$)
- Full rebound ($RE = 1$)
- Backfire ($RE > 1$)
More efficient car engine

- Drive more
- More gasoline cars produced
- New inventions using oil
- Spend money on other things
- New engines need a lot of energy to build
- Buy bigger cars
- “Cruising around” becomes popular
Rebound Effects

Direct Rebound Effect

Indirect Rebound Effects

- Embodied energy cost
- Income effects
- Output effects
- Market effects

Economy Wide Effect
Rebound Effects

Direct Rebound Effect

Indirect Rebound Effects
- Embodied energy cost
- Income effects
- Output effects
- Market effects

Economy Wide Effect

Increasing demand due to lower price
Rebound Effects

Direct Rebound Effect

Indirect Rebound Effects

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Economy Wide Effect

Cost to manufacture efficiency improvement
Rebound Effects

Direct Rebound Effect

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Economy Wide Effect

Cost savings used to purchase other goods
Rebound Effects

Direct Rebound Effect

Indirect Rebound Effects

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Economy Wide Effect

Cheaper manufacture used by producers to increase output
Rebound Effects

Direct Rebound Effect

Indirect Rebound Effects

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- Income effects
- Output effects
- Market effects

Cheaper energy encourages energy consumption and investments

Economy Wide Effect
Rebound Effects

Direct Rebound Effect

Indirect Rebound Effects

- Embodied energy cost
- Income effects
- Output effects
- Market effects

Economy Wide Effect

Sum of direct and indirect effects
More efficient car engine

- Drive more
- More gas-cars produced
- New inventions using oil
- Spend money on other things
- New engines need a lot of energy to build
- Buy bigger cars
- “Cruising around”

Direct rebound
- Output effects
- Market effects
- Income effect

Indirect Rebound Effects
- Embodied energy cost
- Income effects
- Output effects
- Market effects
Historical Perspective
The Rebound Effect
How to estimate
Energy Efficiency
Digitalization
Scope

Time frame:

E.g. 5 year study or 30 year study

System boundary:

E.g. household, sector or national economy
Direct Rebound Effect

- Empirical estimates through data sets
- Economic Models

For example:
Single-Sector Studies
- One service
- One input resource considered
- Assumes reversibility of investment possible

Sorrell, UK Energy Research Centre Report, 2007
Indirect and Economy Wide Rebound

- Difficult to measure empirically
- Complex economic models

For example:
Multi-Sector Studies
- Can additionally model substitution (i.e. train vs car usage)

- Choice of methodology and scope are important

Sorrell, UK Energy Research Centre Report, 2007
Historical Perspective

The Rebound Effect

How to estimate

Energy Efficiency

Digitalization
Energy Efficiency

Energy efficiency has been an important part of environmental strategy

Binswanger, Ecological Economics, 2001
The graph illustrates the relationship between price and quantity of a product, showing the intersection of supply and demand curves at point $P$, which represents the equilibrium price and quantity ($Q$).
A graphical representation of supply and demand with the price and quantity of a product. The supply curve is labeled as 'Supply' and the demand curve as 'Demand'. The equilibrium price (P) intersects with the equilibrium quantity (Q) on the graph.
Direct Rebound
What if we assume, an efficiency improvement has no rebound?
Price

Quantity of Product

Supply

P

P_new

Q
Results

● “For most consumer energy services in OECD countries, direct rebound effects are unlikely to exceed 30% “

● “There are relatively few quantitative estimates of indirect and economy-wide rebound effects, but several studies suggest that economy-wide effects may exceed 50% “

Sorrell, UK Energy Research Centre Report, 2007
General Purpose Technologies

Three characteristics:

- Pervasiveness
- Improvement
- Innovation spawning

Bresnahan & Trajtenberg, Journal of Econometrics, 1995
# General Purpose Technologies

<table>
<thead>
<tr>
<th>General Purpose Technologies (GPT):</th>
<th>Non GPT:</th>
</tr>
</thead>
<tbody>
<tr>
<td>● Steam engines</td>
<td>● House insulation</td>
</tr>
<tr>
<td>● Electricity</td>
<td>● More efficient car wheels</td>
</tr>
<tr>
<td>● Information technology</td>
<td>● More efficient dishwasher designs</td>
</tr>
</tbody>
</table>

=> Higher Rebound / Backfire                                      => Lower Rebound
Historical Perspective
The Rebound Effect
How to estimate
Energy Efficiency
Digitalization
Rebound in Digitalization

- If a person prints all emails  => *Rematerialisation*
- People want all their music available all the time  => *Changed practices*
- If a person orders almost daily from an online shop  => *Induction*

And more...

Rivera et al, Environmental Modelling & Software, 2014
Time Rebound
Time Rebound

Time-saving innovations  => Lower time cost

But Time Rebound  => Higher usage

Additionally:

- Often more energy needed (or less?)
- Time used for other energy intensive activities

Binswanger, Ecological Economics, 2001
Summary

- Rebound effect is real
  - Difficult to estimate
- General Purpose Technologies have higher rebound
- Digitalization
  - New rebounds types
- Time Rebound important