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Analysis

The rebound effects of switching to vegetarianism. A microeconomic analysis of Swedish consumption behavior

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ABSTRACT

Sustainable diets, in particular vegetarianism, are often promoted as effective measures to reduce our environmental footprint. Yet, few conclusions take full-scale behavioral changes into consideration. This can be achieved by calculating the indirect environmental rebound effect related to the re-spending of expenditure saved during the initial behavioral shift. This study aims to quantify the potential energy use and greenhouse gas emission savings, and most likely rebound effects, related to an average Swedish consumer's shift to vegetarianism. Using household budget survey data, it estimates Engel curves of 117 consumption goods, derives marginal expenditure shares, and links these values to environmental intensity indicators. Results indicate that switching to vegetarianism could save consumers 16% of the energy use and 20% of the greenhouse gas emissions related to their dietary consumption. However, if they re-spend the saved income according to their current preferences, they would forego 96% of potential energy savings and 49% of greenhouse gas emission savings. These rebound effects are even higher for lower-income consumers who tend to re-spend on more environmentally intensive goods. Yet, the adverse effect could be tempered by purchasing organic goods or re-spending the money on services. In order to reduce the environmental impact of consumption, it could thus be recommended to not only focus on dietary shifts, but rather on the full range of consumer expenditure.

1. Introduction

The unsustainability of Western lifestyles has increasingly become a topic of interest to researchers and policy-makers. Environmental footprint analyses reveal that we would require a bio-capacity of 4.5 Earths if every human attempted to live like the average American (Pollard, 2010). In response to this challenge, governments and civil society organizations have often called for consumption changes at the individual level. In particular, nutritionally comparable dietary choices have shown to be vastly different in a range of environmental impacts (Hertwich and Katzmayr, 2003). This difference is especially apparent when comparing animal-based products to plant-based ones, using indicators as diverse as greenhouse gas emissions (Steinfeld et al., 2006), energy use (Berners-Lee et al., 2012; Dutilh and Kramer, 2000), and land requirement (Gerbens-Leenes et al., 2002). A number of authors thus concur with McMichael et al. (2007) that a 'contraction and convergence' strategy in animal production is required to curb the agricultural sector's environmental impacts, and advocate for a reduction of individual consumers' meat consumption as a significant and relatively easy contribution to more sustainable lifestyles (Carlsson-Kanyama and González, 2009; González et al., 2011; McMichael et al., 2007; Steinfeld et al., 2006; Taylor, 2000).

Importantly, though, these conclusions are reached analyzing expenditure category-specific consumption choices and ignoring total household expenditure behavior (Murray, 2013). However, multiple inquiries have shown that diet costs increase with the amount of meat consumed (Drewnowski et al., 2004; Lusk and Norwood, 2009), suggesting important savings opportunities in a switch to vegetarianism. Yet, Drewnowski et al. (2004) also showed increased diet costs with increased fruit and vegetable consumption, whereas fats, sweets and carbohydrates were significantly cheaper. It is thus unclear from previous research whether consumers can significantly lower their food costs by eating vegetarian.

If the necessary expenditure for the new diet does change, however, and available income is held constant, single-category analyses will ignore the consequences of redistributing the surplus available income (Alfredsson, 2004). This is typically called an indirect rebound effect and can occur at different levels. Ignoring such substitution behavior might seriously overstate the environmental benefits attached to isolated consumption behavior changes, leading to faulty conclusions that category-specific changes are sufficient to lead society toward more sustainable consumption patterns. In particular, the indirect environmental rebound effect – the environmental effect of re-spending money saved by not purchasing meat or fish – of vegetarianism deserves further study. This study focuses explicitly on the rebound effect of such individual-level diet changes in a Swedish context in order to inform consumption policy by providing more accurate predictions of likely effects.

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To this end, we proceed in four steps. First, using household expenditure data in 117 categories and matching environmental intensity parameters, we construct the current average consumer's environmental footprint. Then, we calculate potential savings stemming from a diet change, and third, we approximate the most likely re-spending behavior through the estimation of Engel curves. Finally, the indirect environmental rebound effect can be derived from the relative difference between the potential and actual savings. In our sensitivity analyses, we furthermore explore whether this rebound effect is different between low- and high-income households, and what the most environmentally benign re-spending behavior would look like.

The remainder of the paper is structured as follows. Section 2 gives an overview of the literature concerning rebound effects of behavioral changes. Section 3 specifies the data and methods used. Section 4 summarizes and discusses the study's results and presents sensitivity analyses. Finally, Section 5 concludes the paper, considers its limitations and motivates further research.

2. State of the Art

The rebound effect of consumer-led shifts to alternative purchasing behavior is generally defined as the percentage of potential savings in particular environmental impacts of consumption that were *not* realized due to consumers' rebound (in particular, re-spending) behavior. We thus compare three different states: the baseline (observed) behavior, represented mathematically by E^B, the environmental footprint associated with that behavior; E^F, the footprint after first-round effects, representing the situation where exogenous behavior changes were made, but no re-spending has occurred; and E^S, the footprint after second-round effects, which considers the sum of exogenous and endogenous changes in consumption, where the endogenous changes were derived using household consumer theory.

In mathematical terms, the rebound effect can then be written as follows (Druckman et al., 2011):

$$Rebound = \frac{\Delta E_P - \Delta E_A}{\Delta E_P} \quad (1)$$

in which the potential change is $\Delta E_P = E^B - E^F$, and the actual change in the environmental footprint is $\Delta E_A = E^B - E^S$.

Though the literature on the indirect rebound effects of consumption pattern changes is only in its infancy, a number of first estimations concerning a variety of potential lifestyle shifts have been carried out.

One of the first studies in this area, Chalkley et al. (2001), looks at the likely re-spending behavior resulting from the use of more energy-efficient household appliances in the United Kingdom. They find energy use rebound effects between 22% and 27%. The findings by Chitnis et al. (2012a) also focus on energy efficiency improvements in UK dwellings, are measured in greenhouse gas emissions, and show a range of 5–15% rebound.

In comparison, measures that investigate consumption pattern changes in relatively less energy- or GHG-intensive categories – including dietary decisions – find much larger rebound effects. This makes intuitive sense if the assumed re-spending of the avoided expenditure occurs in categories with higher environmental loads such as household fuels and personal transportation. Druckman et al. (2011) focus on UK household carbon footprints measured in GHGs. Here, a sustainable consumption change in the food category (eliminating food waste) is associated with a rebound effect of 59%, the highest of four simulated scenarios. Similarly, Chitnis et al. (2014) find that food waste reduction results in the highest rebound effects of all tested scenarios, reaching 66–101% (measured in GHG terms). Alfredsson (2004)'s model of a 'green', more plant-based diet even shows that though the new diet is lower in energy use and CO_2 emissions, re-spending the savings leads to a backfire effect of 316% in energy use and 238% in carbon emissions. The greatest re-spending categories are, in order of magnitude, travel, recreation, food, clothes, and housing. Carlsson-Kanyama et al. (2005), on the other hand, find a decrease of household energy use of 13–32% after a shift to an energy-efficient diet; but this is mainly due to their assumption that 'green' consumers will purchase organic products and incur larger costs than in the original scenario.

Finally, Lenzen and Dey (2002) find that a switch to a more healthy diet, represented by the Australian recommended dietary intake, would lead to net savings in CO_2-equivalent emissions of around 20%. They also identify GHG rebound effects of around 50%, and even 111–123% rebound in the case of energy. This analysis also estimates re-spending and rebound effects for three consumer categories – low, middle and high income groups – separately, allowing for a more rich evaluation of the effectiveness of such changes. The backfire effect is largest for the low-income group, showcasing their tendency to re-spend the saved expenditure in relatively energy-intensive expenditure categories. This conclusion is supported by Chitnis et al. (2014) and Murray (2013), who confirms in his analysis of 'green' consumption decisions (such as reduced vehicle or electricity use) that "in both the conservation and efficiency models the total rebound effect, and both the direct and indirect effects individually, were inversely related to household income level" (Murray, 2013, p. 247).

This review points to several previous insights into the role of food consumption patterns and environmental impacts when seen from a rebound framework. First, the definition of 'sustainable diets' is extremely broad and studies have utilized a variety of measures to transform the idealized concept into concrete change scenarios. This makes a direct comparison of results difficult. Overall, it seems that dietary changes, unless accompanied by substantial increases in food expenditure as in the example of Carlsson-Kanyama et al. (2005), have a comparatively small net impact on energy use and greenhouse gas emissions and high rebound effects. This is mainly due to their relatively low energy intensity compared to other consumption categories. However, as Lenzen and Dey (2002) and Murray (2013) show, there can be interesting differences in effect depending on household income. In general, only very few studies have focused on complete-diet substitutions, contrasting nutritionally sound, data-informed dietary patterns, while using recent and disaggregated data such as ours. In particular, the switch toward a vegetarian diet in a rebound framework requires further investigation. This study intends to fill this research gap while giving more insights on the theoretical approach of calculating rebound effects through the estimation of Engel curves.

3. Data and Methods

3.1. Data

The analysis uses expenditure category-specific Swedish household expenditure data from 2006, in particular the data differentiated by income deciles available in Statistics Sweden's database (SCB, 2014), which is based on a budget survey of 4000 households (Berglind, 2007). The results are disaggregated into 117 product categories, 71 of which are food consumption categories. Fig. 1 shows the proportional expenditure per category across the equalized income deciles. We can note that in the Swedish case, Engel's law (Zimmerman, 1932) – that proportional expenditure on food decreases with increasing income – is only weakly present, as the highest income categories spend almost equal proportions of their income on food (12–13%) as the lowest ones (14–15%). However, we can identify a shift toward services, transportation, and leisure expenditure, and away from housing, as incomes increase. This is in line with theory, as essential needs such as housing are addressed first and luxury wants are prioritized later (Zimmerman, 1932).

This data is linked to expenditure-based environmental intensity indicators (on energy use and CO_2-equivalent emissions) of 192 Swedish consumption products derived from environmentally extended input–output frameworks and life cycle analyses by Johansson et al. (2010).