Income Tax Structure and Income Distributions: An Index

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Motivation

Main questions

1. What does the structure of the income tax system say about tax elasticity and progressivity?

2. How can we compare across different tax systems in terms of elasticity, progressivity, inequality and revenue stability?

3. Can we create an index that captures how the progressivity of a tax system affects individuals on different levels of incomes?

How does income tax structure affects progressivity and revenue stability?

Motivation: The Irish Tax System, 2019

- *2001: Ireland switches from a traditional tax-free allowance system with multiple incremental thresholds to a simple one with tax credits on the premise that such a system would increase the tax base and thus revenue raising*
- *2008: They also introduce a small traditional tax, USC*

Personal circumstance	**Single/widower, no children**	**Couple 1 earner**	**Couple 2 earners**	**Single/widower with children**
Tax credit	1,650	3,300	3,300	1,650
Threshold	35,300	44,300	44,300	39,300
Low rate	20%	20%	20%	20%
Higher rate	40%	40%	40%	40%

What do credits imply?

Tax-free allowance

1. $0 \ - \ \alpha_1 \rightarrow 0 \ tax \ rate$
2. $\alpha_1 - \alpha_2 \rightarrow t_1 \ tax \ rate$
3. $above \ \alpha_2 \rightarrow t_1 tax \ rate$

- $T_{y1} = 0$
- $T_{y2} = t_1(y_2 - \alpha_1)$
- $T_{y3} = t_1(\alpha_2 - \alpha_1) + t_2(y_3 - \alpha_2)$

$$\varepsilon_2 = \frac{dT_{y2}}{dy_2}\frac{y_2}{T_{y2}} = \frac{t_1 y_2}{t_1(y_2 - \alpha_1)}$$

$$\varepsilon_3 = \frac{t_3 y_3}{(t_1 - t_2)\alpha_2 - t_1\alpha_1 + \ t_2 y_3}$$

Tax credit

1. $0 \ - \alpha \rightarrow t_1 \ tax \ rate$
2. Above $\alpha \ \rightarrow t_2 \ tax \ rate$
3. Every body gets back a TC from tax liability, which is NOT refundable

- $T_{y1} = t_1 y_1$-TC
- $T_{y2} = t_1\alpha + t_2(y_2 - \alpha) - \mathrm{TC}$

$$\varepsilon_1 = \frac{t_1 y_1}{t_1 y_1 - TC}$$

$$\varepsilon_2 = \frac{t_3 y_3}{(t_1 - t_2)\alpha + \ t_2 y_2 - TC}$$

What do credits imply?

- In theory $TC = t_1\alpha_1$
- You can find the equivalent income that corresponds to the threshold
- But it depends a lot on whether TC are refundable
- They affect the marginal effect!
- Individuals with an income around that point display the highest marginal responsiveness in income tax revenues compared to those who do not face credits
- TC do not change taxable income distribution, but impact tax revenue distribution
- We observe that the tax structures with tax credits, the equivalent threshold is much than tax-free allowances
- Tax base is affected

Our story in five steps

1. **Step I:** Use of binned income and income tax data from Ireland to extract the income distribution pre- and post-tax, and the revenue distribution
2. **Step II:** Use of this information on distribution to extrapolate observations of individuals (i.e. gross and taxable income) and then compute the tax paid by each
3. **Step III**: Compare this created revenue distribution with the actual revenue distribution
4. **Step IV:** Estimate the elasticity of the income tax, by regressing income on the tax paid
5. **Step IV:** Use of non-parametric techniques to create a personal index which captures the individual tax elasticity, i.e. how much each individual's tax will change with changes to its gross and taxable income
6. **Step V:** We simulate other countries' income tax structure on our data to compare tax systems in terms of elasticity, progressivity, inequality, revenue stability. We do the same using EUROMOD

Implications of our study

1. Our technique allows to simulate different tax systems in terms of progressivity and revenue stability using publicly available distributional administrative data

2. Allows to compare our results to those arising from micro-level survey data

3. Allows to isolate the non-discretionary effects of changes of income on tax revenue, since we create unique combinations of tax-payer's income – tax paid

4. Allows to capture redistributive effects; identify the distribution of benefits and pensions

5. Our non-parametric index can be used in income inequality analysis or any other micro-level analysis; individual tax elasticity which can be used to examine how taxation affects income earners earning different levels of income

Literature

Two distinct strands:

1. Taxation, elasticity, and progressivity

- Creedy and Gemmell (2004); Creedy and Sanz-Sanz (2014): analytically estimate income tax elasticities
- Attinasi et al. (2011); Gerber et al. (2018): estimate income tax elasticities using aggregate variables across countries

2. Income distributions and inequality

- Piketty (2003); Piketty and Saez (2003); Piketty et al. (2018) examine inequality in France and the USA using a combination of distributional, survey, and national accounts data
- Jargowsky and Wheeler (2018) provide a methodology on estimating income distributions and inequality indices

Data and Income Tax Structures

Irish data

- Irish annual binned data on the distribution of taxpayers' incomes, for 2019 (Irish Revenue Commissioners)
- We start our analysis with one year, to focus on the comparison during similar economic conditions, but the plan is eventually to move towards a panel dataset
- Gross income, taxable income, tax revenues, and the number of cases within each income band for the different taxpayer categories
- 4 main categories for taxpayers (single, married couples with one earning (M1E), married couples with both earning (M2E), and widows/ers)
- 21 income groups
- Combined with tax rates, thresholds and credits for 2019

Data Benefits

- Aggregate administrative data, publicly available for all countries
- Our data captures the total national official labor income and can be connected to national accounts
- Clean of discretionary changes
- Identify different types of tax payers
- Tax revenue depending on their income tax base
- Allows to examine different tax-payer categories separately
- Allows to estimate income distributions and re-create potential close-to-real observations
- Comparable across countries
- Allows to map the different tax systems (rates, thresholds) to the equivalent percentages of the population

The Irish Tax System I

- Double tax on income on different tax base:

1. Income Tax
2. Universal Social Charge (USC)

- Income Tax is applied on the taxable income:

$$Taxable\ Income$$
$$= Gross\ income\ -\ pensions(Gross\ income)$$
$$- contributions(Gross\ income)$$

- USC is applied on the USC income:

$$USC\ income = Gross\ income\ - benefits\ - scholarships\ - reliefs$$

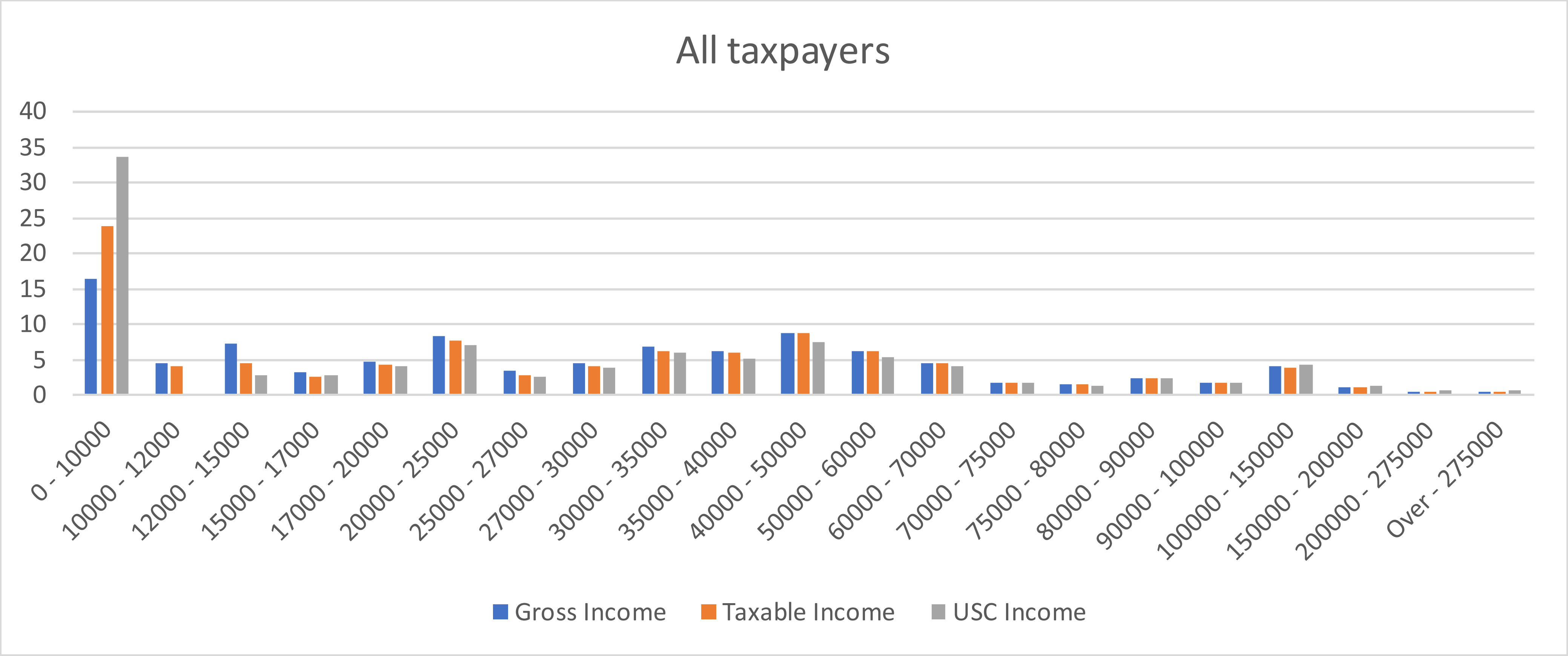
The Irish Tax System II: Income Tax 2019

Personal circumstance	**Single/widower, no children**	**Couple 1 earner**	**Couple 2 earners**	**Single/widower with children**
Tax credit	1,650	3,300	3,300	1,650
Threshold	35,300	44,300	44,300	39,300
Low rate	20%	20%	20%	20%
Higher rate	40%	40%	40%	40%

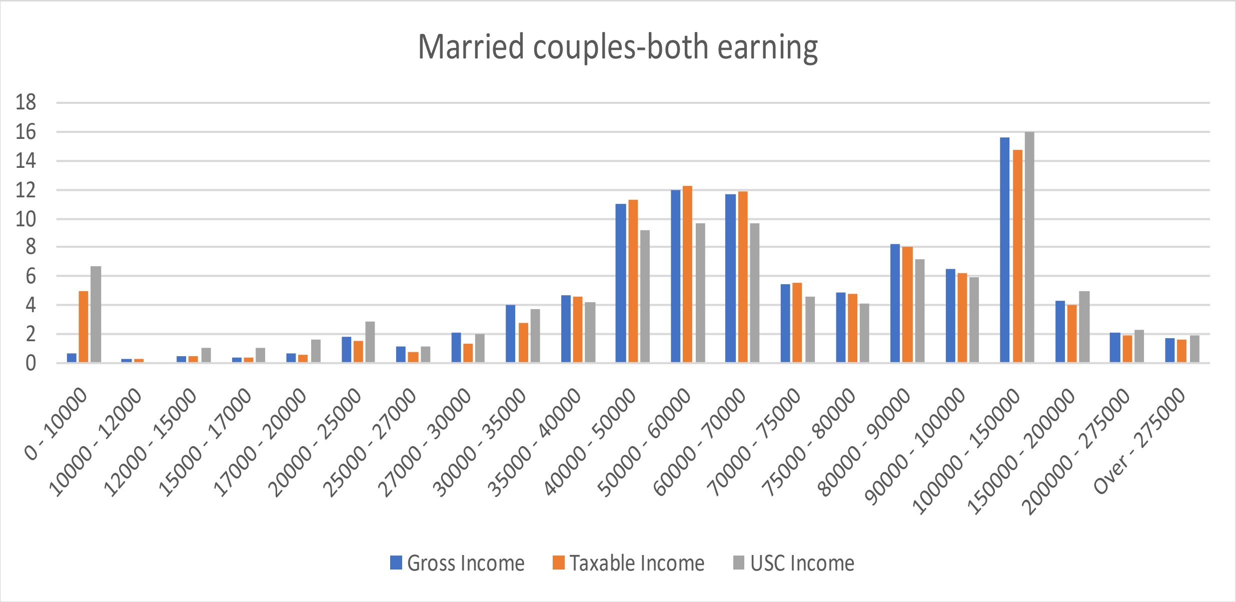
The Irish Tax System III: USC 2019

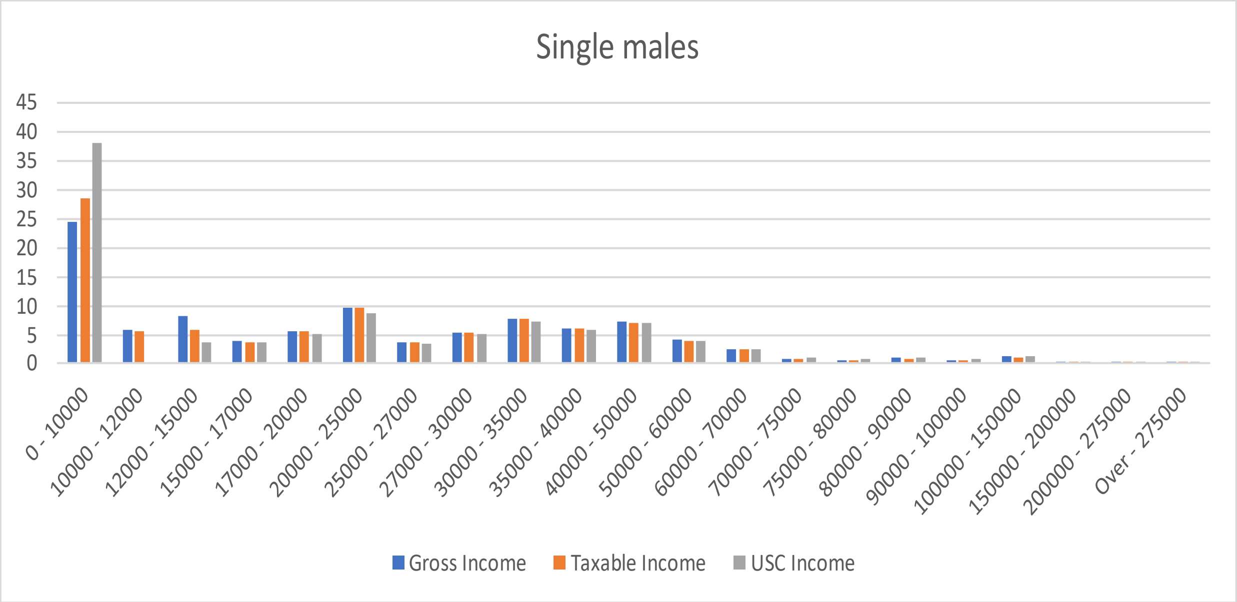
	PAYE	Self-employed
Thresholds	Rates	Rates
First €12,012	0.5%	0.5%
Up to €19,874	2%	2%
Up to €70,044	4.5%	4.5%
Above €70,044	8%	8%
Above €100,000	----	11%

Distributional data: All taxpayers per gross, taxable, and USC



Distributional data: Singles and males





Methodology and preliminary results

Methodology: stages

Stage I: Estimate the gross, taxable, and USC income distributions using a combination of different linear quadratic functions (Gamma, Generalized beta 2)

Stage II: Extrapolate observations for each different category and compute the tax paid

Stage III: Regress the tax paid on the base income to estimate the average elasticity for each category, then use the weighted elasticity to estimate the overall elasticity for Ireland

Stage IV: Non-parametric techniques to estimate the index of individual elasticity

Stage V: Simulate other EU systems on the above data (for now we will present Greece), we also use EUROMOD results to compare our results to the survey data

Stage 1: Income distributions

- We use the techniques of Jargowsky and Wheeler (2018) to estimate income distributions
- Bin data have an open ending so we need a combination of Pareto distribution for the higher end of the distribution
- We use a Generalized beta2, Gamma, Pareto distribution to map our data
- The output provides all the distribution parameters but also information about each quantile

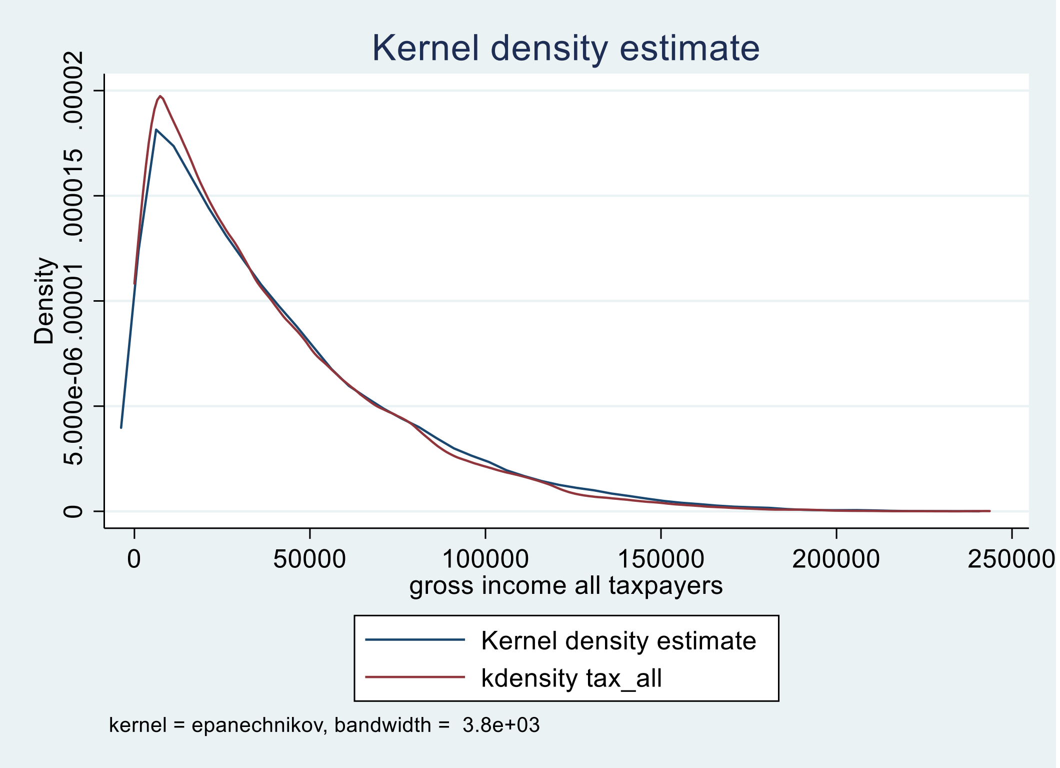
$$GB2(y; a, b, p, q) = \frac{|a| y^{ap-1}}{b^{ap} B(p,q)\ (1 + \left(\frac{y}{b}\right)^{a})^{p+q}}$$

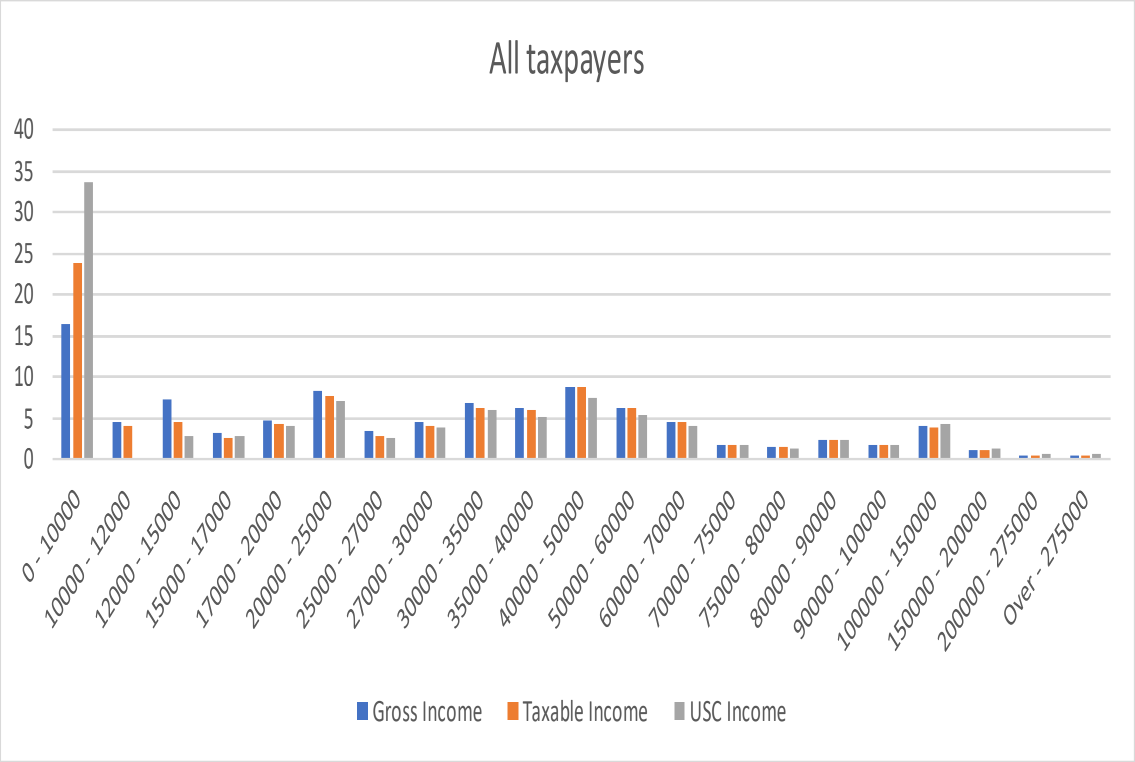
Stage 1: Income distributions

status	N	mean	var	sd	cov	theil	alpha	topmean	b_param
All Taxpayers	2,902,110.00	40,455.00	2,920,000,000.00	54,075	1.337	0.454	2.215	501,393.70	6.415595
MC2	521,169.00	83,616.00	5,170,000,000.00	71,937	0.86	0.218	2.448	464,909.10	2.587823
MC1	549,478.00	47,236.00	5,000,000,000.00	70,694	1.497	0.433	2.01	550,000.00	5.351041
Single females	812,773.00	24,571.00	660,000,000.00	25,698	1.046	0.356	2.532	454,534.20	11.20953
Single males	894,545.00	26,931.00	1,030,000,000.00	32,088	1.192	0.39	2.217	500,948.30	10.13977
Widowers	34,954.00	35,692.00	2,270,000,000.00	47,598	1.334	0.353	2.01	550,000.00	7.405229
Widows	89,191.00	27,899.00	909,000,000.00	30,144	1.08	0.263	2.103	524,385.00	9.753162

Stage 2: Extrapolation

- We extrapolate 30,000 observations from our income distributions





Stage 3: Simple regression results, elasticities

	USC_all	tax_females	tax_males	tax_widowers	tax_widows	tax_marr_both	tax_marr_one
elasticity	2.300***	2.048***	1.997***	2.145***	2.291***	1.895***	2.265***
	[479.029]	[473.036]	[512.718]	[500.927]	[421.501]	[648.752]	[475.170]
Constant	-17.712***	-12.785***	-12.277***	-14.028***	-15.514***	-11.868***	-15.715***
	[-347.899]	[-290.472]	[-307.687]	[-313.310]	[-277.583]	[-361.846]	[-305.470]
Adjusted R-squared	0.910	0.911	0.922	0.919	0.900	0.943	0.914

And then we estimated the weighted elasticity for income tax:

	Tax_units	elasticities	Weights	Weights*elasticities
All Taxpayers	2,902,110			
MC2	521,169	1.89	0.18	0.34
MC1	549,478	2.26	0.19	0.429
Single females	812,773	2.05	0.28	0.57
Single males	894,545	1.99	0.31	0.61
Widowers	34,954	2.14	0.01	0.026
Widows	89,191	2.29	0.03	0.07
Total	2,902,110		1	**2.054**

And the weighted overall elasticity: $e_{ie} = 1.15 + 1.027 = \mathbf{2.177}$

Stage 3: Euromod results, elasticities

	USC_all	Tax_singles	tax_widow	tax_MC2	tax_MC1
elasticity	1.820***	2.320***	2.461***	1.836***	1.840***
	(0.00453)	(0.0330)	(0.134)	(0.0361)	(0.0342)
Constant	-10.38***	-12.94***	-14.18***	-8.752***	-8.831***
	(0.0368)	(0.262)	(1.053)	(0.306)	(0.291)
Observations	3,877	1,348	127	794	791
Adjusted R-squared	0.977	0.786	0.730	0.765	0.786

And then we estimated the weighted elasticity:

	Tax_units	Weights	Weights*elasticities
All Taxpayers	2,902,110		
MC2	521,169	0.18	0.329
MC1	549,478	0.19	0.348
Single females	812,773	0.28	0.649
Single males	894,545	0.31	0.715
Widowers	34,954	0.01	0.029
Widows	89,191	0.03	0.075
Total	2,902,110	1	**2.148**

And the weighted overall elasticity: $e_{ie} = 0.74 + 1.07 = \mathbf{1.81}$

Much smaller than the computed one from the administrative data

Stage 4: Non-parametric results, elasticities

- Generate individual indices of tax elasticities
- Using kernel (non-parametric regressions)
- This allows for a deeper analysis on how taxation affects different levels of income
- We estimate the individual indices for all different categories
- Applying this to more years and countries will give us a panel data on how different individuals with different incomes react under different tax systems
- Our mean kernel estimation is **2.04**

Stage 5: Simulating the Greek tax system I

- For now we do not consider the equivalent of the USC
- We map the Greek tax system on the Irish data

Tax Bands	Tax Rates	Number of Taxpayers	Percentage of Taxpayer Population	cumulative	IE gross income (all)
Up to €10,000	9%	3,694,013	57.13%		up to 35,000
€10,000 - 20,000	22%	1,626,315	25.15%	82.28%	35,000 - 60,000
€20,000 - 30,000	28%	614,250	9.50%	91.77%	60,000 - 90,000
€30,000 - 40,000	36%	287662	4.45%	96.22%	90,000 - 150,000
Over €40,000	44%	244255	3.78%	100.00%	over 150,000

Stage 5: Simulating the Greek tax system II

For the administrative data:

	Income Tax
elasticity	1.18***
	[1141]
Kernel elasticity	1.33
Constant	-3.99***
	[-382.15]
Adjusted R-squared	0.98

For Euromod data:

	USC_all	Tax_singles	tax_widow	tax_MC2	tax_MC1
elasticity	3.179***	1.116***	1.220***	1.167***	1.191***
	(0.0315)	(0.00374)	(0.0229)	(0.00593)	(0.00636)
Constant	-23.35***	-3.168***	-3.981***	-3.499***	-3.686***
	(0.270)	(0.0277)	(0.165)	(0.0461)	(0.0494)
Observations	2,154	2,378	619	1,985	2,047
Adjusted R-squared	0.825	0.974	0.822	0.951	0.945

- And the weighted overall tax elasticity: $e_{ie} = \mathbf{1.14}$

Much smaller than the Irish tax system

- The equivalent tax for USC is more progressive for Greece
- 3.179 instead of 1.82

Up to now

- Estimation of elasticities
- Methodology for individual index
- Proposing a new index that captures individual’s tax elasticity
- Based on administrative, publicly available data
- This can be used to any analysis that you can derive data on income distributions
- The Irish tax system is one of the most progressive in the EU in contrast to the Greek one
- Different results to Euromod

Work in progress

- Robustness checks on the distribution characteristics
- Creating three-dimensional distributions to capture the consistency of the population of the different tax payers
- Add all EU countries
- Progressivity, Inequality measures
- Use the information on quantiles
- Revenue stability measures
- Compare with Euromod and understand further the differences
- Creation of the individual index for all EU countries
- Construction of a panel dataset to be used to understand how tax structure affects of the aspects of the economy

Thank you!