An Application of Portfolio Theory to Tax Revenue Volatility
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The PBO’s Working Paper Series

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This Note draws from Working Paper 1 of 2019, Examining the Volatility of Ireland’s Tax Base in the Paradigm of Modern Portfolio Theory.

Key findings

- We establish the existence of a trade-off in terms of the rate of tax revenue growth (or revenue “returns”) and volatility (or revenue “risk”), more typically found in assets traded in financial markets. In other words, the most volatile taxes also experience the highest growth rate on average;

- We find strong linkages between tax categories. This implies that, from a volatility minimising perspective, there are limited benefits from diversifying Ireland’s tax structure across multiple tax categories;

- Prior to 2008, the volatility of the State’s total tax revenue has increased in line with the diversification of the tax structure, highlighting that the State has diversified into more volatile tax categories over time. Beyond 2008, more emphasis was placed on relatively stable sources of tax revenue (e.g. Income Tax);

- In terms of practical policy implications, our analysis suggests that there is greater scope for the consideration of revenue growth and volatility in the design of tax policies that would alter the composition of the State’s tax portfolio.

Introduction

The issue of tax revenue volatility (i.e. large yearly swings in government revenue), particularly in relation to Corporation Tax, has dominated recent debate on fiscal policy in Ireland. Having a tax base that consists of highly volatile revenue streams can potentially undermine the stability and sustainability of the public finances. In practical terms, if a new spending programme is funded using windfall tax receipts, additional revenue or spending cuts to other areas will be required to continue to fund this programme when these windfall receipts fail to materialise in future. Furthermore, revenue volatility complicates prudential fiscal planning, as forecasting revenue is likely to be more challenging for volatile taxes.

This Note summarises some of the key findings of the PBO’s first Working Paper (Fitzgerald and Bedogni, 2019), which relies on approaches and analytical tools more typically used in studies of financial economics to examine the issue of tax revenue volatility in Ireland. This work uses annual tax revenue data for each tax category taken from the Databank of the Department of Public Expenditure and Reform. The dataset includes annual exchequer receipts for:

- Income Tax;
- Value Added Tax;
- Excise Duty;
- Corporation Tax;
- Stamp Duty;
- Customs; and
- Capital Taxes (Capital Gains Tax and Capital Acquisitions Tax).

We analyse historical trends in tax shares in the total tax revenue of the State. We further examine the linkages between tax revenues and finally, we assess if Ireland has diversified its tax structure over time and how this compares to changes in tax revenue volatility.


2 The Training and Employment Levy, the Local Property Tax and Motor Vehicle Duties are excluded from the calculations due to the short time series available. For consistency purposes, Capital Gains Tax and Capital Acquisitions Tax are aggregated and defined as Capital Taxes (these taxes have only been reported separately in outturn data since 2000).
The relationship between risk and return in relation to financial assets is intuitive; riskier investments will need to compensate prospective investors for taking on additional risk relative to safer investment options. More generally, if a low-risk and high-return asset did exist, rational investors would flock to that asset, driving up the price and reducing the rate of return (while the reverse would hold for a high-risk low-return asset). The volatility or risk of the investor's portfolio depends on the volatility of the underlying assets, their share in the portfolio, and the strength and direction of the relationships among these assets. The investor must decide on the appropriate share of each asset in the portfolio, based on these criteria.

Modern portfolio theory can be applied to an analysis of Ireland's tax revenues. In this way, the volatility of total tax revenue is dependent on:

i. The share of each tax category in total tax revenue (similar to financial asset shares in an investor's portfolio);
ii. The volatility of each tax category (similar to the volatility of the financial assets in an investor's portfolio);
iii. The strength and direction of the relationship among these tax categories.

Intuitively, the higher the volatility of each tax category in the State's tax portfolio, and the stronger and more positive the linkages among these taxes (i.e., different taxes are impacted by common factors and therefore follow similar trends); the greater total tax revenue volatility will be. We calculate revenue growth rates for each tax (which we refer to as 'returns') and the standard deviation of these growth rates (which we refer to as 'risk' or 'volatility').

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3 The standard deviation of a collection of data points indicates the level of dispersion among these data points. Specifically, the standard deviation captures the extent to which each individual data point deviates from the average value of all of the data points. This is a standard measure of risk or volatility when assessing the returns of financial assets.

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The pre- and post-crisis period saw significant changes to Income Tax, which impacted on its relative share. Income Tax is the largest revenue stream of the Exchequer. This is true both historically and at present, with taxes on income (including USC) accounting for 39.4% (or €20 billion) of Exchequer revenue in 2017 (relative to an average of 36.4% over 1984 – 2016). The Income Tax share fell to a low of 27.2% in 2006. This is partially explained by the pre-crisis implementation of budget measures that narrowed the Income Tax base, and by the dramatic rise in VAT revenue during this time (Income Tax receipts grew by 36% from 2000 – 2006, while VAT receipts grew by 80% over the same period).

In the aftermath of the fiscal crisis of 2008, in an attempt to restore the public finances, Income Taxes were increased and several tax expenditures were reduced. As a result, the Income Tax share peaked at around 42% in 2013 and 2014. In recent years, Income Tax receipts have grown strongly (increasing by 27% since 2013), notwithstanding the implementation of measures which have contributed to the narrowing of the base. In fact, Income Tax shows a significant degree of concentration with the top 13% of total Income Tax units\(^5\) (those with gross income above €70,000), accounting for 64% of total tax paid (including USC) in 2016.

**Transaction-based taxes**

Similarly to Income Tax, VAT receipts have increased by 28.7% since 2013. VAT is the second largest revenue stream accounting for 26.2% of total tax receipts (or €13.3 billion) in 2017, below the long-term average over 1984-2016 of 27.2%. However, the VAT share in total tax revenue has decreased in recent years, due to the increasing share of Corporation Tax.

During the boom period, the share of Stamp Duty in total tax revenue doubled from 4.1% in 2000 to 8.2% in 2006, before falling to 2.8% in 2009 (with a share of 2.4% in 2017). Similarly, for Capital Taxes, the share increased from 3.7% in 2000 to 7.6% in 2006, before falling to 2.4% in 2009 (with a share of 2.5% in 2017).
Risk-return trade-off

We now investigate the relationship between revenue growth and volatility for the main tax categories. Table 1 shows the average return and standard deviation, as well as the ratio of the two, for the seven taxes in our sample from 1984 – 2017. We observe that Capital Taxes and Corporation Tax tend to have the highest average annual growth rates, and, alongside Stamp Duty, are among the most volatile in terms of standard deviation.

Among the largest taxes (Income Tax, VAT, Excise Duty and Corporation Tax) Corporation Tax has the highest standard deviation (17.3%), meaning that the annual percentage changes in Corporation Tax would tend on average to fluctuate significantly from their average value (17.3 percentage points above or below the average annual change). Corporation Tax also exhibits the highest average annual growth rate at 12.2%, while Excise Duty grew on average by 4.2% each year over the period. Excise Duty is the tax category with the lowest standard deviation (5.6%). Income Tax, VAT, and Excise generally perform well in terms of their mean return or growth, relative to their volatility (0.96, 0.84 and 0.76 respectively).

The data in Table 1 suggests the existence of a trade-off in terms of the rate of tax revenue growth (or return) and volatility, more typically associated with assets traded in financial markets. This trade-off is clearer from Figure 2, which for each tax category, plots the standard deviation against the average growth rate. In Figure 2, the risk-return trade-off is assessed relative to investments in financial assets with three different risk-return profiles: US T-Bills (low volatility and low return investments), the S&P 500 (medium volatility and medium return investments), and an index of emerging market equities (high volatility and high return investments). Generally (with the exception of Corporation Tax), revenue streams having high volatility and large returns, such as Capital Taxes and Stamp Duty, are pro-cyclical, being based on transactions involving activities that are subject to ‘boom and bust’ cycles.

Table 1. Average revenue growth rate and standard deviation, 1984 - 2017

<table>
<thead>
<tr>
<th>Tax</th>
<th>Average growth rate (return)</th>
<th>Standard deviation (risk or volatility)</th>
<th>Return-risk ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Income Tax</td>
<td>6.61%</td>
<td>6.90%</td>
<td>0.96</td>
</tr>
<tr>
<td>VAT</td>
<td>6.68%</td>
<td>7.91%</td>
<td>0.84</td>
</tr>
<tr>
<td>Excise Duty</td>
<td>4.24%</td>
<td>5.55%</td>
<td>0.76</td>
</tr>
<tr>
<td>Corporation Tax</td>
<td>12.24%</td>
<td>17.27%</td>
<td>0.71</td>
</tr>
<tr>
<td>Stamp Duty</td>
<td>9.42%</td>
<td>23.07%</td>
<td>0.41</td>
</tr>
<tr>
<td>Customs</td>
<td>4.25%</td>
<td>14.96%</td>
<td>0.28</td>
</tr>
<tr>
<td>Capital Taxes</td>
<td>16.38%</td>
<td>33.91%</td>
<td>0.48</td>
</tr>
</tbody>
</table>

Notes. The table above presents the annual average growth rate for each of the tax revenue streams, along with the standard deviation, or volatility, of these revenue streams. The ‘Return-risk ratio’ represents the trade-off between revenue growth and volatility; a ratio below one indicates that the average growth rate is below the volatility for the tax in question. Capital Taxes comprise Capital Acquisitions Tax and Capital Gains Tax (reported separately in outturn data since 2000).

Figure 2. Risk-return trade-off among the main tax categories, 1984 - 2017

Notes. This graph illustrates the trade-off between revenue growth and revenue volatility, and compares this trade-off for each of the tax categories to the risk-return trade-off for Treasury Bills (low risk, low return), investments in the S&P 500 (medium risk, medium return), and investments in an emerging market index (high risk, high return).
Correlation of tax categories

Modern portfolio theory advances that diversification benefits arise from holding a portfolio of underlying assets that do not display strong and positive linkages. The existence of a strong and positive relationship (correlation) between certain tax revenue streams implies that there are limited benefits to diversifying across these taxes.

From an analysis of the bivariate correlation\(^6\) between each pair of tax revenue streams, we observe that overall, Customs is the least correlated with other taxes generally, while VAT appears to be the most correlated. The highest individual correlation is between VAT and Excise Duty (0.78), as expected, given that these taxes are levied on some of the same products. Similarly, Stamp Duty and Capital Taxes have the second highest correlation (0.67), reflective of the fact that they (like VAT and Excise Duty) share elements of the same tax base.

Concentration of the tax base

Figure 3 overleaf shows the degree of concentration or diversification of tax revenue over time, alongside changes in the standard deviation of the State’s tax portfolio. In particular, we are interested in assessing whether Ireland has diversified its tax portfolio over time, and how this compares with portfolio volatility.

We calculate the level of concentration in the tax portfolio using the Herfindahl–Hirschman Index (HHI), which is an index typically employed in competition economics to measure the level of market power in an industry. The index ranges between 0 and 1, with 1 being the case that all tax revenue is coming from a single source. Thus, the higher the index, the lower the degree of diversification of the tax base (i.e. the base is highly concentrated in a small number of taxes). Generally, financial market theory would suggest that more diversification is better in terms of risk reduction. However, this must take account of strength of the relationship among tax categories and the underlying volatility of each tax category.

The purple line in Figure 3 highlights that, historically, Ireland’s tax base has been highly concentrated in a small number of taxes. From 1989, the tax base became more diversified, with the highest level of diversification reached in 2006. Since then, the trend has reversed, and the tax base has become more concentrated. The pink line in Figure 3 highlights an interesting point: the increase in the diversification of tax revenue was associated with an overall increase in portfolio volatility or risk. The negative relationship between the two series (with a correlation of \(-71\%\)) was particularly evident during the boom period. This can be explained by the tax base shifting towards more volatile revenue sources (i.e. an increasing share of Capital Taxes and Stamp Duty). While tax revenue was seemingly more diversified during this time, this spike in the share of certain taxes was temporary and unsustainable. With the 2008 economic and financial crisis, the inevitable collapse of these revenues, and the fiscal consolidation measures that followed, more emphasis was placed on relatively more stable sources of revenue, such as Income Tax.

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\(^6\) The correlation coefficient is a metric used to capture the extent to which two variables change together. When a pair of variables change together in the same direction, there is a positive correlation between these variables. The correlation coefficient is bound above by 1, and below by -1 (with 1 indicating a perfect positive correlation and -1 indicating a perfect negative correlation).
Conclusion

This Note draws from the analysis contained in the PBO’s first Working Paper (Working Paper 1 of 2019).

We establish that a trade-off exists between tax revenue growth and volatility, more commonly seen in the case of assets traded in financial markets. Furthermore, we find strong linkages among the seven largest tax categories (in terms of revenue generated), and observe that the overall volatility of the State’s tax portfolio has increased in line with the level of diversification across the seven main tax categories.

In terms of practical policy implications, this analysis suggests that there is greater scope for the consideration of revenue growth and volatility in the design of tax policies that would alter the composition of the State’s tax portfolio.

Notes. The HHI ranges from 0 to 1, with 1 being the case that all tax revenue is coming from a single source. As of end-2017, the tax base is largely concentrated around Income Tax, Excise Duty, Valued-Added Tax and Corporation Tax. These taxes make up 94% of the revenue aggregate across the taxes included in our sample.
Publications

Publication 11 of 2019  Multiannual Expenditure Ceilings: An effective control for spending or simply the baseline? 08 March 2019

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