Estimating Ireland's Budgetary Semi-Elasticities

Killian Carroll

July 2019

Analytical Note No.12

Irish Fiscal Advisory Council

This report can be downloaded at **www.FiscalCouncil.ie**

1. Introduction

This analytical note examines the relationship between Ireland's budget deficit and the cycle. We use new alternative estimates of Ireland's cyclical position (output gap) that have been developed over the past few years by both the Council and the Department of Finance.

The budgetary semi-elasticity is a measure of how responsive the budget balance, as a per cent of GDP, is to changes in the economic cycle.[1] This allows for the estimation of the cyclically-adjusted budget balance: the budget balance that would have transpired had the economy been running at its potential output. That is, the budget balance that would have been expected if the economy's output were at its "sustainable" level over the medium to long run, where sustainable implies that output is not unduly influenced in any particular direction by imbalances in the economy, be they external, internal or financial.

Structural balance estimates are used in assessing compliance with both the EU fiscal rules and Ireland's domestic budgetary rule. If the economy is operating above potential, the budget balance typically benefits from buoyant tax revenues and lower expenditure on unemployment benefits. The converse is true if the economy is operating below potential: the budget balance suffers from lower tax revenues and increased expenditure on unemployment benefits. The cyclically-adjusted budget balance can be further corrected for one-offs and temporary measures to arrive at a structural (budget) balance estimate.

Estimates of the budgetary semi-elasticity depend on the output gap estimates used. The European Commission uses estimates of the budgetary semi-elasticities for all EU member states based on the output gap derived using the Commonly Agreed Methodology (CAM). These elasticities were estimated by researchers at the OECD, first by Girouard and André (2005), and subsequently updated by Price *et al.* (2014) (referred to hereafter as OECD (2005) and OECD (2014) respectively).

Taking the alternative, more plausible, estimates of the output gap for Ireland, this note estimates the sensitivity (the semi-elasticity) of the budget balance to the

[1] Semi-elasticities differ from elasticities, in that semi-elasticities apply to a ratio, in this case the ratio of the general government balance-to-GDP ratio, whereas elasticities apply to levels.

choice of the output gap. We find that budgetary semi-elasticities for both the Department's GDP and GVA-based estimates of the output gap and IFAC's own estimates of the output gap are relatively similar to those for the standard EU production function approach.[2] The budgetary semi-elasticities of the Department's GDP and GVA based estimate of the output gap are estimated to be 0.588 and 0.520 respectively. While the estimate of the budgetary semi-elasticity, using IFAC's estimates of the output gap, is 0.658.This compares to the estimate of 0.522 using the European Commission's estimates of the output gap for Ireland.

[2] See Casey (2018) for a description of IFAC's GVA-based output gap estimates. See Murphy *et al.* (2018) for a description of the Department's GVA and GDP-based estimates of the output gap.

2. Data and Methodology

The structural balance is an estimate of the budget balance which accounts for one-off and temporary measures, and the effect that the position of the economy in cycle has on the fiscal balance. Formally:

$$SB_t = GGB_t - \varepsilon \times OG_t$$

Where SB_t is the structural balance at time *t,* GGB_t is the general government balance*,* less one-off and temporary measures, at time *t*, OG_t is the output gap at time *t,* all expressed as a per cent of GDP*,* and ε is the budgetary semi-elasticity, which is assumed to be time-invariant over the medium term.[3]

The budgetary semi-elasticity can be broken down into the difference between the semi-elasticity of revenue, ε_R, and the semi-elasticity of expenditure, ε_G, which in turn, are a function of the cyclical elasticity of revenue, η_R, and the cyclical elasticity of expenditure η_G:[4]

$$\varepsilon = \varepsilon_R - \varepsilon_G = (\eta_R - 1)\frac{R}{Y} - (\eta_G - 1)\frac{G}{Y}$$

The cyclical elasticities of revenue are constructed as the weighted average of its components elasticities, $\eta_{R,i}$:

$$\eta_R = \sum_{i=1}^{4} \eta_{R,i}\frac{R_i}{R}$$

While the cyclical elasticities of expenditure are the product of the elasticity of government unemployment expenditure with respect to the cycle times the share of unemployment expenditure in total government expenditure:

$$\eta_G = \eta_{G,U}\frac{G_U}{G}$$

[3] See Table 7 for a timeline of re-estimation of the budgetary semi-elasticity, and see Section 4 for an investigation of this assumption.

[4] For a detailed derivation, see Mourre et al. (2019) or Mourre et al. (2014).

Revenue is broken into five broad categories, Personal Income Tax, Corporation Tax, Social Security Contributions, Indirect Taxes and Non-Tax revenue. Non-tax revenue is assumed to be independent of the cycle, and so has an elasticity of zero.[5]

Government expenditure is broken into two categories, Unemployment Expenditure and Other Government Expenditure, of which, only Unemployment Expenditure is assumed to vary with the cycle.[6]

To estimate the individual elasticities of the revenue items and expenditure items with respect to the cycle, we followed a two-step methodology developed by Van Den Noord (2000), which was used by the OECD in 2005 and 2014 in estimating the budgetary semi-elasticities for EU countries.

The two step-methodology for estimating elasticities with respect to the output gap, involves: 1) estimating the elasticity of the budgetary item to that items tax/expenditure base and 2) estimating the elasticity of the tax/expenditure base to the output gap. The product of these two estimates will then give the overall elasticity of the budgetary item with respect to the output gap. Formally, that is:

$$\eta_{R,i} = \varepsilon_{Ti,Bi} \times \varepsilon_{Bi,OG}$$

Where $\varepsilon_{Ti,Bi}$ is the elasticity of the tax item to its tax base, and $\varepsilon_{Bi,OG}$ is the elasticity of the tax base to the output gap. The elasticity of unemployment expenditure to the output gap, $\eta_{G,U}$, can be decomposed in a similar manner.

The OECD (2014) has empirically estimated the elasticity of each budgetary item to their respective tax bases. This analytical note uses the OECD's estimates of the elasticity of the tax/expenditure to tax/expenditure base. The reason for this is twofold: 1) the elasticity of the tax/expenditure to the tax/expenditure base is independent of the output gap and so does not need to be re-estimated for each output gap estimate; and 2) this allows for a comparison with the original OECD (2014) estimates of the budgetary semi-elasticity (based on the Commission's

[5] Hence, why the elasticity of revenue with respect to the cycle is the sum of four categories and not five.

[6] Unemployment related expenditure is all expenditure under the COFOG99 category in the Eurostat database.

output gap estimates) to see what are the key drivers of the differences in the budgetary semi-elasticity.

The scope of this analytical note is, therefore, to (1) estimate the elasticity of each tax/expenditure base to the output gap, for various output gap methods, and (2) to combine these estimates with the estimates of the elasticity tax/expenditure to tax/expenditure base as estimated by the OECD (2014). These two steps allow us to arrive at estimates of Ireland's budgetary semi-elasticity. The procedure for estimating the tax/expenditure base to output gap elasticities follows that of the OECD (2014).

The original estimates of the elasticities of the base with respect to the output gap were estimated by the OECD (2005) using Generalized Least Squares (GLS) method, with an AR(1) correction to account for auto-correlation in the residuals. The GLS model took the following form:

$$\Delta LN\left(\frac{Base_t}{Y_t^*}\right) = \alpha + \beta\Delta LN\left(\frac{Y_t}{Y_t^*}\right) + \nu_t$$

Where $Base_t$ is the tax/expenditure base, Y_t^* is the potential output and Y_t is output. The coefficient of interest is β, which represents the short-run elasticity of the tax/expenditure base to the output gap.

Building on that work, the OECD (2014) estimated the base to output gap elasticity using an additional two models. The first is an error correction model (ECM), while the second is an error correction model which accounts for possible auto-correlation in the residuals (ECM AR(1)). The error correction models allow for the estimated elasticities to vary over the cycle, unlike a first differenced model (OECD, 2014). Both models have the following form:

$$\Delta LN\left(\frac{Base_t}{Y_t^*}\right) = \alpha + \beta\Delta LN\left(\frac{Y_t}{Y_t^*}\right) + \lambda\left(LN\left(\frac{Base_{t-1}}{Y_{t-1}^*}\right) - \left(\alpha_1 + \beta_1 LN\left(\frac{Y_{t-1}}{Y_{t-1}^*}\right)\right)\right) + \nu_t$$

Again, β is the short-run elasticity of the base to the output gap; λ, is the coefficient of the error-correction term, which represents the speed of the adjustment to the long-run trend; and β_1 represent the long-run elasticity of the base to the output gap.

Following OECD (2014), there are five tax base-to-output gap elasticities to estimate. Of these, three form part of Personal Income Tax: 1) earnings, which are measured by compensation of employees; 2) income of the self employed, which is measured by self employment income; and 3) capital income, which is measured by rental income. The other two are Corporation Tax, whose base is measured by gross operating surplus, and Unemployment Expenditure, whose base is measured by the unemployment rate. The base for Social Security Contributions is also measured by compensation of employees. Indirect taxes are assumed to be unitary elastic with respect to their base, following OECD (2014).

As mentioned above, the elasticities of the tax/expenditure to their base are taken from OECD (2014). Table 1 shows the estimates/assumptions taken from the OECD (2014). The elasticity of Unemployment Expenditure with respect to its base, the unemployment rate, is assumed to be unitary elastic. Therefore, the estimate of the elasticity of the unemployment rate to the output gap is equivalent to the elasticity of Unemployment Expenditure to the output gap. Similarly, the elasticity of Indirect Taxes to its base, consumption, is assumed to be unitary. [7] The elasticity of Corporation Tax to its base, GOS, was estimated empirically to be 1.00.[8] As a result, the estimate of the elasticity of the corporation tax base (GOS) to the output gap will be equivalent to the estimate of Corporation Tax to the output gap. The OECD (2014) estimate of the elasticity of Social Security Contribution to its base, Compensation of Employees, is 1.51. Finally, the OECD estimates of the tax revenue to the tax base, for the components that make up Personal Income Tax, Earnings, Self Employment, and Capital Income are 2.11, 1.61 and 1.81 respectively.

[7] The use of a unitary assumption for the elasticity of indirect taxes to their tax base is justified on the grounds that these taxes are in general proportional taxes (OECD, 2005). However, there are reasonable grounds to consider this assumption questionable, particularly when there are different rates for the tax, as is the case for VAT. In such cases, the elasticity can either exceed unity, in which case it is a progressive tax (higher rates would apply to more income elastic items), or fall below unity, in which case it is regressive. VAT makes up approximately two-thirds of revenue from Indirect Taxes. For Ireland, some estimates of the short-run elasticity of VAT with respect to its base, consumption, are larger than one. For instance, Conroy (2019) estimates the elasticity of VAT with respect to consumption to be in the region of 1.27–1.82.

[8] Casey & Hannon (2016) estimated the elasticity of Corporation tax to GOS for Ireland, and found that the elasticity was in the region of 0.92-1.67.

Table 1: Assumptions Based on OECD 2014 Estimates

	Tax/Tax base Elasticity	*Expenditure/ Expenditure Base Elasticity*	*Base*
Earnings	2.11		Compensation of Employees
Self Employment	1.61		Self Employment Income
Capital	1.81		Rental Income
Social Security Contribution	1.51		Compensation of Employees
Corporation Tax	1.00		Gross Operating Surplus
Indirect Taxes	1.00		Consumption
Unemployment Expenditure		1.00	Unemployment Rate

Sources: OECD (2014).

The tax/expenditure base to output gap elasticities are estimated for a number of different estimates of the output gap. Specifically:

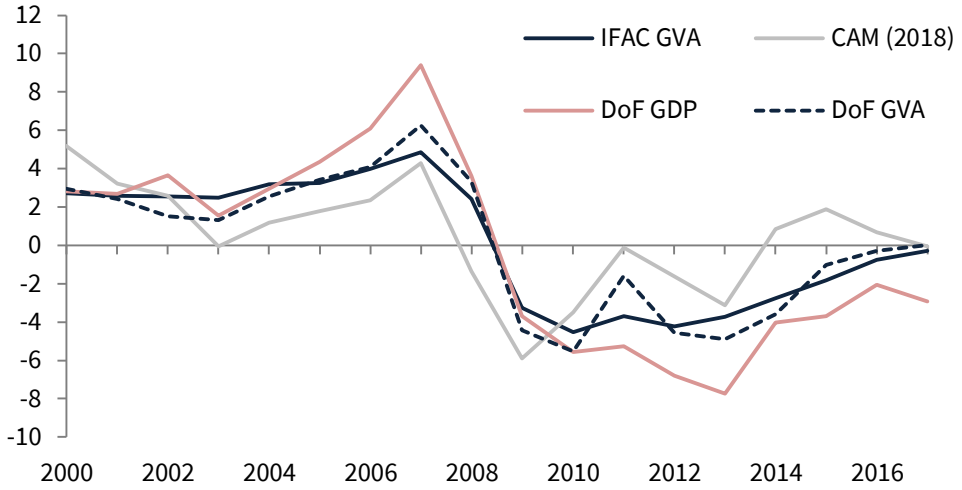
- The Department of Finance's GDP-based estimate, which is the mid-point of a suite of GDP-based estimates.
- The Department of Finances GVA-based estimate, which is the mid-point of a suite of domestic GVA-based estimates.
- IFAC's GVA-based estimate, which is the mid-point of a suite of GVA-based estimates.
- The European Commission's CAM-based output gap estimates.

Figure 1 shows the different output gap estimates. The vintage of the Department's estimates of the output gap used in estimation here, are those provided by the Department to the Council, as part of the Council's endorsement function, prior to *Budget 2019*. Similarly, the estimates of IFAC's output gap used, are those produced

by IFAC prior to *Budget 2019.* The vintage of CAM estimates of the output gap used, are those presented in the European Commission's Autumn 2018 forecasts.[9]

Figure 1: Output Gap models

Per cent of Potential Output



Sources: CSO; Department of Finance; Ameco; and internal IFAC calculations.
Note: IFAC GVA is the mid-point of a suite of domestic GVA-based models. DoF GDP is the mid-point of the Department's GDP-based models. DoF GVA is the mid-point of the Department's GVA-based models. CAM (2018) is the European Commission's Autumn 2018 CAM-based estimates of the output gap for Ireland.

Data for Compensation of Employees, Gross Operating Surplus, Self Employment Income, Unemployment rate, and Capital Income, for the years 2000-2017, are all taken from the CSO.[10] Gross Operating Surplus is constructed in line with Casey and Hannon (2016), that is:

$$GOS_t = Gross\ Value\ Added\ (Basic\ Prices)_t - Compensation\ of\ Employees_t$$

And Capital Income is constructed as:

$$Capital\ Income_t = Rent\ of\ Dwellings(Actual\ and\ Imputed)_t - Rent\ of\ Dwellings(Imputed)_t$$

[9] The OECD (2014) used the European Commission's Autumn 2013 vintage of the output gap in their estimation, so the sample period was from 1990-2013. The OECD (2014) tax/expenditure base to output gap estimates are provided in each table for comparison purposes. In each table, CAM (2014) relates to the original estimates of the elasticities as estimated by OECD (2014) and CAM (2018) relates to new estimates of the elasticities using output gap estimates from the Commission's Autumn 2018 forecasts.

[10] The sample period for estimation is from 2000-2017as these are the years for which the Department has provided the Council with output gap estimates.

Dummies are included in all equations for 2008, for the economic crisis, and for 2015, relating to the level shift in National Accounts data.

Model selection follows closely the criteria used by the OECD (2014). First the significance of the elasticities estimates are considered. Then the significance of the error correction term, λ, is considered. If the error correction term proves significant, then a comparison of the Durbin Watson statistic is considered to determine which error correction model is preferred, the ECM or the ECM AR(1). Finally, the adjusted R-squared is considered to determine which model is chosen.[11] In the event that no estimate of the elasticity from each of the three models proves significant, the original OECD (2014) estimate of the tax/expenditure base to output gap elasticity is used. [12,13]

[11] The Error Correction Model's are preferred provided that the fit of the model, as measured by the adjusted R-squared is within 0.05 of the R-squared of the GLS model.

[12] OECD (2014) addresses the issue of non-significant elasticities by using the EU average as the estimated elasticity. Here, we do not have that luxury.

[13] This only occurred for two estimates: 1) the elasticity of the capital income tax base to output gap for the Department's GVA estimate and 2) the elasticity of the Earnings base to output gap for the CAM estimates using CSO data and output gap estimates from the Commission's Autumn 2018 forecasts. Due to the weight attached to capital income, the use of the OECD's estimate has a negligible impact on the estimated budgetary semi-elasticity, akin to a rounding error. For the second case, the use of the OECD's estimate will have a non-negligible impact on the estimate of the budgetary semi-elasticity. However, OECD (2014) estimate is within the range of other estimates of the earnings base to output gap elasticity, and the OECD (2014) estimate is based on the same methodology for estimating of the output gap (albeit a different vintage and over a different time period, 1990-2013 vs 2000-2017). As a result, the OECD (2014) estimate is considered a plausible proxy in this instance.

3. Results

Appendix 1-4 shows estimates of each model, along with goodness of fit statistics, tests for autocorrelation of the residuals, and results of significance tests. The estimates of the preferred models are shown in Table 2 for each series of output gap estimates.

Overall, estimates are broadly similar between the various alternative output gap estimates, with the exception of some of the elasticities with respect to IFAC's GVA based output gap. Estimates of the elasticity of the Earnings base to output gap range from 0.97–1.57, with the highest estimate associated with the Department's GDP-based estimates. Estimates of the elasticity of the Corporation tax base to the output gap are all greater than one, ranging from 1.16–1.97. The OECD's (2014) estimate based on the CAM produced the largest elasticity in this case. The estimated elasticity of Self Employment Income to the output gap ranges from 1.28–3.23. Interestingly, the CAM based estimates produced the lowest two estimates in this range. Estimates of the elasticity of Capital Income Tax base to the output gap range from 3.05– 5.70. The CAM (2014) estimate is the lowest in this range, with all other estimates significantly greater than that (including the CAM (2018) estimate), which may be as a result of the different sample period considered. However, the weight attached to the estimates of the Capital Income Tax elasticity is relatively low and so these estimates will have a negligible impact on the overall budgetary semi-elasticities. The largest variation in estimates is with respect to the Unemployment base to output gap estimates. These range from minus 3.28 to minus 10.75. IFAC's GVA-based estimate is an outlier in this instance.[14]

[14] A single model in IFAC's suite of models appears to be driving this large elasticity. IFAC's Cyclical indicator estimate of the output gap is either the minimum or the maximum of the output gap estimates in 15 of the 18 years in the sample. As such, this has a large bearing on the mid-point estimate used here. This Cyclical indicator estimate of the output gap is constructed using Principle Components method, and the largest factor loadings are ascribed to an indicator of how far housing completions depart from their long-run levels and to an indicator of inflation in the non-traded sector. Intuitively, these are strongly correlated with the unemployment rate.

Table 2: Estimated Elasticities of the base with respect to the Output Gap

Output Gap Estimate	DoF GDP	DoF GVA	IFAC GVA	CAM(2014)	CAM (2018)
Earnings	1.57	0.97	1.36	1.08	1.08[2]
Corporation	1.16	1.21	1.67	1.97	1.25
Self Employment	2.52	2.25	3.23	1.68	1.28
Capital Income	4.68	3.05[1]	5.70	3.05	4.07
Unemployment	-3.85	-3.55	-10.75	-5.45	-3.28

Sources: CSO; Department of Finance; European Commission (2019); AMECO; and internal IFAC calculations.
Note: [1]Estimates of the Capital Income base elasticity with respect to the output gap for the Department's GVA based output gap estimate were found not to be significant. [2]Estimates of the Earnings base elasticity with respect to the CAM (2018) were found not to be significant. As a result, estimates from OECD (2014) were used proxies for these elasticities. See Appendix 1-4 for further details. Figures in grey are those taken from OECD (2014), and are used here for comparison purposes.

From the income side of the output equation, the sum of Compensation of Employees, GOS, and Self Employment Income must equal the total output:

$$Y_t = Compensation\ of\ Employees_t + GOS_t + Self\ Employment\ Income_t$$

This identity implicitly requires that the weighted sum of the elasticities of Compensation of Employees, GOS, and Self Employment Income must sum to one. As a result, an adjustment is required in order to constrain the weighted sum of these elasticities to one. The results of this adjustment are shown in Table 3, and follow the same adjustment methodology as OECD (2014).

Table 3: Adjusted Elasticities

Output Gap		DoF GDP	DoF GVA	IFAC GVA	CAM (2014)	CAM (2018)
Elasticity of Base to Output Gap	*SE*	2.52	2.25	3.23	1.68	1.28
	Earnings	1.57	0.97	1.36	1.08	1.08
	CT	1.16	1.21	1.67	1.97	1.25
GDP Weights	*SE*	0.10	0.10	0.10	0.10	0.10
	Earnings	0.42	0.42	0.42	0.42	0.42
	CT	0.48	0.48	0.48	0.48	0.48
	Adjustment Parameter	1.47	1.21	1.69	1.57	1.18
Adjusted Elasticity	*SE*	1.72	1.86	1.91	1.07	1.08
	Earnings	1.07	0.80	0.80	0.69	0.91
	CT	0.79	1.00	0.99	1.26	1.06
	Weighted Sum	1.00	1.00	1.00	1.00	1.00

Sources: CSO; Department of Finance; OECD (2014); AMECO; and internal IFAC calculations.
Note: GDP weights are taken from table A1.10 of OECD (2014). The Adjustment Parameter is the weighted sum of the elasticities of the bases to the output gap. The adjusted elasticities are then calculated as the elasticity of the base to the output gap divided by the adjustment parameter. SE refers to self-employment earnings. CT refers to Corporation Tax. Figures in grey are those taken from OECD (2014).

Looking at the adjusted elasticities, the CAM (2014) estimates again appear to be the outlier. In each case, the CAM (2014) estimates are either the lower or upper bound of the estimates. This perhaps, reflects a change in the underlying structure of the economy over which the sample periods differ.

The weighted average of the elasticity of earnings, self-employment income and capital income to output gap are combined to arrive at a personal income tax to output gap elasticity. The results are shown in Table 4. The tax revenue to tax base elasticities are taken from table A1.2 of OECD (2014). The elasticity of personal income tax with respect to the Department's GVA estimate, IFAC's GVA estimate and the CAM (2018) estimate are all relatively close to 2. While the largest personal income tax to output gap elasticity is for the Department's GDP based output gap estimate. The CAM (2014) estimate is significantly lower than the other estimates, at 1.58.

Table 4: Personal Income Tax to Output Gap Elasticity

Output Gap			*DoF GDP*	*DoF GVA*	*IFAC GVA*	*CAM (2014)*	*CAM (2018)*
Tax Revenue to Tax Base	***Earnings***	**[1]**	2.11	2.11	2.11	2.11	2.11
	SE	**[2]**	1.61	1.61	1.61	1.61	1.61
	Capital	**[3]**	1.81	1.81	1.81	1.81	1.81
	PI	**[4]**	2.04	2.04	2.04	2.04	2.04
Tax Base to Output Gap	***Earnings***	**[5]**	1.07	0.80	0.80	0.69	0.91
	SE	**[6]**	1.72	1.86	1.91	1.07	1.08
	Capital	**[7]**	4.68	3.05	5.70	3.05	4.07
	PI	**[8]**	**1.20**	**0.97**	**1.01**	**0.79**	**0.98**
Tax Revenue to Output Gap	***Earnings***	**[9]**	2.26	1.69	1.69	1.46	1.93
	SE	**[10]**	2.77	2.99	3.07	1.73	1.74
	Capital	**[11]**	8.48	5.52	10.32	5.52	7.37
	PI	**[12]**	**2.41**	**1.91**	**1.99**	**1.58**	**1.98**
	PI	**[13]**	2.46	1.97	2.06	1.61	2.00
GDP Weights	***Earnings***	**[14]**	0.60	0.60	0.60	0.60	0.60
	SE	**[15]**	0.09	0.09	0.09	0.09	0.09
	Capital	**[16]**	0.01	0.01	0.01	0.01	0.01

Sources: CSO; Department of Finance; OECD (2014); AMECO; and internal IFAC calculations.
Note: SE is self employment income and PI is personal income. Tax revenue to tax base estimates and GDP Weights are taken from table A1.2 of OECD (2014). The values in row 12 do not exactly equal the values in row 13 as the weights in rows 14-16 do not sum to one (due to the exclusion of public transfers). Figures in grey are those taken from OECD (2014).

Shown in Table 5 is the social security contribution to output gap elasticity. The social security contribution elasticity with respect to its base, Compensation of Employees, is taken from table 5 of OECD (2014). Again, the CAM (2014) estimate provides the lowest elasticity, with estimates based on more recent data showing higher elasticities.

Table 5: Social Security Contribution to Output Gap Elasticity

Output Gap		*DoF GDP*	*DoF GVA*	*IFAC GVA*	*CAM(2014)*	*CAM (2018)*
Social Security Contribution to Earnings Elasticity	(a)	1.51	1.51	1.51	1.51	1.51
Earnings to Output Gap Elasticity	(b)	1.07	0.8	0.8	0.69	0.91
Social Security Contribution to Output Gap Elasticity	c=a*b	1.61	1.21	1.21	1.04	1.38

Sources: CSO; Department of Finance; OECD (2014); AMECO; and internal IFAC calculations.
Note Social Security Contribution to Earnings elasticity is taken from table 5 of OECD (2014).
Figures in grey are those taken from OECD (2014).

The final elasticities of the taxes/expenditure items to output gap estimates are shown in Table 6. The Weights are taken from European Commission (2019). The weights are constructed as ten-year averages (2008–2017) of their tax/expenditure share. As mentioned earlier, non-tax revenue and other expenditure is assumed to be independent of the cycle and so have elasticities of 0. Indirect tax revenue is assumed to be unitary elastic with respect to the output gap.

Table 6: Estimated Elasticities of Revenue and Expenditure items with respect to the Output Gap

Output Gap	*Revenue*					*Expenditure*	
	Personal Income Tax	**Corporation Income Tax**	**Social Security Contribution**	**Indirect Taxes**	**Non-Tax Revenue**	**Unemployment Related Expenditure**	**Other Expenditure**
DoF GDP	2.41	0.79	1.61	1.00	0.00	-3.85	0.00
DoF GVA	1.91	1.00	1.21	1.00	0.00	-3.55	0.00
IFAC GVA	1.99	0.99	1.21	1.00	0.00	-10.75	0.00
CAM(2014)	1.58	1.25	1.04	1.00	0.00	5.45	0.00
CAM (2018)	1.98	1.06	1.38	1.00	0.00	-3.28	0.00
	Share of Revenue as % of Total Revenue					**Share of Expenditure as % of Total Expenditure**	
Weights	29.13	8.48	17.02	32.26	13.11	4.52	95.48

Sources: CSO; Department of Finance; European Commission (2019); AMECO; OECD (2014); and internal IFAC calculations.
Note: Weights are taken from European Commission (2019). Figures in grey are those taken from OECD (2014).

Presented in Table 7 are the final budgetary, aggregate spending and revenue semi-elasticities for each of the output gap approaches. Column (a) shows the weighted sum of all of the individual tax to output gap elasticities. Likewise, column (b) is the weighted sum of all the expenditure to output gap elasticities. Column (c) corresponds to the estimate of $(\eta_R - 1)$, similarly, column (d) corresponds to the estimate of $(\eta_G - 1)$. Columns (g) and (h) show the respective estimates of the budgetary semi-elasticity of revenue and expenditure.

Interestingly, the estimate of the revenue semi-elasticity for the Department's GDP-based output gap is relatively larger than the other estimates for revenue semi-elasticity. The lowest estimate of revenue semi-elasticity, by some margin, is the CAM (2014) estimate. Again, this may be as a result of the differing time periods used in estimation. The estimates of the expenditure semi-elasticities show some a large degree of variability. In particular, the IFAC GVA estimate is much larger, due to the large elasticity of unemployment expenditure with respect to the output gap. As a result, the IFAC GVA estimate of budgetary semi-elasticity is also relatively larger (column (i)), though it is still within the range of time-varying semi-elasticities for all other approaches. The Department's GVA based estimate, and the CAM (2018) estimate are similar to the CAM (2014) estimate of budgetary semi-elasticity. While,

the Department's GDP based estimate is larger than these, mainly due to the larger elasticity of revenue with respect to the output gap.

Table 7: Estimated Semi-Elasticities with respect to the Output Gap

	Output Gap		DoF GDP	DoF GVA	IFAC GVA	CAM (2014)	CAM (2018)
Elasticity of:	Revenue Level	(a)	1.37	1.17	1.19	1.06	1.23
	Expenditure Level	(b)	-0.17	-0.16	-0.49	-0.25	-0.15
	Revenue to GDP	c=a-1	0.37	0.17	0.19	0.06	0.23
	Expenditure to GDP	d=b-1	-1.17	-1.16	-1.49	-1.25	-1.15
Weights (%of GDP)	Total Revenue	(e)	32%	32%	32%	32%	32%
	Total Expenditure	(f)	40%	40%	40%	40%	40%
Semi-Elasticity for:	Revenue	g=c*e	0.116	0.053	0.060	0.021	0.071
	Expenditure	h=d*f	-0.472	-0.467	-0.597	-0.501	-0.462
	Budget Balance	i=g-h	0.588	0.52	0.658	0.522	0.533

Sources: CSO; Department of Finance; European Commission (2019); AMECO; OECD (2014); and internal IFAC calculations.
Note: Weights are taken from European Commission (2019). Figures in grey are those taken from OECD (2014).

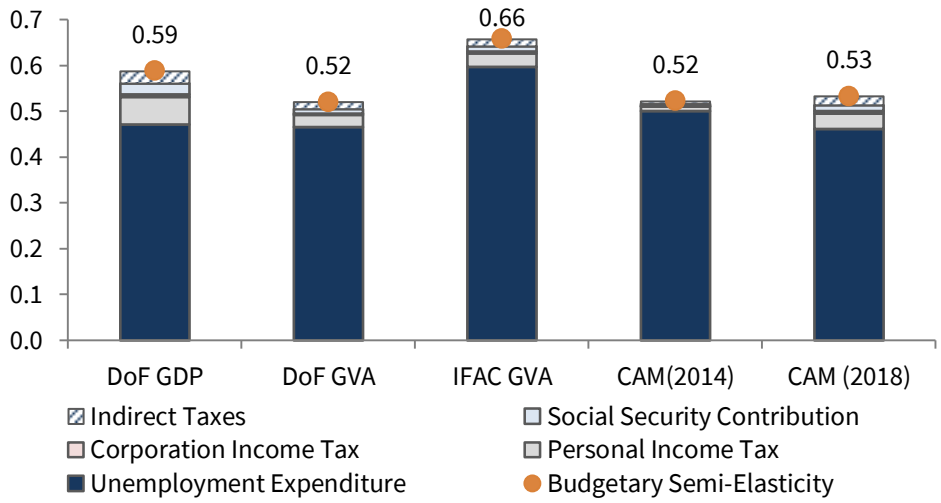
4. Analysis of the Budgetary Semi-Elasticities

This section looks at the semi-elasticities estimated in section 3 in more detail. We focus on decomposing the budgetary semi-elasticities into their component revenue and expenditure elasticities, and looking at how the semi-elasticities evolved overtime by using time varying weights.

Decomposing the Semi-Elasticities

A clearer picture of the contributions of each of the individual tax/expenditure elasticities to the overall budgetary semi-elasticity can be seen in Figure 2. The extent to which the estimate of the budgetary semi-elasticity is dominated by the unemployment expenditure is quite apparent. The elasticities of the revenue items only contribute a small fraction to the budgetary semi-elasticity by comparison. The degree to which the IFAC GVA estimate produces larger elasticities is, evidently, driven by the Unemployment Expenditure to output gap elasticity.

Figure 2: Contributions of Individual Tax/Expenditure Items to the Budgetary Semi-Elasticity



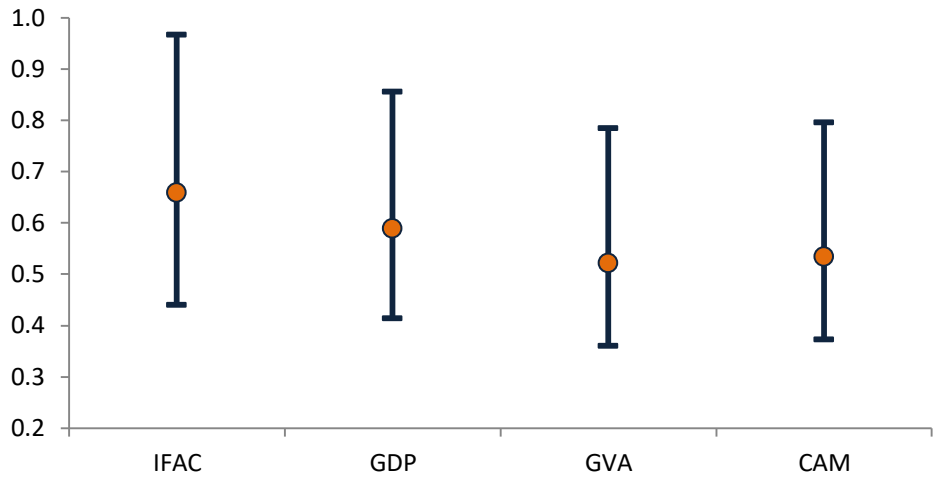
Sources: CSO; Department of Finance; European Commission (2019); AMECO; OECD (2014); and internal IFAC calculations.

Using Time-Varying Weights

One key simplification used in the methodology outlined above is the use of constant weights in the estimation of the semi elasticities. One way to test this simplification is to use time-varying weights to estimate annual semi-elasticities.

Following Mourre et al. (2019), Figure 3 shows the range of budgetary semi-elasticities for each output gap estimate using annual weights for each of the individual revenue and expenditure components and the annual expenditure/revenue-to-GDP ratios, for 2000–2016.[15] The range of estimates using annual weights is quite large, in each case the range is larger than 0.42, indicating a substantial variability in the annual semi-elasticity estimates.

Figure 3: Range of Time-Varying Semi-Elasticities, 2000–2016



Sources: CSO; Department of Finance; European Commission (2019); AMECO; OECD (2014); and internal IFAC calculations.
Note: Navy bars show the range of estimates for the budgetary semi-elasticities when the weights are based on annual data. The circles show the budgetary semi-elasticities corresponding to those presented in Table 7, which use weights based on ten-year averages (2008-2017).

Given the wide range in the estimated time-varying semi-elasticities, the use of constant weights appears a strong assumption. However, as shown in Figure 4, most of the variability arises around the crisis years, with the time-varying semi-elasticities all peaking in 2010. While the spike around 2010 is partly as a result of substantial increases in expenditure related to unemployment benefits, the majority of the spike relates to expenditure on state support for the banking sector, which caused a spike in the expenditure-to-GDP ratio to 65 per cent in 2010 (Appendix 5 Figure A5.1).[16]

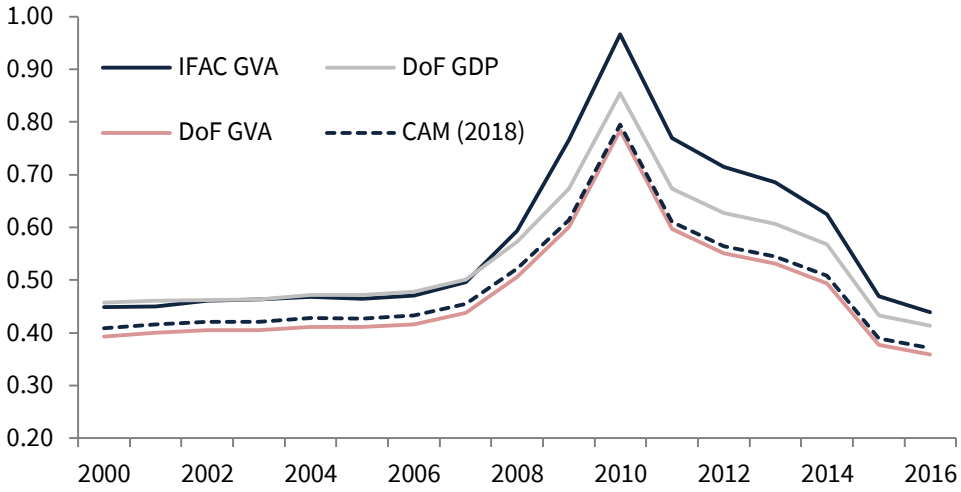
Given that these expenditure items are one-off in nature, it is questionable as to why these figures were included in the calculation of the weights for government

[15] Weights are taken from the AMECO database. See Annex III of Mourre et al. (2019) for details.

[16] Approximately 2.3, 20.2, and 2.4 per cent of GDP can be attributed to expenditure related to bank bailouts in 2009, 2010 and 2011 respectively. See McArdle (2012) for details.

expenditure.[17] However, given that the cumulative effects of expenditure on the bailouts were approximately 25 per cent of GDP this would have only increased the share of expenditure in GDP of the ten-year average by 2.5 percentage points. This would only had a minor effect of elevating the estimated budgetary semi-elasticity by somewhere in the region of 0.03 over what would have been the case had the expenditure to GDP ratio corrected for the bank bailouts been used.

Figure 4: Time-Varying Budgetary Semi-Elasticities



Sources: CSO; Department of Finance; European Commission (2019); AMECO; OECD (2014); and internal IFAC calculations.
Note: This figure shows the estimated budgetary semi-elasticities using time-varying weights of revenue and expenditure items.

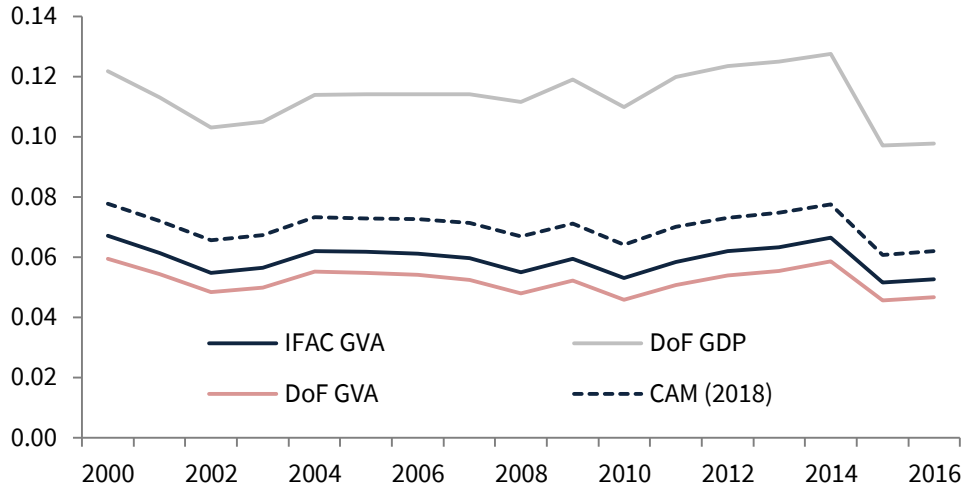
When thinking about revenue-semi elasticities, intuitively, one would expect that the revenue semi-elasticity would be close to zero, as the revenue-to-GDP ratio would remain relatively constant over the cycle. This arises from the fact that there is almost a one-for-one relationship between revenue and GDP. In other words, as GDP rises, revenues rise proportionally. Therefore, the revenue-to-GDP ratio remains relatively constant throughout the cycle.

The time-varying revenue elasticities are shown in (Figure 5). The revenue semi-elasticities are close to zero and remain relatively stable throughout the time horizon, with all estimates showing a level shift after 2015 relating to the level shift in GDP at the time. The Department's GDP-based estimate of the revenue semi-elasticity is relatively higher than the other estimates indicating that the revenue-to-

[17] Appendix 5 shows figures of the time-varying budgetary and expenditure semi-elasticity when government expenditure is corrected for the expenditure related to bank bailouts.

GDP ratio is more responsive to changes in the Department's GDP-based output gap than to other estimates of the output gap.

Figure 5: Time-varying Revenue Semi-Elasticities

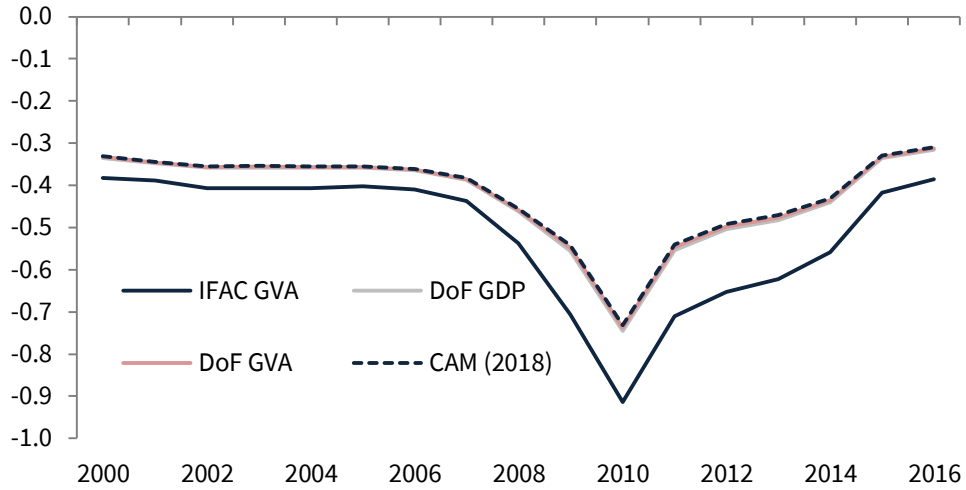


Sources: CSO; Department of Finance; European Commission (2019); AMECO; OECD (2014); and internal IFAC calculations.
Note: This figure shows the estimated budgetary semi-elasticities using time-varying weights of revenue items.

The estimated expenditure semi-elasticities are negative, indicating that as output goes above potential, the expenditure-to-GDP ratio falls. This is largely due to the cyclical nature of unemployment expenditure. In good times, when output is above potential, unemployment expenditure decreases. Therefore, the expenditure-to-GDP ratio is counter-cyclical.

The expenditure semi-elasticities remained relatively constant from 2000–2008 (Figure 6). All expenditure semi-elasticities decreased markedly around 2010, in part due to increased expenditure on unemployment benefit, but also due to the expenditure on state support for the banking sector.

Figure 6: Time-varying Expenditure Semi-Elasticities



Sources: CSO; Department of Finance; European Commission (2019); AMECO; OECD (2014); and internal IFAC calculations.
Note: This figure shows the estimated budgetary semi-elasticities using time-varying weights of revenue and expenditure items.

The budgetary semi-elasticity is used to arrive at the cyclically adjusted budget balance. One crude measure of how useful the budgetary semi-elasticity is, is to compare the correlation between the general government balance and the output gap with the correlation between the cyclically adjusted budget balance and the output gap. If the budgetary semi-elasticity functions as expected, one would expect that the correlation between the output gap and the cyclically adjusted budget balance would be considerably lower than the correlation between the output gap and the general government balance.

Table 8 shows the correlation between each output gap estimate and the general government balance (net of one-offs) and the output gap and their corresponding structural balance (which is the cyclically adjusted budget balance net of one-offs). The correlation between the output gap and the general government balance is particularly high for the CAM-based estimate (0.86), while the Department's GDP-based estimate has the lowest correlation (0.68). In all cases the correlation between the output gap and the general government balance are higher than the correlation between the output gap and the structural balance, implying that using the budgetary semi-elasticities to adjust the budget balance for the cycle gives a better indication of the fiscal stance. One particularly interesting point to note is that the estimate of the budgetary semi-elasticity using the Department's GDP based estimates of the output gap is very good at adjusting for the cycle, as the

correlation between the Department's GDP-based estimate of the output gap and the corresponding structural balance is very weak. The CAM-based estimated of the semi-elasticity is the poorest in this regard.

Table 8: Correlation of the Budget Balances with the Cycle

	GGB	SB
DoF GDP	0.68	0.11
DoF GVA	0.76	0.51
IFAC	0.79	0.51
CAM (2018)	0.86	0.74

Sources: CSO; Department of Finance; European Commission (2019); AMECO; OECD (2014); and internal IFAC calculations.
Note: GGB column shows the correlation between the general government budget balance (excluding one-offs) and each output gap for the period 2000-2017. SB column shows the correlation of each of the implied structural balance estimates with their corresponding output gap for the period 2000-2017.

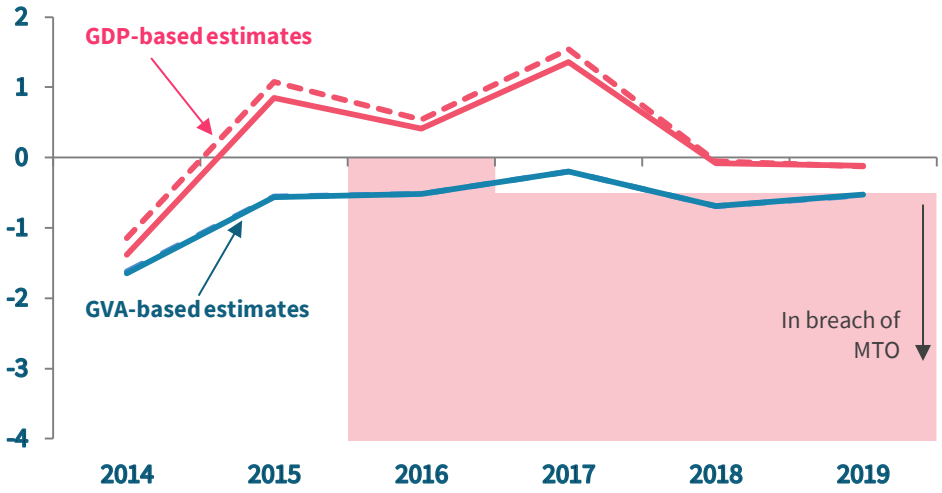
Previous Council estimates of the Structural balance using Alternative output gap measures

Previously, the Council published estimates of the structural balance based on the Department's GDP and GVA-based estimates of the output gap (Box E IFAC, 2018). These estimates of the structural balance used the same budgetary semi-elasticity that was used by the European Commission at the time (estimated to be 0.5275).

Figure 7 shows what these estimates would now look like, with the new estimates of the budgetary semi-elasticity, in comparison to those previously published. It is clear that, quantitatively, the estimates of the structural balance are not substantially different, and that the new estimates of the budgetary semi-elasticity would not have changed any assessment of compliance/non-compliance with the MTO.

Figure 7: Structural Balance Comparison using new Budgetary Semi-elasticities

Per Cent of GDP



Sources: CSO; Department of Finance; European Commission (2019); AMECO; OECD (2014); and internal IFAC calculations.

Note: The dashed lines are estimates presented in the November Fiscal Assessment Report (IFAC, 2018), where a budgetary semi-elasticity of 0.5275 was used for both the GDP and GVA-based estimates of the output gap. The solid lines represent estimates of the structural balance using the budgetary semi-elasticities presented in this note. The GDP based estimate of the budgetary semi-elasticity is 0.588, and the GVA-based estimate is 0.520. Note that the GVA-based estimates are near identical using the old and new semi-elasticities.

5. Conclusions

In this note, we estimate new budgetary semi-elasticities for a range of output gap estimates for Ireland. Budgetary semi-elasticities are estimated for both the Department's GDP and GVA-based estimates of the output gap and for IFAC's own estimates of the output gap. The budgetary semi-elasticities of the Department's GDP and GVA based estimate of the output gap are estimated to be 0.588 and 0.520 respectively. While the estimate of IFAC's budgetary semi-elasticity is 0.658.

As these alternative estimates of the output gap offer a more plausible approximation of the position of the economy in the cycle, the Council has decided to use these estimates (specifically, the Department's preferred GDP-based estimates of the output gap) as the basis for assessing compliance with Ireland's domestic Budgetary Rule. The semi-elasticities estimated here will allow for the estimation of more plausible structural balance estimates than those estimated using the European Commission's CAM-based estimates of the output gap.

Going forward, the Council will re-estimate the budgetary semi-elasticities in line with the timeline followed by the European Commission (see Table 8). That is, new revenue and expenditure weights are updated every two MTO cycles (six years), and new individual elasticities are updated every three MTO cycles (nine years). The next update will be in 2025, when both the weights and the individual elasticities will be estimated.

Table 8: European Commission timeline of re-estimation of Budgetary Semi-elasticity

	2013 MTO Cycle (2014-2016)	***2016 MTO Cycle (2017-2019)***	***2019 MTO Cycle (2020-2022)***	***2022 MTO Cycle (2023-2025)***	***2025 MTO Cycle (2026-2028)***
	Update	Update	Update	No Update	Update
New Weights	✔		✔		✔
New Individual Elasticities		✔			✔

Sources: European Commission (2019).

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Appendix 1: GDP-based Output gap Estimates

Table A1.1: Elasticity of the Earnings Base to the Output Gap

Model	Elasticity	P value	Adjusted R^2	P value of λ	Durbin Watson
GLS	0.84	0.01	0.63	-	1.77
ECM	1.57	0.00	0.64	0.07	1.48
ECM AR(1)	1.15	0.01	0.62	0.14	1.77
Preferred Model:	**ECM**				

Sources: CSO; Department of Finance; and internal IFAC calculations.

Table A1.2: Elasticity of the Corporation Tax Base to the Output Gap

Model	Elasticity	P value	Adjusted R^2	P value of λ	Durbin Watson
GLS	1.22	0.00	0.85	-	1.46
ECM	1.16	0.00	0.83	0.09	1.33
ECM AR(1)	1.19	0.01	0.83	0.52	1.48
Preferred Model:	**ECM**				

Sources: CSO; Department of Finance; and internal IFAC calculations.

Table A1.3: Elasticity of the Self Employment Tax Base to the Output Gap

Model	Elasticity	P value	Adjusted R^2	P value of λ	Durbin Watson
GLS	2.52	0.06	0.37	-	1.83
ECM	2.14	0.01	0.48	0.12	2.23
ECM AR(1)	2.51	0.05	0.43	0.17	1.80
Preferred Model:	**GLS**				

Sources: CSO; Department of Finance; and internal IFAC calculations.

Table A1.4: Elasticity of the Capital Income Tax Base to the Output Gap

Model	Elasticity	P value	Adjusted R^2	P value of λ	Durbin Watson
GLS	4.68	0.09	0.30	-	1.70
ECM	4.19	0.08	0.32	0.97	1.54
ECM AR(1)	4.95	0.10	0.24	0.86	1.67
Preferred Model:	**GLS**				

Sources: CSO; Department of Finance; and internal IFAC calculations.

Table A1.5: Elasticity of the Unemployment Rate to the Output Gap

Model	Elasticity	P value	Adjusted R^2	P value of λ	Durbin Watson
GLS	-3.85	0.01	0.53	-	1.92
ECM	-4.92	0.01	0.51	0.48	1.56
ECM AR(1)	-3.74	0.05	0.49	0.85	1.83
Preferred Model:	**GLS**				

Sources: CSO; Department of Finance; and internal IFAC calculations.

Appendix 2: GVA-based Output gap Estimates

Table A2.1: Elasticity of the Earnings Base to the Output Gap

Model	Elasticity	P value	Adjusted R^2	P value of λ	Durbin Watson
GLS	0.97	0.01	0.58	-	1.83
ECM	1.48	0.01	0.49	0.28	1.07
ECM AR(1)	1.04	0.01	0.55	0.55	1.78
Preferred Model:	**GLS**				

Sources: CSO; Department of Finance; and internal IFAC calculations.

Table A2.2: Elasticity of the Corporation Tax Base to the Output Gap

Model	Elasticity	P value	Adjusted R^2	P value of λ	Durbin Watson
GLS	1.06	0.01	0.83	-	1.68
ECM	1.21	0.01	0.84	0.07	1.55
ECM AR(1)	1.09	0.01	0.82	0.15	1.66
Preferred Model:	**ECM**				

Sources: CSO; Department of Finance; and internal IFAC calculations.

Table A2.3: Elasticity of the Self Employment Tax Base to the Output Gap

Model	Elasticity	P value	Adjusted R^2	P value of λ	Durbin Watson
GLS	2.25	0.02	0.32	-	1.92
ECM	2.37	0.01	0.45	0.22	1.94
ECM AR(1)	2.38	0.01	0.34	0.44	1.92
Preferred Model:	**GLS**				

Sources: CSO; Department of Finance; and internal IFAC calculations.

Table A2.4: Elasticity of the Capital Income Tax Base to the Output Gap

Model	Elasticity	P value	Adjusted R^2	P value of λ	Durbin Watson
GLS	3.80	0.13	0.24	-	1.77
ECM	3.54	0.13	0.29	0.76	1.66
ECM AR(1)	3.63	0.18	0.17	0.87	1.80
Preferred Model:	**CAM (2014)**				

Sources: CSO; Department of Finance; and internal IFAC calculations.
Note: The OECD CAM estimates is chosen here as all elasticity estimates proved non-significant at the 10 per cent significance level.

Table A2.5: Elasticity of the Unemployment Rate to the Output Gap

Model	Elasticity	P value	Adjusted R^2	P value of λ	Durbin Watson
GLS	-3.55	0.01	0.60	-	2.16
ECM	-5.17	0.01	0.49	0.84	1.21
ECM AR(1)	-4.05	0.01	0.63	0.14	1.83
Preferred Model:	**GLS**				

Sources: CSO; Department of Finance; and internal IFAC calculations.

Appendix 3: Estimates of the CAM-based budgetary semi-elasticity

Table A3.1: Elasticity of the EarningsBase to the Output Gap

Model	Elasticity	P value	Adjusted R^2	P value of λ	Durbin Watson
GLS	0.37	0.36	0.62	-	1.47
ECM	0.32	0.58	0.32	0.78	0.63
ECM AR(1)	0.23	0.68	0.61	0.57	1.66
Preferred Model:	**CAM (2014)**				

Sources: CSO; Department of Finance; AMECO; and internal IFAC calculations.
Note: The OECD CAM estimates is chosen here as all elasticity estimates proved non-significant at the 10 per cent significance level.

Table A3.2: Elasticity of the Corporation Tax Base to the Output Gap

Model	Elasticity	P value	Adjusted R^2	P value of λ	Durbin Watson
GLS	1.25	0.01	0.85	-	1.41
ECM	0.90	0.03	0.81	0.13	1.33
ECM AR(1)	1.21	0.01	0.82	0.75	1.45
Preferred Model:	**GLS**				

Sources: CSO; Department of Finance; AMECO; and internal IFAC calculations.

Table A3.3: Elasticity of the Self Employment Tax Base to the Output Gap

Model	Elasticity	P value	Adjusted R^2	P value of λ	Durbin Watson
GLS	1.28	0.11	0.11	-	1.90
ECM	1.34	0.16	0.16	0.61	1.73
ECM AR(1)	1.32	0.14	0.00	0.81	2.02
Preferred Model:	**GLS**				

Sources: CSO; Department of Finance; AMECO; and internal IFAC calculations.

Table A3.4: Elasticity of the Capital Income Tax Base to the Output Gap

Model	Elasticity	P value	Adjusted R^2	P value of λ	Durbin Watson
GLS	4.07	0.10	0.22	-	1.62
ECM	3.09	0.25	0.22	0.75	1.53
ECM AR(1)	3.23	0.23	0.11	0.78	1.66
Preferred Model:	**GLS**				

Sources: CSO; Department of Finance; AMECO; and internal IFAC calculations.

Table A3.5: Elasticity of the Unemployment Rate to the Output Gap

Model	Elasticity	P value	Adjusted R^2	P value of λ	Durbin Watson
GLS	-3.28	0.03	0.52	-	1.66
ECM	-3.15	0.24	0.14	0.60	0.91
ECM AR(1)	-3.78	0.17	0.46	0.68	1.74
Preferred Model:	**GLS**				

Sources: CSO; Department of Finance; AMECO; and internal IFAC calculations.

Appendix 4: Estimates of IFAC's GVA-based Budgetary Semi-elasticity

Table A4.1: Elasticity of the Earnings Base to the Output Gap

Model	Elasticity	P value	Adjusted R^2	P value of λ	Durbin Watson
GLS	1.36	0.05	0.62	-	1.88
ECM	2.10	0.01	0.54	0.30	1.12
ECM AR(1)	1.57	0.10	0.57	0.27	1.84
Preferred Model:	**GLS**				

Sources: CSO; Department of Finance; and internal IFAC calculations.

Table A4.2: Elasticity of the Corporation Tax Base to the Output Gap

Model	Elasticity	P value	Adjusted R^2	P value of λ	Durbin Watson
GLS	1.47	0.05	0.83	-	1.81
ECM	1.67	0.01	0.84	0.05	1.69
ECM AR(1)	1.61	0.07	0.81	0.05	1.68
Preferred Model:	**ECM**				

Sources: CSO; Department of Finance; and internal IFAC calculations.

Table A4.3: Elasticity of the Self Employment Tax Base to the Output Gap

Model	Elasticity	P value	Adjusted R^2	P value of λ	Durbin Watson
GLS	3.61	0.22	0.40	-	1.92
ECM	3.23	0.01	0.49	0.18	2.02
ECM AR(1)	3.27	0.22	0.39	0.23	1.88
Preferred Model:	**ECM**				

Sources: CSO; Department of Finance; and internal IFAC calculations.

Table A4.4: Elasticity of the Capital Income Tax Base to the Output Gap

Model	Elasticity	P value	Adjusted R^2	P value of λ	Durbin Watson
GLS	8.52	0.33	0.36	-	1.64
ECM	5.70	0.09	0.38	0.25	1.69
ECM AR(1)	6.51	0.52	0.28	0.57	1.79
Preferred Model:	**ECM**				

Sources: CSO; Department of Finance; and internal IFAC calculations.

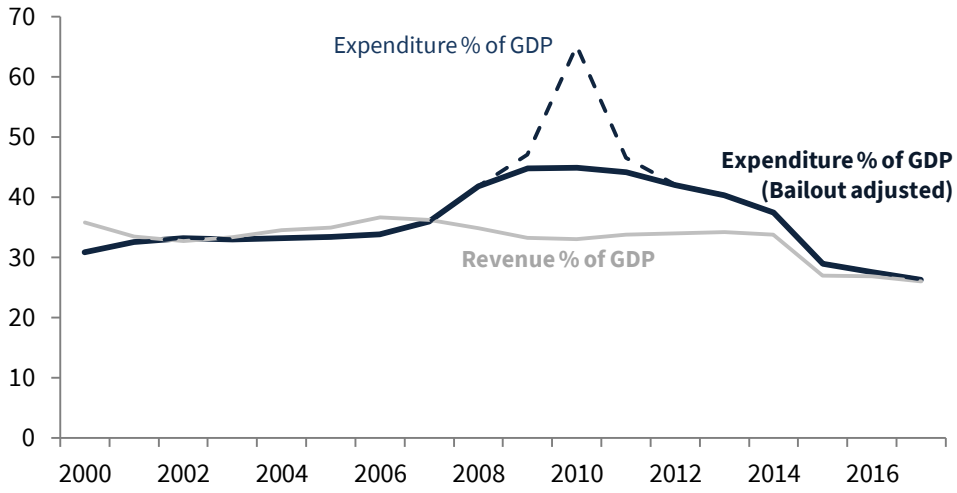
Table A4.5: Elasticity of the Unemployment Rate to the Output Gap

Model	Elasticity	P value	Adjusted R^2	P value of λ	Durbin Watson
GLS	-9.48	0.01	0.83	-	1.93
ECM	-10.74	0.01	0.84	0.14	1.75
ECM AR(1)	-10.75	0.02	0.81	0.08	1.74
Preferred Model:	**ECM AR(1)**				

Sources: CSO; Department of Finance; and internal IFAC calculations.

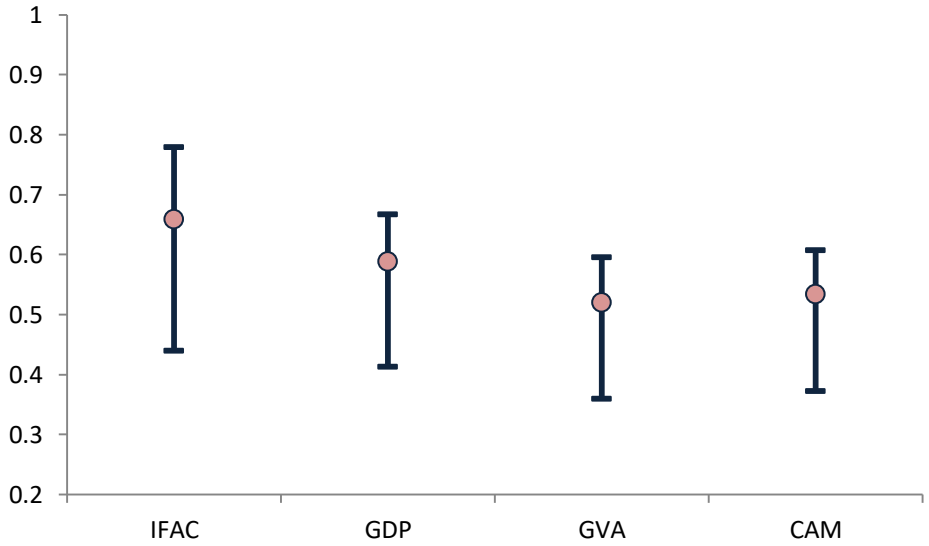
Appendix 5: Adjusting Time-Varying Semi-Elasticities for State Support of the Banking Sector

Figure A5.1: Expenditure and Revenue as a share of GDP



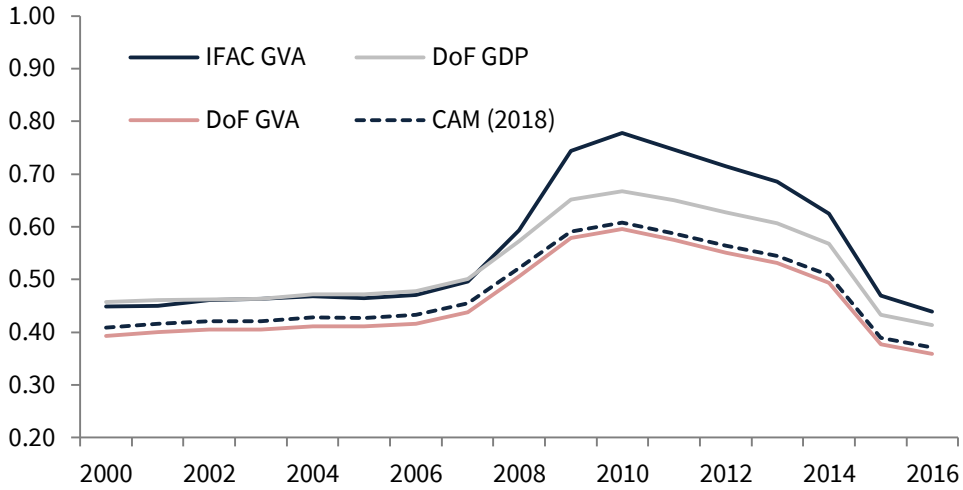
Sources: AMECO.
Note: Dashed navy line represents expenditure as a share of GDP as reported in the AMECO database. The solid navy line represents expenditure as a share of GDP adjusted for the expenditure on bank bailouts in 2009, 2010 and 2011.

Figure A5.2: Range of Time-Varying Budgetary Semi-Elasticities (Bank Bailout Adjusted)



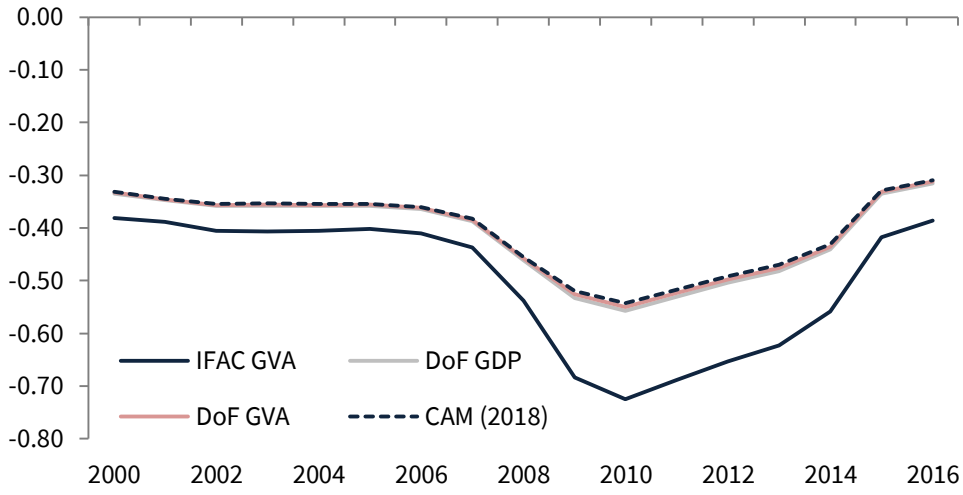
Sources: CSO; Department of Finance; and internal IFAC calculations.
Note: This figure shows the range of estimated budgetary semi-elasticities using time-varying weights of revenue and expenditure items. Weights are adjusted for expenditure on bank bailouts in 2009, 2010 and 2011.

Figure A5.3: Time-Varying Budgetary Semi-Elasticities (Bank Bailout Adjusted)



Sources: CSO; Department of Finance; and internal IFAC calculations.
Note: This figure shows the estimated budgetary semi-elasticities using time-varying weights of revenue and expenditure items. Weights are adjusted for expenditure on bank bailouts in 2009, 2010 and 2011.

Figure A5.4: Time-varying Expenditure Semi-Elasticities (Bank Bailout Adjusted)



Sources: CSO; Department of Finance; and internal IFAC calculations.
Note: This figure shows the estimated budgetary semi-elasticities using time-varying weights of revenue and expenditure items. Weights are adjusted for expenditure on bank bailouts in 2009, 2010 and 2011.