Irish Fiscal Advisory Council

Estimating Ireland's Tax Elasticities, a Policy-Adjusted Approach

IEA Conference

10th May 2019

Outline

- Motivation
- Literature
- Methodology
- Results
- Conclusions

Motivation

- Elasticities describes the endogenous change in tax revenue in response to a change in the tax base.
- Changes to tax revenue can be due to endogenous or exogenous factors.
- The most important exogenous changes which occur are policy changes, i.e. changes in tax rates, bands credits etc.

Motivation

Elasticities are important for:

- Forecasting revenue
- Assessing progressivity of tax system
- Assessing the cyclicality of revenue
- Calculating the cyclically adjusted budget balance

Motivation

3 contributions:

1. Compiling a new dataset of policy changes. Using this dataset to adjust revenue for policy changes.

2. Estimating short-run and long-run elasticities.

3. Estimate elasticities for PRSI and VAT, as well as income tax.

Literature

Irish literature focuses on revenue buoyancy.

- Acheson et al (2017) Income tax
- Deli et al (2017) Income tax
- Acheson et al (2018) VAT

International literature on estimating elasticities:

- Mourre and Princen (2015) EU pooled analysis
- Wolswijk (2007) Netherlands, policy-adjusted revenue

Methodology – Policy changes

Compile a dataset with policy changes from budget publications (1987 – 2018).

Some have been digitised….

Summary of Budget 2019 Measures – Policy Changes

Taxation Measures for Introduction in 2019

Measure	Yield/Cost 2019	Yield/Cost Full Year
USC The following changes to USC will apply from 1 January 2019. • €502 increase to €19,372 band ceiling • 4.75% rate reduced to 4.5% Total cost of USC measures The increase in the 2% rate band ceiling will ensure that a full-time adult worker who benefits from the increase in the hourly minimum wage rate from €9.55 to €9.80 will remain outside the top rates of USC. The reduction in the third rate of USC will ensure that the marginal tax rate on incomes up to €70,044 is reduced from 48.75% to 48.5%.	-€105m	-€123m

Methodology – Policy changes

Some have not….

PART V: TAXATION MEASURES

SECTION A: 20 JANUARY BUDGET PROPOSALS OF PREVIOUS GOVERNMENT AS CONFIRMED OR AMENDED

		Comment
(i) Excise Duties (Implemented from midnight 20 January).	Excise duties were increased from midnight on 20 January, 1987 as follows (all figures are inclusive of VAT):	*Yield*: £48.5 million in 1987.
	pence packet of *20 cigarettes* etc. 4 gallon of *petrol* 4 gallon of *auto-diesel* 3 gallon of *auto-LPG* 2 gallon of *non-auto oils, non-auto LPG* 9.9	Existing rebates on petrol to handicapped drivers were increased to match the duty increase. The duty increase on auto-diesel does not apply to scheduled road passenger services. The duty increase on non-auto oils, does not apply to fishermen, horticulturalists or mushroom growers; existing concessions for these categories were maintained.
(ii) Foreign Travel Tax.	Proposed change in existing £5 charge to *ad valorem* charge.	The change as proposed on 20 January is not being proceeded with.
(iii) Stamp Duties.	(*a*) The stamp duty on life assurance premiums will be increased from 1½ per cent to 3 per cent from 1 May.	*Yield*: £2.4 million in 1987. This was estimated as £4 million last January; the reduction is due to delay in introducing the measure.

Methodology – Policy changes

Policy adjusted revenue calculated using proportional adjustment method (Prest, 1962)

For the last observation (2018), adjusted revenue equals actual revenue.

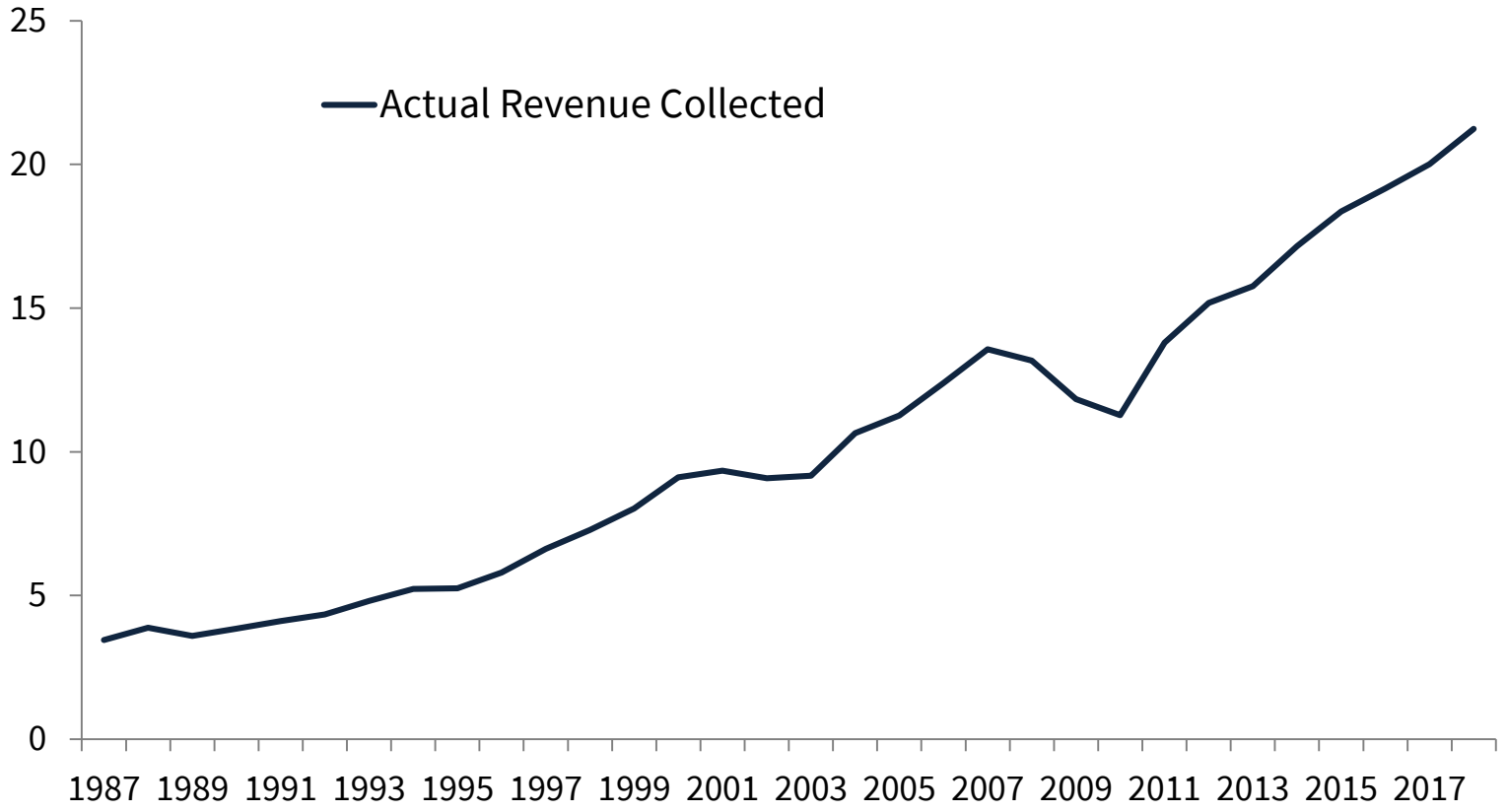
For prior years, adjust so that you are estimating what revenue would have been if the 2018 tax system applied

$$AR_t = R_t * \prod_{k=t+1}^{j} \left(\frac{R_k}{R_k - DM_k} \right) \text{ for all } t < j$$

Methodology – Income tax

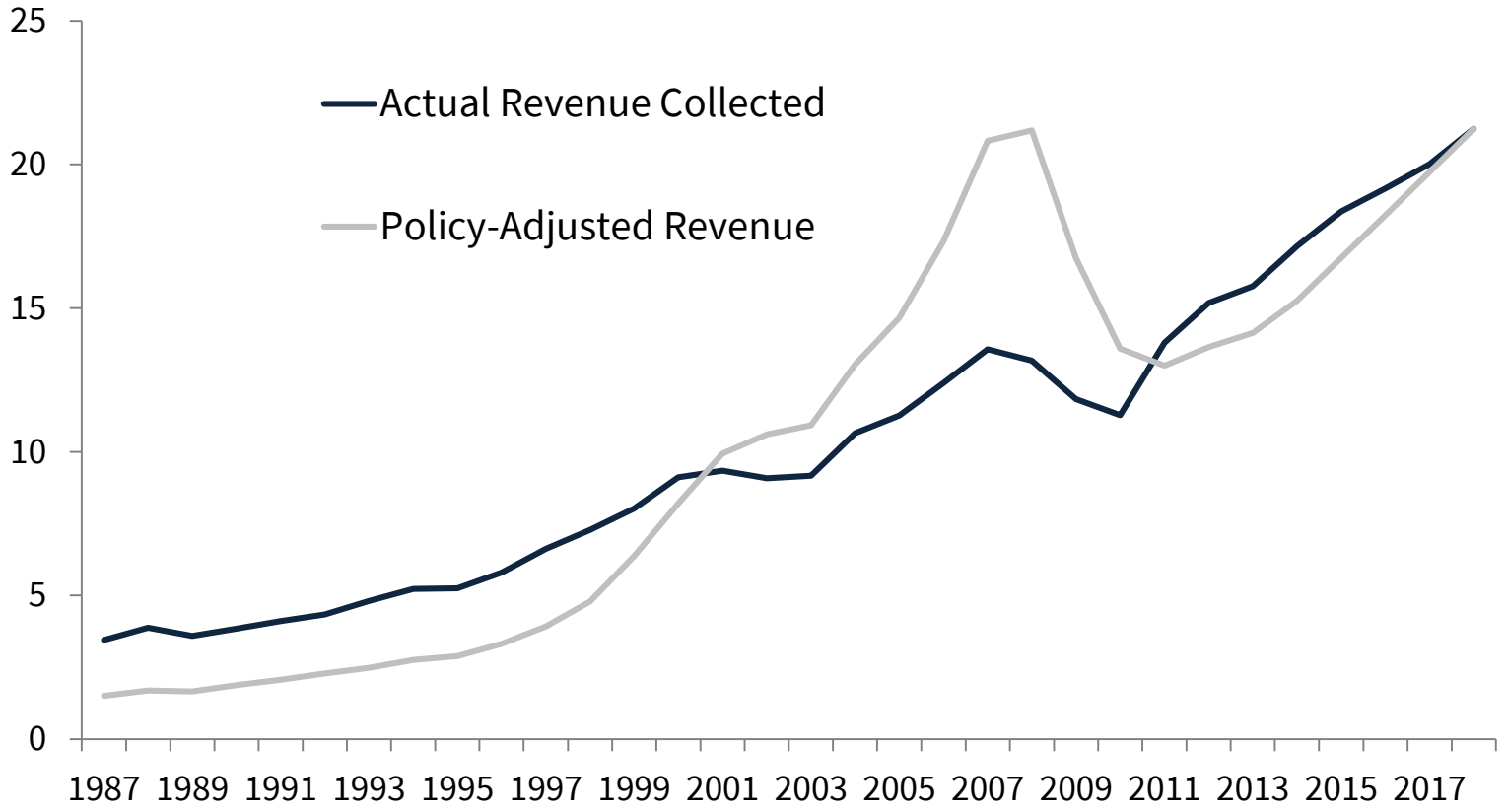
Actual income tax revenue.

€ Billions, 1987-2018



Methodology – Income tax

Actual and policy-adjusted income tax revenue.
€ Billions, 1987-2018



Methodology – Policy changes

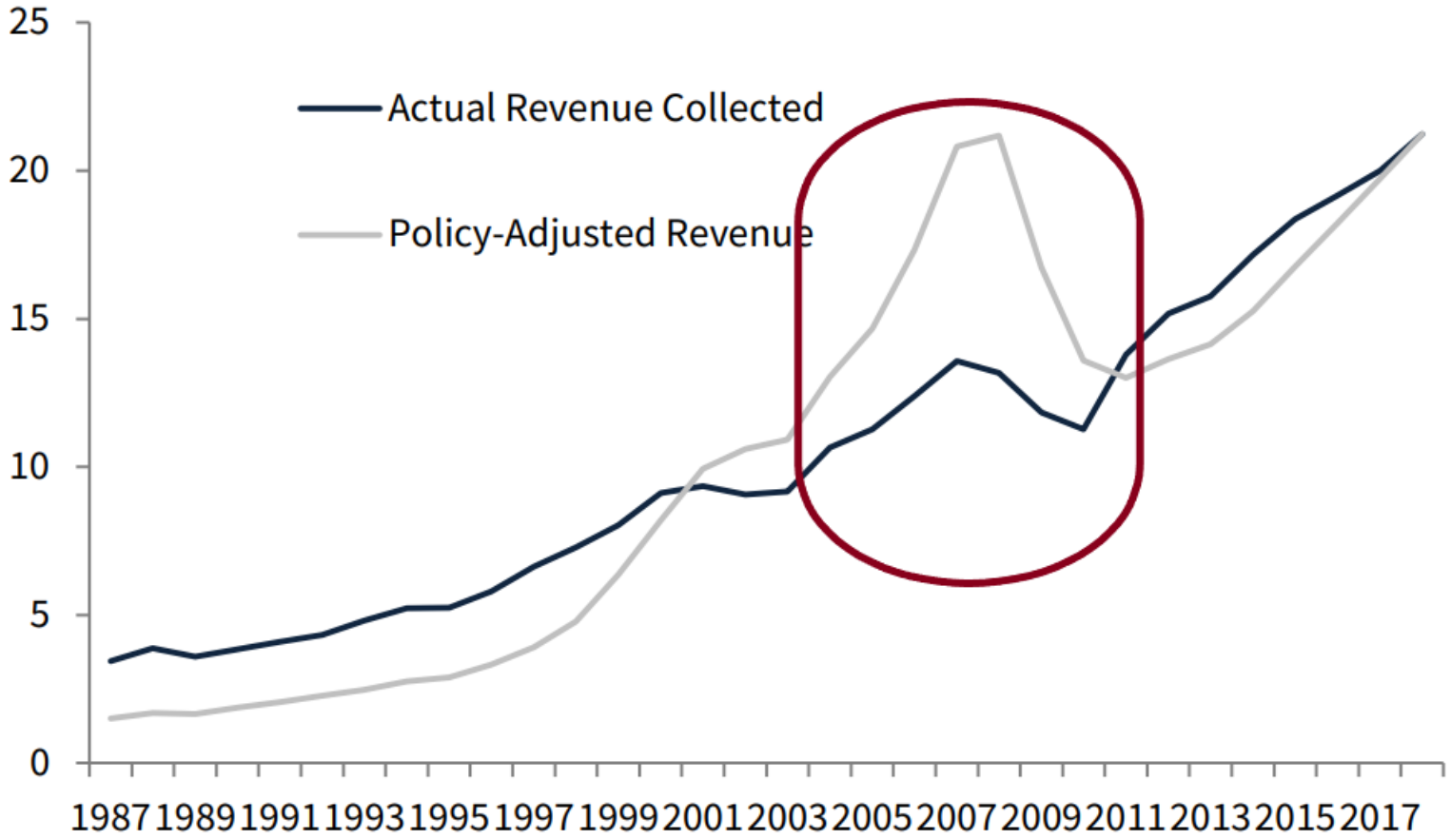
- Policy-adjusted income tax much lower in early years, much larger tax credits and wider bands now than in 1987.

- Policy changes are negatively correlated with the economic cycle. Income tax cuts during economic boom (early 2000s). Income tax increases during recession.

- This implies that using unadjusted revenue to calculate elasticities will bias estimates of the elasticities downwards.

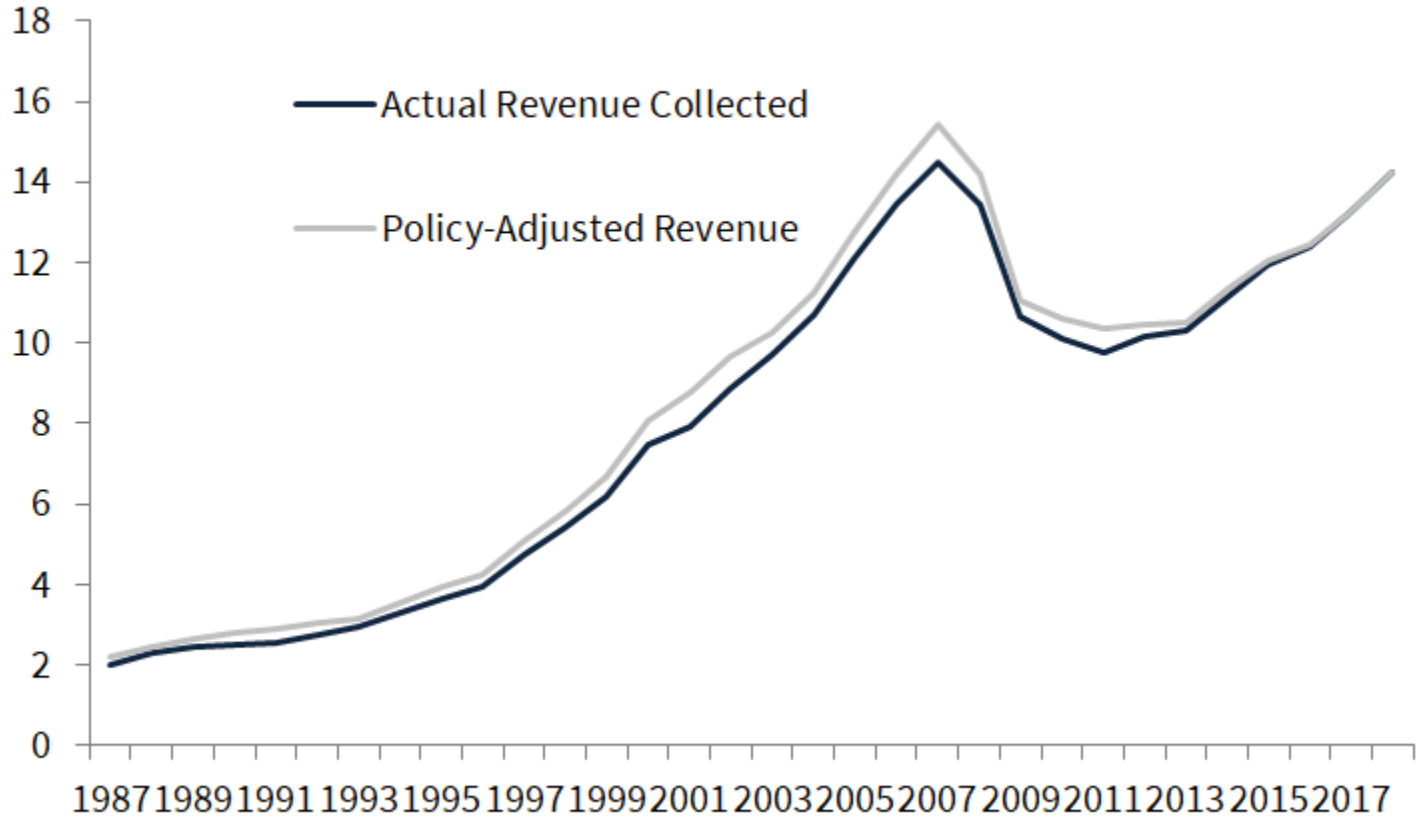
Methodology – Income tax

Figure 3.1: Actual and policy-adjusted income tax revenue.
€ Billions, 1987-2018



Methodology – VAT

Figure 3.2: Actual and policy-adjusted VAT.
€ Billions, 1987-2018

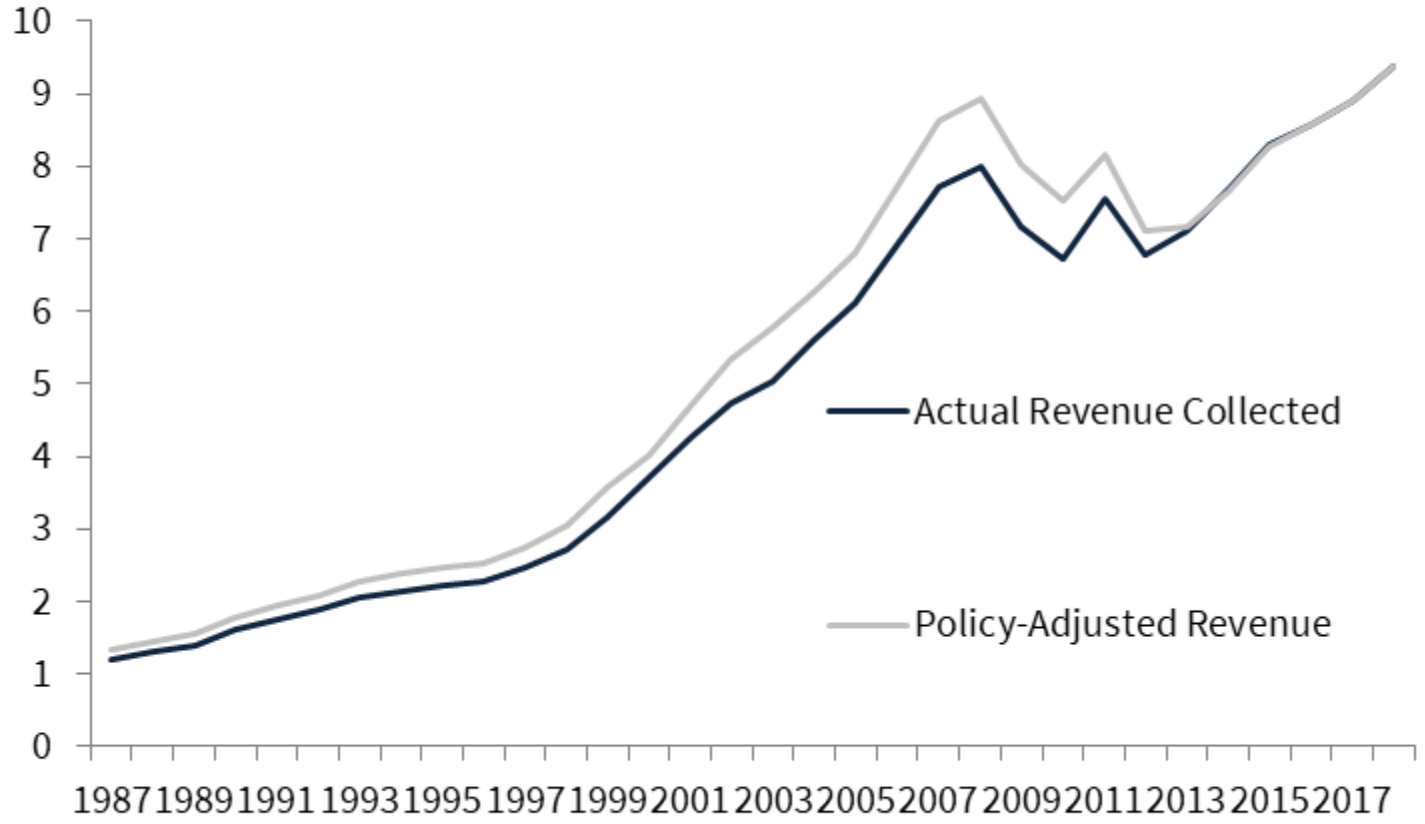


Sources: CSO; Department of Finance; and authors' own calculations.

Methodology – PRSI

Figure 3.3: Actual and policy-adjusted PRSI.

€ Billions, 1987-2018



Sources: CSO; Department of Finance; and authors' own calculations.

Methodology

Estimate long-run and short-run elasticities

Long-run equation:

$$Log(PAR_t) = \alpha_1 + \alpha_2 * \text{Log}(MD_t) + \alpha_3 * \text{Dlog}(MD_{t-1}) + \alpha_4 * \text{Dlog}(MD_t) + \alpha_5 * \text{Dlog}(MD_{t+1}) + \varepsilon_t$$

Short-run equation:

$$Dlog(PAR_t) = \beta_0 + \beta_1 * Dlog(MD_t) + \beta_2 * (\log(PAR_{t-1}) - (\alpha_1 + \alpha_2 * \log(MD_{t-1}) + \alpha_3 * \text{Dlog}(MD_{t-2}) + \alpha_4 * \text{Dlog}(MD_{t-1}) + \alpha_5 * \text{Dlog}(MD_t))) + \mu_t$$

PAR- Policy-Adjusted Revenue

MD- Macroeconomic Driver.

Results

- To see if there is an impact from using policy-adjusted revenue, we estimate the equations using actual revenue and policy-adjusted revenue.

- One-step and two-step models are also estimated to see if there are any significant differences.

Results – Income tax

Estimation method: Policy-Adjusted?	(1) One-step Adjusted	(2) Two-step Adjusted	(3) One-step Unadjusted	(4) Two-step Unadjusted
Long-Run elasticity				
Log(Income(-1))	1.40^{+}***	1.33^{+}***	0.83^{-}**	0.81^{-}**
	(0.08)	(0.02)	(0.06)	(0.04)
Short-run elasticity				
Dlog(Income)	1.51**	1.57**	0.98**	0.80**
	(0.33)	(0.13)	(0.18)	(0.11)
ECM	-0.27	-0.27	-0.19**	-0.19
	(0.19)	(0.24)	(0.09)	(0.12)
N	30	30	30	30

Sources: CSO, Department of Finance and authors calculations.
Note: +/- indicates that long-run elasticity estimated is significantly greater than/less than one. ** and * indicate significance at 5% and 10% levels respectively, standard errors are in parenthesis.

Results – Income tax

Estimation method: Policy-Adjusted?	(1) One-step Adjusted	(2) Two-step Adjusted	(3) One-step Unadjusted	(4) Two-step Unadjusted
Long-Run elasticity				
Log(Income(-1))	1.40^{+***}	1.33^{+***}	0.83^{-**}	0.81^{-**}
	(0.08)	(0.02)	(0.06)	(0.04)
Short-run elasticity				
Dlog(Income)	1.51**	1.57**	0.98**	0.80**
	(0.33)	(0.13)	(0.18)	(0.11)
ECM	-0.27	-0.27	-0.19**	-0.19
	(0.19)	(0.24)	(0.09)	(0.12)
N	30	30	30	30

Sources: CSO, Department of Finance and authors calculations.
Note: +/- indicates that long-run elasticity estimated is significantly greater than/less than one. ** and * indicate significance at 5% and 10% levels respectively, standard errors are in parenthesis.

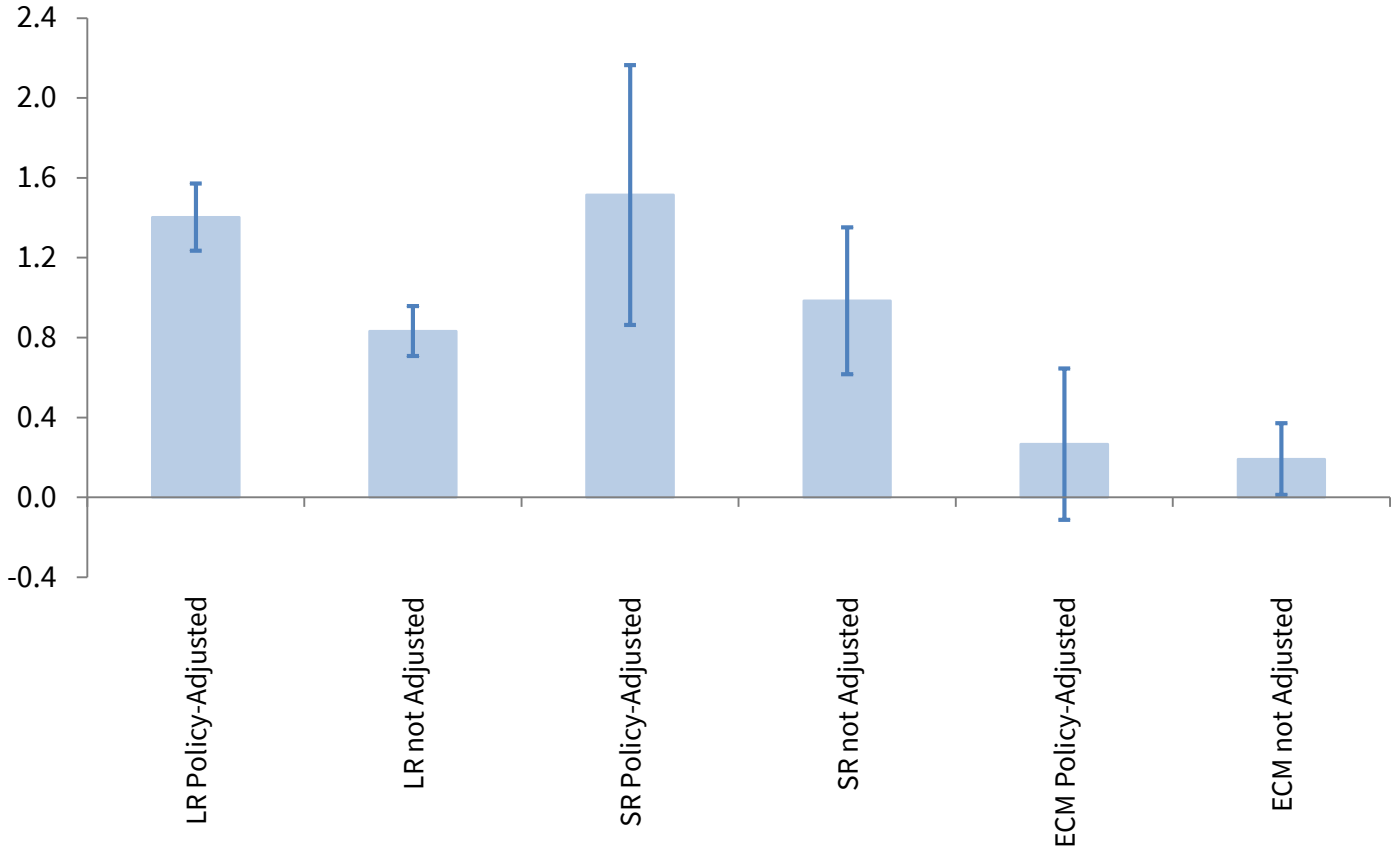
Results – Income tax

Estimation method: Policy-Adjusted?	(1) One-step Adjusted	(2) Two-step Adjusted	(3) One-step Unadjusted	(4) Two-step Unadjusted
Long-Run elasticity				
Log(Income(-1))	1.40^{+}**	1.33^{+}**	0.83^{-}**	0.81^{-}**
	(0.08)	(0.02)	(0.06)	(0.04)
Short-run elasticity				
Dlog(Income)	1.51**	1.57**	0.98**	0.80**
	(0.33)	(0.13)	(0.18)	(0.11)
ECM	-0.27	-0.27	-0.19**	-0.19
	(0.19)	(0.24)	(0.09)	(0.12)
N	30	30	30	30

Sources: CSO, Department of Finance and authors calculations.
Note: +/- indicates that long-run elasticity estimated is significantly greater than/less than one. ** and * indicate significance at 5% and 10% levels respectively, standard errors are in parenthesis.

Results – Income tax

- Adjusting for policy changes makes significant impact, long-run estimates significantly above one as opposed to significantly below one.
- One-step and two-step estimates are equivalent.



Results – Income tax

- After using policy adjusted revenue, long-run estimates tend to be much higher.

	Method	Macro Driver	Policy-Adjusted Revenue?	Estimate
Deli et al (2017)	Empirical	GNP	No	1.17
Acheson et al (2017)	Empirical	Income	No	0.83
Köster and Priesmeier (2017)	Empirical	GDP	No	0.88[1]
Wolswijk (2007)	Empirical	Income	Yes	1.57[2]
Conroy (2019)	Empirical	Income	Yes	1.40

Note: 1 Total current government revenue, rather than income tax is the dependent variable.
2 Wolswijk (2007) is an analysis on the Netherlands. As it uses a very similar approach to this paper, adjusting for policy measures and estimating short- and long-run elasticities, the results are shown.

Results – Income tax

- After using policy adjusted revenue, long-run estimates tend to be much higher.

	Method	Macro Driver	Policy-Adjusted Revenue?	Estimate
Deli et al (2017)	Empirical	GNP	No	1.17
Acheson et al (2017)	Empirical	Income	No	0.83
Köster and Priesmeier (2017)	Empirical	GDP	No	0.88[1]
Wolswijk (2007)	Empirical	Income	Yes	1.57[2]
Conroy (2019)	Empirical	Income	Yes	1.40

Note: 1 Total current government revenue, rather than income tax is the dependent variable.
2 Wolswijk (2007) is an analysis on the Netherlands. As it uses a very similar approach to this paper, adjusting for policy measures and estimating short- and long-run elasticities, the results are shown.

Results – Income tax

- Using policy-adjusted revenue gives:
  - ➢ Larger long-run elasticity
  - ➢ Larger short-run elasticity
  - ➢ Faster error correction

- This is due to estimates not being biased by the negative correlation between tax measures and the economic cycle.

- Elasticities above one indicate a progressive tax.

Results – PRSI

- Adjusting for policy changes makes little difference as policy changes have been less frequent/impactful.

Estimation method: Policy-Adjusted?	(1) One-step Adjusted	(2) Two-step Adjusted	(3) One-step Unadjusted	(4) Two-step Unadjusted
Long-Run elasticity				
Log(Income(-1))	1.00**	1.00**	1.03**	1.02**
	(0.03)	(0.02)	(0.04)	(0.03)
Short-run elasticity				
Dlog(Income)	0.48**	0.99**	0.59**	0.99**
	(0.25)	(0.09)	(0.24)	(0.09)
ECM	-0.48*	-0.48**	-0.34**	-0.34*
	(0.23)	(0.16)	(0.15)	(0.12)
N	30	30	30	30

Note: **, * indicate significance at 5% and 10% levels respectively, standard errors are in parenthesis.

Results – PRSI

- Limited literature to compare to.
- Elasticity of one indicates PRSI is neither progressive nor regressive.

	Method	Macro Driver	Policy-Adjusted Revenue?	Estimate
Mourre and Princen (2015)	Empirical	Income	Yes	0.98[1]
Price et al (2014)	Analytical	Income	No	1.51
Conroy (2019)	Empirical	Income	Yes	1.00

Note: 1 Panel analysis of the EU, no individual country elasticities are estimated. Revenue data are corrected for policy changes.

Results – VAT

Estimation method: Policy-Adjusted?	(1) One-step Adjusted	(2) Two-step Adjusted	(3) One-step Unadjusted	(4) Two-step Unadjusted
Long-Run elasticity				
Log(Consumption(-1))	0.80**	0.82**	0.88**	0.90**
	(0.04)	(0.03)	(0.06)	(0.03)
Log (B&C)	0.21**	0.20**	0.18**	0.17**
	(0.03)	(0.02)	(0.04)	(0.02)
Short-run elasticity				
Dlog(Consumption)	1.42**	0.94**	1.32**	0.93**
	(0.12)	(0.10)	(0.24)	(0.11)
Dlog(B&C)	0.13**	0.16**	0.17**	0.16**
	(0.04)	(0.04)	(0.06)	(0.04)
ECM	-0.73**	-0.71**	-0.68**	-0.68**
	(0.19)	(0.23)	(0.19)	(0.21)
N	30	30	30	30

Note: + indicates that the long-run elasticity estimated is significantly greater than one. **, * indicate significance at 5% and 10% levels respectively, standard errors are in parenthesis.

Results – VAT

	Method	Macro Driver	Policy-Adjusted Revenue?	Estimate
Acheson et al (2018)	Analytical	Taxable income	No	0.6
Acheson et al (2018)	Analytical	Consumption	No	0.7
Price et al (2014)	Analytical	Consumption	No	1.18
Mourre and Princen (2015)	Empirical	Consumption	Yes	1.08[1]
Wolswijk (2007)	Empirical	Consumption	Yes	0.90[2]
Conroy (2019)	Empirical	Consumption	Yes	1.09[3]
Conroy (2019)	Empirical	Consumption	Yes	0.80[4]

Note: 1 Panel analysis of the EU, no individual country elasticities are estimated. Revenue data are corrected for policy changes. 2 Wolswijk (2007) is an analysis on the Netherlands. As it uses a very similar approach to this paper, adjusting for policy measures, the results are shown. 3 This refers to estimates where only consumption is used as an explanatory variable. 4 This refers to where consumption and investment in the building and construction sector are used as explanatory variables.

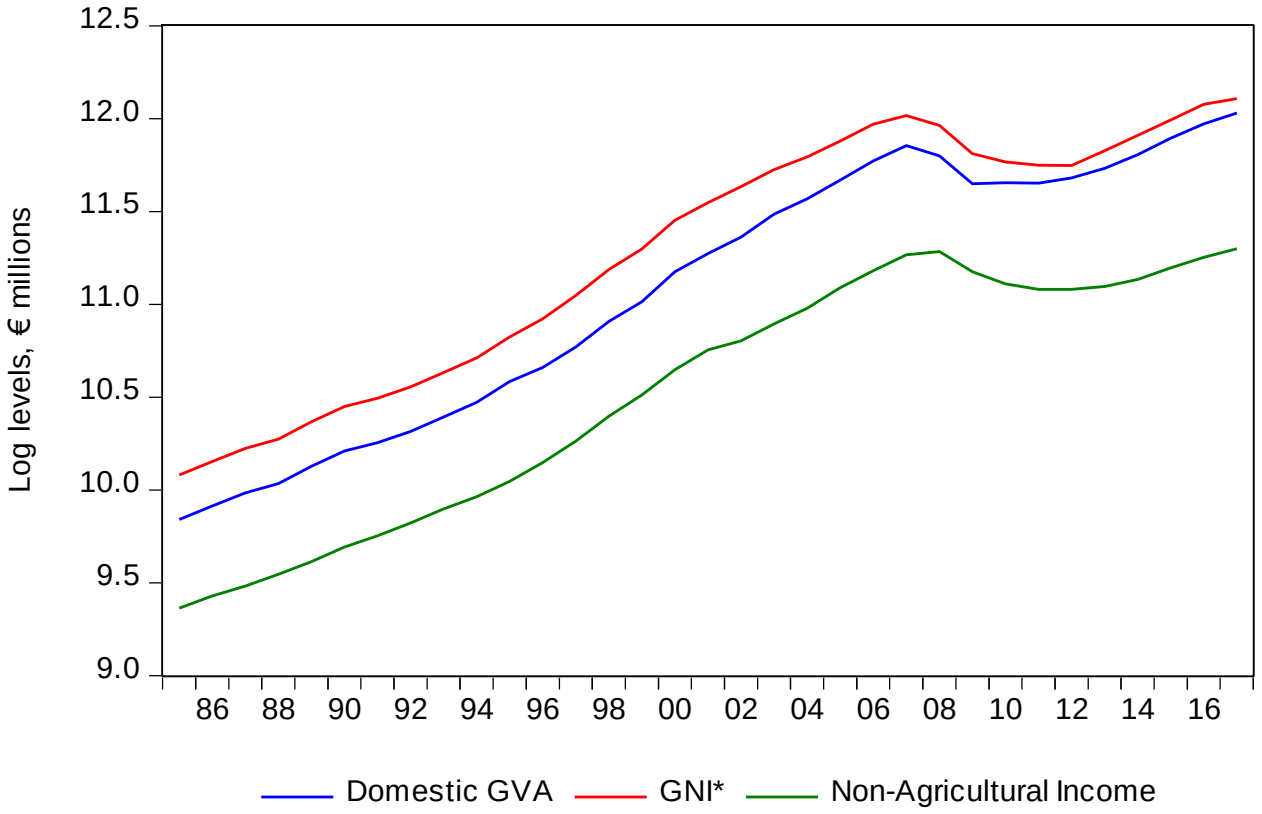
Conclusion

- A new dataset is compiled of budget day estimates of the impact of policy changes.
- This allows us estimate unbiased estimates of revenue elasticities are obtained.
- Significantly higher elasticities for income tax, differences less noticeable for VAT and PRSI.
- Important to use policy-adjusted revenue to arrive at unbiased estimates of the elasticities.
- Short-run and long-run elasticities can be quite different

Appendix - Robustness

Robustness checks:

- Different Macroeconomic drivers (GNI*, Domestic GVA) have no impact on results.



Appendix - Robustness

Robustness checks:

- Checked for asymmetric speed of error correction i.e. does it matter if you are above/below long-run equilibrium level.
- Evidence points towards no difference, i.e. $\beta_3 = 0$

$$Dlog(AR_t) = \beta_0 + \beta_1 * Dlog(MD_t) + \beta_2 * (\log(AR_{t-1}) - (\alpha_1 + \alpha_2 * \log(MD_{t-1}))) + Dum\_ECM_t * \beta_3 * (\log(AR_{t-1}) - (\alpha_1 + \alpha_2 * \log(MD_{t-1})))$$

Appendix - Robustness

Robustness checks:

- Checked for the impact of the output gap as an additional control variable.
- It was inserted into long-run and short-run equations with little impact.
- Also tried interacting an output gap dummy with the long run elasticity, short-run elasticity and ECM term.
- The long-run interaction was statistically significant, but not economically meaningful.

Appendix - Methodology

Estimate long-run and short-run elasticities

One step estimation

$$Dlog(PAR_t) = \beta_0 + \beta_1 * Dlog(MD_t) + \beta_2 * (\log(PAR_{t-1}) - \beta_3 * (\mathrm{Log}(MD_{t-1}) - \alpha_3 * \mathrm{Dlog}(MD_{t-2}) - \alpha_4 * \mathrm{Dlog}(MD_{t-1}) - \alpha_5 * \mathrm{Dlog}(MD_t)\ ) + \mu_t$$

PAR- Policy-Adjusted Revenue, MD- Macroeconomic Driver.

Appendix – Results comparison

	Method	Macro Driver	Policy- Adjusted Revenue?	Estimate
Deli et al (2017)	Empirical	GNP	No	1.17
Acheson et al (2017)	Empirical	Income	No	0.83
Acheson et al (2017)	Analytical	Income	No	2.0[1]
Acheson et al (2017)	Analytical	Income	No	1.2[2]
Price et al (2014)	Analytical	Income	No	2.11
Köster and Priesmeier (2017)	Empirical	GDP	No	0.88[3]
Wolswijk (2007)	Empirical	Income	Yes	1.57[4]
Conroy (2019)	Empirical	Income	Yes	1.40

Sources: Various.
Note: 1 Refers to estimate based on income tax only, not including USC.
2 Estimate based on USC only. 3 Total current government revenue, rather than income tax is the dependent variable.
4 Wolswijk (2007) is an analysis on the Netherlands. As it uses a very similar approach to this paper, adjusting for policy measures and estimating short- and long-run elasticities, the results are shown.

Appendix – VAT, using consumption only

Estimation method: Policy-Adjusted?	(1) One-step Adjusted	(2) Two-step Adjusted	(3) One-step Unadjusted	(4) Two-step Unadjusted
Long-Run elasticity				
Log(Consumption(-1))	1.09+**	1.11+**	1.14+**	1.14+**
	(0.03)	(0.03)	(0.03)	(0.03)
Short-run elasticity				
Dlog(Consumption)	1.82**	1.26**	1.81**	1.26**
	(0.12)	(0.09)	(0.12)	(0.09)
ECM	-0.27**	-0.27**	-0.36**	-0.36**
	(0.11)	(0.13)	(0.14)	(0.14)
N	30	30	30	30

Note: + indicates that the long-run elasticity estimated is significantly greater than one. **, * indicate significance at 5% and 10% levels respectively, standard errors are in parenthesis.

Appendix – Stationarity Tests

Table B.1: Augmented Dickey Fuller test, 1987-2017

	(1) Level	(2) Level with trend	(3) First Difference
Income Tax	-0.43	-2.87	-4.58**
VAT	-1.25	-2.40	-2.67*
PRSI	-0.45	-1.92	-3.88**
Income	-0.55	-3.14	-2.93*
Consumption	-0.56	-2.31	-2.96*
B&C Investment	-1.55	-1.86	-3.65**
GNI*	-0.62	-3.35*	-3.06**
Domestic GVA	-0.11	-3.07	-2.63*

Sources: CSO, Department of Finance and authors calculations.
Note: T-statistics are shown, ** and * indicate significance at 5% and 10% levels respectively.

Appendix – Granger Causality Tests

Table C.2: Granger-Causality Tests

	Null: Macro driver does not cause revenue	Null: Revenue does not cause macro driver
Income Tax (policy-adjusted)	18.3**	12.3**
Income tax	0.1	2.3
PRSI (policy-adjusted)	12.7**	0.3
PRSI	6.2**	0.1
VAT (policy-adjusted)	6.0**	12.1**
VAT	6.2**	15.6**

Sources: CSO, Department of Finance and authors calculations.
Note: In each case tests are performed with two lags. ** and * indicate significance at 5% and 10% levels respectively. The macro drivers for Income tax, PRSI and VAT are non-agricultural income, non-agricultural income and private consumption respectively. 29 observations used (1989 – 2017).