An introduction to tax revenue buoyancy
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Introduction

This Note examines tax revenue buoyancy with respect to developments in Gross Domestic Product (GDP) and alternative measures of Ireland’s economic output; namely Gross National Product (GNP), Modified Gross National Income (GNI*) and Gross Value Added (GVA). It further provides separate buoyancy estimates for Income Tax, Value-Added Tax (VAT) and Corporation Tax in respect of these indicators of economic performance, and with respect to certain underlying drivers (i.e. wages and employment, consumer spending, and firms’ profits respectively).

Estimates of tax revenue buoyancy capture the sensitivity of tax receipts to changes in the economy, or to fluctuations in the value of a specific macroeconomic factor. This information is important for prudential fiscal planning, and informs forecasts of future tax revenue.

Buoyancy versus elasticity

Although they are closely related and often used interchangeably, the “buoyancy” and “elasticity” of tax revenue are distinct concepts.

Buoyancy estimates show the response of tax revenue to changes in an underlying macroeconomic base, including changes that may result from policy actions. Elasticities aim to capture the scenario where no policy change has occurred, that is, they measure the responsiveness of tax revenue to changes in an underlying macroeconomic base, while removing the impact of policy actions.

In this way, elasticities capture the “pure” response of revenue with respect to (“endogenous”) changes in a macroeconomic base, and can signify the “automatic” growth potential of tax revenue (see Acheson et al. (2017)).

Key findings

- Revenue buoyancy captures the response of tax revenue to changes in an underlying economic driver (typically GDP). Buoyancy and elasticity are distinct concepts; elasticities control for changes in tax policy, whereas buoyancy estimates do not. Understanding the buoyancy of the tax system is important for accurate revenue forecasting, and can soften the impact of revenue “surprises.”
- Revenue buoyancy is estimated using statistical techniques. Generally, an estimate greater than one implies that any change in the economic driver of interest (e.g. GDP) will result in an even greater change in revenue, and suggests that the tax in question is an effective tool in smoothing the effects of the economic cycle.
- Our analysis suggests an average buoyancy estimate for total tax revenue equal to one, across a suite of economic growth indicators. This implies that total tax revenue moves in line with changes in economic growth.
- We also find that: PAYE receipts move in line with employment, and increase 0.8% for every 1% increase in wages, VAT receipts increase 1.5% for every 1% increase in personal consumption, and Corporation Tax receipts increase 0.8% for every 1% increase in Gross Operating Surplus.

Buoyancy estimates in revenue forecasting

Forecasts of macroeconomic variables are used to predict tax revenue into the future (see Hannon, Leahy and O’Sullivan (2015) for a description of the Department of Finance’s tax models). Generally, a greater understanding of the buoyancy of the tax system (that is, how responsive tax revenue is to changes in economic growth or to changes in other relevant macroeconomic variables) allows for greater accuracy in revenue forecasting. The Department of Finance produces five-year ahead fiscal forecasts. Accurately measuring tax revenue buoyancy can help to soften revenue surprises, or to avoid substantial forecast errors in relation to these forecasts.

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Revenue buoyancy is also closely linked to fiscal sustainability. Buoyancy estimates inform the calculation of the cyclically-adjusted and structural budget balances (core indicators within the Stability and Growth Pact fiscal surveillance framework of the European Commission). Given the substantial impact of the economic cycle on tax revenue, accurate estimates of tax revenue buoyancy are required to avoid distortions in the estimation of cyclical and structural budget balances (see Deli et al. (2018); Koster and Preismeier (2017)).

Measuring revenue buoyancy

Tax revenue buoyancy is generally measured using statistical techniques (or "parametric" methods). These methods involve the use of a regression analysis, in which a tax category is modelled as a function of a relevant indicator of economic activity (typically GDP). Mathematically, this model is represented by the following equation:

\[ d\ln(T) = \alpha + \beta d\ln(Y) \] (1)

where, \( d\ln(T) \) is the year-on-year revenue growth rate for the tax of interest, and \( d\ln(Y) \) is the year-on-year growth rate in GDP. The buoyancy of tax revenue is indicated by the magnitude of the \( \beta \) coefficient in equation (1), above. In interpreting this estimate, as a general rule:

- If revenue buoyancy (\( \beta \)) is equal to one, then a one per cent increase in GDP increases tax revenue also by one per cent (i.e. there is no change in the tax-to-GDP ratio);
- If revenue buoyancy (\( \beta \)) exceeds one, then a one per cent increase in GDP increases tax revenue by more than one per cent (i.e. there is an increase in the tax-to-GDP ratio); and,
- If revenue buoyancy (\( \beta \)) is below one, then a one per cent increase in GDP increases tax revenue by less than one per cent (i.e. there is a decrease in the tax-to-GDP ratio). Indeed, Figure 1 shows that the tax-to-GDP ratio in Ireland has been declining over the past number of years).

Generally, a buoyancy estimate in excess of one implies that any change in GDP will result in an even greater change in tax revenue. This is desirable in terms of long-term fiscal sustainability, assuming that the demand for public expenditure is also increasing over time (factoring in demographic pressures).

Furthermore, buoyancy estimates greater than one also indicate that the tax in question is an effective stabilisation tool for smoothing the effects of the economic cycle. Specifically, a particularly large increase in tax receipts during periods of strong economic growth signals that the tax system is effective in taking more money out of the economy when the economy is performing well, while the reverse is true in the event of an economic downturn.

A practical application

To illustrate, we adopt a relatively straightforward approach, and estimate (using Ordinary Least Squares regression) the equation in (1). We measure aggregate tax revenue buoyancy with respect to changes in Gross Domestic Product (GDP), Gross National Product (GNP), Modified Gross National Income (GNI*), and Gross Value Added (GVA). These are among the standard suite of metrics used to assess economic performance for Ireland. In addition, we estimate the buoyancy of specific taxes, namely Pay-As-You-Earn (PAYE) income tax, Value-Added Tax (VAT) and Corporation Tax, with respect to these four indicators of economic performance.

Table 1 contains the buoyancy estimates for the period 1995-2017. As shown, all of the buoyancy estimates are statistically significant (generally at the one per cent significance level; i.e. the estimated relationships are unlikely to have occurred by chance). We proceed by calculating an average of the buoyancy estimates across the suite of indicators; GDP, GNP, GNI* and GVA. In doing so, we observe buoyancy estimates at (or around) one for Total Revenue.

The buoyancy of Total Revenue with respect to GDP in particular is 0.83 (slightly below one), which corresponds to the gradual decline in the tax-to-GDP ratio observed in Figure 1. In the Annual Taxation Report (January 2018), the Department of Finance indicate that this trend could be explained by the fact that the recovery has largely been driven by export sectors, which are less tax-intensive. In other words, the activity of export sectors has not impacted on aggregate tax revenue to the same extent that it has driven economic growth, as these sectors account for relatively less revenue from taxation generally.

In Table 1, we also observe an average buoyancy estimate of one for VAT. However, the average estimate for PAYE

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is substantially below one, while for Corporation Tax it is substantially greater than one. These results suggest that, of the three tax categories examined, Corporation Tax appears to be the best automatic stabiliser. These results also appear to echo the findings of similar work in this area (see Deli et al. (2018)).

We next estimate the buoyancy of these taxes with respect to changes in their underlying drivers; for PAYE we use non-agricultural wages and employment, for VAT we use non-tourist spending, and for Corporation Tax we use Gross Operating Surplus. These macroeconomic bases are also used by the Department of Finance in forecasting future revenue for these taxes. As noted in Hannon, Leahy and O’Sullivan (2015), the Department generally assumes an elasticity of one (implying that revenue moves exactly in line with changes in the underlying driver, with the exception of PAYE which assumes an elasticity of 2.15 with respect to growth in earnings and 0.9 with respect to growth in employment).

The results of our analysis (shown in Table 1) suggest that:

- PAYE receipts move in line with changes in non-agricultural employment, but are somewhat less buoyant with respect to changes in non-agricultural wages (with receipts increasing 0.8% for every 1% increase in wages);
- VAT receipts are substantially buoyant with respect to changes in personal consumption (with receipts increasing almost 1.5% for every 1% increase in personal consumption);
- Corporation Tax receipts move slightly below Gross Operating Surplus (with receipts increasing 0.8% for a 1% increase in Gross Operating Surplus).

It should be noted that the analysis contained in this Note employs relatively straightforward parametric methods, and more complex modelling has been undertaken in respect of the estimation of both tax revenue buoyancy and elasticity. Some of this previous work involves expanding on the equation estimated in (1) to include additional control variables, including lagged values of the relevant economic growth indicator or macroeconomic base.

Additional work has also expanded on the type of static analysis undertaken in this Note, to examine revenue buoyancy and elasticity in a time-varying dynamic framework (examining both short and long-term buoyancy estimates). For recent examples of this work, see Acheson et al. (2017), Deli et al. (2018), and Koster and Preismeier (2017).

<table>
<thead>
<tr>
<th>Macroeconomic variables</th>
<th>Total Revenue</th>
<th>PAYE</th>
<th>VAT</th>
<th>Corporation Tax</th>
</tr>
</thead>
<tbody>
<tr>
<td>GDP</td>
<td>0.83***</td>
<td>0.39*</td>
<td>0.88***</td>
<td>1.63***</td>
</tr>
<tr>
<td>GNP</td>
<td>1.01***</td>
<td>0.58**</td>
<td>1.10***</td>
<td>1.74***</td>
</tr>
<tr>
<td>GNI*</td>
<td>1.06***</td>
<td>0.69***</td>
<td>1.20***</td>
<td>1.53***</td>
</tr>
<tr>
<td>GVA</td>
<td>0.76***</td>
<td>0.34*</td>
<td>0.82***</td>
<td>1.58***</td>
</tr>
<tr>
<td>Average</td>
<td>0.92</td>
<td>0.50</td>
<td>1.00</td>
<td>1.62</td>
</tr>
<tr>
<td>Non-agricultural employment</td>
<td>-</td>
<td>1.08***</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Non-agricultural wages</td>
<td>-</td>
<td>0.81***</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Personal consumption</td>
<td>-</td>
<td>-</td>
<td>1.47***</td>
<td>-</td>
</tr>
<tr>
<td>Gross operating surplus</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.82***</td>
</tr>
<tr>
<td>Overall average</td>
<td>0.92</td>
<td>0.65</td>
<td>1.09</td>
<td>1.46</td>
</tr>
</tbody>
</table>

Notes. *, **, and *** indicate statistical significance at the 10, 5 and 1 per cent level respectively. Statistical significance indicates the probability that the observed relationship has simply occurred by chance. In other words, at the 10, 5 and 1 per cent significance levels, we are 90, 95 and 99 per cent sure that the observed relationship is not a random occurrence. These results refer to the period from 1995 to 2017. These estimates are based on the estimation of equation (1) for Total Revenue, PAYE, VAT and Corporation Tax, using the macroeconomic variables listed in the Table above as independent variables. Tax revenue data is taken from the statistical database of the Department of Public Expenditure and Reform, while macroeconomic data is taken from the CSO.
**Figure 1 - Tax-to-GDP ratio, 1995 - 2017**

![Graph showing the tax-to-GDP ratio from 1995 to 2017.](image)

**Notes.** The tax-to-GDP ratio has been declining over time, indicating that GDP has been growing at a faster rate than aggregate tax revenue, and suggesting a tax revenue buoyancy of less than one. Indeed, our analysis establishes a statistically significant (at the 1 per cent level) buoyancy estimate of 0.83 for aggregate tax revenue with respect to GDP. Source: OECD Data.

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Contact: PBO@Oireachtas.ie  
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