THE REBOUND EFFECT

Authors and date

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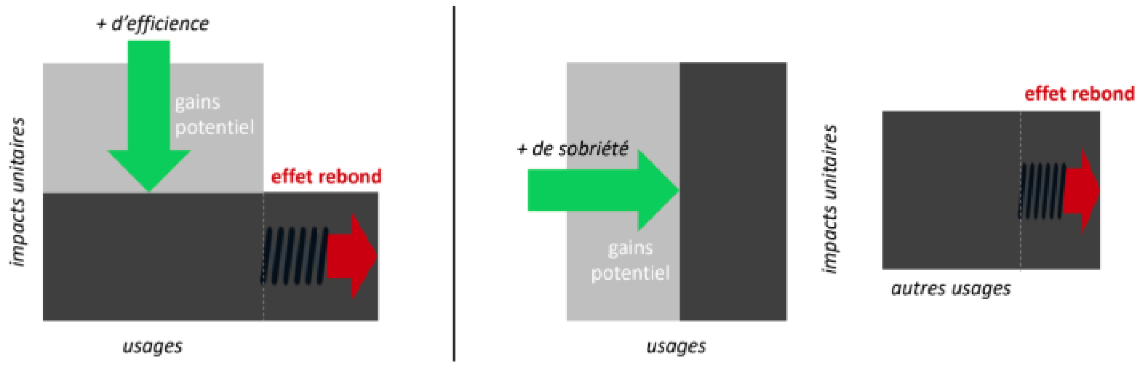
INTRODUCTION

Solutions to reduce our environmental impacts can be based on two dimensions:

- the technological dimension in the approaches to improving efficiency which makes uses more economical in resources and less emissive in pollution, without calling them into question. It is a question of "doing the same thing, or even more, with less", i.e. reducing the "unit" consumption of our uses.
- the dimension of uses in the *sobriety* approaches in which it is a question of "doing less with less".

For example, improving the fuel economy of a car is part of the first dimension, while reducing its annual mileage is part of the second. The **rebound effect** cancels out some or all of the environmental benefits obtained on one dimension because of "secondary" effects on the other dimension: improving the fuel efficiency of a vehicle may lead to an "intensification" of its use (e.g. increase in annual mileage, average speed, etc.).



WHAT IS THE REBOUND EFFECT?

A more efficient technology tends to be used more, for example because of the lower cost of use. This was already the observation made by W.S. Jevons during the industrial revolution in England in the 19th century concerning the progress in energy efficiency of the steam engine: these had indeed led to an increase in the demand for coal and not the opposite. This situation is known as the rebound effect (or more precisely the direct rebound effect), or

Jevons' paradox in reference to this historical example of coal. A typical example of the rebound effect is Induced demand: more efficient transport infrastructure can cause an increase in demand, i.e. road traffic. This phenomenon prevents congestion problems from being solved simply by increasing road capacity.

The example of the Katy Freeway in Houston: despite its 26 lanes, it has not solved congestion problems because of the traffic it induces (Source: Aliciak3yz, CC BY-SA 4.0, via Wikimedia

Commons).

Examples of the rebound effect in the digital sector are numerous[1]: since Eniac (the first all-electronic computer) miniaturization has made possible the explosion in the number of electronic objects[3] (personal computers, *smartphones*, connected objects, etc.), improvements in the energy efficiency of transmission networks combined with improvements in data rates and storage capacities have enabled the explosion in data traffic [2], etc.

Indirect rebound effects

We speak of *indirect* rebound effects when savings made in one area generate consumption in another[3]. Thus a sobriety approach can also be a source of rebound effects, because of the savings made which are reinvested (whether monetary or temporal), or because of moral licensing effects on the consumption of other products[4]. For example, replacing the car by the bicycle for daily trips allows savings that can be used for long-distance air travel during vacations, which cancels out the environmental benefits associated with the use of the bicycle.

Causes of the rebound effect

The rebound effect can occur when one or more limits to use and/or production are pushed back[4]. These limits can be economic, physical, technical, psychological, sociological, regulatory, etc. At the macro-economic level, the rebound effect translates into an increase in economic activity, so that it prevents the (absolute) decoupling of growth and environmental impacts[5]. The rebound effect is not only explained as the result of the sum of individual behavior, it also has more structural origins in growth policies[4], business strategies, the effect of markets and financialization, social, technical, and regulatory norms[6].

Measuring and predicting the rebound effect

The magnitude of the rebound effect is defined as the share of potential gains that is cancelled out by the increase in usage, and is referred to as *backfire* when it exceeds 100%, i.e. when the potential gains are more than offset by the negative effects. Predicting this magnitude is useful to anticipate the reality of the gains that can be expected from a solution, but it remains (very) difficult. The current approach to do this is to use economic models that are not designed to account for deep societal changes[7] (which are probably what we need, for example to decarbonize our economies).

To understand and predict the rebound effect, studying historical trends is also very useful. They show us, for example, that the continuous optimization of digital infrastructures and equipment cannot compensate for the increase in usage, so that the overall carbon footprint of our networks, data centers and terminal equipment tends to increase[2]. More generally, the history of technology shows us how uses stack up and complement each other more than they substitute each other[8].

WHEN CAN WE EXPECT A REBOUND EFFECT?

The rebound effect is likely to occur in "win-win" solutions, especially those that:

- lead to savings in money, time (acceleration effects), space (miniaturization)
- bring new functionalities (generating new uses)
- encourage more use through increased performance or comfort of use.

HOW TO LIMIT THE REBOUND EFFECT?

- raise awareness of the rebound effect, encourage awareness of intentions (are they ecological? economic?)
- think in a systemic way and on a large scale (therefore on a collective rather than individual scale)
- favor "low-tech" solutions (because they generally avoid generating new needs)
- redirect the budgets saved (in money or in time) towards other environmental improvements to fight against indirect rebound effects.

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