



The rebound effect, gender and social justice: A case study in Germany



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HIGHLIGHTS

- Economically disadvantaged groups often show the highest rebound effects.
- But they usually have the lowest absolute levels of energy consumption.
- A study of female vs male commuting distance rebound effects confirms this.
- This is consistent with the mathematical structure the rebound effect concept.
- Policymakers need to problematize high consumption, not high rebound effects.

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ABSTRACT

Energy efficiency increases are essential in reducing energy consumption and CO₂ emissions. Policy is therefore rightly concerned about rebound effects, which cause energy and CO₂ emission reductions to be less than anticipated. A policy dilemma is emerging in that less economically privileged groups tend to show the highest rebound effects. Some studies suggest policymakers may therefore be reluctant to support energy efficiency upgrades among such groups. This paper argues this is based on a misunderstanding of the conceptual structure of the rebound effect. Firstly, a mathematical analysis confirms that the rebound effect is merely a comparison of proportions, not a measure of absolute levels of energy consumption, which are the real cause of increased CO₂ emissions. Secondly, an empirical study of commute distances in North-Rhine-Westphalia, Germany's largest state, reveals that female commuters show considerably higher rebound effects than male commuters, both in time and cross-sectional analyses. However, male commuters consume the most energy and produce the most CO₂ emissions, by every measure. This resonates with recent studies showing the same disjunction between rebound effects and absolute consumption, in home heating among poorer and wealthier households. Policy needs to focus on absolute consumption levels and be cautious in interpreting rebound effects.

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1. Introduction

Increasing energy efficiency is an important component in reducing energy consumption and CO₂ emissions. Along with energy consumption reduction goals and renewable energy targets, the EU Commission has set a goal of 20% improvements in energy efficiency by 2020, and the EU's Low Carbon Roadmap extends and deepens this to 2050 (EU 2011). Various EU and other OECD countries are also developing energy efficiency targets for periods up to 2050 (e.g. HM Government, 2011; Ziesing, 2009).

However, since the late 1970s it has been recognized that energy efficiency improvements do not generally lead to one-to-one reductions in energy consumption (Khazzoom, 1980; Saunders,

1992). Usually, only a portion of the energy efficiency increase goes to reducing energy consumption. The remaining portion is 'taken back' by consumers to increase their level of energy services consumption (e.g. warmer homes, more kilometers traveled, more products manufactured). This is generally thought to be because the increase in efficiency reduces the endogenous price of energy, i.e. it makes it cheaper to warm one's home, travel in a car, or manufacture products (Berkout et al., 2000; Sorrell and Dimitropoulos, 2008). This phenomenon has come to be widely called the 'rebound effect' (Schipper, 2000).

The rebound effect is a challenge for policy making because it compromises the quantity of energy saving and CO₂ emission reduction that are likely to be achieved through specific levels of energy efficiency increase (Galvin, 2014a; Saunders, 2013). Various governing bodies have therefore commissioned studies on the extent and magnitude of the rebound effect in a range of sectors of

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the economy (Madlener and Alcott, 2011; Maxwell and McAndrew, 2011; Sorrell, 2007). There is also increasing interest in estimating ‘economy-wide’ macroeconomic rebound effects, whereby energy efficiency increases in industry are believed to have knock-on effects which could possibly amplify throughout the economy (Barker et al., 2007; 2009; Saunders, 2000).

This study concerns ‘direct’ rebound effects only, which occur on the microeconomic scale and are associated with consumer behavior rather than production changes. In particular, this study is situated within literature that expresses concern that economically disadvantaged groups tend to exhibit significantly larger rebound effects than others.

For example, low income households in thermally poor homes show larger rebound effects after energy efficiency retrofits, than higher income households in thermally better homes (Boardman, 2010; Hong et al., 2006; Milne and Boardman, 2000; Ürge-Vorsatz and Herrero, 2012). It has also been noted that rebound effects in most sectors in developing and emerging economies tend to be larger than those in OECD countries (Orasch and Wirl, 1997; Roy, 2000). This is thought to be because such consumers are a long way from ‘satiation’ of their energy services needs (Sorrell et al., 2009; also called ‘unmet demand’, as in Roy, 2000 and Chakravarty et al., 2013). When an energy efficiency improvement reduces the cost of these services – i.e. when the endogenous price of energy falls – they are more likely to take advantage of this to improve their quality of life. Chitnis et al. (2014) find a general tendency toward higher rebound effects among lower socio-economic groups in the UK.

The problem this poses for policy is that, on the one hand, the imperative for social justice implies that disadvantaged people should be supported in improving their quality of life, while on the other hand, it is imperative to reduce energy consumption and CO₂ emissions. Ürge-Vorsatz and Herrero (2012) argue that these energy services increases among disadvantaged people should therefore not be called ‘rebound effects’, as this gives inappropriate connotations to positive improvements in these people’s lives. Boardman (1991) raised the concern that these high rebound effects might deter policymakers from tackling fuel poverty. In more recent work, Boardman (2010) proposes a trade-off between direct and supposed indirect rebound effects in home heating, wherein she suggests the total rebound effect would be greater among privileged groups than among less privileged groups. As yet, however, there is little empirical evidence for this. Chakravarty et al. (2013) discuss the issue of ranges of rebound effects in developing countries, where there is considerable unmet demand for energy services. These ranges can include high rebound effects where increases in energy services enable quality of life to be improved to reasonable standards.

This paper argues that equating the magnitude of rebound effects with the magnitude of energy consumption is predicated on a misunderstanding of what the rebound effect actually is, and that this goes to the root of its mathematical definition and structure and therefore its real world effects. High rebound effects among groups initially consuming disproportionately small quantities of energy services do not compromise climate and energy goals more than low rebound effects among more privileged groups. Usually, in fact, their high rebound effects make much less impact on energy consumption and CO₂ emissions than the lower rebound effects of more privileged groups. The paper argues that governments therefore need to take this into account in developing policy in response to the rebound effect. Focusing solely on the magnitudes of rebound effects may not serve the policy goal of correctly identifying impediments to energy consumption and CO₂ emission reduction.

The paper offers a mathematical–conceptual description of this proposition, then illustrates it by means of an empirical study of

commuting distances of female compared to male workers in North-Rhine Westphalia (NRW), Germany’s most populous and economically powerful federal state. It then shows parallels between these results and those of two already published studies on rebound effects in buildings in Germany.

Female workers in Europe and the US are frequently framed as economically disadvantaged compared to their male counterparts, and this is often seen as reflected in their shorter average distances to work (McLafferty, 1997; Madden, 1981; and reviews in Crane, 2007; Hanson, 2010). It is argued that gender power structures in the home, and the expectation that women take most of the burden of domestic work, make it harder for women to commute longer distances and therefore they have less opportunity to be employed in the best paying jobs. This is often seen alongside lingering societal and employer gender bias against women emulating male work and commuter patterns.

With regard to Germany, Best and Lanzendorf (2005) found women in Cologne, NRW’s largest and most job-rich municipality, worked closer to home and for less pay, on average, than men. In an earlier, German wide survey, Blanke et al. (1996) found that mothers working full-time who had children up to five years old spent 5.13 h per day doing household work, compared to 2 h for fathers. A number of other German studies confirm these tendencies (Arntz et al., 2008; Heywood and Jirjahn, 2002; Huinink and Feldhaus, 2012; Trappe and Rosenfeld, 2000).

It therefore seems reasonable to frame female workers in Germany as less economically privileged than male workers as a consequence of their more limited spatial access to the jobs of their choice. It is therefore interesting to see how their rebound effects, in terms of commuting distance to work, compare with male workers’.

Section 2 presents the methodology, which includes the mathematics used in the paper plus an introduction to the NRW case study. Section 3 gives the rebound effect results and their implications, and compares these to results for social privilege in recent German buildings studies. Discussion is offered in Section 4, and Section 5 gives policy recommendations and conclusions.

2. Methods

The first three subsections of this section give the mathematical basis for the formulae that are used in analyzing the data to give the findings in Section 3. The last sub-section introduces the case study of commuters in NRW.

2.1. Rebound effects and absolute levels of consumption

The rebound effect is defined in economics literature as the energy elasticity of energy services consumption, i.e. the ratio between the proportionate change in energy services consumption and the proportionate change in energy efficiency (Berkout et al., 2000; Sorrell and Dimitropoulos, 2008). This can be formally expressed as

$$\eta_{\epsilon S} = \frac{\partial S}{\partial \epsilon} \cdot \frac{\epsilon}{S} \quad (1)$$

where S is the level of energy services being consumed, and ϵ is efficiency.

Consider an economically privileged group P who are consuming energy services S_{P1} at time t_1 in an appliance (house, car, etc.) with efficiency ϵ_{P1} . Their appliance is then upgraded to efficiency ϵ_{P2} at time t_2 , after which they consume energy services of S_{P2} . It can be shown (see Appendix A) that their rebound effect is then given by

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