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OECD Forecasts During and After the Financial Crisis: A Post Mortem

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By Nigel Pain, Christine Lewis, Thai-Thanh Dang, Yosuke Jin and Pete Richardson

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ABSTRACT/RÉSUMÉ

OECD forecasts during and after the financial crisis: a post mortem

This paper assesses the OECD's projections for GDP growth and inflation during the global financial crisis and recovery, focussing on lessons that can be learned. The projections repeatedly over-estimated growth, failing to anticipate the extent of the slowdown and later the weak pace of the recovery – errors made by many other forecasters. At the same time, inflation was stronger than expected on average. Analysis of the growth errors shows that the OECD projections in the crisis years were larger in countries with more international trade openness and greater presence of foreign banks. In the recovery, there is little evidence that an underestimate of the impact of fiscal consolidation contributed significantly to forecast errors. Instead, the repeated conditioning assumption that the euro area crisis would stabilise or ease played an important role, with growth weaker than projected in European countries where bond spreads were higher than had been assumed. But placing these errors in a historical context illustrates that the errors were not without precedent: similar-sized errors were made in the first oil price shock of the 1970s. In response to the challenges encountered in forecasting in recent years and the lessons learnt, the OECD and other international organisations have sought to improve their forecasting techniques and procedures, to improve their ability to monitor near-term developments and to better account for international linkages and financial market developments.

JEL classification: E17, E27, E31, E32, E37, E62, E66, F47, G01

Keywords: Forecasting, economic outlook, economic fluctuations, inflation, fiscal policy

Prévisions de l'OCDE pendant et après la crise financière : Post mortem

Ce document évalue les projections de l'OCDE relatives à la croissance du PIB et à l'inflation durant la crise financière mondiale et lors de la reprise, tout en mettant l'accent sur les leçons qui peuvent être tirées. Les projections ont surestimé la croissance de façon répétée, à défaut d'anticiper l'ampleur du ralentissement puis, plus tard, le faible rythme de la reprise — des erreurs commises par de nombreux autres prévisionnistes. Simultanément, l'inflation a été, en moyenne, plus forte que prévu. L'analyse des erreurs relatives à la croissance montre que les prévisions de l'OCDE durant les années de crise économiques ont été plus importantes dans les pays dotés d'une plus grande ouverture au commerce international et d'une plus grande présence de banques étrangères. Durant la reprise, il y a peu d'évidences qu'une sous-estimation de l'impact de la consolidation budgétaire ait conduit de manière significative aux erreurs. Au lieu de cela, l'hypothèse de conditionnement répétée que la crise de la zone euro devrait se stabiliser ou a joué un rôle important, avec une croissance plus faible que prévu dans les pays européens où les écarts de rendement des obligations étaient plus élevés que ce qui avait été supposé. Mais placer ces erreurs dans un contexte historique montre que les erreurs ne sont pas sans précédent: des erreurs de taille similaire ont été faites lors du premier choc des prix du pétrole dans les années 70. En réponse aux difficultés rencontrées dans les prévisions au cours des dernières années et les leçons apprises, l'OCDE et d'autres organisations internationales ont cherché à améliorer leurs techniques et procédures de prévision, afin d'améliorer leur capacité à surveiller l'évolution à court terme et à mieux appréhender les liens internationaux et l'évolution du marché financier

Classification JEL: E17, E27, E31, E32, E37, E62, E66, F47, G01

Mots-Clés: Prévisions, perspectives économiques, fluctuations économiques, inflation, politique budgétaire

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OECD FORECASTS DURING AND AFTER THE FINANCIAL CRISIS: A POST MORTEM

By Nigel Pain, Christine Lewis, Thai-Thanh Dang, Yosuke Jin and Pete Richardson[1]

1. Introduction and summary

1. This paper assesses the performance of OECD projections for GDP and inflation over the period 2007-12. The focus is on the lessons that can be learned from projection errors and their cross-country differences and the changes to forecasting models and procedures that have occurred since the start of the financial crisis, both inside the OECD and in other international organisations.

2. Forecasting the timing, depth and ramifications of the global financial crisis proved exceptionally difficult. Particular challenges included the identification of imbalances and unsustainabilities entering the crisis, the timing of their unwinding and the likely impact on real activity. These challenges were compounded by the unusually high speed and depth of cross-country interconnections between real and financial developments, the increased variability of economic growth compared with the pre-crisis period, the lack of timely data on many important financial factors and the limited understanding of macro-financial linkages. All these came on top of the normal difficulties experienced when forecasting around major turning points in activity.

3. The main findings from the analysis of the projection errors over 2007-12 and the factors associated with them include the following:

- On average across OECD and the BRIICs economies, calendar year GDP growth was overestimated across 2007-12, with the largest errors occurring in the projections for the vulnerable euro area economies. The largest errors were made at the height of the financial crisis in 2009 but there were also growth disappointments during the recovery.

- The OECD was not alone in finding this period particularly challenging. The profile and magnitude of the errors in the GDP growth projections of other international organisations and consensus forecasts are strikingly similar.

- Growth has typically been weaker than expected and errors higher in countries that are more open to external developments and exposed to shocks from other economies. For example, international trade openness and the presence of foreign banks in the economy are strongly associated with larger errors during the downturn period. This suggests that the projections failed to fully reflect the higher exposure of these economies to interconnected negative global shocks.

- Growth in countries with more regulated product and labour markets has generally proved more difficult to forecast. In part this may reflect insufficient attention paid to the extent to which tighter regulations have delayed the necessary reallocation across sectors in the recovery phase.

- Growth in the recovery has been weaker than expected in countries in which banks had low pre-crisis capital ratios and in countries in which non-performing loans have risen strongly.

1. The authors wish to thank Jørgen Elmeskov, Jean-Luc Schneider, Sveinbjorn Blondal, other colleagues in the OECD Economics Department and Pierre-Alain Pionnier for comments on earlier drafts, Jérôme Brézillon for statistical assistance, and Isabelle Fakih and Maartje Michelson for assistance in preparing the document.

- Stronger projected fiscal consolidation has been associated with growth disappointments, but only in some years and only if Greece is included in the sample considered. The repeated assumption that the euro crisis would dissipate over time, and that sovereign bond yield differentials would narrow, has been a more important source of error. This underlines the conditional nature of OECD projections, which are not intended to be forecasts, but also raises questions about the conditioning assumptions chosen.

- Although recent projection errors were large, they were not unprecedented: the first oil-price shock in the early 1970s also proved to be an equally difficult period for forecasters. Over this longer perspective, the OECD projections for G7 countries have generally been efficient and informative. Allowing for variations in growth volatility over time, the projection errors over 2007-12 are of a broadly similar magnitude to those in the pre-crisis years.

4. During the period 2007-12, inflation was, on average, underestimated despite growth being weaker than projected. Inflation has been underestimated during the recovery, especially in Europe, which may reflect a weaker-than-expected impact of economic slack on wages and prices, or an underestimate of the impact of the post-crisis indirect tax increases in many countries, or that the extent of spare capacity in the economy has been less than thought at the time of the forecasts.

5. In response to the crisis, the OECD and other international organisations have been reviewing and changing their forecast procedures and practices. Key changes include:

- Greater centralisation of the forecast process at an early stage. This ensures that global economic developments and cross-country spillover effects are reflected consistently in the projections for individual economies.

- Enhanced monitoring and statistical modelling of near-term developments. The OECD's existing indicator models for near-term GDP and global trade growth have proved to be a useful source of guidance for some time. Anecdotal evidence from contacts with businesses has also become more important.

- A stronger focus on financial market developments, with financial market indicators increasingly being integrated into projection processes and macroeconomic models.

- Communication efforts have been enhanced to characterise the shape of the risk distribution around the baseline projection, including forecast ranges and the use of fan charts. Greater use is also now made of quantitative scenarios analyses to illustrate the implications of key risks.

6. The structure of this paper is as follows. Section 2 briefly reviews forecasting and risk assessment practices before the onset of the financial crisis and then discusses the properties of the errors made for the 2007-12 period. Section 3 assesses whether OECD projection errors in the 2007-12 period, or the downturn and recovery sub-periods, are systematically linked to pre-crisis conditions, structural conditions, and policy assumptions. Section 4 places the recent errors in a longer-run context to better understand whether they are unusual errors from an unusual period. A discussion of the nature of the projections follows. The final part of the paper takes stock of recent changes in forecasting procedures and practices in the OECD and other international organisations to address the identified weaknesses with earlier forecasting practices, drawing on a series of interviews undertaken in early 2013. Additional detailed results are provided in a series of Appendices. Information on the data set used and the statistical procedures undertaken is summarised in Box 1.

Box 1. Data and definitions

Data

The results in this document make use of data sets for projections made by the OECD for the OECD countries and six non-member countries (the BRIICS: Brazil, Russia, India, Indonesia, China and South Africa), with the main focus on OECD countries. Annual calendar year GDP growth data for 2007-12 are used for all countries except India, where annual growth over the fiscal year (to April) is used. Inflation is calculated as the year-on-year percentage change in the private consumption deflator from the national accounts for better comparability across countries Three different sets of projections are considered:

- May *Economic Outlook* projections for calendar year GDP growth and inflation in the same year.
- May *Economic Outlook* projections for calendar year GDP growth and inflation in the following year.
- November *Economic Outlook* projections for calendar year GDP growth and inflation in the following year.

For both GDP growth and inflation, the projection error is defined as the outturn less the projection. The outturn data for GDP growth and inflation in any given year are taken from the May *Economic Outlook* in the year immediately after. An issue for all evaluations of forecasting performance is the appropriate vintage of data to use, since the initial outturn estimates may not be especially reliable, particularly at times of rapid changes in the economy (Shrestha and Marini, 2013). But use of the latest vintages of data can result in the calculated forecast errors being misleading, since they can also contain changes to national accounting procedures and concepts that were not known about at the time of the projection. This paper follows standard practice in using early realisations of the outcome.

To enable longer-run comparisons, OECD growth projections for the G7 countries from 1971 are also used. For some countries, these include GNP growth projections, rather than GDP growth, over the first part of the sample period.

Use is also made of a short-run and longer-run dataset of other forecasters' projections for GDP growth in the G7 countries. The short dataset, covering 2007-12, includes projections published by the IMF, European Commission and Consensus Economics, where the latter is the average of private-sector economists' forecasts for each country. The longer-run dataset for the G7 countries, covering 1991-2012, also includes consensus forecasts from 1991 onwards.

Key metrics

The paper uses three key measures of the size of the errors:

- The **average error** for each country, which is the average projection error (defined as above) over a given period. The means for various country groups are based on unweighted means across countries and time.
- The **average absolute error**, defined as the average of the *absolute value* of individual country errors over the time period shown. For country groups, this is calculated as the unweighted mean of absolute errors across countries and time. For greater comparability across countries and time, the average absolute error is also scaled by the corresponding average absolute growth rates. The ratio of country groups is calculated as the unweighted mean ratio across countries.
- The **root mean squared error (RMSE)**, which is calculated by squaring individual country errors, then averaging these over the time period shown and taking the square root of the result. For country groups, this is the square root of the average of country squared errors, where the average is calculated across countries and time. To improve comparability, the RMSE is also scaled by the average volatility of growth (i.e. standard deviations) for a country or time period. The ratio of country groups is calculated as the unweighted mean across countries.

Forecast evaluation tests

- **Unbiasedness**: tested by a pooled regression of country projection errors on a constant. Unbiasedness requires that α=0 in:

$$Error_{it} = \alpha + \varepsilon_{it}$$

Box 1. Data and definitions (*Cont.*)

- Information content: tested by a pooled regression. Informative projections have positive β in:

$$Outcome_{it} = \alpha + \beta Forecast_{it} + \varepsilon_{it}$$

  The information content is also tested relative to two alternative forecasts: a naïve forecast of the previous year's growth rate; and the consensus forecasts.

- **Efficiency:** this can be measured in several ways, with different degrees of strength. A basic requirement is simply that the RMSE is smaller at each forecast horizon. A slightly stronger definition is that the error should not be predictable and the projections should be informative – 'weak efficiency' – which requires that *both* α=0 and β=1 in the second regression above. A third, stronger form of efficiency is that projections embody all information available to the forecasters at the time, in which case the projection errors should be uncorrelated with informative data series.

- **Directional accuracy**: this measures whether the projections were qualitatively accurate, in the sense of accurately projecting rising or declining growth rates in the forecast period.

2. Forecasting before and during the crisis

2.1 Forecasting and risk assessment practices before the onset of the financial crisis

7. The pre-crisis period was one of relative economic stability. OECD projections in this period appeared to perform relatively well (Vogel, 2007), with only limited revisions to GDP growth projections typically observed as the forecast horizon narrowed, even for 2007 (Figure 1). However, changes in the global economy and financial system in the early to mid-2000s contributed to the subsequent difficulties of forecasting once the crisis began. This period was one of increasing globalisation and integration of real and financial activity, raising the potential for cross-border and cross-market transmission of economic and financial shocks. Foreign-owned banks became more important in domestic banking markets and in many economies bank funding relied increasingly on international markets. Financial leverage and risk-taking expanded rapidly in a low interest rate environment, reflected in strong asset price and credit growth. External imbalances also built up to what were widely viewed as unsustainable levels.

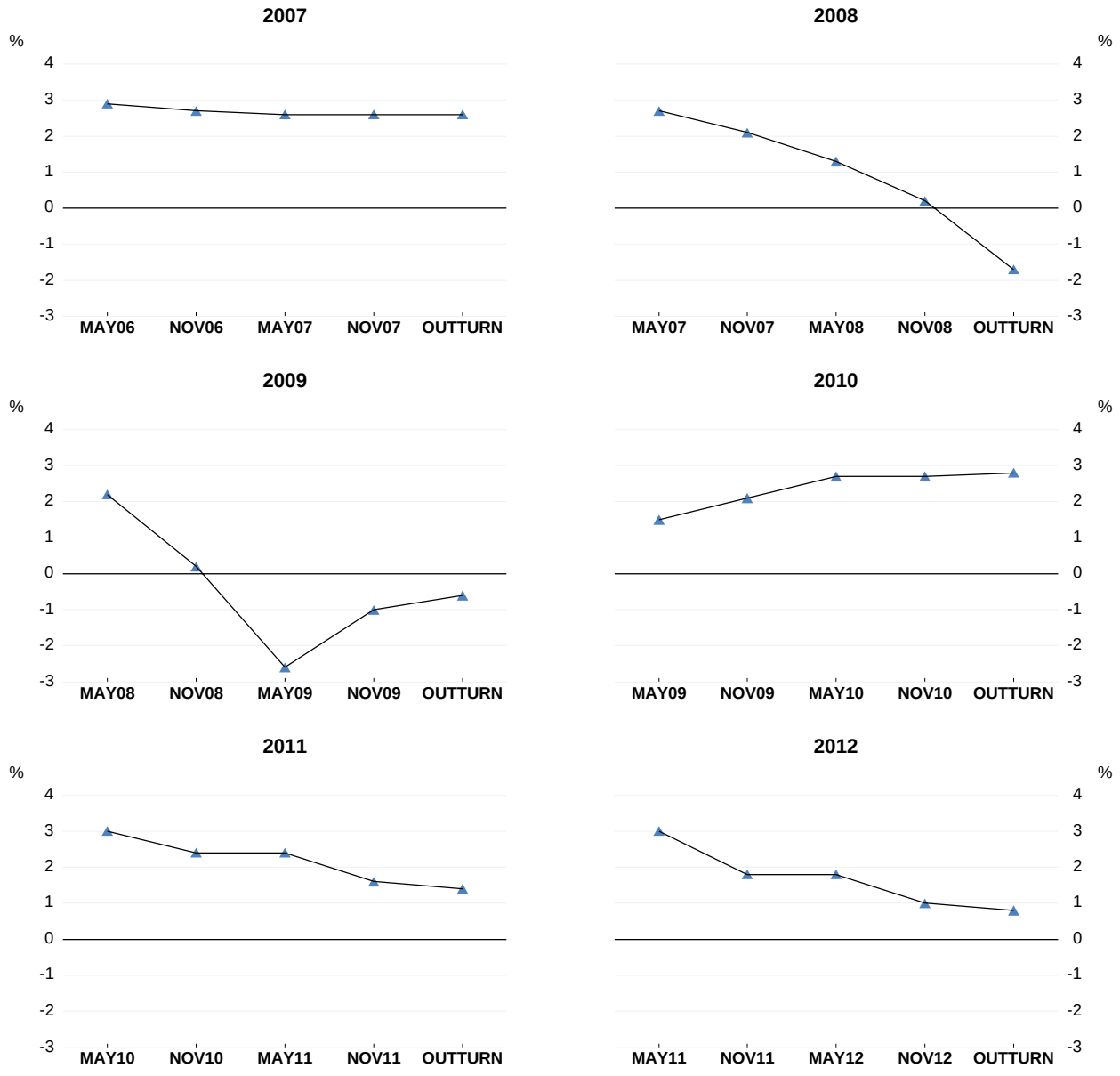
8. Limited weight was given to the possible impact of excessive risk-taking in the projections made before the crisis, not least because the extent of risk-taking was often hidden in off-balance-sheet activities or masked by derivative positions. That said, frequent risk analysis was done of the extent of over-valuation of housing markets and the activity implications stemming from developments such as the run-up and subsequent correction in US house prices.[2] However, only a handful of financial variables were integrated fully into the forecast process and the background models used; typically, account was taken only of policy interest rate and asset price effects on activity.[3] Certain structural policy settings, notably less stringent product and labour market regulations, were believed to enhance the resilience of economies by improving the flexibility to bounce back relatively quickly from downturns, conditional on the assumption that financial markets and the monetary transmission mechanism functioned in a normal manner (Duval et al., 2007; Duval and Vogel, 2008). In this context, increases in financial depth were seen as being beneficial to both long-term growth and cyclical resilience.

2. See for example: OECD (2005, 2006), van den Noord (2006), Dieter et al. (2009) and Shigehara and Atkinson (2012).

3. Empirical analysis and macro-model simulations of an increasingly globalised financial system did, however, highlight the resulting potential for shocks in one economy to spill over to others to an ever greater extent (Hervé et al., 2007).

Figure 1. The evolution of year-on-year projections for OECD GDP growth

Q4-on-Q4 percentage change in GDP at each forecast date shown



Note: Outturn is defined as the published figure at May the following year.

Source: OECD Economic Outlook databases; and OECD calculations.

2.2 Forecast performance during the financial crisis and its aftermath: GDP growth

9. As the crisis intensified, it spread across countries rapidly, in a manner well beyond that suggested by the linkages built into standard forecasting and simulation models (Bini Smaghi, 2010). Global trade collapsed in late 2008 and the early part of 2009, and private sector sentiment fell sharply worldwide. The cumulative errors in the May 2008 projections for GDP growth in 2008 and 2009 were large. Forecasts were revised down consistently and very rapidly when the sub-prime crisis erupted and Lehman Brothers subsequently failed, with growth outturns in 2009 nonetheless still proving substantially weaker than had been projected (Figure 2).[4] The onset of the euro area crisis in 2010, with the re-pricing of sovereign debt and banking sector risks, subsequently contributed to a further period of growth disappointments, particularly in Europe.

10. Thus, on average across countries, calendar year GDP growth was overestimated across 2007-12 (Table 1).[5] As might be expected, given the larger information set available at the time of the forecast, the errors in (current year) projections of current year growth are smaller than in (current year) projections of GDP growth for the year ahead. On average, growth was overestimated in both the OECD and BRIICS economies, though the errors in the latter were slightly smaller than in the OECD economies (Figure 3). The largest errors were made in the vulnerable euro area economies.

Table 1. Average errors of calendar year GDP growth projections for OECD countries

2007-12, percentage points

	May projection for current year	November projection for next year	May projection for next year
Full period: 2007-12	-0.1	-0.9	-1.4
Sub-periods			
2007-09	-0.2	-1.8	-2.6
2010-12	-0.1	0.1	-0.3

Note: See Box 1 for description of the calculation of errors and the different projections considered. Errors are calculated as actual growth less projected growth at each forecast horizon, where actual growth is the published outturn as at May the following year. A negative (positive) average error indicates over(under)-prediction. There is only partial coverage for Chile, Estonia, Israel and Slovenia.

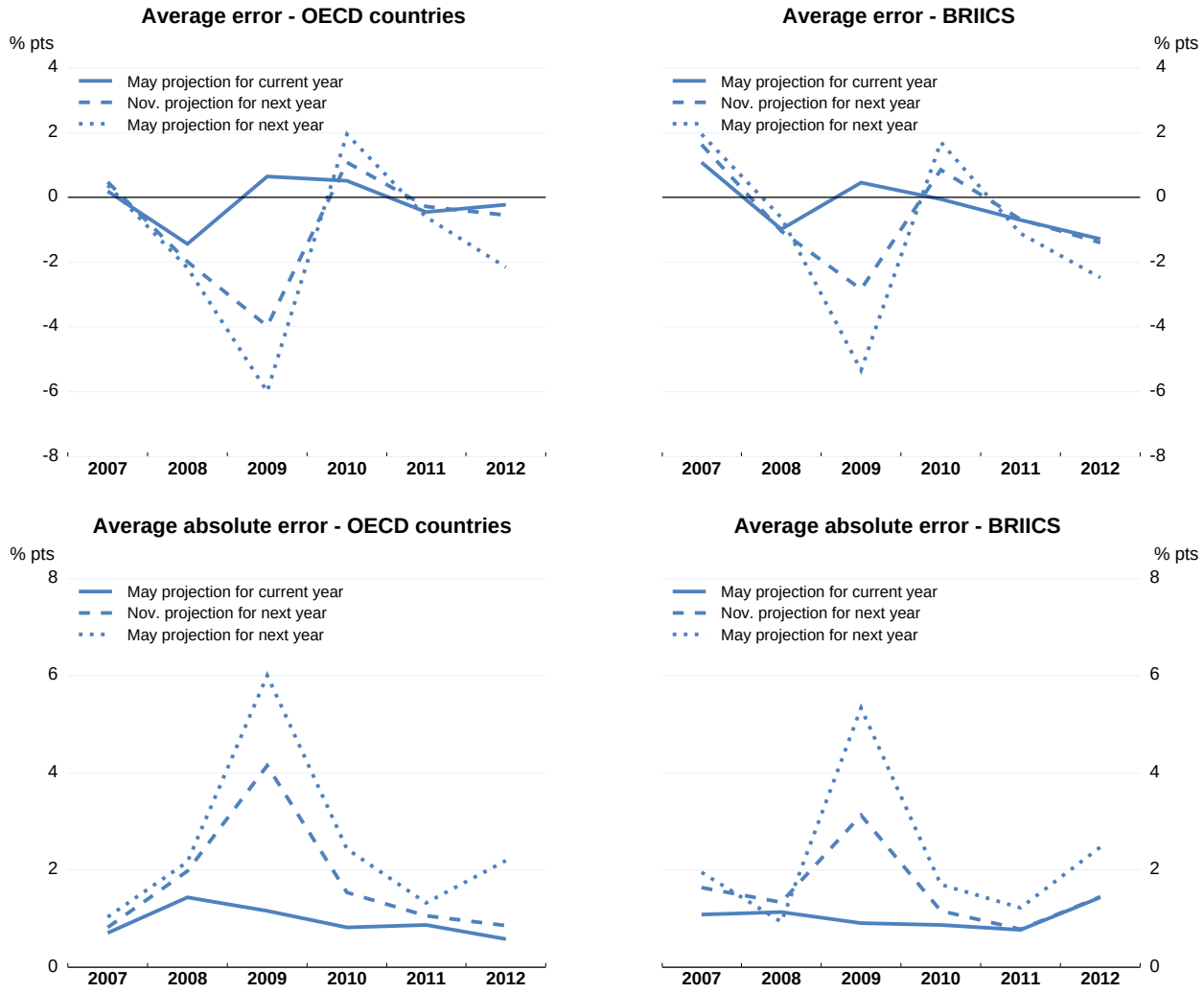
Source: OECD Economic Outlook databases and OECD calculations.

4 . With the projection errors in each year tending to be in the same direction for almost all countries, the average absolute error across countries in Figure 2 is similar in magnitude to the average errors.

5 . The projection errors are derived by subtracting the forecast from the outturn, so that an overestimate of growth results in a negative projection error.

Figure 2. Errors in calendar year GDP growth projections in recent years

Unweighted mean across countries in each year

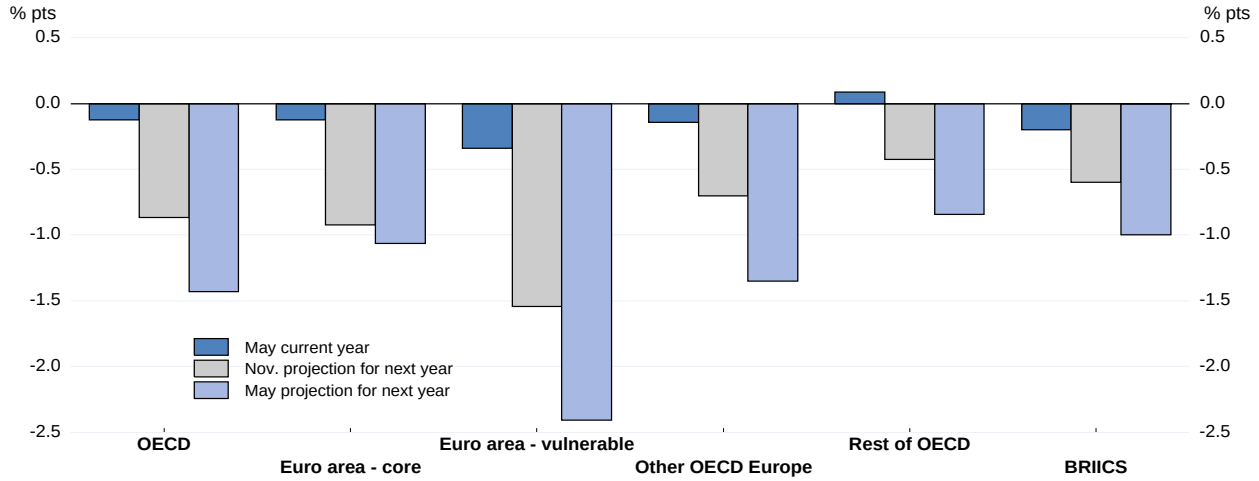


Note: See Box 1 for description of the calculation of errors and the different projections considered. Errors are calculated as actual growth less projected growth at each forecast horizon, where actual growth is the published outturn as at May the following year. A negative (positive) average error indicates over(under)-prediction. There is only partial coverage for Chile, Estonia, Indonesia, Israel, Slovenia and South Africa.

Source: OECD Economic Outlook databases; and OECD calculations.

Figure 3. Average errors of calendar year GDP growth projections by country group

2007-12, percentage points



Note: See Box 1 for description of the calculation of errors and the different projections considered. Errors are calculated as actual growth less projected growth at each forecast horizon, where actual growth is the published outturn as at May the following year. A negative (positive) average error indicates over(under)-prediction. There is only partial coverage for Chile, Estonia, Indonesia, Israel, Slovenia and South Africa. Countries included in the 'euro area - vulnerable' group are: Greece, Ireland, Italy, Portugal and Spain.

Source: OECD Economic Outlook databases; and OECD calculations.

11. The differences in forecasting performance across countries narrow if the projection errors are adjusted for the considerable cross-country differences during this period in average GDP growth rates and the volatility of GDP growth. On average, in the May current-year projections, the RMSE for OECD countries is a little under one-half of the volatility of GDP growth over 2007-12, whereas for the projections of growth a year ahead it is around the same magnitude as GDP growth volatility (Appendix 1). For the non-OECD countries, the adjusted measure of accuracy is similar to the OECD countries. For projections to be efficient, accuracy should improve as the forecast horizon shortens, which is the case for the average error, average absolute error and RMSE for almost all countries (Appendix 1). An additional analysis of the quarterly GDP growth projections for the G7 economies also shows that forecast errors rise very quickly more than one quarter ahead (Box 2).

Box 2. Errors in quarterly GDP growth projections during and after the crisis

Quarter-on-quarter growth projections are also published in the *Economic Outlook* twice each year, and it is of interest to see how these projections perform. The analysis that follows is for the G7 economies only and considers three different forecast horizons:

- Projections for the same quarter in which the *Economic Outlook* is published, which are available for Q2 and Q4 each year.
- Projections for the next quarter, which are available for Q3 and Q1 each year (i.e. growth in the quarter subsequent to that in which the *Economic Outlook* is published).
- Projections for two quarters ahead, which are available for Q4 and Q2 each year (i.e. growth two quarters after that in which the *Economic Outlook* is published).

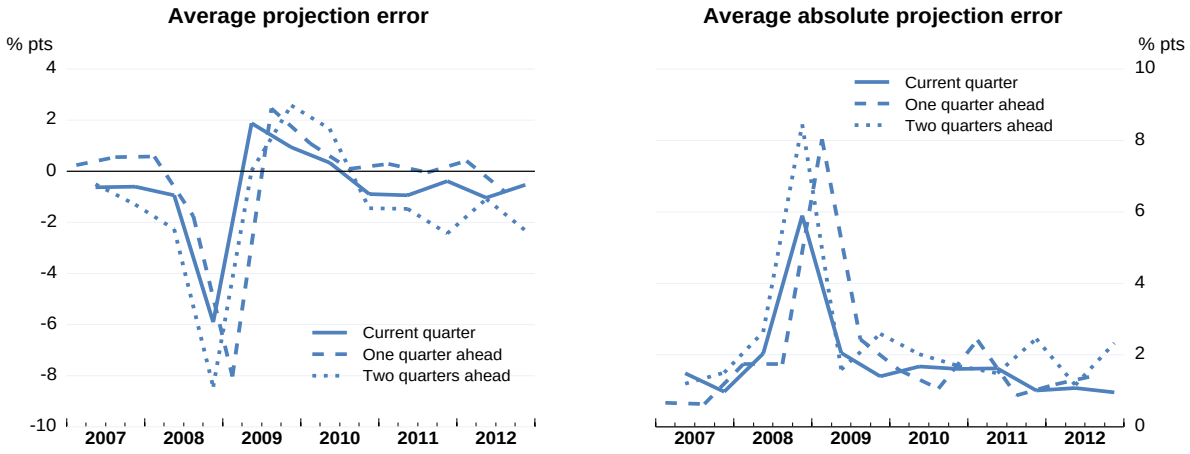
The time profile of the average errors for the G7 countries shows that the errors for GDP growth in 2008Q4 and 2009Q1 were the largest made (see figure). That is, the largest two-quarter-ahead projection errors were made in the May 2008 forecasting round and the largest current-quarter and quarter-ahead projection errors were made in the November 2008 forecasting round, after Lehman Brothers collapsed. More recently, the current-quarter and one--quarter-ahead errors have been closer to zero but growth two quarters ahead has been overestimated on average. In absolute terms, current-quarter projection errors declined during the recovery but the two-quarter-ahead projection errors are little changed through this period.

Box 2. Errors in quarterly GDP growth projections during and after the crisis (*Cont.*)

Further detail on the quarterly projection errors is contained in Appendix 1. A striking finding is that the errors in the two quarter ahead projections over 2007 to 2012 are, on average, of a broadly similar magnitude to the standard deviation of the quarterly GDP growth rate in the quarters concerned, highlighting the difficulties in accurately projecting quarterly changes more than one quarter in advance.

Mean error in G7 annualised quarterly growth projections over time

2007Q1-2012Q4, percentage points of GDP



Note: See Box 1 for description of the calculation of errors and the different projections considered. Errors are calculated as actual growth less forecast growth at each forecast horizon, where actual growth is the published outturn in the first *Economic Outlook* published after the quarter being forecast. A negative (positive) average error indicates over(under)-prediction of quarter-on-quarter GDP growth.

Source: OECD Economic Outlook databases; and OECD calculations.

12. Statistical tests of the properties of the OECD country growth projections are in Appendix 2, though, given the small timespan of the sample used, the results need to be viewed with some caution. The main findings include:

- The projections for OECD countries are found to be biased during this period, particularly the projections for the following year.
- The projections in this period were informative, in the sense that they contain statistically-significant information correlated with the outturns, but other than the requirement that the projections become more accurate as the forecast horizon narrows, various tests of efficiency are not passed at any of the horizons.
- The May projections for GDP growth in the same year and the following year contain additional statistically-significant information over a naïve forecast that uses only the previous year's growth rate.

- Similar results are found for other forecasters (detailed in Appendix 3), with forecast-encompassing tests suggesting that consensus forecasts do not contain additional information over the OECD projections at any horizon.[6]

13. Another way of judging the usefulness of the projections is by their ability to get the 'story' right – or directional accuracy. In the sample period 2007-12, there were 56 instances of a year-on-year rise in GDP growth in an OECD country (growth in year *t* was higher than growth in year *t-1*) and 118 instances of declines.[7] The projections correctly anticipated around 90% of the growth pick-ups, both in the same year and the year ahead. But declines were more difficult: around 90% of declines were correctly projected in the same year, but the performance of the projections made in May for growth in the following calendar year were no better than a coin toss. This feature of OECD projections was also reported in an earlier assessment for the pre-crisis period (Vogel, 2007) and is also present in the 40-year dataset discussed below.

2.3 Forecast performance during the financial crisis and its aftermath: inflation

14. The inflation projections considered are the year-on-year change in the private consumption deflator in each of the OECD countries. An advantage of using this definition, rather than the headline consumer price index, is that it is a national accounts series, thus allowing a common basis of comparison across countries.

15. On average, over 2007-12, inflation was underestimated, particularly at longer horizons (Table 2 and Appendix 2). If the projections had correctly anticipated the weaker-than-expected GDP growth outcomes, it is possible that the underestimate of inflation outturns would have been even greater. That said, at the country level there is no clear relationship between the average errors in the GDP growth projections and those in the inflation projections, particularly during the recovery over 2010-12 (Figure 4).

Table 2. Average errors of calendar year inflation projections for OECD countries

2007-12, percentage points

	May projection for current year	November projection for next year	May projection for next year
Full period: 2007-12	0.1	0.2	0.4
Sub-periods			
2007-09	0.1	0.0	0.2
2010-12	0.0	0.4	0.7

Note: Inflation is measured as the change in the private consumption deflator. See Box 1 for description of the calculation of errors and the different projections considered. Errors are calculated as actual inflation less projected inflation at each forecast horizon, where actual inflation is the published outturn as at May the following year. A negative (positive) average error indicates over(under)-prediction. There is only partial coverage for Chile, Estonia, Israel and Slovenia.

Source: OECD Economic Outlook databases and OECD calculations.

16. There are a number of possible explanations for the underestimation of inflation. One explanation is that the impact of increasing spare capacity and rising unemployment on inflation was overestimated (i.e. that the Phillips curve was flatter at low rates of inflation than thought). A second possibility is that the extent of spare capacity in many economies has been less than estimated at the time of the projections,

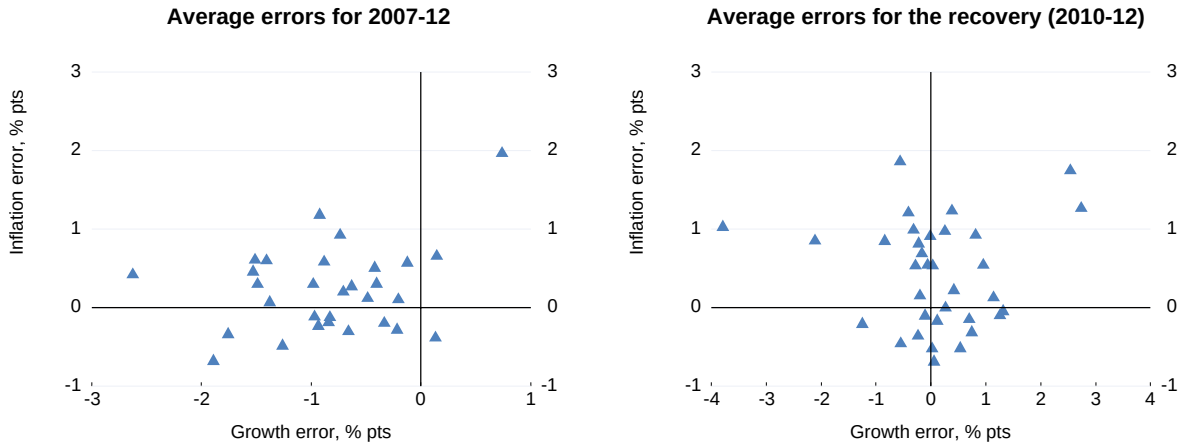
6. This is based on the tests of the errors for G7 countries in Appendix 3 (Table A.3.6).

7. Changes in growth of less than 0.1 percentage points (from rounded data) are excluded (see Appendix 2).

reflecting the well-known difficulties with real-time estimates of output gaps (Koske and Pain, 2008).[8] Alternatively, given the low level of inflation in many OECD economies at the start of 2014, it could just be that the impact of economic slack on inflation has taken longer to emerge than projected. A final possibility is that the projections underestimated the impact of the significant increases in indirect taxes and administered prices that have occurred in some countries, especially in Europe, as a result of fiscal consolidation.[9]

Figure 4. Relationship between projection errors for growth and inflation

Error in projection made at November for the next year



Note: Inflation is measured as the change in the private consumption deflator. See Box 1 for description of the calculation of errors and the different projections considered. Errors are calculated as the actual value less the projected value at each forecast horizon, where the actual value is the published outturn as at May the following year. A negative (positive) average error indicates over(under)-prediction. Countries with partial coverage for the period are excluded from the left panel (Chile, Estonia, Israel and Slovenia).

Source: OECD Economic Outlook databases; and OECD calculations.

17. Although the inflation projection errors are smaller than the growth projection errors on average, they are slightly higher if allowance is made for the relative volatility of the outcomes (as a way of adjusting for the relative difficulty of forecasting each variable). Moreover, as found for the growth projections, the inflation projections are informative but generally not efficient (see Appendix 2).

8. For instance, in the May 2010 and May 2011 issues of the *Economic Outlook*, the OECD-wide output gap was estimated to be -3.8 per cent in 2010 and -3.2 per cent in 2011 respectively. By the time of the May 2013 *Economic Outlook*, the output gaps in 2010 and 2011 had been revised down to -2.3 and -2.0 per cent respectively.

9. Official estimates for some countries suggest that the effects of increases in indirect taxes and administered prices were large: the changes in vulnerable countries in 2010 and 2011 boosted the 12 month rate of HICP inflation by almost ½ percentage point, while in the United Kingdom, two VAT increases added 1¾ percentage points compared to a scenario of constant tax rates (as discussed in Box 1.5 of the May 2011 *Economic Outlook*).

3. Factors correlated with the growth forecast errors

3.1 Factors correlated with errors over the whole period and during the downturn

18. This section highlights some of the variables correlated with the growth projection errors over the whole period and during the downturn phase (2008-09). Pair-wise correlations between the country forecast errors, four broad sets of pre-crisis factors and four indicators of contemporaneous economic developments are set out in Table 3.[10] Key findings include:

- Growth was weaker than expected and projection errors higher in countries that are more open to external developments and exposed to shocks from other economies. Factors such as openness to international trade and the share of total national banking assets held by foreign-owned banks are found to be significantly negatively correlated with forecast errors over the period as a whole and particularly so during the downturn (Figure 5). This suggests that the projections failed to fully reflect the increasing globalisation of real and financial activity prior to the crisis, which had raised the potential for cross-border and cross-market transmission of economic and financial shocks. In particular, there was a tendency for foreign-owned banks – an increasingly important presence in domestic banking markets in the pre-crisis period – to cut credit extensions or reduce new lending in their host economies in order to meet lower risk targets imposed by their parent banks.[11]

- Larger forecast errors over 2007-12 have occurred in countries with more stringent pre-crisis labour and product market regulations (Figure 6). In part this may reflect the weight given to pre-crisis evidence that tight regulations could help to cushion economic shocks (Duval et al., 2007), together with insufficient attention being paid to the extent to which tighter regulations might delay necessary reallocations across sectors in the recovery phase. A third possibility is that it reflects a correlation between restrictive regulation and the pre-crisis build-up of imbalances, although indicators such as pre-crisis house price and credit growth are not found to be strongly correlated with the forecast errors.[12]

- Growth has been weaker than expected in the recovery in countries in which banks had a low ratio of regulatory capital to risk-weighted assets in 2007 (Figure 7, left panel). This may suggest that insufficient account was taken of the impact of the rapid pre-crisis expansion of financial leverage in a low interest rate environment and the greater need for weakly capitalised banks to deleverage subsequently. Although, over the period as a whole, sizeable projection errors (i.e. large RMSEs) have been made in countries in which banks have comparatively high levels of regulatory capital, this primarily reflects the higher underlying growth volatility of these economies in this period.[13]

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10. The set of explanatory variables here is related to that in other studies that seek to explain cross-country differences in growth outcomes during the crisis, including Rose and Spiegel (2010), Cecchetti et al. (2011), and Berkmen et al. (2012). This paper focuses on a smaller set of countries (OECD member countries) and projection errors during the recovery as well as the downturn, and also considers some contemporaneous developments.

11. The evidence points to the enhanced exposure of host economies to source economy shocks during the downturn outweighing the potential for foreign-owned banks, with access to internal capital resources, to help shield host economies from domestic shocks, which would limit negative growth surprises. A related finding is reported by Cetorelli and Goldberg (2012). Claessens and van Horen (2012) also show that foreign banks reduced their domestic credit more sharply than domestic banks during the crisis.

12. Related measures of business and labour market regulation produced by the World Bank and the Fraser Institute were found to have similar relationships (not shown here).

13. The negative relationship early in the crisis is more difficult to interpret since other studies have shown that countries with higher capital ratios outperformed those with lower ratios during that time (Cecchetti et al.,

Table 3. Correlation between growth projection errors and pre-crisis conditions

	Full period: 2007-12		Sub-periods		
	Average error	RMSE	Cumulative error over two years shown		
	From projections at May for the next year		2008-09 (May-08 EO)	2010-11 (May-10 EO)	2011-12 (May-11 EO)
Openness					
Trade openness	-0.3*	0.4**	-0.4**	0.0	-0.3
Financial openness^	0.3	-0.3	0.4*	0.0	0.0
Foreign banks' assets	-0.3*	0.5***	-0.5***	0.1	0.0
Economy-wide regulations					
Product market regulation	-0.1	0.3*	-0.2	0.2	-0.2
Employment protection legislation	-0.1	0.4*	-0.4*	0.3	-0.2
Financial structure					
Stock market capitalisation	0.2	-0.3	0.3*	-0.1	0.0
Regulatory capital	0.1	0.4**	-0.3*	0.5***	0.3
Financial services^	0.1	-0.3	0.3	-0.3*	0.3
Pre-crisis imbalances					
House price growth (2000-07)	-0.2	-0.1	0.1	-0.2	-0.1
Private-sector credit growth (2000-07)	-0.2	0.0	0.0	-0.2	-0.1
Current account balance	0.3*	-0.1	0.0	0.2	0.0
Contemporaneous developments					
Equity prices	0.3	0.0	0.0	0.7***	0.8***
Non-performing loans	-0.7***	0.3*	-0.3	-0.5***	-0.5***
Business confidence (manufacturing)	0.1	0.0	0.2	0.4*	0.2
Consumer confidence	0.3*	-0.1	0.0	0.6***	0.4**

Note: Errors are calculated as actual growth less projected growth at each forecast horizon, where actual growth is the published outturn as at May the following year. A negative (positive) error indicates over(under)-prediction. Negative correlations for average errors indicate more negative growth surprises are correlated with more positive changes in the other variable. *, **, *** denotes significant at the 10%, 5%, or 1% level, respectively. ^ denotes variables with extreme values that have been omitted because they change the nature of the relationship. The first three columns exclude countries with partial coverage: Chile, Estonia, Israel and Slovenia. Contemporaneous developments are the change over the relevant period being considered.

Sources: IMF Financial Soundness Indicators, OECD Economic Outlook databases; OECD Going for Growth (2012); OECD House Price database; OECD Structural Analysis database; World Bank Global Financial Development database; World Bank World Development Indicators; and OECD calculations.

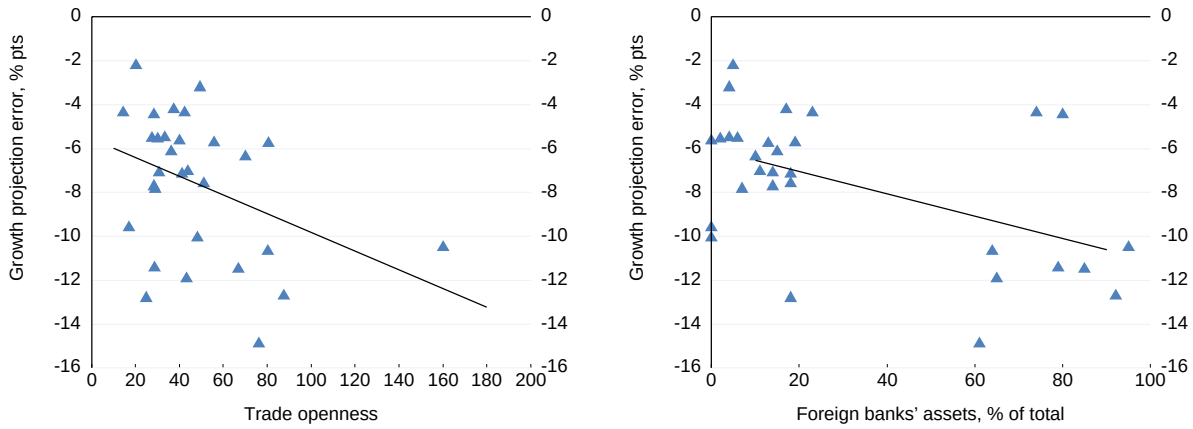
- During the post-crisis recovery period there are strong correlations between projection errors and changes in equity prices, private sector confidence and non-performing loans in the banking sector (Figure 7, right panel). This suggests that the impacts of impaired banking systems and weak confidence may have been underestimated in the projections.[14] There is also evidence that such correlations with forecast errors also occurred in the pre-crisis period, particularly for financial variables (Appendix 6).

2011). One difference here is the focus on errors, rather than outcomes. Another is the use of regulatory capital (rather than total capital) to risk-weighted assets.

14. It is possible that the correlations could also reflect a reverse causal link, with weaker growth outcomes leading to more impaired loans and deteriorating confidence. However, qualitatively similar results are obtained if confidence changes available at the time of the forecasts are used instead.

Figure 5. Relationship between growth projection errors for 2008-09 and other characteristics

Cumulative errors for 2008-09 calendar year projections made at May 2008

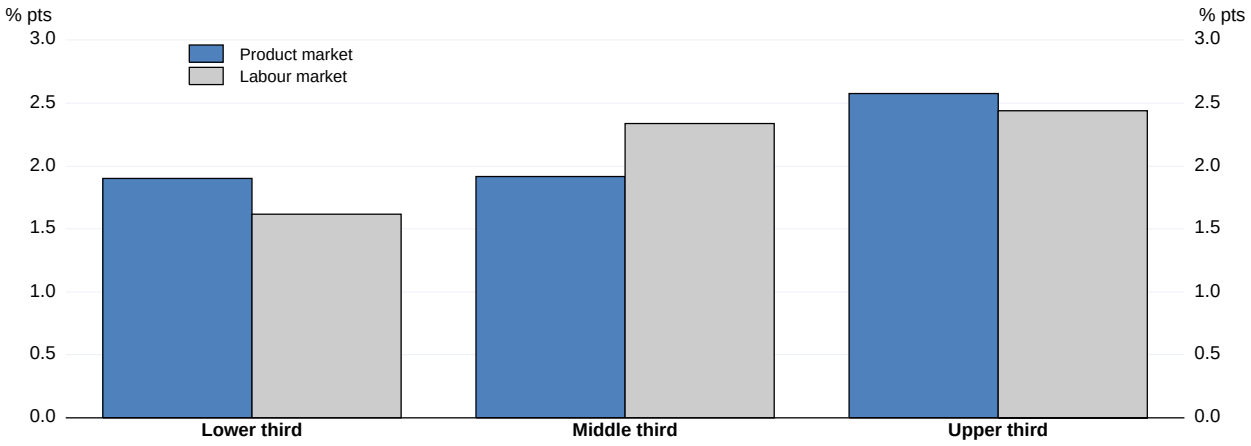


Note: See Box 1 for description of the calculation of errors and the different projections considered. Errors are calculated as actual growth less forecast growth at each forecast horizon, where actual growth is the published outturn as at May the following year. A negative (positive) error indicates over(under)-prediction. Countries with partial coverage for the period are excluded (Chile, Estonia, Israel and Slovenia).

Source: OECD Economic Outlook databases; World Global Financial Development database; and OECD calculations.

Figure 6. Relationship between accuracy of growth projections and regulation

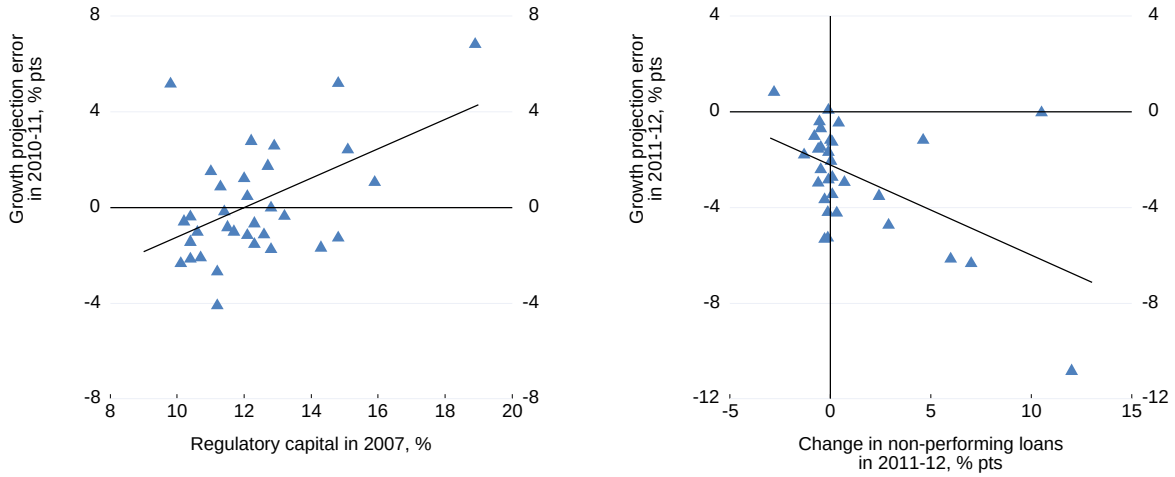
Average RMSE of growth projections for 2007-12 made at November a year earlier



Note: See Box 1 for description of the calculation of errors and the different projections considered. Countries with partial coverage for the period are excluded (Chile, Estonia, Israel and Slovenia).

Source: OECD Going for Growth (2012); OECD Economic Outlook databases; and OECD calculations.

Figure 7. Relationship between errors in growth projections in the recovery and the financial sector



Note: See Box 1 for description of the calculation of errors and the different projections considered. Errors are calculated as actual growth less projected growth at each forecast horizon, where actual growth is the published outturn as at May the following year. A negative (positive) error indicates over(under)-prediction.

Source: IMF Financial Soundness Indicators; OECD Economic Outlook databases; World Bank Global Financial Development database; and OECD calculations.

19. Perhaps surprisingly, indicators of pre-crisis vulnerabilities such as house price increases and private credit growth are not generally associated with negative growth surprises since the crisis began.[15] A possible explanation might be that these vulnerabilities have been generally well understood and incorporated successfully into forecast judgements. However, larger downside surprises on average have occurred in countries with a pre-crisis current account deficit.

20. Changes in the OECD composite leading indicators (CLIs) ahead of May 2008 were negatively correlated with the errors in the growth projections made at that time, with the CLIs continuing to improve in some countries even at the point at which GDP was past its peak (Appendix 7). This suggests that the usual relationship between many high-frequency variables – including activity, labour market and survey data – broke down during this period.

3.2 Fiscal consolidation, bond spreads and growth disappointments in 2010-11 and 2011-12

21. In 2010-11 and 2011-12, the acceleration in the pace of the global recovery projected in the May 2010 and May 2011 *Economic Outlooks* ultimately failed to materialise. As mentioned above, one factor behind this may have been an underestimate of the impact of impaired banking systems and bank deleveraging during these years (Figure 7). But these years also saw the deepening of the euro area crisis and the onset of widespread fiscal consolidation, providing other possible explanations for the projection errors. IMF studies point to a negative relationship between the errors in its Spring 2010 *World Economic Outlook* projections for GDP growth over 2010-11 and projected fiscal consolidation during this period

15. Cecchetti et al. (2011) find that lower pre-crisis levels of private-sector credit to GDP and lower rates of growth in private-sector credit from 2005-07 were associated with better growth outcomes in the downturn (across a broader sample of countries). In contrast, there is evidence of a positive, but not significant, relationship between the errors in the OECD growth projections and pre-crisis level of private-sector bank credit.

(IMF, 2012; Blanchard and Leigh, 2013). An implication drawn from this is that fiscal multipliers were underestimated considerably, thereby contributing to an overestimate of growth prospects.[16]

22. A more nuanced picture appears from the OECD projections published in the *Economic Outlook* in May 2010 and May 2011 for cumulative GDP growth during 2010-11 and 2011-12 respectively. Projected fiscal consolidation is negatively correlated with the growth forecast errors in 2010-11 (Figure 8, upper left panel), but not in 2011-12 (Figure 8, lower left panel). To the extent that the former reflects an initial underestimation of the multiplier effects of fiscal consolidation, the latter suggests that OECD forecasters revised their judgement as the impact of consolidation in an environment with limited monetary policy space became clearer. Moreover, the finding for 2010-11 stems from the downside growth surprises in the European economies, and in particular, Greece; without Greece, the relationship remains negative but no longer statistically significant. Outside Europe, the relationship is harder to discern.

23. A further possibility is that the correlation between fiscal consolidation and growth forecast errors could rise from an underestimate of the amount of fiscal consolidation, rather than from an underestimate of the fiscal multiplier. On average, in the European economies, cumulative fiscal consolidation in 2010-11 was 0.8 per cent of GDP greater than projected in the May 2010 *Economic Outlook*.[17] The actual level of fiscal consolidation is also negatively correlated with the growth forecast errors in 2010-11, but this relationship is again found to be dependent on the inclusion of Greece in the sample considered.

24. The published OECD projections in these years relied on a "muddling-through" assumption, with the euro area crisis assumed to be diminishing slowly and government bond spreads between other European countries and Germany narrowing over the projection period. In fact, spreads widened in many countries over the projection period. There is a clear correlation between the errors in the assumptions about spreads and the growth forecast errors in 2010-11 (Figure 8, upper right panel), with growth weaker than projected in countries whose bond spreads relative to Germany were higher than had been assumed. This negative correlation is robust to the exclusion of Greece.

25. Because bond spreads are clearly endogenous to growth outcomes and the possibility of further fiscal consolidation, it is difficult to identify conclusively whether incorrect assumptions about fiscal multipliers or bond spreads are more important. However, econometric evidence suggests that the errors in the bond spread assumptions appear to be a more important explanation for forecast errors than the possible underestimation of fiscal multipliers or the underestimation of the amount of fiscal consolidation. Considered together, there is no longer any significant relationship between the forecast errors and either projected or actual fiscal consolidation, but the errors in bond spreads remain negatively, and in most cases significantly, related to the forecast errors for 2010-11 (Appendix 5). A similar result is reported in European Commission (2012). Repeating the exercise for 2011-12 reinforces the finding that projected fiscal consolidation is not significantly related to the errors. The relationship with bond spreads is not robust and varies according to the estimation techniques used and whether Greece is included in the sample.

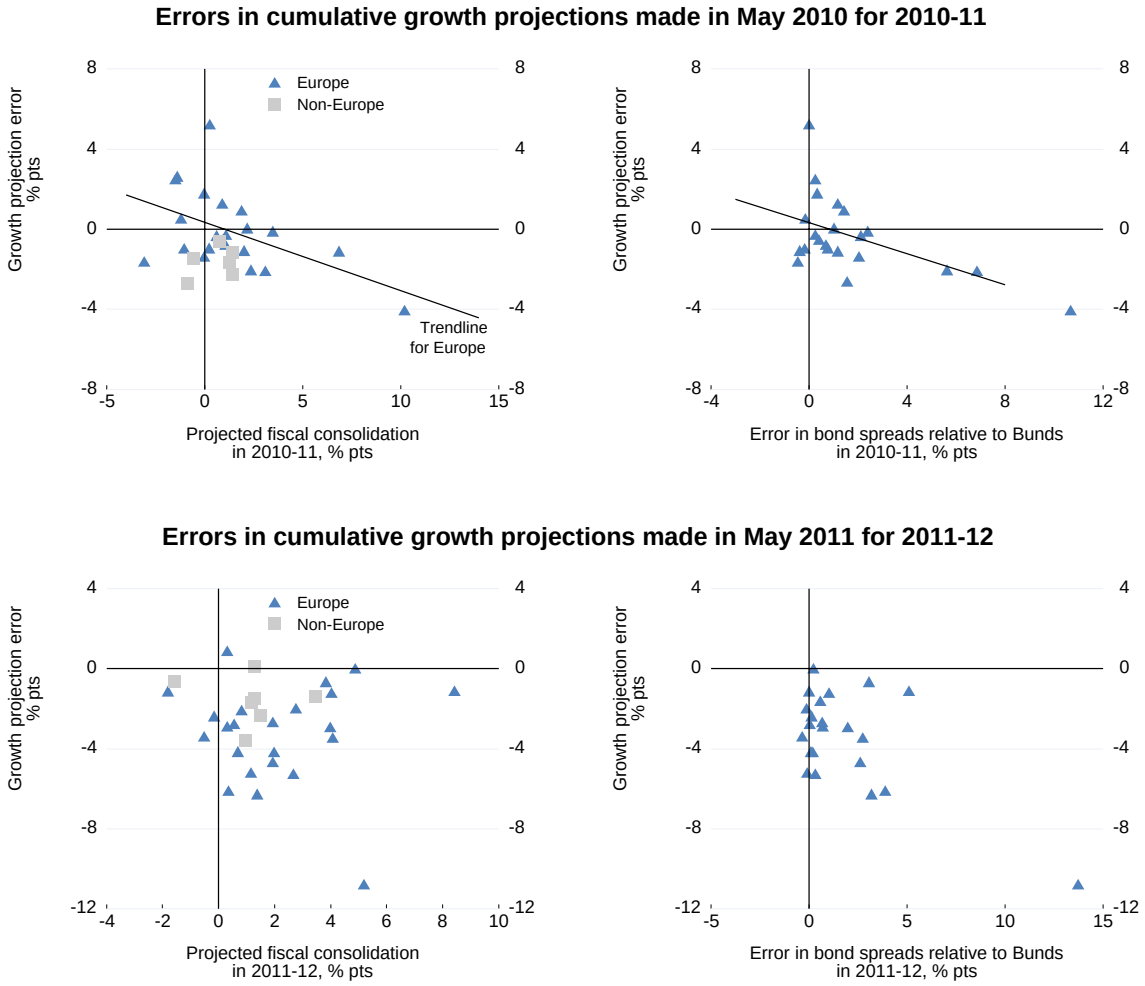
26. These findings raise questions about the appropriateness of the forecast assumptions made during the recovery, particularly the prevailing assumption that the euro area crisis would ease over the projection period. However, other factors also contributed to the projection errors, especially in 2011-12. As mentioned above, there are signs that the impact of impaired banking systems and bank deleveraging may

16. The IMF studies focus primarily on European countries, although the main findings remain even if the sample is broadened to other advanced economies.

17. Actual fiscal consolidation was however strongly positively correlated with projected fiscal consolidation.

have been underestimated during these years (Figure 7). Simple correlations also suggest that changes in the composite leading indicators, equity prices, sentiment and interest rates both during the forecast period and in the year *ahead* of the projections were not always adequately incorporated into the projections in recent years (see Appendices 6 and 7).

Figure 8. Relationship between errors in growth projections in the recovery and economic developments



Note: See Box 1 for description of the calculation of errors and the different projections considered. Errors are calculated as actual growth less forecast growth at each forecast horizon, where actual growth is the published outturn as at May the following year. A negative (positive) error indicates over(under)-prediction. The trendline for the error in bond spreads to Bunds excludes Greece. Trendlines are not shown where the relationship is not statistically significant at the 10 per cent level.

Source: Economic Outlook databases; and OECD calculations.

4. A longer-term perspective on recent growth projection errors

4.1 OECD forecasts over 1971-2012

27. Examining the characteristics of the OECD growth projections for the G7 countries – for which there are data from 1971 – helps to place the characteristics of recent forecast errors in context, and allows an assessment of whether they are markedly different from past experience. Key findings include:

- The errors made during the crisis are large, but not unprecedented. Errors of a magnitude comparable to those in 2009 occurred in the early 1970s, following the first oil crisis (Figure 9).[18]

- The mean absolute projection error in the G7 economies declined from the late 1970s to the mid-2000s. In part, this reflects the moderation in the volatility of output growth. At shorter horizons the decline might also reflect improved data availability, especially regarding near-term developments, and improvements in forecasting procedures.

- Overall, the near-term projections for G7 countries over four decades have been unbiased. The average error in the May projections for growth in the same year is close to zero (or not statistically different from zero) for each country. In contrast, the November and May projections for growth the following calendar year have, on average, been overly optimistic, although in many cases the bias is not statistically significant (Appendix 4). In the May projections for GDP growth in the following year, the extent of over-prediction in recent years was markedly worse than the average over 1982-2006 (Figure 10).[19]

- On average across the G7 countries, the RMSEs over 2007-12 are higher than over the period from 1991-2006 (Table 4, left panel). However, this difference disappears if the RMSEs are standardised by the volatility of GDP growth in the different samples. This is true also over a longer period from 1971 onwards; indeed the errors made during the period from 2007-12 are smaller than those made in the decade after 1971, reflecting the difficulties in forecasting the impact of the oil price shocks, as well as the exceptionally high volatility in GDP growth since the start of the financial crisis.

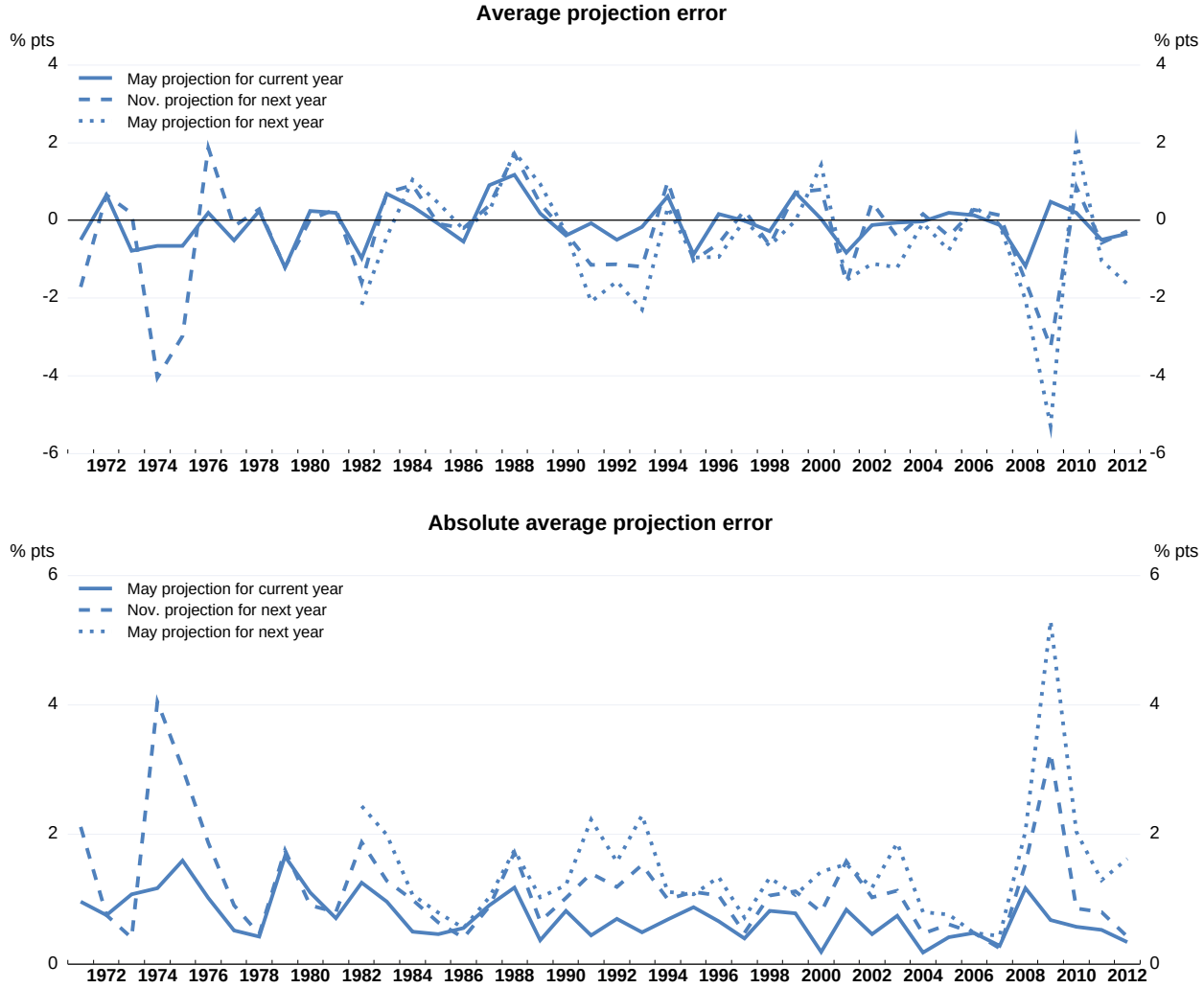
28. The general tendency to overestimate growth in the year-ahead, on average, is common to many forecasters (Abreu, 2011). Two reasons appear to be a common failing to predict downturns and to predict their size: directional accuracy is asymmetric, with a much lower share of decelerations and recessions predicted a year in advance; and errors are larger in recessions (Abreu, 2011; González Cabanillas and Terzi, 2012).

18. The average error and average absolute error of projections made in November 1973 for growth in 1974 were both larger than any projection error from the November year-ahead forecasts during the financial crisis.

19. The equivalent difference in the size of the errors from the May projections for growth in the same year is smaller in magnitude but still statistically significant for three countries (France, Italy and the United Kingdom).

Figure 9. Errors in GDP growth forecasts for G7 countries over the long run

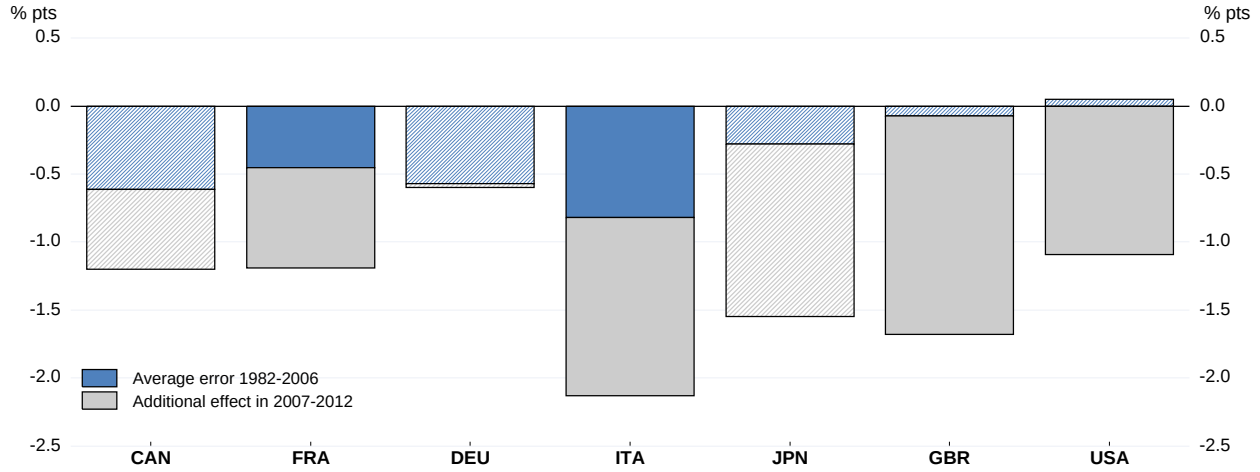
Unweighted mean across countries in each year



Note: See Box 1 for description of the calculation of errors and the different projections considered. Errors are calculated as actual growth less forecast growth at each forecast horizon, where actual growth is the published outturn as at May the following year. A negative (positive) average error indicates over(under)-prediction. May projections for GDP growth in the following year are available only from 1982.

Source: OECD, Economic Outlook publications and databases; and OECD calculations.

Figure 10. G7 countries: errors in the May GDP growth projections for the following year



Note: See Box 1 for description of the calculation of errors and the different projections considered. Errors are calculated as actual growth less forecast growth at each forecast horizon, where actual growth is the published outturn as at May the following year. A negative (positive) average error indicates over(under)-prediction. Shading indicates the error is not significant at the 10% level in a regression of the error on a constant and a dummy variable for 2007-12 using data from 1982-2012.

Source: OECD Economic Outlook databases; and OECD calculations.

Table 4. RMSE of calendar year GDP growth projections over the longer run

Unweighted mean of G7 countries

	Percentage points of GDP			Ratio to standard deviation of growth		
	May projection for current year	November projection for next year	May projection for next year	May projection for current year	November projection for next year	May projection for next year
1971-2012	1.0	1.7	n.a.	0.4	0.7	n.a.
1971-1981	1.3	2.2	n.a.	0.5	0.8	n.a.
1982-1990	1.0	1.3	1.7	0.6	0.8	1.0
1991-2006	0.7	1.3	1.6	0.5	0.9	1.2
2007-2012	0.7	1.6	2.7	0.3	0.6	1.1

Note: Errors are calculated as actual growth less projected growth at each forecast horizon, where actual growth is the published outturn as at May the following year. May projections for the following year are only available from 1982.

Source: OECD Economic Outlook publications and databases; and OECD calculations.

29. Standard forecast evaluation tests of the long-run sample of projections of the G7 countries provide mixed findings (Appendix 4):

- For each forecast horizon, it cannot be rejected that the majority of the growth projections for the individual G7 economies are weakly efficient; indeed the projections for the United Kingdom and the United States are weakly efficient at all forecast horizons.

- In contrast, the directional accuracy of the long sample of G7 growth projections does not appear very different from that of the broader sample of countries over 2007-12. There is a high degree

of accuracy in projecting growth pick-ups, but little success predicting declines in growth (especially in the year ahead, with the success rate approximately as good as a coin toss). A similar finding is reported by Vogel (2007), using data for 1991-2006.

4.2 Comparisons with other forecasters

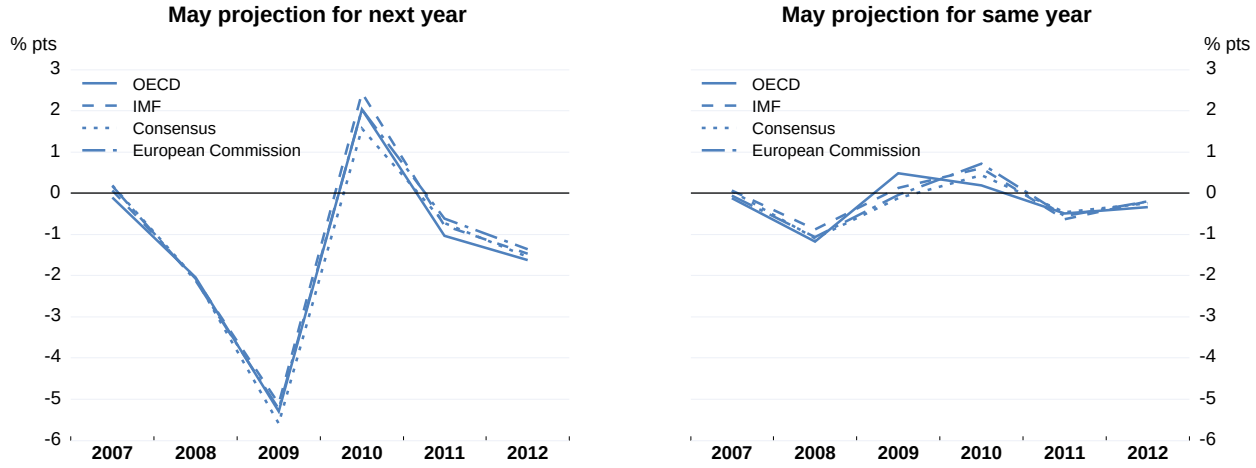
30. Overall, the size and profile of the OECD projection errors are very similar to the errors in the projections made by other international organisations, such as the IMF and the European Commission (González Cabanillas and Terzi, 2012), and also the errors that are implied by consensus forecasts (Figure 11). All of these overestimated growth considerably in 2009 and were then surprised by the extent of the initial bounce-back in 2010 and the subsequent weakness of the recovery. On average, all forecasters over-predicted growth during the period 2007-12. No set of projections clearly outperformed the others during this period; for instance, the RMSEs of the calendar year growth projections made in May the same year were almost identical across forecasters for each of the G7 economies. At the margin, the OECD projections made in November for the following year are slightly more accurate than those of the IMF, but this seems likely to reflect the slight timing advantage that the OECD has; in particular, a later publication date allows the initial Q3 GDP outturns to be incorporated for many countries (see Appendix 3).

31. A comparison of the OECD growth projections and consensus forecasts for G7 countries over a longer period reveals similar patterns. On average, GDP growth was overestimated in both sets of projections, with the extent of overestimation rising as the forecast horizon lengthens. The RMSEs over the two decades are also very similar. Reflecting this, there is little significant difference in the overall accuracy of the OECD and consensus forecasts over the past two decades.[20] Forecast-encompassing tests (following Fair and Shiller, 1990) suggest that the OECD May current-year projections and November year-ahead projections encompass the consensus forecasts (i.e. contain all the relevant information contained in the consensus forecasts). However, neither of the separate May projections for growth in the following year encompasses the other. This is the case for both the pre-crisis period, and also over 2007-2012.

20. When accuracy is measured by the difference in the squared error each year, the only statistically significant differences (at the 10% level of significance) are for Italy (in the projections made in May of the same year) and France (in the projections at November for the next year, using the modified Diebold-Mariano test proposed by Harvey et al. (1997). See Appendix 3 for details.

Figure 11. Comparison of average projection errors for growth in G7 countries

Unweighted mean error across countries, percentage points



Note: See Box 1 for description of the calculation of errors and the different projections considered. Errors are calculated as actual growth less forecast growth at each forecast horizon, where actual growth is the published outturn as at May the following year. A negative (positive) average error indicates over(under)-prediction. European Commission and IMF projections are released in April.

Source: Consensus Economics; European Commission European Economic Forecast publications; IMF World Economic Outlook databases; OECD Economic Outlook databases; and OECD calculations.

5. The nature of the projections

32. The OECD forecasts are conditional projections rather than pure forecasts. The projections are consistent with the advice given about monetary policy settings and rest on explicit and implicit assumptions, such as fiscal policy changes and whether the euro area crisis will be successfully contained. Some potentially endogenous factors, such as commodity prices and nominal exchange rates, are also switched off over the projection period.[21] This raises a number of difficult issues:

- The projections, and especially the accompanying commentary, sometimes point to unsustainable developments and the need for policy changes. If these are built into the projections, but the advice is not followed (or vice versa), an error in the projections will likely occur. It is not clear how or whether this type of error can be controlled for in the projection process.

- As emphasised above, the projections made during the euro area crisis placed a lot of weight on the assumption that the euro area crisis would be contained and subsequently ease, with accompanying declines in sovereign bond spreads and improvements in confidence. Yet it is not clear what else could have been assumed in projections for a period of over two years made public by an inter-governmental organisation. One possible answer – and the route chosen – is to make extensive use of scenario analyses to quantify possible adverse outcomes if key assumptions did not hold.

21. In 2008 and 2009, commodity prices were assumed to be fixed in the projections. In fact, they acted as an important automatic stabiliser for global activity, falling sharply as the crisis intensified and rebounding as the recovery began. If these developments had been incorporated in the OECD projections, then it is possible that the underestimation of the depth of the recession in 2008-09 and the extent of the bounce-back in 2009-10 would have been larger.

- Given the skewed distribution of possible projections depending on the assumptions chosen in the recovery phase, and the emergence of fat negative tail risks in particular, the nature of the published projections has changed. Whereas previously they were best seen as mean projections, they are now best regarded as modal forecasts, i.e. not giving any weight to possible extreme outcomes. This has, however, resulted in communication problems, as many users of the projections still view them as mean projections.

6. Recent changes in forecasting techniques and procedures and the unfinished agenda

33. The challenges encountered in forecasting in recent years have led to changes in forecasting techniques and procedures in the OECD and in other international organisations, some of them still in progress. Key developments are outlined below, drawing on OECD experience and consultations with experts from the IMF, World Bank, European Commission and European Central Bank.[22]

6.1 Increases in the centralisation or "top-down" component of the forecast process

34. Reflecting the common errors made in all country forecasts in recent years, and the extent to which these have been associated with stronger than expected global financial, trade and sentiment interconnections, increasing weight has been placed on central strategic guidance at an early stage of the forecast process, at the OECD and elsewhere.

- One aspect has been early identification of key global developments and risks and their likely quantitative implications for global activity and global trade. This ensures a consistent view amongst country specialists of forces acting on the forecasts and outlook for the major economies.

- Initial early guidance in the form of top-down centralised projections is now provided at the OECD and elsewhere, to help ensure that projections for individual countries are based on a common general storyline. These projections draw together the key points from standalone analyses such as indicator models and assessments of financial market developments.

Box 3. Indicator models, composite leading indicators and OECD projections

Two models available to the OECD forecasters are the short-term indicator models, which are used to predict GDP growth for two quarters, and the OECD Composite Leading Indicators (CLIs), which are designed to predict turning points in growth relative to trend. As explained below, both tools are designed to extract information about growth from high frequency and timely data sources. By responding reasonably rapidly, the reliance on the indicator models likely reduced overall forecast errors. But it does seem that better use of the information in the CLIs could have reduced the forecast errors in the November projections for growth in the following year (but not the other horizons).

Although both tools combine recent data to produce signals about economic growth, they are different by construction.

- The short-term indicator models (Sédillot and Pain (2003) and Mourougane (2006)) are regression-based models that efficiently combine available monthly and quarterly data to predict current quarter and quarter-ahead GDP growth for the G7 countries and the euro area. The input data include "hard" data, such as industrial production and retail sales, and "soft" data, such as business and consumer sentiment. Because the dependent variable is GDP growth, the process of producing a forecast is straightforward. Other work has shown the main gain from the indicator approach is for current-quarter forecasts, where estimated indicator models appear to outperform autoregressive time series models, both in terms of size of error and directional accuracy.

22. As part of the consultation it was agreed that individual comments and remarks would not be attributable to any individual institution. Additional relevant information is taken from Kenny and Morgan (2011) and González Cabanillas and Terzi (2012).

Box 3. Indicator models, composite leading indicators and OECD projections (Cont.)

- The OECD CLIs are long-running series produced for all OECD countries and some non-OECD countries. For each country, 5-10 series are used that best predict turning points in the business cycle. The CLI is typically available with a two-month lag. Because the results are primarily qualitative, it is possible that the information contained in these series is not used optimally in the forecasting round.

The performance of the indicator models in the crisis

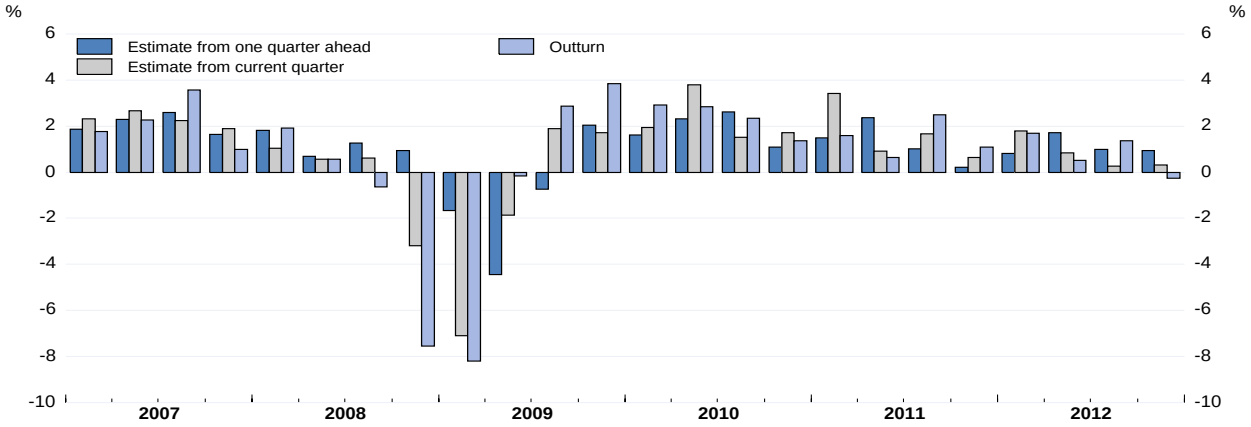
The OECD growth indicator models during the crisis provided a very useful real-time signal of a significant slowdown and then major contraction (see figure below). Nonetheless, large errors were recorded in the December quarter 2008 and early 2009 and even when the September quarter 2008 was underway, the contraction in growth was not foreseen. But both the downturn and bounce-back were highlighted relatively quickly. Overall, the indicator models were useful in compiling the projections at that time and likely reduced the size of the overall errors made.

The real-time performance of the indicator models during the crisis can also be assessed relative to that in the pre-crisis period and the simulated out-of-sample performance when the models were first developed. The root mean squared errors (RMSE) for the G7 countries are shown below (see table). There are slight differences in the timing and information sets for each forecast, but in almost all cases 1-2 months of hard indicator data and 2-3 months of survey data were available for each economy. Three main points emerge from the 2007-12 period:

- The current quarter real-time forecast errors are comparable to those before the crisis (Sédillot and Pain, 2005), both in terms of the cross-country pattern of the errors and the size of the errors. A notable exception is the United Kingdom, where the real-time errors since 2007 have been more than double those in the pre-crisis period. The errors were also larger in Japan. But overall, the data suggest that the current quarter models have remained a useful guide to current economic activity.
- The real-time forecast errors in the quarter-ahead forecasts were generally larger than might have been expected based on those from the pre-crisis period and the initial out-of-sample exercise, particularly in Japan, Germany and the United Kingdom. However, the cross-country differences in the magnitude of the errors are broadly comparable to the pre-crisis period. The generally-higher real-time errors over 2007-12 appear to be largely due to the relatively greater volatility of growth outcomes in the recent period: when the RMSEs are scaled by the standard deviation of growth outcomes, the errors over 2007-12 are all smaller, except for the United Kingdom.
- In all economies the real-time errors for the one-quarter ahead forecasts have been greater than those for the current quarter forecasts. The difference between the two is smallest for France.

OECD indicator model estimates and G7 GDP growth

Annualised quarter-on-quarter percentage changes, 2007q1 - 2012q4



Note: Outturn is defined as the published figure at the following Economic Outlook. Indicator model estimates shown are real-time estimates, typically from the last month of the quarter. Data are weighted using nominal GDP at PPP rates in 2010.

Source: OECD Economic Outlook databases; and OECD calculations.

Box 3. Indicator models, composite leading indicators and OECD projections (*Cont.*)

The current quarter indicator model has performed well in recent years

RMSE of annualised quarter-on-quarter GDP growth projections, percentage points

	Current quarter			One-quarter ahead		
	Simulated RMSE	Actual RMSE		Simulated RMSE	Actual RMSE	
	1998Q1-2002Q4	2003Q1-2005Q1	2007Q1-2012Q4	1998Q1-2002Q4	2003Q1-2005Q1	2007Q1-2012Q4
United States	1.6	1.4	1.5	2.1	1.7	2.3
Japan	2.3	2.3	4.3	2.5	2.8	5.9
Germany	1.7	1.3	1.9	2.2	1.5	4.2
France	1.0	1.0	1.4	1.6	1.2	2.0
Italy	1.0	1.8	2.0	1.6	2.1	3.3
United Kingdom	1.0	0.5	2.0	1.0	0.9	2.7
Canada	0.8	-	2.0	1.8	-	2.7

Note: The simulated RMSEs and actual out-of-sample RMSEs for 2003Q1-2005Q1 are derived from Sédillot and Pain (2005, Table 4). The simulated RMSEs for Canada are derived from Mourougane (2006, Table 3) based on the availability of one month of GDP data. The outturn data for 2003-05 are the first available outturn estimate of GDP growth; the outturn data for 2007-12 are the first available published outturn data reported in following issues of the OECD *Economic Outlook*.

Source: Sédillot and Pain (2005); Mourougane (2006); and OECD calculations.

The usefulness of the OECD composite leading indicators since the crisis began

A simple way of assessing whether the real-time CLIs contained information that might have helped to reduce the real-time projection errors is to regress the errors in GDP growth projections on the change in the CLIs that would have been available to forecasters at the time. One-month, 3-month, 6-month and 12-month changes up to the projection date in the CLIs for the G7 countries were considered for the period 2007-12 (see Appendix 7).

Some caution is, of course needed in interpreting the results, but the following points emerge from this exercise:

- It does not appear that there was some information in the CLIs that could have been used to reduce the projection errors made in May 2008 as the downturn got underway.
- However, in the early stages of the recovery, at a time of considerable uncertainty, the errors in the November 2009 and May 2010 growth projections are found to be positively associated with the changes in the CLIs at the time of the forecast.

6.2 Enhanced monitoring of near-term activity developments:

35. Although it took time for the full effects of the sub-prime and Lehman Brothers collapse to start to appear in published activity data, they were reflected swiftly in high-frequency tendency surveys. Developments such as the generalised collapse of confidence during the Great Recession and more recently when the euro area crisis intensified have also pointed to the potential usefulness of early survey-based signals. This has been reflected in a number of ongoing developments:

- The longstanding use of statistical composite leading indicators by the OECD has been augmented by the use of empirical "nowcasting" models, exploiting high-frequency information to gain an early picture of key activity developments (Box 3). Examples used by the OECD in forming projections for the *Economic Outlook* include the suite of quarterly GDP growth models for G7 economies introduced a decade ago (Sédillot and Pain, 2003), and the more recently developed suite of indicator models for global trade (Guichard and Rusticelli, 2011). The OECD growth indicator models during the crisis provided a very useful real-time signal of a significant slowdown and then major contraction. Elsewhere, the indicator model approach is being

extended by using high-frequency information to model private sector expenditure. Assessments are also being undertaken of possible non-linearities in the relationship between indicator variables and growth outcomes at times of extreme stress.

- Greater use has also been made of the anecdotal information gathered from outside business contacts. At times of fast-moving financial developments these may provide an early signal of changes in factors such as credit conditions, and thus near-term activity developments. One example given in the interviews was an early signal about the impact of a freezing of trade credits at the height of the crisis.

- Increasing attempts have been made, though not yet in the OECD, to utilise high-frequency information on real-time activity developments provided by internet-based indicators ("big data"). Internet-based search measures, based on Google Trends, have been used to identify early signals about specific housing and labour market developments (Hellerstein and Middeldorp, 2012; McLaren and Shanbhogue, 2011), as well as policy uncertainty (Baker et al., 2012). Recent studies have also sought to use real-time financial transactions data (such as the volume of SWIFT banking transactions, or data on credit card transactions) as an early indicator of GDP growth and trends in global trade finance (Gill et al., 2012).[23] The usefulness of such indicators when combined with other longstanding indicator variables has yet to be explored.

6.3 Enhanced monitoring of financial market developments and greater integration into the forecast process.

36. Increasing attention is now paid to financial market developments in the construction of the projections and in empirical analysis.

- As the financial crisis progressed, the OECD Secretariat developed new financial conditions indices (FCIs) for the United States, Japan, the euro area and the United Kingdom (Guichard and Turner, 2008; Guichard et al., 2009). These weight together a wide range of financial variables that have a well-established link with GDP growth 12 to 18 months later.[24] The FCIs have been used extensively in the forecasting rounds since 2008-09 and as a guide to possible GDP effects in scenario analyses.

- A limitation of the aggregate FCIs is that they do not pick up all recent financial market developments, notably financial fragmentation in the euro area. Thus some organisations have also sought to directly incorporate country-specific information on bank lending rates and lending conditions in the set of variables being projected.

- In the OECD and elsewhere, discussions with internal financial market specialists and/or outside experts have been strengthened. In the OECD there are regular contacts between the Economics Department and the Directorate for Financial and Enterprise Affairs. Elsewhere, developments include the establishment of new divisions/units covering financial market developments and macro-financial linkages and considering key risks.

23. One example of the usefulness of such indicators was provided by the early signal of the extent of supply disruption in Japan following the earthquake and tsunami in March 2011. As noted in the May 2011 OECD *Economic Outlook*, an indicator of product availability compiled by the Billion Prices Project at MIT showed a fall of around 15% in online product availability in March.

24. The variables used include changes in credit availability, corporate bond spreads, short and long interest rates, exchange rates and household wealth-income ratios.

- Work is underway in some institutions on the difficult tasks of augmenting existing macroeconomic models with more detailed relationships of banking sector behaviour and strengthening linkages to reflect global financial interconnectedness. The macroeconomic models available at the time of the crisis typically ignored the banking system and failed to account for the possibility of bank capital shortages and credit rationing having an impact on macroeconomic developments. However, incorporating the financial sector into macroeconomic models is proving to be a major challenge.

6.4 Enhanced focus on risk assessments and global spill-overs

37. Reflecting the uncertainty about the basic assumptions underlying the projections and the speed and depth of cross-country spillovers since the crisis began, there is now an enhanced focus on risk assessments and global spillovers in all international organisations:

- Greater information is now being provided about the distribution of risks around the central projections. At the OECD, while not providing a numerical risk distribution, the risk profile for the *Economic Outlook* projections has typically been characterised qualitatively as being balanced or skewed or bimodal and the projections themselves characterised as being modal rather than average projections.[25] Other international forecasting organisations have presented their assessed numerical risk distribution in the form of a fan chart or in the form of forecast ranges for key variables.

- Greater use is being made of quantitative scenario analyses to illustrate alternative outcomes and their global implications. One notable example in the OECD was the scenario used to illustrate a severe downside outcome arising from adverse euro area developments (OECD, 2011). This scenario made use of new forecasting tools, such as the financial conditions indices and models linking uncertainty and confidence with final expenditure, as well as a standard macroeconomic model, to calibrate the potential near-term activity impact of deteriorating financial conditions and a collapse in confidence brought about by a further worsening of the euro area crisis.

25. Attempts have also been made to provide an indication of the uncertainty associated with the projections from the growth indicator models (Laurent and Kozluk, 2012; Rusticelli, 2012).

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APPENDIX 1: SUMMARY OF PROJECTION ERRORS

1. This appendix summarises the errors in the GDP growth and inflation projections for each country and for groups of countries.

2. As in the main paper, the key statistics are:

- The average error, which is positive or negative, depending on whether growth (or inflation) was under- or over-predicted on average during the period. This statistic is also a measure of bias.

- The average absolute error and root-mean squared error (RMSE), which are indicators of accuracy. They can be scaled to facilitate comparisons across countries or time – to do this the average absolute error is scaled by average absolute growth (or inflation) during the same period and the RMSE is scaled by the volatility of growth (or inflation) in that period (the standard deviation).

Projections for GDP growth are examined for OECD countries and the BRIICS (Brazil, Russia, India, Indonesia, China and South Africa). Inflation projections, using the percentage change in the private consumption price deflator, are considered for OECD countries.

Errors in annual GDP growth projections

3. In the 2007-2012 period, the average errors in the projections for GDP growth in the following year were negative for almost all countries – i.e. growth was weaker than projected. In contrast, the errors in the May projections for growth in the same year were, on average, close to zero, and negative in less than half of the OECD economies (see Table A1.1).[1]

4. There is a wide range of outcomes around these means. The largest over-predictions of growth amongst those countries where projections were made throughout 2007-2012 were in Greece and Ireland amongst the OECD economies and in Russia for the BRIICS. Some small positive surprises occurred in Poland and Switzerland; these countries also had the smallest errors for the May projections for growth in the following year.

5. The average errors mask offsetting positive and negative errors in the projections. As a result, the average absolute errors or RMSEs (Tables A.1.2 and A.1.3) are larger than the average errors. Average absolute errors are typically around 1 percentage point for the May current year projections, but rise as the forecast horizon is lengthened to over 2 percentage points for most countries. The RMSEs present a similar picture. By both metrics, OECD countries outside of Europe had lower errors in the projections made for growth in the year ahead.

6. Scaling these measures growth outcomes provides a more standardised basis with which to compare accuracy across countries. Key results include:

- When scaled by absolute GDP growth outcomes, the average absolute error in the current year projections is around 20-30% of the typical absolute growth rate of GDP (Table A.1.2, column 4). In contrast, for the average OECD economy, the average absolute error in the May projections for growth in the following year is approximately the same size as the absolute growth rate (Table A.1.2, column 6).

1. The mean error across projections for OECD economies was -0.1 percentage points for the May current year projections, increasing to an over-prediction of 1.4 percentage points for the projections made at May for the following year.

- Errors in the vulnerable euro area economies are a little higher than those for other OECD countries.

- For the BRIICS, the average absolute error, when expressed relative to the average absolute growth rates of these economies, is much lower than in the OECD economies.

- On the basis of the RMSEs relative to the volatility of growth, the projections for the OECD countries were typically as accurate as those for the BRIICS (Table A.1.3., columns 4 to 6). Projection errors are, on average, around one-half of the volatility of GDP growth in the May current year projections, but broadly equal to the standard deviation of growth in the May projections for growth in the following year.

- After allowing for actual outcomes, the largest year-ahead projection errors were made for Hungary, Ireland and Luxembourg. The smallest year-ahead projection errors were made for Iceland, Norway and Spain.

Table A.1.1. Average errors of GDP growth projections for 2007-12

Percentage points

	May projection for current year	November projection for next year	May projection for next year
OECD countries			
Australia	0.2	-0.3	-0.5
Austria	0.2	-0.1	-0.5
Belgium	0.0	-0.4	-0.9
Canada	-0.4	-0.5	-1.2
Chile[1]	0.5	0.7	0.5
Czech Republic	-0.3	-1.8	-2.4
Denmark	-0.8	-1.5	-1.8
Estonia[1]	1.4	-1.0	1.8
Finland	-0.8	-1.4	-1.8
France	-0.4	-0.6	-1.2
Germany	0.1	-0.2	-0.6
Greece	-1.2	-2.6	-3.7
Hungary	-0.6	-1.4	-3.0
Iceland	0.3	0.7	-1.2
Ireland	-0.3	-1.9	-3.5
Israel[1]	0.7	0.5	1.2
Italy	-0.5	-1.5	-2.1
Japan	0.0	-1.3	-1.5
Korea	-0.2	-0.9	-1.4
Luxembourg	-0.8	-1.5	-2.4
Mexico	0.1	-0.9	-1.6
Netherlands	0.1	-0.7	-1.2
New Zealand	0.4	-0.2	-1.0
Norway	-0.2	-0.7	-0.5
Poland	0.2	0.1	0.0
Portugal	0.2	-0.8	-1.4
Slovak Republic	0.1	-0.8	-1.6
Slovenia[1]	-1.2	-4.1	-2.3
Spain	0.1	-0.9	-1.3
Sweden	0.0	-1.0	-1.3
Switzerland	0.3	0.1	-0.2
Turkey	0.0	-0.7	-1.5
United Kingdom	-0.4	-1.0	-1.7
United States	-0.2	-0.4	-1.0
OECD aggregate projection	-0.1	-0.7	-1.2
Non-OECD countries			
Brazil	-0.1	-0.4	-0.9
China	0.1	-0.1	-0.6
India	-0.7	-0.7	-0.9
Indonesia[1]	0.4	0.1	-0.2
Russia	-0.8	-1.7	-2.3
South Africa[1]	-0.7	-0.7	-1.8
Country group averages[2]			
OECD	-0.1	-0.9	-1.4
Euro area	-0.2	-1.1	-1.5
Euro area: core	-0.1	-0.9	-1.1
Euro area: vulnerable	-0.3	-1.5	-2.4
Other OECD Europe	-0.1	-0.7	-1.4
OECD outside Europe	0.1	-0.4	-0.8
BRIICS	-0.2	-0.6	-1.0

Note: Errors are calculated as actual growth less projected growth at each forecast horizon, where actual growth is the published outturn as at May the following year. A negative (positive) average error indicates over(under)-prediction. All projections are calendar year except India, which is fiscal year. "OECD aggregate projection" refers to the published projection for the OECD area.

1. Projections only available for part of the period 2007-12.

2. Countries included in the "euro area: vulnerable group" are: Greece, Ireland, Italy, Portugal and Spain.

Source: OECD, Economic Outlook databases; and OECD calculations.

Table A.1.2. Average absolute errors of GDP growth projections for 2007-12

	Average absolute error Percentage points			Ratio of average absolute error to average absolute growth		
	May projection for current year	November projection for next year	May projection for next year	May projection for current year	November projection for next year	May projection for next year
OECD countries						
Australia	0.8	0.8	1.1	0.3	0.3	0.4
Austria	0.4	1.2	1.9	0.2	0.5	0.8
Belgium	0.7	1.1	1.9	0.4	0.6	1.0
Canada	0.4	0.9	2.0	0.2	0.4	0.9
Chile	0.9	0.9	0.5	0.2	0.2	0.1
Czech Republic	0.7	2.4	3.3	0.2	0.8	1.1
Denmark	1.1	1.8	2.4	0.6	0.9	1.3
Estonia	1.5	5.1	2.7	0.2	0.7	0.6
Finland	1.6	2.8	3.2	0.5	0.9	1.0
France	0.6	0.7	1.6	0.4	0.5	1.2
Germany	0.8	1.4	2.4	0.3	0.5	0.9
Greece	1.2	2.7	3.8	0.3	0.6	0.9
Hungary	0.8	2.1	4.0	0.4	1.0	2.0
Iceland	1.2	1.7	2.3	0.4	0.5	0.7
Ireland	1.5	2.3	3.7	0.6	0.9	1.4
Israel	1.0	1.2	2.2	0.3	0.4	0.5
Italy	0.7	1.5	2.4	0.3	0.8	1.3
Japan	0.9	2.0	2.6	0.4	0.8	1.1
Korea	1.3	1.7	2.3	0.4	0.5	0.7
Luxembourg	1.3	2.0	3.8	0.5	0.8	1.6
Mexico	0.8	2.2	2.6	0.2	0.5	0.6
Netherlands	0.6	1.2	2.2	0.3	0.5	1.0
New Zealand	1.4	1.4	2.1	0.7	0.7	1.0
Norway	0.6	1.1	1.0	0.3	0.5	0.5
Poland	0.9	1.0	1.9	0.2	0.2	0.5
Portugal	0.7	1.1	2.1	0.4	0.6	1.2
Slovak Republic	0.7	2.4	3.3	0.1	0.5	0.6
Slovenia	1.2	4.1	2.7	0.4	1.4	2.2
Spain	0.3	1.1	1.8	0.1	0.6	1.0
Sweden	1.5	2.3	3.2	0.5	0.7	1.0
Switzerland	0.7	0.8	1.6	0.4	0.4	0.8
Turkey	1.7	3.5	5.0	0.3	0.7	1.0
United Kingdom	0.5	1.1	2.1	0.3	0.6	1.2
United States	0.3	0.6	1.7	0.1	0.3	0.8
OECD aggregate projection	0.4	1.0	1.9	0.2	0.5	0.9
Non-OECD countries						
Brazil	1.1	2.0	2.7	0.3	0.6	0.7
China	0.8	0.9	1.2	0.1	0.1	0.1
India	1.4	1.9	2.2	0.2	0.3	0.3
Indonesia	0.4	0.5	1.3	0.1	0.1	0.2
Russia	1.3	2.5	3.2	0.2	0.4	0.6
South Africa	0.7	0.8	1.8	0.2	0.3	0.6
Country group averages						
OECD	0.9	1.7	2.5	0.3	0.6	1.0
Euro area	0.9	1.8	2.4	0.3	0.6	1.1
Euro area: core	0.8	1.9	2.3	0.3	0.6	1.0
Euro area: vulnerable	0.9	1.8	2.8	0.3	0.7	1.1
Other OECD Europe	1.0	1.8	2.7	0.4	0.7	1.0
OECD outside Europe	0.8	1.2	1.7	0.3	0.5	0.8
BRIICS	1.0	1.6	2.3	0.2	0.3	0.4

Note: Errors are calculated as actual growth less projected growth at each forecast horizon, where actual growth is the published outturn as at May the following year. All projections are calendar year except India, which is fiscal year. Projections are only available for part of the period 2007-12 for Chile, Estonia, Israel, Slovenia, Indonesia and South Africa; these are excluded from country group averages of the ratio of average absolute error to average absolute growth. Countries included in the "euro area: vulnerable" group are: Greece, Ireland, Italy, Portugal and Spain.

Source: OECD, Economic Outlook databases; and OECD calculations.

Table A.1.3. RMSE of GDP growth projections for 2007-12

	RMSE Percentage points			Ratio of RMSE to standard deviation of growth outcomes		
	May projection for current year	November projection for next year	May projection for next year	May projection for current year	November projection for next year	May projection for next year
OECD countries						
Australia	0.9	0.9	1.2	0.9	0.9	1.1
Austria	0.5	1.5	2.4	0.2	0.6	1.0
Belgium	0.7	1.4	2.5	0.3	0.7	1.1
Canada	0.5	1.3	2.5	0.2	0.6	1.1
Chile	0.9	1.1	0.5	2.3	2.6	1.6
Czech Republic	0.9	3.1	4.3	0.2	0.9	1.2
Denmark	1.3	2.3	2.9	0.5	0.9	1.1
Estonia	1.8	6.7	2.9	0.2	0.7	1.1
Finland	1.8	3.8	4.5	0.4	0.9	1.0
France	0.7	1.0	2.0	0.4	0.6	1.2
Germany	0.9	2.0	3.0	0.3	0.6	1.0
Greece	1.8	3.1	4.5	0.4	0.7	1.0
Hungary	0.9	2.6	4.7	0.3	0.9	1.6
Iceland	1.5	1.9	3.0	0.4	0.5	0.7
Ireland	2.0	3.1	5.1	0.5	0.8	1.4
Israel	1.4	1.4	2.7	0.8	0.8	3.2
Italy	0.8	2.1	3.2	0.3	0.8	1.3
Japan	1.3	2.6	3.4	0.4	0.8	1.1
Korea	1.5	1.9	2.7	0.7	0.9	1.3
Luxembourg	1.8	2.8	4.5	0.6	1.0	1.5
Mexico	1.0	3.2	4.3	0.2	0.7	1.0
Netherlands	0.7	1.7	2.9	0.2	0.6	1.1
New Zealand	1.7	1.8	2.2	0.8	0.9	1.1
Norway	0.7	1.4	1.5	0.4	0.8	0.8
Poland	1.1	1.0	2.2	0.6	0.6	1.2
Portugal	1.0	1.4	2.5	0.5	0.7	1.2
Slovak Republic	0.9	3.8	4.8	0.2	0.8	1.0
Slovenia	1.5	5.4	3.2	0.4	1.3	1.8
Spain	0.3	1.4	2.4	0.1	0.6	1.0
Sweden	2.0	2.9	4.0	0.5	0.8	1.1
Switzerland	0.8	1.0	1.8	0.5	0.6	1.2
Turkey	1.8	4.1	5.6	0.3	0.8	1.1
United Kingdom	0.6	1.7	2.9	0.2	0.6	1.1
United States	0.4	0.8	1.9	0.2	0.4	1.0
OECD aggregate projection	0.5	1.4	2.5	0.2	0.6	1.1
Non-OECD countries						
Brazil	1.3	2.2	3.0	0.4	0.7	1.0
China	0.9	1.1	1.4	0.6	0.7	1.0
India	1.8	2.1	2.5	0.9	1.0	1.2
Indonesia	0.6	0.6	1.5	0.7	0.7	7.2
Russia	1.4	4.3	6.0	0.2	0.8	1.1
South Africa	0.7	0.9	1.8	2.3	3.1	4.4
Country group averages						
OECD	1.2	2.6	3.4	0.4	0.7	1.1
Euro area	1.2	2.9	3.4	0.4	0.7	1.1
Euro area: core	1.2	3.1	3.3	0.3	0.7	1.1
Euro area: vulnerable	1.3	2.4	3.7	0.4	0.7	1.1
Other OECD Europe	1.2	2.4	3.5	0.4	0.7	1.1
OECD outside Europe	1.1	1.8	2.5	0.5	0.7	1.1
BRIICS	1.2	2.4	3.6	0.5	0.8	1.1

Note: Errors are calculated as actual growth less projected growth at each forecast horizon, where actual growth is the published outturn as at May the following year. All projections are calendar year except India, which is fiscal year. Projections are only available for part of the period 2007-12 for Chile, Estonia, Israel, Slovenia, Indonesia and South Africa; these are excluded from country group averages of the ratio of the RMSE to the standard error of growth. Countries included in the "euro area: vulnerable" group are: Greece, Ireland, Italy, Portugal and Spain.

Source: OECD, Economic Outlook databases; and OECD calculations.

Errors in quarterly GDP growth projections

7. In the assessment below of errors in the quarterly growth projections, current quarter growth estimates are taken to be those made for Q2 and Q4 respectively (reflecting the May and November publication dates). The one-quarter-ahead projections are correspondingly for Q3 and Q1 in the following year and the two-quarter-ahead projections refer to Q4 in the current year and Q2 in the following year.

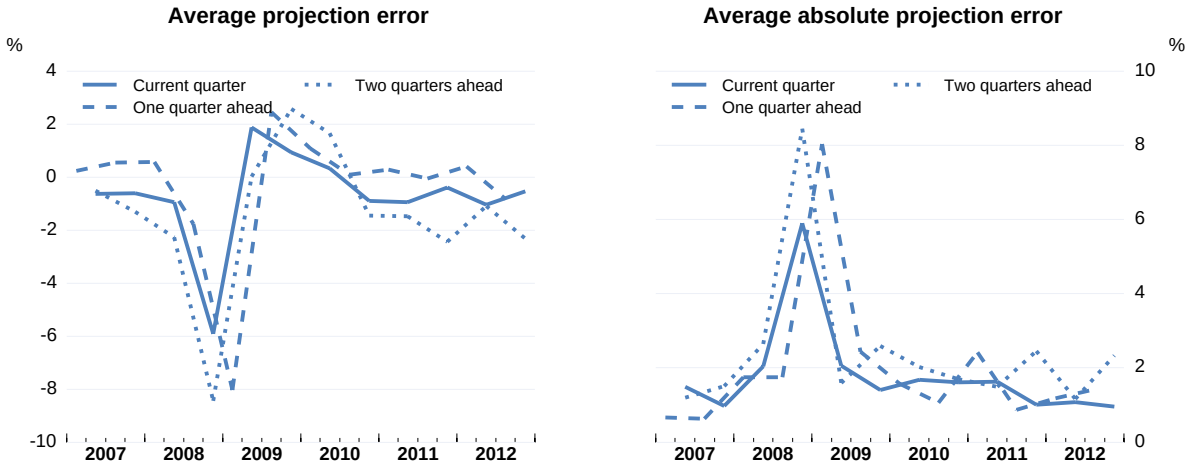
8. Reflecting the difficulties of projecting the full extent of the financial crisis, the largest individual quarterly errors were made in the projections for 2008Q4 and 2009Q1, with the errors falling sharply thereafter (Figure A1.1). That is, the largest current quarter and one-quarter-ahead projection errors were made in the November 2008 forecast, after Lehman Brothers had already collapsed; the largest two-quarter-ahead projection error was made in the May 2008 forecasting round.

9. Quarterly average growth projection errors are typically negative for G7 countries (Table A.1.4). As might be expected from the pattern of the annual growth errors, the two-quarter-ahead projection is the most negative for each country and is generally around ½ - ¾ of a percentage point (at an annualised rate) higher than current-quarter error. Measures of forecast accuracy – the average absolute error and RMSE – generally rise with the forecast horizon. The RMSEs of two-quarter-ahead projection errors are close to one standard deviation of growth. However, there is little difference between current quarter and one-quarter-ahead projection performance.

10. The errors in the quarterly growth projections for the United States were close to zero on average and were the most accurate of the G7 economies after allowing for outcomes. One-quarter-ahead projection errors for France and Germany were also close to zero. Although projections for Canadian growth were too high on average, the RMSEs adjusted for growth volatility were amongst the lowest at each horizon. Quarterly projections for Italy and Japan appear the least accurate by most metrics.

Figure A.1.1. Average error in G7 annualised quarterly growth projections over time

2007Q1-2012Q4, percentage points



Note: See Box 1 for description of the calculation of quarterly projection errors and the different quarterly projections considered. A negative (positive) average error indicates over-(under)prediction.

Source: OECD, Economic Outlook databases; and OECD calculations.

Table A.1.4. Errors in annualised quarterly GDP growth projections for G7 countries

2007Q1-2012Q4, percentage points unless noted

A. Average projection error

	Mean error			Mean absolute error		
	Current quarter	One-quarter ahead	Two-quarters ahead	Current quarter	One-quarter ahead	Two-quarters ahead
Canada	-0.5	-0.4	-1.1	1.3	1.7	2.0
France	-0.6	0.0	-1.1	1.4	1.2	1.9
Germany	-0.3	-0.1	-1.1	1.8	2.9	3.0
Italy	-1.5	-1.2	-2.3	1.9	1.8	2.4
Japan	-1.4	-0.9	-2.5	3.2	3.6	3.5
United Kingdom	-0.9	-0.4	-1.5	1.5	1.3	2.3
United States	0.0	0.0	-0.4	1.6	1.3	1.8
Mean G7 country	-0.7	-0.4	-1.4	1.8	2.0	2.4
Median G7 country	-0.6	-0.4	-1.1	1.6	1.7	2.3

B. RMSE of projections

	Percentage points			Ratio to standard deviation of growth		
	Current quarter	One-quarter ahead	Two-quarters ahead	Current quarter	One-quarter ahead	Two-quarters ahead
Canada	1.6	2.2	2.5	0.6	0.7	1.0
France	1.9	1.6	2.5	0.9	0.7	1.2
Germany	2.9	4.6	4.2	0.7	0.9	1.0
Italy	2.6	3.0	3.4	0.9	0.9	1.2
Japan	4.4	5.3	5.1	1.0	0.9	1.1
United Kingdom	1.9	2.1	2.9	0.7	0.7	1.0
United States	1.9	1.7	2.6	0.6	0.7	0.9
Mean G7 country	2.5	2.9	3.3	0.8	0.8	1.1
Median G7 country	1.9	2.2	2.9	0.7	0.7	1.0

Note: Errors are calculated as actual growth less projected growth at each forecast horizon, where actual growth is the published outturn as at publication of the following *Economic Outlook*. A negative (positive) average error indicates over(under)-prediction.

Source: OECD Economic Outlook databases and OECD calculations

Errors in inflation projections

11. At each forecast horizon, inflation, as measured by the percentage change in the private consumption deflator, was typically underestimated during 2007-12, despite the overestimate of growth outcomes in the same set of projections (Table. A.1.5). For the average (unweighted mean) OECD country the average error in the May projections of inflation in the following year was 0.4 percentage points, compared to an average errors of -1.4 percentage points for GDP growth. The only year where inflation was overestimated for the mean OECD country was 2009 (Figure A.1.2).

12. The inflation underestimates were particularly large for European countries outside of the euro area, reflecting primarily the large errors made in the projections for Iceland (Table A.1.5, Figure A.1.3). Given the distortions that arise from these specific errors, Iceland is generally excluded from the analysis of the projection errors below. Inflation projection errors for Mexico and Turkey were also large and positive. The largest over-predictions were made for Ireland, Japan and Switzerland.

13. Other notable findings include:

- The average errors mask offsetting positive and negative errors in different years. Average absolute errors are typically around ½ percentage point for the May current year projections, rising with the forecast horizon to around 1¼ percentage point (Table A.1.6). RMSEs are marginally higher and also rise with the forecast horizon (Table A.1.7).

- Using either metric, the errors made in the year-ahead inflation projections for countries outside Europe are smaller than the average errors made in the projections for European countries.

- Projection errors for the year ahead are more evenly distributed around zero than for GDP growth (which was typically over-predicted for almost all countries). For example in the May projections for inflation in the following year, inflation was under-predicted on average for only 21 of the 30 countries with projections for the whole period.

14. A better comparison of accuracy can be obtained by scaling the average absolute error and RMSE by the absolute inflation outcomes and the standard deviation of inflation, respectively. This also enables comparisons to be made between the relative accuracy of the GDP growth and inflation projections.

- The average absolute error in the current year projections is around 20% of the typical absolute rate of inflation (Table A.1.6, right hand side). For the mean OECD country, the absolute errors in the May projections for the year ahead were around half of the absolute growth rate.

- On average, in the May current-year projections, the RMSE for OECD countries is around one-half of the volatility of inflation over 2007-12, similar to the outcome observed earlier for the GDP growth projections. However, by this metric, the inflation projections made for the following year were less accurate than the equivalent GDP growth projections over 2007-12; the RMSE of the year-ahead projections made in November is almost the same as the volatility of inflation and in the May projections for the following year the ratio exceeds one.[2]

- There are a handful of countries in which the inflation projection errors do not widen uniformly as the forecast horizon expands.

- The RMSEs in the year-ahead inflation projections were greatest in the "vulnerable" euro area countries (Table A.1.7). However, once allowance is made for cross-country differences in the volatility of inflation, the least accurate projections during the period were in European countries outside of the euro area, particularly Hungary, Poland and Turkey.

2. In contrast, Abreu (2011) found that inflation forecasts produced by the IMF, European Commission and Consensus Economics generally had a smaller error than growth projections after allowing for differences in in-sample volatility. The difference with the results reported here could be due to the use of different price series (Abreu used national consumer price inflation rather than the harmonised private consumption deflator), a different sample time period or differences in the countries considered.

Table A.1.5. Average errors of inflation projections for 2007-12

Percentage points

	May projection for current year	November projection for next year	May projection for next year
OECD countries			
Australia	-0.1	-0.2	0.1
Austria	0.2	0.6	0.6
Belgium	0.2	0.5	0.7
Canada	0.0	0.1	0.0
Chile[1]	-0.7	-0.3	-1.0
Czech Republic	-0.6	-0.3	-0.3
Denmark	0.1	0.6	0.2
Estonia[1]	0.0	-0.7	1.9
Finland	-0.3	0.1	0.3
France	0.0	0.3	0.2
Germany	0.1	0.1	0.2
Greece	0.4	0.4	0.9
Hungary	0.0	0.6	2.0
Iceland	1.6	2.0	4.1
Ireland	-0.2	-0.7	-0.7
Israel[1]	0.5	0.0	0.0
Italy	0.1	0.3	0.3
Japan	-0.1	-0.5	-0.7
Korea	-0.3	-0.2	-0.1
Luxembourg	0.3	0.5	0.5
Mexico	0.9	1.2	1.8
Netherlands	-0.3	0.2	-0.1
New Zealand	0.1	-0.3	0.1
Norway	-0.2	-0.3	-0.3
Poland	0.4	0.7	0.5
Portugal	-0.1	-0.1	0.1
Slovak Republic	0.6	-0.2	0.2
Slovenia[1]	0.0	-0.3	0.6
Spain	0.1	0.6	0.7
Sweden	-0.4	-0.1	-0.3
Switzerland	-0.2	-0.4	-0.6
Turkey	0.4	0.9	2.3
United Kingdom	0.1	0.3	0.9
United States	0.1	0.3	0.4
OECD aggregate projection	0.1	0.3	0.4
Country group averages[2]			
OECD	0.1	0.2	0.4
Euro area	0.1	0.1	0.4
Euro area: core	0.1	0.2	0.4
Euro area: vulnerable	0.0	0.1	0.3
Other OECD Europe	0.1	0.4	0.8
OECD outside Europe	0.0	0.0	0.1

Note: Errors are calculated as actual inflation less projected growth at each forecast horizon, where actual inflation is the published outturn as at May the following year. A negative (positive) average error indicates over(under)-prediction.

1. Projections only available for part of the period 2007-12.

2. There is only partial coverage for Chile, Estonia, Israel and Slovenia. Countries included in the “euro area: vulnerable” group are: Greece, Ireland, Italy, Portugal and Spain.

Source: OECD, Economic Outlook databases; and OECD calculations.

Table A.1.6. Average absolute errors of inflation projections for 2007-12

	Average absolute error Percentage points			Ratio of average absolute error to average absolute inflation		
	May projection for current year	November projection for next year	May projection for next year	May projection for current year	November projection for next year	May projection for next year
OECD countries						
Australia	0.3	0.5	0.4	0.1	0.2	0.2
Austria	0.3	0.6	1.0	0.1	0.3	0.4
Belgium	0.4	1.2	1.3	0.2	0.5	0.6
Canada	0.4	0.3	0.3	0.3	0.2	0.2
Chile	0.9	0.7	1.1	0.4	0.3	0.5
Czech Republic	0.7	0.8	1.1	0.3	0.3	0.5
Denmark	0.3	0.7	0.9	0.1	0.3	0.4
Estonia	0.7	2.7	1.9	0.2	1.0	0.6
Finland	0.5	0.6	1.1	0.2	0.3	0.5
France	0.3	0.6	1.0	0.2	0.4	0.6
Germany	0.3	0.5	0.8	0.2	0.3	0.5
Greece	0.5	1.0	1.5	0.2	0.3	0.5
Hungary	0.8	0.6	2.0	0.2	0.1	0.4
Iceland	2.5	3.0	4.2	0.3	0.4	0.5
Ireland	0.6	1.2	1.4	0.2	0.5	0.6
Israel	0.8	0.6	1.0	0.3	0.2	0.4
Italy	0.2	0.9	1.1	0.1	0.4	0.5
Japan	0.2	0.7	0.8	0.2	0.6	0.8
Korea	0.4	0.9	0.9	0.1	0.3	0.3
Luxembourg	0.7	1.1	1.2	0.3	0.4	0.5
Mexico	0.9	1.7	1.9	0.2	0.3	0.4
Netherlands	0.5	0.9	1.0	0.3	0.5	0.6
New Zealand	0.4	0.8	0.9	0.2	0.3	0.4
Norway	0.4	0.8	1.0	0.2	0.5	0.5
Poland	0.5	0.7	1.4	0.2	0.2	0.4
Portugal	0.6	1.1	1.5	0.2	0.5	0.6
Slovak Republic	0.7	0.8	1.4	0.3	0.3	0.5
Slovenia	1.1	1.6	0.7	0.6	0.8	0.3
Spain	0.6	1.5	1.9	0.2	0.6	0.7
Sweden	0.7	0.5	0.6	0.4	0.3	0.4
Switzerland	0.4	0.4	0.8	0.6	0.7	1.2
Turkey	0.9	2.1	3.0	0.1	0.3	0.4
United Kingdom	0.6	1.0	1.4	0.2	0.4	0.5
United States	0.2	0.7	1.0	0.1	0.4	0.5
OECD aggregate projection	0.2	0.6	0.9	0.1	0.3	0.4
Country group averages						
OECD	0.5	0.9	1.2	0.2	0.4	0.5
Euro area	0.5	1.0	1.2	0.2	0.4	0.5
Euro area: core	0.5	0.9	1.0	0.2	0.4	0.5
Euro area: vulnerable	0.5	1.1	1.5	0.2	0.5	0.6
Other OECD Europe	0.6	0.9	1.4	0.3	0.3	0.5
OECD outside Europe	0.4	0.7	0.8	0.2	0.3	0.4

Note: Errors are calculated as actual inflation less projected growth at each forecast horizon, where actual inflation is the published outturn as at May the following year. All projections are calendar year except India, which is fiscal year. Projections are only available for part of the period 2007-12 for Chile, Estonia, Israel and Slovenia; these are excluded from country group averages of the ratio of average absolute error to average absolute inflation. Countries included in the "euro area: vulnerable" group are: Greece, Ireland, Italy, Portugal and Spain. "OECD" and "Other OECD Europe" excludes Iceland.

Source: OECD, Economic Outlook databases; and OECD calculations.

Table A.1.7. RMSE of inflation projections for 2007-12

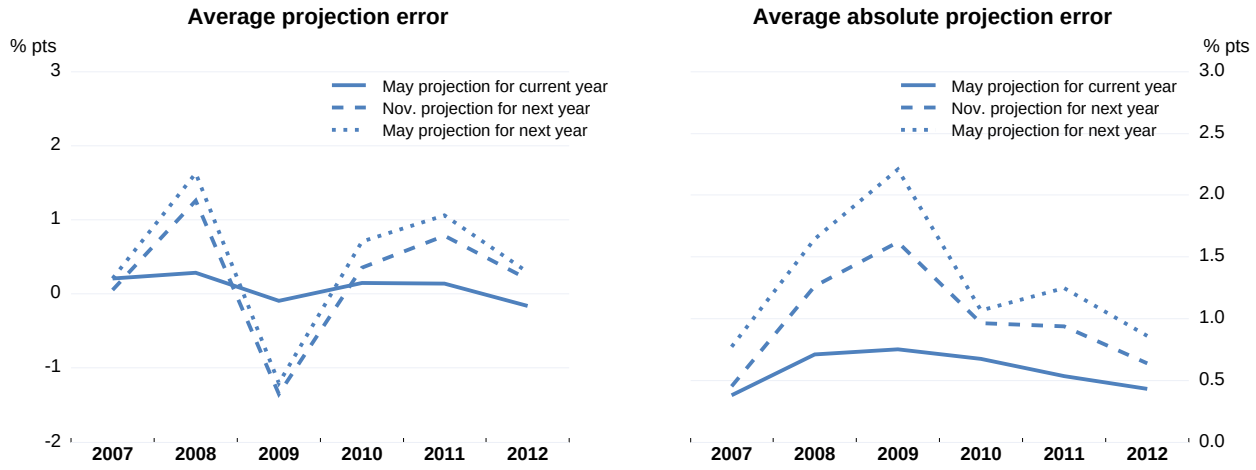
	RMSE Percentage points			Ratio of RMSE to standard deviation of inflation outcomes		
	May projection for current year	November projection for next year	May projection for next year	May projection for current year	November projection for next year	May projection for next year
OECD countries						
Australia	0.4	0.6	0.7	0.5	0.9	0.9
Austria	0.4	0.7	1.1	0.6	1.0	1.5
Belgium	0.4	1.4	1.6	0.3	0.9	1.1
Canada	0.4	0.3	0.4	0.8	0.6	0.7
Chile	1.3	0.8	1.5	0.8	0.4	0.8
Czech Republic	0.9	1.0	1.5	0.5	0.6	0.8
Denmark	0.4	0.9	0.9	0.6	1.4	1.4
Estonia	0.7	3.6	2.2	0.3	1.5	1.6
Finland	0.5	0.8	1.2	0.5	0.7	1.1
France	0.5	0.7	1.2	0.5	0.7	1.2
Germany	0.4	0.6	1.0	0.5	0.8	1.3
Greece	0.7	1.3	1.9	0.5	0.9	1.2
Hungary	0.9	0.8	2.2	1.0	1.0	2.7
Iceland	2.9	4.5	6.1	0.5	0.9	1.2
Ireland	0.7	1.9	2.3	0.2	0.7	0.8
Israel	1.0	0.7	1.1	1.6	1.1	1.5
Italy	0.2	1.1	1.3	0.2	0.9	1.1
Japan	0.3	0.9	1.2	0.4	1.0	1.3
Korea	0.5	1.0	0.9	0.6	1.3	1.1
Luxembourg	0.8	1.4	1.5	0.5	0.8	0.9
Mexico	1.3	2.0	2.6	0.6	1.0	1.3
Netherlands	0.9	1.1	1.5	0.8	1.0	1.3
New Zealand	0.5	0.9	1.0	0.6	1.0	1.1
Norway	0.4	1.0	1.2	0.4	0.8	1.0
Poland	0.7	0.9	1.5	0.9	1.3	2.0
Portugal	0.6	1.5	1.9	0.3	0.8	1.0
Slovak Republic	1.0	1.0	1.6	0.7	0.7	1.1
Slovenia	1.2	2.0	0.8	0.8	1.3	1.7
Spain	0.6	1.7	2.2	0.4	1.1	1.4
Sweden	1.0	0.6	0.6	1.4	0.8	0.9
Switzerland	0.5	0.5	0.9	0.6	0.7	1.2
Turkey	1.3	2.4	3.2	0.8	1.5	2.0
United Kingdom	0.7	1.4	1.8	0.6	1.3	1.7
United States	0.3	0.9	1.1	0.2	0.8	1.1
OECD aggregate projection	0.2	0.7	1.0	0.2	0.9	1.2
Country group averages						
OECD	0.7	1.3	1.6	0.6	0.9	1.3
Euro area	0.7	1.4	1.6	0.5	0.8	1.2
Euro area: core	0.7	1.4	1.3	0.5	0.8	1.2
Euro area: vulnerable	0.6	1.5	2.0	0.3	0.9	1.1
Other OECD Europe	0.8	1.2	1.7	0.8	1.0	1.5
OECD outside Europe	0.7	1.0	1.2	0.5	0.9	1.1

Note: Errors are calculated as actual growth less projected inflation at each forecast horizon, where actual inflation is the published outturn as at May the following year. A negative indicates over(under)-prediction. Projections are only available for part of the period 2007-12 for Chile, Estonia, Israel and Slovenia; these are excluded from country group averages of the ratio of the RMSE to the standard error of inflation. Countries included in the "euro area: vulnerable" group are: Greece, Ireland, Italy, Portugal and Spain. "OECD" and "Other OECD Europe" excludes Iceland.

Source: OECD, Economic Outlook databases; and OECD calculations.

Figure A.1.2. Average errors of calendar year inflation projections in recent years

Unweighted mean across countries in each year

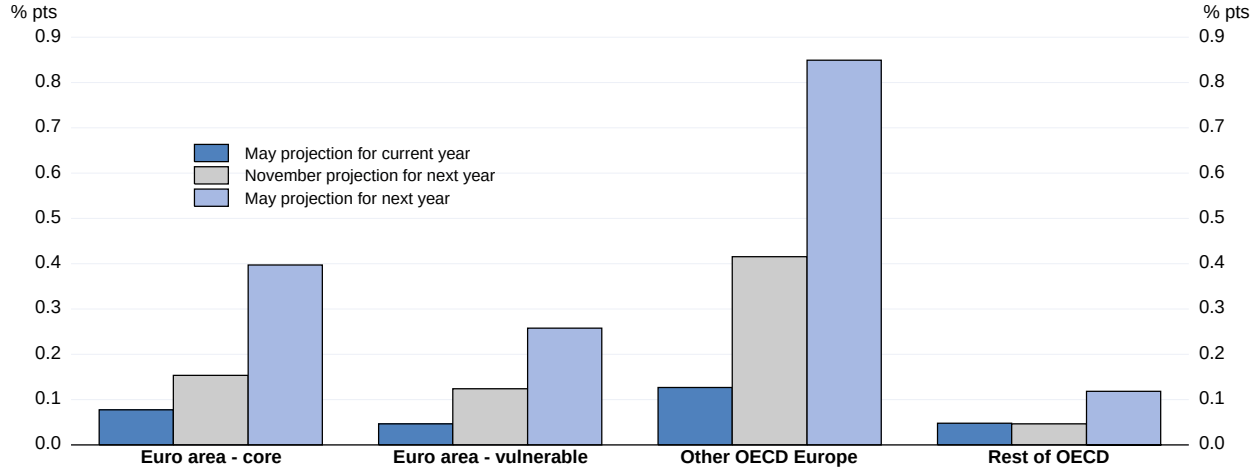


Note: Errors are calculated as actual inflation less projected inflation at each forecast horizon, where actual inflation is the published outturn as at May the following year. A negative (positive) average error indicates over-(under)prediction. There is only partial coverage for Chile, Estonia, Israel and Slovenia.

Source: OECD, Economic Outlook databases; and OECD calculations.

Figure A.1.3. Average errors of calendar year inflation projections by country group

Unweighted average over 2007-12, percentage points



Note: Errors are calculated as actual inflation less projected inflation at each forecast horizon, where actual inflation is the published outturn as at May the following year. A positive average error indicates under-prediction. There is only partial coverage for Chile, Estonia, Israel and Slovenia. Countries included in the 'euro area: vulnerable' group are: Greece, Ireland, Italy, Portugal and Spain.

Source: OECD, Economic Outlook databases; and OECD calculations.

APPENDIX 2: STATISTICAL PROPERTIES OF THE PROJECTIONS IN THE CRISIS AND RECOVERY

1. This appendix provides further details of the outcomes from formal econometric tests of the properties of the GDP growth and inflation projection errors. The properties assessed include whether the projections are unbiased, efficient, contain statistically significant information and are qualitatively useful.

2. Generally, the tests are performed using pooled regressions for a panel of 30 OECD countries for which projections were made throughout the period 2007-12, and separately, for the BRIICS, where an unbalanced panel is used. Given the relatively small sample size, especially for the BRIICS, some caution is merited in drawing strong conclusions from the empirical results.

Properties of the GDP growth projections

Are the growth projections unbiased?

3. A simple test of whether the projections are systematically biased, or non-zero, is to regress the projection errors (E_{it}) on a constant:

$$E_{it} = \alpha + \varepsilon_{it} \qquad (2.1)$$

$$\text{where } E_{it} = Outcome_{it} - Projection_{it}$$

If the projections are unbiased, then α=0. The estimated value of α from each pooled OLS regression is reported in Table A.2.1, along with the standard error and asterisks to indicate statistical significance (providing an indicator of bias). As in the majority of econometric estimates reported below, robust White standard errors are used to correct for potential heteroskedasticity and serial correlation in the errors. Serial correlation is tested following Wooldridge (2010).[1] A Jarque-Bera test statistic for normality of the errors is also reported. In general, there appear to be problems with non-normality of the errors and often serial correlation (although the latter is not surprising given overlapping errors due to use of calendar year average growth rates); accordingly, as emphasised above, some caution is required in interpreting the results shown. As in Vogel (2007), each regression was also estimated with country fixed effects but these were found to be statistically insignificant in most instances.

4. The errors in GDP growth projections for 2007-12 are negative and statistically different from zero at all forecasting horizons, rejecting the null hypothesis of unbiasedness (Table A.2.1). For both the OECD countries and the BRIICS, the bias increases with the forecast horizon. Vogel (2007) also found that the year-ahead OECD growth projections for the G7 countries were biased, but in that sample, which covered a much longer time period with a number of different business cycles, the current year projections were unbiased. Although the errors in May projections for the year ahead appear serially correlated, as would be expected given the moving average error structure implied by overlapping projection errors, this is not the case for other horizons.

1. The lagged errors from the initial regression are included in a revised regression, with coefficient ρ. If ρ is statistically significant, the null hypothesis of non-correlation is rejected.

Table A.2.1. Bias in annual GDP growth projections
2007-12

	OECD countries			BRIICS		
	May projection for current year	November projection for next year	May projection for next year	May projection for current year	November projection for next year	May projection for next year
α	-0.15	-0.84	-1.47	-0.31	-0.62	-1.00
(standard error)	(0.07)**	(0.12)***	(0.16)***	(0.17)*	(0.27)**	(0.35)***
R-squared	0.00	0.00	0.00	0.00	0.00	0.00
Jarque-Bera statistic	17.2***	38.7***	16.7***	1.2	90.1***	94.2***
Serial correlation: ρ	-0.08	-0.05	-0.13***	0.17	-0.06	-0.15**
No. of observations	180	180	180	31	31	29

Note: OECD countries with partial coverage for the period are excluded (Chile, Estonia, Israel and Slovenia). The BRIICS sample is unbalanced due to lack of data for Indonesia and South Africa. Robust standard errors reported in parentheses. *, ** and *** denote significance at the 10%, 5% and 1% levels respectively. ρ is the coefficient in the regression: $E_{it} = \alpha + \rho\widehat{\varepsilon_{it-1}} + e_{it}$; the test is ρ=0.

Source: OECD, Economic Outlook databases; and OECD calculations.

How informative are the growth projections?

5. A simple way of assessing whether the projections contain statistically significant information is to use a forecast encompassing test (Fair and Shiller, 1990) to examine whether they add value over an alternative forecast. Here the alternative growth forecast is taken to be the last observed calendar year growth outturn at the time of the forecast. A more stringent test is whether they encompass the naïve forecast. For the May current year growth projections, the following regression is used:

$$X_{it} = \alpha + \beta X_{it-1} + \delta P_{it} + \varepsilon_{it} \qquad (2.2)$$

Here, growth outcomes in year t (X_{it}) are regressed on the growth outcome observed in year t-1 (X_{it-1}) and the projection for growth in year t (P_{it}). If the projections encompass the naïve forecast, so that the naïve forecast does not improve the prediction of growth, then β=0, (and δ=0 is rejected) and thus $X_{it} = \alpha + \delta P_{it} + \varepsilon_{it}$.[2] At a minimum, the coefficient on the projections should be positive.

6. In the equivalent test for the projections in May of year t for GDP growth in the following year t+1, outcomes are regressed on the growth outturn for year t-1, the projection of growth in year t, and projected growth in year t+1, reflecting the information set available at the time of the projections. Forecast encompassing requires that β=γ=0 and that δ=0 is rejected, so that the equation below reduces to $X_{it+1} = \alpha + \delta P_{it+1} + \varepsilon_{it+1}$.

$$X_{it+1} = \alpha + \beta X_{it-1} + \gamma P_{it} + \delta P_{it+1} + \varepsilon_{it+1} \qquad (2.3)$$

7. The empirical results suggest that the projections for OECD countries and the BRIICS are informative but do not always encompass a naïve forecast (Table A.2.2).

- For OECD and BRIICS projections at both horizons, the coefficient on the projections (or their sum) are positive, suggesting that the projections contain statistically significant information of use for estimating growth outcomes.

2. There are several hypotheses that can be explored with this test (Newbold and Harvey, 2004). For instance, following Diebold and Lopez (1996), a joint test of the unbiasedness and efficiency of the projections can also be undertaken; this requires the restrictions α=β=0 and γ=1 to be satisfied.

- The current year projections for the BRIICS, made in May, encompass a naïve forecast. In all other cases, forecast encompassing is rejected, with both the projections and the competing "naïve forecasts" containing statistically significant information and neither one encompassing the other. This suggests that the OECD projections do not take into account all available information at the time they are produced.
- Vogel (2007) reported qualitatively similar findings over an earlier sample period for the OECD growth projections for the G7 economies. The May current-year growth projections improved upon a naïve forecast but the growth projections for the following year were no better than extrapolating the previous year's growth rate.

Table A.2.2. Do the GDP growth projections beat a naïve forecast?

2007-12

	OECD countries		BRIICS	
	May projection for current year	May projection for next year	May projection for current year	May projection for next year
α	0.01	-2.00	-0.65	-3.76
(standard error)	(0.12)	(0.45)***	(0.28)**	(1.44)**
β	-0.07	-0.23	0.02	-0.22
(standard error)	(0.03)**	(0.06)***	(0.04)	(0.09)**
γ	-	-0.60	-	-0.57
(standard error)	-	(0.09)***	-	(0.12)***
δ	0.95	1.52	1.03	2.03
(standard error)	(0.03)***	(0.20)***	(0.01)***	(0.23)***
Forecast encompassing:				
F-statistic (β=γ=δ=0)	543.6***	24.0***	8047.3***	29.5***
F-statistic (β=γ=0)	-	29.8***	-	15.5***
R-squared	0.87	0.30	0.90	0.40
Jarque-Bera statistic	37.4***	25.7***	1.4	52.0***
Serial correlation: ρ	0.13	0.50***	0.16	-0.02
No. of observations	180	150	30	24

Note: OECD countries with partial coverage for the period are excluded (Chile, Estonia, Israel and Slovenia). The BRIICS sample is unbalanced due to lack of data for Indonesia and South Africa. Robust standard errors reported in parentheses. *, ** and *** denote significance at the 10%, 5% and 1% levels respectively. ρ is the coefficient on the lagged errors when included in the original regression; the test is ρ=0.

Source: OECD, Economic Outlook databases; and OECD calculations.

Are the growth projections efficient?

8. A stronger requirement of the projections is forecast efficiency, i.e. that the projection includes all information available at the time of the projection. This can be tested in a number of ways: the earlier tests for unbiasedness and forecast encompassing are two possibilities. A weak indication is that forecast accuracy improves as the forecast horizon shrinks.

9. A formal and widely-used test of weak efficiency is to regress the growth outcome on a constant and projected growth, then test jointly that α=0 and β=1 so that the outcome (X_{it}) equals the projection (P_{it}).[3] The residuals should also be white noise (unless there are overlapping moving average errors, which is most likely to occur in the May projections for growth in the following year).

$$X_{it} = \alpha + \beta P_{it} + \varepsilon_{it} \quad (2.4)$$

3. As noted above, this test can also be performed jointly with the test for forecast encompassing.

10. These tests suggest that the projections for 2007-12 are generally not efficient, although they confirm the earlier finding that the projections contain statistically significant information (Table A.2.3). For the projections of growth in OECD countries, the joint test of $\alpha=0$ and $\beta=1$ is rejected for each forecast horizon. For the BRIICS, the projections for the two shortest forecast horizons are found to be efficient but the May projections for growth the following year are not.[4] However, the coefficient on the projections (β) is positive in all cases and not statistically different from 1 for the November projections for OECD countries and the projections for the BRIICS. The residuals generally do not appear to be serially correlated except for the May projections for next-year growth in the BRIICS.

11. These findings are broadly similar to those of Vogel (2007) for the G7 countries over a longer period, with the exception that the May current year growth projections were found to be weakly efficient in that sample. A second difference is that the projections at May for the next year are positively related to the growth outcomes over 2007-12, after the average overestimate across the whole sample is allowed for, whereas this was not the case in the pre-crisis sample period.

Table A.2.3. Efficiency of GDP growth projections

2007-12

	OECD countries			BRIICS		
	May projection for current year	November projection for next year	May projection for next year	May projection for current year	November projection for next year	May projection for next year
α	-0.06	-1.13	-0.52	-0.49	-2.15	-0.60
(standard error)	(0.10)	(0.29)***	(0.40)	(0.24)*	(1.34)	(0.99)
β	0.92	1.16	0.61	1.03	1.25	0.94
(standard error)	(0.03)***	(0.11)***	(0.14)***	(0.03)***	(0.20)***	(0.17)***
F-statistic (α=0, β=1)	6.8***	23.6***	42.1***	2.2	2.5	4.1**
R-squared	0.86	0.53	0.10	0.89	0.64	0.27
Jarque-Bera statistic	30.5***	43.6***	16.0***	1.5	47.4***	95.4***
Serial correlation: ρ	0.04	-0.03	-0.01	0.19	-0.05	-0.16**
No. of observations	180	180	180	31	31	29

Note: OECD countries with partial coverage for the period are excluded (Chile, Estonia, Israel and Slovenia). The BRIICS sample is unbalanced due to lack of data for Indonesia and South Africa. Robust standard errors reported in parentheses. *, ** and *** denote significance at the 10%, 5% and 1% levels respectively. ρ is the coefficient on the lagged errors when included in the original regression; the test is ρ=0.

Source: OECD, Economic Outlook databases; and OECD calculations.

Are successive growth projections related to each other?

12. A second set of tests for forecast efficiency is to look at the revisions made in successive forecasts for a given forecast horizon and test whether they are unbiased and not significantly correlated with each other. Projection revisions from one forecasting round to the next should be small and unpredictable if all relevant information is included in each projection. There are two sets of revisions to consider: the revisions made between May and November to the projections for growth in the following year, and the revisions made between November and May in the following year to the projections for growth in that year.

4. The table reports results estimated without country fixed effects. There is evidence that the fixed effects are significant for the errors in May projections for BRIICS for the following year but the finding of inefficiency remains.

13. One test is that in a regression of the projection revisions on a constant, the estimated constant equals zero. Thus the test for efficiency is that α=0 in the following regressions:

$$(P_{it}^{Nov\ for\ next\ year} - P_{it}^{May\ for\ next\ year}) = \alpha + \varepsilon_{it} \quad (2.5)$$

$$(P_{it}^{May\ for\ current\ year} - P_{it}^{Nov\ for\ next\ year}) = \alpha + \varepsilon_{it} \quad (2.6)$$

For the OECD countries, the forecasts through the sample period were downwardly revised, typically by 0.6 percentage points in November and then 0.7 percentage points the following May when the year was underway (Table A.2.4). Vogel (2007) also found that forecast revisions were systematically downwards, although the typical adjustment was smaller than in the current sample. The revisions to the BRIICS growth projections were typically smaller, although the sample is small and unbalanced, so it is not directly comparable.

Table A.2.4. Relationship between successive projections

2007-12

	OECD countries		BRIICS	
	Revision from May for next year to November for next year	Revision from November for next year to May of current year	Revision from May for next year to November for next year	Revision from November for next year to May of current year
α	-0.64	-0.69	-0.36	-0.31
(standard error)	(0.08)***	(0.08)***	(0.10)***	(0.15)***
R-squared	0.00	0.00	0.00	0.00
Jarque-Bera statistic	392***	204***	20.1***	255***
Serial correlation: ρ	-0.24***	-0.19***	-0.43***	-0.25***
No. of observations	180	180	29	31

Note: OECD countries with partial coverage for the period are excluded (Chile, Estonia, Israel and Slovenia). The BRIICS sample is unbalanced due to lack of data for Indonesia and South Africa. Robust standard errors reported in parentheses. *, ** and *** denote significance at the 10%, 5% and 1% levels respectively. ρ is the coefficient on the lagged errors when included in the original regression; the test is ρ=0.

Source: OECD, Economic Outlook databases; and OECD calculations.

14. A second test is whether successive revisions to forecasts for a specific horizon are systematically related. If revisions are based only on information that became available after the last projection was published, there should be no relationship between the revisions and in the following regression it would not be possible to reject the hypothesis β=0. A significant positive value for β would suggest that revisions are smoothed (Dovern et al., 2013), and a significant negative value suggests that the first revision is typically too large and later unwound.

$$(P_{it}^{Nov\ for\ next\ year} - P_{it}^{May\ for\ next\ year}) = \alpha + \beta(P_{it}^{May\ for\ this\ year} - P_{it}^{Nov\ for\ next\ year}) + \varepsilon_{it} \quad (2.7)$$

15. Using pooled panel estimates, the revisions to each year's GDP growth projections are found to be significantly positively correlated for both the OECD countries and the BRIICS (Table A.2.5), implying that revisions are smoothed across periods.[5] Allowing for time fixed effects, the average downward

5. For both sets of countries, the hypothesis that the two sets of revisions are of equal size (β=1) cannot be rejected.

revision for OECD countries becomes larger but the relationship with the previous revision disappears. Vogel (2007) also found that time fixed effects were highly significant over the longer sample.

Table A.2.5. Relationship between successive revisions to projections

2007-12

	OECD countries		BRIICS	
	Pooled	Time fixed effects	Pooled	Time fixed effects
α	-0.21	-0.71	0.20	0.22
(standard error)	(0.11)**	(0.17)***	(0.15)	(0.11)*
β	0.75	-0.03	1.34	1.39
(standard error)	(0.25)***	(0.31)	(0.40)***	(0.46)***
R-squared	0.26	0.66	0.58	0.74
Jarque-Bera statistic	269***	331***	3.5	1.0
Serial correlation: ρ	-0.04	-0.14	0.15	-0.12
No. of observations	180	180	29	29

Note: OECD countries with partial coverage for the period are excluded (Chile, Estonia, Israel and Slovenia). The BRIICS sample is unbalanced due to lack of data for Indonesia and South Africa. Robust standard errors reported in parentheses. *, ** and *** denote significance at the 10%, 5% and 1% levels respectively. ρ is the coefficient on the lagged errors when included in the original regression; the test is ρ=0.

Source: OECD, Economic Outlook databases; and OECD calculations.

Are the growth projections directionally accurate?

16. Rather than using only the magnitude of the errors, forecast accuracy can also be judged by whether the 'story' is qualitatively correct. That is, whether growth pick-ups and slowdowns are usually anticipated. Here, in contrast to other studies (such as Vogel, 2007; Abreu, 2011) only changes above a certain threshold are considered, in order to minimise the extent to which growth outcomes that are essentially "little changed" are classified as pick-ups or slowdowns. The threshold used is that the rounded change in growth (to one decimal place) must be greater than 0.1 percentage points for a pick-up or less than -0.1 percentage points for a slowdown.[6] As above, only the information set available to the forecaster at the time of the projection is used. So for the projections made in May for growth in the same year, the change in growth is given by the difference between the projection and the previous year's outcome. The change over the year ahead is calculated as the difference between the May forecasts for growth in the following year and for growth in the current year.

17. Key findings from this exercise include:

- Between 2007 and 2012, there were more than twice as many year-on-year declines in growth than growth pick-ups (Table A.2.6).

- In general, growth pick-ups were correctly identified around 90% of the time, whether they occurred in the current year, or the year ahead. Growth declines were also correctly identified around 90% of the time in the current year, but were poorly identified for the year ahead, being projected only 50% of the time.

6. Relaxing the threshold to consider strictly positive or negative cases (still based on the rounded data) does not change the findings reported below, except to marginally increase the rate of correct prediction. Conversely, increasing the strictness of the threshold to 0.2 percentage points marginally reduces the accuracy of the projections.

- There was also a sizeable proportion of year-ahead projections (almost 30% of the sample) that were directionally inaccurate – i.e. the opposite profile was forecast. These were almost entirely due to pick-ups being projected instead of declines.

- On the occasions when a growth slowdown was correctly projected, the extent of the slowdown was underestimated. Only 1 of the 24 cases in which growth declined and was negative was predicted in the preceding May. This is consistent with the negative bias in the projections noted earlier.

18. Directional accuracy can be tested statistically using the non-parametric statistic proposed by Pesaran and Timmerman (1992). It is a test of whether there is a significant difference between the observed probability of the relationship between the three outcomes – increased, "unchanged", and decreased – and the predictions, where the null is that the projections and outcomes are independent. For both sets of growth projections, the hypothesis that the projections and outcomes are independently distributed is strongly rejected (at the 1% level of significance).

19. Overall, the directional, or qualitative, accuracy of the OECD projections during recent years does not appear to differ greatly from the findings in other studies using different or longer sample periods. It is well-established that it is very difficult to correctly project downturns a year ahead, with even poorer outcomes around major turning points in growth (Vogel, 2007; Koske and Pain, 2008). Abreu (2011) also highlighted the general tendency for forecasters tend to underestimate the fall in GDP even when a recession is correctly projected.

Table A.2.6. Directional accuracy of the GDP growth projections

Change in growth from previous year, 2007-12

	OECD countries		BRIICS	
	Increases	**Decreases**	**Increases**	**Decreases**
Number of cases in the period	56	116	12	17
% correct - projections for current year	86	88	83	76
% correct - projections for next year	91	46	73	53
Memo items for next-year projections				
% correct where growth was positive	84	100	-	-
% correct where growth was negative	60	4	-	-

Note: OECD countries with partial coverage for the period are excluded (Chile, Estonia, Israel and Slovenia). The BRIICS sample is unbalanced due to lack of data for Indonesia and South Africa. Projections for 2006 are included to calculate directional accuracy of the projections for the next year in 2007. The threshold for an increase or decrease is a change growth exceeding 0.1 percentage points (from rounded data).

Source: OECD, Economic Outlook databases; and OECD calculations.

Are the errors in the growth projections correlated across countries?

20. Cross-country correlations in projection errors can also be used to shed light on the nature of the errors. If forecast errors were independent of each other, cross-country correlations would be zero. However, in recent years, given the large common shock of the financial crisis, the difficulty of measuring and estimating the impact of the growing interconnectedness between economies, and the relatively small sample period, it would not be surprising to find that errors were positively correlated. This might be especially likely for more distant projection horizons, when there is less information available. Alternatively, unforeseen country-specific shocks – for instance, a bank failure or large exchange rate movements – could cause forecast errors to be negative.

21. Simple pairwise correlations suggest that the projection errors over 2007-12 are, on average, systematically related across countries (Table A.2.7). The correlations are typically positive, with the extent of correlation being greatest for the most distant forecast horizons. For the OECD economies, the majority of the pairwise error correlations are significantly different from zero in the May and November projections for growth in the following year. Errors in the projections for the following year are less strongly correlated between the four BRICs than between OECD countries.

Table A.2.7. Summary of pairwise correlations of projection errors by country group

2007-12

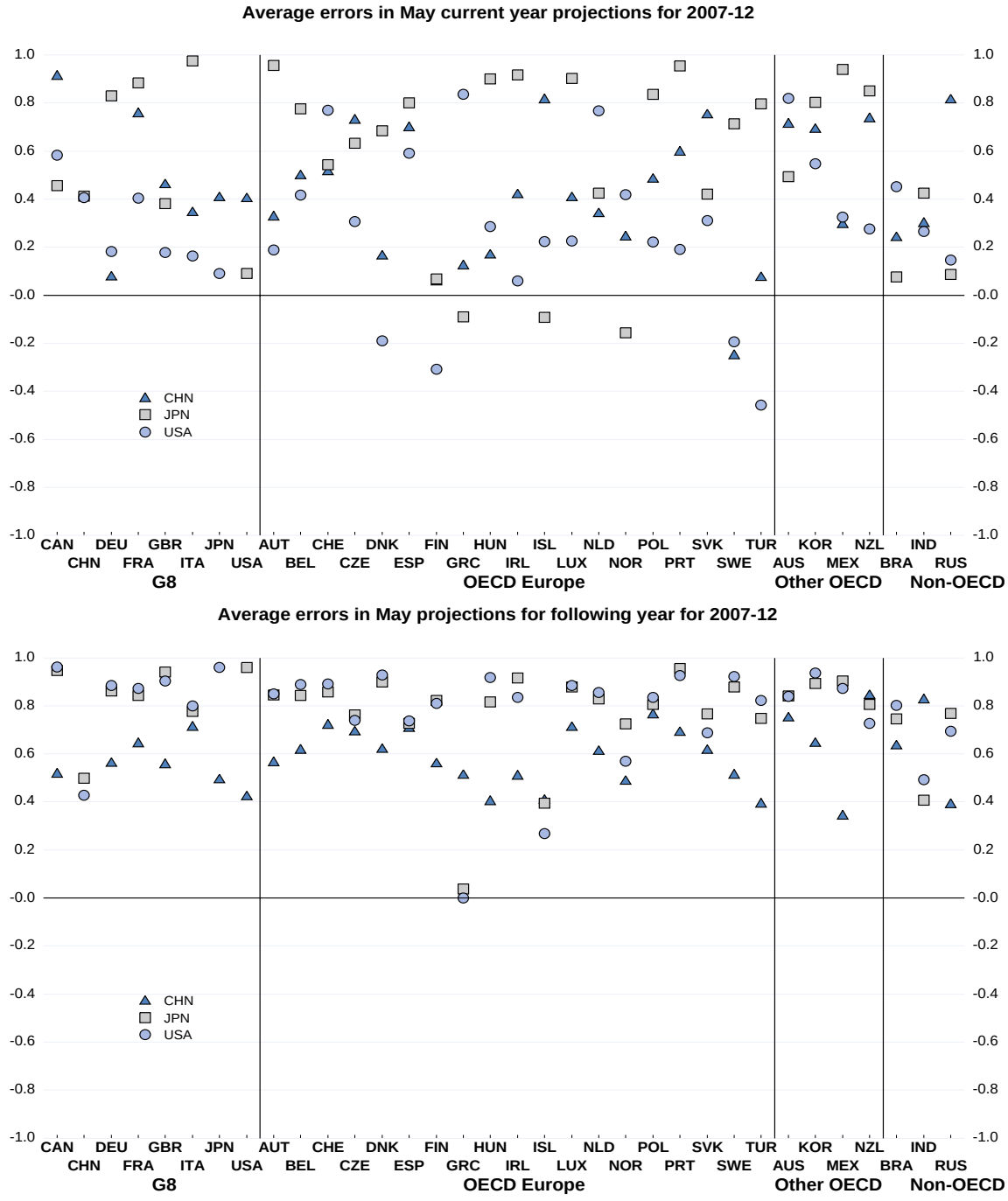
	OECD countries			BRICs		
	May projections for current year	November projections for next year	May projections for next year	May projections for current year	November projections for next year	May projections for next year
Average	0.49	0.65	0.80	0.43	0.34	0.60
Min	-0.60	-0.58	-0.07	0.14	-0.11	0.24
Max	1.00	0.99	1.00	0.91	0.70	0.83
Percentage of pairs that are:						
Positive and significant	32	63	76	33	0	33
Positive and insignificant	57	29	23	67	83	67
Negative and insignificant	11	8	1	0	17	0
Negative and significant	0	0	0	0	0	0

Note: Countries with partial coverage for the period are excluded (Chile, Estonia, Israel and Slovenia for the OECD and Indonesia and South Africa for the BRICs). The threshold for significance is the 10% level.

Source: OECD, Economic Outlook databases; and OECD calculations.

22. The respective pairwise correlations between the growth forecast errors for the United States, Japan and China and those of other countries are shown in Figure A.2.1, using the May current year and year-ahead growth projections. The distribution of the correlations is much wider and closer to zero for the current-year growth projection errors than in the year-ahead growth projection errors. This is consistent with forecasters having less information on the nature of country-specific shocks as the forecast horizon becomes more distant. A second interesting feature is the similarity and strength of the correlations in year-ahead errors between the individual countries and the United States and Japan, compared to the relatively weaker relationship with the errors in the projections for China.

Figure A.2.1. Correlations in projection errors with major countries



Note: Countries with partial coverage for the period are excluded (Chile, Estonia, Israel and Slovenia for the OECD and Indonesia and South Africa for the BRICs).

Source: OECD, Economic Outlook databases; and OECD calculations

Properties of the inflation projections

23. Tests of bias, efficiency and directional accuracy can also be performed on the inflation projections. To improve comparability across countries, inflation is defined as the percentage change in the private consumption price deflator. Generally, the tests are performed for 29 OECD countries: the four countries with partial coverage are excluded (Chile, Estonia, Israel and Slovenia) as is Iceland, because its values are so extreme that they change some results (inflation recorded double-digit rates of growth in 2008 and 2009 during the height of the domestic banking crisis).

Are the inflation projections unbiased?

24. Unbiasedness is again tested by whether $\alpha=0$ in equation (2.1). The errors in the current year inflation projections for 2007-12 are unbiased, but the projections made at May and November for the next year are biased, with inflation underestimated (Table A.2.8). This is consistent with the averages shown in Appendix 1. As with the errors in the GDP growth projections, the bias increases as the forecast period lengthens. None of the sets of inflation projections display serial correlation during this timeframe.

Table A.2.8. Bias in annual inflation projections

OECD countries, 2007-12

	May projection for current year	November projection for next year	May projection for next year
α	0.04	0.19	0.34
(standard error)	(0.06)	(0.08)**	(0.00)***
Country fixed effects?	No	No	Yes
R-squared	0.00	0.00	0.22
Jarque-Bera statistic	69.1***	27.4***	37.9***
Serial correlation: ρ	0.06	-0.11	-0.22
No. of observations	174	174	174

Note: Iceland and countries with partial coverage (Chile, Estonia, Israel and Slovenia) are excluded. Robust standard errors reported in parentheses. *, ** and *** denote significance at the 10%, 5% and 1% levels respectively. Following Wooldridge (2010), the test for the absence of serial correlation is ρ=0 for pooled regressions and ρ=-0.2 with country fixed effects.

Source: OECD, Economic Outlook databases; and OECD calculations.

How informative are the inflation projections?

25. A forecast encompassing test is used to test whether the inflation projections contain statistically significant information and whether they encompass a competing "naïve forecast" (see equation (2.2) above). The forecasts are informative if the coefficient on the projections is significantly different from zero ($\delta=0$ is rejected). The projections encompass the naïve forecast if $\beta=0$ (and $\delta=0$ is rejected) for the current year projections and $\beta=\gamma=0$ (and $\delta=0$ is rejected) for the year-ahead projections.

26. The results suggest that the inflation projections from May of the same year encompass a naïve forecast but that the projections for the following year do not (Table A.2.9).

- The signs on the projections for inflation are positive and statistically significant in the pooled regressions, suggesting that the forecasts do contain useful information for estimating inflation outcomes.
- The current year projections made in May appear to encompass a naïve forecast: the coefficient on the previous outturn is insignificant and the joint test that the coefficients on the previous outturn and the projection are equal to zero is rejected. But encompassing is rejected for the projections for the following year, with the sign on the past realisation positive and significant.

The failure to encompass the alternative projection suggests that OECD inflation forecasts do not take into account all available information at the time the projection is undertaken.

- When differences in average errors across countries are allowed for (using country fixed effects), the current year OECD projections still appear informative but do not encompass the previous outturns because the coefficient on the previous realisation is significant. However, the sign on the projections for the next year is negative and not significantly different from zero at the 5% level, suggesting that the year-ahead projections contain little information of use. In both cases, the country fixed effects are jointly significant, suggesting that the fixed effects regressions are to be preferred to the other regressions.[7]

Table A.2.9. Do the inflation projections beat a naïve forecast?

OECD countries, 2007-12

	Pooled regression		With country fixed effects	
	May projection for current year	May projection for next year	May projection for current year	May projection for next year
α	-0.03	0.33	0.60	4.50
(standard error)	(0.09)	(0.30)	(0.08)***	(0.34)***
β	0.03	0.16	-0.13	-0.47
(standard error)	(0.04)	(0.09)*	(0.03)***	(0.07)***
γ	-	-0.08	-	-0.24
(standard error)	-	(0.08)	-	(0.09)**
δ	0.98	0.80	0.88	-0.37
(standard error)	(0.05)***	(0.21)***	(0.06)***	(0.17)**
Forecast encompassing:				
F-statistic (β=γ=δ=0)	384.5***	11.8***	607.9***	24.3***
F-statistic (β=γ=0)	-	3.8**	-	28.3***
R-squared	0.88	0.36	0.92	0.83
Jarque-Bera statistic	41.7***	7.7**	9.5***	1.9
Serial correlation: ρ	0.10	0.03	-0.14	-0.25
No. of observations	145	116	145	116

Note: Iceland and countries with partial coverage (Chile, Estonia, Israel and Slovenia) are excluded. Robust standard errors reported in parentheses. *, ** and *** denote significance at the 10%, 5% and 1% levels respectively. Following Wooldridge (2010), the test for the absence of serial correlation is ρ=0 for pooled regressions and ρ=-0.2 with country fixed effects.

Source: OECD, Economic Outlook databases; and OECD calculations.

Are the inflation projections efficient?

27. The projections can be tested for weak efficiency using equation (2.4) above, applying a joint F-test of α=0 and β=1. The empirical results suggest that the two sets of projections with the closest forecast horizons contain statistically significant information, with positive and significant coefficients on the projections (Table A.2.10). However, the results also suggest that none of the inflation projections satisfy the conditions for weak efficiency with the null of α=0 and β=1 rejected for each set of projections. One difference from the earlier findings on the GDP growth projections is the tests for the May projections allowed for different average inflation rates using country fixed effects (which are jointly significantly different from zero); however, without country fixed effects, the null of weak efficiency cannot be rejected for the current year projections. There is also evidence that the inflation forecasts are smoothed, with successive revisions found to be positively related (based on equation (2.7) above).

7. The usefulness of this finding is limited. It implies that a set of projections using only the in-sample mean as the projection for each country would have been a better strategy to adopt. However, this is only true on an ex-post basis, provided the in-sample inflation means were different from their historical average (the only information available on a real-time basis).

Table A.2.10. Efficiency of inflation projections

OECD countries, 2007-12

	May projection for current year	November projection for next year	May projection for next year
α	0.30	-0.02	2.35
(standard error)	-(0.26)	(0.14)	(0.74)***
β	0.89	1.09	0.04
(standard error)	(0.09)***	(0.05)***	(0.46)
F-statistic (α=0, β=1)	0.8	6.0***	9.1***
Country dummies?	Yes	No	Yes
R-squared	0.91	0.66	0.65
Jarque-Bera statistic	11.7***	37.8***	12.1***
Serial correlation: ρ	-0.21	-0.16**	-0.17
No. of observations	174	174	174

Note: Iceland and countries with partial coverage (Chile, Estonia, Israel and Slovenia) are excluded. Robust standard errors reported in parentheses. *, ** and *** denote significance at the 10%, 5% and 1% levels respectively. Following Wooldridge (2010), the test for the absence of serial correlation is ρ=0 for pooled regressions and ρ=-0.2 with country fixed effects.

Source: OECD, Economic Outlook databases; and OECD calculations.

Are the inflation projections directionally accurate?

28. Directional accuracy is assessed using the same approach and definitions as for GDP growth earlier. Key findings from this exercise include:

- Between 2008 and 2012 there were more cases of rising, rather than falling, inflation across the OECD (see Table A.2.11).
- Overall, the directional accuracy of the current year projections for inflation is similar to that of the current year growth projections: 90% of the pick-ups in inflation were correctly predicted and 83% of inflation slowdowns were correctly predicted.
- Directional accuracy is lower for the longer horizon: the overall accuracy of the year ahead forecasts made in May falls to 60%, compared to around 80% for the current year projections. In marked contrast to the year-ahead GDP growth projections, falls in inflation are more accurately predicted (82%) than pick-ups, with the chances of projecting the latter no better than a coin toss. Many of the same explanations for the tendency to underestimate inflation apply here also, including expecting large output gaps to cause disinflation and unanticipated austerity measures.
- As for the growth projections, the hypothesis that the projections and outcomes for inflation are independently distributed is strongly rejected (at the 1% level of significance) using a Pesaran-Timmermann test.

Table A.2.11. Directional accuracy of inflation projections

Change in inflation from previous year, OECD countries, 2008-12

	Increases	Decreases
Number of cases in the period	78	60
% correct - projections for current year	90	83
% correct - projections for next year	49	82

Note: OECD countries with partial coverage for the period (Chile, Estonia, Israel and Slovenia) are excluded. The threshold for an increase or decrease is a change in growth exceeding 0.1 percentage points (from rounded data).

Source: OECD, Economic Outlook databases; and OECD calculations.

Are the errors in the inflation projections correlated across countries?

29. Simple pairwise correlations between the inflation projection errors across countries suggest that the errors in same year projections are not systematically related over 2007-12 on average, in contrast to the finding obtained using the GDP growth errors (Table A.2.12). The pairwise correlations are mostly not significantly different from zero and are also more evenly distributed around zero. This suggests that country-specific shocks may be more important for these errors. The errors in the May and November projections for inflation in the following year do appear to have common elements with a larger share being significantly positively correlated. In each set of projections, the proportion of significantly correlated forecasts is smaller than for the corresponding GDP growth projections.

Table A.2.12. Summary of pairwise correlations of inflation projection errors

OECD countries, 2007-12

	May projections for current year	**November projections for next year**	**May projections for next year**
Average	0.02	0.46	0.50
Min	-0.94	-0.91	-0.89
Max	0.97	0.98	0.99
Percentage of pairs that are:			
Positive and significant	5	31	41
Positive and insignificant	49	52	47
Negative and insignificant	42	16	10
Negative and significant	5	1	2

Note: Iceland and countries with partial coverage (Chile, Estonia, Israel and Slovenia) are excluded. The threshold for significance is the 10% level.

Source: OECD, Economic Outlook databases; and OECD calculations.

APPENDIX 3: COMPARISONS WITH OTHER FORECASTERS

1. In light of the unusual events of recent years, the performance of other forecasters provides a useful benchmark for assessing the performance of the OECD forecasts. This appendix compares OECD projections to those of other forecasters over the 2007-12 period as well as a longer sample covering 1991 to 2012. Three other prominent sets of projections are considered here: those published by two other international organisations – the IMF and the European Commission – and the consensus forecasts published by Consensus Economics, which surveys private-sector economists. If one set of forecasts outperforms others, there may be lessons that can be drawn. To provide context for the findings, the relative performance of consensus and the OECD forecasts are also compared over the past two decades.

Short-run comparison of growth projection errors

2. The IMF projections are taken from those published in the *World Economic Outlook*, generally issued in the first half of April and October each year. The European Commission projections are taken from its Spring and Autumn forecasts, usually published in between those of the IMF and the OECD. Consensus Economics publish private-sector forecasts monthly; to maximise comparability with the *Economic Outlook*, the May and November forecasts are used. Thus, on balance in the comparisons, the OECD forecasts have a small but unavoidable informational advantage over the IMF and European Commission forecasts, but only limited informational differences with the consensus forecasts.[1] For all projections the outcome variable is taken to be the GDP growth estimates published in the *Economic Outlook* in May following the end of the year being projected.[2] For comparability with earlier exercises of this type (see, for instance, Vogel, 2007) the comparison focusses on the G7 economies only.

3. As commonly found in forecast comparison studies, no individual set of projections clearly outperforms the others in all respects. Indeed, the similarity of the profile of errors in the respective projections over 2007-12 is striking, with growth overestimated on average in all four sets of projections (Table A.3.1), especially for the following year. The (unweighted) G7 average error is little different across the different sets of forecasts and the dispersion of the individual projection errors for each country is broadly similar at all forecast horizons. Growth disappointments were especially large in Italy, with growth typically around 2 percentage points weaker than had been projected a year earlier.

4. Of course, it is possible that although mean errors are similar, one institution may have larger, but offsetting errors. Root-mean squared errors (RMSEs) are one way of accounting for this. For easier comparison across countries, the RMSEs are scaled by the volatility of growth outcomes during the period. Again, the similarity across institutions is striking (Table A.3.2). On average the RMSE of the May projections for growth in the same year are all around one-third of the standard deviation of growth in this period. Equally, the RMSE of the May year-ahead projections are all marginally above one standard

1. Consensus Economics publishes the mean of private-sector economist forecasts that it surveys. To the extent that some economists update their forecasts infrequently, the OECD forecasts have some informational advantage.

2. It could be argued that each institution's dataset of first outturns should be used; however, Abreu (2011) found this made little difference.

deviation of growth. At the margin, the RMSEs in the OECD projections at November for growth the next year are slightly smaller, which may be due to the slight informational advantage (between October and November), with updated data that can used as leading indicators at the OECD. At the country level, projections errors are remarkably similar across forecasters, with year-ahead growth in Italy appearing the hardest to forecast accurately. The errors in the year-ahead projections for France at May are also large.

5. One difference between the international organisations' forecasts and consensus forecasts is the nature of the forecasts: the international organisations are constrained in the assumptions they can make about policy and financial variables, which gives rise to their characterisation as "projections" rather than pure forecasts (as discussed in the main text). Even though private-sector forecasters are less constrained in their assumptions about policy and financial variables, it is interesting that the consensus forecasts do not outperform those of the international institutions.

6. IMF projections are also readily available for all of the OECD countries, enabling a comparison of errors across country groups. Once more, the magnitude of the average errors and RMSEs is generally similar for the two sets of forecasts (Table A.3.3). As above, the OECD November projections for the following year are more accurate than the October projections of the IMF, pointing to a slight informational advantage in the OECD projections due to their later publication. The RMSEs of the April/May projections for the following year (which are the set of forecasts where the OECD has the smallest relative informational advantage) are almost identical. On average, the 2007-12 OECD projections for the vulnerable euro area countries were a little less biased than those of the IMF. In contrast, the IMF projections for the BRIICS were less biased than those of the OECD, especially at more distant forecast horizons. There is, however, little difference in the RMSEs for the BRIICS projections.

Table A.3.1. Comparison of average projection errors across institutions

G7 countries, 2007-12

A. May projections for current year

	OECD	IMF	European Commission	Consensus
Canada	-0.4	-0.2	-0.3	-0.3
France	-0.4	-0.2	-0.3	-0.3
Germany	0.1	0.7	0.5	0.3
Italy	-0.5	-0.5	-0.6	-0.7
Japan	0.0	-0.3	-0.2	-0.1
United Kingdom	-0.4	-0.5	-0.5	-0.5
United States	-0.2	0.0	0.0	-0.2
Average	-0.2	-0.1	-0.2	-0.2

B. November projections for next year

	OECD	IMF	European Commission	Consensus
Canada	-0.5	-0.9	-0.6	-0.7
France	-0.6	-0.9	-0.8	-0.7
Germany	-0.2	-0.1	-0.2	-0.3
Italy	-1.5	-1.6	-1.7	-1.5
Japan	-1.3	-1.4	-1.1	-1.2
United Kingdom	-1.0	-1.4	-1.1	-1.1
United States	-0.4	-0.5	-0.3	-0.6
Average	-0.8	-1.0	-0.8	-0.9

C. May projections for next year

	OECD	IMF	European Commission	Consensus
Canada	-1.2	-1.2	-1.2	-1.3
France	-1.2	-1.1	-1.0	-1.1
Germany	-0.6	-0.1	-0.4	-0.5
Italy	-2.1	-1.8	-2.0	-1.9
Japan	-1.5	-1.4	-1.2	-1.7
United Kingdom	-1.7	-1.7	-1.7	-1.7
United States	-1.0	-0.7	-0.8	-1.3
Average	-1.3	-1.2	-1.2	-1.4

Note: Errors are calculated as actual growth less projected growth at each forecast horizon, where actual growth is the published outturn as at May the following year. A negative (positive) average error indicates over(under)-prediction.

Source: Consensus Economics; European Commission European Economic Forecast publications; IMF World Economic Outlook databases; OECD, Economic Outlook databases; and OECD calculations.

Table A.3.2. Comparison of accuracy of recent projections across institutions

Ratio of RMSE of projections to standard deviation of growth, 2007-12

A. May projections for current year

	OECD	IMF	European Commission	Consensus
Canada	0.2	0.2	0.2	0.2
France	0.4	0.3	0.4	0.3
Germany	0.3	0.3	0.3	0.3
Italy	0.3	0.3	0.3	0.4
Japan	0.4	0.5	0.4	0.4
United Kingdom	0.2	0.3	0.3	0.3
United States	0.2	0.3	0.2	0.3
Average	0.3	0.3	0.3	0.3

B. November projections for next year

	OECD	IMF	European Commission	Consensus
Canada	0.6	0.8	0.7	0.7
France	0.6	0.8	0.7	0.7
Germany	0.6	0.8	0.8	0.7
Italy	0.8	1.0	1.0	0.9
Japan	0.8	0.9	0.8	0.8
United Kingdom	0.6	0.8	0.7	0.7
United States	0.4	0.7	0.5	0.5
Average	0.6	0.8	0.7	0.7

C. May projections for next year

	OECD	IMF	European Commission	Consensus
Canada	1.1	1.1	1.0	1.1
France	1.2	1.2	1.2	1.2
Germany	1.0	1.0	1.0	1.0
Italy	1.3	1.2	1.2	1.2
Japan	1.1	1.1	1.0	1.1
United Kingdom	1.1	1.2	1.1	1.1
United States	1.0	1.0	0.9	1.1
Average	1.1	1.1	1.1	1.1

Note: Errors are calculated as actual growth less projected growth at each forecast horizon, where actual growth is the published outturn as at May the following year.

Source: Consensus Economics; European Commission European Economic Forecast publications; IMF World Economic Outlook databases; OECD, Economic Outlook databases; and OECD calculations.

Table A.3.3. Errors in growth projections by country group over 2007-12

	Average error, percentage points		RMSE, ratio to standard deviation of growth	
	OECD	IMF	OECD	IMF
May projections for current year				
OECD	-0.1	-0.1	0.4	0.5
Euro area - core	-0.1	-0.1	0.3	0.3
Euro area - vulnerable	-0.3	-0.5	0.4	0.4
Other OECD Europe	-0.1	0.0	0.4	0.5
Rest of OECD	0.1	0.1	0.5	0.6
BRIICS	-0.2	0.1	0.5	0.6
November projections for next year				
OECD	-0.9	-1.1	0.7	0.9
Euro area - core	-0.9	-1.2	0.7	0.9
Euro area - vulnerable	-1.5	-1.8	0.7	0.8
Other OECD Europe	-0.7	-1.0	0.7	0.9
Rest of OECD	-0.4	-0.7	0.7	0.9
BRIICS	-0.6	-0.5	0.8	1.0
May projections for next year				
OECD	-1.4	-1.2	1.1	1.1
Euro area - core	-1.1	-0.8	1.1	1.1
Euro area - vulnerable	-2.4	-2.3	1.1	1.2
Other OECD Europe	-1.4	-1.2	1.1	1.1
Rest of OECD	-0.8	-0.6	1.1	1.1
BRIICS	-1.0	-0.3	1.1	1.2

Note: Errors are calculated as actual growth less projected growth at each forecast horizon, where actual growth is the published outturn as at May the following year. A negative (positive) average error indicates over(under)-prediction. Average errors include countries with only partial data for the period; these are excluded from the average RMSE calculations. Countries included in the "euro area – vulnerable" group are: Greece, Ireland, Italy, Portugal and Spain.

Source: IMF World Economic Outlook databases; OECD, Economic Outlook databases; and OECD calculations.

Longer-run comparison of growth projections

7. Overall, despite small differences at the country level, the performance of each of the forecasters was very similar during the financial crisis and in the subsequent years. To consider whether this finding holds also over a longer period, where the crisis does not dominate the sample, the accuracy of OECD projections and consensus forecasts for the G7 countries over 1991-2012 is compared, building on the data set used by Vogel (2007).

8. In fact, over this longer period, the performance of the two alternative sets of forecasts again appears similar, based on average errors and RMSEs. As with the OECD projections, consensus forecasts also overestimated GDP growth on average for almost every forecast horizon and G7 country (Table A.3.4). In both sets of projections, the extent of over-estimation increases as the forecasting horizon is extended. The only instances in which growth has been underestimated on average are in the current year projections for Germany and the November year-ahead projections for the United States. In both cases, growth was underestimated in the consensus forecasts and the OECD projections.

9. The size of the RMSEs relative to the standard deviation of growth outcomes is similar to that found for 2007-12, at around one-third of a standard deviation for the May current year projections and one standard deviation for the May projections for the following year. As in the shorter sample, the relative accuracy of the forecasters appears very similar (Table A.3.4). Cross-country differences are relatively small, but the projections for the United States and United Kingdom are the most accurate, whilst those for Japan are the least accurate.

Table A.3.4. Comparison of forecast errors over two decades

1991-2012

A: Average error, percentage points

	May projection for current year		November projection for next year		May projection for next year	
	OECD	Consensus	OECD	Consensus	OECD	Consensus
Canada	-0.3	-0.2	-0.4	-0.4	-1.0	-0.8
France	-0.2	-0.2	-0.4	-0.4	-0.9	-0.8
Germany	0.1	0.2	-0.3	-0.3	-0.8	-0.6
Italy	-0.3	-0.4	-0.8	-0.9	-1.4	-1.3
Japan	0.0	0.0	-0.6	-0.5	-1.0	-1.0
United Kingdom	-0.1	-0.2	-0.5	-0.5	-0.8	-0.8
United States	0.0	0.0	0.2	0.1	-0.2	-0.3
Average	-0.1	-0.1	-0.4	-0.4	-0.9	-0.8

B: RMSE, ratio to standard deviation of growth

	May projection for current year		November projection for next year		May projection for next year	
	OECD	Consensus	OECD	Consensus	OECD	Consensus
Canada	0.4	0.4	0.8	0.8	1.1	1.0
France	0.4	0.4	0.7	0.8	1.2	1.2
Germany	0.4	0.5	0.8	0.8	1.1	1.1
Italy	0.4	0.4	0.8	0.8	1.2	1.2
Japan	0.5	0.5	0.9	0.9	1.2	1.2
United Kingdom	0.3	0.3	0.7	0.7	1.0	1.0
United States	0.3	0.3	0.7	0.7	1.0	1.0
Average	0.4	0.4	0.8	0.8	1.1	1.1

Note: Errors are calculated as actual growth less projected growth at each forecast horizon, where actual growth is the published outturn as at May the following year. A negative (positive) average error indicates over(under)-prediction.

Source: Consensus Economics; OECD, Economic Outlook databases; and OECD calculations.

10. Although the errors for each country appear to be broadly similar in the two sets of forecasts, the hypothesis that there are no significant differences in forecast accuracy can be empirically assessed by using the modified Diebold-Mariano test statistic suggested by Harvey et al. (1997), based on squared forecast errors.[3] The resulting differences between the squared errors and the p-values of the test statistics are shown in Table A.3.5. In almost all cases there are no significant differences The only exceptions are for the current year growth projections for Italy and the November year-ahead growth projections for France. In both instances the OECD projections significantly outperform consensus forecasts by this measure (reflecting the negative mean difference and significance of the test statistics in Table A.3.5).

3. This assumes that the forecaster's loss function is quadratic. An alternative assumption is that the loss function is the absolute loss, in which case the difference in mean absolute forecast errors would be used.

Table A.3.5. Comparison of squared loss differential: OECD versus consensus forecasts

1991-2012

	May projection for current year		November projection for next year		May projection for next year	
	Mean difference	p-value of test statistic	Mean difference	p-value of test statistic	Mean difference	p-value of test statistic
Canada	0.00	(0.958)	-0.15	(0.627)	0.63	(0.144)
France	-0.02	(0.799)	-0.24	(0.004)	0.14	(0.332)
Germany	-0.08	(0.619)	-0.27	(0.349)	-0.17	(0.576)
Italy	-0.13	(0.067)	-0.34	(0.128)	0.30	(0.175)
Japan	-0.05	(0.766)	-0.09	(0.690)	0.25	(0.594)
United Kingdom	-0.08	(0.251)	-0.20	(0.277)	-0.30	(0.208)
United States	0.01	(0.837)	0.16	(0.334)	0.01	(0.982)

Note: The mean difference is the mean of the squared OECD error less the squared consensus error. The test is the modified Diebold-Mariano test statistic suggested by Harvey et al. (1997).

Source: Consensus Economics; OECD, Economic Outlook databases; and OECD calculations.

11. Another means of assessing the relative performance of the two sets of projections is to use forecast encompassing tests (see Appendix 2), to test whether the OECD projections contain all the information in the consensus forecasts (and vice versa). For each of the three different forecast horizons, G7 country growth outcomes during 1991-2012 are regressed on the OECD's and consensus projections:

$$X_{it} = \alpha + \beta P_{it}^{OECD} + \gamma P_{it}^{Consensus} + \varepsilon_{it} \qquad (3.1)$$

If the OECD projections contain all relevant information, then γ=0 (and ß=0 is rejected). Alternatively, if the consensus forecasts contain all relevant information, then ß=0 (and γ=0 is rejected).

12. To test whether there are significant differences between the pre-crisis period (1991-2006) and the most recent period (2007-12), equation (3.1) can be augmented with an intercept dummy set to 1 over 2007-12 and zero otherwise, and interaction terms between this dummy and the remaining regressors:

$$X_{it} = \alpha_0 + \alpha * D0712 + \beta_0 P_{it}^{OECD} + \beta_1 P_{it}^{OECD} * D0712 + \gamma_0 P_{it}^{Consensus} + \gamma_1 P_{it}^{Consensus} * D0712 + \varepsilon_{it} \qquad (3.2)$$

13. The results from estimating equations (3.1) and (3.2) for each of three different forecast horizons are shown in Table A.3.6.[4] Key findings include:

- The OECD May current-year projections and November year-ahead projections are more informative than the consensus forecasts, but neither set of May year-ahead projections are statistically significant (Table A.3.6).

4. For the May year ahead projections, equation (3.2) is estimated with country fixed effects to allow for different mean growth rates across countries; in all other cases, these were jointly insignificant and thus pooled results are reported. Tables A.3.6 and A.3.7 report results obtained using ordinary standard errors, since there is no evidence found of serial correlation and because robust standard errors can suffer from finite sample bias with a small number of panel members (clusters), (see, for example, Angrist and Pischke, 2009). The only difference in the conclusions that would arise from their use is that the marginal effects in the 2007-12 period would not be jointly statistically different from zero.

- The dummy variable and its interactions are jointly significantly different from zero, suggesting that there is a difference in the relationships in recent years compared to the pre-crisis period.

- The OECD May current-year and November year-ahead projections encompass the consensus projections, but neither set of May year-ahead projections encompasses the other (Table A.3.7). This is the case for the both the pre-crisis period, and also over 2007-12.

- Vogel (2007) reported similar results, also finding that neither set of May forecasts for the year ahead are informative.

Table A.3.6. The information content of OECD and consensus forecasts

Estimated over 1991-2012 for G7 countries

	May projection for current year		**November projection for next year**		**May projection for next year**	
	Full sample	With effect for 2007-12	Full sample	With effect for 2007-12	Full sample	With effect for 2007-12
Constant	-0.04	-0.04	-0.93	0.06	-0.12	1.73
	(0.10)	(0.09)	(0.18)***	(0.20)	(0.48)	(0.70)**
D0712		-0.12		-1.86		-1.36
		(0.10)		(0.47)***		(0.96)
OECD projection	0.80	0.95	1.50	0.46	0.49	0.07
	(0.09)***	(0.15)***	(0.39)***	(0.43)	(0.35)	(0.51)
OECD projection*D0712		-0.10		2.02		0.74
		(0.21)		(0.68)***		(0.83)
Consensus projection	0.15	0.03	-0.24	0.40	0.21	0.00
	(0.12)	(0.18)	(0.38)	(0.45)	(0.46)	(0.55)
Consensus projection*D0712		-0.00		-1.05		-0.74
		(0.22)		(0.81)		(0.94)
Country fixed effects?	No	No	No	No	No	Yes
2007-12 effects?						
F-statistic ($\alpha_1=\beta_1=\gamma_1=0$)		16.0***		18.1***		4.9***
R-squared	0.85	0.85	0.50	0.57	0.09	0.22
Serial correlation: ρ	-0.01	-0.02	-0.10	0.03	0.07	-0.05
No. of observations	154	154	154	154	154	154

Note: Robust standard errors reported in parentheses. *, ** and *** denote significance at the 10%, 5% and 1% levels respectively.

Source: Consensus Economics; OECD, Economic Outlook databases; and OECD calculations.

Table A.3.7. Forecast encompassing tests: OECD versus consensus forecasts

	May projection for current year	November projection for next year	May projection for next year
Coefficients on OECD forecasts			
1991-12	0.80***	1.50***	0.49
1991-06	0.95***	0.46	0.07
2007-12	0.86***	2.48***	0.82
Encompassing tests - 1991-2012			
F-statistic ($\beta=\gamma=0$)	1650***	113***	8.8***
F-statistic ($\gamma=0$)	1.60	0.39	0.20
Encompassing tests - 1991-2006			
F-statistic ($\beta_0=\gamma_0=0$)	874***	60.8***	0.05
F-statistic ($\gamma_0=0$)	0.03	0.76	0.00
Encompassing tests - 2007-12			
F-statistic $[(\beta_0+\beta_1)=(\gamma_0+\gamma_1)=0)]$	411***	93.0***	0.84
F-statistic ($\gamma_0+\gamma_1=0$)	0.05	1.10	0.89
Efficiency - 1991-2012			
F-statistic ($\alpha=0$, $\beta=1$, $\gamma=0$)	15.1***	18.7***	13.0***
Efficiency - 1991 - 2006			
F-statistic ($\alpha_0=0$, $\beta_0=1$, $\gamma_0=0$)	0.98	23.4***	10.7***
Efficiency - 2007-12			
F-statistic $[(\alpha_0+\alpha_1)=0$, $(\beta_0+\beta_1)=1$, $(\gamma_0+\gamma_1)=0)]$	16.3***	17.9***	10.5***

Note: Estimated using robust standard errors; see equations (3.1) and (3.2) and Table A.3.6 for the underlying specifications. *, ** and *** denote significance at the 10%, 5% and 1% levels respectively.

Source: Consensus Economics; OECD, Economic Outlook databases; and OECD calculations.

14. The directional accuracy of the two sets of forecasts can be compared in the same way as in Appendix 2, but over the longer sample period 1991-2012. Again, growth pick-ups in the current year and the following year are both projected 85-90 per cent of the time. In marked contrast, current year growth slowdowns are projected accurately around 80% of the time, but less than 40% of the time for the following year. There are only minor differences in the accuracy of the two different sets of projections. This indicates that the problem of successfully projecting slowdowns in advance is a long-standing one.

Table A.3.8. Comparison of directional accuracy of growth projections

Percentage of correct projections in each category, for G7 countries 1991-2012

	May projection for current year		May projection for next year	
Outcome	OECD	Consensus	OECD	Consensus
Increased	90	90	87	85
Unchanged	23	23	23	23
Decreased	78	83	39	35
Total	78	81	58	55

Note: The threshold for an increase or decrease is a change growth exceeding 0.1 percentage points (from rounded data).

Source: Consensus Economics; OECD, Economic Outlook databases; and OECD calculations.

15. The similarity of the OECD forecasting performance to that of other institutions and private-sector forecasts, across countries and time periods, is also highlighted in other studies, including Abreu (2011) and González Cabanillas and Terzi (2012). The tendency to systematically overestimate growth in the coming year seems the likely result of two common factors: (i) asymmetric directional accuracy, with a much lower share of decelerations and recessions predicted a year in advance; and (ii) that overestimates in recessions are typically larger than in other times.

APPENDIX 4: STATISTICAL PROPERTIES OF THE LONG-RUN GROWTH PROJECTIONS

1. As shown in the main text, the last time forecast errors were made that were comparable to those in the financial crisis was in the early 1970s. Undertaking formal empirical tests for bias, efficiency and directional accuracy over a long sample of OECD projections helps to determine whether the recent errors are the result of difficulties specific to the most recent period or more general features that the forecasting process needs to account for. It also enables tests to be undertaken for individual countries and the results compared with a pooled regression across all economies.

2. May projections of current-year growth and November projections of growth in the following year are available for each of the G7 countries back to 1971. The May projections of growth in the following year are available from 1982. In some countries prior to 1992, projections were made and outcomes reported for GNP growth rather than GDP growth.

Are the long-term growth projections unbiased?

3. As in Appendix 2, bias can be tested via a regression of the projection errors (E_t) on a constant and testing the null hypothesis that the average error is zero (i.e. α=0):

$$E_t = \alpha + \varepsilon_t \qquad (4.1)$$

$$\text{where } E_t = Outcome_t - Projection_t$$

4. The results show that in almost all instances the growth projections have on average been over-optimistic (α is negative), with the average errors generally increasing with the forecasting horizon (Table A.4.1). Despite the negative sign, most errors are not significantly different from zero, suggesting that the forecasts are generally unbiased. Indeed, the hypothesis of bias can be rejected for the majority of countries for the May current year projections and the November year-ahead projections. However, in the May year-ahead projections, only those for Japan, the United Kingdom and the United States are unbiased. Finally, it is interesting to note that the intercept estimated from a pooled cross-country regression does point to significant bias in all cases, highlighting the potential for misleading results to be obtained from this approach in some circumstances.

Table A.4.1. Testing for bias in G7 annual GDP growth projections

	May projection for current year 1971-2012		**November projection for next year** 1971-2012		**May projection for next year** 1982-2012	
	α	(std error)	α	(std error)	α	(std error)
Canada	-0.17	(0.13)	-0.35	(0.23)	-0.72	(0.37)*
France	-0.13	(0.14)	-0.33	(0.15)**	-0.60	(0.23)**
Germany	-0.01	(0.14)	-0.29	(0.21)	-0.57	(0.29)*
Italy	-0.10	(0.14)	-0.46	(0.31)	-1.07	(0.32)***
Japan	0.00	(0.17)	-0.57	(0.31)*	-0.52	(0.45)
United Kingdom	-0.10	(0.12)	-0.34	(0.24)	-0.38	(0.36)
United States	-0.15	(0.10)	0.00	(0.20)	-0.16	(0.31)
Average	-0.09	(0.02)***	-0.33	(0.06)***	-0.58	(0.10)***

Note: Errors are calculated as actual growth less projected growth at each forecast horizon, where actual growth is the published outturn as at May the following year. A negative indicates over(under)-prediction. Newey-West standard errors reported in parentheses. *, ** and *** denote significance at the 10%, 5% and 1% levels respectively. The row labelled "Average" shows the outcome from a pooled regression across all countries.

Source: OECD Economic Outlook publications, databases and calculations

Are the long-term growth projections efficient?

5. Efficiency is assessed by testing the joint hypothesis α=0 and β=1 in a regression of the outcome for each country (X_t) on the projection (P_t) and an intercept:

$$X_t = \alpha + \beta P_t + \varepsilon_t, \quad (4.2)$$

The results for the separate sets of country projections are reported in Table A.4.2. In the majority of cases it cannot be rejected that the May current year projections and November year-ahead projections are (weakly) efficient over this longer sample period, in marked contrast to the findings over 2007-12. For the May year-ahead projections, efficiency is rejected for four countries, but not for Japan, the United Kingdom and the United States, likely reflecting the differences in the extent and significance of bias.

Table A.4.2. Efficiency of long-run GDP growth projections for G7 countries

p-values of test statistic

	May projection for current year 1971-2012	**November projection for next year** 1971-2012	**May projection for next year** 1982-2012
Canada	0.342	0.349	0.000
France	0.104	0.064	0.002
Germany	0.113	0.381	0.020
Italy	0.376	0.161	0.008
Japan	0.036	0.057	0.390
United Kingdom	0.687	0.373	0.427
United States	0.264	0.893	0.878

Note: Based on joint tests of whether in country-level regressions of the outcome on the projection and a constant, the coefficient for the projections is one and the constant is zero, with shading indicating significance at the 10% level or higher. Newey-West standard errors are used. May projections for the next year are only available from 1982.

Source: OECD Economic Outlook publications, databases and calculations

Are the growth projections directionally accurate?

6. Forecast accuracy can also be judged on the basis of whether pick-ups and slowdowns in growth are usually anticipated. As in Appendix 2, only changes above a certain threshold are considered, in order to minimise the extent to which growth outcomes that are essentially "little changed" are classified as pick-ups or slowdowns. The threshold used is that the rounded change in growth (to one decimal place) must be greater than 0.1 percentage points for a pick-up or less than -0.1 percentage points for a slowdown. Only the information set available to the forecaster at the time of the projection is used. So for the projections made in May for growth in the same year, the change in growth is given by the difference between the projection and the previous year's outcome. The change over the year ahead is calculated as the difference between the May forecasts for growth in the following year and growth in the current year.

7. Overall the directional, or qualitative, accuracy of the OECD projections for the G7 economies does not appear to have changed substantially over time (Table A.4.3). For growth pick-ups, accuracy is reasonable for both current-year projections and year-ahead projections, and even improved a little over 2007-2012. For growth slowdowns there is little change over time. For growth slowdowns, current-year outcomes are projected with a reasonable degree of accuracy, but there is only an evens chance in projecting a downturn in the year ahead. Despite this, over the full sample of projections, the Pesaran-Timmermann (1992) non-parametric test of predictive performance still suggests there is predictive power in the forecasts: the hypothesis of no predictive value is strongly rejected (at the 1% level).

Table A.4.3. Directional accuracy of the GDP growth projections for G7 countries

	1971-2012	1982-2012	1982-2006	2007-2012
Increases				
Number of cases in the period	124	93	82	11
% correct in May projections	83	81	79	91
% correct in projections for next year		77	74	100
Decreases				
Number of cases in the period	142	106	78	28
% correct in May projections	82	82	83	79
% correct in projections for next year		46	45	50

Note: The threshold for an acceleration or deceleration is a change in growth exceeding 0.1 percentage points (from rounded data).

Source: OECD Economic Outlook publications, databases and calculations

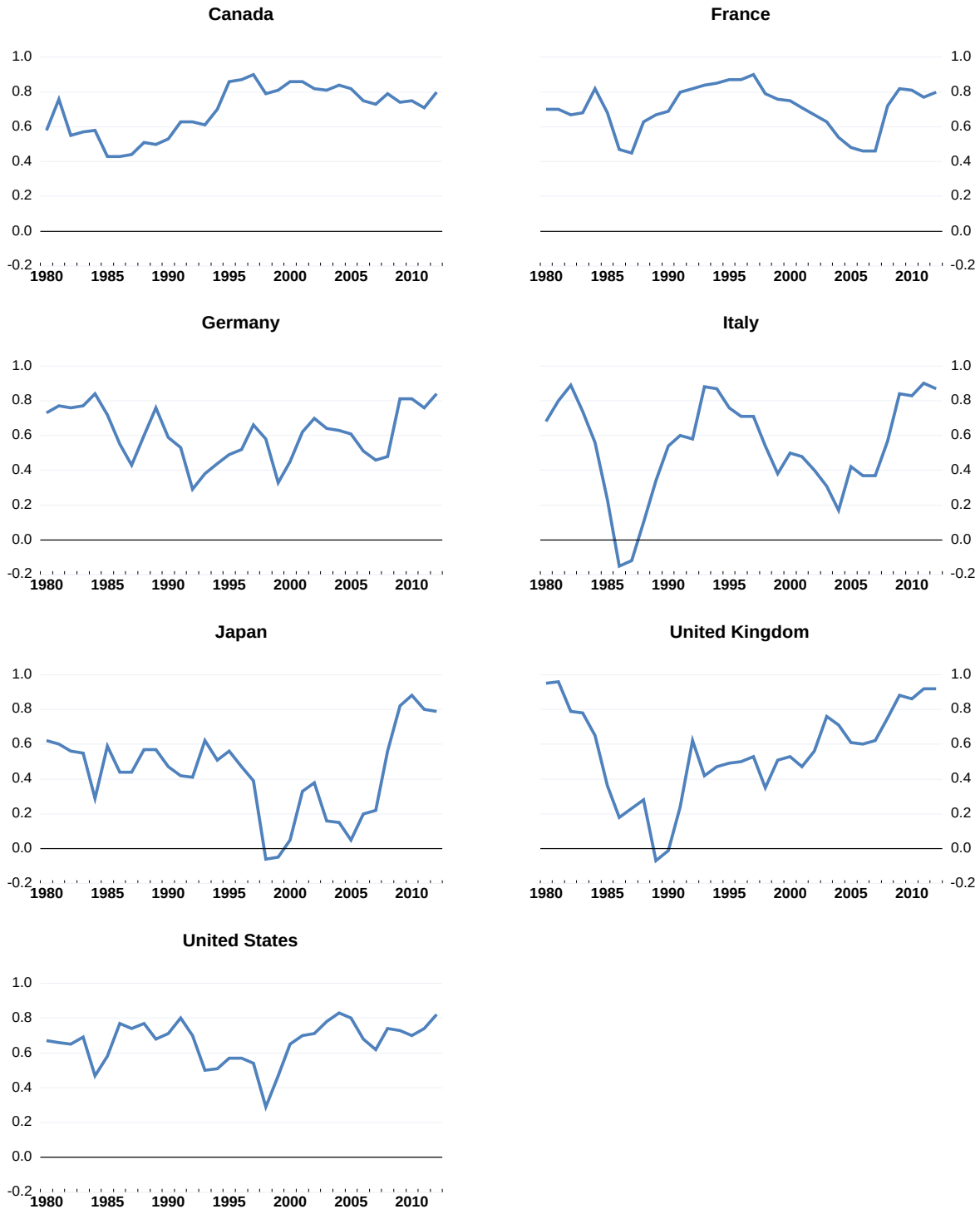
Are the errors in the projections correlated?

8. Cross-country correlations in projection errors can also be used to shed light on the nature of the errors. If forecast errors were independent of each other, cross-country correlations would be zero. Simple pairwise correlations suggest that the projection errors over 2007-12 are not only systematically related across countries (on average), but also more strongly correlated than in the previous two decades. This likely reflects the common nature of the shocks during recent years, whereas country or region-specific shocks are likely to matter more in more normal times, especially at shorter forecasting horizons. During 2007-12, the strongest bilateral error correlations in the projections made in May for growth in the following year (when less is known about the country specific nature of the errors) are between the three euro area countries, France, Germany and Italy, and between the United States, Canada and Japan. This likely reflects a combination of common external shocks and trade and financial interdependencies between the countries.

9. It is also possible to illustrate changes in the extent of cross-country error correlations over recent decades by calculating the correlation between errors in each country's forecasts for the following year (at November) and the mean error for the rest of the G7 (unweighted average excluding that country) over rolling 10-year windows to the date shown (Figure A.4.1). The correlation between the errors made for Canada and the G7 average is the highest amongst the G7 and the most stable over the past four decades. For most other countries, the correlation was high during the 1970s (the 1980 data in Figure A.4.1 show the 10-year average over the 1970s) – another period when countries faced a common shock – but fell as the errors during the first oil price shock dropped out of the sample. The correlations then rose again for most countries in the most recent decade as the financial crisis enters the sample. Overall, the cross-country correlation coefficients were around their highest levels over the past decade, at 0.8 to 0.9.

Figure A.4.1. Changes in correlations between year-ahead projection errors for G7 countries

Correlation with rest of G7 average over rolling 10-year windows to date shown



Note: Based on year-ahead projections made in November. The G7 average is the unweighted average error excluding the country shown.

Source: OECD Economic Outlook publications, databases and calculations

APPENDIX 5: VARIABLES RELATED TO PROJECTION ERRORS DURING 2007-12

1. This appendix provides additional background details underlying the analysis in Section 3 of the main text. The first section describes the data in more detail. This is followed by regression analysis of the relationship between growth disappointments in the recovery, fiscal consolidation and errors in bond spread projections. The final section considers the relationship between projection errors and country characteristics in a multivariate framework.

Details of data used in this paper

2. Table A.5.1 below sets out key summary statistics and sources for the variables used in Section 3 of the main text. Most variables come from OECD databases or the World Bank Global Financial Development database. Variables related to trade, government and assumptions are taken from OECD *Economic Outlook* databases; sentiment and equity prices are from the OECD Main Economic Indicators database (supplemented with series from Datastream); and the main regulatory variables are from the OECD *Going for Growth* publication. The indicators of financial structure are mostly drawn from the World Bank Global Financial Development database. For variables that are prone to revision (for example, fiscal variables), the vintage of data available at the time the projections are made is used.

3. There is a trade-off between making the analytical exercises as comprehensive as possible, by including all countries, and ensuring that the reported results are not misleading due to the inclusion of extreme values for some variables. Accordingly, extreme values were identified using a common procedure and eliminated from the sample considered. These values were those whose distance from the cross-country median was five times the interquartile range, or more.[1] Given the relatively small sample of countries available, the priority was to exclude as few observations as possible. Accordingly, only those observations that are very far from the rest of the sample *and* change the sign of the correlation are excluded. Observations deemed too extreme are listed in the final column of Table A.5.1.

1. This measure of distance is preferable to using standard deviations from the mean because it is less affected by the extreme values themselves.

Table A.5.1. Variable list

Variable	Mean	Median	IQR[1]	Obs.	Source	Extreme values[2]
International openness						
Trade openness (exports+imports, % of GDP, 2007)	48.4	41.8	34.9	34	OECD Analytical database	-
Financial openness (international financial assets and liabilities, % of GDP doubled, 2007)	232.7	145.1	138.6	32	World Bank Global Financial Development database	CHE, LUX
Foreign bank assets (% total bank assets, 2007)	31.6	17.0	57.0	33	World Bank Global Financial Development database	-
Regulation						
Product market regulation (2008)	1.4	1.3	0.4	34	OECD Going for Growth 2012	-
Employment protection legislation (2008)	2.1	2.3	0.8	34	OECD Going for Growth 2012	-
Financial system structure						
Market capitalisation (% GDP, 2007)	96.0	87.1	83.2	34	World Bank Global Financial Development database	-
Regulatory capital (% risk-weighted assets, 2007)	12.3	12.1	1.8	33	World Bank Global Financial Development database	-
Financial services industry (% GDP, 2007)	6.0	5.5	3.0	31	OECD Structural Analysis database	LUX
Vulnerabilities						
Growth in real house prices (2000-07, % change)	39.8	45.1	51.3	25	OECD House Price database	-
Credit growth (% GDP, %pt change 2000-07)	35.1	28.2	39.1	34	World Bank World Development Indicators database	-
Current account balance (% GDP, 2007)	-1.5	-1.8	10.0	34	OECD Economic Outlook 93 database	-
Contemporaneous variables						
Change in equity prices (%)	-	-	-	-	OECD Main Economic Indicators	
- 2008 & 2009	-40.7	-39.7	14.4	34		-
- 2010 & 2011	18.9	21.3	25.3	34		-
- 2011 & 2012	-6.0	-3.0	25.1	34		-
Change in non-performing loans (% total loans, %pt change)	-	-	-	-	IMF Financial Soundness Indicators (April 2013)	
- 2008 & 2009	2.0	1.4	2.2	29		-
- 2010 & 2011	1.0	0.3	1.0	33		-
- 2011 & 2012	1.2	-0.1	1.0	31		-
Change in (standardised) business confidence	-	-	-	-	Datastream; OECD Main Economic Indicators	
- 2008 & 2009	-2.7	-2.9	0.7	30		-
- 2010 & 2011	2.1	2.2	0.7	30		-
- 2011 & 2012	-0.6	-0.7	0.7	30		-
Change in (standardised) consumer confidence	-	-	-	-	Datastream; OECD Main Economic Indicators	
- 2008 & 2009	-1.8	-1.9	1.3	30		-
- 2010 & 2011	0.6	0.7	1.3	30		-
- 2011 & 2012	-0.9	-1.0	0.9	30		-
OECD projections						-
Cumulative change in underlying government primary balance (%pts of potential GDP)	-	-	-	-	OECD Economic Outlook databases	-
- 2010 & 2011	1.2	0.9	2.1	28		-
- 2011 & 2012	1.9	1.3	2.5	31		-
Error in assumption for long-term government bond spreads (to Bunds, %pts)	-	-	-	-	OECD Economic Outlook databases	-
- 2010 & 2011	1.7	0.9	1.7	22		-
- 2011 & 2012	1.8	0.6	2.6	22		-

1. Interquartile range

2. These values are excluded from the descriptive statistics shown here.

Source : OECD calculations.

Fiscal consolidation, bond spreads and growth disappointments during 2010-12

4. As discussed in the main text, important factors that may be related to the errors in the growth projections published in May 2010 for 2010-11 include: projected fiscal consolidation (reflecting an underestimation of fiscal multipliers); an *ex-ante* underestimate of the amount of fiscal consolidation;[2] errors in the assumptions about spreads in national long-term government bonds relative to Bunds (reflecting the euro area crisis); and an underestimate of the extent of banking sector pressures.

5. The question of which of these might be most important is explored initially using bivariate regressions in which the cross-country projections errors are regressed separately on each variable of interest. Projected fiscal consolidation is also used as an instrument in the bivariate relationship between the errors and actual fiscal consolidation. A similar approach was adopted in Blanchard and Leigh (2013). Given the small cross-country sample used, some caution is warranted in drawing strong conclusions from the reported results throughout.

6. Key findings include:

- Both projected fiscal consolidation and actual fiscal consolidation are significantly negatively related to the projection errors in the full sample of OECD countries for which data are available, and also the full sample of European countries.[3] However, Greece is a notable outlier (see main paper) and if it is dropped from the sample, both fiscal measures are no longer statistically significant.

- The relationship between the growth projection errors and the errors in bond spreads is also negative and statistically significant in the full sample, but is less sensitive to inclusion of Greece.[4] This suggests that the intensification of the euro area crisis over 2010-11 was the more important source of the overestimate of growth outcomes. The coefficient estimates imply that an unforeseen one percentage point increase in the spreads of government bonds relative to Bunds was associated with weaker-than-expected growth of around 0.4 percentage point.[5]

2. In this case, actual fiscal consolidation over 2010-11 should be negatively correlated with the forecast errors. In the analyses below, actual fiscal consolidation is taken to be the outturn estimate of fiscal consolidation reported in the May 2012 projection.

3. Slovenia is excluded from all of the reported regressions to ensure consistency. Projections of fiscal consolidation as a percentage of potential GDP were not available in the May 2010 projections, although an outturn estimate was available by the time of the May 2012 projections.

4. This result is robust to the alternative approach of using Cook's distance to identify influential outliers.

5. For comparison, the average increase in spreads over 2010 and 2011 was around 1¼ percentage points for the sample, excluding Greece.

Table A.5.2. Explaining the errors in the 2010-11 growth projections

Dependent variable: cumulative error in the GDP growth projections from May 2010 for 2010-11

	Full sample	Europe	Europe excl. Greece	Europe excl. Greece & Germany
	(1)	(2)	(3)	(4)
Projected fiscal consolidation				
Coefficient	-0.29**	-0.34**	-0.25	-0.19
Standard error	(0.122)	(0.127)	(0.173)	(0.168)
No. of observations	28	22	21	20
Actual fiscal consolidation[1]				
Coefficient	-0.34***	-0.41***	-0.34	-0.26
Standard error	(0.117)	(0.113)	(0.201)	(0.192)
No. of observations	28	22	21	20
Error in bond spread projections				
Coefficient	-0.40***	-0.40***	-0.38**	-0.38**
Standard error	(0.080)	(0.080)	(0.133)	(0.133)
No. of observations	21	21	20	20

1. Estimated using instrumental variables analysis, using projected fiscal consolidation as an instrument.

Note: Coefficients are from the regression: $error_i = \alpha + \beta variable_i + \varepsilon_i$; which includes a constant not shown above. Robust standard errors reported in parentheses. *, ** and *** denote significance at the 10%, 5% and 1% levels respectively.

Source: OECD calculations

7. A second approach is to use a multivariate framework to explore the relative importance of the errors in the bond spread assumptions and projected fiscal consolidation. It is also important to allow for potential endogeneity in the relationship between growth projection errors and the errors in bond spread assumptions, with weaker growth outcomes leading to bond spreads rising by more than had been assumed in the projections.[6] To address this problem, an instrumental variable approach can be used. Three possible instruments are: [7]

- The change in spreads in April 2010 - the time the final assumptions used in the May 2010 *Economic Outlook* were being made. Countries in which bond spreads rose in April 2010 also had larger increases in spreads in 2010 and 2011 as a whole, and larger errors in the initial assumptions.

- The difference between the assumed spread for 2011 (the calendar year average) and the spread at April 2010: the OECD projections assumed that spreads to Bunds would narrow in almost all countries during the latter half of 2010 and 2011, when in fact spreads *widened* in most of the countries.

6. This also applies to the bivariate relationship between the growth projection errors and the errors in bond spread assumptions in Table A.5.2. However, even if bond spread errors are treated as endogenous, the results reported are little changed.

7. In the empirical exercises reported below none of these instruments are found to be endogenous on the basis of a Sargan-Hansen test.

- The current account balance at 2007; when the euro area crisis took hold in 2010 and 2011, those countries with the highest bond spreads relative to Germany were mainly ones in which external imbalances had built up significantly prior to the crisis.

8. The resulting empirical estimates continue to confirm the statistically significant relationship between the growth projection errors and the errors in the bond spread assumptions at the time of the projection (Table A.5.3), with errors in projected fiscal consolidation found to be insignificant, whilst bond spread errors remain significant. This result is relatively robust across a number of different samples and different econometric techniques. If actual fiscal consolidation is used rather than projected fiscal consolidation, the coefficients on fiscal consolidation are also found to be small and statistically insignificant. The coefficients on bond spreads remain negative but the standard errors become somewhat larger and lose significance in some specifications.

Table A.5.3. Explaining the errors in the 2010-2011 growth projections

Dependent variable: cumulative error in the GDP growth projections from May 2010 for 2010-11

Sample	**Europe**	**Europe**	**Europe excl. Greece**	**Europe**	**Europe excl. Greece**
Estimation method	**TSLS**	**TSLS**	**TSLS**	**OLS**	**OLS**
	(1)	(2)	(3)	(4)	(5)
Error in bond spreads	-0.43***	-0.47**	-0.49*	-0.36***	-0.36**
(to Bunds)	(0.087)	(0.210)	(0.243)	(0.126)	(0.135)
Projected fiscal		0.02	0.01	-0.05	-0.05
consolidation		(0.207)	(0.213)	(0.155)	(0.193)
Constant	0.52	0.54	0.57	0.47	0.46
	(0.484)	(0.508)	(0.599)	(0.482)	(0.553)
Obs	21	21	20	21	20
R-squared	0.34	0.34	0.16	0.34	0.17
F-statistic of excluded instruments from first stage	61.0	21.7	12.9	-	-

Note: Sample is restricted to those countries with values for both variables. Robust standard errors reported in parentheses. *, ** and *** denote significance at the 10%, 5% and 1% levels respectively.

Source: OECD calculations

9. The other country characteristics discussed in Section 3 of the main text, such as trade and banking sector openness, are also insignificant when included in regressions alongside the error in bond spreads. The estimated effect of the error in bond spreads remains around 0.3 to 0.5 percentage points and in most cases, remains significant, whether or not Greece is included in the sample.

10. The analysis set out above was repeated using the projections made in May 2011 for growth over 2011-12. These data suggest that the relationship between growth projection errors and errors in bond spread assumptions is less robust than over 2010-11.

- In bivariate regressions, equivalent to those in Table A.5.2, neither projections of fiscal consolidation, nor actual fiscal consolidation, were found to be significantly related to the errors in the GDP growth projections. The errors in the bond spread assumptions were negatively related to the growth errors in the full sample, but the coefficient was close to zero if Greece was excluded.[8]

8. In the 2011-12 case, the best instrumental variable found (and used) are the change in the spread to Bunds in the month of April 2011 and the current account balance in 2007. Again, Sargent-Hansen tests suggest the instruments are valid.

- In multivariate regressions, equivalent to those in Table A.5.3, using both projected fiscal consolidation and bond spread errors as explanatory variables, the magnitude and significance of the coefficients was found to vary depending on the country sample, regression techniques, and instrumental variables used. Neither variable was significant if Greece was excluded from the sample.[9]

Overall the results are not strong enough to conclude that there is any relationship in the 2011-12 projection errors. The results are similar when actual, rather than projected, fiscal consolidation is used.

Fiscal consolidation and growth disappointments since 1993

11. The question of whether there is a long-standing relationship between the growth projection errors and projected fiscal consolidation (though the use of mistaken fiscal multipliers) can be explored using the long-run dataset for the G7 countries also used in Appendices 3 and 4. Three dependent variables are considered: the errors in the projections for the following year made at May and November each year and those at May for the same year. The explanatory variable is the projected change in the cyclically-adjusted budget balance from the same vintage of projections, with data available from 1993. Panel regressions with country fixed effects are used. Key findings include:

- Over the period as a whole there is a marginally significant relationship (at the 10% level) between projected fiscal consolidation and errors in the May projections for growth in the current year and the following year. In contrast there is no significant relationship between projected consolidation and errors in the November year-ahead forecasts. Using dummy variables for the crisis period to test for differences over time suggests that there are no significant differences in these relationships between the pre-crisis period and the years since 2007 (after allowing for differences in the mean of the projection errors in these two different periods).

- As in the previous analysis of the relationship, there is some evidence that the bivariate association between fiscal consolidation and the projection errors may be driven by other factors that are correlated with both the downside surprises to growth and projected fiscal consolidation.

What other factors are associated with differences in cross-country forecast accuracy?

12. As noted in the main text, the growth projections over 2007-12 were less accurate (based on the RMSEs) in countries that were more open and more heavily regulated. Specifically, larger errors are associated with: higher trade openness, a greater share of foreign bank assets in total bank assets, more stringent product market regulation and more stringent employment protection legislation. Larger errors are also related to two pre-crisis financial characteristics: a smaller financial services industry and levels of bank capital relative to assets. The relative importance of these factors is explored using multivariate panel regressions.

13. The projection errors used are the 2007-12 RMSEs derived from the projections made in May and November for GDP growth in the following year. Given the limited degrees of freedom and the strong colinearity between the two variables measuring regulation and also the two variables related to openness, the regulation measures are normalised and then averaged to create a single variable to proxy for the

9. Even when using limited information maximum likelihood estimation to address potential bias arising from weak instruments, the estimated coefficients were similar and the conclusions unchanged.

degree of regulation and the average of the two normalised openness measures is used to proxy for openness.[10]

14. Selected empirical results are reported in Table A.5.4. The main findings are:

- Openness and regulation are both found to be significantly associated with the forecast errors in bivariate regressions, with the larger errors occurring in more open economies and more heavily regulated economies (columns 1 and 2). If the two factors are considered jointly, both remain statistically significant in the upper panel using the November year-ahead projection errors (column 3), but only openness remains significant in the lower panel using the May year-ahead errors. Together, these two factors capture around 30 per cent of the cross-country variation in the RMSEs.
- Openness also appears to be relatively robust to the inclusion of either financial indicators (columns 4 and 5). The additional financial variables are generally not found to be statistically significant.

Table A.5.4. Variables affecting accuracy of the projections for next year

Dependent variable: RMSE over 2007-12 of November projections for growth in the following year

	(1)	(2)	(3)	(4)	(5)
Openness	0.45**		0.34*	0.60**	0.41*
	(0.186)		(0.196)	(0.229)	(0.221)
Regulation		0.53**	0.42*		
		(0.199)	(0.229)		
Financial services				-0.11*	
				(0.062)	
Regulatory capital					0.18
					(0.109)
Constant	2.15***	2.17***	2.17***	2.79***	0.00
	(0.159)	(0.162)	(0.158)	(0.403)	(1.313)
Observations	30	30	30	28	29
R-squared	0.18	0.21	0.30	0.39	0.32

Dependent variable: RMSE over 2007-12 of May projections for growth in the following year

	(1)	(2)	(3)	(4)	(5)
Openness	0.67***		0.56**	0.87***	0.64**
	(0.197)		(0.239)	(0.300)	(0.248)
Regulation		0.59**	0.41		
		(0.240)	(0.293)		
Financial services				-0.07	
				(0.093)	
Regulatory capital					0.18
					(0.143)
Constant	3.20***	3.22***	3.23***	3.60***	0.98
	(0.187)	(0.201)	(0.189)	(0.555)	(1.752)
Observations	30	30	30	28	29
R-squared	0.26	0.17	0.33	0.38	0.37

Note: Robust standard errors reported in parentheses. *, ** and *** denote significance at the 10%, 5% and 1% levels respectively.
Source: OECD calculations

10. Principal component analysis also suggests that the weights should be equal.

APPENDIX 6: RELATIONSHIP BETWEEN ERRORS IN GDP GROWTH PROJECTIONS AND TIMELY VARIABLES

1. This appendix examines whether there has been information available at the time of the forecasts that could have improved the accuracy of the projections. A wide range of different indicators are used, for the G7 countries over 1992-2011, with particular attention paid to whether the reported findings vary in the pre- and post-crisis periods. A bivariate regression approach is used to identify which of the potential indicators chosen is correlated with growth projection errors, followed by some discussion of the effects in a multivariate setting. If an indicator available at the time of the projections is found to have a statistically significant relationship with the projection errors, it provides additional evidence that the projections are not fully efficient, since efficiency implies that the forecast errors should be orthogonal to the information contained in the set of past forecasts.

2. The potential set of variables that might be informative is large, encompassing financial indicators, commodity prices and survey indicators. Here, the following subset of real-time monthly data is considered:

- Financial variables: changes in nominal short- and long-term interest rates on government debt;[1] changes in equity prices, changes in credit conditions (a quarterly variable surveyed by central banks) and stock market volatility (a proxy for uncertainty).
- Commodity prices: changes in Brent oil prices;
- Survey data: the level and change in business sentiment; and the level and change in consumer sentiment.

These variables are all monthly and available at, or soon after, the end of the reference month. Given that the *Economic Outlook* projections are published in May and November, the values up to April and October, respectively, are considered to be available prior to the finalisation of the published projections. A 3-month moving average is used for all variables (except credit conditions) to smooth out volatile month-to-month movements. All survey data were normalised over two decades.

Is there a relationship between real-time indicators and the projection errors?

3. The question of whether there are generally systematic relationships between real-time data and the errors in the growth projections can be assessed by regressing the errors for the target year (E_t) on a constant and the indicator (at the time of forecasting) (I), with j lags retained where they are significant, and country (C) fixed effects. The projection error is calculated as the growth outcome less the growth projection. To consider the possible differences between the pre-crisis period and subsequent years, a dummy variable set to 1 in the period 2007-11 and zero otherwise is included as a constant and interacted with all parameters:

$$E_{it} = (\alpha + \theta D_{0711}) + \sum_{j=0}^{J}(\beta_j + \gamma_j D_{0711}) I_{t-j} + \varphi C_i + \varepsilon_{it} \qquad (6.1)$$

1. Broadly similar results are obtained using real interest rates (calculated with the lagged quarterly GDP deflator).

4. Equation (6.1) was estimated first over the whole period (with no dummy variable or interaction terms) and only significant lags of the indicator (up to three lags) were retained. The restricted equation was then estimated with dummy variable for the period 2007-11. The results of joint tests on the sum of the coefficients on the remaining terms for the pre-crisis sample (1992-2006) and post-crisis sample (2007-11) are shown in Table A.6.1. Key results include:

- There are relatively few significant associations found in the pre-crisis period, especially with the errors in the May projections for growth in the following year. In contrast, the majority of indicator variables are significantly associated with the projection errors over the period 2007-11.

- Amongst the financial variables considered, movements in interest rates prior to the projection date appear to be systematically related to the projection errors, even during the pre-crisis period, with this relationship strengthening during the crisis period. Other financial indicators available at the time of the projections, such as the change in credit conditions, equity price growth and movements in stock market volatility, are found to be significantly associated with the year-ahead projection errors, but mostly only over 2007-11. In all cases, tighter financial conditions are associated with growth proving to be weaker than projected.

- The strength and magnitude of the relationship between changes in oil prices and the growth projection errors is also most prominent over 2007-11, with the coefficients implying that oil price rises are associated with growth disappointments.

- The findings for the different indicators of business or consumer sentiment are mixed, but it seems that information contained in the *changes* in the sentiment variables may not have been incorporated in the growth projections for the year ahead, particularly during the recent period. The signs on the reported coefficients are difficult to interpret on occasion; for instance, the significant negative sign on the level of the survey variables in some sets of projections might suggest that too much weight was placed on the level, rather than the change, in sentiment.

- When the timely variables above are considered together in a multivariate regression, with key variables retained using a general-to-specific modelling approach, they are found to be jointly significant for all three sets of projections over the sample as a whole. There are also significant differences in the relationship between the indicators and the projection errors between 1992-2006 and 2007-2011 for the May current year and year-ahead projections, with the magnitude of the coefficients on the indicator variables rising in the latter period. While it is clear that the indicator variables collectively have useful information, the coefficients on most of the variables vary in sign and significance across the different sets of projections. The strongest finding is that there is a significant positive relationship between past equity price growth and the subsequent growth projection error for all three sets of projections over the period 1992-2006, a time when wealth effects were an important driver of household expenditure. Over the crisis years, 2007-11, changes in oil prices and also changes in, and the level of, business sentiment appear to have contained information that was not fully incorporated in the May projections for the following year.

5. Many of the variables above are included in the indicator models discussed in Box 3 of the main paper, with these models now used to set the initial quarterly projections for the G7 economies.

Table A.6.1 Bivariate relationships between timely variables and errors in the growth projections

G7 countries, 1992-2011

Variable	May projection for current year		November projection for next year		May projection for next year	
	1992-2006 β	2007-2011 β+γ	1992-2006 β	2007-2011 β+γ	1992-2006 β	2007-2011 β+γ
Short-term interest rate (12 month change, smoothed, %pts)	-0.12**	-0.23**	-0.17**	-0.25**	-0.05	-0.81***
Long-term interest rate (12 month change, smoothed, %pts)	-0.10	-0.31	-0.54***	-1.29**	-0.55**	-2.61***
Share price index (3 month change, smoothed, %)	0.06***	0.05	0.03	0.16**	0.04	0.12***
Credit conditions (3 month change, pts)	0.24	0.08	0.30	-0.57**	-0.08	-1.46***
Brent oil price (3 month change, smoothed, %)	0.00	-0.02***	-0.04**	-0.44**	-0.01	-0.09***
Business sentiment (level, 3 month average)	-0.15*	-0.38***	-0.37**	-0.57***	-0.27	-1.10***
Business sentiment (3 month change, smoothed, pts)	0.51***	0.10	0.56*	2.03***	-0.19	-1.40***
Consumer sentiment (level, 3 month average)	-0.02	-0.13	-0.11	0.39	-0.05	-1.04***
Consumer sentiment (3 month change, smoothed, pts)	0.46**	0.11	-0.11	1.95***	-0.27	1.55*
Volatility index (3 month change, smoothed, pts)	-0.64	0.08	0.56	-1.41***	0.30	-3.13***

Note: Estimated with least squares including country fixed effects and a constant term. The table shows the sum of the retained coefficients from equation (6.1) and their joint significance, with 1, 2 and 3 signs denoting significance at the 10%, 5% and 1% levels respectively. Where indicated, variables have first been smoothed using a 3-month-ended average.

Source: Datastream; OECD Economic Outlook databases; OECD Main Economic Indicators database, and OECD calculations

APPENDIX 7: FORECAST PERFORMANCE AND THE OECD COMPOSITE LEADING INDICATORS

1. The OECD Composite Leading Indicators (CLIs) are designed to provide an early signal of turning points in economic activity. This appendix provides further details about the extent to which the information contained in the CLIs was adequately incorporated in the projections. First, the CLIs themselves are explained. The following section addresses the question of whether the projections adequately made use of the CLIs during the crisis and subsequent years. The longer-run relationship between the projection errors and the CLIs is then assessed for the G7 countries. These analyses do not address the performance of the CLIs but only whether there was *additional* information in the CLIs that could have improved the *Economic Outlook* projections.

The Composite Leading Indicators (CLIs)

2. The CLIs have been published monthly by the OECD since the 1970s, with the range of countries expanding over time. The indicators are created from a range of (usually) monthly data on economic activity, financial markets and monetary conditions to signal changes in the direction of economic activity. Key features of the CLIs include:

- The CLIs are published around the middle of the month, usually with a two month lag. In May, for example, CLIs are available to March for most countries.

- The average lead in the index is six months, suggesting that they may be most useful for forecasting at shorter horizons.

- The reference series was industrial production until 2012, when it was changed to GDP for most countries. While the general timing of the cycle should be similar to that of GDP, the amplitude of the cycle will be larger.

- The CLIs are released in two main forms:

  i. OECD communication in recent years presents the "amplitude-adjusted" series, which is a de-trended series with the properties that 100 equals the long-run trend of the reference series and its amplitude is, on average, the same size as that of the cycles in the reference series. This series should be compared to de-trended GDP, or the output gap.

  ii. The "trend-restored CLI" has the same cyclical amplitude and long-run trend as the reference series, which means it is comparable to GDP *growth*. For this reason, the quantitative analysis below uses the trend-restored CLIs. However, the growth rates are not directly comparable because the reference series during most of the period was industrial production.

- Interpretation of the cycle in the two series is different. Peaks in the amplitude-adjusted series indicate that the output *gap* is starting to decrease, whereas peaks in the 12-month percentage change of the trend-restored series indicate that output *growth* is decreasing.[1]
- Sources of revision to the CLIs include: the component data; the trend, which is subject to revision as new data become available; and occasional changes in the methodology. The amplitude-adjusted series is subject to less revision than the trend-restored series.

3. Given the potential for large revisions, real-time data from the OECD *Main Economic Indicators Revisions* database are used to explore whether there is a relationship between the CLIs and the projection errors. The data are from May and November each year. With a two-month lag in the construction of the series, there is generally data to March and September available at the time of the OECD projections.

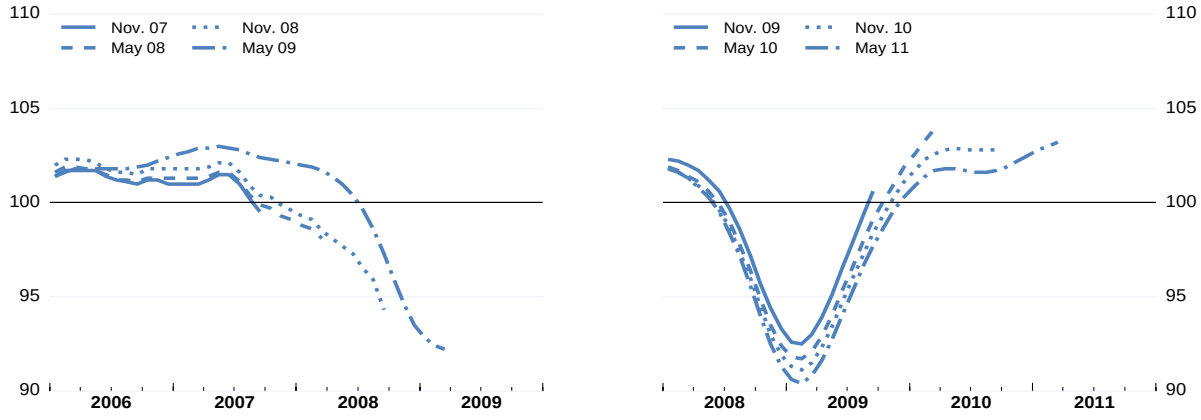
Projection errors during and after the crisis and the CLIs

4. To assess qualitatively whether the projections incorporated fully all information from the CLIs in the downturn and recovery, press releases and the amplitude-adjusted CLI are compared to the OECD-wide output gap projections.

- In May 2008, the CLIs were suggestive of a slowdown, but that outlook weakened considerably between May and November 2008, and then a little further in May 2009 (Figure A.7.1). The projections made for the OECD appear consistent with this, with the May 2008 *Economic Outlook* forecasting a negative output gap to open up, which was revised in November to be considerably larger.
- The difficulties in forecasting during the early stages of the recovery are reflected in the indications from the CLI. In November 2009, the CLIs were pointing to a recovery in the OECD, but by May 2010, the message was mixed across countries, with some slowing in the pace of activity. Likewise, by November 2009, the output gap was projected to begin closing in aggregate.

Figure A.7.1. Composite Leading Indicator for the OECD

Amplitude-adjusted CLI as at date shown



Note: The amplitude-adjusted CLI is designed to be equal to 100 when growth is at trend.
Source: OECD Economic Outlook database; and OECD Main Economic Indicators Revisions database

1. For further information on the CLI methodology and the difference between the amplitude-adjusted and trend-restored versions, see: http://www.oecd.org/std/41629509.pdf and http://www.oecd.org/std/leading-indicators/39430336.pdf.

5. It is not clear that at an OECD-wide level, there was further information that could have been taken into account by forecasters. Looking at the CLI for individual countries at the start of the downturn also suggests that the CLIs would not have helped forecasters to foresee the depth of the downturn earlier. At May 2008, for example, there were eight countries where the amplitude-adjusted CLI was above 100, and in four cases, it had risen in recent months, suggesting activity should accelerate relative to trend in the future. But for all of these countries, growth slowed (and except for one case became negative) from 2008 to 2009.

6. Given the difficulties inherent in qualitative assessments across many countries, a quantitative assessment follows. The first exercise considers whether there is a relationship between changes in the (trend-restored) CLIs and the GDP growth projection errors for all OECD countries, focussing on the downturn and early stages of the recovery.[2]

- The focus here is on the projections formed in May 2008 and from November 2009 and May 2010, when the CLIs began rising above 100.

- As in the main text, the error in the growth projection is calculated as the error in the cumulative growth rate over a two-year period. For the May and November 2008 projections the period considered is 2008-09. For the November 2009 projection and the May 2010 projection the periods considered are 2009-10 and 2010-11 respectively. The outturn data are those published in the first May after the projection period.

- Changes in the trend-restored CLI over the preceding 3, 6 and 12 months are considered. For practical reasons, where data to March are not available, the change to February or January is used (and similarly for the November vintage).

7. If the CLIs contained information that was *not* incorporated in the projections, the correlation with the growth projection errors would be significant, and ideally positive. However, the relationship between the CLIs and projection errors is mixed:

- It does not appear that there was additional information in the CLIs that would have reduced the projection errors in the downturn (Table A.7.1). A significant association is found with the errors in the May 2008 projection, but the relationship is negative, i.e. growth tended to be weaker than expected in countries in which the CLI was improving at the time the projection was made.

- In the subsequent recovery, at a time of sizeable uncertainty as to whether an initial pick-up in activity in the latter half of 2009 could be sustained, the information in the CLIs available at the time of the November 2009 projection is significantly correlated with the projection errors, suggesting that greater attention should have been paid to the signal provided by the CLIs at that time. A positive correlation is also found between the CLIs and the errors in the May 2010 projection, but it is not statistically significant.

2. Although the CLIs are not designed to be used as indicators of the *extent* of the change in GDP growth, particularly given that the reference series was industrial production until very recently, it is still the case that the trend-restored series resembles the cycle in GDP growth.

Table A.7.1. Correlations between changes in the CLIs and the growth projection errors

OECD countries, errors are those in the cumulative growth projection for the two years shown

	Downturn		Recovery	
Projection for:	2008-09 growth	2008-09 growth	2009-10 growth	2010-11 growth
Percentage change in CLI available at	*May-08*	*Nov-08*	*Nov-09*	*May-10*
from 3 months earlier	-0.46**	0.13	0.46**	0.27
from 6 months earlier	-0.47**	0.02	0.59***	0.26
from 12 months earlier	-0.43**	-0.24	0.32	0.31

Note: Errors are calculated as actual growth less forecast growth at each forecast horizon, where actual growth is the published outturn as at May the following year. Countries with partial coverage (Chile, Estonia, Israel and Slovenia) are excluded. *, ** and *** denote significance at the 10%, 5% and 1% levels respectively.

Source: OECD Economic Outlook databases; OECD Main Economic Indicators Revisions database; and OECD calculations.

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