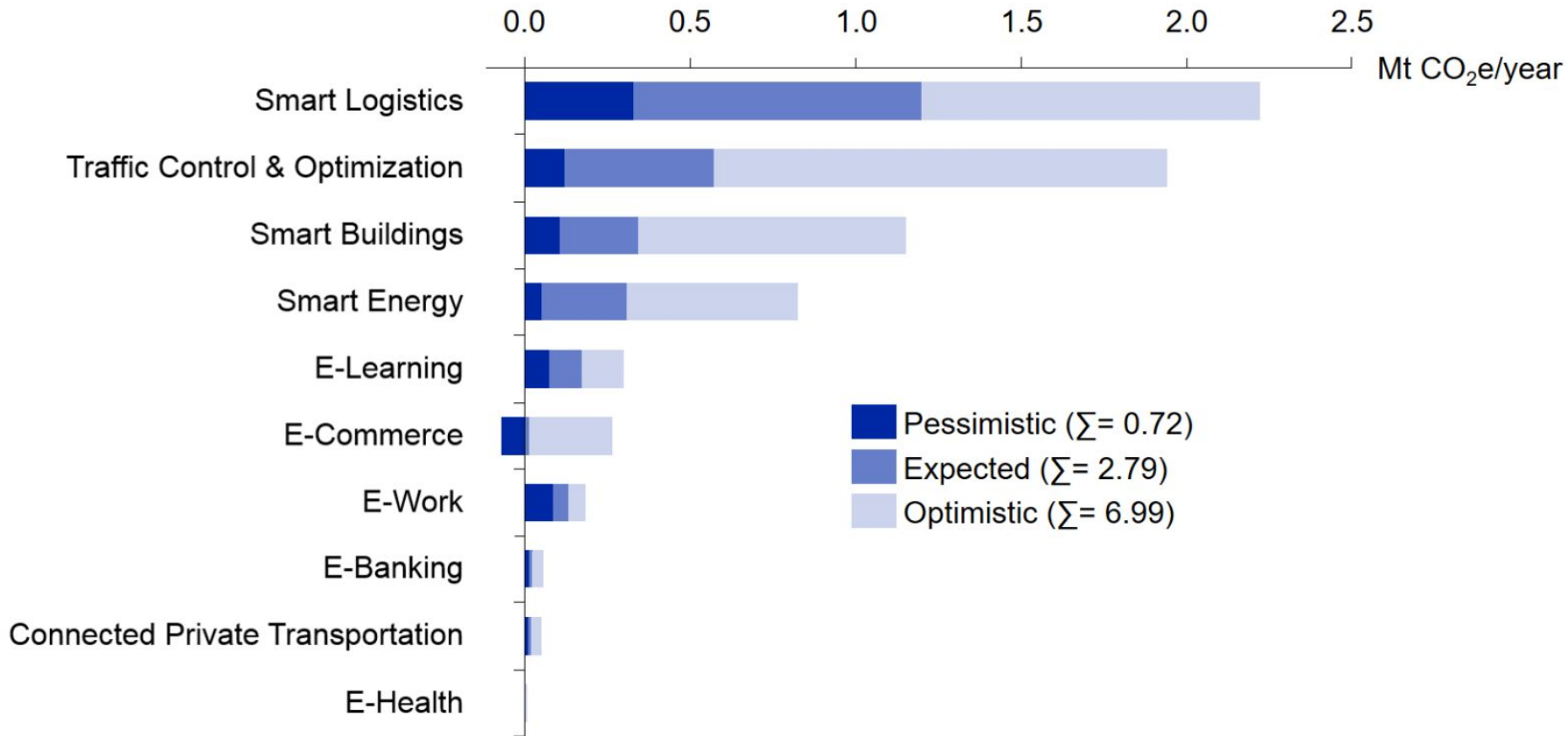




# Rebound Effects

Digitalization and the Rebound Effect - Seminar HS2019

Martin Blapp



## Greenhouse gas abatement potential for Switzerland in 2025



## **Historical Perspective**

The Rebound Effect

How to estimate

Energy Efficiency

Digitalization

# Jevons' Paradox



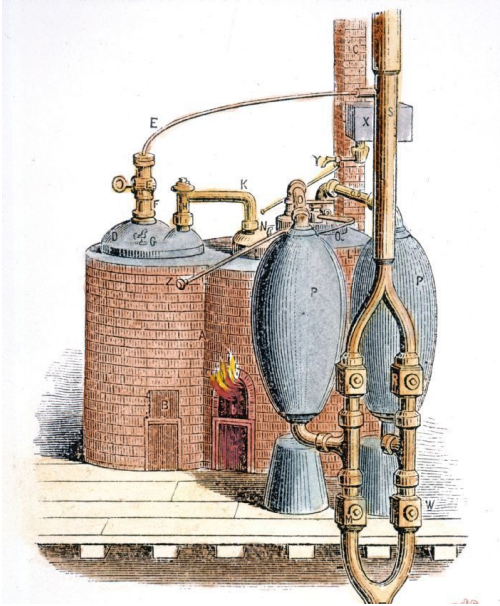
Jevons observed in 1865:

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

Some assumed improving technology would reduce coal consumption

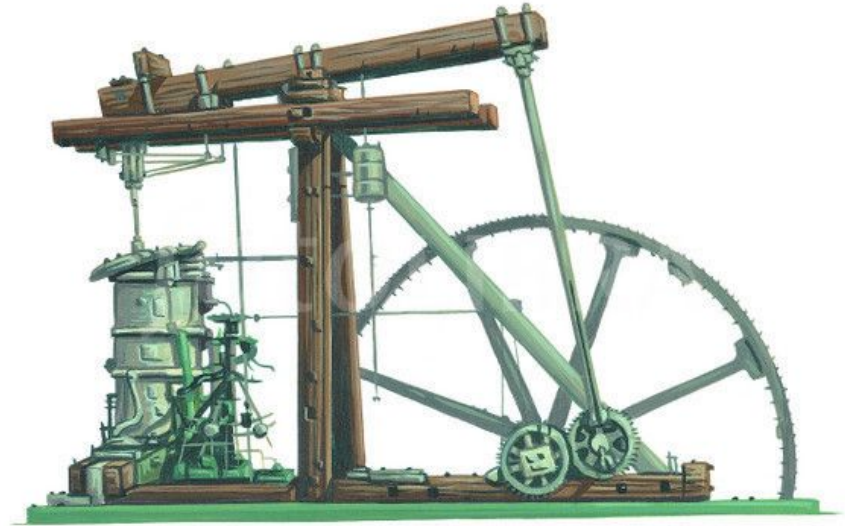
Alcott, Ecological Economics, 2005

# Jevons' Paradox



Savery steam engine ( 1702)

<https://wikipedia.org/>

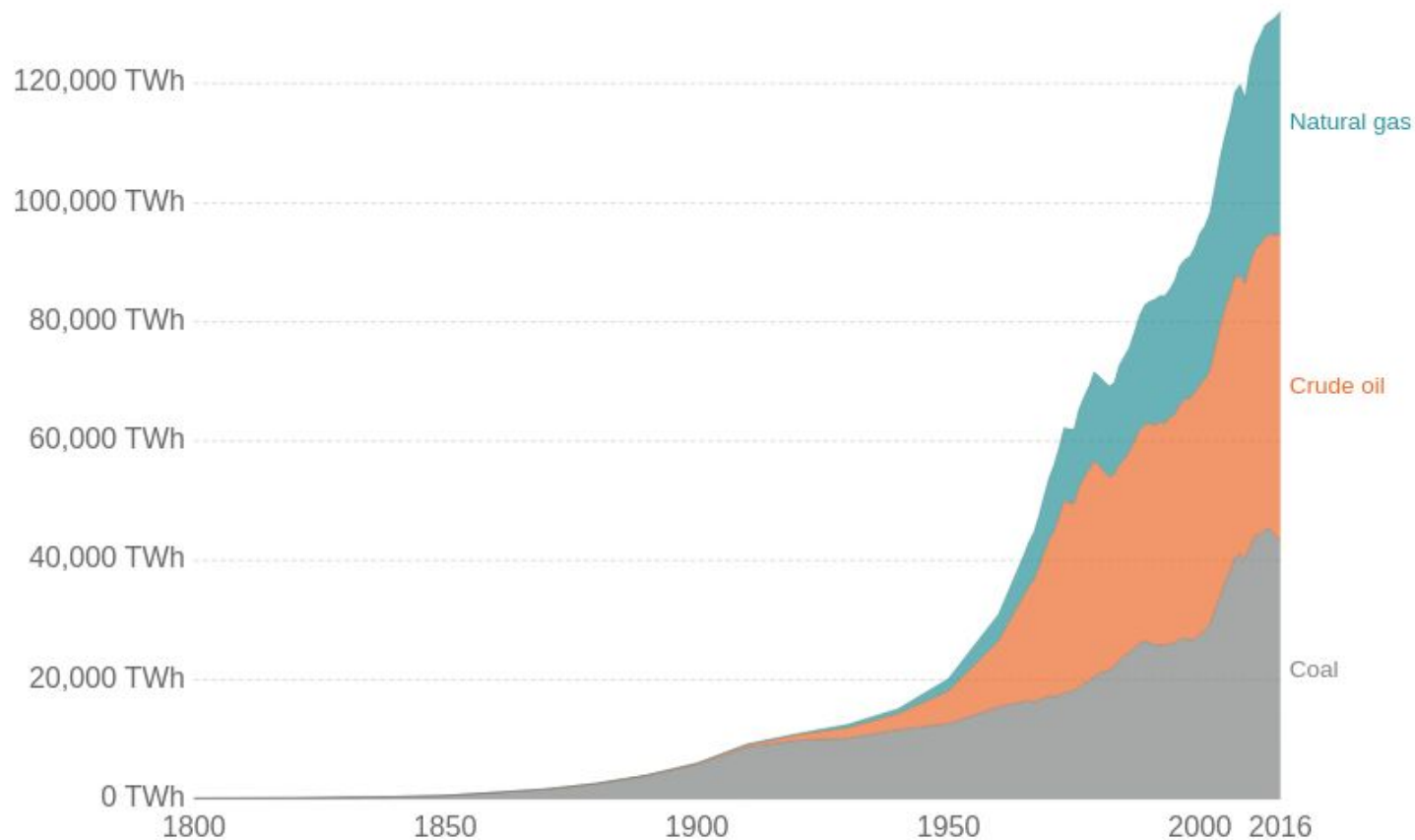


Watt steam engine ( ~1775)

<https://fotolibra.com>

# Global fossil fuel consumption

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



Source: Vaclav Smil (2017). Energy Transitions: Global and National Perspective & BP Statistical Review of World Energy  
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



Increasing demand due to lower price

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



Cost to manufacture efficiency improvement

## Economy Wide Effect


# Rebound Effects



## Direct Rebound Effect

## Indirect Rebound Effects

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



Cost savings used to purchase other goods

## Economy Wide Effect

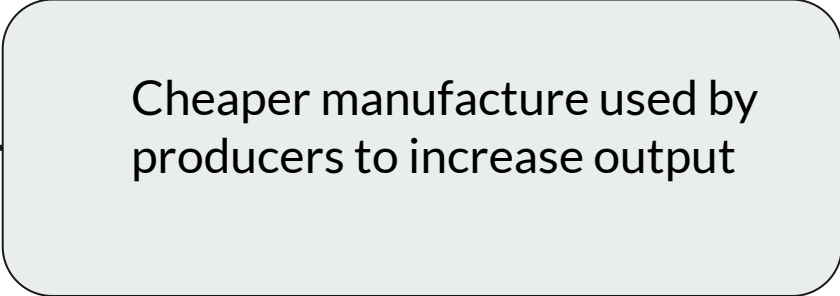
# Rebound Effects



## Direct Rebound Effect

## Indirect Rebound Effects

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



Cheaper manufacture used by producers to increase output

## Economy Wide Effect

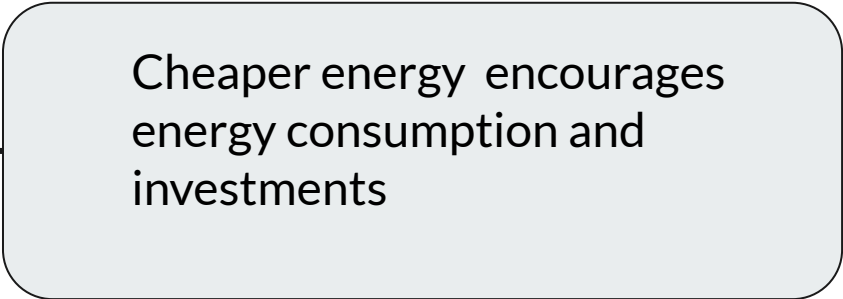
# Rebound Effects



## Direct Rebound Effect

## Indirect Rebound Effects

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



Cheaper energy encourages energy consumption and investments

## Economy Wide Effect



# Rebound Effects

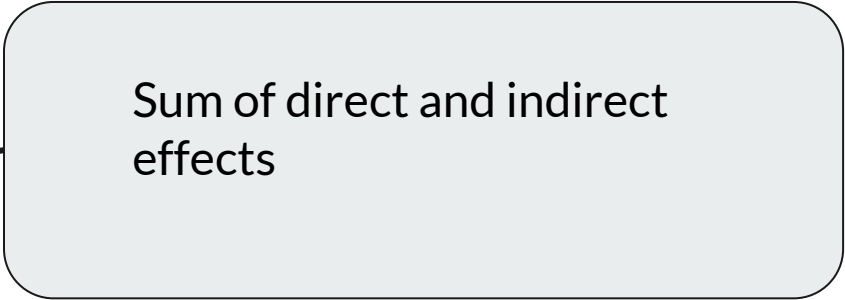


Direct Rebound Effect

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 → Direct rebound
- More gas-cars produced → Output effects
- New inventions using oil → Market effects
- Spend money on other things → Income effect
- New engines need a lot of energy to build → Embodied energy C.
- Buy bigger cars → Direct? / Market?
- “Cruising around” → ?

## Direct Rebound 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

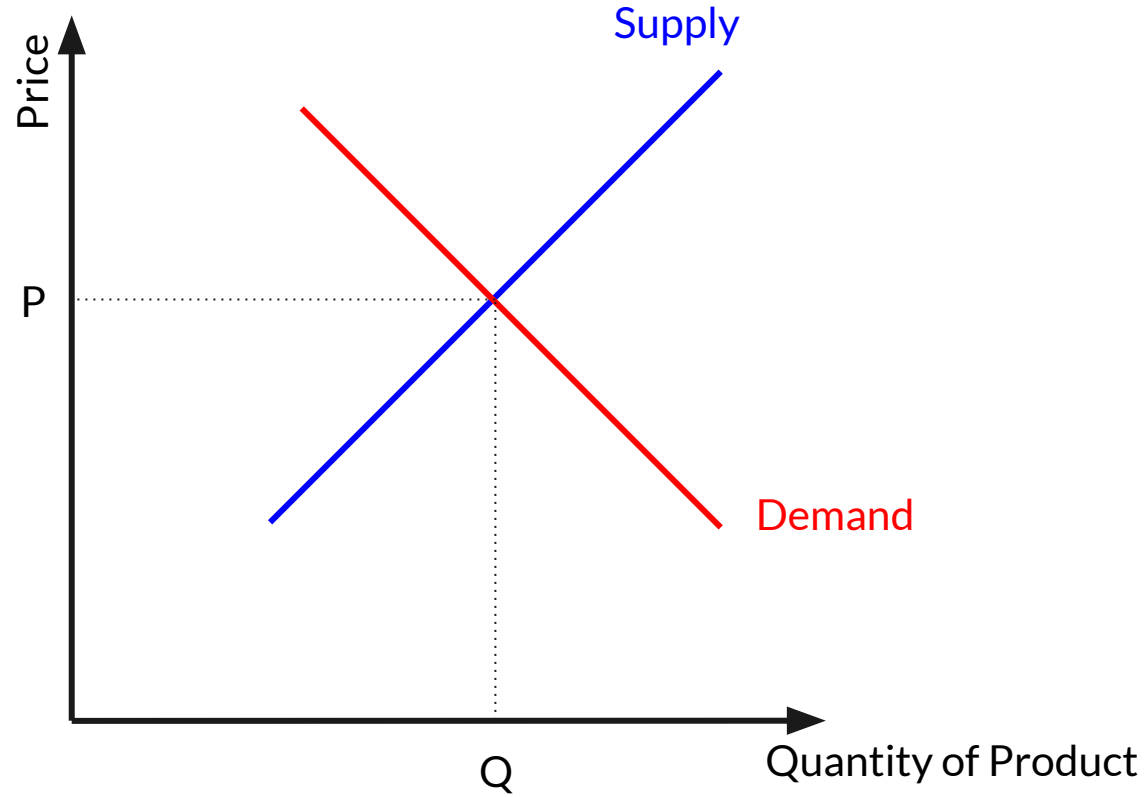
# Energy Efficiency

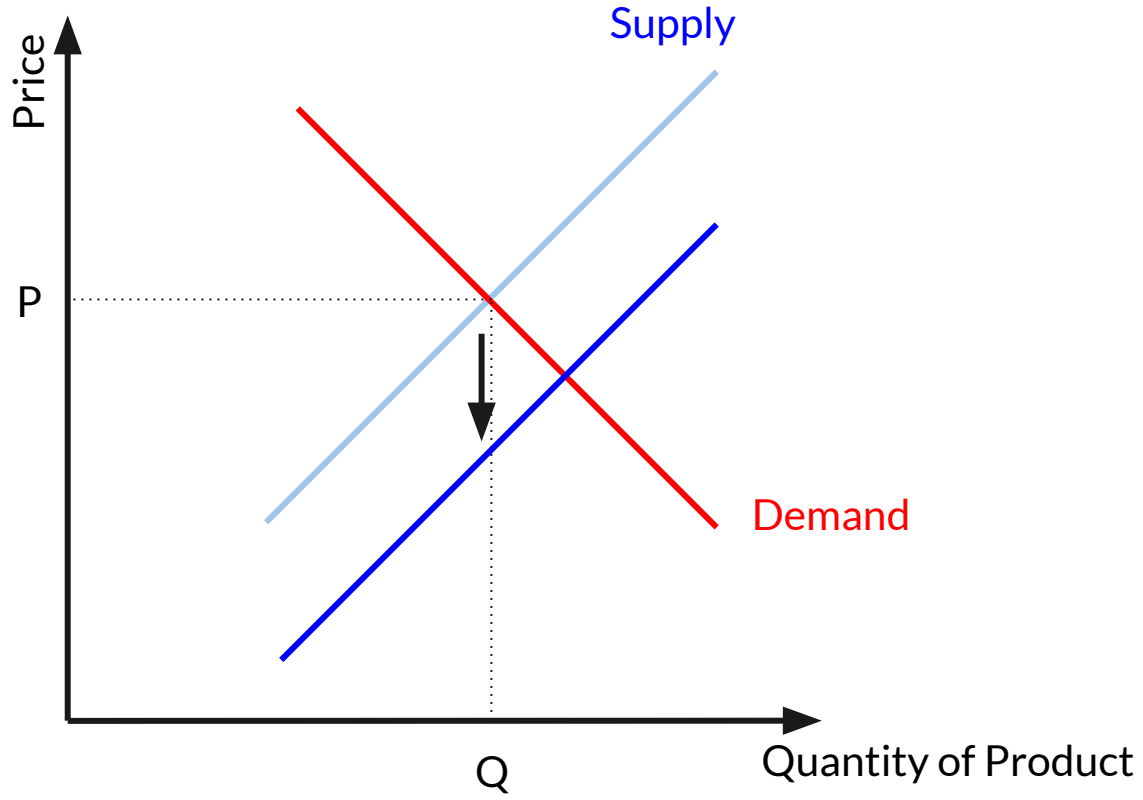


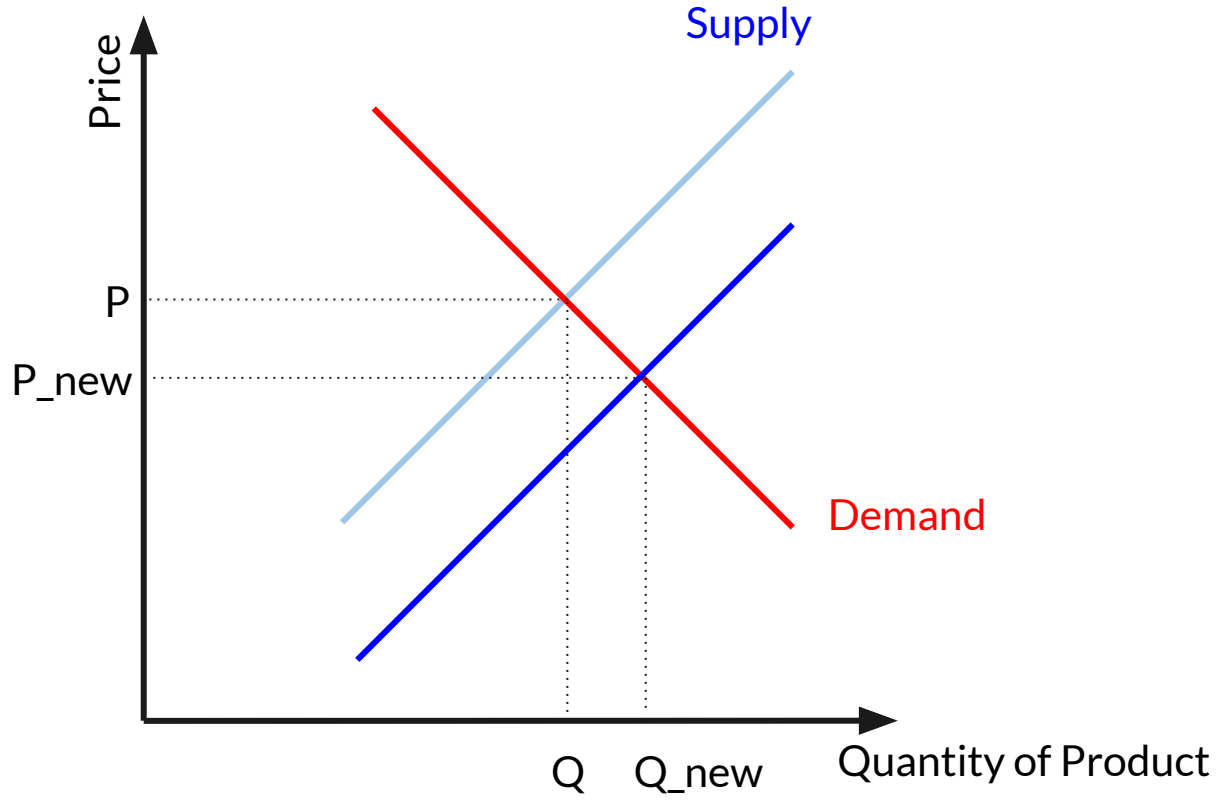
Energy efficiency has been an important part of environmental strategy

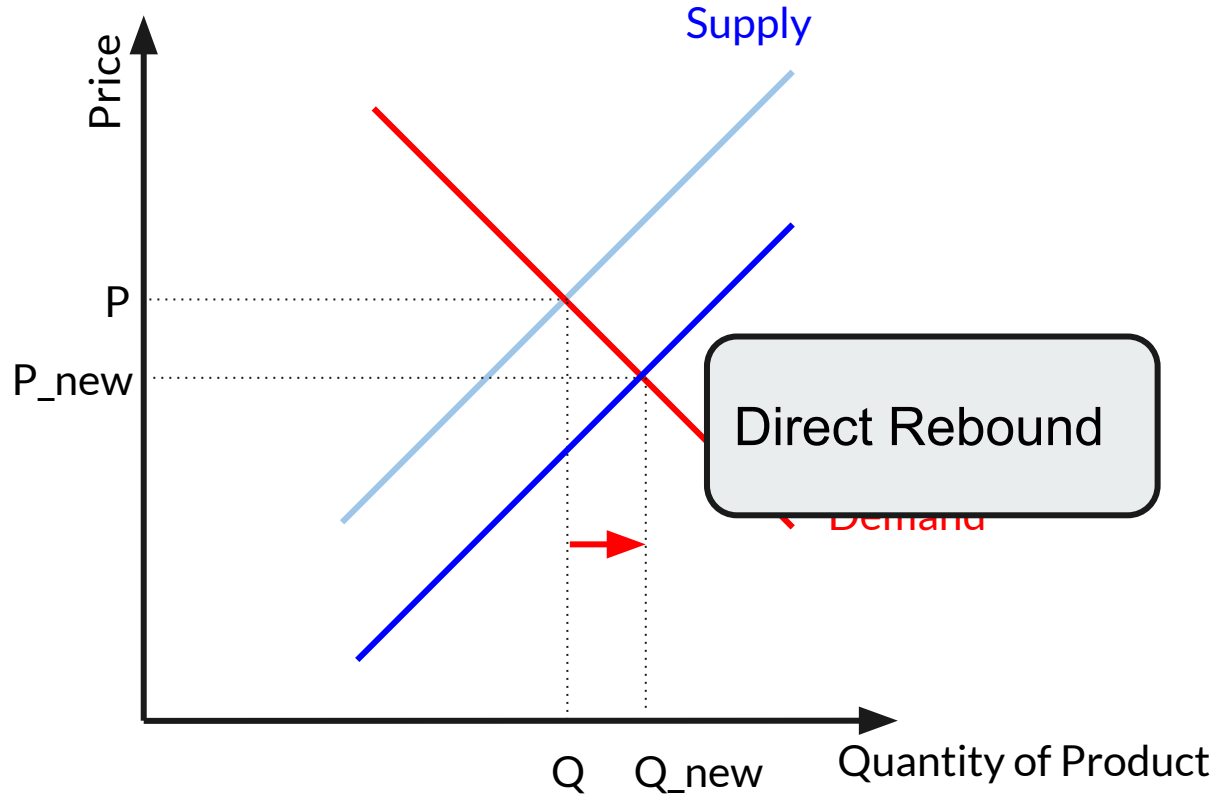
Binswanger, Ecological Economics, 2001



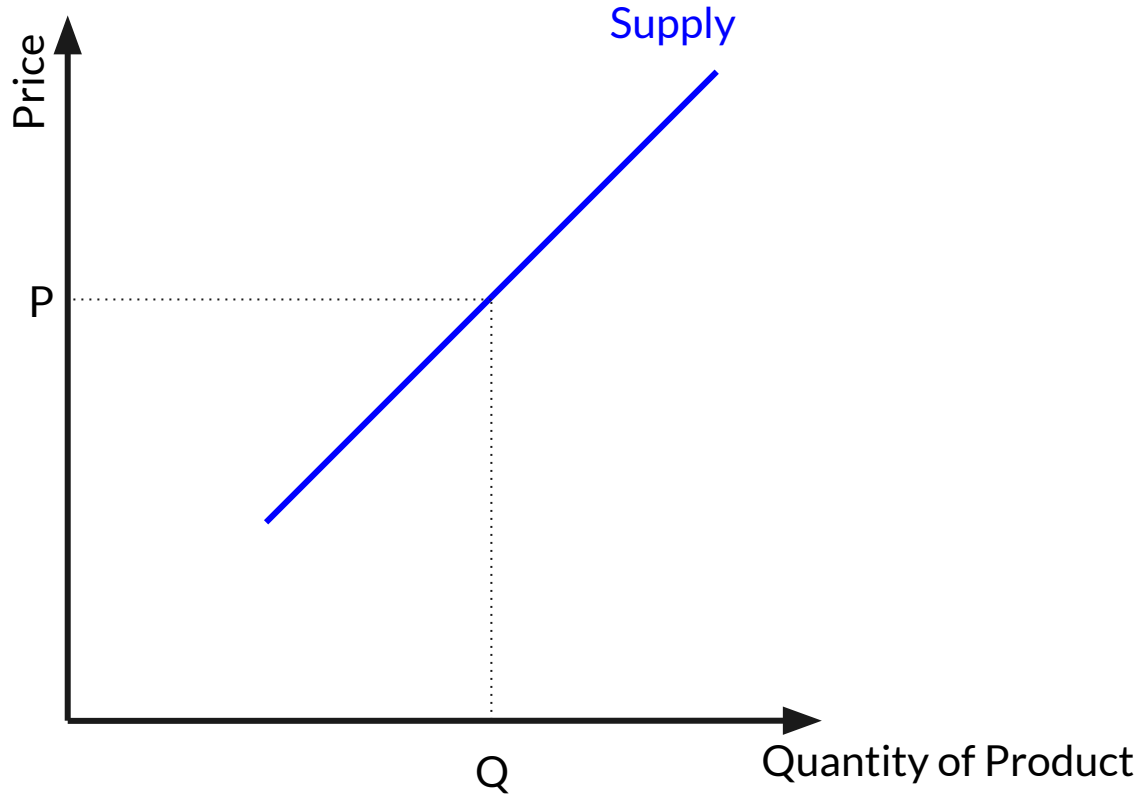


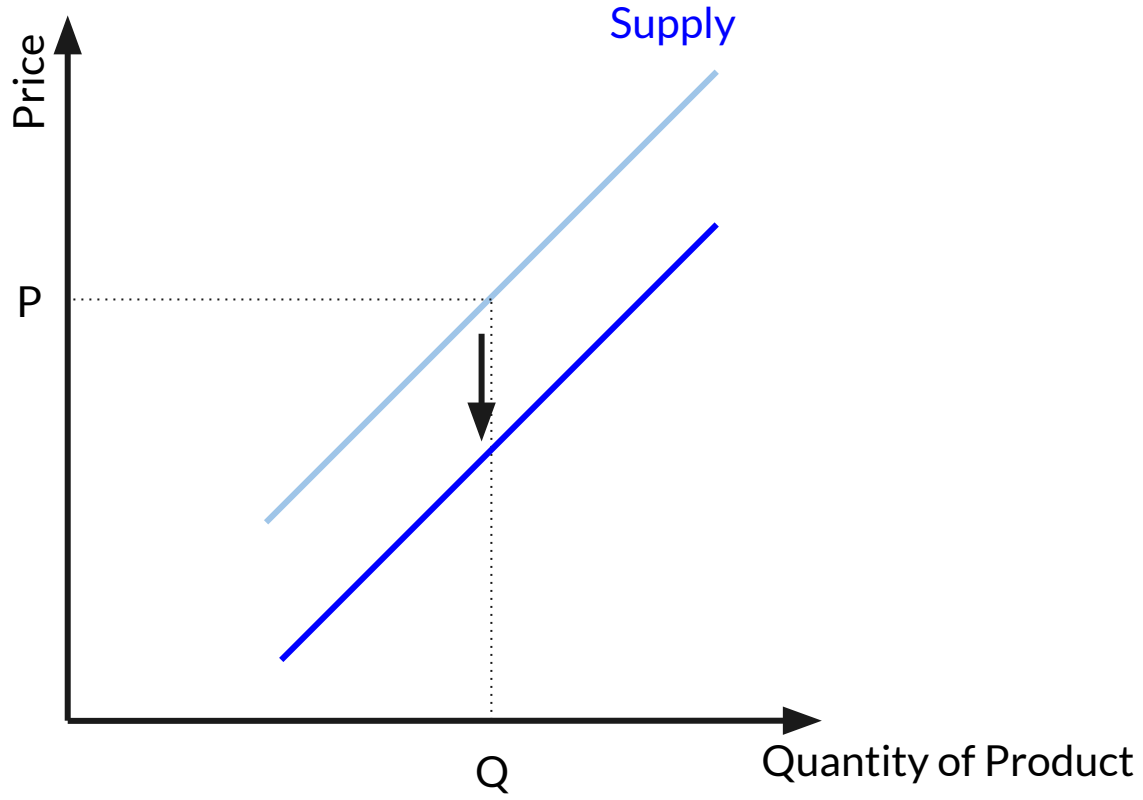


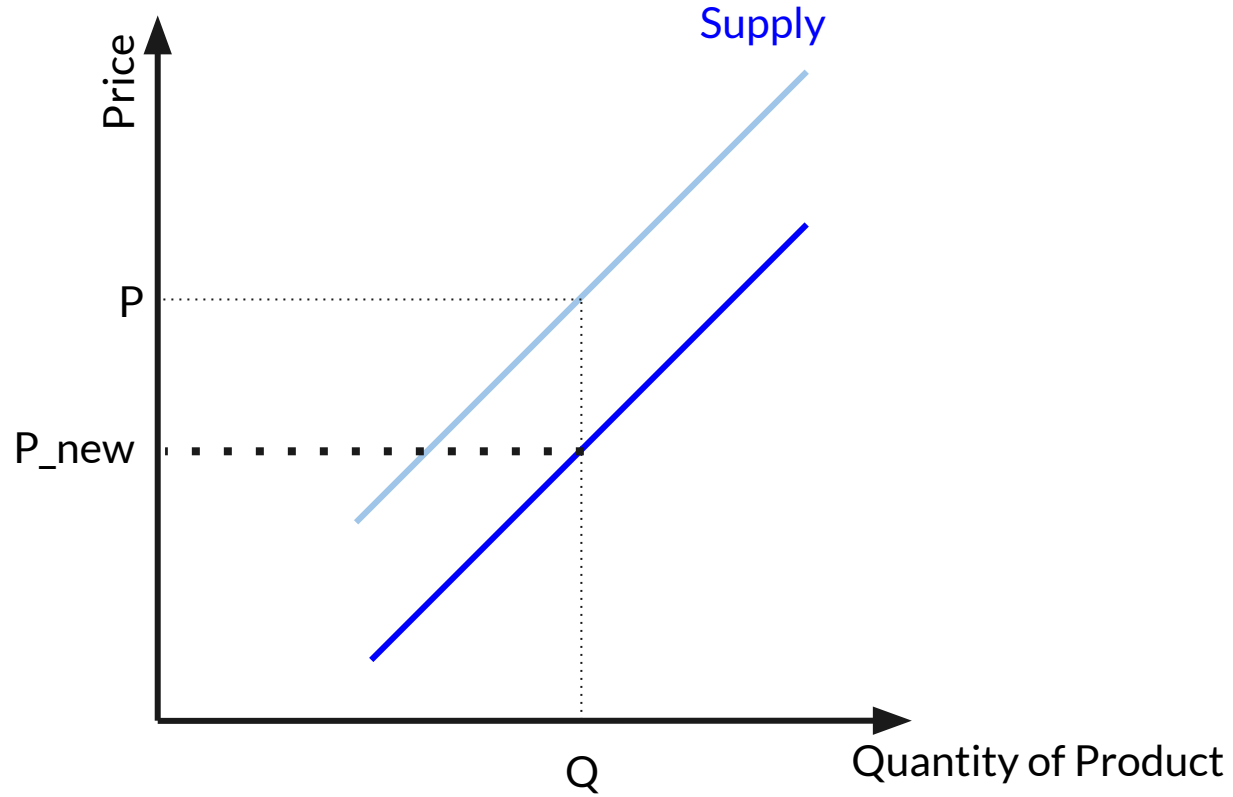




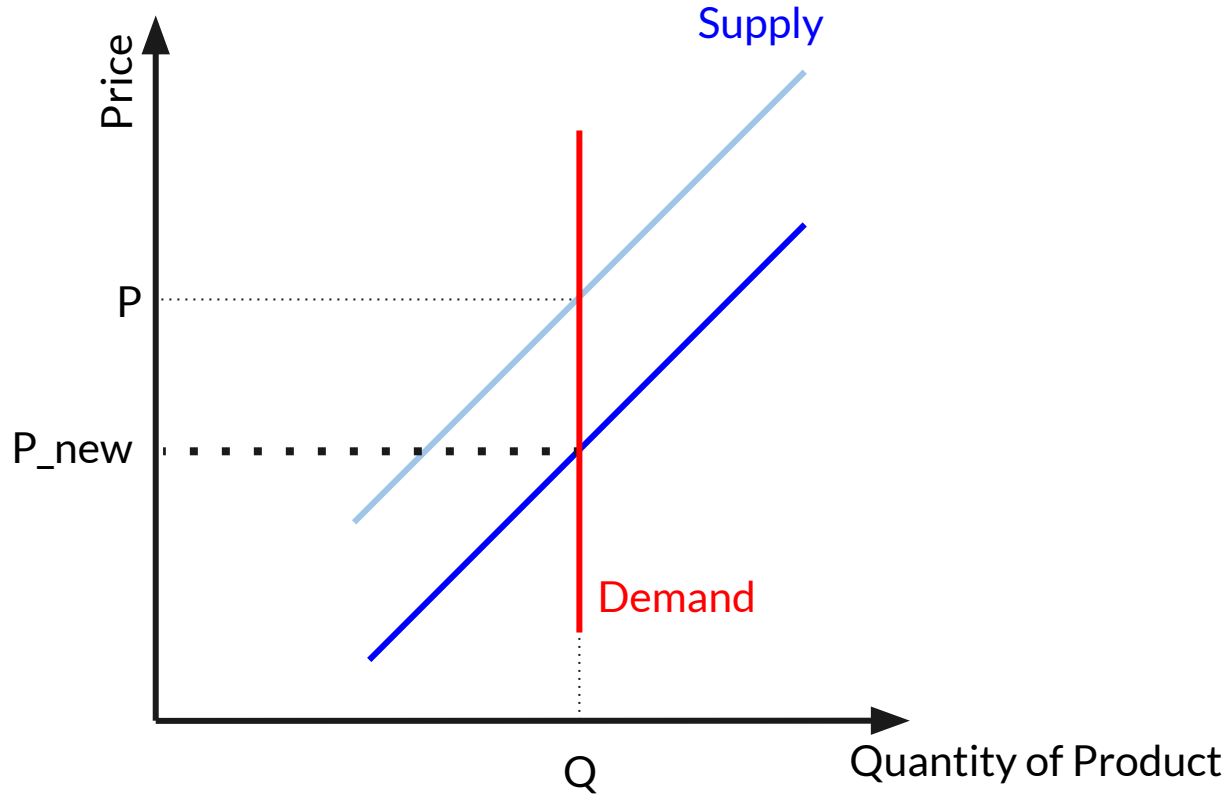
**What if we assume, an efficiency improvement has no rebound?**











# 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



## General Purpose Technologies (GPT):

- Steam engines
- Electricity
- Information technology

=> Higher Rebound / Backfire

## Non GPT:

- House insulation
- More efficient car wheels
- More efficient dishwasher designs

=> Lower Rebound



Historical Perspective

The Rebound Effect

How to estimate

Energy Efficiency

**Digitalization**

# Rebound in Digitalization

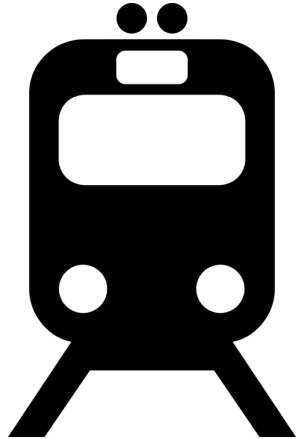


- If a person prints all emails => **Rematerialisation**
- People want all their music available all the time => **Changed practices**
- If a person orders almost daily from an online shop => **Induction**

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

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