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Distributional Impacts of Carbon Taxation on South African Households

Jennifer Uju Okonkwo

Presented at:

42nd IAEE International Conference 2019

Montreal, Canada

May 30, 2019

Introduction

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- Many countries are currently transitioning to low-carbon economies with South Africa at the forefront of these effort among African countries.

- The South African government plans to implement a carbon tax policy from June 1 2019.

- The introduction of a carbon tax to mitigate emissions is expected to be followed by an increase in prices of energy related products.

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Introduction (*contd.*)

- South African Households are likely to be greatly affected since their energy-related expenditure accounted for almost 50% of their incomes in 2015.

- Households are heterogeneous in terms of economic, socio-economic, demographic and physical features.

- Thus, energy usage patterns differ substantially from one household to another, especially across income groups

Fig 1: Average Household Energy Expenditure Shares by Income Deciles

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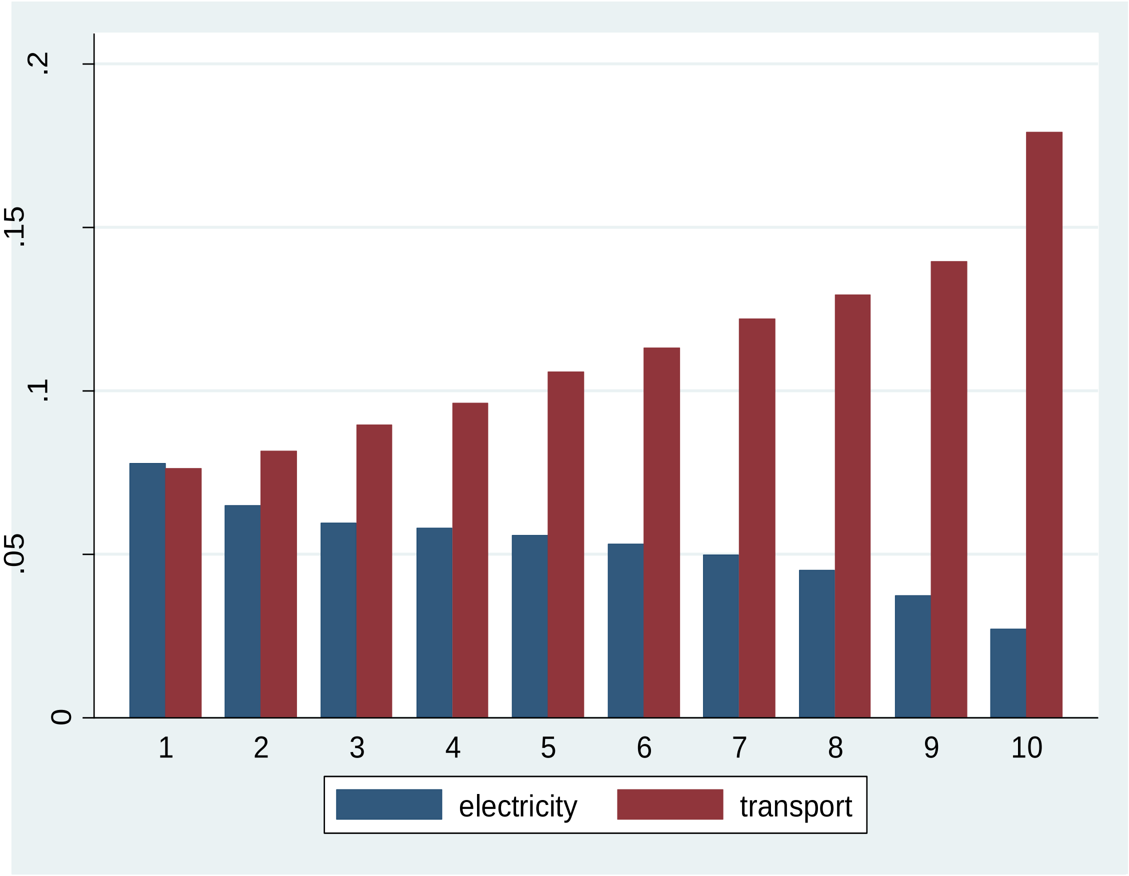

Aim of the Study

- The main objective of this paper is to study how the implementation of a carbon tax policy affects different income groups in South Africa.

- A household demand system is estimated using the Quadratic Almost Ideal Demand System (QUAIDS) model to evaluate the distributional and welfare effects of carbon taxation in South Africa.

Previous Literature

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- Computable General Equilibrium (CGE) model of Carbon taxation in South Africa.
  - van Heerden et al., 2006 (Energy J.); Alton et al., 2014 (Appl Energy); PMR 2016 (WB report);

- Welfare effects of carbon taxation on Households using QUAIDS model.
  - West and Williams III, 2004 (JEEM); Rosas-Flores et al. 2017 (Energy Econ); Moshiri and Santillan 2018 (Energy Pol); Renner et al. 2018 (Energy Econ)

Contribution to the Literature

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- This study contributes to the existing literature by providing empirical evidence on the distributional effects of the carbon tax in South Africa.

- It also provides an in-depth understanding of the welfare impacts of households as a result of the tax.

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Methodology

- Quadratic Almost Ideal Demand (QUAIDS) model developed by Banks et al 1997.

$$w_i = \alpha_i + \sum_{j=1}^{n} \gamma_{ij}\, lnp_j + \beta_i ln\left[\frac{m}{a(p)}\right] + \frac{\lambda_i}{b(p)}\left\{ln\left[\frac{m}{a(p)}\right]\right\}^2$$

Where: w_i denotes the budget share of the household for good i

p_j is the price of good j

m is the total consumption expenditure

ln $a(p)$ is the transcendental log function

b(p) is the Cobb- Douglas price aggregator

α_i, γ_{ij}, β_i and λ_i are parameters to be estimated by the model.

Data

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- South African Income and Expenditure Survey (IES) and the Living Conditions Survey (LCS) datasets conducted by Statistics South Africa (Stat SA).

- Four expenditure categories:

  Two energy goods: electricity and transport

  Two non-energy goods: food and other goods

- Demographic variables: age of head, province, household size and type of settlement
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Results

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- The results are presented in three steps:
  - The elasticities calculated from the demand system estimation.
  - The first and second-order welfare losses for income deciles and settlement type.
  - The welfare effect from a lump-sum transfer.

Results

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Table 2: Demand Elasticities

		Price			
		Electricity	Transport	Food	Other
Budget elasticities					
		0.505	1.252	0.947	1.050
		(0.005)	(0.006)	(0.002)	(0.002)
Compensated elasticities					
Demand	Electricity	-0.343	-0.387	-1.100	1.830
		(0.019)	(0.054)	(0.073)	(0.087)
	Transport	-0.180	-3.083	2.510	0.752
		(0.026)	(0.124)	(0.136)	(0.190)
	Food	-0.142	0.676	-0.639	0.106
		(0.009)	(0.037)	(0.070)	(0.077)
	Other	0.239	0.207	0.107	-0.553
		(0.011)	(0.052)	(0.078)	(0.115)
Uncompensated elasticities					
Demand	Electricity	-0.370	-0.444	-1.312	1.621
		(0.019)	(0.054)	(0.073)	(0.087)
	Transport	-0.248	-3.224	1.984	0.236
		(0.026)	(0.124)	(0.136)	(0.190)
	Food	-0.193	0.568	-1.037	-0.285
		(0.009)	(0.037)	(0.070)	(0.077)
	Other	0.182	0.088	-0.334	-0.986
		(0.011)	(0.052)	(0.078)	(0.115)

Standard errors in parentheses

Welfare Losses from price changes as a result of carbon tax

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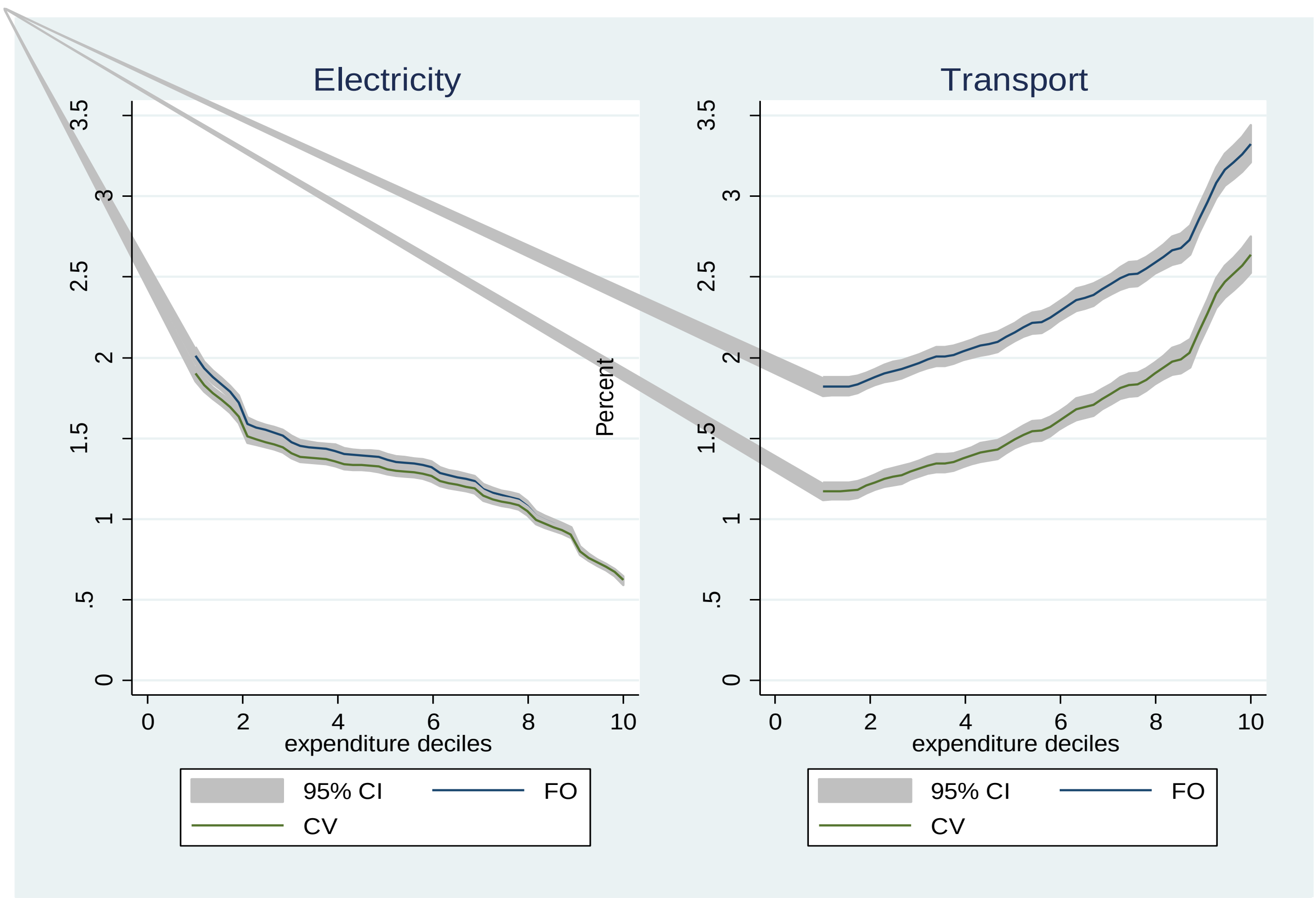

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Welfare losses from energy goods

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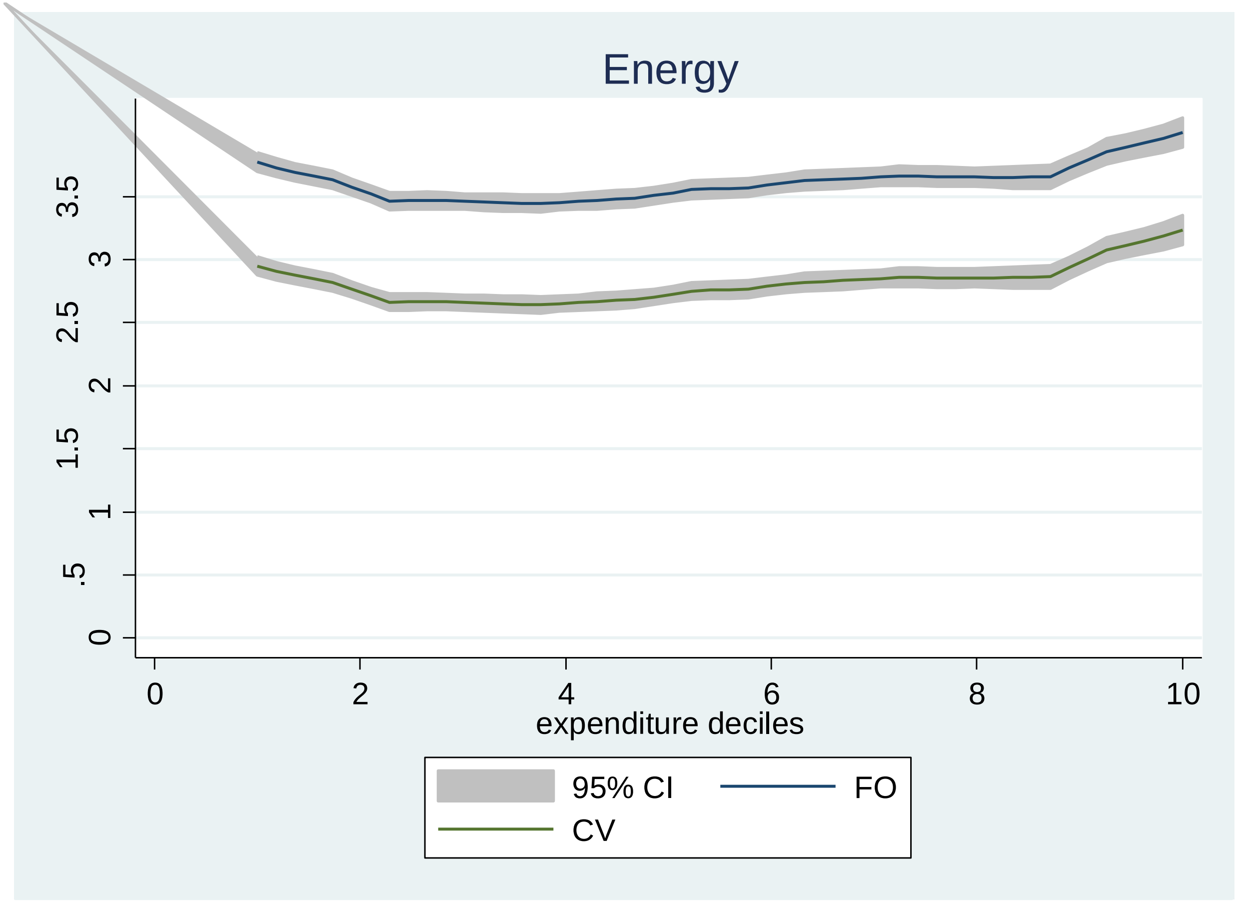

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Welfare losses by settlement type

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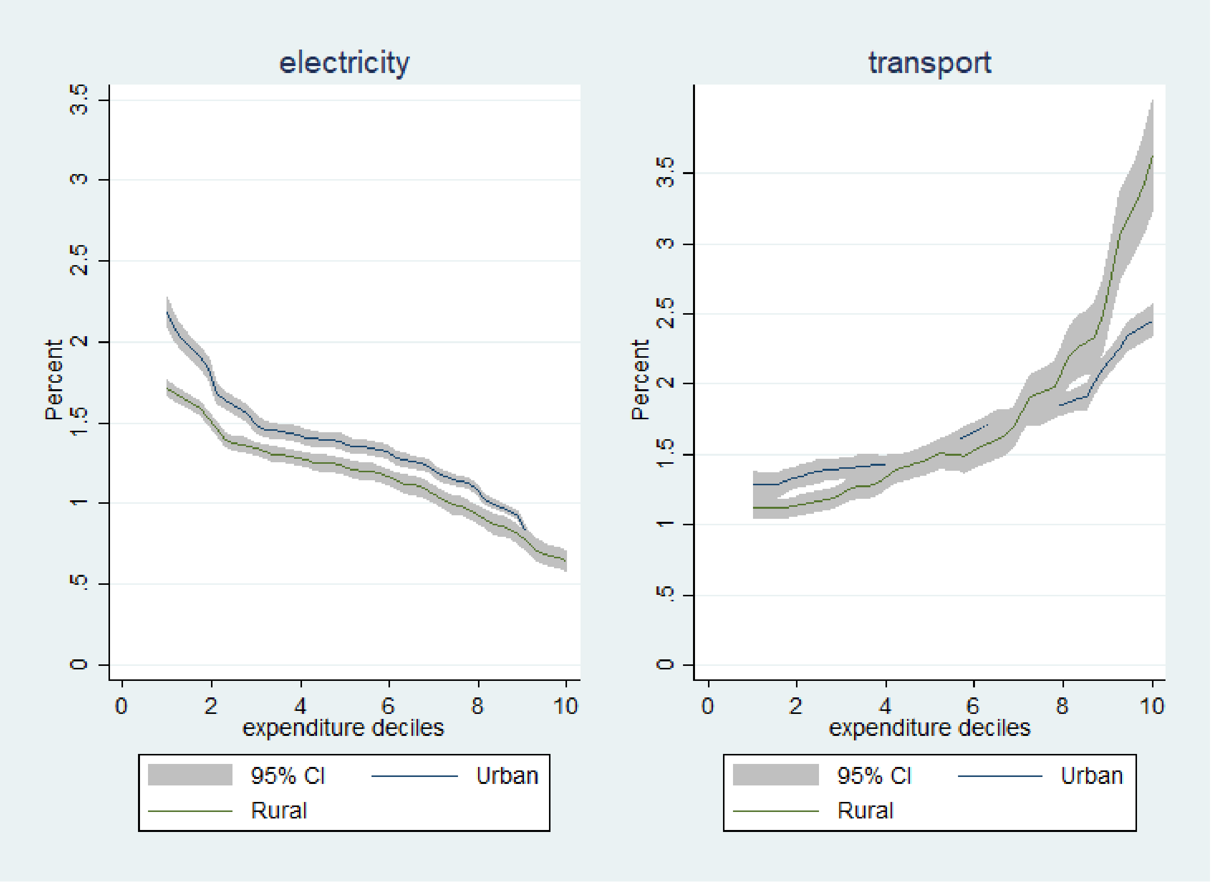

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Welfare losses by settlement

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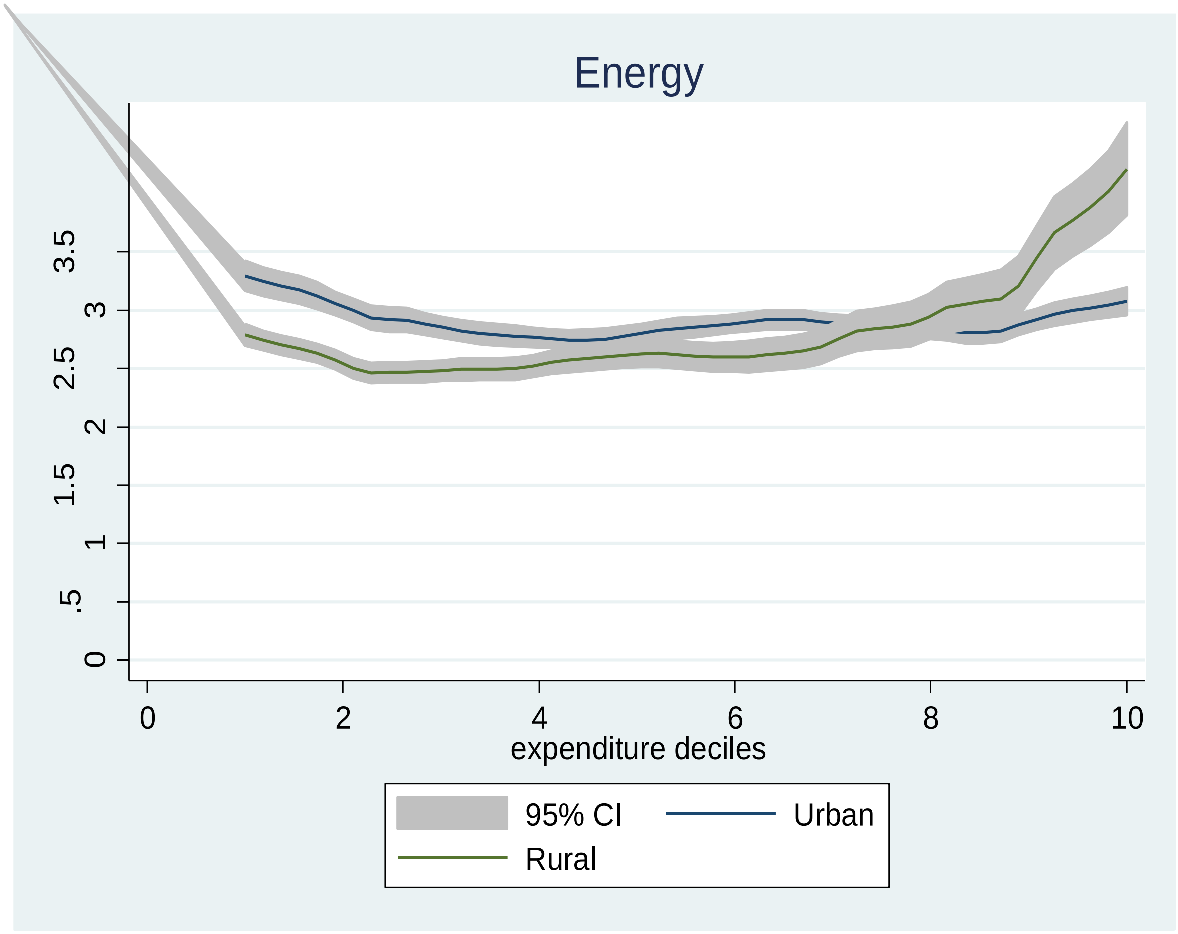

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Lump-sum Tax Transfer

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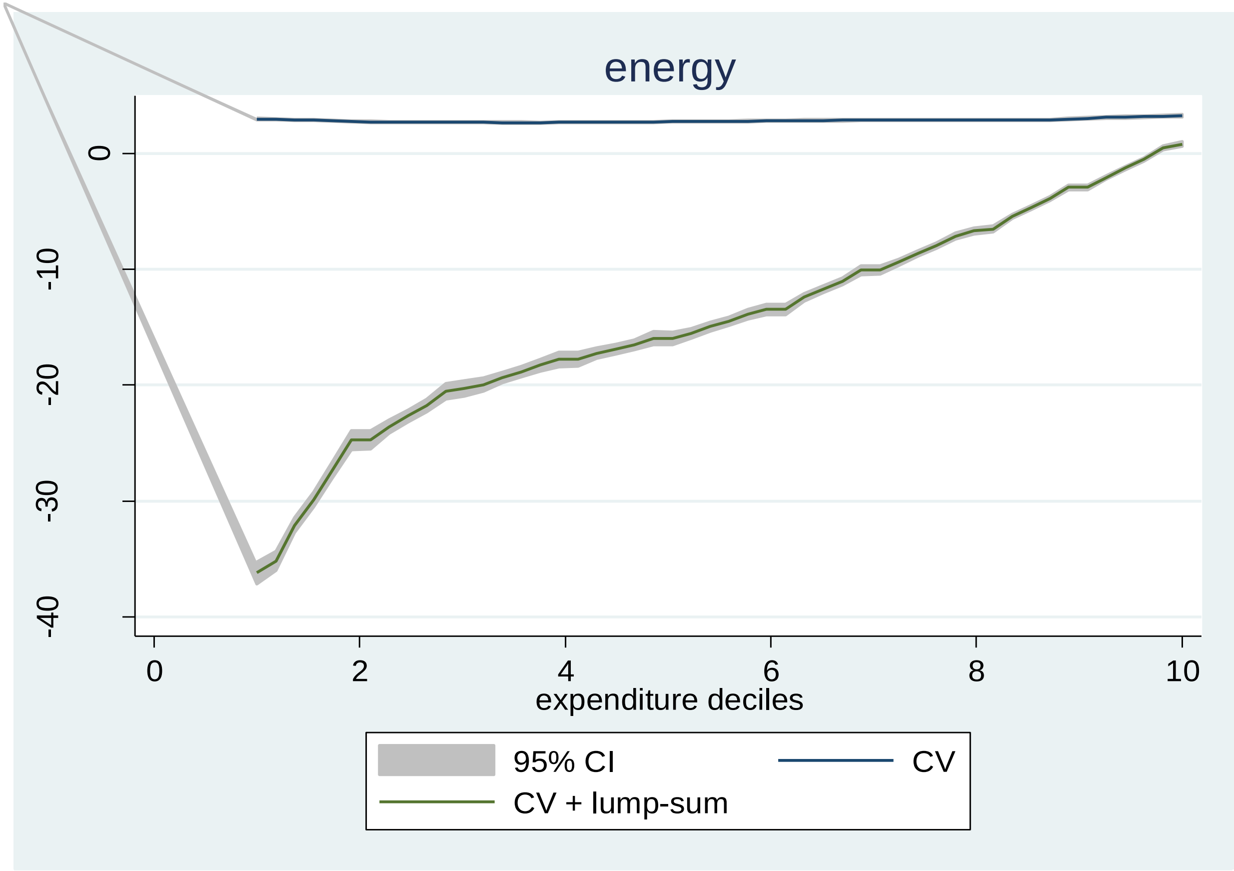

Conclusion

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- The first-order effect overestimates the welfare loss.
- Electricity price changes is regressive while transport-related price changes is progressive.
- Simultaneous price increases for the energy goods lead to a U-shaped welfare loss curve.
- Revenue recycling such as lump-sum transfers is important to reduce the adverse effects of the tax on the poor

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