DO SUFFICIENCY CONSUMPTION CHANGES DRIVE EMISSIONS DOWN ? A PRODUCTION NETWORK APPROACH

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Overview

Energy efficiency and decarbonized energy sources are essential yet insufficient for meeting ambitious climate change mitigation goals. Sufficiency strategies, which involve reducing consumption and shifting to less environmentally impactful lifestyles, are increasingly recognized as crucial for decarbonization. However, their wider economic implications remain underexplored. This paper develops a static macroeconomic model with a detailed microeconomic production framework to analyze these implications. We derive comparative statics to unravel three primary propagation channels for consumption changes: direct demand effects, price effects, and substitution effects, based on the production network structure and elasticities of substitution. Using multi-regional input-output data, we assess the impacts of two sufficiency-driven consumption changes: adopting a vegetarian diet and reducing energy use. Our findings reveal significant rebound effects, up to 38% for domestic emissions and 60% for global emissions (accounting for carbon leakage), compared to estimates excluding behavioral aspects. Rebound effects from sufficiency strategies are smaller than those from energy efficiency improvements. Alternatively, conceptualizing sufficiency as increased leisure time preference results in reduced rebound effects and negative carbon leakage.

Methods

To tackle this research question, we develop a static, stylized macroeconomic model that integrates changes in consumption patterns within a disaggregated microeconomic production framework. Our model builds on recent advancements in the macroeconomic effects of production networks (Carvalho et al., 2019; Baqaee et al., 2019b). In our model, sectors produce final goods by combining primary factors and intermediate goods, while consumers derive utility from consuming those final goods using the wages they earn. The production process is represented through a CES function. This stylized approach enables us to analytically examine the different channels through which changes in consumption patterns propagate in the network. Sufficiency consumption changes are initially represented as shocks to consumers' relative preferences for goods.

We calibrate our model using multi-regional input-output data tables. Our numerical calibration focuses on a two-region economy, comprising the European Union (EU) and the Rest of the World (RoW), which aggregates all other countries. Our numerical exercise extends the analytical model to include more complex nested CES production and consumption utility functions. Our analysis specifically examines the impact of changes in consumption patterns for two preference shocks: a 'Food' shock modeling a transition to a vegetarian diet, and an 'Energy' shock reflecting reductions in energy consumption.

Results

Our findings highlight three key propagation mechanisms. First, the demand effect causes preference shifts to propagate upstream through the production network. This upstream effect accounts for life-cycle considerations – whereby shifts in final demand influence upstream sectors' production through global supply chains – and consumer behavior adaptation, where changes in relative preferences result in a reallocation of disposable income across sectors. Second, the price effect occurs when sectoral demand changes induce price shifts, influencing both production and final consumption and potentially triggering rebound effects. Specifically, a sector facing decreased relative preference experiences a drop in relative demand, resulting in lower relative prices that subsequently impact downstream sectors. Third, the substitution effect emerges as firms and consumers reallocate intermediate and final goods in response to price changes, affecting emissions outcomes.

Numerical results indicate that the combination of demand, price and substitution effect can amount to rebound effects as substantial as 38% for EU emissions compared to estimates based on input-output models without behavioral mechanisms. Elasticities of substitution are central in shaping final emissions reduction. This demonstrates the importance of consumer's behavior modeling hypotheses, with lower elasticities of substitution suggesting a reduced propensity to consume emission-intensive goods that have become cheaper following the shift in preferences. Additionally, we observe that carbon leakage - whereby a shift in preferences in the EU impacts RoW emissions - can be either positive or negative depending on the type of preference shock. Specifically, the

‘Food’ shock results in negative leakage, while the ‘Energy’ shock leads to positive carbon leakage once price and substitution effects are considered. Overall, the ‘Food’ shock and the ‘Energy’ shock result in rebound effects of 60% and 55%, respectively, for global emissions compared to estimates from input-output.

Conclusions

To meet the ambitious, yet currently out of reach, climate goals, it is essential that changes in consumption patterns and reductions in consumption levels complement existing technology-orientated efficiency measures. Yet, most models addressing sufficiency consumption changes rely heavily on exogenous projections of demand changes and often overlook significant feedback effects. This omission can skew understanding of the full economic impact of adopting sufficiency measures. Our study highlights the need to integrate behavioral mechanisms and economic interactions when evaluating sufficiency strategies. While sufficiency measures can contribute to emissions reductions, their effectiveness depends on how they interact with production networks and substitution behaviors. Explicitly incorporating these dynamics into economic models is essential for accurately assessing their mitigation potential.

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