Irish Fiscal Advisory Council

Working Paper No.1

March 2015

Uncertainty in Macroeconomic Data: The Case of Ireland

Eddie Casey and Diarmaid Smyth*

* The authors are economists at the Irish Fiscal Advisory Council (IFAC) and the Central Bank of Ireland respectively. We are grateful for comments received following presentations at the Central Statistics Office (CSO), the Central Bank of Ireland and the 2014 Dublin Economics Workshop. We would also like to acknowledge helpful comments received from IFAC members, particularly Sebastian Barnes (OECD), as well as those comments from Michael Connolly (CSO), Karl Whelan (UCD) and Shane Enright (Department of Finance). We are also grateful to Colin Bermingham (BNP Paribas) for supplying us with his original real time database. The authors can be contacted at eddie.casey@fiscalcouncil.ie and diarmaid.smyth@centralbank.ie.

© Irish Fiscal Advisory Council 2015

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

CONTENTS

ABSTRACT

This paper examines revisions to Irish quarterly macroeconomic data focusing on growth rates of real GDP as well as the main expenditure components. A real-time database is constructed from the Central Statistics Office's Quarterly National Accounts release. This is used to measure the extent of data revisions while also formally testing the presence of statistical bias in Irish data. Although estimates of GDP are found to be unbiased, the same cannot be said for some of the sub-components, most notably investment spending. Using data from the OECD, we compile an additional data set for 25 OECD economies to assess the relative scale of revisions to Irish data. Finding that revisions to Irish real GDP growth rates are among the largest observed – even when allowing for differences in growth rates – we examine a number of factors that may indicate why cross-country differences emerge. The scale of data revisions, particularly in Ireland, appears to bear some relation to the structure of the traded sector. More generally the paper also highlights the potential for weaker forecasting performances in countries where data revisions are likely to be relatively high.

SECTION 1: INTRODUCTION

Uncertainty in relation to macroeconomic activity can manifest itself in a number of ways. While often acknowledged for forecasts, uncertainty can also extend backwards into historical outturns, further confusing the divide between 'known knowns' (historical outturns) and the various 'unknowns' (projected growth).[1] This paper addresses one aspect of uncertainty by assessing revisions to quarterly macroeconomic (national accounts) data. These data are a key source of information for economists, policymakers and those engaged in forecasting. Data revisions are little understood, however, and can magnify subsequent forecast errors (Stark and Croushore, 2002). We focus on the case of Ireland where revisions are among the highest observed in the OECD, while also examining properties associated with international data revisions to get a better understanding of why these come about.

Using a real-time database constructed based on historical quarterly macroeconomic data, we build on previous work in the area by Ruane (1975), McCarthy (2004), Bermingham (2006) and Quill (2008). We examine the magnitude and frequency of revisions to data in Ireland before formally testing for the presence of bias in the data using an extended dataset to end-2013.[2] We then put Irish data revisions in an international context, using a large OECD real-time database encompassing 25 economies. Finally, we explore some of the unique facets of the Irish economy to examine whether these characteristics may have some commonly observed association with revisions internationally.

Previous findings have shown conflicting results as regards the systematic bias in Irish Gross Domestic Product (GDP) data. This appears to relate to potential serial correlation in the data revision series, with new releases often influencing several quarters of data. Our findings, which cover an extended time period encompassing the financial crisis, suggest that (a) while revisions to headline Irish GDP data are large and continuously made, estimates are not biased; (b) some of the components of GDP – namely investment – do, however, appear to indicate some systematic bias that may be predictable; and (c) Irish data revisions are among the largest in an international context, still ranking highly even when an allowance is made for differences in the size of GDP growth rates.

Using international data, we find that revisions to macroeconomic data are highly correlated with forecast errors. Based on analyses of various characteristics of OECD economies, we find that the scale of macroeconomic data revisions in Ireland appears to bear some relation to the idiosyncratic structure of the traded sector, which is marked by a high degree of specialisation, sectoral concentration and a significant multinational presence. Other characteristics such as size, openness and volatility of the economy, on their own, do not appear to represent especially convincing reasons for the scale of revisions observed.

---

[1] Donald Rumsfeld, the former US Department of Defense, confused reporters with this typology at a briefing in February 2002. Often repeated, it suggests that "there are things we know we know". We would caution that the propensity for macroeconomic data revisions suggests that there are perhaps less of the 'known knowns' than we might routinely take for granted.

[2] The analysis in this paper also draws on the approach used by the UK's Office for National Statistics (ONS) for estimating statistical bias in the presence of serial correlation as outlined in Jenkinson and Stutttard (2004).

SECTION 2: IMPORTANCE OF DATA REVISIONS AND THEIR ORIGINS

The rise and subsequent collapse of the Irish economy over the past decade or so has seen an increasing demand for high frequency economic data and accompanying commentary. A key source of information provided by the Central Statistics Office (CSO) are the Gross Domestic Product (GDP) growth figures included in the Quarterly National Accounts (QNA) release. These figures attract considerable attention and the associated commentary serves to inform financial, business and policy decisions as well as to signal economic developments to the broader public. The releases can therefore play an important role in interacting with investor, consumer and business confidence. The information content within the QNAs is also a key ingredient for economists engaged in forecasting. It is important that the practitioners and users of these statistics are aware of the nature of data revisions before any firm inferences are drawn.

Data revisions also matter from a fiscal perspective given the preeminent role played by nominal GDP in determining key budgetary metrics. The annual Budget document for example (which sets out expenditure and taxation plans for the forthcoming year), is prepared and released following two quarters of QNA data for the current year. If budgetary projections are predicated on initial growth estimates that are prone to substantial revision, these types of interactions could potentially be quite disruptive. Mauro (2011) emphasises the significant bearing that data revisions can have on adjustment needs and incentives during periods of fiscal correction. Of particular note is a tendency for governments, when faced with improved initial balances owing to upward GDP revisions, to ease off on adjustments more than they would tighten when confronted with the inverse.[3] Revisions that imply worse balances than initially assumed, by extension, will often mean that governments find it more challenging to attain fiscal balances they have set themselves.

There are several reasons why data gets revised. First, the CSO in preparing the QNA relies on the outputs from a range of surveys. These surveys can be monthly (e.g. retail sales data), quarterly (e.g. quarterly national household surveys), annual (e.g. services inquiries) or periodic (e.g. censuses of the population and industrial production). The survey results become available with lags of varying lengths that need to be accounted for when preparing the QNAs. As well as providing new information, survey data can also lead to existing data being revised, thereby causing ripple effects throughout previous QNA estimates. These types of revisions are sometimes referred to in the literature as “informative revisions”.

The second type of revision, sometimes referred to as “uninformative revisions”, captures the effect of methodological changes. For example, the adoption of new ESA 2010 accounting standards in 2014 resulted in significant changes to the QNA. For Ireland, the largest impacts on GDP arose from changes in the treatment of Research and Development (R&D) expenditure.[4]

[3] Mauro (op cit.) also shows an asymmetry with positive growth surprises improving fiscal adjustment plans in line with automatic increases in revenues, whereas negative surprises worsen fiscal balances by more than expected in terms of lost revenues.

[4] Previously R&D was categorised as an ancillary cost in production whereas in ESA 2010 it is included as part of capital investment. For Ireland, this change (as well as some other factors) on a full year basis added approximately €10 billion to the level of nominal GDP.

From our point of view, it may be useful to include a third type of revision that relates purely to measurement error, where data is revised to correct for previous errors. Subsequent releases, therefore, serve not just to include new economic information, or the adoption of methodological changes, but also the correction of past errors. In this paper our analysis focuses on the frequency, and magnitude of macroeconomic data revisions as well as testing for bias.[5]

[5] It was not possible to formally test for the reasons behind revisions across countries.

SECTION 3: DATA AND METHODOLOGY

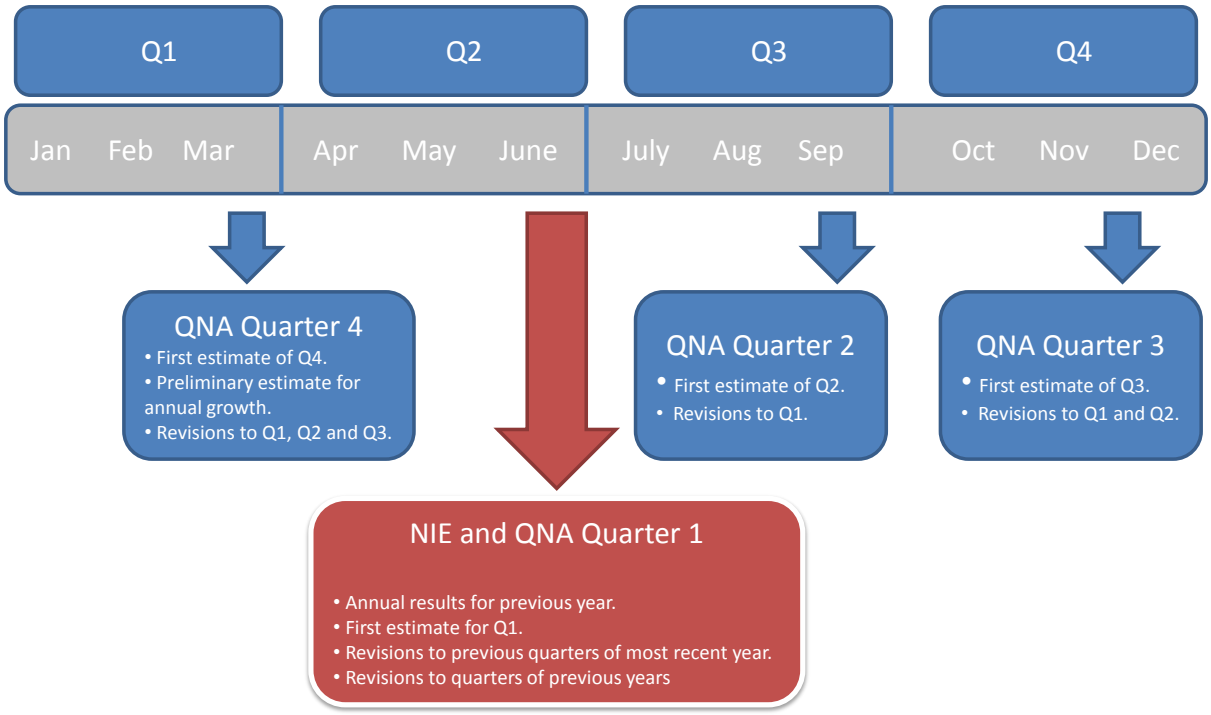
3.1 The Quarterly National Accounts

The QNA Cycle

The QNAs have been published since November 1999 (with data stretching back to 1997). These include estimates for Gross Domestic Product (GDP), Gross National Product (GNP) as well as all of their main sub-components in both volume and value terms. Data are usually published within 90 days of the end of a quarter with the typical cycle depicted in Figure A.

The first quarter estimate for growth is usually published in June, along with the annual results for the previous year in the National Income and Expenditure Accounts (NIE). The second quarter estimate follows normally in September. This release also revises the first quarter estimates for that year. The third quarter is published in December with the fourth quarter normally published in March of the following year.

FIGURE A: QNA DATA CYCLE



Each QNA presents estimates for the most recent quarter as well as revisions for quarters in that year. The CSO are explicit that the quarterly data are subject to revision noting:

> *"The calculation methods for quarterly accounts are similar to those used in the annual National Income and Expenditure. As some of the available sources are of lesser reliability than those used for the annual national accounts, the quarterly estimates are subject to a greater margin of error than the annual figures. These preliminary estimates will therefore be revised when the next detailed annual results are published."*
>
> CSO Quarterly National Accounts, Quarter 2 2014.

In order to produce the NIE, the CSO relies on a number of key surveys some of which are available with lags of varying length. The CSO is tasked with then retrospectively ensuring that data are revised to be consistent with survey results. A key source of survey information is the corporation and self-employed tax files prepared by the Revenue Commissioners. These data only become available with lags of up to one year. Once the NIE data are prepared, the CSO then has to ensure that all quarterly series are consistent with the new annual estimates. This results in significant revisions to data within the QNAs for the current year as well as for preceding years.

Following the publication of the NIE, the QNAs for that year are then fixed for four quarters until the next NIE. This cycle repeats itself and there is no policy that data of a particular vintage are not to be revised, so that theoretically revisions can be continuously made. In practice, however, data beyond five years rarely changes to any great extent except for methodological reasons (Quill, 2008).

The Dataset

A real-time database was constructed in line with the procedures set out by Bermingham (2006). This was supplemented by our own work using more recent QNA data. The database was set up in a in a series of spreadsheets with each column relating to a vintage of data stretching from November 1999 (the first release of a QNA) to March 2014 (data for 2013Q4). Each row then contains an estimate for the aggregate under consideration in a particular quarter. This structure means that datasets are quite large.[6] For example, we have 59 observations for real GDP relating solely to the first quarter of 1999 (as well as for each of the main expenditure components and nominal GDP).

The variables studied are GDP, the main components of expenditure: personal consumption, investment, government, exports and imports of goods and services, and net exports of goods and services. The main focus is on annual growth rates for real aggregates at quarterly intervals.[7] We also assess both nominal GDP and the implied deflator given the importance of nominal aggregates in determining fiscal deficit and debt ratios.

A second source of data was the OECD real-time database.[8] This includes quarterly time series data stretching back over a number of decades for a wide range of countries. Using the OECD data, we were able to construct cross-country datasets for the same variables as described above. This enabled us to put the Irish results in perspective. The results of this analysis are discussed in Section 4.

3.2 Revisions to the Quarterly National Accounts

Two striking features from the real-time database for Ireland are the extent and frequency of revisions. For example, in Figure B, we depict how the estimated real GDP growth rate in 2000Q1 varies at different vintages. If the data were not revised, the graphic would show a circle (i.e. the growth rate is unchanged at each vintage) whereas in reality the data gets continuously revised. For

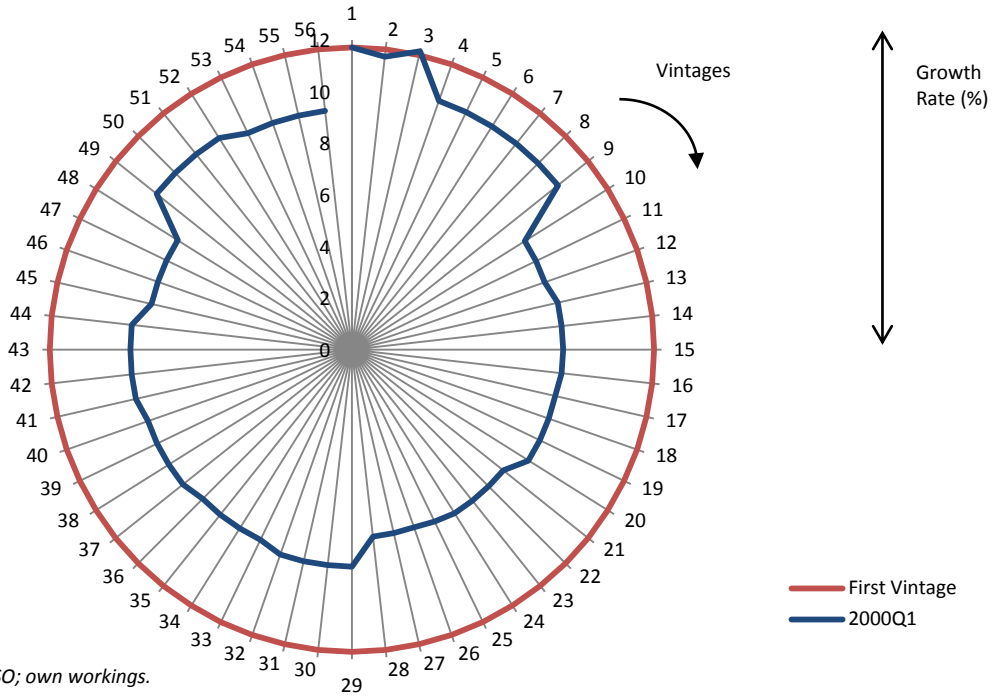
[6] Given the number of observations, variables and vintages in the datasets, there is a reasonable probability of human error to which we take full responsibility. However, various checks were performed at regular intervals to minimise the occurrence of these.

[7] An alternative exercise could have been to examine seasonally adjusted quarter-on-quarter growth rates. However annual comparisons facilitated a longer time-series as seasonally adjusted data were only published from 2003 onwards.

[8] See http://stats.oecd.org/mei/default.asp?rev=1

2000Q1, the estimate coinciding with the end of our sample period (56th vintage) is for real growth of 9.3 per cent but at times growth rates ranged from 11.9 per cent (3rd vintage) to a low of 7.3 per cent (26th vintage). Typically the largest revisions occur following the publication of annual results (5th vintage, 9th vintage, etc.) as the CSO revise earlier quarters to be consistent with detailed annual results.

FIGURE B: ANNUAL REAL GROWTH RATES (%) AT DIFFERENT VINTAGES, 2000Q1

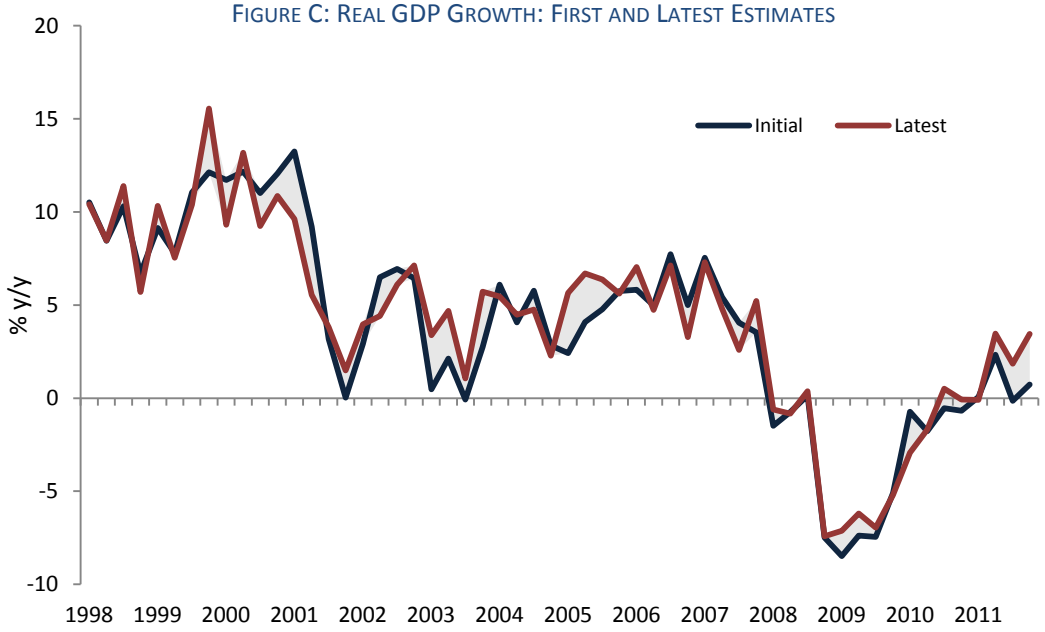


Sources: CSO; own workings.

An alternative way of depicting data revisions is shown in Figure C. Here we plot the initial estimates for real GDP growth in a given quarter with the latest published estimate.[9] However, plotting the initial against the final estimate can potentially hide a lot of information as no account is taken of changes to the data in intervening periods.

[9] As of 2013Q4 (the end of our sample).

FIGURE C: REAL GDP GROWTH: FIRST AND LATEST ESTIMATES



Sources: CSO; own workings.

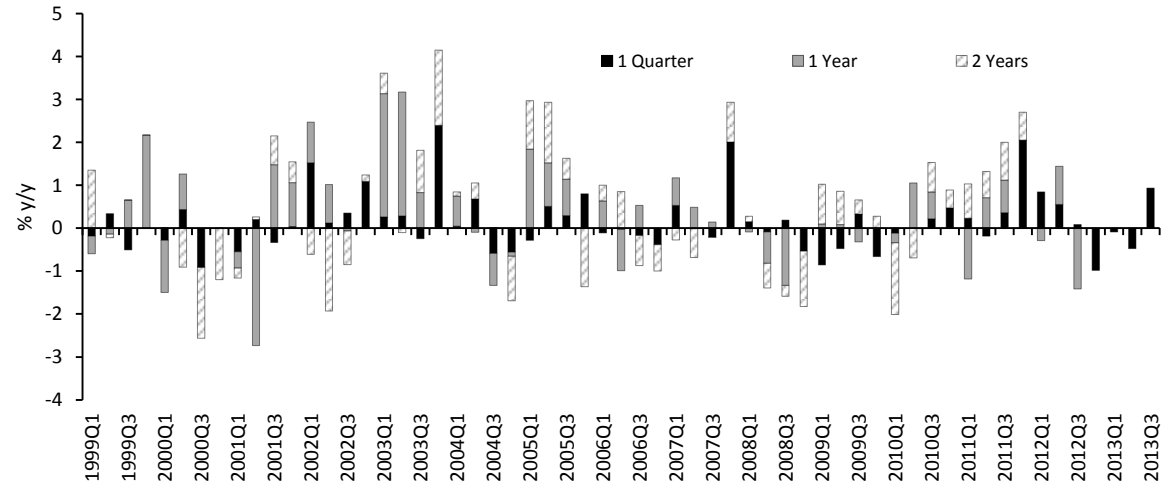
To get a firmer handle on the direction and size of revisions to real GDP, in Figure D, we show revisions to the growth rate at intervals of one, four and eight quarters from 1999Q1 to 2013Q4 (see Annex A for the expenditure components of GDP).

Specifically, we define:

- 1 Quarter: revision to the growth rate after one quarter.
- 1 Year: revision to the growth rate after one year (relative to the first quarter).
- 2 Years: revision to the growth rate after two years (relative to the first year).

From the Figure, it can be seen that the largest revisions usually occur within the first year, although from time-to-time revisions after two years can be sizable. Typically, for a specific quarter, revisions tend to be in one direction. In more recent years, positive revisions appear to have become more likely (this is tested formally in the next Section).

FIGURE D: REVISIONS TO REAL GDP GROWTH AT SELECTED HORIZONS



Sources: CSO; own workings.

3.3 Methodology

In this section, we first outline a suite of statistical measures describing the extent to which data gets revised. Then we outline tests for the rationality of estimates based on the approach followed by Mankiw, Runkle, Shapiro (1986). A more formalised approach for testing the predictability of revisions is then outlined (the Mincer-Zarnowitz test). Finally, two tests for bias are explored: the standard t-test and the modified t-test approach as employed by the UK's ONS.

Typical Measures of Revisions

There are a number of ways to describe revisions. The following measures are used in this paper.

Mean Revision (MR):

$$MR = \frac{1}{n}\sum_{t=1}^{n}(l_t - p_t)$$

...where n is the total number of revisions for each of the data time periods t; l is the latest estimate of the observation relating to reference period t; and p is the preliminary estimate of the observation for that same reference period. Each observation represents a given quarter's annual growth rate in the context of this work.

The MR is a simple average of revisions over a given interval. However, it can understate the scale of revisions if negative values (i.e. downward revisions) offset positive values (i.e. upward revisions).

Mean Absolute Revision (MAR):

$$MAR = \frac{1}{n}\sum_{t=1}^{n}|l_t - p_t|$$

This is similar to the mean revision except that the absolute values are taken in order to prevent negative and positive observations counteracting one another.

Mean Absolute Cumulative Revision (MACR):

If we define the MAR as before, then we can define the MACR as follows:

$$MACR = \sum_{j=1}^{m} MAR_j$$

The MACR looks at the cumulative size of absolute revisions across defined sub-intervals (in this case up to 'm' intervals). This gives a sense of the total movements that can occur over the data cycle.

Mean Absolute Final Revision (MAFR):

$$MAFR = \frac{1}{n}\sum_{t=1}^{n}|f_t - p_t|$$

...where f is the final estimate of the variable for reference period t.

This looks at the difference between the initial and final estimate. However, in the Irish context, there are no final estimates *per se* (revisions may occur indefinitely). For our purposes, we define the final estimate as that corresponding to the end of our sample period (i.e. data corresponding to the QNA release for 2013Q4).[10]

Root Mean Squared Revision (RMSR):

$$RMSR = \sqrt{\frac{1}{n}\sum_{t=1}^{n}(l_t - p_t)^2}$$

This is a standard measure of uncertainty. It is designed to overcome problems of positive and negative observations offsetting one another by taking the squared values of revisions and then returning the square root of their mean.

Relative Mean Absolute Revision (RMAR):

$$RMAR = \frac{\sum_{t=1}^{n}|l_t - p_t|}{\sum_{t=1}^{n}|p_t|}$$

The RMAR shows the typical proportion of the initial estimate that is revised over a given period. This measure has the added advantage of controlling for differences in growth rates. This is especially useful for studying international variations in revisions.

Range of Revisions:

$$Range = (Max\ Revision - Min\ Revision)$$

This measures the difference between the highest and lowest revisions.

Percentage Positive Revisions:

$$\%\ Positive\ R = 100 * \frac{1}{n}\sum_{t=1}^{n} V_t\,, \qquad where\ V_t = 1\ if\ R_t > 0$$

R_t represents the revision to the growth rate.

This measure is intended to show the share of total positive revisions in the sample.

Contributions to Real GDP Revisions:

Another useful measure involves looking at the contributions of each component of GDP to the overall GDP growth rate revision. The contribution formula for a given vintage takes the form:

$$Contribution_t = \frac{(C_t - C_{t-1})}{GDP_t - GDP_{t-1}} * g_t$$

[10] In this paper we focus on the period up to end-2013. This also corresponds with the last QNA prepared on an ESA 95 basis.

...where C_t is the real level of a given expenditure component at time t; GDP is the real level of GDP calculated as the sum of all expenditure components; and g is the real GDP growth rate.[11] The contributions to any revised GDP estimate are then simply taken as the difference between the latest and preliminary contributions estimates.

For the purposes of our analysis (and particularly for international comparisons), the key statistics we focus on are the RMSR and the RMAR.

Properties of Rational Estimates

While the previous measures can be useful for assessing revisions, they do not tell us very much about any systematic tendencies. Of particular interest is whether revisions to data releases incorporate all available information at the time of publication. If this is not the case, then perhaps future revisions may be predictable on the basis of currently available information.

We first test to see if data revisions are predictable by focusing on the noise versus news hypotheses (Mankiw *et al.*, 1986). Under the latter, initial estimates are expected to incorporate all available information efficiently at the time of publication. Subsequent revisions therefore simply reflect the availability of new information. In the case of the noise hypothesis, revisions to the initial estimate do not incorporate new information, but arise due to the correction of earlier inaccuracies or bias in the data. In such circumstances, it might be expected that the revisions could contain some predictable elements. This would imply that the initial estimate is not as informative as it could be and is therefore not a "rational" estimate of the "true" value.[12] The noise versus news hypotheses are often characterised as representing irrational and rational estimates: irrational – whereby subsequent revisions correct for noise in the initial estimates – and rational – whereby revisions incorporate news that subsequently becomes available.

If we assume that the true estimate is close to the estimate eight quarters after the initial estimate's release, one can describe the preliminary estimate p as equal to the latest value l plus an error term, $\in$:

$$p_t = l_t + \in_t$$

...so that the revision 'R' is described as follows:

$$R_t = l_t - p_t$$

A rational estimate has three key properties:

1. $MR = 0$ ...the mean revision (MR) should equal zero.
2. $\rho_{R_t P_t} \leq \rho_{R_t L_t}$ ...the preliminary estimate p_t should not be more strongly correlated with the revision than the final estimate. If the initial estimate were more strongly correlated with the revision, this would indicate that the initial estimate did not fully avail of all available information.

[11] Note that GDP components do not necessarily sum to the official GDP estimate provided by the CSO due to the existence of a statistical discrepancy and chain linking. The growth rate used refers to the actual GDP aggregate published by the CSO rather than the sum of components.

[12] Put more simply, information available at the time of the initial estimate is not being used efficiently to help us to get closer to the true value.

3. $\sigma_{p_t}^2 < \sigma_{l_t}^2$ ...the variance of the preliminary estimate p_t should be lower than the variance for the latest estimate l_t. If the initial estimates are efficient predictors of the true estimates, then these should have lower variances that those of the true values.

Mincer-Zarnowitz Test

A more formal test of bias is the Mincer-Zarnowitz test (1969). Again, a rational estimate is considered to be one where any subsequent revisions cannot be predicted by information available at the time of the initial estimate. The test is based on the following regression:

$$(l_t - p_t) = \alpha + \beta p_t + \mu_t$$

...where the revision is equal to a constant $\boldsymbol{\alpha}$ plus a coefficient $\boldsymbol{\beta}$ times the preliminary estimate plus an error term $\boldsymbol{\mu}$. The test checks to see whether the revision can be forecast using the preliminary estimate – if this proves to be the case, then the initial estimate is considered to be an irrational one. Specifically, the rationality of the initial estimate is examined under the joint hypothesis:

$$\boldsymbol{H_0}: \boldsymbol{\alpha} = \boldsymbol{\beta} = \mathbf{0}.$$

Standard and Modified T-Tests

Statistical bias in revisions can also be formally tested for using t-tests. Standard t-tests examine whether revisions, on average, are significantly different from zero. Information on the mean of a revisions series and its standard deviation are examined under the assumption that the sample of revisions is normally distributed. If the revision is not statistically significant, this implies that any observed revisions may have occurred due to chance rather than due to any systematic bias in a given direction.

One potential problem with using the standard t-test however is in the event of serial correlation in the revisions series. It is reasonable to expect that such an issue may arise given the nature of macroeconomic revisions. Specifically, revisions typically occur following the release of new survey information which will often relate to a string of consecutive quarters. This is common as many of the key surveys are of an annual frequency. In such cases, standard t-tests could overstate the significance of any results where successive revisions are not independent.

An argument against controlling for serial correlation in revisions is that the correlation itself might represent some informative characteristic of the data. While this could be a factor, we question such interpretations. If revisions take place simultaneously (as is often the case with quarterly macroeconomic time series) then, by definition, there would be no exploitable signal to avail of. Not controlling for serial correlation in these circumstances could lead one to incorrectly conclude that successive revisions have some predictable pattern.

An alternative approach is to use a modified t-test to account for any serial correlation. The modified t-test applied here is the same as that used by the ONS for analysing bias in UK macroeconomic data (see Annex B for details).

SECTION 4: RESULTS FOR IRISH QUARTERLY NATIONAL ACCOUNTS (QNA) DATA

4.1 Uncertainty in the Irish Data – Standard Statistical Measures

A summary of the main measures of revisions using QNA releases from 1997 to 2013 are shown in Table 1. Our assessment focuses on initial estimates for year-on-year growth (first vintage) with estimates after a two year horizon (eighth vintage).[13] We examined real GDP as well as all of the main expenditure components, namely, consumption (C), investment (I), government (G), exports (X), imports (M) and net exports (NX). We also examined the GDP deflator (GDP Price) and nominal GDP (GDP Value).

Real GDP is subject to absolute revisions averaging about 1.3 percentage points from the time of the initial estimate to the vintage after two years, as well as by the final period (i.e. 2013Q4). Over the sample, real GDP growth rate estimates see the equivalent of some 23 per cent of their initial year-on-year growth rate revised. Almost 59 per cent of revisions are positive and revisions range from a downward revision of 2.6 percentage points (2000Q3) to an upward revision of 4.2 percentage points (2003Q4). Finally, the root mean square revision statistic at 1.6 percentage points is relatively high given that the GDP growth rate averages 3.6 per cent over the period.

TABLE 1: IRISH MACROECONOMIC DATA REVISIONS, 1998Q1 –2013Q4
(PERCENTAGE POINT GROWTH RATE REVISIONS UNLESS STATED)

	GDP	C	I	G	X	M	NX	GDP Price	GDP Value
Avg. Growth Rate	3.6	3.6	0.8	2.3	6.8	5.9	23.0	4.2	6.0
MR	0.4	0.7	1.8	0.4	0.9	1.5	0.7	-0.2	0.2
MAR	1.3	1.1	3.5	1.9	2.2	2.7	13.3	1.0	1.8
MACR	2.0	1.7	5.7	3.4	3.5	4.0	18.2	2.0	3.1
MAFR	1.3	1.3	4.2	2.0	2.1	3.0	28.4	1.4	1.9
RMAR (% of $\|p_t\|$)	23%	22%	27%	42%	26%	32%	57%	31%	21%
RMSR	1.6	1.3	4.3	2.5	2.8	3.3	17.4	1.3	2.4
Range	-2.6 to 4.2	-1.4 to 3.3	-7.2 to 8.5	-5.2 to 6.6	-3.8 to 7.7	-4.7 to 7.8	-32.4 to 69.1	-3.3 to 3.5	-4.5 to 6.8
% Positive	58.9	76.8	73.2	55.4	60.7	64.3	39.3	48.2	50.0
Avg Contributions		0.4	0.4	0.0	0.9	-1.1	-0.2		
Avg Absolute Contributions		0.7	1.0	0.4	2.7	3.1	1.5		

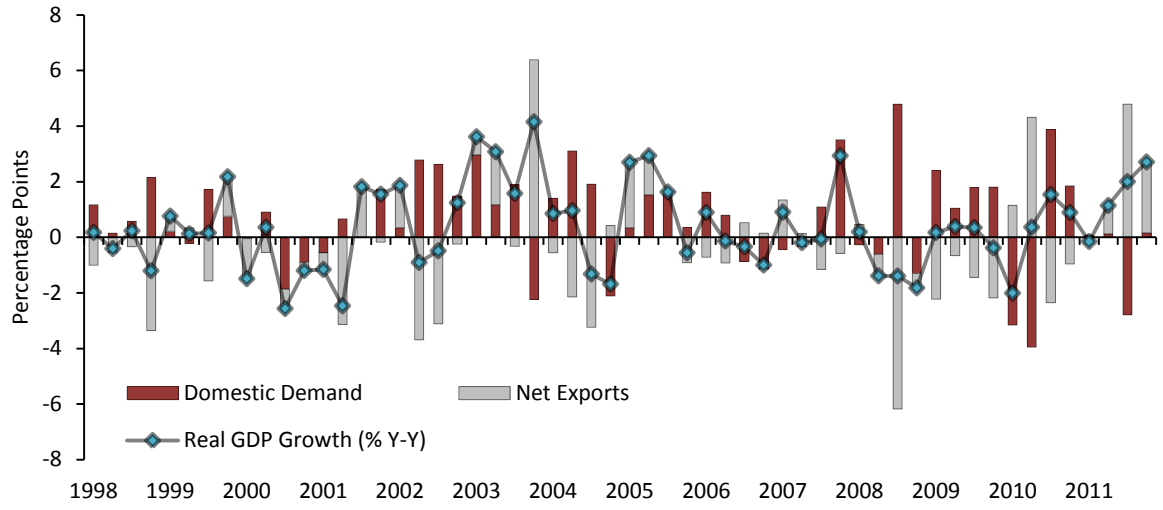
Source: CSO and internal calculations.

Looking at the components of domestic demand, the investment series is subject to significant revisions, having the highest root mean square statistic (RMSR) observed aside from net exports – which combines two series. The tendency for upward revisions (nearly three quarters of the time) to both consumption and investment is a notable feature of the data as is the range of revisions to investment. Perhaps the most striking feature of the results is the large contribution to GDP growth rates stemming from investment revisions, particularly given that investment is one of the smaller

[13] Most revisions tend to occur within a two-year horizon, so our cut-off point was the eighth vintage. This also enabled a sufficiently long sample to be observed.

expenditure components (equivalent to less than half the size of consumption).[14] Overall, domestic demand components are found to exert a sizable influence on revisions to GDP (Figure E).

FIGURE E: CONTRIBUTIONS TO ANNUAL REAL GDP GROWTH RATE REVISIONS



Source: CSO and internal calculations.
Note: Revisions are based on estimates after two years relative to the first quarter estimate.

On the trade side, both exports and imports are also susceptible to large revisions.[15] The imports series has the second largest root mean square statistic in the sample (excluding net exports) with upward revisions to the growth rate occurring nearly two thirds of the time. The absolute contribution made by imports to the GDP growth rate also exceeds that made by exports. In net terms, the trade revisions tend to reduce GDP growth estimates slightly.

For the deflator, revisions are sizable with a root mean square revision of 1.3 per cent and a cumulative revision of 2.0 per cent. Clearly revisions to deflators (for GDP and each of the components) are an additional source of uncertainty in the data given their potential to impact on the both nominal and real growth rates.

From Table 1, it is also clear that the range of revisions varies widely particularly for investment and imports. We tested to see if there were any outliers in the data or rather what happens in the event of "extreme estimates". The latter are defined here as observations lying outside of 1.5 times the standard deviation of the series. The analysis indicates that extreme estimates tend to mean revert to varying extents within four years (Figure F).[16] The incidence of extreme estimates also appears to have decreased since 2005.

Putting some rationale on the results in Table 1 is difficult. Some of the volatility in the investment series might reflect the activities of multinational enterprises (MNEs) through their machinery and equipment investment decisions. The smaller revisions to personal consumption expenditure may reflect a more stable data gathering process, with CSO estimates only revised in the event of new

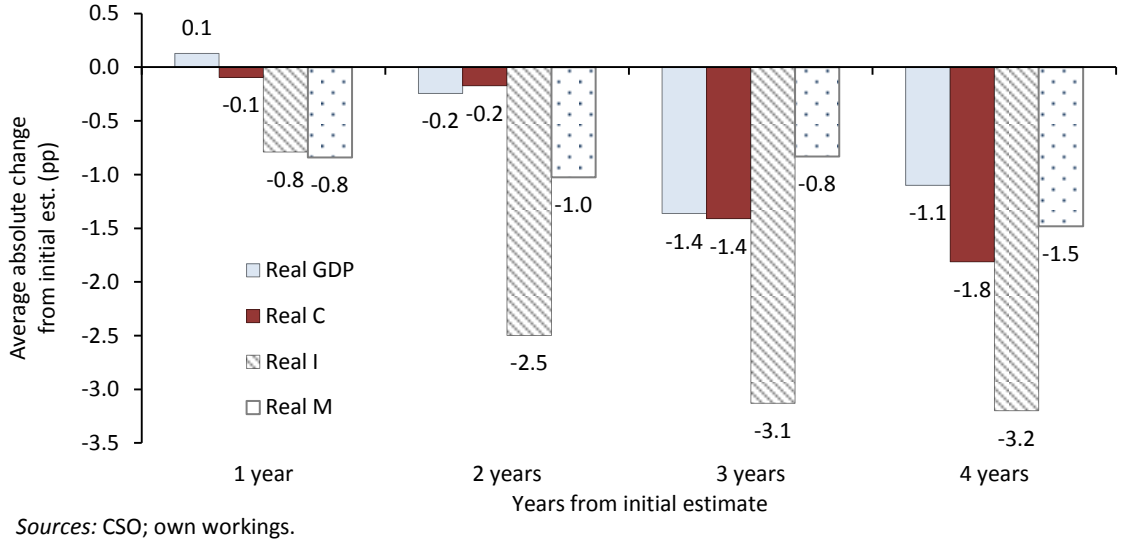
[14] Over the period 1995-2013, investment averages some 22 per cent of GDP compared to exports (88 per cent); imports (73 per cent); personal consumption (48 per cent); and government consumption (15 per cent).

[15] A great variety of goods and services are included within exports and imports. A potential useful follow up to this paper would be to investigate trade in goods and services separately.

[16] There are not enough extreme observations to test for systematic mean reversion tendencies.

information from annual surveys and periodic census results.[17] Finally, the relative mean absolute revision is surprisingly high for government expenditure, with some 42 per cent of the initial estimate revised on average.

FIGURE F: MEAN REVERSION IN EXTREME GROWTH RATE ESTIMATES



Sources: CSO; own workings.
Note: Extreme estimates are measured as mean +/- 1.5 times the standard deviation for respective year-on-year growth rates.

The volatility in the exports and imports series may reflect the open nature of the economy and the dominance of MNEs, where revisions and firm specific data can potentially have large effects on economy-wide aggregates. The exports and imports series tend to move together given the high import content of certain types of export related activity. In Section 4.2, we examine these factors in greater detail.

Pre- and Post- Financial Crisis

We also examine revisions across two distinct time periods, namely the pre- and post-financial crisis (1998-2007 and 2007-2013, respectively) to investigate whether the pattern of revisions has been affected by the financial crisis.[18]

From Tables 2 and 3, we can see that revisions to real GDP have not changed dramatically with the crisis. The size of root mean squared revisions has declined (by 0.3 percentage points) with positive revisions becoming slightly more common. Looking at the relative scale of revisions – the RMAR – suggests that the revisions have increased more than other measures would indicate. The proportion of initial growth rate estimates revised after two years has risen to 38 per cent relative to 20 per cent pre-crisis.

Turning to the components of GDP, two features are striking. First, investment data show markedly different patterns. Root mean squared revisions have widened (from 4.1 percentage points to 4.7 percentage points); absolute contributions from revisions are also more than double their pre-crisis

[17] For example, imputed rents (included in personal consumption) and headcount figures (used to estimate consumption) are significantly impacted following the census.

[18] These periods were chosen on the basis of judgement rather than for statistical reasons.

estimates; and the more recent revisions are almost exclusively upward. Second, revisions to trade components and government consumption have swung from being predominantly positive to negative. The mean squared revision estimates for both exports and imports have narrowed; although this partly relates to lower growth rates (the RMAR is proportionally larger for exports in the more recent period).

TABLE 2: PRE- FINANCIAL CRISIS REVISIONS, 1998Q1–2007Q2
(PERCENTAGE POINT GROWTH RATE REVISIONS UNLESS STATED)

	GDP	C	I	G	X	M	NX	GDP Price	GDP Value
Avg Growth Rate	6.7	6.4	8.3	5.4	10.1	10.4	18.3	4.2	11.2
MR	0.4	0.7	0.9	1.1	1.8	2.4	0.1	-0.1	0.3
MAR	1.3	1.0	3.3	1.9	2.4	3.3	12.5	0.9	1.9
MACR	2.0	1.7	5.4	3.2	3.8	4.4	16.4	2.1	3.2
MAFR	1.4	1.2	3.6	2.0	2.4	3.6	32.1	1.3	2.0
RMAR (% of $\|p_t\|$)	20%	19%	36%	38%	24%	35%	61%	24%	18%
RMSR	1.7	1.2	4.1	2.6	3.2	3.8	15.3	1.3	2.5
Range	-2.6 to 4.2	-1.3 to 2.3	-7.2 to 8.5	-3.0 to 6.6	-2.7 to 7.7	-4.7 to 7.8	-32.4 to 29.9	-3.3 to 3.5	-4.5 to 6.8
% Positive	57.9	78.9	63.2	65.8	71.1	76.3	42.1	52.6	52.6
Avg Contributions		0.4	0.1	0.2	1.6	-1.8	-0.2		
Avg Absolute Contributions		0.7	0.7	0.3	3.0	3.8	1.3		

Sources: CSO; own workings.

TABLE 3: FINANCIAL CRISIS REVISIONS, 2007Q3 –2013Q4
(PERCENTAGE POINT GROWTH RATE REVISIONS UNLESS STATED)

	GDP	C	I	G	X	M	NX	GDP Price	GDP Value
Avg Growth Rate	-0.9	-0.6	-10.0	-2.1	2.0	-0.6	29.8	-1.0	-1.8
MR	0.3	0.7	3.9	-1.0	-1.0	-0.2	1.8	-0.2	0.1
MAR	1.1	1.1	4.1	2.0	1.7	1.5	15.1	1.2	1.8
MACR	1.8	1.6	6.5	3.8	2.8	3.3	22.1	1.8	2.7
MAFR	1.0	1.6	5.6	2.0	1.6	1.5	20.7	1.5	1.7
RMAR (% of $\|p_t\|$)	38%	31%	19%	55%	34%	24%	52%	61%	41%
RMSR	1.4	1.5	4.7	2.4	1.9	1.9	21.3	1.3	2.2
Range	-2.0 to 2.9	-1.4 to 3.3	-1.9 to 7.5	-5.2 to 2.9	-3.8 to 2.1	-3.2 to 4.2	-24.9 to 69.1	-2.5 to 2.0	-3.9 to 3.8
% Positive	61.1	72.2	94.4	33.3	38.9	38.9	33.3	38.9	44.4
Avg Contributions		0.3	1.0	-0.3	-0.7	0.5	-0.3		
Avg Absolute Contributions		0.7	1.8	0.4	2.2	1.8	1.9		

Sources: CSO; own workings.

In terms of a rationale behind the changes, one explanation for the downward revisions to government consumption dominating in the later period may stem from an initial underestimation of receipts relating to the bank guarantee scheme introduced during the financial crisis.[19] Another explanation could be due to an initial overestimation of departmental spending as fiscal consolidation measures were being undertaken. More generally, pro-cyclical spending tendencies in

[19] These are netted out of government consumption.

the Irish context (Lane, 1998) may be reflected in the contrasting pattern of revisions for the pre- and post-crisis periods. As for investment, two factors may explain why the impact of revisions here with respect to real GDP growth rates magnified in the post-crisis period: (i) average quarterly growth rates widened in the aftermath of the housing bubble, yet growth rates in other components narrowed; (ii) volatility observed in the building and construction sector as well as in other business investment categories may have aggravated the extent of revisions subsequently observed.

4.2 Are Data Revisions Predictable?

In this Section we test more systematically for the presence of bias in the QNA data recalling the properties of a rational estimate. We first test for bias by measuring whether mean revisions are significantly different from zero using a standard t-test. [20] The results are shown in Table 4. The t-test compares the mean revision over the sample period and the variability of the revisions under the assumption that these should be equal to zero. The results suggest that the only expenditure component where revisions are seen to be *not* statistically different from zero are those related to government consumption.

As alluded to earlier, the standard t-test is based on the assumption that data revisions are independent of each other. This may not be true if revisions made for one period are associated with revisions to preceding periods. To check for the possibility of serial correlation in the revision series, in Table 4, we show the results of an AR(1) model. The coefficient on the AR(1) term is significant in all cases except for net exports, thus invalidating the standard t-test approach.

To address this issue we use the modified t-test. This adjusts the relevant number of independent observations for estimating the mean as well as the variance of the mean.[21] Using this approach, the mean revision for real GDP is not found to be statistically significant. However mean revisions are found to be statistically significant for consumption, investment and imports (see Annex C for detailed results). In each of these cases, the revisions observed – which are typically positive – may be said to exhibit systematic bias. The degree of significance is highest in the case of investment. There may also be some overlap across these series given the high import content of consumer and investor goods.

We next look at some additional checks for systematic bias with reference to the remaining properties of a 'rational' estimate. The results suggest that investment, exports and the implied GDP price deflator series also violate the variance and correlation properties of a rational estimate. First, for each variable, the initial growth rate estimates have a higher correlation with the revisions series than final estimates. Second, initial estimates have a larger variance than final estimates. On the basis of these results and the t-tests, the investment series appears to consistently violate the three properties of a rational estimate. This suggests that systematic bias is evident which could potentially be exploited.

[20] We tested for the appropriateness of assuming a Normal distribution by using a Jacque-Bera test (also reported in Table 4). The test failed to reject the null hypothesis that the data are normally distributed for all of the components with the exception of net exports.

[21] For details see Annex B and Jenkinson and Stuttard (2004).

A third means of testing for systematic bias in the revisions series is provided by the Mincer-Zarnowitz test (also summarised in Table 4). Growth rate revisions for a given component are regressed on preliminary estimates to examine if initial estimates themselves could be used to predict revisions. In addition to the constant, the coefficients on X_t (i.e. the coefficients on the preliminary estimates) are shown. The standard errors are computed correcting for heteroscedasticity and for serial correlation using the Newey-West (1987) approach. Revisions to the GDP growth rate do not appear to exhibit any predictable element, suggesting that initial estimates for GDP growth are indeed rational. However, the same result does not hold true for investment and net exports. We are less interested in the results for net exports for several reasons: (i) the series are non-normally distributed; (ii) other tests fail to indicate systematic bias and (iii) the net exports series represents the difference between two very different gross flows (exports less imports) and is inherently more volatile than an individual component. Investment spending estimates are of considerable interest, however. The null of forecast rationality (i.e. that the F-test of the joint hypothesis that the constant and the coefficient are both zero) is rejected for the preliminary estimates of investment at the 1 per cent significance level. This appears to confirm the results of the other tests.

Overall, the three approaches appear to suggest that initial estimates of real GDP are not biased, though there may be some issues with components of expenditure. In particular, the analysis consistently indicates that there may be some potential bias underlying initial estimates of investment expenditure. Furthermore, the revisions to the investment series appear to have some predictable component that could be exploited using nothing more than the initial growth rate estimates. It is difficult to explain why the investment revisions are so large, but it is quite possible that machinery and equipment investment may relate to highly concentrated, large-scale manufacturing activities among MNE-dominated sectors in Ireland.[22] Further, the overall impact on the GDP growth may be lessened by the fact that a large proportion of investment goods are imported.

[22] An example of this scale is the concentration of pharma-chem activities in manufacturing, with the sector accounting for approximately a quarter of total Irish exports (Enright and Dalton, 2013).

TABLE 4: SYSTEMATIC PROPERTIES OF REVISIONS DATA[23]

	GDP	C	I	G	X	M	NX	GDP Value	GDP Price
Mean Revision	0.4	0.8	2.0	0.5	0.9	1.5	1.3	0.3	-0.2
Std. Dev.	1.6	1.1	3.9	2.6	2.8	3.1	18.0	2.5	1.4
Jacque-Bera (JB) Probability	0.586	0.823	0.528	0.621	0.192	0.658	0.000	0.591	0.960
Significant? (standard t)	**Yes**	**Yes**	**Yes**	No	**Yes**	**Yes**	No	No	No
Significant? (modified t)	No	**Yes**	**Yes**	No	No	**Yes**	No	No	No
Tests for Serial Correlation									
X_{t-1}	**0.4054**	**0.6892**	**0.4965**	**0.5950**	**0.6286**	**0.5517**	**0.142**	**0.4174**	**0.5205**
	(0.1331)**	(0.1027)***	(0.1228)***	(0.1091)***	(0.1097)***	(0.1175)***	(0.1413)	(0.1315)**	(0.1212)***
R^2	0.09	0.16	0.05	0.36	0.32	0.13	0.02	0.16	0.25
RMSE	10.89	6.82	27.03	14.49	16.33	20.30	127.30	16.13	8.36
Additional Checks for Properties of Rational Estimates									
Var. (p_t)	**28.1**	**21.2**	**237.4**	**15.6**	**54.3**	**67.0**	**502.2**	**60.8**	**9.3**
Var. (l_t)	28.1	21.8	203.4	26.9	50.0	69.9	575.0	62.4	8.7
Corr. (R_t, p_t)	-0.10	-0.10	-0.40	0.20	-0.30	-0.10	-0.30	-0.10	-0.30
Corr. (R_t, l_t)	0.20	0.20	-0.20	0.70	0.10	0.20	0.50	0.20	0.15
Mincer-Zarnowitz Tests									
Constant	0.6006	0.7995	1.6266	0.0682	1.546	1.6185	6.2761	0.4611	0.0473
	(0.3887)	(0.2575)**	(0.6789)*	(0.6341)	(0.9344)	(0.6608)*	(3.0826)*	(0.6866)	(0.3343)
X	-0.044	-0.0131	-0.1029	0.1529	-0.1104	-0.0482	-0.2457	-0.0365	-0.1305
	(0.0568)	(0.0433)	(0.0316)**	(0.1232)	(0.0815)	(0.0465)	(0.1105)*	(0.0576)	(0.0803)
R^2	0.02	0.00	0.17	0.06	0.09	0.02	0.09	0.01	0.09
RMSE	11.32	7.72	25.30	18.02	19.08	21.88	122.63	17.48	9.24
F stat	0.600	0.091	10.623	1.540	1.831	1.074	4.944	0.401	2.637
P(F stat)	0.442	0.764	0.002**	0.22	0.182	0.305	0.031*	0.529	0.111

Notes: Standard errors in parentheses; * p<0.05, ** p<0.01, *** p<0.001. Sample of 52 observations for each component. F-Statistics shown apply heteroscedasticity and autocorrelation-robust Wald tests (Newey-West estimator).

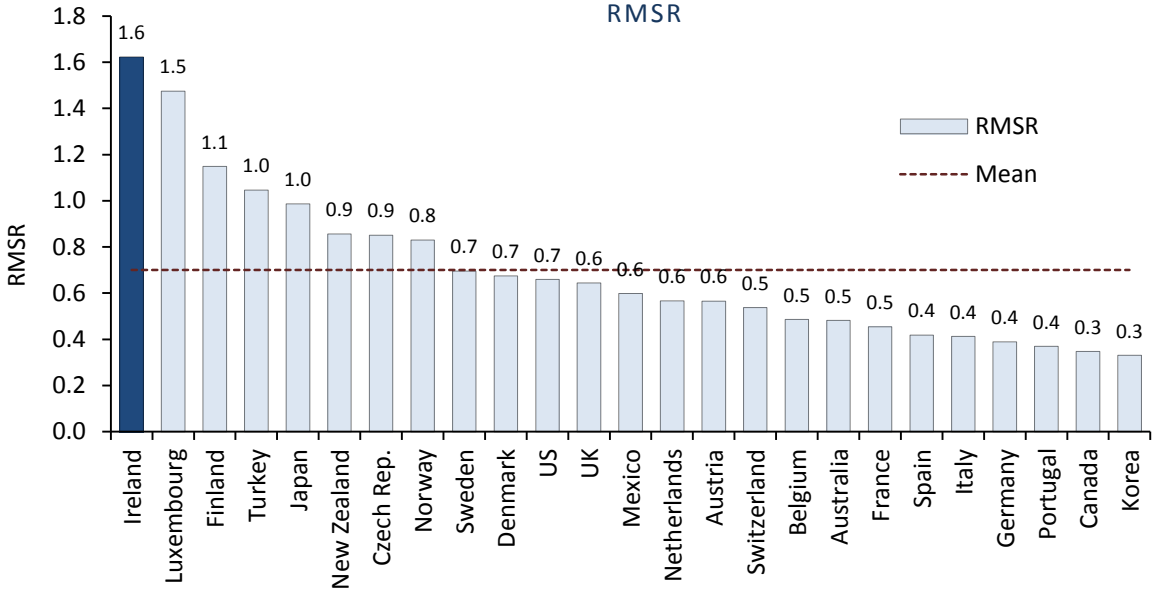
[23] Note that the period 1999 Q1–2011 Q4 is used here rather than the period identified in Tables 1-3. This loss of four observations is imposed due to a stricter interpretation that first estimates are represented by the newest available quarterly outturn (i.e. the very latest estimate in a given QNA release).

SECTION 5 INTERNATIONAL MACROECONOMIC DATA REVISIONS

To put the uncertainty of the Irish macroeconomic data in perspective, we use the OECD real time database.[24] A sample of 25 economies was taken covering the period 2002 to 2013.[25] All of the main components of GDP were examined although the focus was on real GDP growth rates. We examined initial estimates for real GDP growth with estimates available eight quarters later using two main indicators – the root mean square revision (RMSR) and the relative mean absolute revision (RMAR).[26]

The cross country results for real GDP are depicted in Figure G. On the basis of the root mean square revision measure, initial estimates of Irish GDP growth are prone to the largest revisions of the 25 OECD countries studied and are more the double the sample average.

Figure G: Real GDP Data Revisions in an International Context: RMSR



Sources: OECD real-time database and internal calculations.
Note: Harmonised sample, with the exception of Luxembourg.

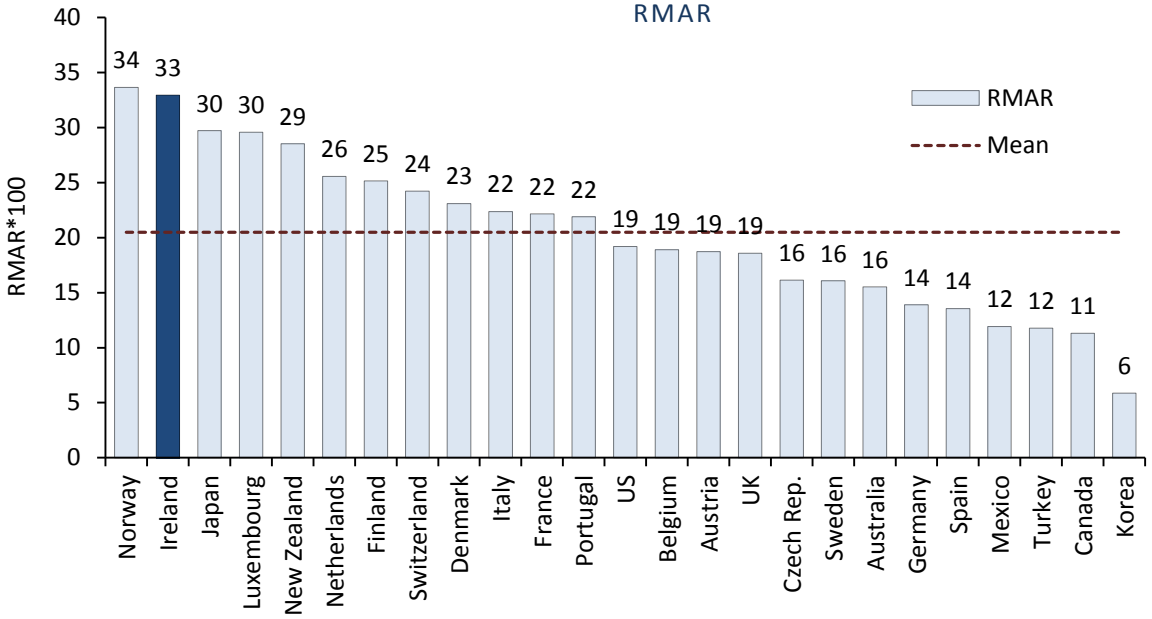
As discussed earlier, the RMAR can be interpreted as a robustness check for the initial estimate as it has the added advantage of controlling for variation in the size of growth rates. The results in Figure H confirm that Irish data are prone to large revisions in an international context, with the second highest RMAR in the sample.

[24] The OECD real-time database only provides quarterly national accounts data in seasonally adjusted levels. As such, the year-on-year growth rates we examine are complicated by this adjustment. In theory, there should not be any significant differences between annual growth rates in the adjusted and unadjusted measures. In practice, however, there are some slight differences due to some issues with seasonal adjustment although these tend to be small with a mean of 0.002 per cent across the sample.

[25] For Luxembourg, data was only available from end-2005.

[26] The use of the OECD database (and a different sample period) means that the results for Ireland in this Section are not directly comparable to those reported earlier in the paper.

Figure H:Real GDP Data Revisions in an International Context: RMAR



Sources: OECD real-time database and internal calculations.
Note: *Harmonised sample, with the exception of Luxembourg.*

RMAR and RMSR scores were also calculated for each of the main components of GDP with the results summarised in Table 5. These confirm that Irish data are subject to significant revisions both in absolute terms and also relative to other economies (see Annex D for charts showing all of the main expenditure components).

TABLE 5: UNCERTAINTY IN INTERNATIONAL DATA, 2002-2013 AND IRISH RANKING

	Ireland RMSR	OECD RMSR	*Rank* RMSR	Ireland RMAR*100	OECD RMAR*100	*Rank* RMAR*100
GDP	1.6	0.7	*1*	33.0	20.5	*2*
Consumption	1.9	0.9	*1*	40.2	28.5	*6*
Investment	4.5	2.5	*1*	24.3	36.5	*18*
Government	2.3	1.3	*3*	42.2	51.2	*13*
Exports	3.3	1.9	*4*	51.5	24.9	*1*
Imports	3.4	2.0	*3*	43.3	23.8	*3*
Nominal GDP	2.5	1.0	*1*	32.7	16.3	*1*
GDP Deflator	1.4	0.8	*4*	47.9	27.6	*3*

Sources: Internal calculations based on OECD real time data set. Luxembourg was excluded from the sample for the components of GDP due to a lack of observations. In addition, Turkey was excluded from the GDP deflator series.

For Ireland, the revisions to domestic demand components appear relatively less pronounced on the basis of the RMAR statistics.[27] However, the susceptibility of the trade data to revisions remains a notable characteristic of the data. These findings might not be altogether surprising given the very open nature of the Irish economy and the importance of the export orientated MNE sector.

[27] While consumption and investment revisions are large on an RMSR basis, this partly reflects high growth rates in Ireland compared to other economies.

In light of these findings, the next question was to examine possible sources of uncertainty – as reflected by revisions – in the Irish data. Several factors might explain the relatively large revisions:

(a) Size: The smaller size of the Irish economy in value terms may explain some of the volatility if developments in specific sectors have a larger proportionate impact on growth rates. Of the 25 OECD economies we study, Ireland had the fourth smallest economy in GDP value terms in 2013.

(b) Openness: The scale of Ireland's traded sector is large in an international context. In 2013, exports were equivalent to about 108 per cent of GDP, while exports and imports combined were equivalent to some 190 per cent. On both counts, Ireland was the second most open economy in the sample. Difficulties in measuring output related to these activities may explain the larger scale of revisions.

(c) Volatility: The economic cycle in Ireland has tended to be quite volatile with several boom/bust periods. This partly reflects the openness of the economy, the susceptibility to shocks and a recent history of policy errors.

(d) Multinational Sector: The size of the multinational sector in Ireland is often cited as a source of potential volatility. An example of this is given by direct investment income outflows.[28] Outflows from Ireland in 2013 were the second highest in the sample of countries for which data existed.

(e) Characteristics of National Statistical Institutes (NSIs): There are a myriad of NSI idiosyncrasies that might be cited as potential explanatory factors for the scale of revisions observed. The adequacy of resources and the quality of surveys, for instance, may be offered as a rationale for difficulties in producing more stable estimates. We explore these in more detail in Annex E, but find little apparent explanatory power for either characteristic. Another consideration is that the QNA data in Ireland are relatively new compared to datasets available from other OECD economies. Thus, there may be inherent uncertainties in the data gathering process in Ireland that have yet to be fully addressed. Relatedly, one might expect that statistical agencies become better through time at measuring economic activity.[29] It may also be the case that certain NSIs are less inclined to revise data and may also consciously smooth releases to prevent unduly large revisions.

Using proxies for each of the above, we attempt to identify whether these issues have some association with the scale of revisions observed. Plotting the various measures against both the RMSR and RMAR statistics for each country in the sample, we find that, for size and openness, the relationship is relatively unsatisfactory. For size, while the relationship appears to be a negative one (revisions increasing as the size of the economy falls), Luxembourg and Ireland appear to exert

[28] Direct investment income inflows and outflows provide a useful proxy for multinational activity as it measures income accruing to an Irish or foreign direct investor from their ownership of a direct investment enterprise located abroad or in Ireland (see CSO for more details).

[29] We were unable to test for this due the absence of clear commencement dates for quarterly national accounts data across the countries studied. This is further complicated by methodological differences, backwards interpolation of data and the non-reporting of past vintages for individual countries.

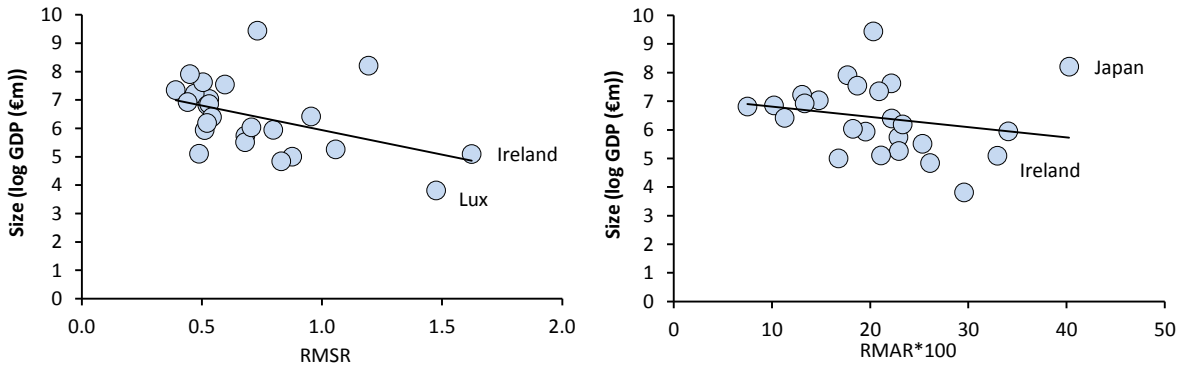
undue influence on any observed correlation (Figure I). Openness reveals similar issues, with Luxembourg and Ireland again pulling the observed relationship upwards (Figure J).

We also checked to see if there was any relationship between the volatility in the economy and the scale of revisions observed as suggested by McCarthy (2004). We proxy for volatility by using the standard deviation of real GDP growth rates. The results in Figure K appear to suggest that more volatile economies are associated with higher RMSR statistics. Plotted against the RMAR statistic, however, the association turns negative and the possibility that outliers may be exerting undue influence on the observed association is again a concern.

Comparing the size of the multinational sector with the size of revisions proves difficult as we do not have concrete measures for this across countries. Instead, we proxy for it by measuring direct investment outflows scaled against nominal GDP. As Figure L shows, the relationship is positive as expected, yet outliers in the form of Luxembourg and Ireland again may drive the observed association. This issue is even more pronounced when we look at Foreign Direct Investment (FDI) inflows as a share of GDP: the association, while ostensibly positive, hinges on several outliers (Figure M).

Finally, we examine whether the diversity and sectoral concentration of merchandise exports might have any potential association with data revisions. The scatter plot in Figure N suggests that countries such as Ireland that have larger concentrations of merchandise exports do tend to exhibit larger revisions to real GDP growth rates. Yet again, we have to caution, however, that these findings are not especially strong, and may be influenced by outliers (such as Norway). Using the diversity of merchandise exports relative to global averages, we note that Ireland's merchandise output is highly diversified relative to the global average (Figure O). For both revisions measures, greater export diversity vis-à-vis global averages would appear to be positively associated with larger growth rate revisions, though the association is relatively weak when using the RMAR statistic.[30]

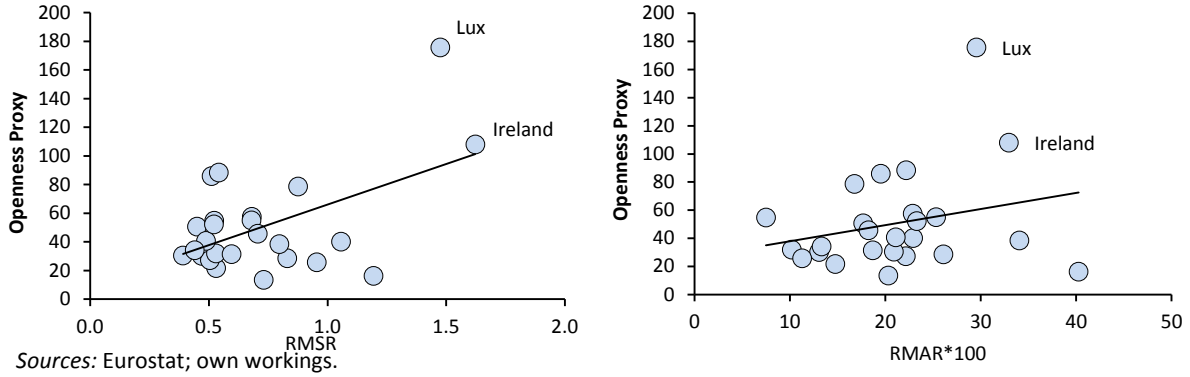
FIGURE I: SIZE OF THE ECONOMY (NOMINAL GDP) AND REVISIONS



Sources: Eurostat; own workings.

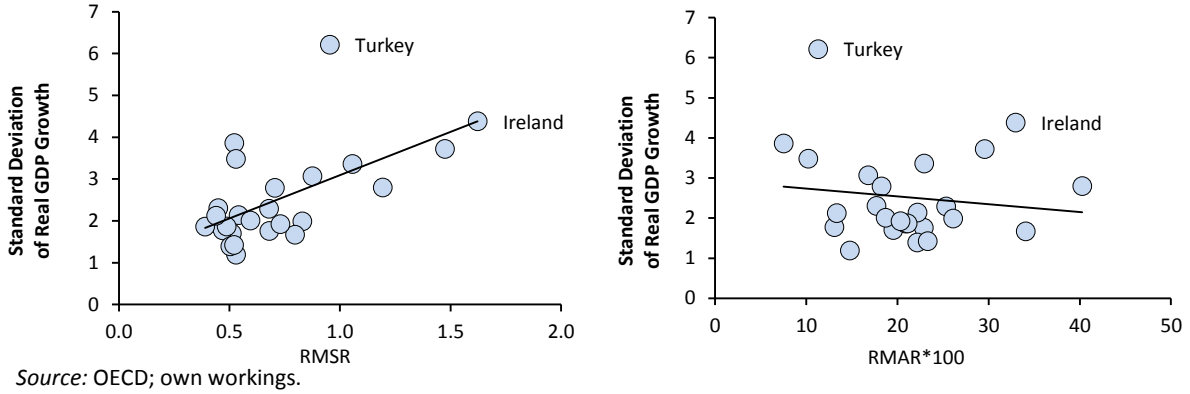
[30] The diversification index signals whether the structure of exports by product of a given country differs from the structure of world production. The index is computed by measuring absolute deviations of individual country shares from the world structure. The index ranges from 0 to 1 indicating the extent of the differences between the structure of trade of the country or country group and the world average. Index values closer to 1 indicate larger differences from the world average (see Finger and Kreinin (1979)).

FIGURE J: OPENNESS OF THE ECONOMY AND REVISIONS



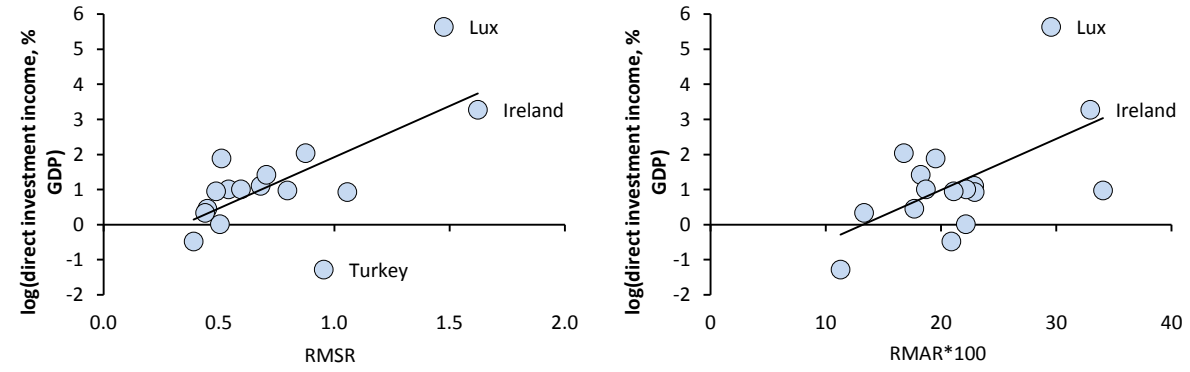
Sources: Eurostat; own workings.
Note: Openness proxy = Exports as % GDP (2013).

FIGURE K: VOLATILITY OF REAL GDP GROWTH AND REVISIONS



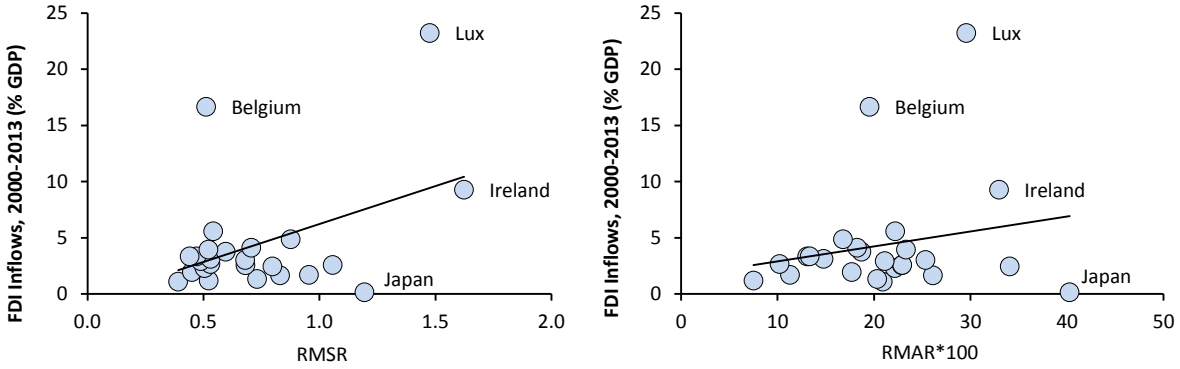
Source: OECD; own workings.
Note: SD of Quarterly Y-Y Growth Rates (1998-2012)

FIGURE L: MULTINATIONAL SECTOR (DIRECT INVESTMENT INCOME OUTFLOWS % GDP) AND REVISIONS



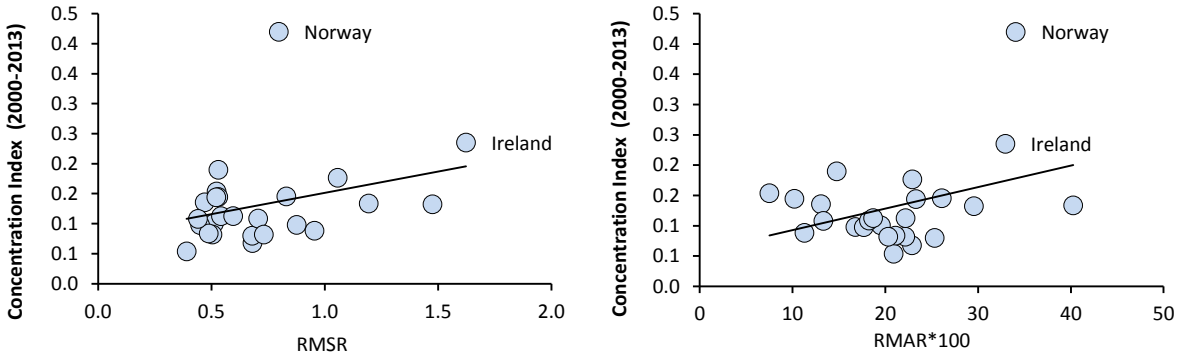
Sources: Eurostat; own workings.

FIGURE M: FDI INFLOWS (% GDP) AND REVISIONS



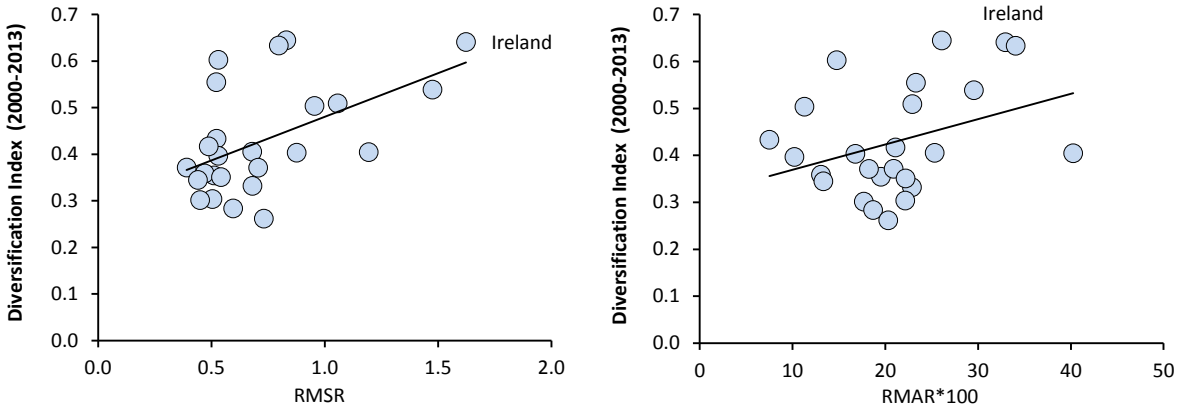
Sources: UNCTADSTAT; own workings.

FIGURE N: SECTORAL MERCHANDISE EXPORT CONCENTRATION INDICES AND REVISIONS



Sources: UNCTADSTAT; own workings.
Note: Normalised Herfindahl-Hirschmann index.

FIGURE O: SECTORAL MERCHANDISE EXPORT DIVERSIFICATION INDICES AND REVISIONS



Sources: UNCTADSTAT; own workings.
Note: The diversification index is a modified Finger-Kreinin (1979) measure of similarity in trade.

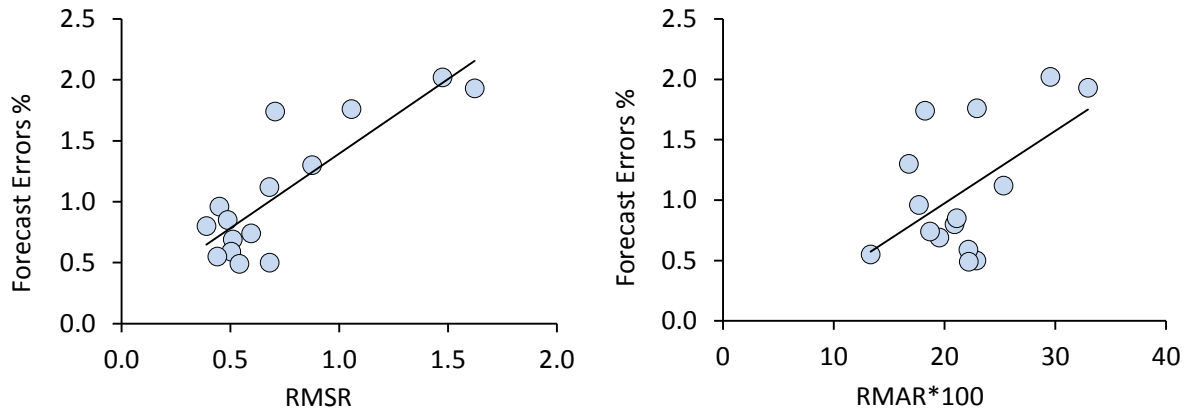
Reflecting on these scatter plots, we note that there does not appear to be an altogether satisfactory single explanation for why Irish data in particular may be so prone to large revisions. The size, openness and volatility of the economy do not appear to represent especially convincing reasons. Issues relating to the structure of the traded sector – the degree of sectoral concentration and specialisation as well as the size of the multinational sector – appear to offer a slightly more compelling basis for the observed scale of revisions. Nonetheless, the possibility that other unobservable factors may be at play cannot be discounted.

SECTION 6: IMPLICATIONS FOR FORECASTING

An obvious problem facing forecasters is the propensity for the latest available data to be revised. Findings by Stark and Croushore (2002) in relation to US forecasts suggest that data revisions may not be just another consideration in forecasting, rather they may be the major source of forecast uncertainty and one which is frequently ignored.[31] They note three potential channels through which forecasts can be impacted by revisions: (1) by changing the data that are inputted into a model; (2) by changing the coefficient estimates of the model; and (3) by changing the structure of a model (for example the number of lags that provide the model's best fit). These factors might explain an apparent consistency between the large revisions we observe in Irish macroeconomic data and the large forecast errors also observed for the Irish economy. González Cabanillas and Terzi (2012) note that root mean squared errors for both European Commission and consensus forecasts of Irish real GDP growth are typically double the euro area average. Moreover, IMF (2013) findings show that macroeconomic forecast errors in Ireland were relatively large in the EU in part due to the volatility in the economy and the scale of data revisions.

Looking at real GDP forecast errors (using the estimates in González Cabanillas and Terzi, 2012) across EU member states relative to their respective data revisions, we note a moderate to strong correlation present over the period 2004 to 2011 (Figure P). [32] This highlights the potential for less accurate forecasting performances in countries where revisions are likely to be relatively high, with the causality likely arising from some blend of those characteristics discussed in Section 5.

FIGURE P: EUROPEAN COMMISSION CURRENT YEAR REAL GDP FORECAST ERRORS AND REVISIONS



Sources: González Cabanillas and Terzi (2012); OECD; and own workings.

From an Irish perspective, the scale of the revisions to the QNA data is likely to pose a particular challenge for forecasters and policymakers alike. As a means of illustrating the problems encountered by forecasters, we take the Department of Finance (2014) forecasts for real GDP growth from Budget 2015. We construct a fan chart around the forecasts based on historic Department of Finance forecast errors to illustrate uncertainty.[33] However, we supplement the

[31] See also (Croushore, 2011).

[32] The Pearson correlation coefficient is 0.84 on the RMSR measure and 0.54 on the RMAR measure.

[33] For a description on fan charts, see the approach outlined by the Irish Fiscal Advisory Council (Fiscal Assessment Report September 2012 and specifically Annex A, IFAC 2012).

forward looking fan chart using the results from the real-time QNA database to retrospectively show uncertainty surrounding revisions to "historic data". The fan chart bands in Figure Q for the historical period indicate the typical scale of revisions applying to historical estimates of Irish real GDP growth.[34] Of particular note is the finding that uncertainty with respect to growth estimates for the preceding year – as embodied by revisions – can be nearly as high as forecasts for the current year.[35, 36]

It is also worth noting that the expected size of revisions for preceding periods changes over the course of the year. [37] Figure Q is based on historical revisions prior to the NIE release, whereas Annex F shows how the typical scale of revisions can narrow for forecasts prepared later in the year.

Depending on where the true estimate of real GDP growth lies on the distribution of possible estimates of outturns one can have, forecasts can start from very different 'jumping-off' points. This variation can potentially result in large errors, particularly if forecast models have particularly large coefficients on the first autoregressive term.

Frankel and Schreger (2012) have highlighted recent evidence of over-optimism in real GDP growth forecasts, which also tends to translate into over-optimism in official budget forecasts. This tendency appears to be especially prevalent during boom periods, but is shown to be counteracted by the adoption of strong national fiscal rules as well as by the presence of independent fiscal institutions that provide their own independent forecasts of the general government balance. Excluding the large forecast errors associated with the financial crisis period, Ireland's official forecasting record does not reveal substantial over-optimism (IMF, 2013). Nonetheless, the large errors reflected in revisions to initial estimates as well as in projections for economic activity for Ireland suggest that wider error margins may be prudently assumed when formulating official budgetary forecasts.

It is important that forecasters, policymakers and the media alike recognise the uncertainty in macroeconomic data releases. Often however, a reliance on a specific number or point forecast is favoured, which may be prone to substantial revision. A more appropriate approach would see short-term forecasts accompanied by ranges that take account of both data revisions and forecast uncertainty as depicted here. There is also scope for future research to examine the implications for forecasters and modellers of using revision-prone data.

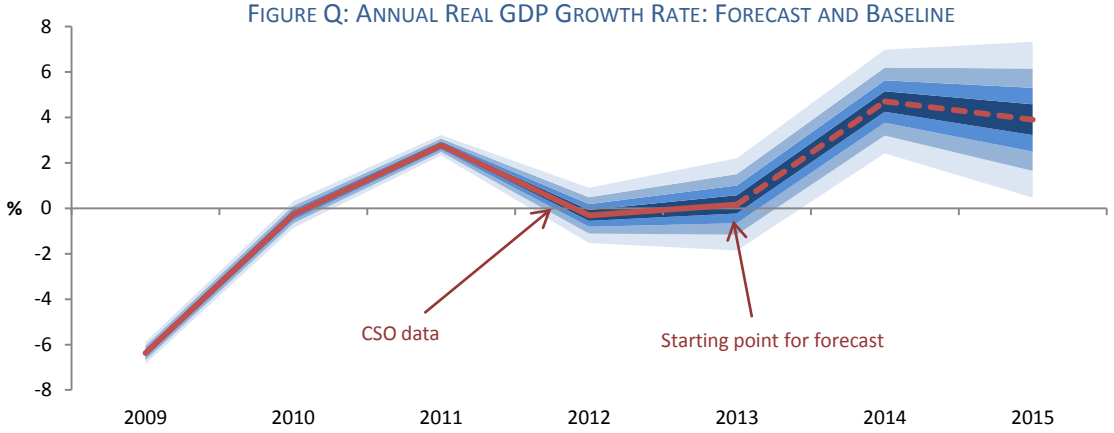
[34] We use the cumulative revisions that can be expected over a five year period in this case.

[35] The red line in the fan chart depicts the real GDP growth rates for 2009 to 2013 as estimated by the CSO. The dotted section depicts the Budget 2015 forecast for growth to 2015.

[36] Revisions for the latest full-year of data are typically large, especially when it comes to the first estimate of real GDP growth (i.e. with the release of the preliminary fourth quarter QNA results). A typical RMSR value of 1.6 for the previous full year of data compares to a RMSE of 1.8 for the current year's forecast. This means that the uncertainty surrounding the current forecast year is little less than that of the previous year for which four quarters of data are available. The RMSR for the previous year narrows substantially to 0.9 after the release of the NIE in the summer of each year.

[37] Even following the NIE release, the RMSR for the previous two years is typically as much as half that for the current forecast year.

FIGURE Q: ANNUAL REAL GDP GROWTH RATE: FORECAST AND BASELINE



Sources: CSO; Department of Finance forecasts as of Budget 2015 and own workings.
* Distributions or 'fans' around historical growth estimates are based on previous revisions to real GDP data. Both forecast errors and revisions are based on 1999-2005 sample. This fan chart is valid for the first (i.e. the Q4 QNA) estimate of the 2013 outturn.

SECTION 7: CONCLUSIONS

This paper assesses the scale, frequency and the potential for bias in Irish quarterly macroeconomic data. Revisions to real GDP and its components are found to be large both in absolute terms and also relative to other OECD economies. This is true even when allowing for cross-country differences in growth rates.

The traded sector appears to be the main source of revisions to headline GDP growth rates in Ireland, though the contributions from domestic demand components are also significant. While there is no evidence of any predictable bias to the initial estimates of real GDP growth, the same cannot be said for some of the components, most notably initial estimates of investment spending. Comparing the pre- and post-crisis periods separately, we note that the pattern of revisions does not change dramatically. Elsewhere, when we examine initial real GDP growth rates that are unusually high or low, we find that these tend to exhibit some evidence of mean-reversion over time.

In terms of reasons behind the large data revisions in Ireland, neither the size, openness or volatility of the economy appear to offer especially convincing reasons on their own. Issues relating to the idiosyncratic structure of the traded sector – the degree of sectoral concentration, export composition, and the preponderance of multinationals – do, however, appear to offer a slightly more compelling basis for the larger relative scale of revisions in Ireland.

From an Irish perspective, the presence of large multinationals, particularly in the Information Technology and Pharma-Chem. sectors, can have disproportionate effects on economy wide aggregates. Related to this, the CSO remains reliant on a number of key surveys such as the Corporation and Self-employed Tax files prepared by the Revenue Commissioners, many of which only become available after considerable lags.

Data revisions pose considerable problems for forecasters particularly as they can influence the starting point from which projections are made. That is not to say that timely – albeit potentially less accurate – estimates are not desirable. Data revisions in the QNA reflect continuous attempts by the CSO to accurately depict underlying activity and users of the datasets would suffer from an absence of timely estimates.

Given that initial estimates are highly influential in framing various economic decisions, the onus is on users of the statistics to better account for uncertainties in the data. In particular, in the event of unexpectedly strong/weak estimates (where doubts surround the link to the underlying dynamics of the economy), it is arguably more appropriate to assume some degree of mean reversion. At a minimum, initial QNA releases should be interpreted with a higher degree of caution given the propensity and magnitude of revisions.

Bibliography

Bermingham, C. (2006). "*An Examination of Data Revisions in the Quarterly National Accounts.*" Central Bank of Ireland, Research Technical Paper, 10/RT/06.

Cabanillas, L.G. and A. Terzi (2012). "The accuracy of the European Commission's forecasts re-examined." European Commission, European Economy Economic Papers, No. 476, December (Brussels: European Commission).

Croushore (2011). "Forecasting with Real-Time Data Vintages." In: Clements, M.P. and D.F. Hendry (eds). "*The Oxford Handbook of Economic Forecasting*." Oxford: Oxford University Press.

Department of Finance (2014). "Budget 2014."

Enright, S. and M. Dalton (2013). "*The Impact of the Patent Cliff on Pharma-Chem Output in Ireland.*" Department of Finance Working Paper Series, 2013.

Finger, J. M. and M. E. Kreinin (1979), "*A measure of 'export similarity' and its possible uses*." Economic Journal, 89: 905-12.

Frankel, Jeffrey A. and Jesse Schreger (2012). *"Over-optimistic Official Forecasts in the Eurozone and Fiscal rules."* NBER Working Paper 18283.

IFAC (2012). "*Fiscal Assessment Report, September.*" Available at: http://www.fiscalcouncil.ie/wp-content/uploads/2012/09/AnnexA4.pdf

IFAC (2013). "*Fiscal Assessment Report, April.*" Available at: http://www.fiscalcouncil.ie/wp-content/uploads/2013/04/1_MacroForecasts1.pdf

International Monetary Fund (2013). "*Ireland: Fiscal Transparency Assessment*." Washington DC: International Monetary Fund.

Jenkinson, G. and N. Stuttard (2004). "*Revisions information in ONS First Releases.*" Office for National Statistics, Economic Trends No. 604, pp 70–72. Available at: http: //www.statistics.gov.uk/CCI/article.asp?ID=793

Lane, P. (1998). "*On the Cyclicality of Irish Fiscal Policy.*" The Economic and Social Review, Vol. 29, No. 1, January, 1998, pp. 1-16.

Mankiw, N.G., D.E. Runkle and M.D. Shapiro (1986). "News or Noise? An Analysis of GNP Revisions." Survey of Current Business, May, 1986, pp. 20-25.

Mauro, P. (ed) (2011). *"Chipping Away at Public Debt – Sources of Failure and Keys to Success in Fiscal Adjustment."* London: J Wiley & Sons, Inc.

McCarthy, C (2004). "*Volatility in Irish Quarterly Macroeconomic Data.*" Article in the Quarterly Economic Commentary, ESRI, Spring 2004.

Mincer, J. and V. Zarnowitz (1969). "The evaluation of economic forecasts." In J. Mincer (Ed.), Economic Forecasts and Expectations.

Newey, W. and K. West (1987). "*A Simple Positive Semidefinite, Hetroscedasticity and Autocorrelation Consistent Covariance Matrix.*" Econometrica, Vol. 55, pp. 703-708.

Quill, P (2008). "*An Analysis of Revisions to Growth Rates in the Irish Quarterly National Accounts*." Special article in Quarterly Economic Commentary, ESRI, Autumn 2008, pp. 44-59.

Robinson, H (2005). "*Revisions to quarterly GDP growth and its production (output), expenditure and income components*." Office for National Statistics, Economic Trends No. 625, pp. 34-49.

Ruane F (1975). "*Statistical analysis of revision to Irish national accounts.*" The Economic and Social Review, Vol. 06, No. 3, 1975.

Stark, T. and D. Croushore (2002). "*Forecasting with a Real-Time Data Set for Macroeconomists*." Journal of Macroeconomics 24 (December): 507−31.

ANNEX A: REVISIONS TO REAL GDP GROWTH AT VARIOUS HORIZONS

In this Annex, we take a closer look at revisions to real growth rates for GDP and its major subcomponents at various intervals using the real time QNA database. We examine the period from 1999 to 2013.

We define:

- 1 Quarter: revision to the growth rate after one quarter.
- 1 Year: revision to the growth rate after a year relative to the first quarter.
- 2 Years: revision to the growth rate after two years relative to the first year.
- 3 Years: revision to the growth rate after three years relative to the second year.
- Final: revision to the growth rate at the end of the sample relative to the third year.

The results are depicted in Figures and Tables A1 to A8. Most of the revisions tend to occur within the first two years of the initial release, although at times there can be very large revisions beyond this period

Figure A1: Revisions to Real GDP

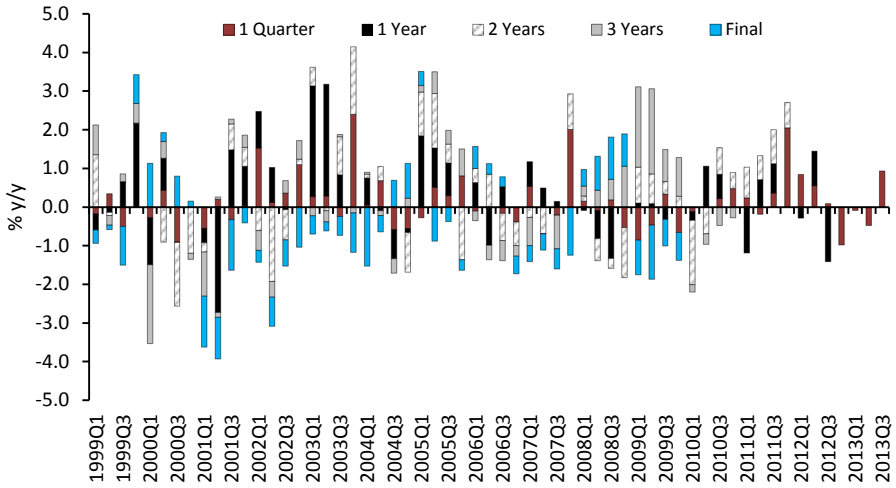


Figure A2: Revisions to Personal Consumption Expenditure

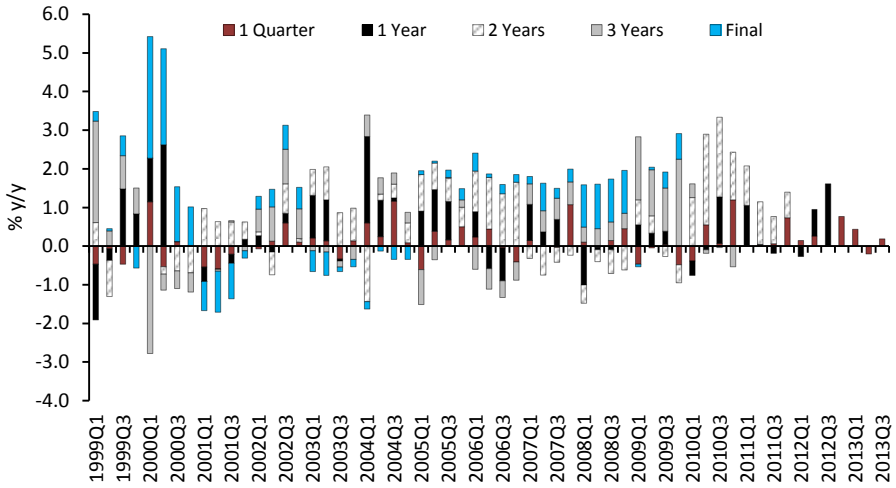


Figure A3: Revisions to Investment

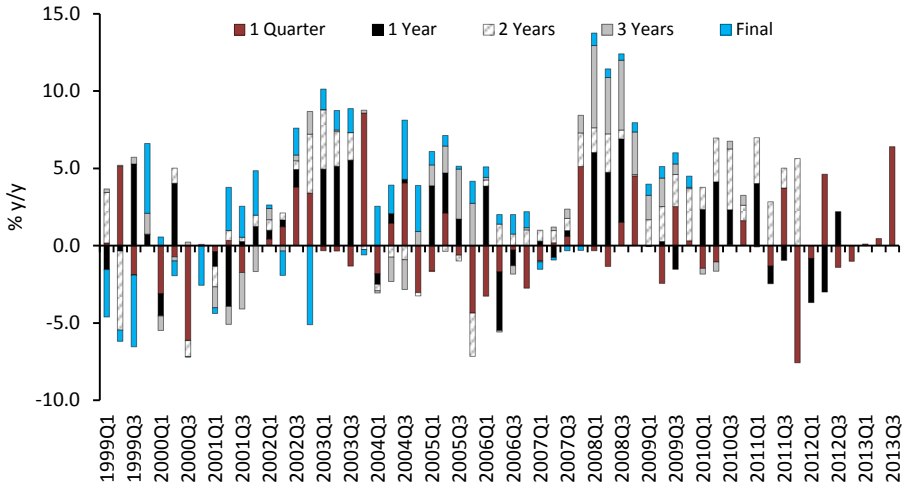


Figure A4: Revisions to Government Consumption

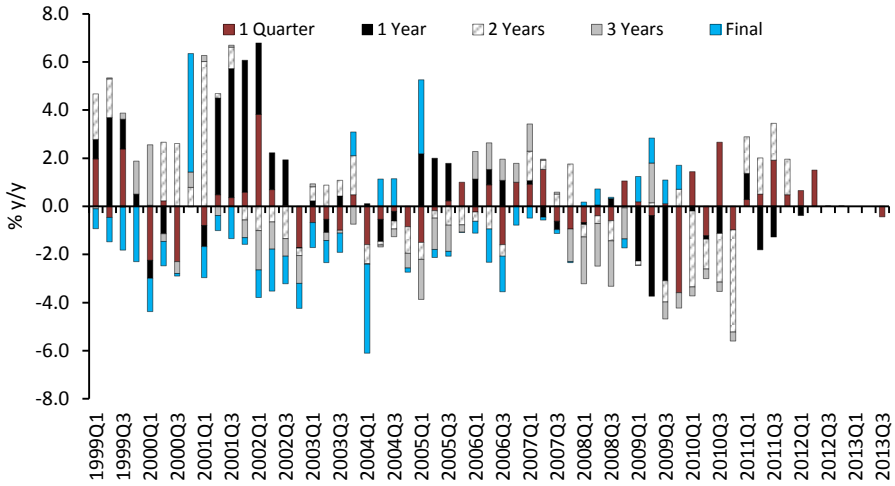


Figure A5: Revisions to Exports

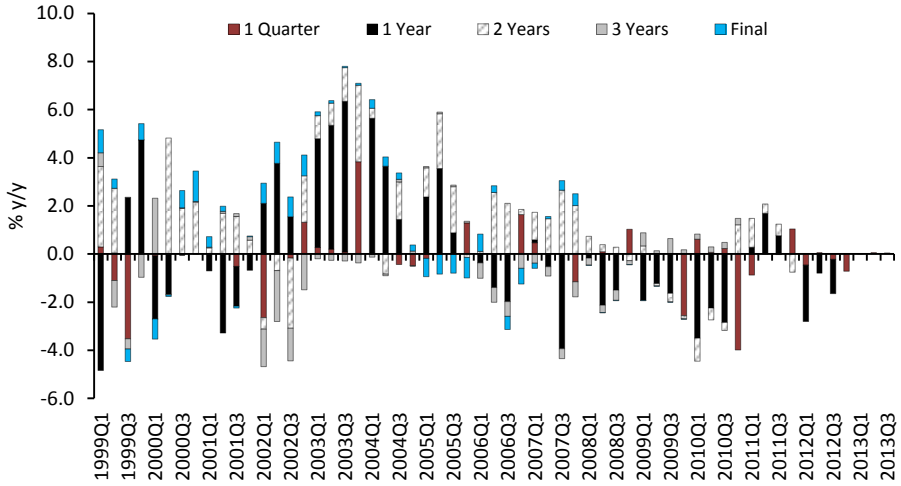


Figure A6: Revisions to Imports

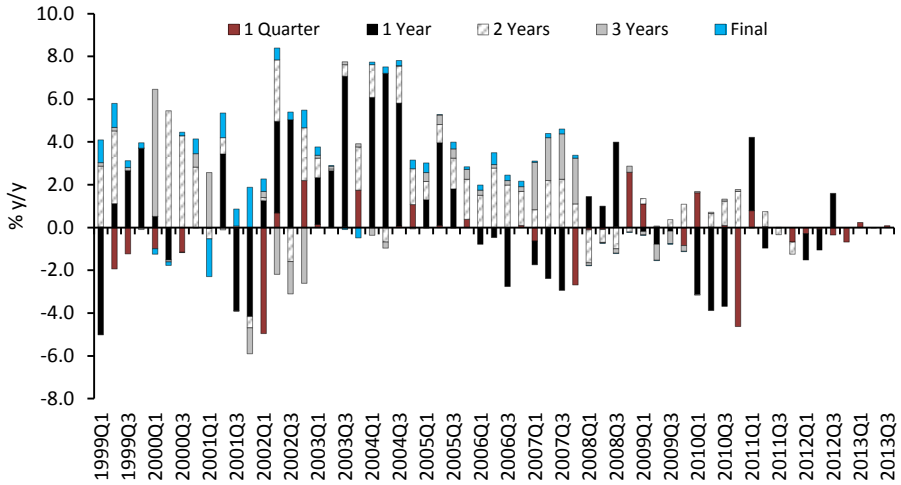


Figure A7: Revisions to Nominal GDP

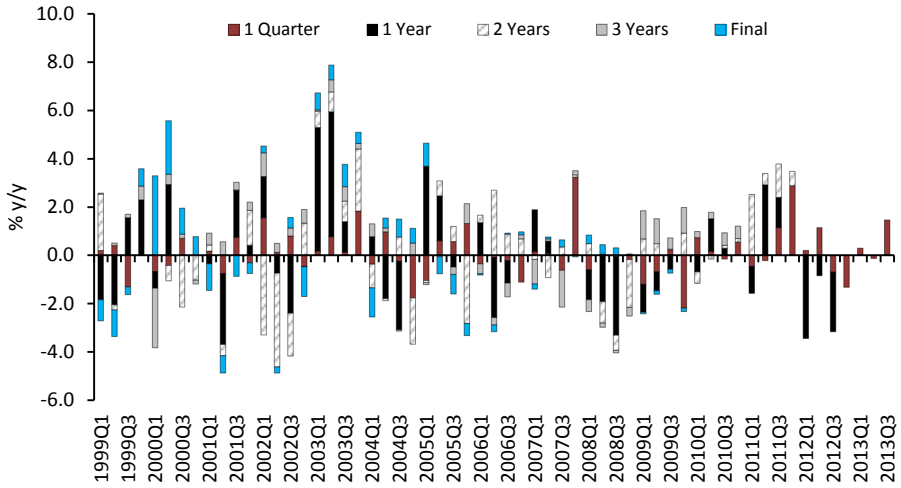
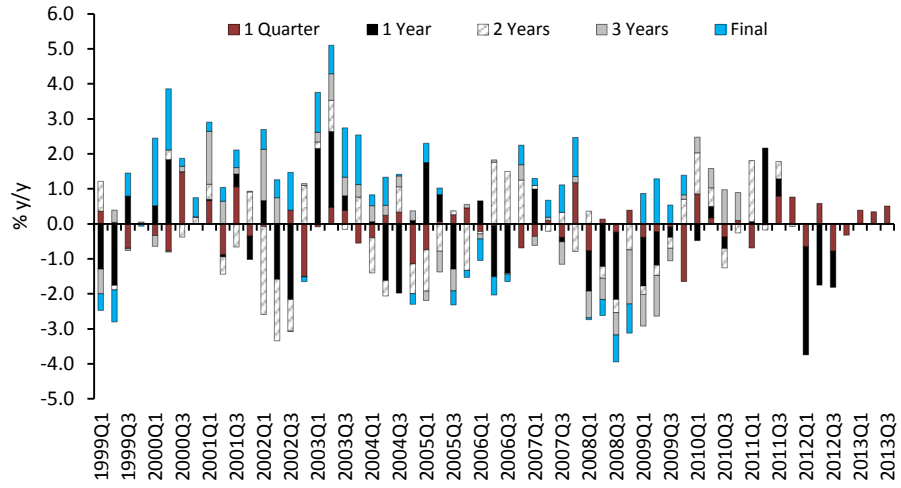


Figure A8: Revisions to the GDP Deflator



Sources: CSO; own workings.

TABLE A1: REAL GDP GROWTH REVISIONS AT VARIOUS HORIZONS, 1999 TO 2013

	1Q	4Q	8Q	12Q	Latest	Latest-Initial
Mean Revision	0.15	0.24	0.03	0.08	-0.24	0.25
Mean Absolute Revision	0.48	0.68	0.67	0.49	0.63	1.29
RMAR	0.10	0.13	0.12	0.09	0.11	0.23
Max Revision	2.4	2.9	1.8	2.2	1.1	3.4
Min Revision	-1.0	-2.7	-1.9	-2.0	-1.5	-3.7
% Positive Revisions	51%	47%	60%	50%	31%	54%
Mean Cumulative Revision	0.48	1.16	1.81	2.28	2.91	0.00
Average Growth Rate	3.3					
Max Growth Rate	13.2	12.7	14.3	14.3	14.8	15.6
Min Growth Rate	-8.5	-9.3	-9.2	-9.3	-8.2	-7.4

TABLE A2: PERSONAL CONSUMPTION GROWTH REVISIONS AT VARIOUS HORIZONS, 1999 TO 2013

	1Q	4Q	8Q	12Q	Latest	Latest-Initial
Mean Revision	0.11	0.31	0.37	0.23	0.28	1.15
Mean Absolute Revision	0.32	0.54	0.71	0.60	0.53	1.28
RMAR	0.07	0.11	0.14	0.12	0.10	0.28
Max Revision	1.2	2.6	2.3	2.6	3.1	4.0
Min Revision	-0.6	-1.4	-1.4	-2.8	-1.1	-1.1
% Positive Revisions	61%	50%	69%	58%	63%	90%
Mean Cumulative Revision	0.32	0.85	1.56	2.17	2.71	0.00
Average Growth Rate	3.3					
Max Growth Rate	10.2	10.7	12.3	12.1	11.7	14.2
Min Growth Rate	-9.1	-9.6	-9.1	-8.4	-6.8	-6.9

.

TABLE A3: INVESTMENT GROWTH REVISIONS AT VARIOUS HORIZONS, 1999 TO 2013

	1Q	4Q	8Q	12Q	Latest	Latest-Initial
Mean Revision	0.12	0.90	0.96	0.54	0.45	2.71
Mean Absolute Revision	2.00	1.79	1.48	1.10	1.31	4.28
RMAR	0.16	0.15	0.13	0.10	0.14	0.32
Max Revision	8.6	6.0	5.6	5.3	4.5	13.4
Min Revision	-7.6	-3.9	-5.1	-2.4	-5.1	-6.9
% Positive Revisions	44%	52%	71%	69%	63%	71%
Mean Cumulative Revision	2.00	3.78	5.19	6.07	7.37	0.00
Average Growth Rate	-0.1					
Max Growth Rate	25.1	23.2	28.4	28.4	28.9	24.2
Min Growth Rate	-35.0	-34.1	-34.1	-32.5	-31.3	-30.6

TABLE A4: GOVERNMENT EXPENDITURE GROWTH REVISIONS AT VARIOUS HORIZONS, 1999 TO 2013

	1Q	4Q	8Q	12Q	Latest	Latest-Initial
Mean Revision	0.02	0.34	0.13	-0.26	-0.28	0.02
Mean Absolute Revision	0.91	1.05	1.06	0.76	0.95	1.86
RMAR	0.22	0.21	0.19	0.14	0.21	0.39
Max Revision	3.8	5.5	6.0	2.5	4.9	6.3
Min Revision	-3.6	-3.3	-4.2	-1.9	-3.7	-6.0
% Positive Revisions	47%	45%	44%	33%	25%	35%
Mean Cumulative Revision	0.91	2.02	3.14	3.89	4.84	0.00
Average Growth Rate	2.1					
Max Growth Rate	9.2	9.9	12.4	13.3	13.4	14.1
Min Growth Rate	-7.0	-7.1	-7.1	-8.3	-8.7	-8.7

TABLE A5: EXPORTS GROWTH REVISIONS AT VARIOUS HORIZONS, 1999 TO 2013

	1Q	4Q	8Q	12Q	Latest	Latest-Initial
Mean Revision	-0.11	0.10	0.84	-0.20	0.12	0.65
Mean Absolute Revision	0.54	1.75	1.16	0.46	0.37	1.99
RMAR	0.08	0.26	0.15	0.06	0.05	0.28
Max Revision	3.8	6.3	4.8	2.3	1.3	7.5
Min Revision	-4.0	-4.8	-2.9	-2.1	-0.8	-3.6
% Positive Revisions	39%	36%	71%	46%	52%	58%
Mean Cumulative Revision	0.54	2.31	3.51	4.10	4.47	0.00
Average Growth Rate	5.7					
Max Growth Rate	22.2	22.2	21.5	21.7	21.7	22.4
Min Growth Rate	-12.8	-12.6	-8.0	-7.1	-7.3	-7.1

TABLE A6: IMPORTS GROWTH REVISIONS AT VARIOUS HORIZONS, 1999 TO 2013

	1Q	4Q	8Q	12Q	Latest	Latest-Initial
Mean Revision	-0.14	0.56	0.99	0.24	0.23	1.65
Mean Absolute Revision	0.59	2.02	1.28	0.68	0.35	2.60
RMAR	0.09	0.30	0.16	0.08	0.04	0.34
Max Revision	2.6	7.2	5.5	5.9	1.9	7.8
Min Revision	-5.0	-5.0	-1.6	-2.6	-1.8	-4.0
% Positive Revisions	44%	39%	77%	63%	65%	73%
Mean Cumulative Revision	0.59	2.64	3.98	4.84	5.19	0.00
Average Growth Rate	4.5					
Max Growth Rate	21.5	21.5	21.5	21.5	23.6	22.5
Min Growth Rate	-13.7	-13.5	-12.0	-11.7	-12.3	-12.3

TABLE A7: NOMINAL GDP GROWTH REVISIONS AT VARIOUS HORIZONS, 1999 TO 2013

	1Q	4Q	8Q	12Q	Latest	Latest-Initial
Mean Revision	0.10	0.02	0.01	0.14	0.10	0.33
Mean Absolute Revision	0.70	1.37	0.95	0.47	0.56	1.87
RMAR	0.09	0.16	0.11	0.05	0.06	0.24
Max Revision	3.2	5.2	2.7	1.2	3.3	7.9
Min Revision	-2.2	-3.4	-3.9	-2.5	-1.2	-4.4
% Positive Revisions	51%	38%	60%	69%	48%	40%
Mean Cumulative Revision	0.70	2.05	2.96	3.36	3.93	0.00
Average Growth Rate	5.3					
Max Growth Rate	17.9	17.9	20.2	20.2	20.8	21.5
Min Growth Rate	-10.4	-12.4	-12.4	-11.5	-10.4	-10.6

TABLE A8: GDP DEFLATOR REVISIONS AT VARIOUS HORIZONS, 1999 TO 2013

	1Q	4Q	8Q	12Q	Latest	Latest-Initial
Mean Revision	-0.05	-0.23	-0.01	0.05	0.32	0.06
Mean Absolute Revision	0.48	0.81	0.64	0.45	0.57	1.38
RMAR	0.16	0.28	0.22	0.14	0.15	0.39
Max Revision	1.5	2.2	1.8	1.5	1.9	5.1
Min Revision	-1.6	-3.1	-2.5	-1.5	-0.9	-3.9
% Positive Revisions	44%	40%	42%	60%	60%	42%
Mean Cumulative Revision	-0.05	-0.23	-0.01	0.05	0.32	0.06
Average Growth Rate	1.9					
Max Growth Rate	7.3	7.2	7.8	6.5	6.8	7.4
Min Growth Rate	-5.4	-7.1	-7.1	-6.4	-6.2	-5.7

Sources: CSO; own workings.

ANNEX B: MODIFIED T-STATISTIC

This approach is identical to that outlined in Jenkinson and Stuttard (2004). Revisions to a series are considered to be biased if mean revisions are statistically different from zero. A modified t-test is used to test the significance of the mean revisions given that successive revisions may not be independent (i.e. serial correlation may exist in the revisions). In such cases, standard t-tests would overstate the significance of the results.

Assuming revisions r_t fit a model of the form:

$$r_t = \mu + \varepsilon_t$$

where μ is the population mean revision (which we will assume is zero and test for as our null hypothesis) for t=1 to n (with no explanatory variable). If the errors are thought to be serially correlated, they follow an autoregressive model of order one, *AR(1)*:

$$\varepsilon_t = \alpha\varepsilon_{t-1} + u_t$$

where the errors u_t are independent and the serial correlation coefficient α is between –1 and 1.

The standard t-statistic is:

$$t = \frac{\bar{r} - \mu}{\sqrt{\sigma^2/n}}$$

where $\bar{r}$ is our sample mean revision, σ^2 is the variance and n is the number of observations.

Priestly (1981) suggests that, where serial correlation exists, the equivalent number of independent observations for estimating the mean should be reduced to:

$$n\,\frac{(1-\alpha)}{(1+\alpha)}$$

so that the variance of the mean should be adjusted by increasing it to:

$$\frac{\sigma^2(1+\alpha)}{n\,(1-\alpha)}$$

Under these circumstances, the modified t-adjusted statistic is:

t-adj = $\frac{\bar{r}}{\sqrt{adjusted\ variance}}$ [using n*degrees of freedom]

with the null hypothesis that the population mean is zero and n*, the equivalent number of independent observations for estimating the variance, is:

$$n\,\frac{(1-\alpha^2)}{(1+\alpha^2)}$$

The calculation follows the steps below:

1. *Calculate the sample mean:*

$$\bar{r} = \frac{\sum_{t=1}^{n} r_t}{n}$$

2. *The coefficient α is estimated by $\hat{a}$ where:*

$$\hat{a} = \frac{Cov(r_{t-1}, r_t)}{\sqrt{Var(r_{t-1})\, Var(r_t)}} = \frac{\sum_{i=2}^{n}(r_{i-1} - \bar{r}_{t-1})\,(r_i - \bar{r}_t)}{\sqrt{\sum_{i=1}^{n-1}(r_i - \bar{r}_{t-1})^2 \;\sum_{i=2}^{n}(r_i - \bar{r}_t)^2}}$$

where:

$\bar{r}_{t-1} = \frac{\sum_{i=1}^{n-1} r_i}{n-1}$ and $\bar{r}_t = \frac{\sum_{i=2}^{n} r_i}{n-1}$

3. *The estimate for the variance of the sample mean is s where:*

$$s^2 = \frac{\sum_{t=1}^{n}(r_t - \bar{r})^2}{n}$$

4. *The estimate of the adjusted sample variance is s* where:*

$$s^{*2} = \frac{s^2(1+\hat{\alpha})}{n(1-\hat{\alpha})}$$

5. *The adjusted degrees of freedom is n* where:*

$$n^* = n\,\frac{(1-\hat{\alpha}^2)}{(1+\hat{\alpha}^2)}$$

6. *Calculate modified t-statistic, t-adj:*

t-adj $= \frac{\bar{r}}{s^*}$ [using n* degrees of freedom]

7. *Calculate the t-adjusted value with the critical t-value:*

Compare the absolute t-adjusted value against the critical t value at 95 per cent significance (2-tailed) and reject the null hypothesis if |t-adj| > t-critical, i.e. if rejected the test statistic is statistically significant.

ANNEX C: DETAILED STANDARD AND MODIFIED T-STATISTIC TEST RESULTS

DETAILED RESULTS, 1999Q1 – 2013Q4

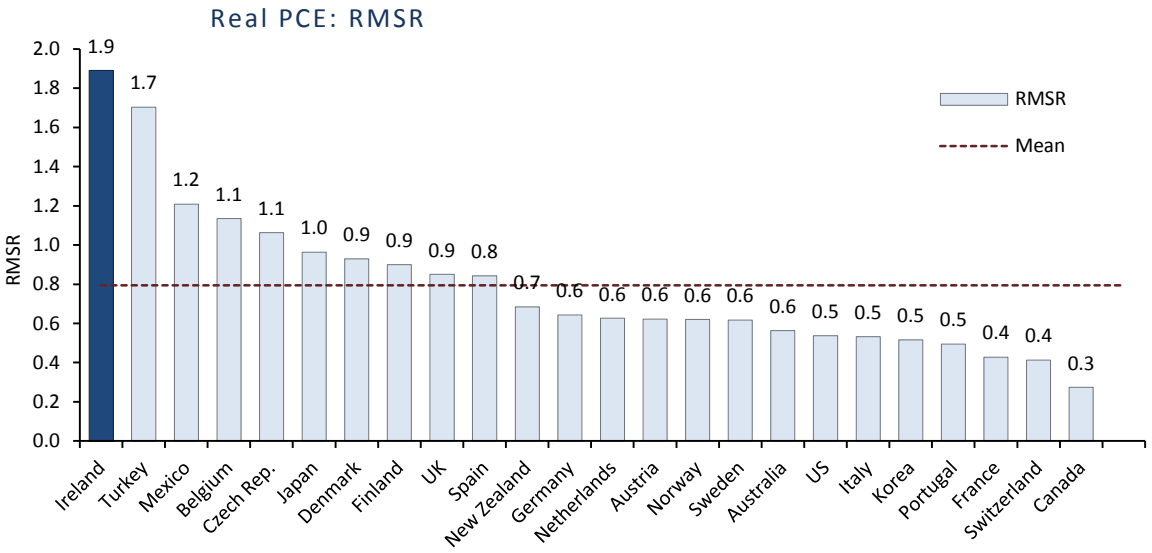
Component	Coefficient on Mean	Standard Error	Stat. Significant? (Standard t-test)	Modified t-stat	t-critical	Stat. Significant? (Modified t-test)
GDP	1	(0.4974)*	Yes	1.4	2.0	No
Consumption	1	(0.1964)***	Yes	2.8	2.0	Yes
Investment	1	(0.2733)***	Yes	2.5	2.0	Yes
Government	1	(0.7299)	No	0.7	2.1	No
Exports	1	(0.4171)*	Yes	1.2	2.1	No
Imports	1	(0.2927)**	Yes	2.1	2.0	Yes
Net Exports	1	(1.8894)	No	0.5	2.0	No
Nominal GDP	1	(1.3276)	No	0.5	2.0	No
GDP Deflator	1	(0.9282)	No	-0.8	2.0	No

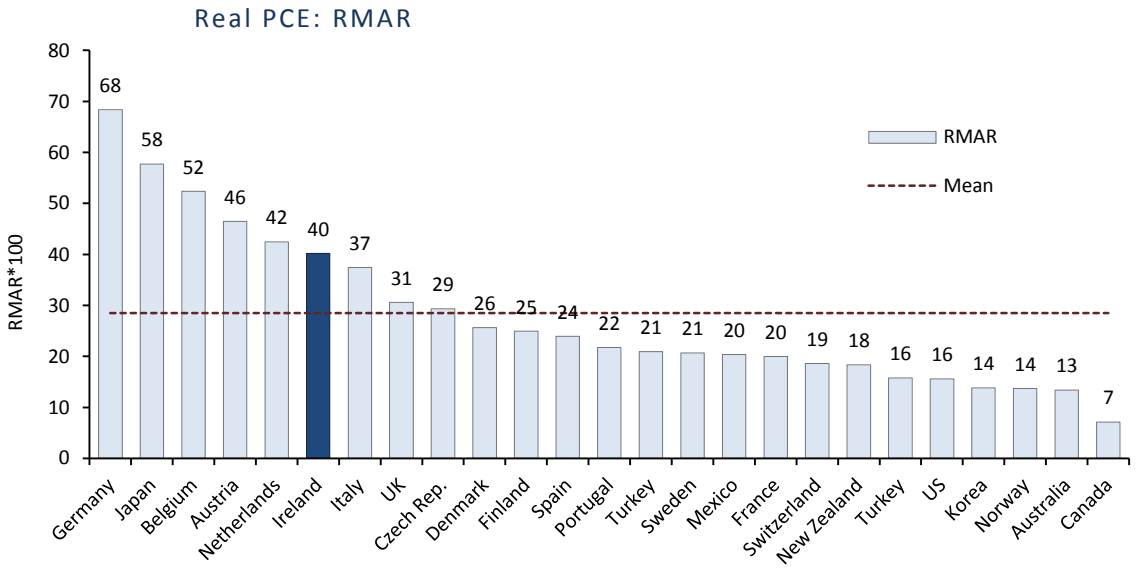
Sources: CSO; own workings.

Notes: Standard errors in parentheses; * p<0.05, ** p<0.01, *** p<0.001.

ANNEX D: INTERNATIONAL DATA REVISIONS, COMPARATIVE RMSR AND RMAR STATISTICS[38]

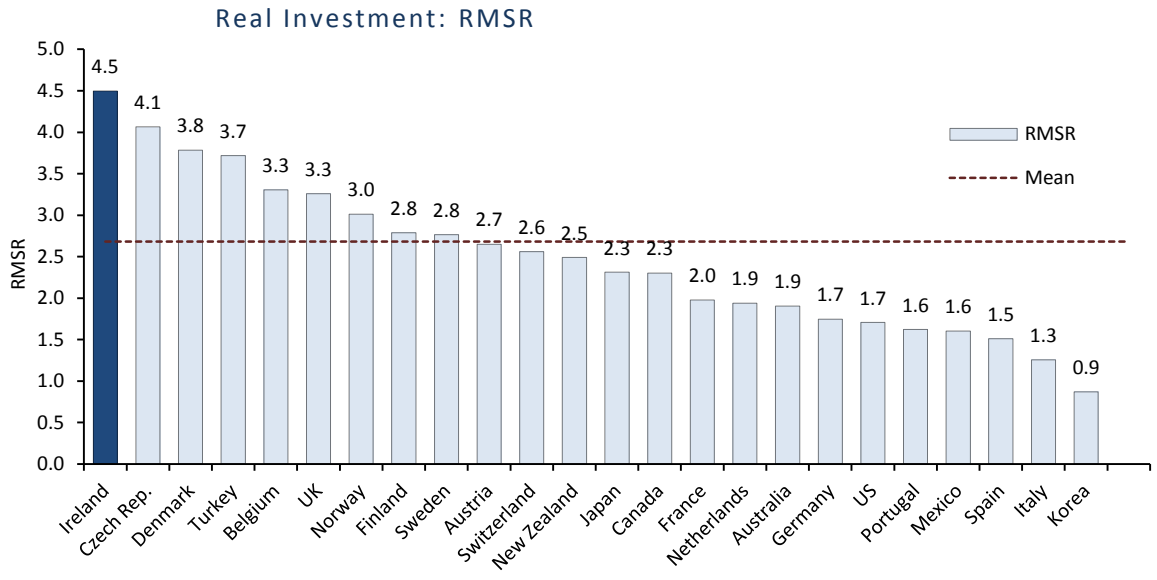
Personal Consumption Expenditure (PCE)

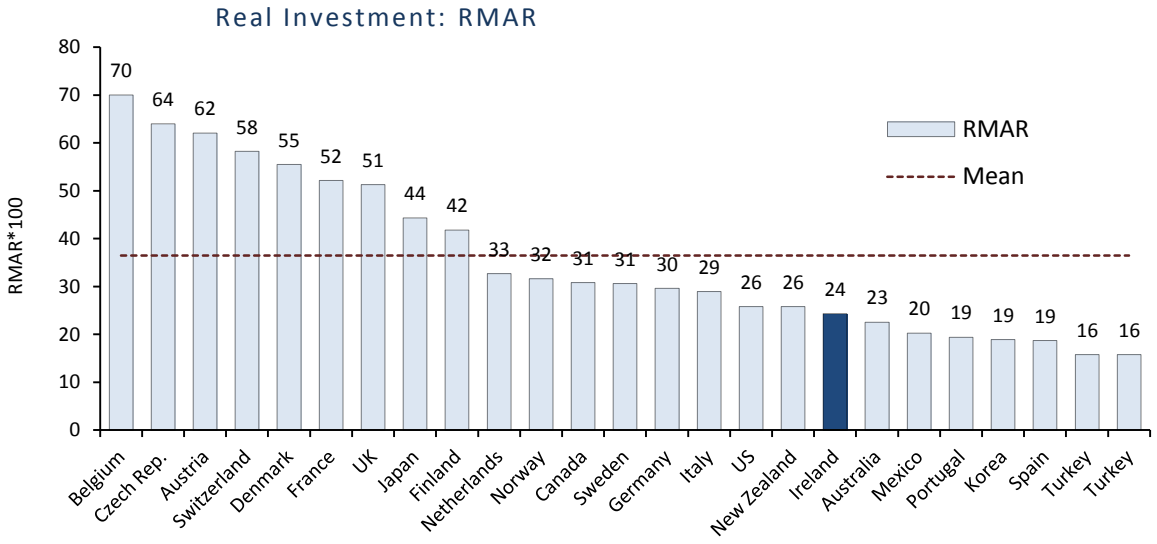




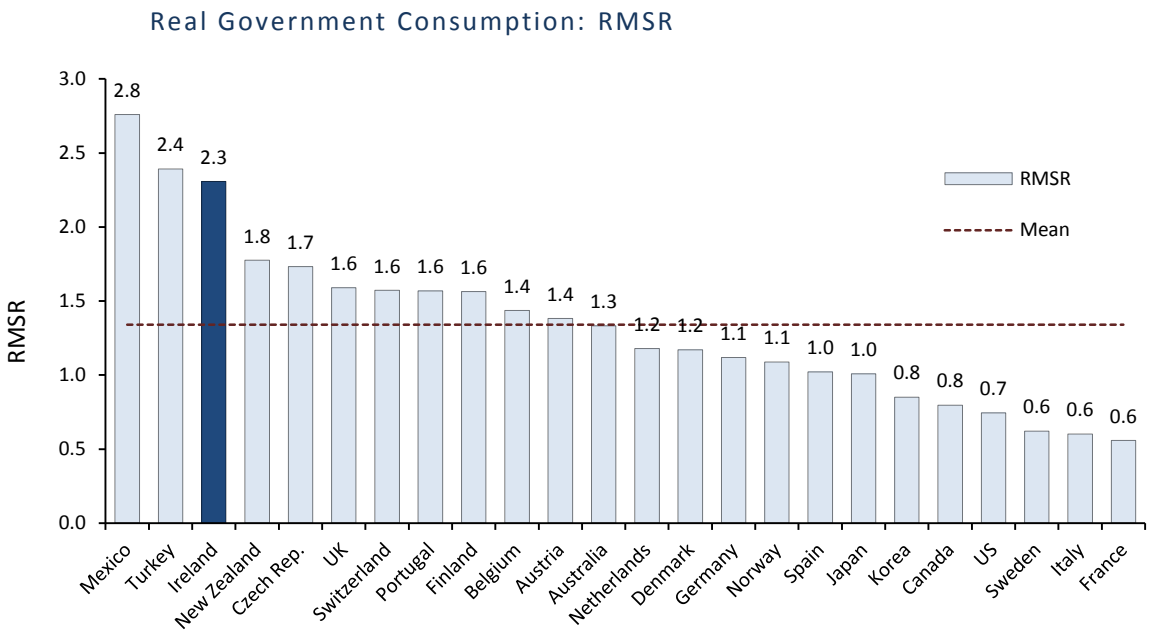
[38] The source here is the OECD real-time database based on our estimates at time intervals of t and t+8.

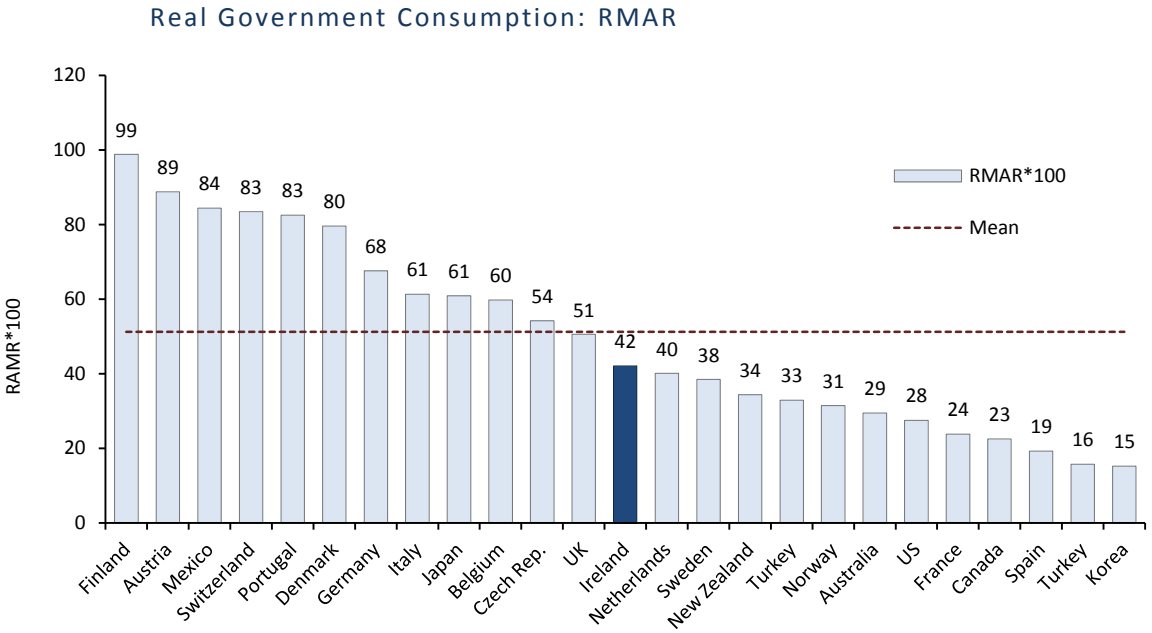
Investment


Real Investment: RMSR
RMSR
Mean
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
4.5
4.1
3.8
3.7
3.3
3.3
3.0
2.8
2.8
2.7
2.6
2.5
2.3
2.3
2.0
1.9
1.9
1.7
1.7
1.6
1.6
1.5
1.3
0.9
Ireland
Czech Rep.
Denmark
Turkey
Belgium
UK
Norway
Finland
Sweden
Austria
Switzerland
New Zealand
Japan
Canada
France
Netherlands
Australia
Germany
US
Portugal
Mexico
Spain
Italy
Korea

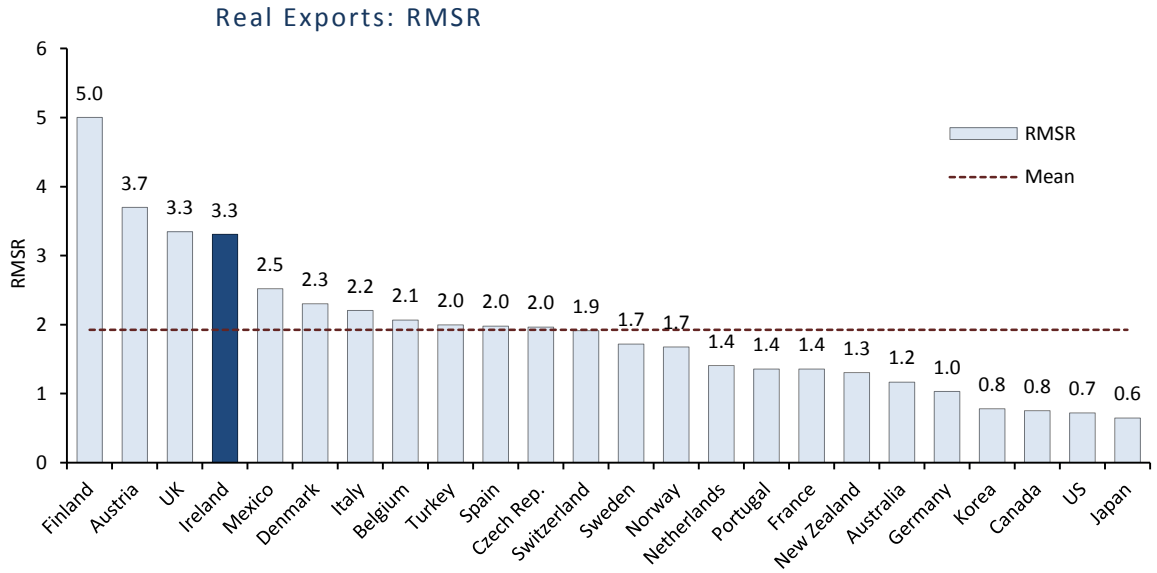

Real Investment: RMAR
RMAR*100
RMAR
Mean
80
70
60
50
40
30
20
10
0
70
64
62
58
55
52
51
44
42
33
32
31
31
30
29
26
26
24
23
20
19
19
19
16
16
Belgium
Czech Rep.
Austria
Switzerland
Denmark
France
UK
Japan
Finland
Netherlands
Norway
Canada
Sweden
Germany
Italy
US
New Zealand
Ireland
Australia
Mexico
Portugal
Korea
Spain
Turkey
Turkey

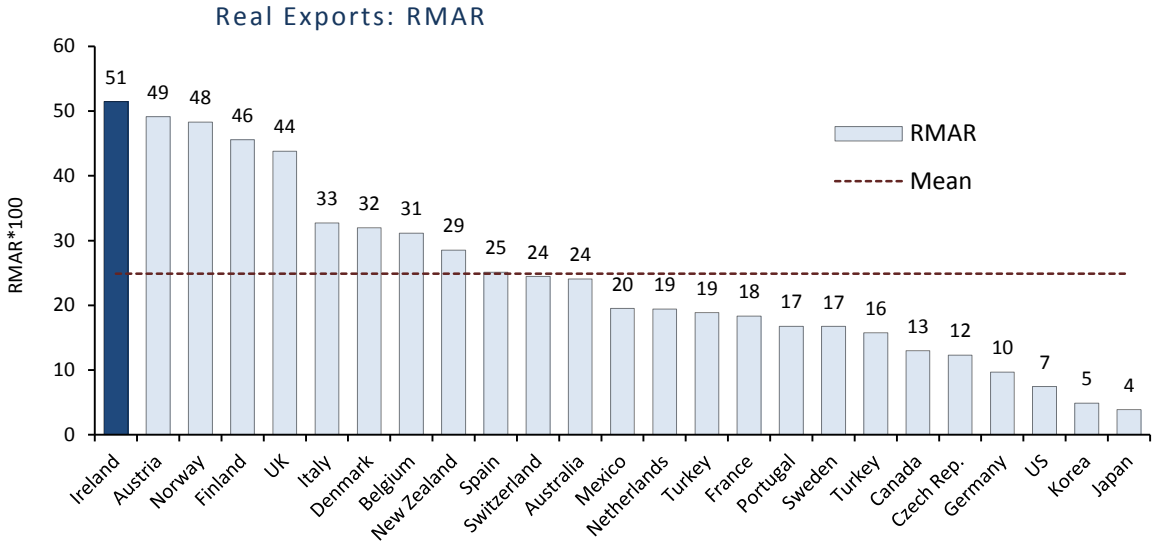
Government Consumption



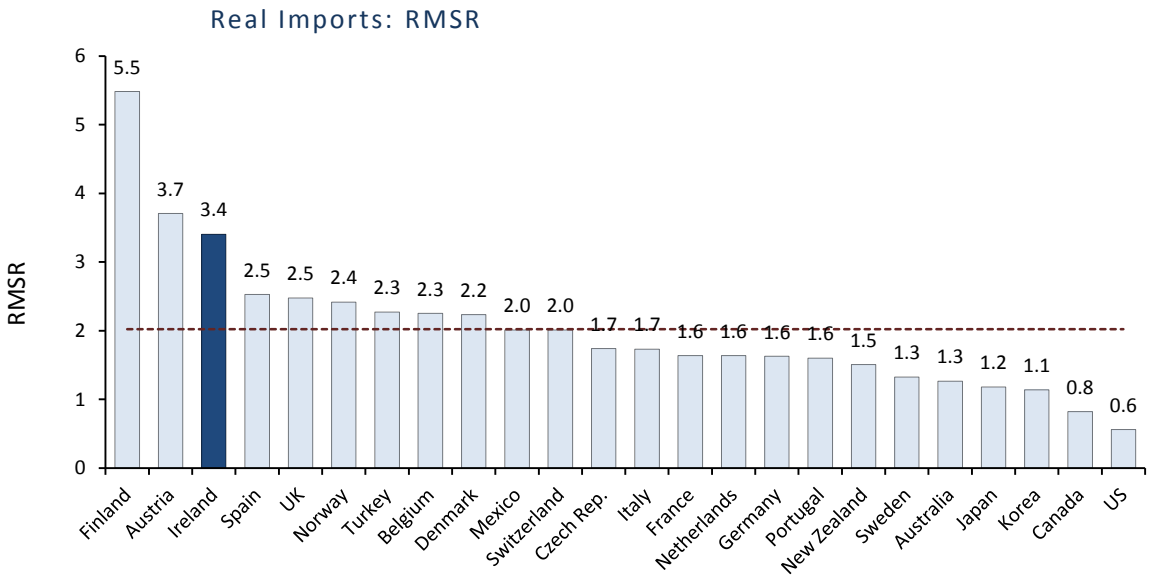


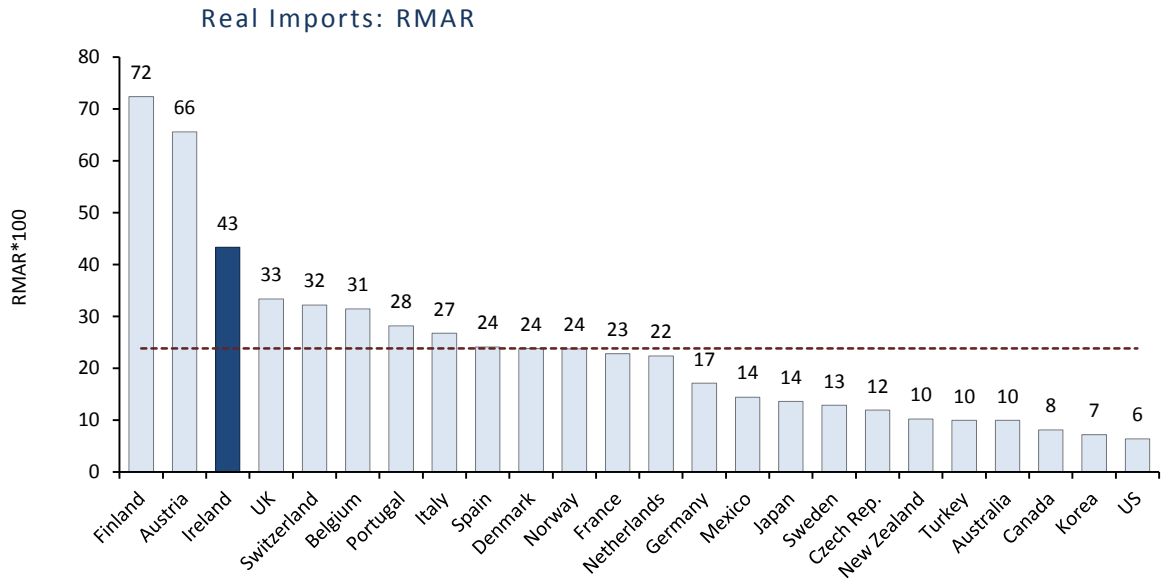
Exports


Real Exports: RMSR
RMSR
Mean
RMSR
0
1
2
3
4
5
6
5.0
3.7
3.3
3.3
2.5
2.3
2.2
2.1
2.0
2.0
2.0
1.9
1.7
1.7
1.4
1.4
1.4
1.3
1.2
1.0
0.8
0.8
0.7
0.6
Finland
Austria
UK
Ireland
Mexico
Denmark
Italy
Belgium
Turkey
Spain
Czech Rep.
Switzerland
Sweden
Norway
Netherlands
Portugal
France
New Zealand
Australia
Germany
Korea
Canada
US
Japan

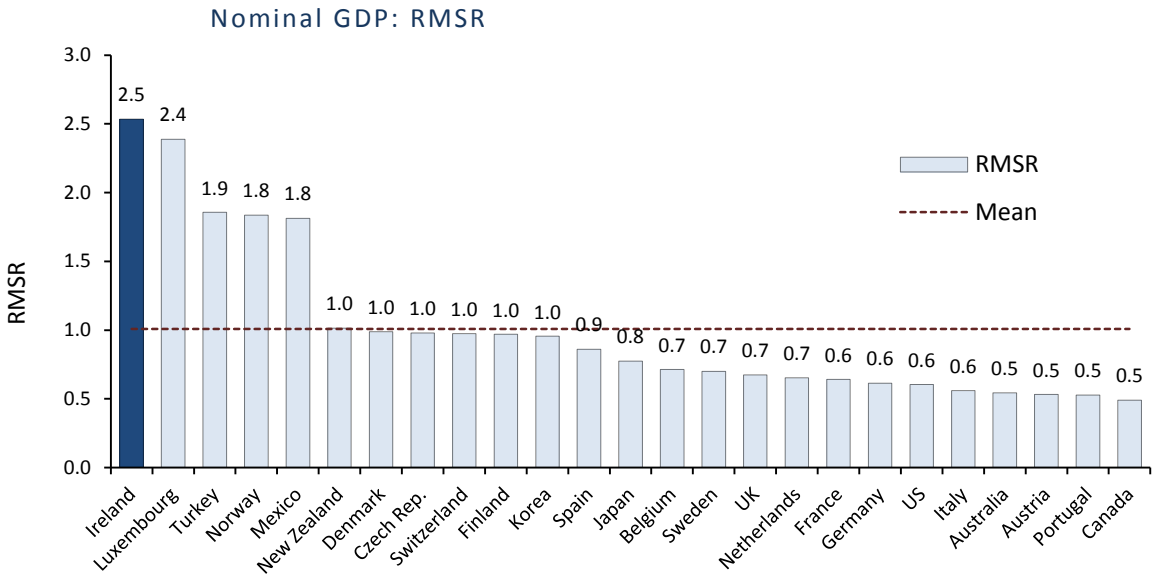

Real Exports: RMAR
RMAR
Mean
RMAR*100
0
10
20
30
40
50
60
51
49
48
46
44
33
32
31
29
25
24
24
20
19
19
18
17
17
16
13
12
10
7
5
4
Ireland
Austria
Norway
Finland
UK
Italy
Denmark
Belgium
New Zealand
Spain
Switzerland
Australia
Mexico
Netherlands
Turkey
France
Portugal
Sweden
Turkey
Canada
Czech Rep.
Germany
US
Korea
Japan

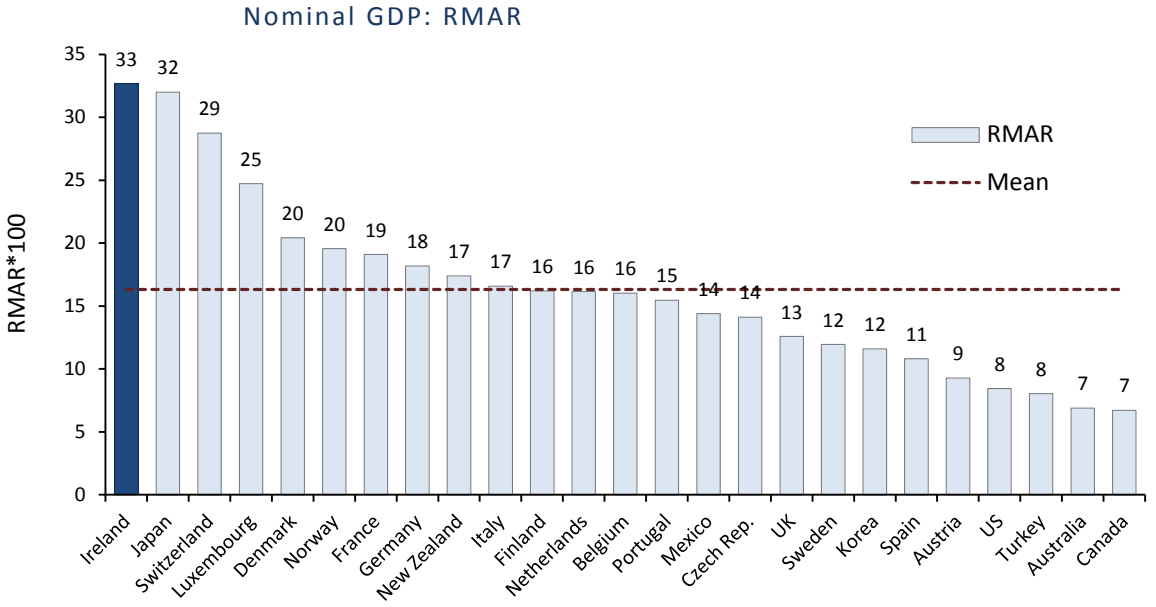
Imports


Real Imports: RMSR
RMSR
6
5
4
3
2
1
0
5.5
3.7
3.4
2.5
2.5
2.4
2.3
2.3
2.2
2.0
2.0
1.7
1.7
1.6
1.6
1.6
1.6
1.5
1.3
1.3
1.2
1.1
0.8
0.6
Finland
Austria
Ireland
Spain
UK
Norway
Turkey
Belgium
Denmark
Mexico
Switzerland
Czech Rep.
Italy
France
Netherlands
Germany
Portugal
New Zealand
Sweden
Australia
Japan
Korea
Canada
US

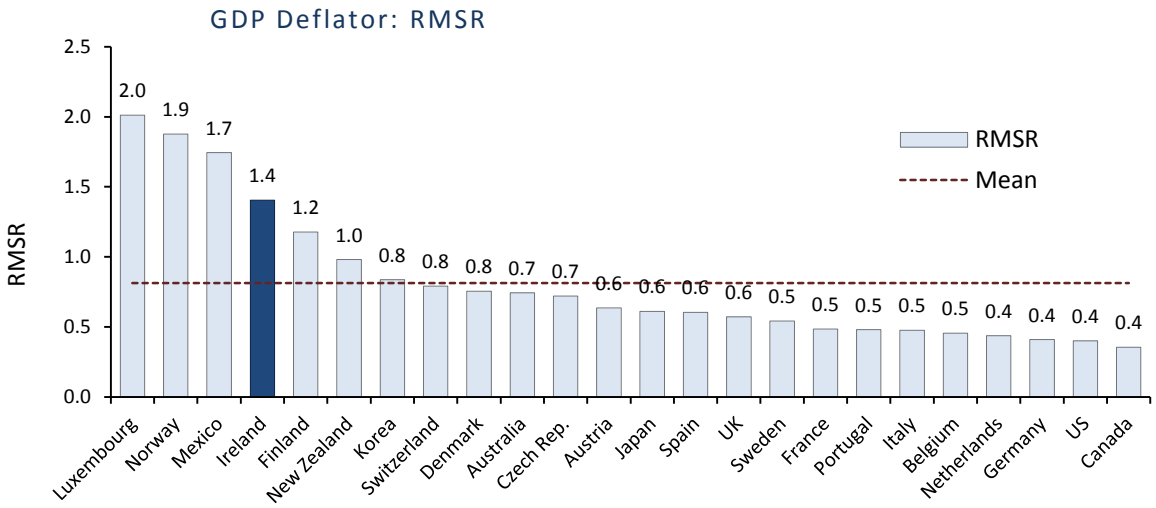

Real Imports: RMAR
RMAR*100
80
70
60
50
40
30
20
10
0
72
66
43
33
32
31
28
27
24
24
24
23
22
17
14
14
13
12
10
10
10
8
7
6
Finland
Austria
Ireland
UK
Switzerland
Belgium
Portugal
Italy
Spain
Denmark
Norway
France
Netherlands
Germany
Mexico
Japan
Sweden
Czech Rep.
New Zealand
Turkey
Australia
Canada
Korea
US

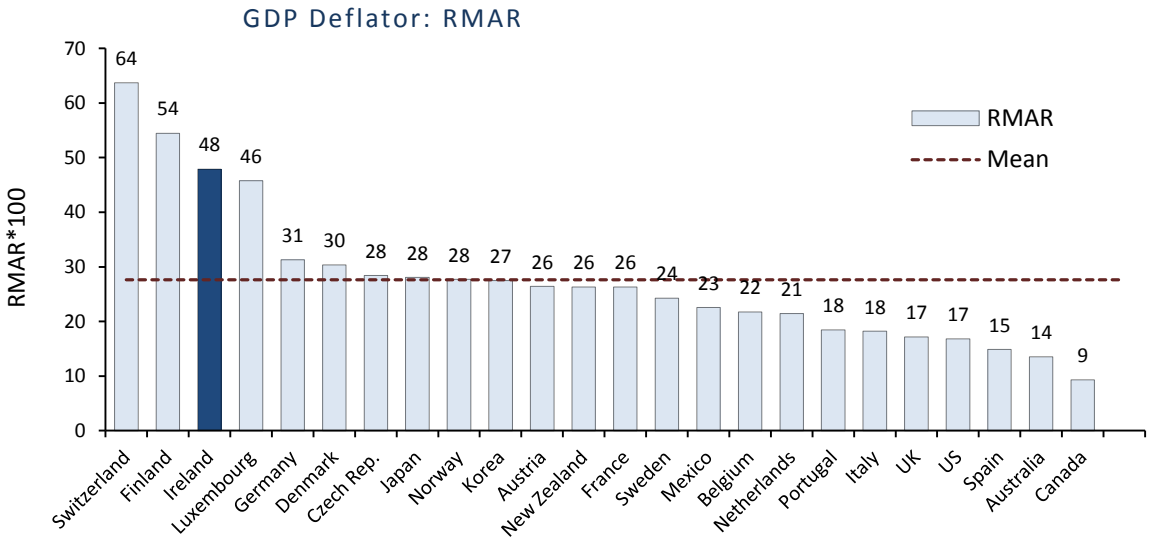
Nominal GDP


Nominal GDP: RMSR
RMSR
RMSR
Mean
3.0
2.5
2.0
1.5
1.0
0.5
0.0
2.5 2.4 1.9 1.8 1.8 1.0 1.0 1.0 1.0 1.0 1.0 0.9 0.8 0.7 0.7 0.7 0.7 0.6 0.6 0.6 0.6 0.5 0.5 0.5 0.5
Ireland
Luxembourg
Turkey
Norway
Mexico
New Zealand
Denmark
Czech Rep.
Switzerland
Finland
Korea
Spain
Japan
Belgium
Sweden
UK
Netherlands
France
Germany
US
Italy
Australia
Austria
Portugal
Canada


Nominal GDP: RMAR
RMAR*100
RMAR
Mean
35
30
25
20
15
10
5
0
33 32 29 25 20 20 19 18 17 17 16 16 16 15 14 14 13 12 12 11 9 8 8 7 7
Ireland
Japan
Switzerland
Luxembourg
Denmark
Norway
France
Germany
New Zealand
Italy
Finland
Netherlands
Belgium
Portugal
Mexico
Czech Rep.
UK
Sweden
Korea
Spain
Austria
US
Turkey
Australia
Canada

GDP Deflator





ANNEX E: NATIONAL STATISTICAL INSTITUTES SELF-ASSESSMENTS AND REVISIONS

The adequacy of resources and the quality of surveys could be offered as a rationale for data sets that are relatively more susceptible to revisions. Comprehensive self-assessments carried out by National Statistical Institutes (NSIs) in Europe and Eurostat on the basis of a common questionnaire give some indication of NSI characteristics, albeit from the NSI's perspective.[39]

Looking across the countries for which results are available, there does not appear to be a clear relationship between data revisions and the either the adequacy of resources or the commitments to quality (Figures E1 and E2). It is common to find instances where NSIs report strongly or poorly on both counts, but for whom revisions do not appear to be a problem. For example, the scale of data revisions in Ireland and Luxembourg are much larger than in Germany, despite their self-assessed quality commitment being virtually identical. In terms of resources, Ireland's statistics office indicated that their resources were being better met than Germany's statistics office, whereas Luxembourg reported that theirs were being only partly met.

The absence of a clear relationship between revisions and the NSI self-assessed results could be due to a number of factors. In particular, country specific macroeconomic characteristics are likely to play a large role irrespective of self-ratings. Also, the fact that these NSI reports are self-assessed means that they may be biased. Finally, it is not altogether clear how comparable the self-assessed results are across countries. The histories, mandates and structures of individual statistics offices are often unique (some produce only partial national accounts statistics for example), while data sources and methods may also exhibit considerable variation.

Figures E1 and E2 are produced on the basis of the self-assessment results for the following questions:

(i) Adequacy of Resources:
- Indicator 3.1: "Staff, financial, and computing resources, adequate both in magnitude and in quality, are available to meet current European Statistics needs."

(ii) Quality commitment:
- Indicator 4.1: "Product quality is regularly monitored according to the ESS quality components."
- Indicator 4.2: "Processes are in place to monitor the quality of the collection, processing and dissemination of statistics."
- Indicator 4.3: "Processes are in place to deal with quality considerations, including trade-offs within quality, and to guide planning for existing and emerging surveys."
- Indicator 4.4: "Quality guidelines are documented and staff are well trained. These guidelines are spelled out in writing and made known to the public."

[39] European National Statistics offices provided self-assessments on the basis of 7 of the 15 principles in the European Statistics Code of Practice, with answers then explored in detail in the peer-review process. These were undertaken in advance of a series of peer-review reports over 2006 -2008 conducted by the European Statistical Governance Advisory Board. The Code of Practice (CoP) outlines principles covering the institutional environment, statistical processes and statistical output. They set out the standards for developing, producing and disseminating European statistics. The indicators developed for each principle provide a reference for reviewing the implementation of the CoP. The peer reviews resulted in reports that are published on the Eurostat website available at: http://ec.europa.eu/eurostat/web/quality/first-round-of-peer-reviews.

- Indicator 4.5: “There is a regular and thorough review of the key statistical outputs using external experts where appropriate.”

Possible responses range from ‘fully met’ to ‘not met’. We assign values of 1-4 for each response as follows: ‘fully met’ = 4 ; ‘largely met’ = 3 ; ‘partly met’ = 2 ; ‘not met’ = 1. For the measure of ‘Adequacy of Resources’, we report the respective values for indicator 3.1, while for quality commitment, we report the unweighted average of all responses to indicators 4.1 to 4.5 for each country.

FIGURE E1: ADEQUACY OF RESOURCES

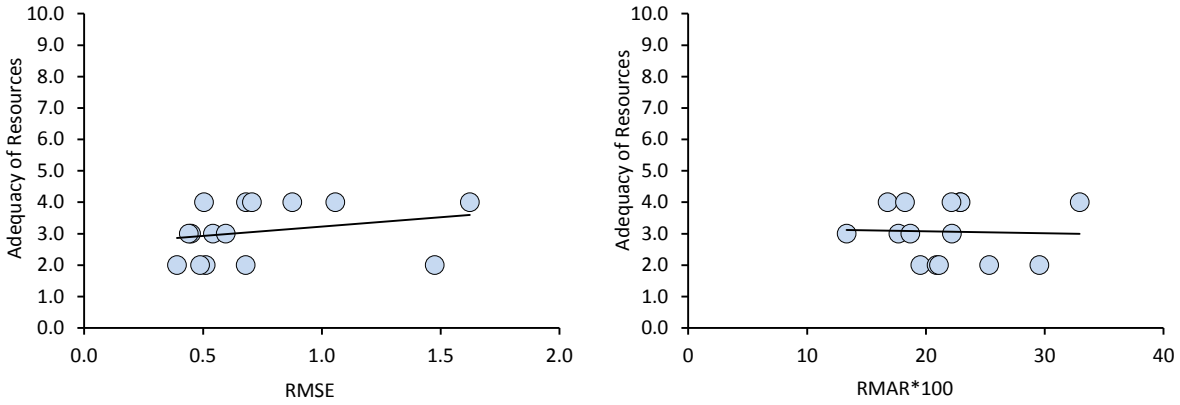
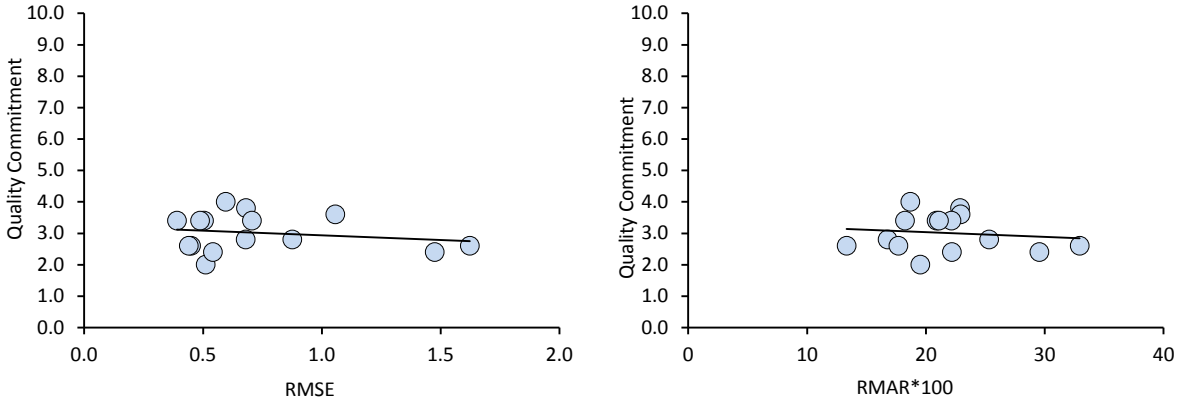
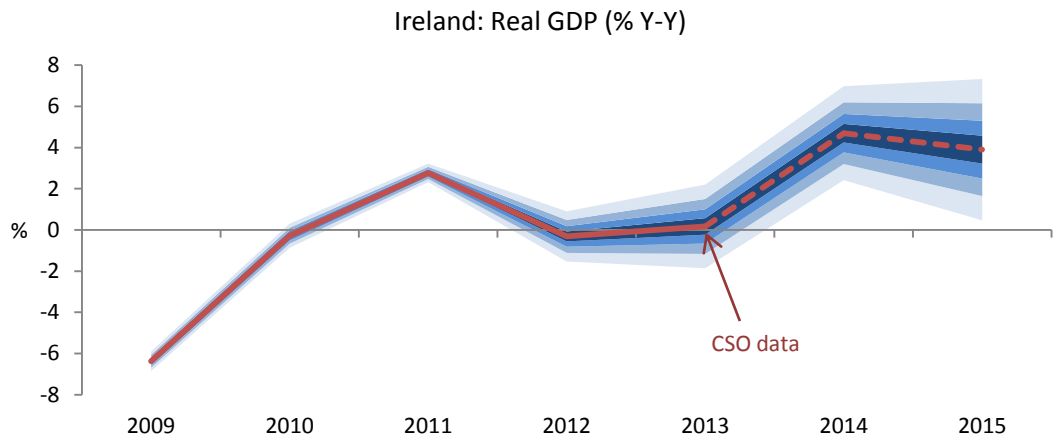


FIGURE E2: QUALITY COMMITMENT

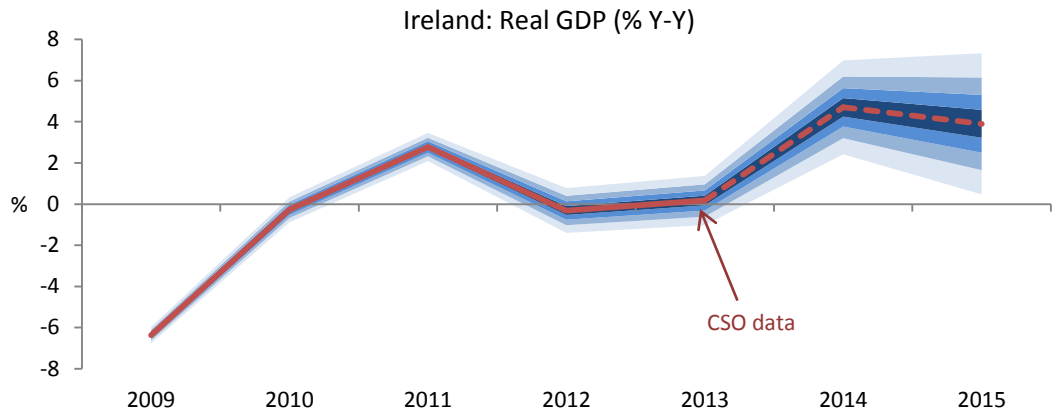


ANNEX F: FAN CHARTS FOR REAL GDP GROWTH BASED ON DIFFERENT PERIODS OF THE YEAR

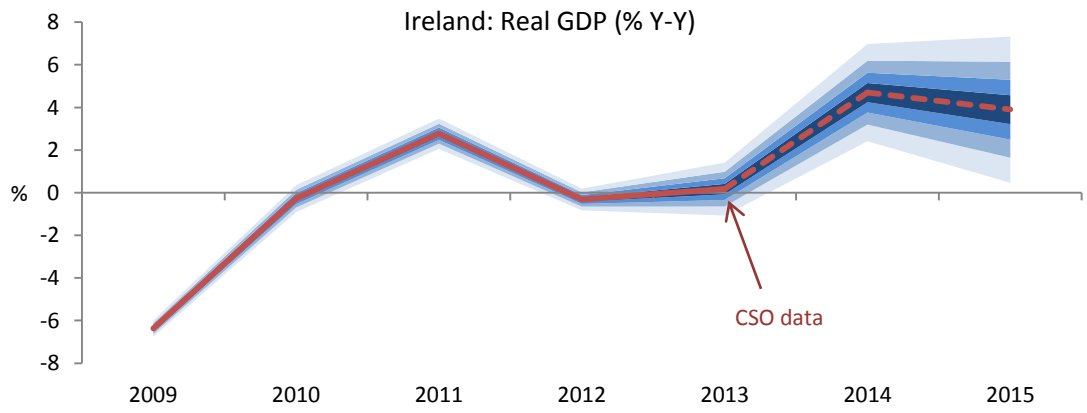
FAN CHART FOR MAR-MAY PERIOD (PRE NIE-DATA RELEASE)



FAN CHART FOR JUN-SEP PERIOD (POST NIE-DATA RELEASE)



FAN CHART FOR SEP-DEC PERIOD



Sources: CSO, Deparment of Finance and own workings.