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Challenges Forecasting
Irish Corporation Tax

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KEY MESSAGES

- This note examines the forecasting approach used by the Department of Finance and the Revenue Commissioners for Irish corporation tax revenues. It is motivated in part by the large size of forecast errors in recent years. The note also assesses the wider implications for medium-term expenditure planning of the difficulties in forecasting these receipts.

- As well as being highly unpredictable, corporation tax receipts are the most volatile of Ireland's main tax heads, with this volatility having become more pronounced in recent years. This is evident even when controlling for differences in growth rates typically observed.

- Part of the reason for the volatility and unpredictability of corporation tax receipts is the degree to which receipts are concentrated among a small number of firms. This mirrors Ireland's export sector, which is concentrated and dissimilar to international norms. As a result, there is greater exposure to idiosyncratic shocks such as the 'patent cliff' and company restructurings and inversions.

- The standard approach used by the Department of Finance to forecast corporation tax has produced large forecast errors in recent years. This note tests a number of alternatives. While the sample period of the available data is short, nominal GDP appears to be a slightly better predictor of receipts than gross operating surplus. However, even the better performing models fail to explain a large portion of the within-sample variation in the annual growth of receipts. The fact that this variation appears to be unexplained to a large extent by the economic fundamentals that we have tested suggests the importance of idiosyncratic developments.

- In light of the unpredictable and volatile nature of corporation tax receipts, it is advisable that this revenue source is treated with greater care when compared to other tax sources. In particular, it would be unwise to use sharp, unpredictable increases in corporation tax receipts as a basis to fund increases in permanent expenditure. A number of options exist, including using windfall receipts to reduce public debt to safer levels or as a basis for funding a rainy day fund – something that is currently being considered.

1. INTRODUCTION

This note examines the forecasting approach used for corporation tax revenues by the Department of Finance, which are formed with input and assistance from the Revenue Commissioners. It also assesses the wider implications of the difficulties involved in forecasting these receipts. As Figure 1 shows, corporation tax receipts have become a much more important source of government revenues in the past two decades representing on average one in every eight euro of taxes collected each year.

FIGURE 1: CORPORATION TAX RECEIPTS (% OF TOTAL TAX RECEIPTS)
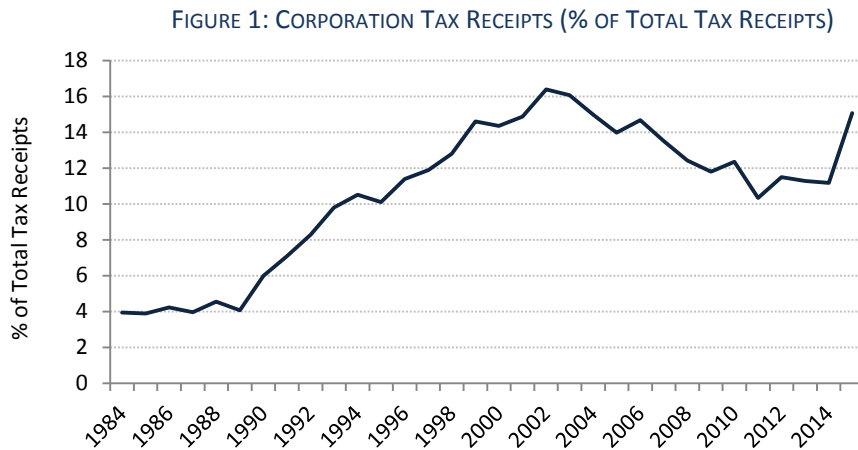
Sources: Department of Finance; internal IFAC calculations.

Forecasting corporation tax revenues in Ireland has traditionally been difficult. In addition to the usual uncertainties related to macroeconomic growth, the highly concentrated nature of Ireland's business sector means that various company- and sector-specific developments can have large impacts on annual outturns. This has significant implications for the accuracy of budgetary forecasts, but also for the appropriateness of the fiscal stance given that the stability and sustainability of revenue sources are central aspects of prudent budgetary planning.

FIGURE 2: CORPORATION TAX FORECAST ERRORS (1981-2015)
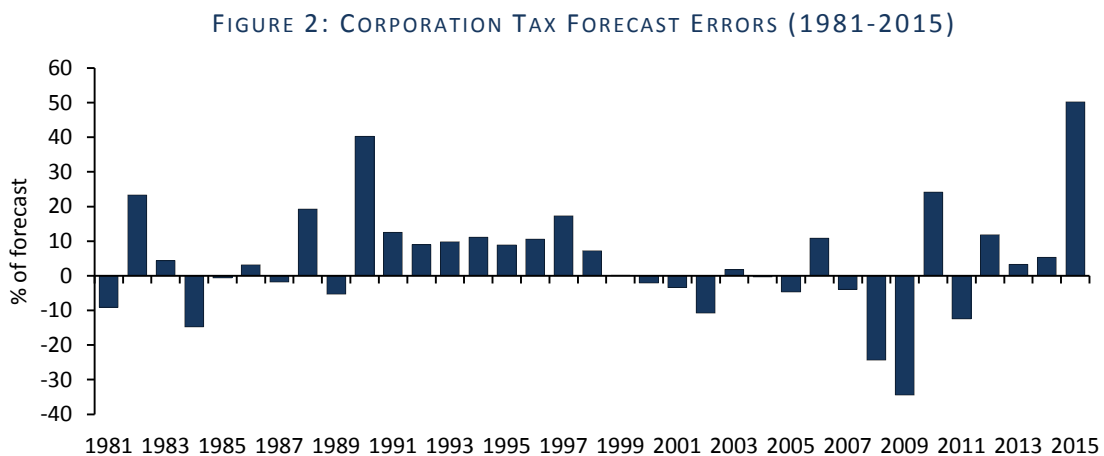
Source: Department of Finance (forecasts from various Budget documents).
Notes: Errors relate to Budget-day forecasts for the following year.

This note is motivated in part by the size of forecast errors in recent years. Figure 2 shows that (when expressed as a percentage of the forecast outturn) the 2015 error is the largest in more than a decade.

TABLE 1: DEPARTMENT OF FINANCE FORECASTING ERRORS 1985-2015

Tax Head	2015 Receipts (€m)	Mean Error (%)	RMSE(%)
Corporation Tax	6,872	4.9	16.6
VAT	11,944	-1.7	8.2
Excise	5,292	-0.8	6.1
Income Tax	18,359	1.3	4.7
Capital Taxes	1,069	6.1	40.3
Other	1,595	2.0	19.2

Source: Hannon, Leahy and O' Sullivan (2015) – updated for 2015 Exchequer outturn data.
Note: Capital taxes refer to CGT and CAT.

Table 1 shows that CT forecast errors – as revealed by the Root Mean Square Error (RMSE) – are the highest of the four largest tax heads. The tax heads covered in Table 1 accounted for 94 per cent of total tax revenues collected in 2015. Only the comparatively small capital taxes and other taxes have a larger RMSE.

2. THE CORPORATE TAX BASE

The obvious starting point for forecasting Corporation Tax (CT) receipts is the tax base itself, which in this case is the profit made by firms on their activities. The principal measure of firms' operating profits – in the context of the national accounts – is Gross Operating Surplus (GOS).

Following the national accounts definition, GOS is defined as net income generated by incorporated enterprises' operating activities after paying labour input costs. These labour input costs include employers' social contributions in addition to wages and salaries. GOS is given by:

$$GOS = Gross\ Output - Intermediate\ Goods\ and\ Services - Compensation\ of\ Employees$$
$$= Gross\ Value\ Added\ (Basic\ Prices) - Compensation\ of\ Employees$$

The Department of Finance uses GOS as the main variable for the purposes of CT forecasts. The Department typically produces a new set of macroeconomic forecasts in each spring Stability Programme Update and autumn Budget document from which GOS can be determined.[1]

At the company-level, GOS may differ from profits shown on an accounting basis for several reasons, in particular as only a subset of total costs are subtracted from gross output to arrive at national accounts

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[1] While not published, GOS estimates are produced as part of the Department's macroeconomic forecasts.

estimates of GOS. It is also important to note that the national accounts measure of profits will refer only to profits corresponding to activities carried out within an economic territory.[2]

The cost of intermediate goods and services and compensation of employees are deducted from gross output to arrive at GOS, but pre-tax profits in company accounts make a number of additional adjustments. The following is a reconciliation of the company accounts measure of pre-tax profits with its national accounts equivalent (Lequiller and Blades, 2014):

Company Accounts Pre-Tax Profits   = Gross Operating Surplus
- Conceptual/Practical Differences [3]
- Property Income Paid (national accounts) [4]
+ Property Income Received
+ Exceptional Profits and Losses [5]
+ Inventory Appreciation (national accounts measure)
- Depreciation (company accounts measure)

It is likely that the adjustments to the national accounts (GOS) measure of profits outlined above will not remain stable over time. For example, capital gains/losses related to sales or purchases of assets may lead to sharp divergences between the two measures. Consequently, one would expect that the relationship between GOS and taxable income will also be subject to change from year-to-year.

Even if it were a perfect proxy for taxable profits, forecasting GOS – as with any macroeconomic aggregate – is subject to a high degree of uncertainty. In particular, this reflects the uncertainty of international trading conditions and currency markets, among other factors. International trading conditions are assumed by the Department to evolve in line with official forecasts from agencies such as the European Commission (EC), OECD and IMF, while currency markets are assumed to remain constant (i.e., fixed at their recent ten-day average as of the time of forecasting).

It is widely understood that forecasts of external developments can be subject to sharp unexpected changes. Currency markets are notoriously volatile and difficult to predict, while expectations for demand conditions in major trading partners can also be prone to frequent and marked changes.[6] Figure 3 shows

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[2] The basis for Irish CT is, broadly speaking, the profits of companies resident in Ireland and of certain non-residents that trade in the State via branches. Revenue has full sight of relevant profits through tax returns, though profits reported publicly by large multinationals with global supply chains may often differ from these. This is due to the fact that these may often include profits made by their overseas subsidiaries, and breakdowns of geographical activities may not be provided.

[3] Note that conceptual/practical differences can relate to differences in the treatment of intellectual property, fraud, leasing arrangements, etc. The national accounts, for example, treat spending on intellectual property primarily as investment rather than intermediate consumption so that this form of expenditure has little impact on GOS other than through depreciation.

[4] Property income paid in this case does not include distributed income and reinvested earnings on foreign direct investment as measured in the national accounts.

[5] In particular, these exceptional profits/losses cover capital gains/losses, such as on the sale of subsidiaries or related to gains/losses on currency transactions.

[6] For a discussion, see Wang (2008). One influential study examining the so-called "disconnect puzzle" is Meese and Rogoff (1983), which finds that "random walk" models are just as good at predicting exchange rates as models based on economic

various vintages of EC forecasts of real GDP for the Euro Area – Ireland's largest trading partner – in recent years. Cumulatively, Euro Area growth was expected to be two percentage points higher in 2013 relative to 2010 than subsequently turned out to be the case. Empirical research using Irish data has shown that such disappointments can have significant impacts on Irish exports, real GDP and government revenues (see, for example, Bermingham and Conefrey (2011); and Nkusu (2013)).

The implication is that, as difficult as it can be to firmly link CT receipts to GOS, forecasting CT is even more difficult because of the many challenges posed by forecasting GOS itself.

FIGURE 3: EURO AREA REAL GDP (EUROPEAN COMMISSION FORECAST VINTAGES)
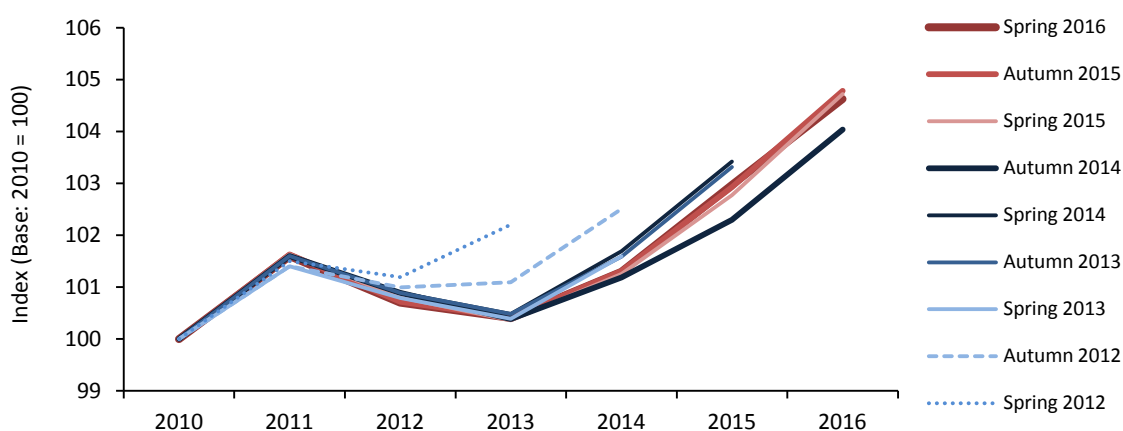
Source: European Commission Forecasts, Different Vintages.

3. CONCENTRATION OF THE CORPORATE TAX BASE

One feature of the corporate tax base in Ireland that plays a significant role in annual developments is its concentration. In particular, the highly concentrated business sector in Ireland can mean that various company- and sector-specific developments have large impacts on profitability, with consequent impacts on corporation tax receipts. This feature is evident from various measures of sectoral concentration and can be seen to have also become more pronounced in recent years.

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fundamentals like trade balances, money supply, national income and other variables. Evidence since then suggests that alternative modelling techniques have failed to outperform random-walk forecasts in the short-term.

FIGURE 4: CONCENTRATION AND DIVERSIFICATION OF MERCHANDISE EXPORTS, DEVELOPED ECONOMIES (2014)
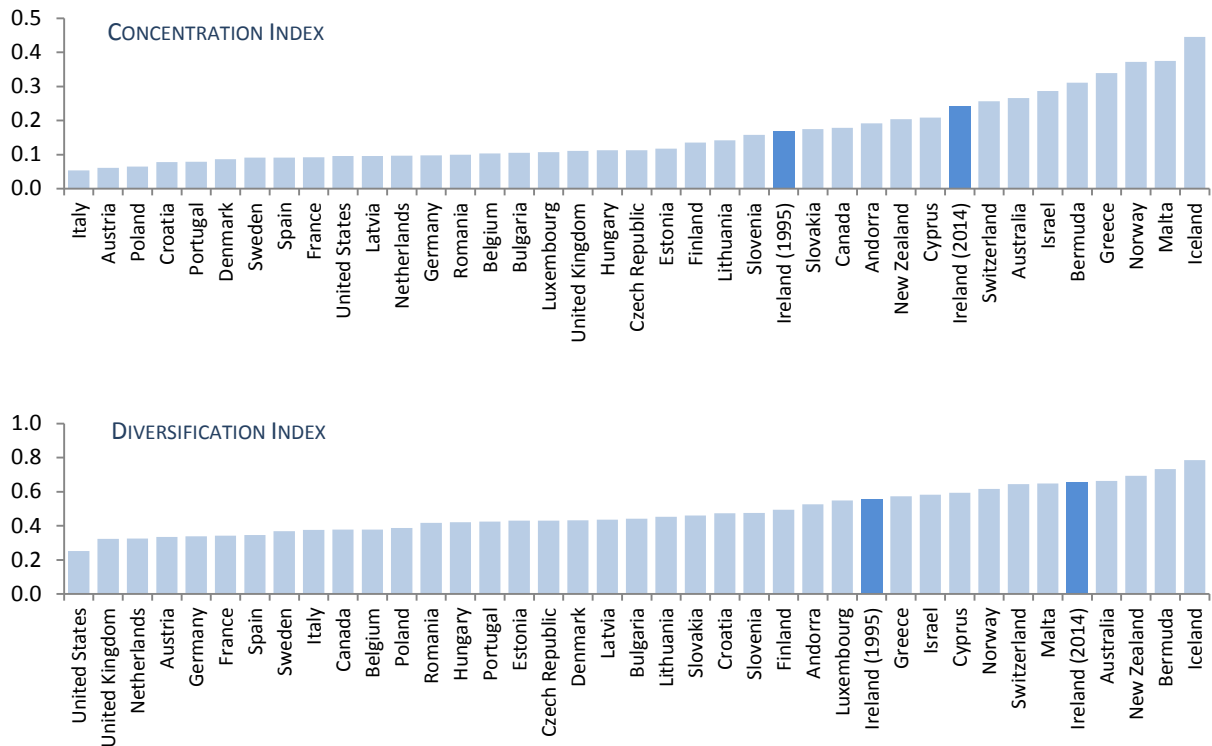
Sources: UNCTADSTAT; internal IFAC calculations.

Note: The diversification index is a measure of similarity in trade, which signals whether the structure of exports by product of a given country differs from the structure of world production. Higher scores indicate greater dissimilarity. The concentration index is a normalised Herfindahl-Hirschmann index. Ireland is shown for both 1995 and 2014; all 37 other developed economies shown for 2014.

Figure 4 shows summary measures of the concentration and specialisation of Irish merchandise exports relative to other developed economies developed by the World Bank.[7] The first measure shown, the product concentration index, measures the extent to which exports can be said to be concentrated in relatively few products. It takes the form of a normalised Herfindahl- Hirschmann index. The second measure, the diversification index, indicates whether the structure of exports by product differs from global norms. If a greater share of total manufactured goods in a given country is made up of a specific product – say pharmaceuticals for example – compared to the share of that product in world exports, then a higher score is obtained on the diversification index. It can also be understood as a measure of dissimilarity in manufacturing, with higher scores indicating higher dissimilarity. Calculating the diversification index involves summing the demeaned shares of all manufactured products in a given country with respect to the world mean.

Two key points can be discerned from the concentration and diversification indicators: (1) Irish merchandise exports are quite concentrated, with a product mix that is highly dissimilar to the typical

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[7] More information and data are available at: unctadstat.unctad.org/

global product mix; (2) the concentration and dissimilarity of Irish merchandise exports has become more pronounced in the past two decades.

While dissimilarity can be an advantage, in the sense that a manufacturing sector's product mix may not be tied to wider cyclical developments in global demand, it also means greater exposure to idiosyncratic, sector-specific shocks.[8] An example of this type of idiosyncratic risk has been visible in Ireland recently in what is known as the 'patent cliff' whereby a number of high value drugs became off-patent in quick succession beginning in 2011. Enright and Dalton (2014) assess the phenomenon though it is not clear what the ex-post impact was for CT receipts. The authors also note that the Irish corporation tax take has "always been both concentrated and more prone to changes in composition over the years, compared to more stable forms of revenue such as labour taxation or VAT".

Exposure to idiosyncratic shocks of the form of the 'patent cliff' can mean that there is a greater onus on Irish authorities to maintain an awareness of highly sector-specific risks and developments. It also highlights the degree of unpredictability and uncertainty that may exist in relation to corporation tax receipts linked to activities such as these.

FIGURE 5: EXPORTS OF CHEMICALS AND RELATED PRODUCTS

Sources: CSO; internal IFAC calculations.

The high concentration in overall Irish merchandise exports can be largely accounted for by the pharma-chem sector, where exports in 2015 accounted for 57 per cent of all goods exports and one-quarter of total exports (both goods and services). The rising value of services exports in the last decade has meant that the broad pharma-chem sector's share of total exports has not risen as much in proportion to total exports as it has within goods alone (Figure 5).

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[8] An example of this is apparent in 2008-09, when Irish exports performed relatively better than expected compared to other economies during the global trade downturn. This partly reflected the relatively acyclical composition of Ireland's tradable sector, with pharmaceutical production and information and communications technology featuring heavily.

High concentration and specialisation is not unique to Ireland's merchandise trade sectors, with services exports also exhibiting evidence of this. Disaggregated data on Irish services exports is more limited than that available for goods exports, but data available for the period 2003-2014 suggest that three sectors account for over 70 per cent of services exports (Table 2). In particular, computer services exports represent 47 per cent of all services exports as of 2014.

TABLE 2: CONCENTRATION OF SERVICES EXPORTS (SELECTED PERIOD AVERAGES DURING 2003-2014)

	2003-07	2008-09	2010-13	2014
€ billions				
Computer Services	16.7	24.1	34.8	47.9
Financial Services & Insurance	13.2	13.9	15.7	17.6
Operational Leasing	3.8	5.7	7.2	7.8
Other	16.8	24.0	25.8	28.4
Total Services	50.6	67.8	83.5	101.8
Total Exports	136.9	158.3	181.6	215.0
% Services Exports				
Computer Services	33.0	35.6	41.7	47.1
Financial Services & Insurance	26.1	20.5	18.8	17.3
Operational Leasing	7.6	8.5	8.6	7.7
Other	33.3	35.4	30.9	27.9
% Total Exports				
Computer Services	12.2	15.2	19.2	22.3
Financial Services & Insurance	9.7	8.8	8.6	8.2
Operational Leasing	2.8	3.6	4.0	3.6
Other	12.3	15.2	14.2	13.2

Sources: CSO, International Trade in Services - various releases.

Taking the data on services and goods exports together, the pharma-chem and computer services sectors account for almost a half of total Irish exports in recent years. These sectors are largely dominated by multinational enterprises (MNEs). CSO estimates for 2014 indicate that sectors dominated by foreign-owned multinationals account for close to one-quarter of total Gross Value Added (GVA) in the Irish economy (Table 3).
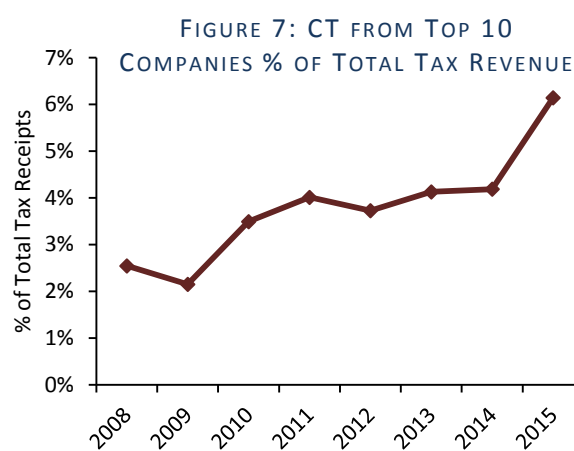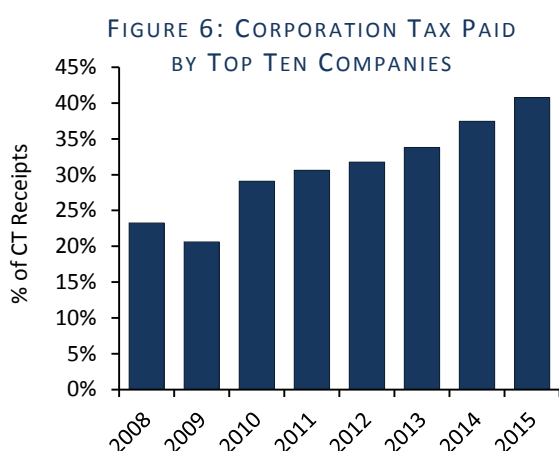
The concentration of the corporate tax base can be further illustrated by observing the concentration of CT receipts themselves. Figure 6 shows the share of total net (i.e., after repayments or similar amendments) CT derived from the top 10 payers of CT over the period 2008-2014, while Figure 7 shows the share of total taxes accounted for by CT obtained from the top 10 payers of CT. Both graphs illustrate that the rising share of profits being made by a handful of sectors is being reflected in an increasing reliance of CT receipts from a very small number of large corporations. Revenue also notes that around 80 per cent of Corporation Tax comes from the multinational sector, with the majority from ICT and pharmaceutical sectors. Approximately 60 per cent of receipts are reported to come from US companies.

TABLE 3: SHARE OF MULTINATIONAL-DOMINATED SECTORS IN TOTAL GVA (2014)

Description	NACE codes	% 2014 GVA (constant basic prices)
Chemicals and chemical products, basic pharmaceutical products and pharmaceutical preparations	20-21	8.7
Software and communications sectors	58-63	11.6
Other NACE sectors dominated by Foreign-owned MNEs	18.2, 26, 27 and 32.5	4.6
Foreign-owned MNE dominated Total		**24.9**
All other sectors		**75.1**

Source: CSO, *Gross Value Added for Foreign-owned Multinational Enterprises and Other Sectors Annual Results 2014.*
Notes: Foreign owned Multinational Enterprise (MNE) dominated sectors are defined where MNE turnover on average exceeds 85% of the sector total. The "other NACE sectors dominated by foreign-owned MNEs" category includes reproduction of recorded media, computer, electronic and optical products, electrical equipment, and medical and dental instruments and supplies.

FIGURE 6: CORPORATION TAX PAID BY TOP TEN COMPANIES

FIGURE 7: CT FROM TOP 10 COMPANIES % OF TOTAL TAX REVENUE

Sources: Tancred (2016)*;* Pigott and Walsh (2014); authors' analysis of Revenue data; Minister, Department of Finance parliamentary question response (17 July 2014); and own workings.
*Note:* Corporation tax is shown on an Exchequer basis.

Corporation taxes can also be seen to have become more volatile over time. Figure 8 shows the standard deviation and coefficient of variation for each of the main four Irish tax heads' annual growth rates. The coefficient of variation is a useful measure of volatility, computed as the ratio of the sample standard deviation to the mean.[9] In the last 15 years (excluding the financial crisis period), corporation tax receipts have been the most volatile of the main tax heads covered. This heightened volatility may itself partly reflect the more concentrated nature of corporation tax payments.

One means of responding to the volatility and concentration of corporation tax receipts for the purposes of forecasting accuracy is to develop direct engagements with some of the principal payers of corporation tax. This approach can help with anticipating likely developments in trading conditions and expected payments over the course of the year. The Revenue Commissioners do this through engagements with a number of companies via their Large Cases Division (including through an annual survey of the largest

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[9] The coefficient of variation is the ratio of the sample standard deviation to the sample mean expressed as a percentage. By scaling the spread against average outturns, it measures the dispersion of a variable while controlling for large differences in typically observed growth rates.

companies by Revenue case managers).[10] Any information provided to Revenue from companies is summarised and provided to the Department of Finance for inclusion in their forecasts. While helpful in dealing with the large uncertainties involved, the approach may still be unable to yield substantial improvements in forecast accuracy. In addition to the uncertainties in forecasting their own profits, key developments related to activities in Ireland may be made at the level of parent companies rather than by affiliates based in Ireland. Companies are also under no obligation to share information with Revenue regarding specific factors that may influence future CT payments and only do so on a voluntary basis.

FIGURE 8: VOLATILITY OF ANNUAL TAX RECEIPTS GROWTH RATES (%)
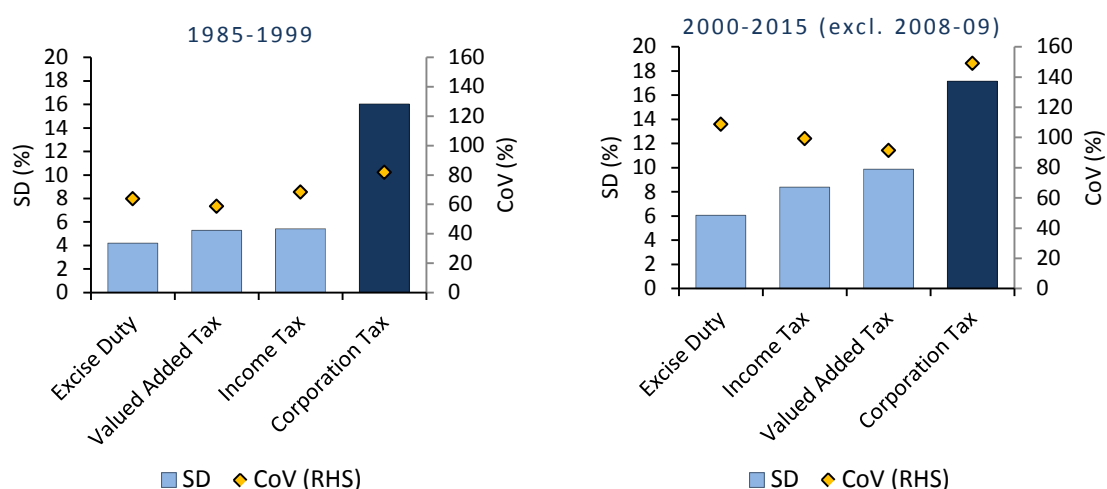
Source: Department of Finance tax revenue data. Internal IFAC calculations.
Notes: Standard deviation of growth rates = SD; Coefficient of Variation = CoV.

It is worth noting that, for sustainability purposes, volatility from year-to-year may not be as significant an issue if receipts follow a more predictable trend over the medium-term. However, the magnitude of uncertainty around CT revenues over the medium-term is of an order much greater than that for nominal GDP, which is already very high. As Table 4 shows, the typical error for nominal GDP forecasts three years-ahead (based on Budget-day forecasts) is roughly 4 percentage points. However, for CT receipts the forecast error is 32 percentage points. Big shocks in CT receipts in the past have clearly been linked to drivers other than fundamentals. Looking beyond the uncertainty regarding fundamental drivers like GDP, there are additional uncertainties for corporation tax receipts specifically arising from possible regime changes at an international level both in terms of tax policies and in relation to corporate structures.

TABLE 4: TYPICAL ERRORS FOR MEDIUM-TERM CT AND NOMINAL GDP GROWTH FORECASTS (1999-07; 2010-14)

RMSE	Year "t+1"	Year "t+2"	Year "t+3"
Nominal GDP	3.1	4.5	4.1
Corporation Tax	9.3	14.4	31.7

Sources: Department of Finance forecasts from various Budgets; internal IFAC calculations.
Notes: RMSE values are reported based on forecasts for nominal GDP and corporation tax receipts for the year ahead.

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[10] The Large Cases Division is responsible for the management and development of service, compliance and audit functions relating to the largest businesses and wealthiest individuals in the State.

4. COMPANY-LEVEL ISSUES FOR PREDICTING RECEIPTS

The predictability of company profits may vary over time due to a number of developments at sectoral and company-level. This is particularly true for multinational enterprises where large and sudden changes may arise due to changes in global supply chain structures, international taxation policies, tax planning at the company-level or accumulated tax assets/liabilities for example.

Multinational Activities: The attractiveness of a given location for investment by MNEs can change over time due to a number of factors. Company- and firm-level decisions that respond to these changes may result in shifts in the location of taxable activities, with corresponding increases or decreases in taxable profits.

These decisions can be hard to predict, but can often relate to cost competitiveness such as for tax, price, wages and other costs. The regulatory environment can also play a role, including considerations such as legislation governing cross-border trade, requirements for construction or registering properties, access to efficient utilities, and legal protections governing investors, contracts, insolvencies, etc. Demographic considerations may also be key, such as the age-demographic of a population and the availability of skilled labour. As well as being subject to change at local level, relative attractiveness can change in response to developments in other jurisdictions.

Deferred tax assets/liabilities: The presence of large deferred tax assets/liabilities on companies' balance sheets can also weaken the relationship between the measured gross operating surplus and taxes that are ultimately owed by firms. For instance, deferred tax assets arise when a firm carries forward or has paid taxes related to current and previous periods not yet recognised in their income statements. These may subsequently be used to help reduce a firm's future taxable income. Developments may be company-specific, but can also be visible across sectors such as in the case of large deferred tax assets that arose in the banking sector following the financial crisis.

Other tax deductions/credits: A company may be able to set various other deductions against their corporate tax liability for a given year. For instance, a 25 per cent tax credit for qualifying research and development expenditure exists for companies engaged in certain research and development activities. Companies may also be entitled to capital allowances in respect of specified capital expenditure such as wear and tear allowances for plant and machinery, and the purchase of intangible assets for the purposes of a trade (e.g. patents, copyright, and trademarks). Furthermore, companies are normally entitled to deduct interest payments and patent royalty costs when computing liabilities. Depending on the extent to which any of these deductions are set against companies' CT liabilities, the standard forecasting relationship with GOS may be altered.

5. ALTERNATIVE FORECASTING APPROACHES

The current approach to forecasting corporation tax receipts in Ireland relies on expectations of economy-wide profits, with judgement applied to account for knowledge of any one-offs or other temporary issues.

The standard assumption is that a one per cent change in GOS would imply a one per cent change in CT at the margin. However, this may not be the case due to various issues such as deferred tax assets, R&D credits, etc., as discussed in Section 4. Using historical data to define the expected relationship is one way to predict receipts for a given forecast of GOS. Aside from difficulties involved in producing the latter, further problems are posed by relatively limited historical data on CT and GOS for Ireland as well as by the numerous structural changes to the nature of the tax.

The standard approach used by the Department of Finance and the Revenue Commissioners implies an equation of the following form, which can be estimated:

$$\Delta lnCT_t = \alpha + \beta \Delta lnGOS_t + \varepsilon_t$$

where CT_t is Corporation Tax; GOS_t is Gross Operating Surplus and ε_t is the error for year "t". In the estimation process, all variables are taken as first-differences of the natural logarithm. These transformations are chosen as the level series are mainly non-stationary variables

One way to account for structural changes in corporation tax is to use a measure of corporation tax receipts that is adjusted for various policy changes introduced over time. We use the 'proportional adjustment method' to create a corporation tax series that is net of discretionary policy-induced tax changes (see Mourre and Princen, 2015). These changes include rate adjustments and the introduction of various tax credits (Figure 9).

FIGURE 9: CORPORATION TAX RECEIPTS, 1989-2015
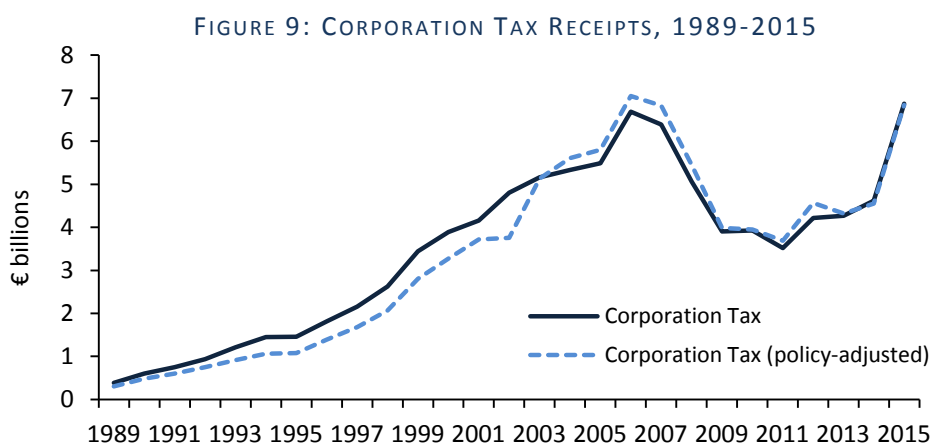
Sources: Department of Finance; internal IFAC calculations.

A variety of alternatives to the standard model employed by both the Department of Finance and Revenue are explored in Table 5. In addition to GOS, the inclusion of a lagged term (CT(-1)), a proxy for major trading partner demand (MTP), the Real Effective Exchange Rate (REER), nominal exchange rates with the U.K. (GBP/EUR) and the U.S. (USD/EUR), a measure of the business cycle (Output Gap as estimated by the IMF) and equity indices relevant for major sectors are also considered.[11] These are intended to capture, respectively, momentum effects, current trading conditions, relative currency and price fluctuations, cyclical developments and various sector-specific developments.[12] Lastly, we include standard measures of aggregate economic activity: nominal GDP and nominal GNP.

All models are estimated using annual data over 1998-2015. While limiting the number of available observations, the choice of annual frequency enables us to use the policy-adjusted CT series produced under the proportional adjustment method. It is also preferable given the seasonality of CT data and the fact that timing of payments intra-year may often reflect corporate decisions rather than short-run developments in activity levels. As a robustness check, Appendix 1 examines a longer sample period for selected models.

In addition to GOS, the results suggest that trading conditions – as captured by weighting trading partner demand – are also a key driver of changes in corporate tax receipts. This appears to offer explanatory power not especially lower than the GOS variable itself. The coefficient suggests that receipts are highly sensitive to external demand conditions, with a one percentage point increase in external demand leading to an approximate 2½ to 3 percentage point increase in corporation tax receipts received. When GOS is also included, MTP is no longer significant, likely reflecting the fact that GOS incorporates these effects.

In relation to last year's receipts, Revenue (2015) noted that a smaller relevant factor (in addition to trading conditions) was the impact of currency fluctuations. While this may be the case for certain companies, there does not appear to be a clear link between currency developments and corporation tax receipts in any specific direction. The coefficients on REER, dollar and sterling movements do not appear significant. This finding may reflect the short sample period involved, or it may be a reflection of hedging activities engaged in by companies' treasury divisions, which serve to mitigate short-run exchange rate developments.

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[11] MTP is based on internal IFAC calculations and is constructed as the weighted import volume growth of Ireland's major trading partners based on various national statistics offices' outturn data for import volumes, and CSO data for Irish exports by destination.
[12] Note that high frequency data on industrial production and services exports have also been used to good effect elsewhere as indicators that may capture sector-specific information (e.g., Purdue, 2016; and Central Bank of Ireland, 2016 - Box D "Corporation Tax Receipts in 2015"). We tested a number of variants of these series also, but, as with the equity indicators, we fail to find significance when included alongside MTP or aggregates such as GOS, GDP or GNP. This finding is likely to be due to the fact that the latter variables will often incorporate sectoral developments also.

	1[†]	2	3	4	5	6	7	8	9	10	11	12	13	14
Δ GOS	1.67*** (0.27)	1.11*** (0.29)							1.01** (0.34)		0.92* (0.36)			
Δ GDP													1.75*** (0.34)	
Δ GNP														2.02*** (0.44)
Δ CT(-1)		0.11 (0.20)		0.07 (0.25)		0.11 (0.32)			-0.16 (0.27)					
Δ MTP			2.83*** (0.88)	2.70** (1.03)	2.84*** (0.91)	2.62** (1.11)	2.78*** (0.91)	3.01* (1.53)	1.62 (0.95)			4.68*** (1.43)		
Δ REER					-0.05 (0.90)	-0.28 (1.14)			0.85 (0.99)					
Δ USD/EUR							-0.19 (0.35)							
Δ GBP/EUR								0.10 (0.68)						
Δ Output Gap										0.38*** (0.12)	0.14 (0.14)			
Δ Equity (US_ICT)												-0.61 (0.23)		
Δ Equity (US_Pharma)												0.28 (0.19)		
Δ Equity (IE_Financial)												-0.06 (0.07)		
Constant	-0.02 (0.04)	-0.03 (0.04)	-0.03 (0.05)	-0.04 (0.05)	-0.04 (0.05)	-0.04 (0.05)	-0.04 (0.05)	-0.05 (0.07)	-0.06 (0.04)	0.07 (0.04)	0.00 (0.04)	-0.10 (0.07)	-0.05 (0.04)	-0.04 (0.04)
Adjusted R-Squared	0.51	0.49	0.36	0.32	0.31	0.27	0.33	0.33	0.53	0.35	0.52	0.49	0.62	0.56
DW	2.20	2.48	1.92	2.00	1.92	2.06	1.97	1.90	2.37	2.32	2.45	1.99	2.64	2.36
Observations	18	18	18	18	18	18	18	18	18	18	18	18	18	18
Period	1998-2015	1998-2015	1998-2015	1998-2015	1998-2015	1998-2015	1998-2015	1998-2015	1998-2015	1998-2015	1998-2015	1998-2015	1998-2015	1998-2015

Sources: Internal IFAC calculations; Department of Finance data on corporate tax revenues.
*Notes*: All series are in log-differences. Corporation tax series adjusted to account for estimated impact of annual policy changes. Standard errors in parentheses. Statistical significance: *** 1 per cent; **5 per cent; *10 per cent. †Regression 1 is the base specification.

In addition to GOS and external demand, we find the IMF's output gap measure for Ireland to be significant. For a one percentage point increase in the output gap, corporate tax receipts are seen to rise by approximately 0.4 percentage points.

While the output gap and external demand appear to be significant drivers of CT receipts, neither appear to generate substantive improvements in terms of explaining the variation in CT receipts over and above GOS. However, we find nominal GDP to be significant driver and to offer greater explanatory power (62 per cent of the variation) than GOS. While GNP is also found to be significant, its explanatory power is weaker than for GDP.

The relatively weak explanatory power for the models explored suggests that there are other factors at play in determining short-run changes in corporation tax receipts. The base specification, which we take as the regression of CT on a constant and GOS, only explains about half of the variation in CT developments, while nominal GDP explains just over 60 per cent.

Figure 10 compares some of the better specifications in terms of their in-sample fit. Models 1, 3, 9, 10, 13 and 14 are chosen as they capture a more diverse range of different determinants, while still having reasonably high coefficients of determination.

FIGURE 10: IN-SAMPLE FITS OF SELECTED MODELS (€ BILLIONS)
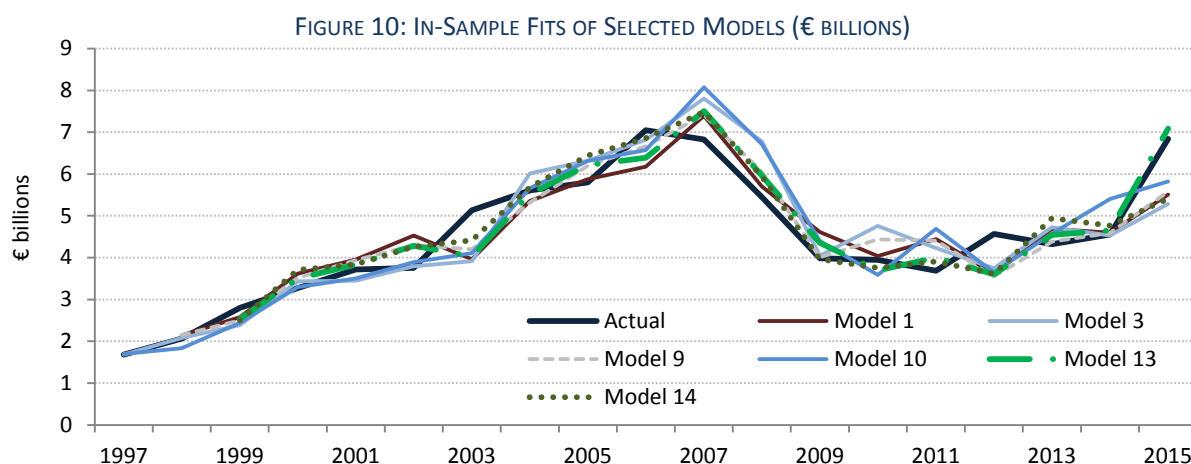
Sources: Internal IFAC calculations; CSO; Department of Finance.

Sizeable errors in both directions are visible in the majority of recent years (Figure 11). For the models selected, the average absolute error on forecasts since 2010 is €530 million (just over 0.2 per cent of 2015 GDP). Given that this is for in-sample performance – thus incorporating available outturn information for GOS – the out-of sample forecasts would be expected to fare even more poorly again.

FIGURE 11: IN-SAMPLE ERRORS FOR SELECTED MODELS (€ BILLIONS)
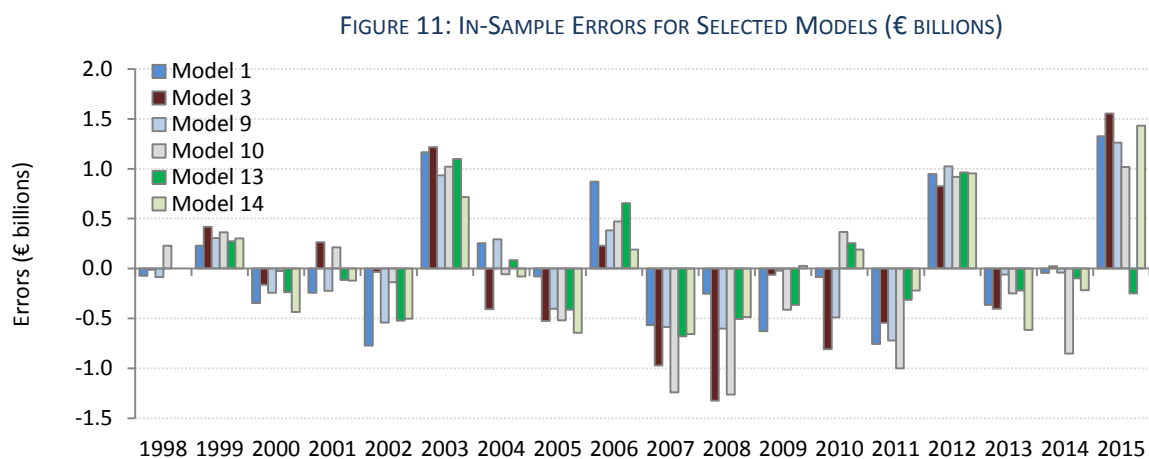
Sources: Internal IFAC calculations; CSO; Department of Finance.
Note: In-sample errors are based on models specified in Table 4, but are shown in € billion amounts.

It is also notable that the better-performing models offer relatively modest improvements over crude benchmark alternatives (Table 6). A naïve forecast - one where the level of CT is assumed unchanged from the previous year – has a RMSE of 21.7 per cent compared to the selected models' average of 12.3 per cent. A model (AR1) where a single autoregressive term and a constant are used to forecast the log-difference of CT revenues also performs only moderately worse than the selected models, with a full-sample RMSE of 17.8 per cent. Most of the models (all except Model 13, which uses July's revised National Accounts estimates of nominal GDP) fail to capture at least €1 billion of the surge in revenues observed in 2015. Similarly, in 2011, all of the models (other than models 13 and 14, which use GDP and GNP) had overestimated revenues by upwards of €0.55 billion.

TABLE 6: ERRORS FOR OFFICIAL FORECASTS AND SELECTED MODEL FITS (1998-2015)

Measure	Official	Model 1	Model 3	Model 9	Model 10	Model 13	Model 14	Model Average	Naïve	AR1
ME (€m)	-41	32	-41	10	-64	-23	-10	-17	287	51
MAE (€m)	574	525	575	479	596	415	459	466	705	720
ME (%)	1.0	1.2	1.1	1.0	0.4	0.6	0.7	0.5	9.1	1.0
MAE (%)	11.7	11.5	12.0	10.4	12.1	9.2	9.9	10.0	16.5	14.5
RMSE (%)	17.6	14.3	15.1	13.0	14.3	11.6	12.3	12.3	21.7	17.8

Sources: Internal IFAC calculations; Department of Finance data on corporate tax revenues.
Notes: Corporation tax series adjusted to account for estimated impact of annual policy changes. ME = Mean Error, and MAE = Mean Absolute Error.

The results suggest that there are large challenges to explaining and forecasting corporation tax receipts.[13] While GOS, GDP and GNP appear to be the best indicators for predicting receipts, the explanatory power of even the final outturn data is still weak. A further challenge for forecasting on this basis is posed by the fact that there are regularly significant lags to the publication of accurate historical data for each of these aggregates. For instance, companies will often not submit final tax returns until nine months after their accounting year end.

A large number of fundamental drivers do not appear to offer any substantive improvement in determining year-to-year developments. In particular, given that close to half of the variation in annual growth in corporation tax receipts remains driven by unknown factors, it seems that idiosyncratic developments often dominate economic fundamentals in explaining year-to-year movements in corporation tax receipts.

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[13] A panel estimation approach was also used to try to model CT receipts on the basis of GOS by sector. The results were not sensible, however, and were thus left out of this analysis. We suspect that this may relate to an inconsistency between how Revenue treat sectoral classifications of CT receipts and how the CSO classify GOS by sector, with the former not revising sectoral classifications once set for an individual entity initially.

One aspect of the Council's regular analysis in its Fiscal Assessment Reports involves a decomposition of tax forecasts into revisions/errors arising from (i) expectations for the macro driver ("macro") such as GOS, (ii) confirmation of the final tax take for the previous base year ("starting point"), and (iii) an "other" source, which captures miscellaneous factors and subjective judgements made by the Department of Finance. Although errors linked to forecasts of GOS (the macro driver) are also apparent, this analysis of historical forecasts highlights that "other" sources (i.e., the miscellaneous factors or elements of judgement) are frequently the largest source of error for CT predictions (Figure 12). This would appear to further emphasise the importance of idiosyncratic developments to forecasting CT receipts.

FIGURE 12: DECOMPOSITION OF CORPORATION TAX FORECAST ERRORS
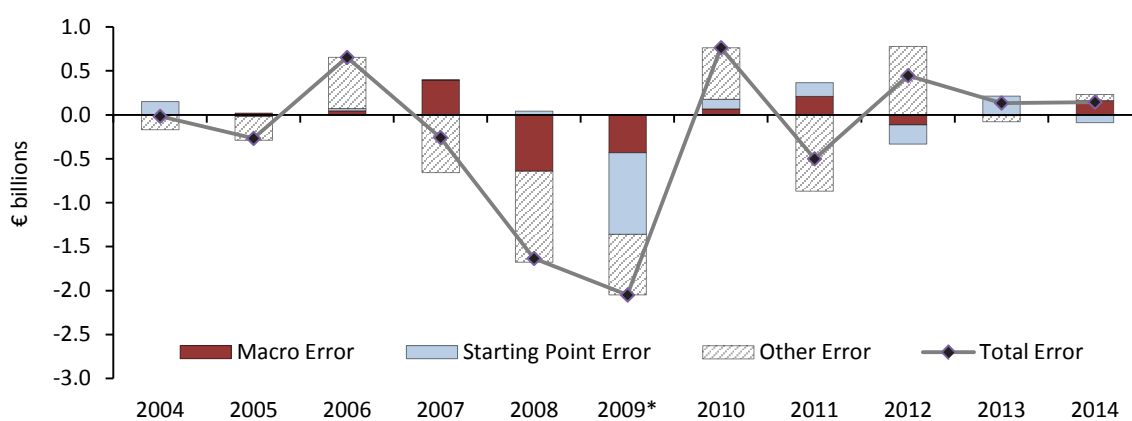
Source: Hannon, Leahy, O'Sullivan (2015).
Note: Pre-2009, CT forecasts were based on GDP growth. From 2009 onwards GOS was used. The bars show how much of the total forecast error is due to error in forecasting the macro driver, due to the starting point error, or other unexplained errors.

6. POTENTIAL POLICY IMPLICATIONS OF THE UNPREDICTABILITY AND VOLATILITY OF CORPORATION TAX

Although we find some evidence that alternative indicators could offer better explanations of within-sample variation of corporation tax receipts, the challenges faced in predicting highly volatile corporation tax receipts still appear difficult to surmount. These challenges are magnified by the difficulties associated with forecasting relevant indicators such as GOS and GDP as well as the extent to which they are subject to subsequent revision (Casey and Smyth, 2016).[14]

There are a number of implications of these findings. In particular, there are concerns that CT revenues coming from relatively few sources could be subject to the risk of large reversals, while sustainable levels

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[14] Out-of-sample forecasts would still have fared poorly for 2015, for example, given the extent of revisions to aggregates such as GDP and GOS between preliminary and subsequent estimates.

of CT receipts are likely to be more difficult to identify. Questions then arise as to how to ensure that the public finances are soundly managed against this backdrop. While circumstances can exist where it may be optimal to fully adjust government expenditure (or discretionary tax measures) to sudden changes to revenues[15], a number of factors might entail that this would be an unwise policy stance for the Government in relation to corporation taxes:

First, the presence of adjustment costs – particularly costs of adjusting expenditure downwards -- would suggest that permanent increases in government expenditure might be considered suboptimal when receipts could prove to be transitory in nature.[16]

Second, the possibility that liquidity or borrowing constraints could become binding in the future, especially when debt levels are high, would also motivate against funding permanent spending increases (or discretionary tax measures) on the back of volatile and unpredictable receipts. These constraints can arise in the context of sustainability concerns. A basic condition for fiscal sustainability is that the debt-to-GDP ratio is stable at an appropriate level or can reasonably be expected to become so in future. The risk that a large portion of revenues may suddenly and unexpectedly disappear, however, can mean that, for a given level of expenditure, government deficits will increase. This may lead to an expanding debt level in cases where other factors such as economic growth are insufficient to offset the impact. Predicating forward-looking debt sustainability assumptions on the basis that a large share of tax revenues will continue to come from a highly unpredictable and volatile revenue sources may therefore prove unwise.

Third, a desire to maintain some level of precautionary savings would also argue against using such receipts for permanent expenditure increases. A basic intuition underpinning savings behaviour is that an increase in volatility will typically warrant higher savings or lower expenditure in order to offset the increased scale of lost income that might be realised at a later stage.[17]

The third factor described above partly motivates the rainy day/contingency reserve fund that has been recently proposed to operate from 2019 (Department of Finance, 2016), though other solutions to the treatment of volatile and unpredictable corporation tax receipts are also available.[18] One aspect being

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[15] Depending on the social welfare function and the weighting of inter-temporal utility, for example.
[16] Engaging in difficult retrenchments at a later stage may also run the risk of discouraging other investment and reducing future growth when pursued.
[17] Leland (1968) provides a formal exposition of this idea in the consumption literature, while Engel and Valdés (2000) apply it in the context of an optimal fiscal strategy for countries with rich oil resources. In addition, the precautionary savings model presented by Caballero (1990) shows how an increase in volatility can lead to higher precautionary saving in the case where income follows a random walk under the assumption of an agent with constant-absolute-risk-averse utility.
[18] The proposed rainy day fund is intended to have a countercyclical role, thereby addressing a notable failing of Irish fiscal policy in the recent past. The Council sees value in such a fund – provided it is designed and managed appropriately – in terms of ensuring an appropriate fiscal stance over the medium term that would provide more room for manoeuvre during a future downturn (IFAC, 2016). In particular, safeguards would have to be put in place to prevent inappropriate uses of the fund and laying out clearly the criteria under which the fund's resources could be accessed.

considered by the Government is the merit of using any one-off receipts (such as windfall corporate tax receipts – or indeed other windfall tax revenues) to capitalise a rainy day fund. In light of the risks described in this Analytical Note, corporate tax receipts would appear to be an obvious candidate from which to draw resources. However, other means of mitigating the risks related to funding permanent expenditure increases with increases in corporate tax receipts could equally be considered. Rather than setting aside receipts for macroeconomic stabilisation purposes, alternative solutions might include allocating receipts towards reducing public debt to a safer level.

While this Note focuses on assessing methods of forecasting CT receipts, it is timely to apply the findings specifically to developments in 2015 given the sharp surge in CT revenues observed last year (see Appendix 2 for a more detailed discussion). Use of the proceeds from the surge in revenues should depend in part on whether these are considered to be temporary or permanent. In light of the limited clarity as to the drivers of growth in economic activity in 2015 and uncertainty as to the persistence of the increases, however, further caution is warranted in using the recent CT revenue surge as a basis for funding long-lasting increases in spending and discretionary tax cuts. Irrespective of expected persistence, the increased volatility of CT receipts would also support higher savings in the presence of a precautionary saving motive.

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Appendix 1: Estimation with Longer Sample Period

Using a longer sample period, we find similar results for use of nominal GDP as a predictor of CT receipts as in the analysis summarised in Section 5. The estimation results (Table A1), which are based on the same policy-adjusted CT series as before albeit over a longer sample period, show a similar coefficient for nominal GDP as in the shorter sample period. Also, the model using nominal GDP again proves better at explaining the in-sample variation in CT receipts relative to GOS. Nominal GNP also provides a good fit, with a similar coefficient as identified before. However, it has the obvious drawback of not incorporating information regarding factor income flows, which are subject to Irish corporate taxation.

TABLE A1: RELATIONSHIPS BETWEEN CORPORATION TAX AND SELECTED DRIVERS (SAMPLE: 1990-2015)

	1	2	3
Δ GOS	1.08*** (0.28)		
Δ GDP		1.64*** (0.37)	
Δ GNP			1.92*** (0.42)
Constant	0.02 (0.04)	-0.01 (0.04)	-0.01 (0.04)
Adjusted R-Squared	0.35	0.43	0.44
DW	1.58	1.70	1.74
Observations	26	26	26
Period	1990-2015	1990-2015	1990-2015

Sources: Internal IFAC calculations; Department of Finance data on corporate tax revenues.
Notes: All series are in log-differences. Corporation tax series adjusted to account for estimated impact of annual policy changes. Standard errors in parentheses. Statistical significance: *** 1 per cent; **5 per cent; *10 per cent. †Regression 1 is the base specification.

APPENDIX 2: THE 2015 CT REVENUE SURGE

In 2015, there was an unexpected surge in CT receipts. The level of these rose by 49 per cent to €6.9 billion from €4.6 billion in the previous year. The increase also amounted to an excess of €2.3 billion (50 per cent) relative to the forecast made in *Budget 2015* (i.e., in October of the previous year) and another €0.3 billion ahead of expectations indicated a little more than one month before the end of 2015 itself (Revenue, 2015).

While the main focus of this Analytical Note is to assess methods of forecasting CT receipts, it is worth examining to what extent the surge in 2015 could be explained using the various approaches we identify. The models that most closely explain the CT surge last year are those that incorporate the latest revised National Accounts estimates of GDP/GOS for 2015. The Initial estimates of GDP for 2015 published by the CSO in March 2016 led to a substantial underestimation of actual CT outturns based on models used to forecast CT discussed in Section 5. Given that the revised data were not available until seven months after the year ended (July, 2016), early model estimates could be expected to encapsulate large forecast errors also observed through 2015.[19]

The revised CSO data published in July 2016 show much larger increases in GDP compared to the initial estimates and the new data are now more consistent with the increase in corporation tax last year. It is worth stating, however, that the increases in both CT and GDP/GOS may be driven by unrelated factors so that the correlation could be a spurious one. To understand whether this is the case or not, it is helpful to explore the reasons underlying the sharp rise in revised GDP levels. The CSO (2016) note that the revisions to the 2015 National Accounts are explained in part by corporate restructuring.[20] Purdue (2016) notes that these restructurings may have arisen following re-domiciling of corporate entities, corporate inversions or the "onshoring" of intellectual property.[21] The authors also note that, while each factor can lead to changes in the level of GDP recorded, the third (onshoring) is more likely to lead to a significant increase in Irish CT receipts.[22]

The reason why onshoring of intellectual property might cause both higher GDP and higher CT receipts relates to traded activities recorded in Irish GDP. For example, an increase in net exports from

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[19] Indeed, even consensus forecasts for Irish real GDP growth in 2015 ranged between 4.8 per cent to 7 per cent as of December 2015, lower than both preliminary (7.8 per cent) and final estimates (26.3 per cent).

[20] Also cited by the CSO are increased aircraft imports related to international leasing activities. Aside from the fact that the cost of these imports may offset any additional profits generated in the short-run, more than 80 per cent of the annual increase in GVA for 2015 arose in the Industry sector as opposed to the services sector where leasing activities are recorded. In addition, the leasing sector itself forms a small part of the services sector. Therefore, it is more likely that the bulk of the revision to GDP arises due to restructuring activities.

[21] An inversion in this case can occur, for example, when a company not domiciled in Ireland merges with one already domiciled in Ireland, whereas a re-domiciling typically occurs when a firm independently changes its domicile to Ireland.

[22] As noted by the authors, this reflects the double taxation relief feature of the Irish tax system. As with most international tax systems, a company can claim relief on its tax bill if a subsidiary was already taxed in another country. Given Ireland's relatively lower corporate tax rate, this relief often offsets the Irish tax liability in the context of world-wide income.

manufacturing sectors may occur if a rise in exports is not matched by rises in imports. The value of Irish goods exports rose by €81.1 billion in 2015. However, the value of all imports (both goods and services) rose by just €50.8 billion, of which €19.5 billion relates to royalties/licenses imports linked to the use of intellectual property. The disproportionate rise in goods exports relative to imports likely reflects in part the relocation of intellectual property assets to Ireland.[23] Of note in particular, is the effect that this has on contract manufacturing activities.[24] These activities previously had a negligible effect on GDP over time (albeit, impacting on specific quarters due to delays between associated exports and offsetting import costs). However, these activities now appear to be producing positive impacts on exports that are not offset by royalty/license and other imports, leading to a material positive effect on overall GDP.

If higher profits arise from export activities recorded in Ireland following the onshoring of assets, this could plausibly explain why CT receipts rose sharply in 2015. However, also evident in 2015 was a sharp rise in the provision for depreciation in the National Accounts (€30.6 billion). As companies may claim capital allowances on account of the amortisation of the acquisition cost of the intangible asset to offset CT payments, this increase may have offset increased CT amounts payable that are associated with the same activities. This factor may undermine the explanation that onshoring of intellectual property assets directly resulted in higher CT receipts in 2015. As a result, more information is needed in order to confirm the nature of the association between the rise in GDP and the rise in CT receipts in 2015.

In terms of policy implications, the use of the proceeds from the surge in revenues should depend in part on whether these are considered to be temporary or permanent. Although the reasons for the surge are becoming somewhat clearer, there is still a great deal of uncertainty about the persistence of the sudden upward shift in the level of receipts. This suggests caution is warranted in using the additional revenues to fund permanent changes in spending and tax changes. Irrespective of the anticipated persistence, the increased volatility of this revenue source more generally would tend to support higher savings in the presence of a precautionary saving motive.

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[23] As noted by the CSO (2016), corporate restructuring arose in part through reclassifications of entire balance sheets in 2015 meaning that the level of capital assets in Ireland increased dramatically compared to 2014.

[24] Contract manufacturing activities occur when an Irish-resident firm (not necessarily Irish owned) contracts a manufacturer overseas to produce a good for supply to an end-client abroad. The activity has been documented in various IFAC Fiscal Assessment Reports since 2014, but is covered in detail in Box A of IFAC (2015).