Pro-rich inflation, redistribution and CO_2 emissions

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Outline

A brief overview of three papers:

- Pro-rich Inflation in Europe: Implications for the Measurement of Inequality (*joint with A. Weichenrieder*)
  - → Poorer individuals in the EU are disproportionately hurt.
- Pro-rich Inflation and Optimal Income Taxation (*joint with A. Weichenrieder*)
  - → Constant optimal average taxes in response to pro-rich inflation.
- Is There a Green Dividend of National Redistribution? (*joint with A. Weichenrieder*)
  - → Higher redistribution (mostly) does not reduce GHG emissions.

Paper 1:

Pro-rich Inflation: Implications for the Measurement of Inequality

(*joint with A. Weichenrieder*)

Overview

Motivation:

- Expenditure baskets of individuals differ, (i.e., Engel curves)
- as well as the changes in the prices of various expenditure categories.
- A uniform CPI cannot capture the heterogeneity in inflation experiences.

Research Question:

- Have inflation exposures differed across the distribution in the EU?

Contribution:

- Majority of the recent literature focused on developing economies (Goni et al., 2006; Arndt et al., 2015)

  $\Rightarrow$ First to analzye this phenomenon in 25 EU countries with 30 expenditure categories.

Data

- The European Union Household Budget Surveys (HBSs), 2010
  - Household-level data on consumption expenditure structure.
  - Unique harmonised survey for 25 countries of Europe.
  - Wave 2010 with an effective sample size of over 270K.
- Harmonised Index of Consumer Prices (HICP), 2001-15
  - Changes in the prices of expenditure groups in 25 European countries.

Final Data Set: Consumption expenditures of households from 25 countries, for 30 categories; price changes over 2001-15.

Methodology

Constructing household specific price indices:

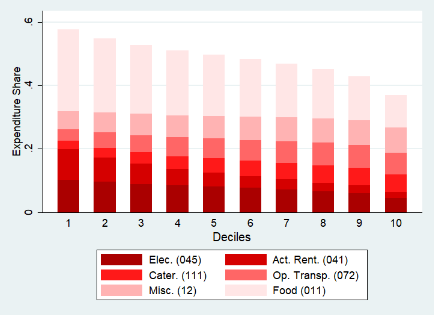
$$\text{Laspeyres Price Index:} \quad q_t^i = \sum_{g \in G} s_{g,t_0}^i \frac{p_{g,t}}{p_{g,t_0}}$$

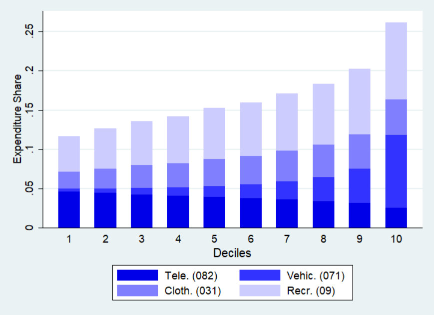
$$\text{Paasche Price Index:} \quad q_t^i = \left(\sum_{g \in G} s_{g,t}^i \frac{p_{g,t_0}}{p_{g,t}} \right)^{-1}$$

- Only the survey of 2010 is available.
- Construct a Paasche index over 2001-10, a Laspeyres index over 2011-15.
- Scale Laspeyres index of 2011 with Paasche of 2011 to avoid a break.
- Yields the lower bound of rich vs. poor inflation differential.

Results (1)

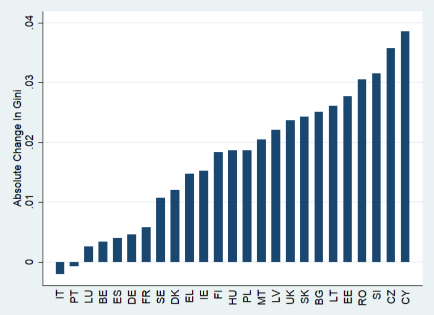
- Poorest decile's basket became 11.2 pp. more expensive compared to top decile.
- Yearly richest vs. poorest decile difference: 0.76% (average CPI = 2.67%).





- Main drivers: Prices of food and housing related items.

Results (2)



- Avg. change in regular disposable income Gini: 0.020
  Avg. change in Gini due to inflation effects: 0.016
- Cross-country differences in inflation effects alter inequality ranking.

Paper 2:

Pro-rich Inflation and Optimal Income Taxation
(*joint with A. Weichenrieder*)

Overview

Motivation:

- Above-average increases in the prices of necessities disproportionately hurt the poor.

Research Question:

- Can income tax policy address the adverse distributional effects?

Contribution:

- Optimal income tax implications with differing subsistence levels (Rowe and Woolley, 1999; Kaplow, 2008)
- Optimal income taxes with differential exposure to prices (Albuoy, 2009)

  $\Rightarrow$ Asymmetric indirect utility effects of price changes arise solely due to income differences (with homog. preferences and common price changes)

The Model

Discrete Mirrlees Model:

- Agents with wages w^i, goods with prices p_g
- $Y_G^i = w^i l^i$ and $Y_N^i = Y_G^i - T(Y_G^i)$
- Agents' utility function (with subsistence parameters γ_g):

$$U^i = \sum_{g \in G} u(c_g^i - \gamma_g) - v(l^i)$$

- Government maximizes a utilitarian social welfare with respect to:
  - an incentive compatibility constraint,
  - a budget constraint.

Comparative Statics with Linear Disutility

- Two types: $i \in \{H, L\}$, linear disutility $\rightarrow$ closed-form solutions.
- Necessities (c_n) and luxuries (c_x): p_n, $p_x = 1$; $\gamma_n > 0$, $\gamma_x = 0$.
- Utility function reads:

$$U^i = \beta_n log(c_n^i - \gamma_n) + \beta_x log(c_x^i) - v\frac{Y_G^i}{w^i}.$$

Proposition 1.

i. $\frac{\partial T(Y_G^i)}{\partial p_n} = 0,$

ii. $\frac{\partial Y_G^i}{\partial p_n} = \frac{\partial Y_N^i}{\partial p_n} = \gamma_n,$

iii. $\frac{\partial I^L}{\partial p_n} > \frac{\partial I^H}{\partial p_n}.$

A Quantitative Thought Experiment (1)

- Utility function reads:

$$U^i = \sum_{g \in G} \beta_g log(c_g^i - \gamma_g) - \frac{(Y_G^i / w^i)^{1+1/\epsilon}}{1 + 1/\epsilon}$$

- 12 consumption goods (COICOP, 1-digit) in the utility function + leisure
- Three countries with different magnitudes of pro-rich inflation: Germany, The UK, Czech Republic
- 4 agents: 10^{th}, 33^{th},66^{th} and 90^{th} percentiles
- Linear expend. system estimates over EU HBS 2010 to receive β_g and γ_g.
- Use actual price increases between 1996-2017 and derive optimal policy.

A Quantitative Thought Experiment (2)

	Perc	Wage	1996 Y_G	1996 $T(Y_G)$	1996 τ	1996 $T'(Y_G)$	1996 V	2017 Y_G	2017 $T(Y_G)$	2017 τ	2017 $T'(Y_G)$	2017 V	l Incr.	V Loss
CZ	10th	7.17	5.71	-3.25	-0.570	0.207	81.39	5.80	-3.30	-0.570	0.214	74.30	1.61 %	8.72 %
	33th	10.38	8.94	-1.56	-0.174	0.248	83.24	9.05	-1.58	-0.174	0.255	76.21	1.30 %	8.44 %
	66th	14.51	13.80	0.86	0.062	0.192	85.67	13.95	0.88	0.063	0.197	78.72	1.12 %	8.11 %
	90th	20.00	21.40	3.95	0.185	0.000	89.13	21.61	4.01	0.185	0.000	82.29	0.99 %	7.68 %
DE	10th	20.48	13.83	-20.67	-1.494	0.282	93.33	13.93	-20.82	-1.494	0.286	89.95	0.73 %	3.62 %
	33th	37.82	31.20	-9.31	-0.298	0.311	95.29	31.39	-9.37	-0.298	0.315	91.95	0.60 %	3.51 %
	66th	57.62	54.27	4.07	0.075	0.261	97.91	54.55	4.12	0.075	0.264	94.61	0.51 %	3.37 %
	90th	88.46	98.90	25.90	0.262	0.000	102.39	99.34	26.07	0.262	0.000	99.14	0.45 %	3.17 %
UK	10th	3.16	1.01	-20.10	-19.9	0.315	89.45	1.01	-20.20	-19.9	0.318	84.00	0.46 %	6.09 %
	33th	21.32	16.01	-8.35	-0.522	0.348	91.01	16.07	-8.38	-0.522	0.351	85.58	0.38 %	5.97 %
	66th	36.15	32.45	2.26	0.070	0.320	93.46	32.55	2.28	0.070	0.322	88.05	0.32 %	5.79 %
	90th	64.72	74.60	26.19	0.351	0.000	98.81	74.81	26.30	0.352	0.000	93.44	0.29 %	5.43 %

- Constant avg. tax rates irrespective of the magnitude.
- Poorer is worse off despite government and individuals acting optimally.

Paper 3:

Is There a Green Dividend of National Redistribution?

(*joint with A. Weichenrieder*)

Overview

Motivation:

- CO_2 emissions are disproportionately caused by the most affluent.
  (Chancel and Piketty, 2015; Oxfam, 2020)

Research Question:

- Does redistribution generate environmental benefits? If yes, how large?

Contribution:

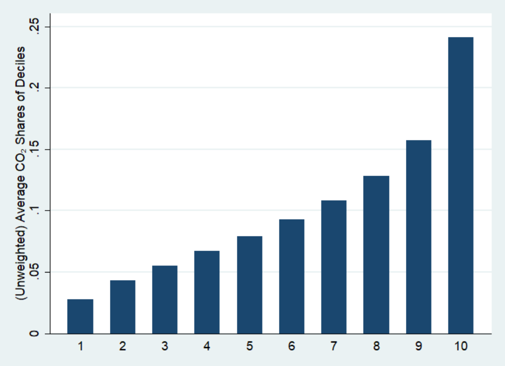
- Exploiting time dimension or cross-country variation
  See Baek and Gweiseah (2013), Tarek and Beldi, (2022) among others.
- Micro-data approach with limited number of products and countries; emission data of only local production
  (Brannlund and Ghalwash, 2008; Duarte et al., 2012; Sorheim, 2021; Golley and Meng, 2021)

  $\Rightarrow$ Focus on 26 EU countries with 200 products whose emission intensities.

Data and Preparation

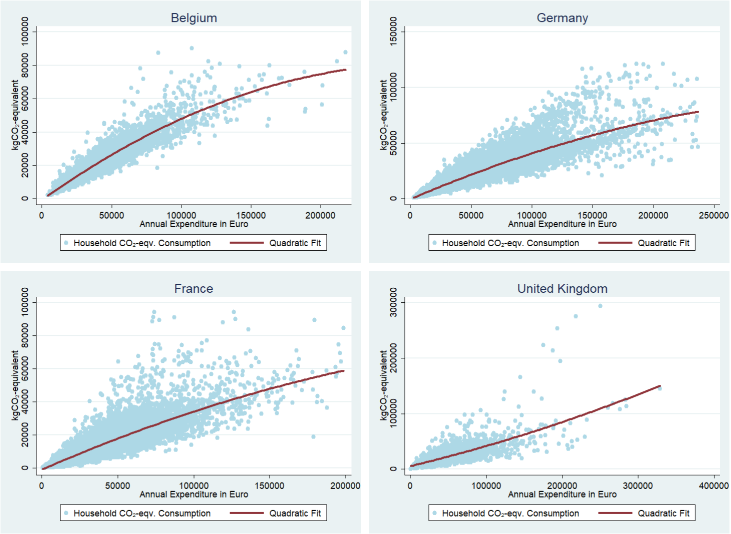
- Emission coefficients for 200 products from EXIOBASE, a multi-regional input-output database
- EU HBSs of 2010 for 26 countries, 63 product baskets (51 for Germany, 59 for Sweden)
  - Convert expenditures for 63 HBS products into 200 EXIOBASE categories (Ivanova and Wood, 2020)
  - Scale expenditures on 200 products to match national accounts
  - Convert expenditures in purchaser prices to basic prices: remove taxes, reallocate trade & transport margins
  - Contrails induced by aviation amplify adverse environmental impact: multiply the coefficient on Kerosene by three (Wit et al., 2005)

A Stylized Fact



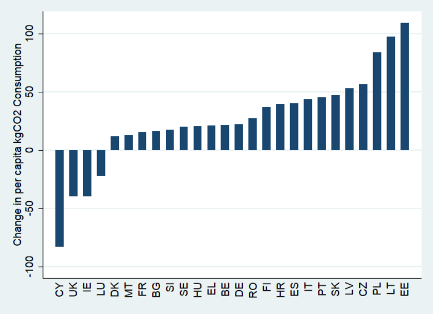
- Top 30% is responsible for more than 50% of emissions in the EU.
- However, Engel curves of CO_2 consumption read ...

Engel Curves



A Thought Experiment

- Tax 10% of net household consumption and redistribute equally (3 to 4 points of change in Gini)
- Assume that redistribution is not distortive Neutralizing Distortions



- Negative green dividend in 22 out of 26 countries

Conclusion

- Is there an asymmetric impact of inflation across the distribution?
  - Basket of the poorest decile became 11.2 ppt. more expensive in the EU over 2001-15 compared to the richest decile.
- Is it optimal to redistribute more in response?
  - Disproportinate labor supply response by low-income individuals counteracts the willingness to redistribute.
- Does redistribution reduce GHG emissions?
  - No, unless the distortions due to taxation are sufficiently high.

Appendix (1)

Pro-rich Inflation:

- Methodology of the price index Price Index
- Category names Names
- Total expenditure shares and prices Total
- Expenditure share differentials and prices Differentials
- Differences in inflation exposure and significance Significance
- Inequality implications Inequality Implications
- Gini changes vs. inflation effects Gini Changes

Optimal Redistribution:

- Problems of agents Problems
- Simulation specifications and calibration Simulations
- Result tables Tables

Appendix (2)

Green Dividend:

- Category names Category Names
- Methodology of experiment Methodology

Methodology

Laspeyres Price Index: $$q_t^i = \sum_{g \in G} s_{g,t_0}^i \frac{p_{g,t}}{p_{g,t_0}}$$

Paasche Price Index: $$q_t^i = \left(\sum_{g \in G} s_{g,t}^i \frac{p_{g,t_0}}{p_{g,t}} \right)^{-1}$$

- Only the survey of 2010 is available.
- Construct a Paasche index over 2001-10, a Laspeyres index over 2011-15.
- Scale Laspeyres index of 2011 with Paasche of 2011 to avoid a break.
- Tracks the lower-bound of cost-of-living across 2001-15.

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Category Names

- **011:** Food
- **012:** Non-alcoholic beverages
- **021:** Alcoholic beverages
- **022:** Tobacoo
- **031:** Clothing
- **032:** Footwear
- **041:** Actual rentals of housing
- **042:** Imputed rentals of housing
- **043:** Maintenance and repair of the dwelling
- **044:** Water supply and misc. services.
- **045:** Electricity, gas and other fuels
- **051:** Furniture and furnishings, floor coverings.
- **052:** Household textile.
- **053:** Household appliances.
- **054:** Glassware, tableware and household utensils.
- **055:** Tools and equipment for house and garden.
- **056:** Goods and services for household maintenance.
- **061:** Medical products, appliances and equipment.
- **062:** Out-patient services.
- **063:** Hospital services.
- **071:** Purchase of vehicles.
- **072:** Operation of personal transport and equipment.
- **073:** Transport services.
- **081:** Postal services.
- **082:** Telephone and telefax services and equipment.
- **09:** Recreation and culture.
- **10:** Education.
- **111:** Catering services.
- **112:** Accommodation services.
- **12:** Misc. goods and services.

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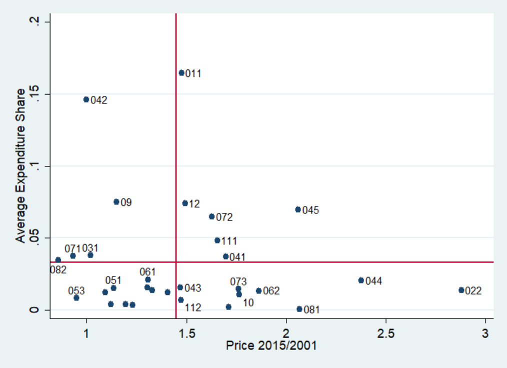
Total Expenditure Shares and Prices



Note: The red line parallel to the x-axis represents the mean of the common CPIs. The red line parallel to the y-axis indicates the mean of the aggregate expenditure shares of 30 categories across countries.

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Expenditure Share Differentials and Prices

Note: Y- axis is the difference in the expenditure shares of the richest and the poorest decile. X-axis is the price of the corresponding category in 2015 divided by the 2001 price. Vertical line indicates the mean of the common CPIs across countries.

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Differences in Inflation Exposure and Significance

Comparison of the increase in the effective inflation rates with the 10th decile (t-tests):

Decile	1	2	3	4	5	6	7	8	9
Difference	0.112***	0.098***	0.088***	0.079***	0.073***	0.065***	0.055***	0.047***	0.034***
	(0.015)	(0.014)	(0.013)	(0.011)	(0.012)	(0.011)	(0.010)	(0.010)	(0.008)
Implied Yearly Difference	0.76	0.67	0.60	0.55	0.51	0.45	0.38	0.33	0.24

Notes: *** denotes the significance level at 1%. Standard errors are reported in parentheses.

Average common CPI: 2.67%

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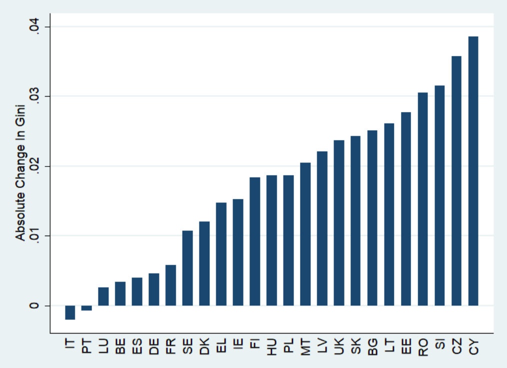
Inequality Implications



Note: Bars indicate the difference between Gini of total expenditures deflated with the common CPI and Gini of total expenditures deflated by household-specific CPIs for the corresponding country.

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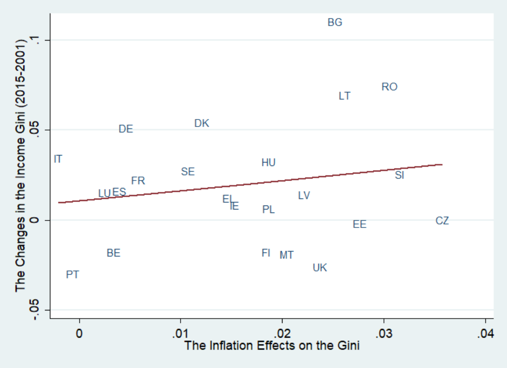
Gini Changes vs. Inflation Effects



Note: Y-axis indicates the difference between the disposable income Ginis of 2015 and 2001. X-axis denotes Gini effects of "pro-rich inflation".

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Problem (Individuals)

Maximize utility:

$$U^i = \sum_{g \in G} u_g(c_g^i - \gamma_g) - v(l^i)$$

with respect to budget constraint:

$$\sum_{g \in G} p_g c_g^i = Y_N^i = Y_G^i - T(Y_G^i) = w^i l^i - T(w^i l^i)$$

2x2 model for analytical purposes:

$$U^i = \beta_n log(c_n^i - \gamma_n) + \beta_x log(c_x^i) - v\frac{Y_G^i}{w^i}, \quad i \in \{H, L\}$$

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Problem (Government)

Maximize total welfare:

$$W = \sum_{i \in I} f^i U^i$$

Resource constraint:

$$\sum_{i \in I} f^i (Y_G^i - Y_N^i) = 0$$

Incentive compatibility constraint:

$$\sum_{g \in G} u_g(c_g^i - \gamma_g) - v(\frac{Y_G^i}{w^i}) \geq \sum_{g \in G} u_g(c_g^{i'} - \gamma_g) - v(\frac{Y_G^{i'}}{w^i})$$

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Simulation Specifications and Calibration (1)

- Four agents: 10^{th}, 33^{rd}, 66^{th} and 90^{th} percentiles of total exp. distribution
- Twelve consumption expenditure goods: COICOP two-digit categories
- Calibrate separately to three countries: Czechia, Germany, the UK
- Utility specification:

$$U^i = \sum_{g \in G} \beta_g log(c_g^i - \gamma_g) - \frac{(\frac{Y_G^i}{w^i})^{1+1/\epsilon}}{1 + 1/\epsilon}$$

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Simulation Specifications and Calibration (2)

Individual utility maximization yields the following set of demand functions:

$$c_g^i = \gamma_g + \frac{\beta_g}{p_g}\left(Y_N^i - \sum_{g \in G} p_g \gamma_g\right)$$

Multiplying both sides with $\frac{p_g}{Y_N^i}$ yields:

$$s_g^i = \frac{p_g \gamma_g}{Y_N^i} + \frac{\beta_g}{Y_N^i}\left(Y_N^i - \sum_{g \in G} p_g \gamma_g\right)$$

where s_g^i denotes the expenditure share of agent i on good g. Y_N^i is observed in the data. p_g is normalized to unity for 2010. Perform a linear expenditure system estimation over four percentiles to estimate $\{\beta_g, \gamma_g\}$ pairs in three countries. (48 targets, 24 parameters)

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Simulation Specifications and Calibration (3)

Estimated parameters:

Good Categories	CZ β_n	CZ γ_g	DE β_n	DE γ_g	UK β_n	UK γ_g
Food and Non-alcoholic Beverages	0.184	0.311	0.124	0.897	0.120	0.524
Alcoholic beverages and Tobacco	0.031	0.007	0.016	0.151	0.030	0.026
Clothing and Footwear	0.059	-0.065	0.059	-0.061	0.060	-0.212
Housing	0.190	0.554	0.097	3.609	0.179	0.906
Furnishing, Household Equipment	0.074	-0.075	0.068	-0.286	0.073	-0.189
Health	0.023	0.067	0.053	-0.171	0.013	-0.023
Transport	0.135	-0.299	0.186	-0.723	0.166	-0.512
Communications	0.047	0.034	0.024	0.327	0.029	0.133
Recreation and Culture	0.117	-0.088	0.140	-0.272	0.131	-0.313
Education	0.009	-0.024	0.012	-0.049	0.018	-0.112
Restaurants and Hotels	0.058	-0.060	0.066	-0.160	0.100	-0.235
Misc. Goods	0.073	-0.016	0.155	-0.460	0.081	0.051

Notes: Reported values for γ_g are in annual (000) EUR units.

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Simulation Specifications and Calibration (4)

Prices over 1996-2017:

	CZ			DE			UK		
Good Categories	1996	2017	Incr.	1996	2017	Incr.	1996	2017	Incr.
Food and Non-alcoholic Beverages	0.831	1.245	0.499	0.852	1.164	0.366	0.721	1.095	0.519
Alcoholic beverages and Tobacco	0.521	1.250	1.400	0.640	1.181	0.847	0.603	1.384	1.297
Clothing and Footwear	1.226	1.026	-0.163	0.983	1.090	0.109	2.066	1.077	-0.479
Housing	0.293	1.136	2.880	0.731	1.098	0.503	0.611	1.217	0.992
Furnishing, Household Equipment	0.961	0.955	-0.006	0.928	1.046	0.127	0.932	1.121	0.203
Health	0.417	1.109	1.660	0.717	1.056	0.474	0.664	1.196	0.801
Transport	0.734	1.031	0.406	0.733	1.078	0.472	0.651	1.149	0.763
Communications	0.567	0.812	0.433	1.497	0.909	-0.393	1.221	1.196	-0.021
Recreation and Culture	0.781	1.034	0.325	0.954	1.088	0.140	0.977	1.041	0.066
Education	0.474	1.120	1.364	0.603	0.974	0.616	0.394	1.742	3.419
Restaurants and Hotels	0.576	1.154	1.006	0.802	1.198	0.494	0.632	1.219	0.931
Misc. Goods	0.584	1.103	0.889	0.806	1.077	0.336	0.677	1.089	0.609

Notes: 2010 is taken as the base year. "Incr." denotes the overall price growth between 1996 and 2017.

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Simulation Specifications and Calibration (5)

Individual optimization with respect to labor supply:

$$1 - T'(Y_G^i) = \left(\frac{1}{w^i}\right)\left(\frac{Y_G^i}{w^i}\right)^{1/\epsilon}\left(Y_N^i - \sum_{g=1}^{12} p_g \gamma_g\right)$$

Utilize OECD Tax and Benefit Simulator to extract actual tax rates of four percentiles in three countries:

	CZ		DE		UK	
Percentiles	METR	AETR	METR	AETR	METR	AETR
10^{th}	0.518	0.097	0.457	0.326	0.353	-6.555
33^{rd}	0.311	0.226	0.524	0.398	0.310	0.213
66^{th}	0.311	0.251	0.469	0.439	0.310	0.254
90^{th}	0.311	0.267	0.469	0.444	0.410	0.303

Substitute in tax rates, Y_N^i, p_g and estimated γ_g values to compute w^i for four percentiles in three countries.

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Main Results

	Percentiles	Wage	1996 $T(Y_G)$	1996 τ	1996 $T'(Y_G)$	2017 $T(Y_G)$	2017 τ	2017 $T'(Y_G)$	I Incr. %	V Loss %
CZ	10^{th}	7.17	-3.25	-0.57	0.21	-3.30	-0.57	0.21	1.61%	8.51%
	33^{rd}	10.38	-1.56	-0.17	0.25	-1.58	-0.17	0.26	1.30%	8.30%
	66^{th}	14.51	0.86	0.06	0.19	0.88	0.06	0.20	1.12%	8.08%
	90^{th}	20.00	3.95	0.18	0.00	4.01	0.18	0.00	0.99%	7.81%
DE	10^{th}	20.48	-20.67	-1.49	0.28	-20.82	-1.49	0.29	0.73%	3.66%
	33^{rd}	37.82	-9.31	-0.30	0.31	-9.37	-0.30	0.31	0.60%	3.60%
	66^{th}	57.62	4.07	0.07	0.26	4.12	0.07	0.26	0.51%	3.51%
	90^{th}	88.46	25.90	0.26	0.00	26.07	0.26	0.00	0.45%	3.40%
UK	10^{th}	3.16	-20.10	-19.99	0.31	-20.20	-19.99	0.32	0.46%	5.35%
	33^{rd}	21.32	-8.35	-0.52	0.35	-8.38	-0.52	0.35	0.38%	5.34%
	66^{th}	36.15	2.26	0.07	0.32	2.28	0.07	0.32	0.32%	5.25%
	90^{th}	64.72	26.19	0.35	0.00	26.30	0.35	0.00	0.29%	5.10%

- Slightly increased net nominal taxes
- Stable average tax rates

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$\gamma_g > 0$

	Percentiles	Wage	1996 $T(Y_G)$	1996 τ	1996 $T'(Y_G)$	2017 $T(Y_G)$	2017 τ	2017 $T'(Y_G)$	I Incr. %	V Loss %
CZ	10^{th}	6.86	-3.37	-0.61	0.22	-3.44	-0.61	0.23	2.22%	8.87%
	33^{rd}	10.08	-1.60	-0.18	0.26	-1.63	-0.18	0.27	1.78%	8.61%
	66^{th}	14.21	0.90	0.07	0.20	0.92	0.07	0.21	1.53%	8.35%
	90^{th}	19.70	4.07	0.19	0.00	4.15	0.19	0.00	1.35%	8.03%
DE	10^{th}	19.04	-21.26	-1.67	0.30	-21.53	-1.67	0.30	1.28%	3.90%
	33^{rd}	36.33	-9.64	-0.32	0.33	-9.74	-0.32	0.33	1.03%	3.82%
	66^{th}	56.18	4.22	0.08	0.27	4.29	0.08	0.28	0.88%	3.71%
	90^{th}	87.06	26.68	0.27	0.00	26.98	0.27	0.00	0.77%	3.55%
UK	10^{th}	2.99	-20.17	-21.20	0.33	-20.37	-21.15	0.33	1.20%	5.60%
	33^{rd}	20.59	-8.66	-0.56	0.36	-8.74	-0.56	0.37	0.82%	5.59%
	66^{th}	35.40	2.22	0.07	0.33	2.25	0.07	0.34	0.69%	5.47%
	90^{th}	63.90	26.62	0.36	0.00	26.86	0.36	0.00	0.61%	5.28%

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Category Names (1)

- Bread and cereals
- Meat
- Fish
- Milk, cheese and eggs
- Oils and fats
- Fruit
- Vegetables
- Sugar, jam, honey, chocolate and confectionery
- Food products n.e.c.
- Non-alcoholic beverages
- Alcoholic beverages
- Tobacco
- Clothing
- Footwear
- Actual rentals for housing
- Imputed rentals for housing
- Maintenance and repair of the dwelling
- Water supply and miscellaneous services relating to the dwelling
- Electricity
- Gas
- Liquid fuels
- Solid fuels
- Heat energy
- Furniture and furnishings
- Carpets and other floor coverings
- Repair of furniture, furnishings and floor coverings
- Household textiles
- Household appliances
- Glassware, tableware and household utensils
- Tools and equipment for house and garden
- Non-durable household goods
- Domestic services and household services
- Medical products, appliances and equipment
- Out-patient services
- Hospital services
- Purchase of vehicles
- Spare parts and accessories for personal transport equipment
- Fuels and lubricants for personal transport equipment
- Maintenance and repair of personal transport equipment
- Other services in respect of personal transport equipment
- Passenger transport by railway
- Passenger transport by road
- Passenger transport by air
- Passenger transport by sea and inland waterway
- Combined passenger transport
- Other purchased transport services
- Communication

Category Names

- Audio-visual, photographic and information processing equipment
- Other major durables for recreation and culture
- Other recreational items and equipment, gardens and pets
- Recreational and cultural services
- Newspapers, books and stationery
- Package holidays
- Education
- Catering services
- Accommodation services
- Personal care
- Jewelry, clocks and watches
- Other personal effects
- Social protection
- Insurance
- Other financial services n.e.c.
- Other services n.e.c.

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Experiment Methodology (1)

$$c_i^{pre} = \alpha + \sum_{k=1}^{7} \lambda_k p_{k,i} + \sum_{j=1}^{5} \sum_{k=1}^{7} \beta_{k,j} p_{k,i} (e_i^{pre})^j + \delta s_i + \varepsilon_i$$

- c_i^{pre}: kg CO_2-equivalent consumption of household i residing in any country observed in the data
- $p_{k,i}$: household type dummies: (i) one adult, (ii) two adults, (iii) more than two adults, (iv) one adult with dependent children, (v) two adults with dependent children, (vi) more than two adults with dependent children, (vii) others
- e_i^{pre}: consumption expenditure of household i residing in any country observed in the data
- s_i: household size

Experiment Methodology (2)

- Tax 10% of consumption exp. c_i^{pre} and redistribute to arrive at c_i^{post}.
- Let 'hat' denote the predicted values of regression coefficients.
- kgCO_2-equivalent consumption of household i after the experiment:

$$c_i^{post} = \hat{\alpha} + \sum_{k=1}^{7} \hat{\lambda}_k p_{k,i} + \sum_{j=1}^{5} \sum_{k=1}^{7} \hat{\beta}_{k,j} p_{k,i} (e_i^{pre})^j + \hat{\delta} s_i + \hat{\varepsilon}_i$$

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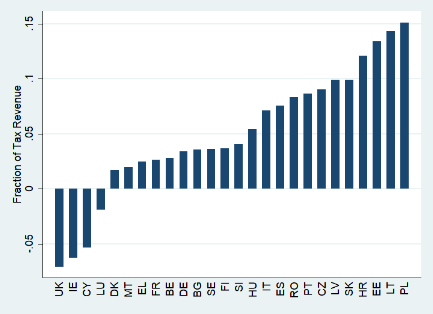
A Thought Experiment

- What about losses in income (and consumption) induced by taxation?
- Required loss in output to overturn redistribution effect on emissons:



- A 10% increase in taxes reduce labor supply up to 5% in the EU (Bargain et al., 2014)

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