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)
⇒ First to analyze 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:

**Laspeyres Price Index:**

\[
q^i_t = \sum_{g \in G} s^i_{g,t_0} \frac{p_{g,t}}{p_{g,t_0}}
\]

**Paasche Price Index:**

\[
q^i_t = \left( \sum_{g \in G} s^i_{g,t} \frac{p_{g,t_0}}{p_{g,t}} \right)^{-1}
\]

- 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.
• 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)

⇒ 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 $p_g$
- $Y^i_G = w^i l^i$ and $Y^i_N = Y^i_G - T(Y^i_G)$
- Agents’ utility function (with subsistence parameters $\gamma_g$):
  \[
  U^i = \sum_{g \in G} u(c^i_g - \gamma_g) - v(l^i)
  \]
- 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 → closed-form solutions.
- Necessities \((c_n)\) and luxuries \((c_x)\): \( p_n, p_x = 1; \gamma_n > 0, \gamma_x = 0 \).
- Utility function reads:

\[
U^i = \beta_n \log(c^i_n - \gamma_n) + \beta_x \log(c^i_x) - v \frac{Y_G^i}{w^i}.
\]

\textit{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. \( \frac{\partial I_L^i}{\partial p_n} > \frac{\partial I_H^i}{\partial p_n}. \)
A Quantitative Thought Experiment (1)

- Utility function reads:
  \[ U^i = \sum_{g \in G} \beta_g \log(c^i_g - \gamma_g) - \frac{(Y^i_G/w^i)^{1+1/\epsilon}}{1 + 1/\epsilon} \]

- 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: 10th, 33th, 66th and 90th percentiles

- Linear expend. system estimates over EU HBS 2010 to receive \( \beta_g \) and \( \gamma_g \).

- Use actual price increases between 1996-2017 and derive optimal policy.
### A Quantitative Thought Experiment (2)

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<th></th>
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<th></th>
<th>2017</th>
<th></th>
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<td>$T'(Y_G)$</td>
<td>$V$</td>
<td>$Y_G$</td>
<td>$T(Y_G)$</td>
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<td>0.282</td>
<td>93.33</td>
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<td>0.311</td>
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<td>57.62</td>
<td>54.27</td>
<td>4.07</td>
<td>0.075</td>
<td>0.261</td>
<td>97.91</td>
<td>54.55</td>
<td>4.12</td>
</tr>
<tr>
<td></td>
<td>90th</td>
<td>88.46</td>
<td>98.90</td>
<td>25.90</td>
<td>0.262</td>
<td>0.000</td>
<td>102.39</td>
<td>99.34</td>
<td>26.07</td>
</tr>
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<td>10th</td>
<td>3.16</td>
<td>1.01</td>
<td>-20.10</td>
<td>-19.9</td>
<td>0.315</td>
<td>89.45</td>
<td>1.01</td>
<td>-20.20</td>
</tr>
<tr>
<td></td>
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<td>16.01</td>
<td>-8.35</td>
<td>-0.522</td>
<td>0.348</td>
<td>91.01</td>
<td>16.07</td>
<td>-8.38</td>
</tr>
<tr>
<td></td>
<td>66th</td>
<td>36.15</td>
<td>32.45</td>
<td>2.26</td>
<td>0.070</td>
<td>0.320</td>
<td>93.46</td>
<td>32.55</td>
<td>2.28</td>
</tr>
<tr>
<td></td>
<td>90th</td>
<td>64.72</td>
<td>74.60</td>
<td>26.19</td>
<td>0.351</td>
<td>0.000</td>
<td>98.81</td>
<td>74.81</td>
<td>26.30</td>
</tr>
</tbody>
</table>

- 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)

⇒ 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 ...
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

• 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?
  - Disproportionate 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
- Category names
- Total expenditure shares and prices
- Expenditure share differentials and prices
- Differences in inflation exposure and significance
- Inequality implications
- Gini changes vs. inflation effects

Optimal Redistribution:

- Problems of agents
- Simulation specifications and calibration
- Result tables
Appendix (2)

Green Dividend:

- Category names
- Methodology of experiment
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.
Category Names

- 011: Food
- 012: Non-alcoholic beverages
- 021: Alcoholic beverages
- 022: Tobacco
- 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.
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.
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.
Differences in Inflation Exposure and Significance

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

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

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

Average common CPI: 2.67%

Back
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.
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”.
Problem (Individuals)

Maximize utility:

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

with respect to budget constraint:

$$\sum_{g \in G} p_g c^i_g = Y^i_N = Y^i_G - T(Y^i_G) = w^i l^i - T(w^i l^i)$$

2x2 model for analytical purposes:

$$U^i = \beta_n \log(c^i_n - \gamma_n) + \beta_x \log(c^i_x) - v \frac{Y^i_G}{w^i}, \quad i \in \{H, L\}$$
Problem (Government)

Maximize total welfare:

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

Resource constraint:

\[ \sum_{i \in I} f^i (Y^i_G - Y^i_N) = 0 \]

Incentive compatibility constraint:

\[ \sum_{g \in G} u_g(c^i_g - \gamma_g) - v(Y^i_G) \geq \sum_{g \in G} u_g(c^{i'}_g - \gamma_g) - v(Y^{i'}_G) \]
Simulation Specifications and Calibration (1)

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

\[ U^i = \sum_{g \in G} \beta_g \log(c^i_g - \gamma_g) - \left( \frac{y^i_G}{w^i} \right)^{1+1/\epsilon} \]

\[ \frac{1}{1 + 1/\epsilon} \]
Simulation Specifications and Calibration (2)

Individual utility maximization yields the following set of demand functions:

$$c^i_g = \gamma_g + \frac{\beta_g}{p_g} \left( Y^i_N - \sum_{g \in G} p_g \gamma_g \right)$$

Multiplying both sides with $\frac{p_g}{Y^i_N}$ yields:

$$s^i_g = \frac{p_g \gamma_g}{Y^i_N} + \frac{\beta_g}{Y^i_N} \left( Y^i_N - \sum_{g \in G} p_g \gamma_g \right)$$

where $s^i_g$ denotes the expenditure share of agent $i$ on good $g$. $Y^i_N$ 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)
### Estimated parameters:

<table>
<thead>
<tr>
<th>Good Categories</th>
<th>( \beta_n )</th>
<th>( \gamma_g )</th>
<th>( \beta_n )</th>
<th>( \gamma_g )</th>
<th>( \beta_n )</th>
<th>( \gamma_g )</th>
</tr>
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<tr>
<td>Food and Non-alcoholic Beverages</td>
<td>0.184</td>
<td>0.311</td>
<td>0.124</td>
<td>0.897</td>
<td>0.120</td>
<td>0.524</td>
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<tr>
<td>Alcoholic beverages and Tobacco</td>
<td>0.031</td>
<td>0.007</td>
<td>0.016</td>
<td>0.151</td>
<td>0.030</td>
<td>0.026</td>
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<tr>
<td>Clothing and Footwear</td>
<td>0.059</td>
<td>-0.065</td>
<td>0.059</td>
<td>-0.061</td>
<td>0.060</td>
<td>-0.212</td>
</tr>
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<td>Housing</td>
<td>0.190</td>
<td>0.554</td>
<td>0.097</td>
<td>3.609</td>
<td>0.179</td>
<td>0.906</td>
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<td>Furnishing, Household Equipment</td>
<td>0.074</td>
<td>-0.075</td>
<td>0.068</td>
<td>-0.286</td>
<td>0.073</td>
<td>-0.189</td>
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<td>0.067</td>
<td>0.053</td>
<td>-0.171</td>
<td>0.013</td>
<td>-0.023</td>
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<td>0.166</td>
<td>-0.512</td>
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<td>-0.272</td>
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<td>-0.049</td>
<td>0.018</td>
<td>-0.112</td>
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<td>-0.060</td>
<td>0.066</td>
<td>-0.160</td>
<td>0.100</td>
<td>-0.235</td>
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<td>-0.016</td>
<td>0.155</td>
<td>-0.460</td>
<td>0.081</td>
<td>0.051</td>
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**Notes:** Reported values for \( \gamma_g \) are in annual (000) EUR units.
## Prices over 1996-2017:

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<th>UK</th>
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<td>Food and Non-alcoholic Beverages</td>
<td>0.831</td>
<td>1.245</td>
<td>0.499</td>
<td>0.852</td>
<td>1.164</td>
<td>0.366</td>
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<tr>
<td>Alcoholic beverages and Tobacco</td>
<td>0.521</td>
<td>1.250</td>
<td>1.400</td>
<td>0.640</td>
<td>1.181</td>
<td>0.847</td>
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<td>Clothing and Footwear</td>
<td>1.226</td>
<td>1.026</td>
<td>-0.163</td>
<td>0.983</td>
<td>1.090</td>
<td>0.109</td>
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<td>Housing</td>
<td>0.293</td>
<td>1.136</td>
<td>2.880</td>
<td>0.731</td>
<td>1.098</td>
<td>0.503</td>
</tr>
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<td>Furnishing, Household Equipment</td>
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<td>0.955</td>
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<td>0.928</td>
<td>1.046</td>
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<td>1.660</td>
<td>0.717</td>
<td>1.056</td>
<td>0.474</td>
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<td>0.406</td>
<td>0.733</td>
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<td>1.497</td>
<td>0.909</td>
<td>-0.393</td>
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<td>0.325</td>
<td>0.954</td>
<td>1.088</td>
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<td>1.364</td>
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<td>0.616</td>
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<tr>
<td>Restaurants and Hotels</td>
<td>0.576</td>
<td>1.154</td>
<td>1.006</td>
<td>0.802</td>
<td>1.198</td>
<td>0.494</td>
</tr>
<tr>
<td>Misc. Goods</td>
<td>0.584</td>
<td>1.103</td>
<td>0.889</td>
<td>0.806</td>
<td>1.077</td>
<td>0.336</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Percentiles</th>
<th>CZ</th>
<th>DE</th>
<th>UK</th>
</tr>
</thead>
<tbody>
<tr>
<td>10^{th}</td>
<td>0.518</td>
<td>0.457</td>
<td>0.353</td>
</tr>
<tr>
<td>33^{rd}</td>
<td>0.311</td>
<td>0.524</td>
<td>0.310</td>
</tr>
<tr>
<td>66^{th}</td>
<td>0.311</td>
<td>0.469</td>
<td>0.310</td>
</tr>
<tr>
<td>90^{th}</td>
<td>0.311</td>
<td>0.469</td>
<td>0.310</td>
</tr>
</tbody>
</table>

Substitute in tax rates, \( Y_N^i \), \( p_g \) and estimated \( \gamma_g \) values to compute \( w_i \) for four percentiles in three countries.
Main Results

<table>
<thead>
<tr>
<th>Percentiles</th>
<th>Wage</th>
<th>$T(Y_G)$</th>
<th>$\tau$</th>
<th>$T'(Y_G)$</th>
<th>$T(Y_G)$</th>
<th>$\tau$</th>
<th>$T'(Y_G)$</th>
<th>Incr. %</th>
<th>V Loss %</th>
</tr>
</thead>
<tbody>
<tr>
<td>10&lt;sup&gt;th&lt;/sup&gt;</td>
<td>7.17</td>
<td>-3.25</td>
<td>-0.57</td>
<td>0.21</td>
<td>-3.30</td>
<td>-0.57</td>
<td>0.21</td>
<td>1.61%</td>
<td>8.51%</td>
</tr>
<tr>
<td>33&lt;sup&gt;rd&lt;/sup&gt;</td>
<td>10.38</td>
<td>-1.56</td>
<td>-0.17</td>
<td>0.25</td>
<td>-1.58</td>
<td>-0.17</td>
<td>0.26</td>
<td>1.30%</td>
<td>8.30%</td>
</tr>
<tr>
<td>66&lt;sup&gt;th&lt;/sup&gt;</td>
<td>14.51</td>
<td>0.86</td>
<td>0.06</td>
<td>0.19</td>
<td>0.88</td>
<td>0.06</td>
<td>0.20</td>
<td>1.12%</td>
<td>8.08%</td>
</tr>
<tr>
<td>90&lt;sup&gt;th&lt;/sup&gt;</td>
<td>20.00</td>
<td>3.95</td>
<td>0.18</td>
<td>0.00</td>
<td>4.01</td>
<td>0.18</td>
<td>0.00</td>
<td>0.99%</td>
<td>7.81%</td>
</tr>
<tr>
<td>10&lt;sup&gt;th&lt;/sup&gt;</td>
<td>20.48</td>
<td>-20.67</td>
<td>-1.49</td>
<td>0.28</td>
<td>-20.82</td>
<td>-1.49</td>
<td>0.29</td>
<td>0.73%</td>
<td>3.66%</td>
</tr>
<tr>
<td>33&lt;sup&gt;rd&lt;/sup&gt;</td>
<td>37.82</td>
<td>-9.31</td>
<td>-0.30</td>
<td>0.31</td>
<td>-9.37</td>
<td>-0.30</td>
<td>0.31</td>
<td>0.60%</td>
<td>3.60%</td>
</tr>
<tr>
<td>66&lt;sup&gt;th&lt;/sup&gt;</td>
<td>57.62</td>
<td>4.07</td>
<td>0.07</td>
<td>0.26</td>
<td>4.12</td>
<td>0.07</td>
<td>0.26</td>
<td>0.51%</td>
<td>3.51%</td>
</tr>
<tr>
<td>90&lt;sup&gt;th&lt;/sup&gt;</td>
<td>88.46</td>
<td>25.90</td>
<td>0.26</td>
<td>0.00</td>
<td>26.07</td>
<td>0.26</td>
<td>0.00</td>
<td>0.45%</td>
<td>3.40%</td>
</tr>
<tr>
<td>10&lt;sup&gt;th&lt;/sup&gt;</td>
<td>3.16</td>
<td>-20.10</td>
<td>-19.99</td>
<td>0.31</td>
<td>-20.20</td>
<td>-19.99</td>
<td>0.32</td>
<td>0.46%</td>
<td>5.35%</td>
</tr>
<tr>
<td>33&lt;sup&gt;rd&lt;/sup&gt;</td>
<td>21.32</td>
<td>-8.35</td>
<td>-0.52</td>
<td>0.35</td>
<td>-8.38</td>
<td>-0.52</td>
<td>0.35</td>
<td>0.38%</td>
<td>5.34%</td>
</tr>
<tr>
<td>66&lt;sup&gt;th&lt;/sup&gt;</td>
<td>36.15</td>
<td>2.26</td>
<td>0.07</td>
<td>0.32</td>
<td>2.28</td>
<td>0.07</td>
<td>0.32</td>
<td>0.32%</td>
<td>5.25%</td>
</tr>
<tr>
<td>90&lt;sup&gt;th&lt;/sup&gt;</td>
<td>64.72</td>
<td>26.19</td>
<td>0.35</td>
<td>0.00</td>
<td>26.30</td>
<td>0.35</td>
<td>0.00</td>
<td>0.29%</td>
<td>5.10%</td>
</tr>
</tbody>
</table>

- Slightly increased net nominal taxes
- Stable average tax rates
\[ \gamma_g > 0 \]

<table>
<thead>
<tr>
<th>Percentiles</th>
<th>Wage</th>
<th>1996</th>
<th>2017</th>
<th>Incr. %</th>
<th>V Loss %</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>( T(Y_G) )</td>
<td>( \tau )</td>
<td>( T'(Y_G) )</td>
<td>( T(Y_G) )</td>
<td>( \tau )</td>
</tr>
<tr>
<td>CZ</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10(^{th})</td>
<td>6.86</td>
<td>-3.37</td>
<td>-0.61</td>
<td>0.22</td>
<td>-3.44</td>
</tr>
<tr>
<td>33(^{rd})</td>
<td>10.08</td>
<td>-1.60</td>
<td>-0.18</td>
<td>0.26</td>
<td>-1.63</td>
</tr>
<tr>
<td>66(^{th})</td>
<td>14.21</td>
<td>0.90</td>
<td>0.07</td>
<td>0.20</td>
<td>0.92</td>
</tr>
<tr>
<td>90(^{th})</td>
<td>19.70</td>
<td>4.07</td>
<td>0.19</td>
<td>0.00</td>
<td>4.15</td>
</tr>
<tr>
<td>DE</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10(^{th})</td>
<td>19.04</td>
<td>-21.26</td>
<td>-1.67</td>
<td>0.30</td>
<td>-21.53</td>
</tr>
<tr>
<td>33(^{rd})</td>
<td>36.33</td>
<td>-9.64</td>
<td>-0.32</td>
<td>0.33</td>
<td>-9.74</td>
</tr>
<tr>
<td>66(^{th})</td>
<td>56.18</td>
<td>4.22</td>
<td>0.08</td>
<td>0.27</td>
<td>4.29</td>
</tr>
<tr>
<td>90(^{th})</td>
<td>87.06</td>
<td>26.68</td>
<td>0.27</td>
<td>0.00</td>
<td>26.98</td>
</tr>
<tr>
<td>UK</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10(^{th})</td>
<td>2.99</td>
<td>-20.17</td>
<td>-21.20</td>
<td>0.33</td>
<td>-20.37</td>
</tr>
<tr>
<td>33(^{rd})</td>
<td>20.59</td>
<td>-8.66</td>
<td>-0.56</td>
<td>0.36</td>
<td>-8.74</td>
</tr>
<tr>
<td>66(^{th})</td>
<td>35.40</td>
<td>2.22</td>
<td>0.07</td>
<td>0.33</td>
<td>2.25</td>
</tr>
<tr>
<td>90(^{th})</td>
<td>63.90</td>
<td>26.62</td>
<td>0.36</td>
<td>0.00</td>
<td>26.86</td>
</tr>
</tbody>
</table>
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.
Experiment Methodology (1)

\[ c_{i}^{pre} = \alpha + \sum_{k=1}^{7} \lambda_k p_{k,i} + \sum_{j=1}^{5} \sum_{k=1}^{7} \beta_{k,j} p_{k,i} (e_{i}^{pre})^j + \delta s_i + \varepsilon_i \]

- \( c_{i}^{pre} \): kgCO₂-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.

- kg$CO_2$-equivalent consumption of household $i$ after the experiment:

$$c_i^{post} = \hat{\alpha} + \sum_{k=1}^{7} \hat{\lambda}_k p_{k,i} + \sum_{j=1}^{5} \sum_{k=1}^{7} \hat{\beta}_{k,j} p_{k,i} (e_i^{pre})^j + \hat{s}_i + \hat{e}_i$$
A Thought Experiment

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

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