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Performance of GLA Economics' employment projections - 2020 update

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Executive summary

GLA Economics has produced long-term projections of London employment since 2002. These trend-based projections are designed to provide a guide to the long-run (approximately two decades) path of employment based on the historic data available at the time of construction.

To provide a basis for policy decisions in the future, the long-term employment projections produced by GLA Economics should (arguably) exhibit three criteria. They should:

- Be accurate or close to the actual estimates over the period under consideration.
- Not exhibit bias, i.e. not consistently underestimate or over estimate employment.
- Be relatively consistent (and thus reliable) over time, i.e. from one round to another.

In assessing the performance of our long-term projections with regards to our first two criteria – that is, be close to actual estimates and not exhibit bias – it is important to keep in mind their purpose and methodology. Because our projection model is not designed to be accurate in the short-term, assessing accuracy and bias is best done when there are many years of data to compare against – something which is only possible for our earlier rounds of projections.

In common with forecasts produced by external organisations, our employment projections have tended to exhibit a downward bias in recent years (i.e. our employment estimates have been consistently below outturn). This is due in part to upward revisions to historic jobs data, which can be substantial. But it also reflects the unusually rapid growth in jobs relative to economic output in the post-financial crisis period – the so-called 'productivity puzzle'.

Yet when comparing our projections for employment growth with the latest outturn data, our projections perform reasonably well compared to forecasts produced by other organisations. They do relatively well on key measures of accuracy and bias, particularly in terms of projected annual rates of growth. The accuracy of our long-run projections also tends to improve the longer the time period over which they are analysed, which is consistent with our approach.

Given the revisions in historic data that underpin our employment projections model it is also unsurprising that there is some variability in successive rounds of projections over time. However – and by design – our revised projections are relatively consistent between rounds. The average revisions between one set of GLA Economics' projections and another are small when compared to other external organisations that provide London employment forecasts.

1 Introduction

GLA Economics has produced long-term projections of London employment since 2002.[1] These projections are trend-based and set out the long-run path of employment considered most likely given observed historic trends.

To produce our trend-based projections we combine historic employment and output data (since 1971) with an assumption about the future growth rate of the London economy. This approach is designed to provide a guide to the long-run (approximately two decades) path of employment based on the data available at the time of construction.[2] Although, since the future can never be known with total precision, it inevitably involves a degree of uncertainty.

Note, however, our long-term projections are not intended to act as forecasts of short-run employment as it fluctuates around its trend. Short-term predictions often provide a basis for detailed business planning and we publish economic forecasts for the next two years separately in our London's Economic Outlook publication.[3] These estimates are based on a different methodology and it's important to distinguish between our short-term *forecasts* and long-term *projections* – with the latter geared towards use in planning to provide capacity (e.g. employment and transport capacity) to accommodate the longer-term needs of the economy.

Given the importance of our long-run employment projections for long-term planning, and bearing in mind their intended purpose, this note looks at how our projections have performed since 2002. It compares our projected employment estimates with the latest outturn data from the Office for National Statistics and with forecasts produced by three external organisations. It updates our previous performance of projections note from 2014.[4]

As outlined then, there is no universally accepted criteria to assess projections. Nevertheless, long-term employment projections should (arguably) exhibit three criteria. They should:

- Be accurate or close to the actual estimates over the period under consideration.
- Not exhibit bias, i.e. not consistently underestimate or overestimate employment.
- Be relatively consistent (and thus reliable) over time, i.e. from one round to another.

This note re-examines our projections against these three criteria and with the latest outturn data. It continues as follows. Section 2 sets out the main sources of data used in this assessment and some potential issues, including historic data revisions. Section 3 examines statistical measures of bias and accuracy for our projections compared to three external forecasters. Section 4 goes on to look at measures of variability for our projections over time.

[1] Projections from 2009 and later are available on the London Datastore
[2] Further information on the methodology behind our long-term projections can be found in our latest London labour market projections report on the GLA Economics Publications page.
[3] Also available on the GLA Economics Publications page
[4] GLA Economics (2014) Performance of GLA Economics' employment projections

2 Data used in this note

This note assesses the relative performance of GLA Economics' long-term employment projections against the latest 'actual' jobs estimates from the ONS and with employment forecasts produced by three external organisations. This section presents the main sources of data used for this assessment.

GLA Economics projections

GLA Economics (GLAE) has produced long-term projections of London employment (jobs) since 2002.[5] In total nine rounds of projections have been produced between 2002 and 2017, as set out below. Since we last reported on the performance of our projections, in 2014, we have five additional years of actual jobs estimates and three additional rounds of projections.[6]

GLAE long-term employment projections (*produced since previous note)

- 2002 to 2016
- 2005 to 2026
- 2007 to 2026
- 2009 to 2031
- 2011 to 2036
- 2013 to 2036
- 2015 to 2036*
- 2016 to 2041*
- 2017 to 2050*

When analysing the performance of our long-run projections with regards to our first two criteria – that is, being close to actual estimates and not exhibiting bias – it is important to keep in mind their purpose and methodology. Because our projection model is not designed to be accurate in the short-term, assessing accuracy and bias is best done when there are many years of data to compare against – something which is only possible for our earlier rounds of projections.

When analysing the performance of our long-run projections with regards to our first two criteria – that is, being close to actual estimates and not exhibiting bias – it is important to keep in mind their purpose and methodology. Because our projection model is not designed to be accurate in the short-term, assessing accuracy and bias is best done when there are many years of data to compare against – something which is only possible for our earlier rounds of projections.

Latest 'actual' jobs estimates and data revisions

The 'actual' or 'outturn' jobs estimates used to assess the performance of our employment projections come from the latest (December 2019) employee and self-employed components of the Workforce Jobs (WFJ) series produced by the Office for National Statistics (ONS).

This dataset provides quarterly estimates of workforce jobs back to 1996, adjusted to compensate for seasonal variations in employment. Annual jobs estimates are produced by adding together the four quarters of WFJ data for employee and self-employed jobs and dividing by four (i.e. by taking a simple average of quarterly estimates). Consistent with the London jobs series, we only count jobs in 19 SIC 2007 sections, excluding sections T and U.[7]

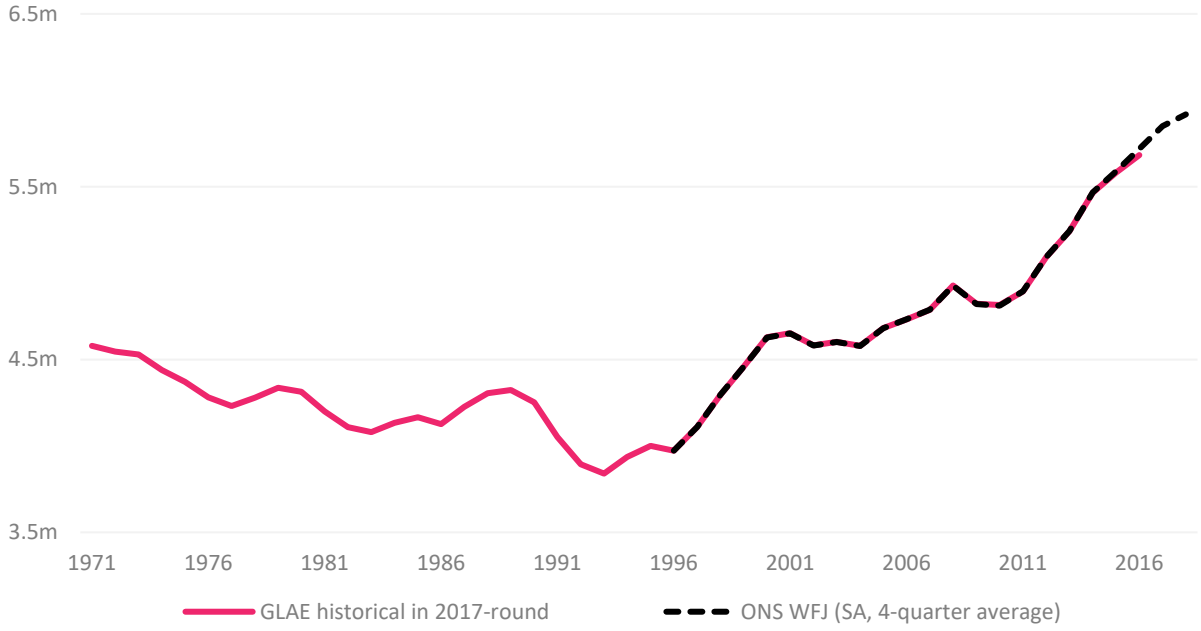
Another possible source of actual employment data is the historic jobs series from the GLAE 2017 projection-round (for the years up to 2016). This has the benefit of offering a longer historical series, dating back to 1971. However, the WFJ series is preferred because it accounts for the latest data revisions and

[5] For the purpose of this note the terms 'employment' and 'jobs' are used interchangeably.
[6] GLA Economics (2014) Current Issues Note 40: Performance of GLA Economics' employment projections
[7] i.e. excluding T (Activities of Households as Employers) and U (Activities of Extra-Territorial Organisations). For more information see: GLA Economics (2011) Working Paper 52: London's jobs history - a technical paper

includes additional estimates for the years 2017 and 2018. Data from before 1996 is also not needed here given the earliest GLAE projection is from 2002.

Figure 1 indicates that these two series are relatively similar. However, the latest WFJ series provides higher estimates in the last two overlapping years (2015 and 2016) and a marginally lower estimate in 2010. This is because historic employment estimates are often subject to developments and revisions.

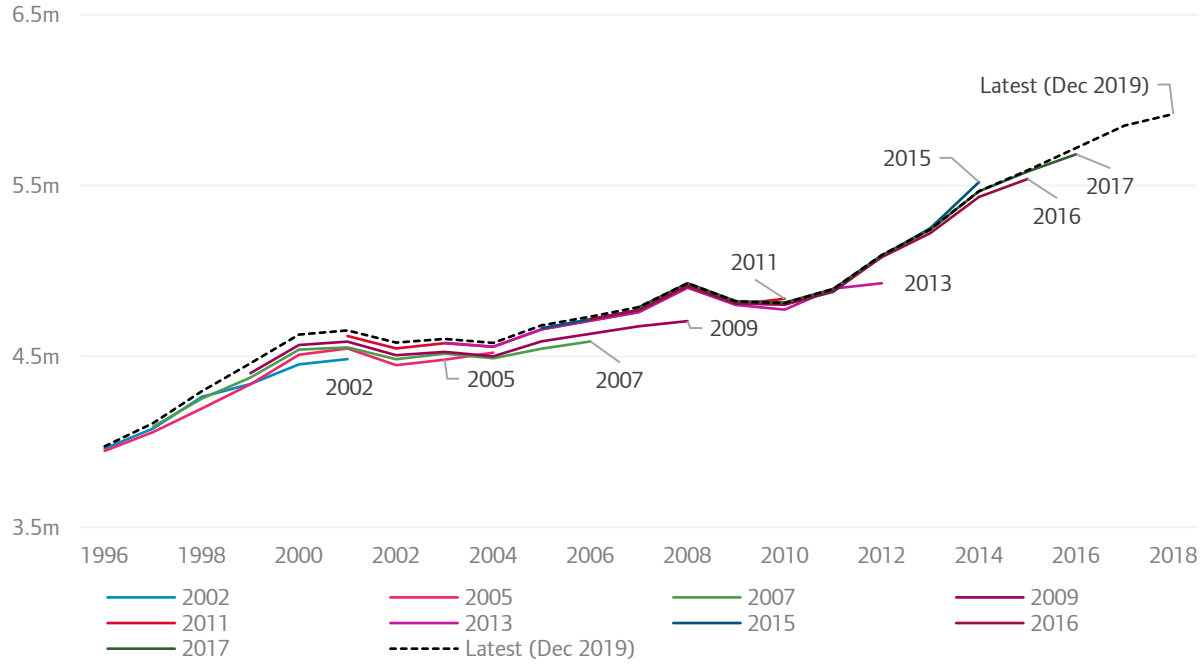
Figure 1: GLAE 2017-round historic job series versus latest actual ONS WFJ, 1971 to 2018



Source: ONS WFJ series (SA) and historic data in GLA 2017-round projection.

This tendency for data to be revised is further revealed in Figure 2, which shows upto ten years of historical data at the time of each of GLAE's employment projections since 2002.

Figure 2: Revisions to GLA historic job series and latest actual ONS WFJ



Source: ONS WFJ series and historical data in GLA projections. Note: a maximum of 10 years of historical data is shown for each series to make the changes in the earlier series easier to see (i.e. to avoid having 10 series across the earlier years).

At every projection round historic data has been revised compared to the previous round. And in the majority of cases this has been an upward revision.[8] This affects both the absolute *level* of employment from which point projections are made (i.e. the point from which projections 'jump-off') as well as historic *rates* of growth, which inform trend-based projections.

This is an important caveat for the analysis that follows, particularly for assessing the accuracy and bias of *absolute* employment projections. In-line with external forecasters, our long-term projections tend to exhibit a downward bias compared to actual employment estimates (i.e. are often below outturn) which is partly due to upward revisions to the historic data series.

Forecasts from external organisations

Forecasts from external organisations are selected for each year that GLAE has published a long-term employment projection. For comparability the external forecast round closest to March of the relevant year has been used when several are available. Since no external forecasts were available for 2002, those used are the earliest available from 2003. Note also that the GLAE 2002-round, and the 2009-round produced by External 1, were incomplete, with values missing for certain years. Interpolation has been used to generate missing data points.

GLA Economics, along with external organisations, publish historic data in their series, as well as projections for future years. For consistency our analysis assumes that estimates are always forecasts from the year of production, i.e. the accuracy of a 2009 forecast round is assessed against actual data from the year 2009 up to the latest year of WFJ jobs data. Table 1 provides a full list of the GLAE projections and external forecasts used and their relevant periods.

[8] Note, for example, the particularly large revisions between our 2009 and 2011 projection rounds (when the estimate for 2008, the latest common year, was increased by 4.2%) and between our 2013 and 2015 projection rounds (when the estimate for 2012 was increased by 3.2%).

Table 1: Projects and forecast rounds used for assessment, GLAE and external

Projection round	GLAE	External 1		External 2		External 3	
	Up to	*Published*	*Up to*	*Published*	*Up to*	*Published*	*Up to*
2002	2016*	Feb 2003	2015	Apr 2003	2012	Feb 2003	2012
2005	2026	July 2005	2015	Feb 2005	2014	Mar 2005	2014
2007	2026	Mar 2007	2020	May 2007	2020	Feb 2007	2017
2009	2031	Mar 2009	2020*	May 2009	2025	Mar 2009	2019
2011	2036	Mar 2011	2025	May 2011	2025	Mar 2011	2021
2013	2036	May 2013	2025	Feb 2013	2031	Feb 2013	2022
2015	2036	Jun 2015	2025	Mar 2015	2031	April 2015	2030
2016	2041	Jan 2016	2030	Mar 2016	2035	April 2016	2030
2017	2050	Aug 2017	2036	Mar 2017	2037	April 2017	2037

*Note: *Incomplete series available – interpolation used to generate data for missing years.*

As a final cautionary point, it is worth noting that the employment estimates produced by GLA Economics and our three external organisations are based on slightly different definitions. While the GLAE definition is based solely on employee and self-employed jobs from 19 SIC 2007 Sections, Externals 1, 2 and 3 also include HM Forces jobs. External 3 further includes jobs in SIC 2007 Section T (Activities of Households as Employers) as well as government-supported trainees. These definitional differences mean that jobs estimates diverge slightly – albeit the magnitude of the effect is small, and estimates remain broadly comparable.[9]

[9] Based on the latest WFJ estimates including Section T, government-supported trainees and HM forces would add 25,564 jobs to the GLAE-based definition of London employment in 2018, equivalent to a 0.4% increase in London employment. Adding HM forces jobs alone only increases the GLAE-based definition by 0.08%.

3 Accuracy and bias of employment projections over time

One of the most important requirements for long-run employment projections is that they should be reasonably accurate and unbiased over the period which they are projecting. That is, they should be close to the actual employment estimates over the period in question and should neither consistently underestimate nor overestimate employment trends. This section examines the performance of GLA Economics' long-run projections on both these counts.

2017-round

Figures 3 and 4 compare the latest GLAE employment projections and external forecasts published in 2017 with actual jobs data; Figure 3 shows employment levels while Figure 4 plots an index of employment growth rates (with 2016 being equal to 100). With only two years of actual jobs estimates to compare against – the years 2017 and 2018, as denoted by the vertical lines – it is clearly too early to judge the accuracy of our latest long-run projection round.

Figure 3: Results of 2017 GLAE projections versus other forecasters (absolute numbers)

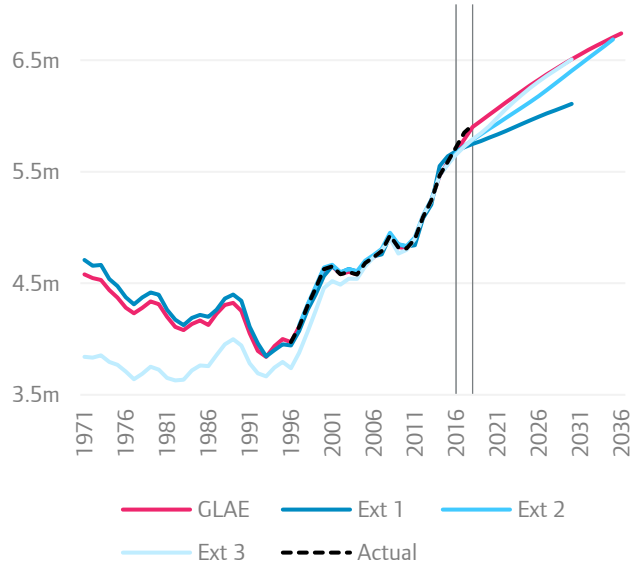
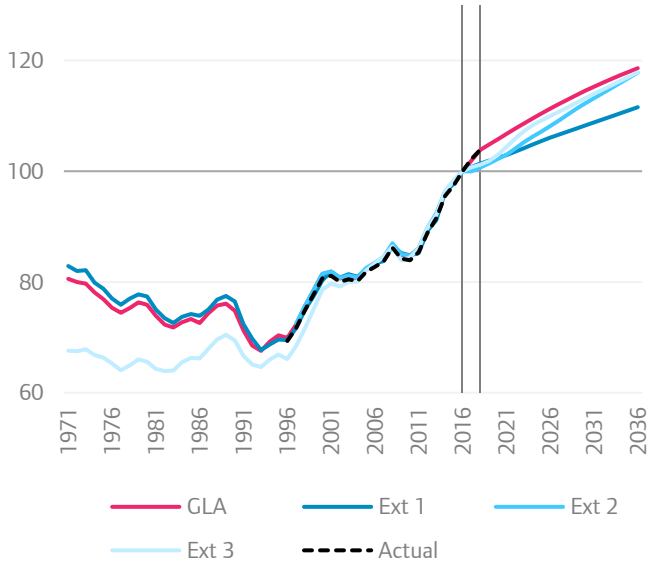


Figure 4: Results of 2017 GLAE projections versus other forecasters (index, 2016=100)



Note: GLAE, External 2 and Actual data covers employee and self-employed jobs only. External 1 data includes HM Forces jobs and External 3 data includes both HM Forces jobs and Government supported trainees.

Still, it is interesting to note that our 2017 projections (the red line) are closely aligned with external forecasts (the blue lines) for long-run employment, except perhaps those produced by External 1. It is also worth noting that every set of projections/forecasts has underestimated the latest ONS WFJ estimates for the *level* of employment in 2017 and 2018. However, for the GLAE projections this is largely the result of revisions to historical data. The *rate* of growth projected by GLAE in 2017 has been relatively close to actual trends since 2016 – and closer than any of the external forecasts set out above (see Figure 4).

2016 and 2015 rounds

Figures 5 to 8 show how the GLAE employment projections produced in 2016 and 2015 compare to actual jobs estimates and external forecasts. Similar to the 2017-round, with only three (for the 2015-round) and four (2016-round) years of overlap with actual ONS WFJ estimates, it is not really sensible to assess the accuracy of these projections over time given their long-term focus.

Figure 5: Results of 2016 GLAE projections versus other forecasters (absolute numbers)

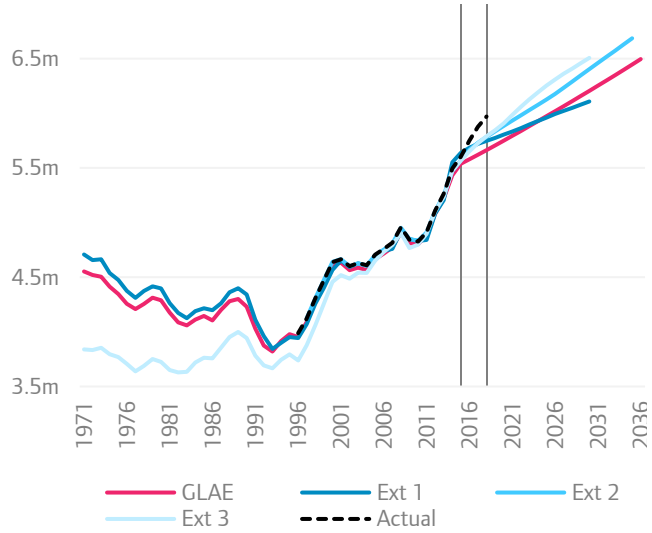


Figure 6: Results of 2016 GLAE projections versus other forecasters (index, 2015=100)

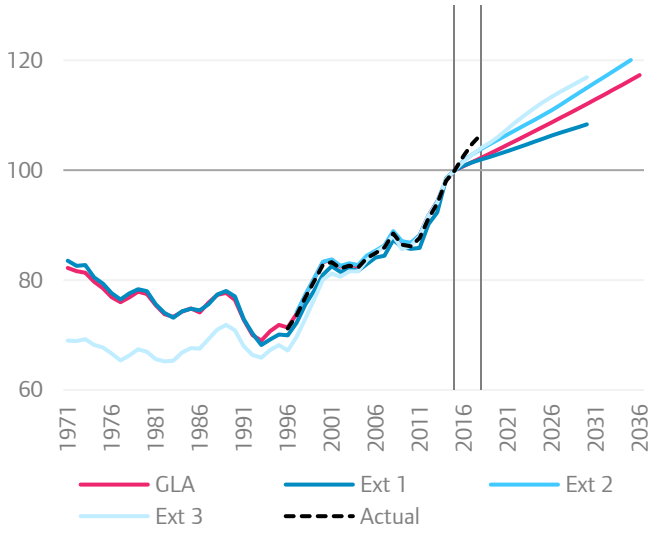


Figure 7: Results of 2015 GLAE projections versus other forecasters (absolute numbers)

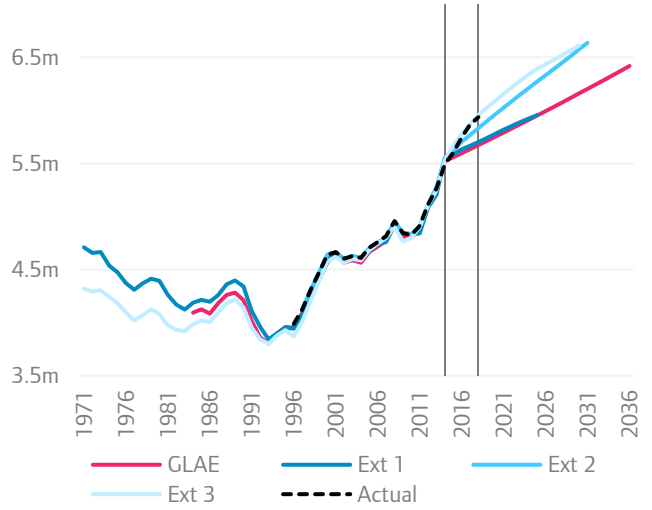
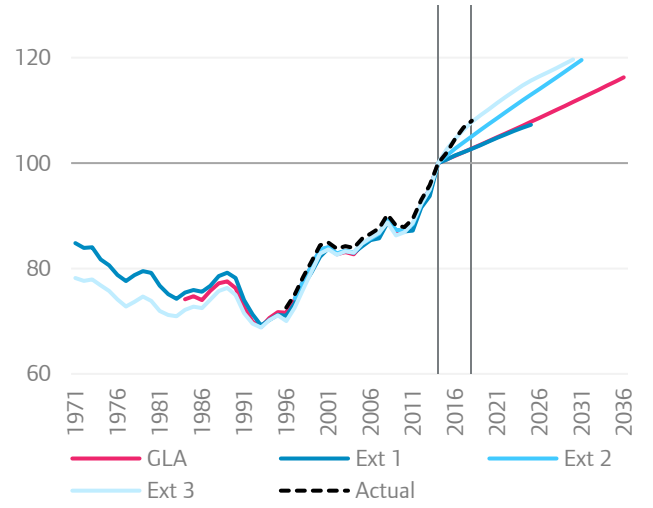


Figure 8: Results of 2015 GLAE projections versus other forecasters (index, 2014=100)



Note: GLAE, External 2 and Actual data covers employee and self-employed jobs only. External 1 data includes HM Forces jobs and External 3 data includes both HM Forces jobs and Government supported trainees.

Again, these projection/forecast rounds have generally undershot the latest ONS WFJ estimates. As we'll see this is a recurring theme over the last decade of projections/forecasts which, in addition to historic data revisions, also reflects the unusually rapid growth in employment relative to output in the post-financial crisis period – the so-called 'productivity puzzle'.[10] Unlike in 2017, the GLAE projections produced in both 2015 and 2016 also predicted a lower rate of employment growth than most of our external forecasters, only ahead of External 1 (see Figures 6 and 8).

[10] The duration of this post-crisis weakness in productivity is the basis for the Office for Budget Responsibility recently making the judgement that UK productivity growth may not recover to historic rates in the medium-term. We incorporated a similar judgement for London in the construction of our 2017 projections. For a discussion of recent trends, see: GLA Economics (2019) Productivity trends in London: An evidence review to inform the Local Industrial Strategy evidence base.

2013 and 2011 rounds

Figures 9 to 12 show the performance of the employment projections created in 2013 and 2011. For these rounds there is now six (2013) and eight (2011) years of overlap with actual WFJ estimates respectively. While this is still some way short of the two decades these projections are designed to provide a guide to, we are now in a better position to begin to assess their accuracy and bias.

Figure 9: Results of 2013 GLAE projections versus other forecasters (absolute numbers)

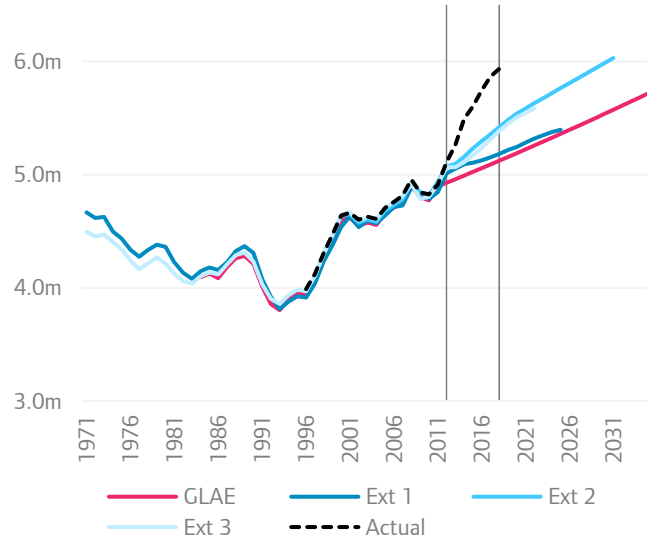


Figure 10: Results of 2013 GLAE projections versus other forecasters (index, 2012=100)

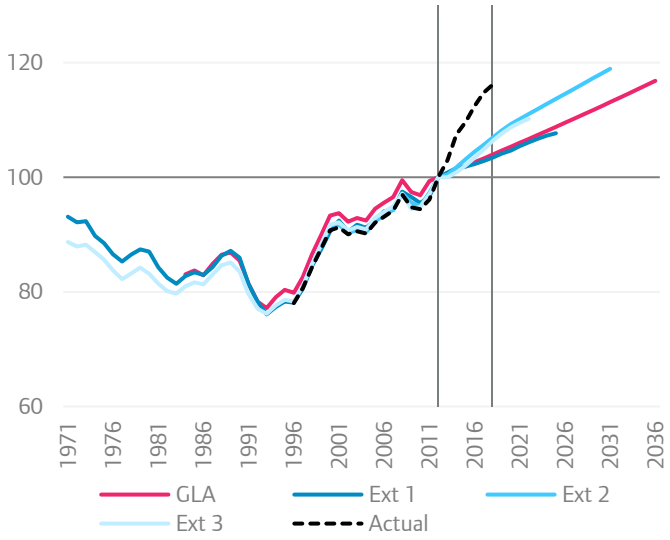


Figure 11: Results of 2011 GLAE projections versus other forecasters (absolute numbers)

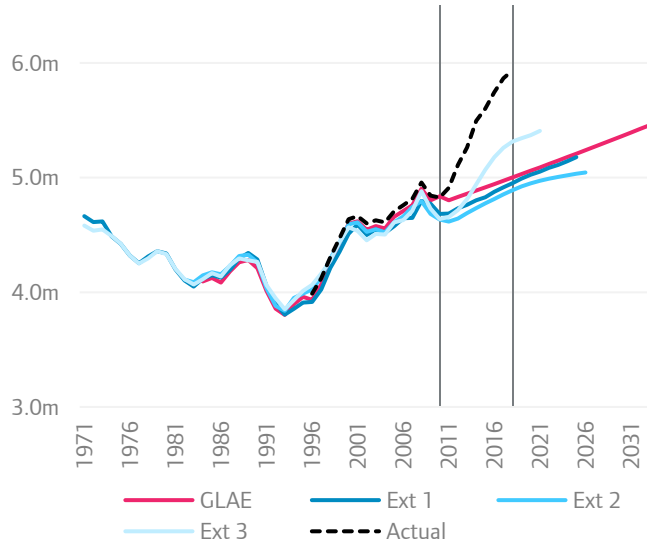
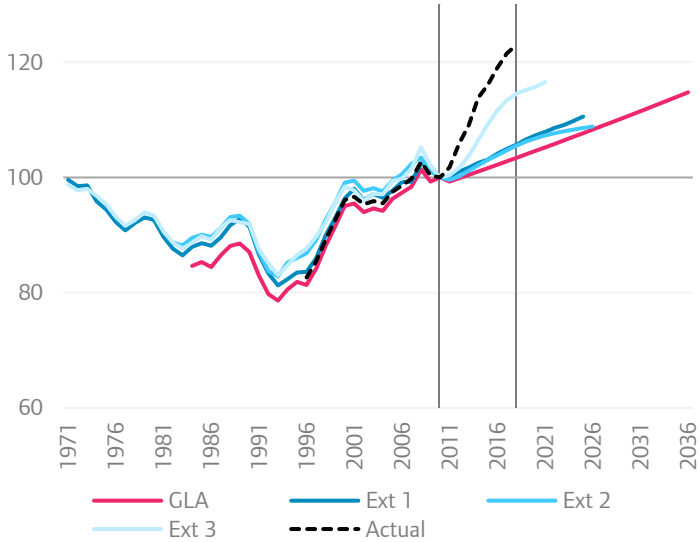


Figure 12: Results of 2011 GLAE projections versus other forecasters (index, 2010=100)



Note: GLAE, External 2 and Actual data covers employee and self-employed jobs only. External 1 data includes HM Forces jobs and External 3 data includes both HM Forces jobs and Government supported trainees.

As Tables 2 and 3 show, the correlation coefficient (a common measure of how closely associated changes in one series are to another) between GLAE's projections and actual employment is high. There has, in other words, been a strong and positive relationship between the projections we produced in 2013 and 2011 and actual employment trends in terms of the direction and magnitude of changes. In both cases we anticipated

relatively steady year-on-year jobs growth and this has occurred in reality.[11] The external forecasts also show a strong relationship on this measure.

However, in our 2013 and 2011 rounds, we again predicted a relatively low rate of jobs growth compared to the latest WFJ estimates and what external forecasters had predicted (see Figures 10 and 12). In 2013 GLAE predicted the second lowest rate of jobs growth including our three external forecasters, and in our 2011-round we predicted the lowest rate of growth. This has resulted in a relatively large divergence between GLAE's 2013 and 2011 projected employment numbers and the latest outturn estimates – a key measure of accuracy.[12]

More specifically:

- For the 2013-round, GLAE projections were over 10% too low on average between 2013 and 2018. This compares to between 9% and 7% below actual employment estimates for the forecasts produced by external organisations (Table 2).
- The 2011-round of GLAE projections were only marginally better, being closer to 10% too low on average between 2011 and 2018, as compared to between 9% and 13% below actual employment estimates for external forecasters (Table 3).

Table 2: Statistical measures of 2013 projection/forecast accuracy and bias

2013-round (assessed: 2013-18)	GLAE	Ext 1	Ext 2	Ext 3
CAGR (pp diff to actual)	-1.9	-2.0	-1.4	-1.5
Correlation co-efficient	0.99	0.99	0.99	0.97
Cumulative sum of forecast errors (000s)	3,542	3,076	2,229	2,506
Mean absolute deviation	590	513	372	418
Mean absolute percentage error	10.4%	9.0%	6.5%	7.3%

Table 3: Statistical measures of 2011 projection/forecast accuracy and bias

2011-round (assessed: 2011-18)	GLAE	Ext 1	Ext 2	Ext 3
CAGR (pp diff to actual)	-2.2	-1.9	-1.9	-0.9
Correlation co-efficient	0.99	0.99	0.99	0.99
Cumulative sum of forecast errors (000s)	4,562	5,224	5,757	3,827
Mean absolute deviation	570	653	720	478
Mean absolute percentage error	10.1%	11.7%	12.9%	8.6%

Note: CAGR = compound annual growth rate – the average year on year growth between two points in time. The difference compared to actual indicates how different in percentage points terms the estimated growth rates are compared to the latest ONS WFJ estimates. The correlation coefficient measures how closely (in direction and magnitude) the projected/forecast series follows the latest estimates. The cumulative sum of forecast errors adds up the difference in each year between projected/forecast estimates and actual employment trends. The mean absolute deviation measures the size of the average error each year regardless of the direction of error i.e. regardless of whether it was larger or smaller. The mean absolute percentage error measures the average of the percentage errors in each year and provides an indication of the scale of error.

[11] Note, according to the latest ONS WFJ estimates the last year of negative annual jobs growth in London was in 2010.

[12] The GLAE 2013-round, for example, suggested there would be 5.12 million jobs in London by 2018; whereas the ONS WFJ series now indicates that there were 5.92 million jobs in the capital in that year.

2009 and 2007 rounds

For projections produced in 2009 and 2007, Figures 13 to 16 show performance against outturn and external forecasts. For these rounds there is an even longer overlap with the latest WFJ estimates to assess performance against – 10 years for the 2009-round and 12 years for the 2007-round. As above, it is clear from the charts below that GLA Economics and our external counterparts have undershot 'actual' employment growth in the years since 2011 – both in terms of absolute levels (Figures 13 and 15) and growth rates (Figures 14 and 16).

Figure 13: Results of 2009 GLAE projections versus other forecasters (absolute numbers)

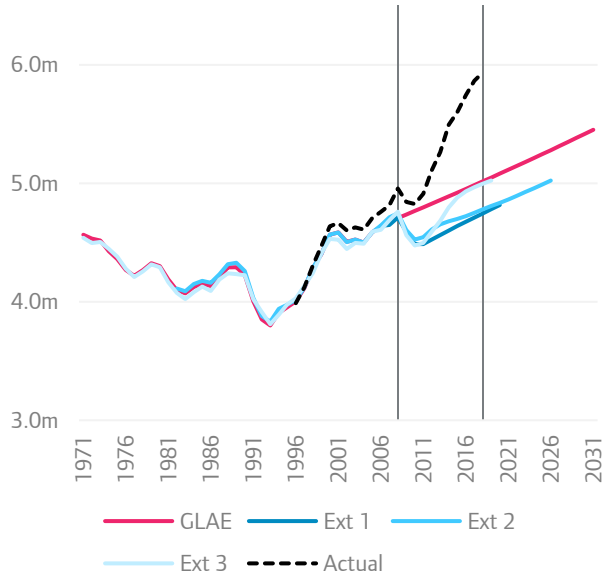


Figure 14: Results of 2009 GLAE projections versus other forecasters (index, 2008=100)

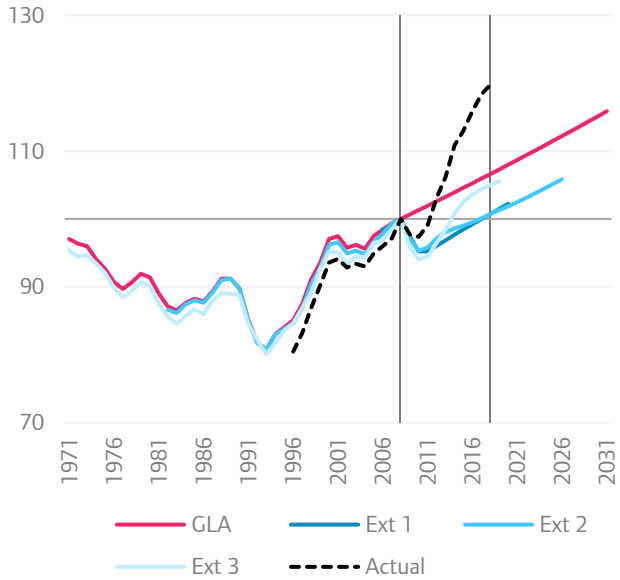


Figure 15: Results of 2007 GLAE projections versus other forecasters (absolute numbers)

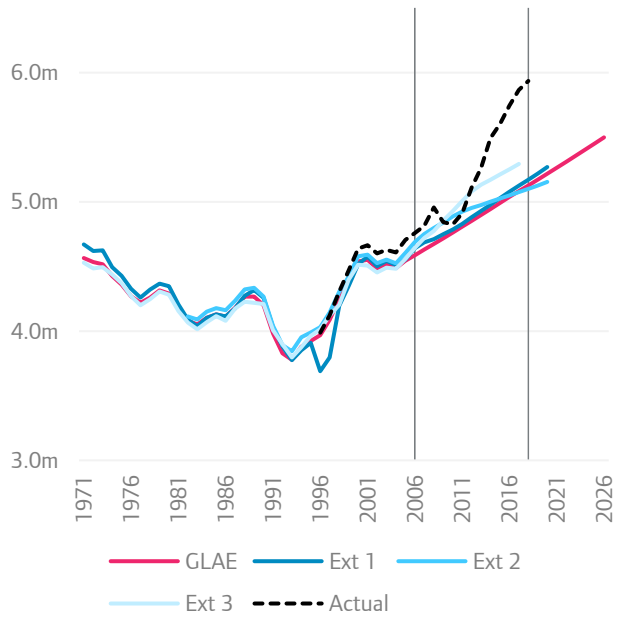
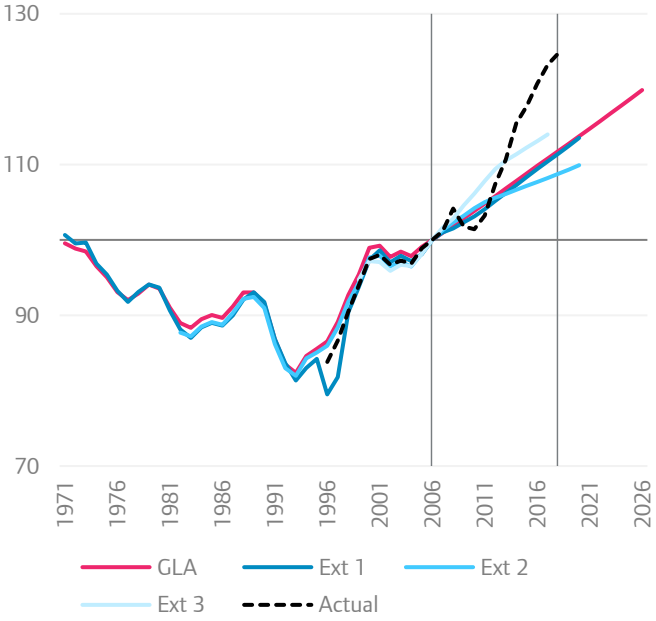


Figure 16: Results of 2007 GLAE projections versus other forecasters (index, 2006=100)



Note: GLAE, External 2 and Actual data covers employee and self-employed jobs only. External 1 data includes HM Forces jobs and External 3 data includes both HM Forces jobs and Government supported trainees.

Historic data revisions are especially relevant when it comes to assessing the 2009-round of projections. As Figure 13 shows, the latest WFJ estimate for 2008 is notably higher than the estimates that we and other external organisations had used in 2009 (also see Tables 4 and 5 below). This is the largest revision linked to our projections and affects both the absolute level of employment from which our projection begins (i.e. the point from which they 'jump-off') as well as the historic rates of growth which inform our trend-based approach.

Still, for both these rounds, the correlation coefficient between GLAE projections and actual employment trends remains strong, indicating a positive relationship (Tables 4 and 5). Although our 2007-round performs slightly less well than our 2009-round on this measure, changes in the GLAE projections are still more closely related to outturn than most of the external forecasts produced in 2007 (in terms of direction and magnitude – the exception here is External 1).

Table 4: Statistical measures of 2009 projection/forecast accuracy and bias

2009-round (assessed: 2009-18)	GLAE	Ext 1	Ext 2	Ext 3
CAGR (pp diff to actual)	-1.2	-1.8	-1.8	-1.4
Correlation co-efficient	0.99	0.92	0.97	0.99
Cumulative sum of forecast errors (000s)	4,596	4,168	3,993	2,308
Mean absolute deviation	466	738	683	603
Mean absolute percentage error	8.3%	13.4%	12.4%	11.0%

The accuracy of our 2009-round is also relatively strong compared to external forecasts. The projected annual growth rate is only 1.2 percentage points below outturn and estimates are, on average, 8.3% away from the latest WFJ estimates (Table 4). On both counts the GLAE projections are closer to the latest outturn data than our external counterparts. For comparison, the deviation for our three external forecasters is between 1.4 and 1.8 percentage points below outturn for the annual growth rate and 11.0% and 13.4% away from outturn in terms of employment levels.

Table 5: Statistical measures of 2007 projection/forecast accuracy and bias

2007-round (assessed: 2007-18/*17)	GLAE	Ext 1	Ext 2	Ext 3*
CAGR (pp diff to actual)	-0.9	-1.0	-1.2	-0.8
Correlation co-efficient	0.96	0.97	0.92	0.91
Cumulative sum of forecast errors (000s)	2,529	3,642	1,954	1,567
Mean absolute deviation	383	347	333	210
Mean absolute percentage error	6.9%	6.3%	5.9%	3.8%

As Table 5 shows, the accuracy of our 2007 projection round is more in-line with our external counterparts but has still performed reasonably well. This is particularly true for the rate of employment growth projected in 2007. We predicted total employment would grow by 0.9% per year between 2007 and 2018, 0.9 percentage points below outturn. Only the annual average growth rate predicted by External 3 has been closer to the latest WFJ estimates than GLAE. In terms of absolute employment levels our projections seem to have performed less well. But this largely reflects different starting points, rather than predictions about the future.

2005 and 2002 rounds

For projections produced in 2005 and 2002, Figures 17 to 20 show performance against the latest WFJ estimates and external forecasts. For these rounds there is an even longer outturn period to measure performances against – 14 years for the 2005-round and 15 years for the 2002-round. For the latter, this represents the whole of the projection period, since it only extended to 2016. Clearly, we have enough data here to assess accuracy and bias against.

As Figures 17-20 suggest, these GLAE projections have performed relatively well over most of the projection period, especially the 2002-round. That said, with more historical data it is even more striking how far the latest employment estimates – both in terms of absolute employment levels and growth rates – have diverged from our projections and external forecasts in recent years, having remained relatively close in the years leading up to 2011.

Figure 17: Results of 2005 GLAE projections versus other forecasters (absolute numbers)

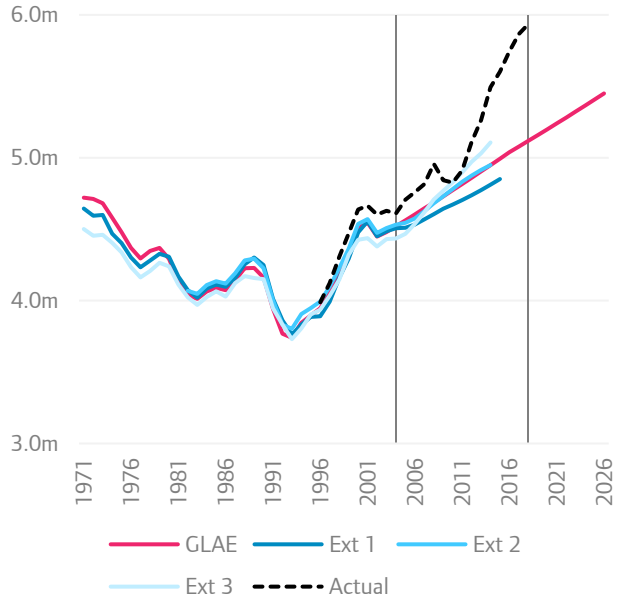


Figure 18: Results of 2005 GLAE projections versus other forecasters (index, 2004=100)

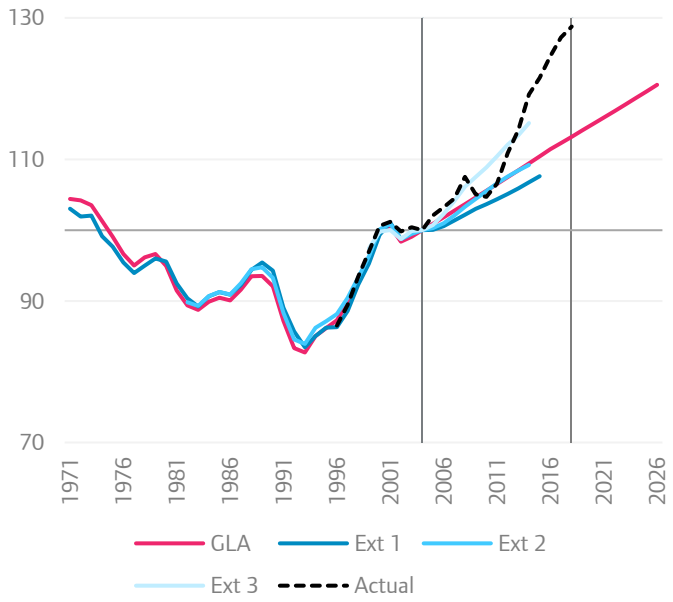


Figure 19: Results of 2002 GLAE projections versus other forecasters (absolute numbers)

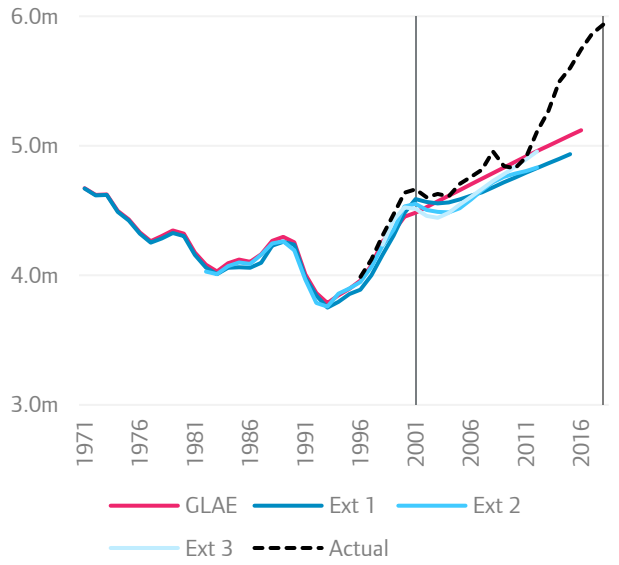
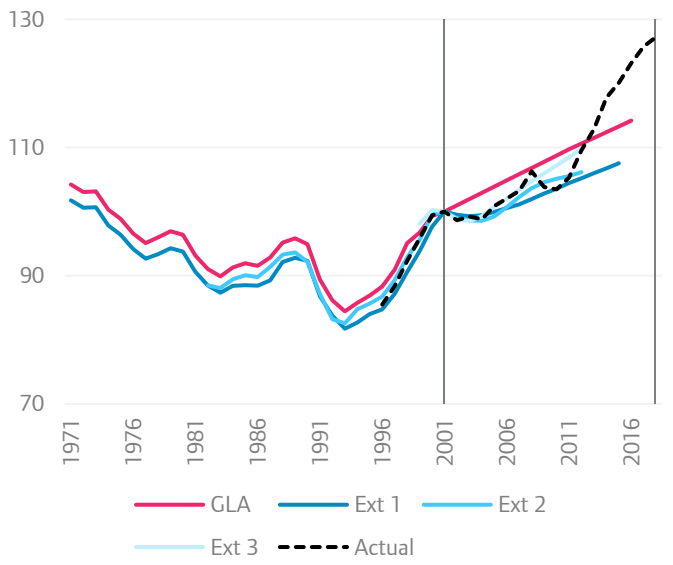


Figure 20: Results of 2002 GLAE projections versus other forecasters (index, 2001=100)



The correlation coefficient for these projection rounds has also fallen compared to more recent rounds (down to 0.92 in both cases, see Tables 6 and 7). This is partly down to variations in the direction of employment in the years up to 2010, which were not reflected in our 2005 and 2002 rounds. This is partly to do with our methodology, which focuses on the average path for future employment growth and not year-on-year variations. Even then, our projections have still done relatively well on this measure compared to external forecasters.

Compared to most of the external organisations, the accuracy of the GLA Economics projections produced in 2005 has also been reasonably strong. During the period from 2005 to 2015 our projected growth rate was 0.9 percentage points below outturn and estimates were, on average, 4.4% away from outturn in

absolute terms.[13] As Table 6 shows, External 3's 2005-round has been even more accurate on these measures – forecasting an average rate of employment growth only 0.4% below the latest WFJ estimates. Otherwise the performance of the GLAE projections compares favourably with Externals 1 and 2 during this time (Table 6).

Table 6: Statistical measures of 2005 projection/forecast accuracy and bias

2005-round (assessed: 2005-15/*14)	GLAE	Ext 1	Ext 2*	Ext 3*
CAGR (pp diff to actual)	-0.9	-1.1	-0.9	-0.4
Correlation co-efficient	0.92	0.92	0.87	0.89
Cumulative sum of forecast errors (000s)	2,529	3,642	1,954	1,567
Mean absolute deviation	230	331	195	157
Mean absolute percentage error	4.4%	6.4%	3.9%	3.1%

Our 2002-round appears to have performed even better in terms of accuracy. As illustrated in Figure 19, it suggested there would be 5.08 million jobs in London by 2015. In fact, there were approximately 5.59 million jobs according to the latest WFJ estimates, so the projection was around 9% too low at that point. This was, however, closer than the only external forecast we have for comparison: External 1 predicted that there would be 4.94 million jobs in London in 2015, around 12% below the latest WFJ estimate for that year.

Table 7 offers more detailed comparisons of our 2002-round with forecasts produced by all three of our external organisations. To enable this comparison, it only uses data for the years between 2002 and 2012.[14] Across this period, we projected employment to grow by around 0.9% per year on average – only 0.1 percentage points different from the actual figure according to the latest WFJ estimates (0.8% per year). In terms of employment levels, we were, on average, just 1.1% away from outturn in absolute terms – and this was closer than any of our external counterparts for this period.

Table 7: Statistical measures of 2002 projection/forecast accuracy and bias

2002-round (assessed: 2002-12)	GLAE	Ext 1	Ext 2	Ext 3
CAGR (pp diff to actual)	0.1	-0.4	-0.3	0.0
Correlation co-efficient	0.92	0.90	0.91	0.93
Cumulative sum of forecast errors (000s)	590	1,214	1,376	1,163
Mean absolute deviation	54	110	125	106
Mean absolute percentage error	1.1%	2.3%	2.6%	2.2%

[13] Note, while the GLA Economics 2005 projection extended to 2026, only the period upto 2015 has been analysed for comparability with external forecasters.
[14] These measures of statistical accuracy therefore exclude most of the divergence in trends in the post-crisis period.

Summary of accuracy and bias

This section has assessed the accuracy and bias of our long-term employment projections. It has shown that, as with forecasts from other organisations, previous GLA Economics' employment projections have tended to exhibit a downward bias in recent years (i.e. our employment projections have generally been below outturn estimates since 2011).

Two main factors are behind this. The first is successive upward revisions to historic ONS WFJ data, which have been substantial in some cases. The second, more significant factor is the unusually rapid growth in employment relative to output in the post-financial crisis period – the 'productivity puzzle'. In common with GLAE, these factors have seen external organisations also underestimating employment trends in London in recent years.

When compared with our external counterparts, however, this section found that our projections have performed reasonably well on key measures of bias and accuracy, especially when analysed over a longer period. By way of illustration, Table 8 brings together the average error in estimates of annual employment growth for each organisation and round. As with the analysis above, the 'assessment period' here is focused on overlapping years of projections or forecast up to 2018 – the latest year of outturn data from the WFJ series. The best and worst-performing estimates from each round are highlighted in green and red respectively.

On this basis we can see that GLAE performs best in two out of nine rounds (2009 and 2017) and worst in only one round (2011). Looking more closely, our earlier rounds appear to have performed relatively well, although the accuracy of our projections seems to have suffered in the aftermath of the financial crisis, especially for our 2011 projection round. That said, additional years of outturn data are needed before we can fully assess the accuracy and bias of the employment projections we have produced since 2011 given their long-term focus.

Table 8: Percentage point error of CAGR for projections/forecasts against latest 'actual' estimates

Projection round	Period assessed	Percentage point diff. from actual			
		GLAE	Ext 1	Ext 2	Ext 3
2002	2001 to 2012	0.1	-0.4	-0.3	0.0
2005	2004 to 2015/*14	-0.9	-1.1	-0.9*	-0.4*
2007	2006 to 2018/*17	-0.9	-1.0	-1.2	-0.8*
2009	2008 to 2018	-1.2	-1.7	-1.7	-1.3
2011	2010 to 2018	-2.2	-1.9	-1.9	-0.9
2013	2012 to 2018	-1.9	-2.0	-1.4	-1.5
2015	2014 to 2018	-1.3	-1.3	-0.7	-0.1
2016	2015 to 2018	-1.2	-1.3	-0.7	-0.6
2017	2016 to 2018	-0.9	-1.0	-1.3	-1.1

4 Consistency of employment projections over time

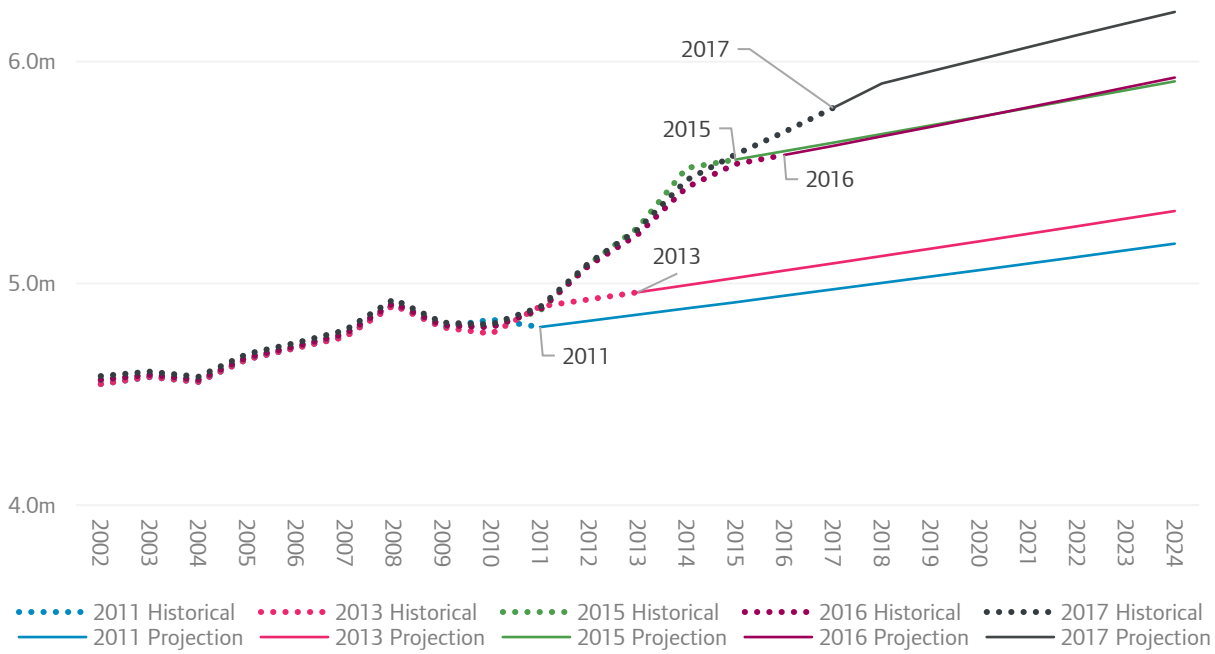
As well as being accurate and unbiased, in the absence of new information, good projections should (arguably) be relatively consistent and thus reliable over time. This is especially relevant for GLA Economics since our estimates are used in planning to provide capacity to accommodate the longer-term needs of the London economy. With that in mind, this section looks at the variation in our employment projections over time.

Consistency of historic employment data

Given the consistency of our methodology, variability in our projections is largely driven by new information available between rounds. As noted in Section 2, changes to historic data are one of the main factors that influence our estimates. There have been numerous developments and revisions to the ONS WFJ series that underpins our trend-based model, so it is not surprising that there is some variability in our projection numbers over time.[15]

This can be seen in Figure 21. It plots historical and projected jobs estimates from the last five rounds of GLAE projections, covering the period from 2002 to 2024. The most obvious difference between rounds is that they are set at different levels – each taking advantage of new information. In most cases, though not including the 2016-round below, the most recent estimates are set at a higher level than the previous round. This is either driven by upward revisions to the WFJ series and/or higher-than-expected jobs growth in the intervening period.

Figure 21: Jobs estimates from successive GLAE projections, historical and projected



Revisions and developments to the WFJ series are a significant factor. The two tables below help to clarify this point. They outline the magnitude of changes in historic jobs data between all our projection rounds for years where historic data overlap (since 1996) – first in absolute terms (Table 9) and then as a percentage change (Table 10).

[15] Details of developments and revisions to the WFJ series are regularly released alongside the ONS's labour market statistical bulletin. For the latest revisions, see: ONS (2019) Revisions to workforce jobs: December 2019

Table 9: Mean absolute deviation in ONS historic jobs data

	2002	2005	2007	2009	2011	2013	2015	2016	2017
2002									
2005	2,100								
2007	33,400	25,100							
2009	63,800	50,300	28,600						
2011	55,900	61,400	51,100	40,500					
2013	56,300	61,800	51,400	40,600	-4,300				
2015	72,100	76,600	64,900	53,800	9,700	20,600			
2016	72,100	76,600	64,900	53,800	9,700	20,600	-6,300		
2017	90,600	93,900	81,900	70,800	26,100	36,400	10,700	18,300	

Table 10: Mean percentage deviation in ONS historic jobs data

	2002	2005	2007	2009	2011	2013	2015	2016	2017
2002									
2005	0.0%								
2007	0.8%	0.6%							
2009	1.5%	1.2%	0.7%						
2011	1.2%	1.4%	1.1%	0.8%					
2013	1.3%	1.4%	1.1%	0.9%	-0.1%				
2015	1.6%	1.7%	1.4%	1.2%	0.2%	0.4%			
2016	1.6%	1.7%	1.4%	1.2%	0.2%	0.4%	-0.1%		
2017	2.1%	2.1%	1.8%	1.5%	0.6%	0.8%	0.2%	0.4%	

Note: the mean historic deviation is the annual average change in figures for overlapping historic years. It provides an indication of the scale of adjustments made – in absolute terms (Table 9) or percentage terms (Table 10).

This shows that the largest divergence in the historic jobs data informing our projections is between the data we had in 2005 compared to that in 2017. In 2017 our historic data was on average 93,900 or 2.1% higher in each overlapping year (1996-2001). Whereas the smallest difference in the historic jobs data is between the series we had available in 2011 and 2013, when our historic data was on average 0.1% lower for each overlapping year (1996-2010).

Overall, the scale of changes to historic jobs data has tended to increase with the length of time between each round of projections.[16] This is a particular issue when it comes to comparing absolute employment projections over longer time periods.

Consistency of projections – employment levels

Having highlighted some of the variation in the historic data available at the time of constructing our projections, we now turn to differences in our projected employment estimates themselves.

Table 11 considers the correlation coefficient between any two rounds of GLAE projections. It provides a statistical measure of how accurately one set of employment projections can be predicted by knowing another. The closer the correlation coefficient is to 1 the stronger is degree of linear association between

[16] This makes sense since if, for example, more revisions and developments affect the series over time, creating an accumulation of changes that moves the new WFJ estimates increasingly further away from original estimates.

two sets of estimates and the more closely related changes in these series are. As suggested above, in the absence of revised information or new evidence, good long-run projections should have relatively predictable changes over time.[17] As such, one would expect high correlation coefficients between projection rounds, and this is indeed the case.

Table 11: Inter-year correlation coefficients for GLAE long-run projections

	2002	2005	2007	2009	2011	2013	2015	2016	2017
2002									
2005	0.999								
2007	1.000	1.000							
2009	1.000	1.000	1.000						
2011	1.000	1.000	1.000	1.000					
2013	1.000	1.000	1.000	1.000	1.000				
2015	1.000	1.000	1.000	1.000	1.000	1.000			
2016		1.000	1.000	1.000	1.000	1.000	1.000		
2017		0.995	0.995	0.996	0.994	0.994	0.994	0.992	

Note: Estimates rounded to three decimal places and cover overlapping projection years only.

The tables below show the average change in the projected level of employment for overlapping years from one round to another, in absolute (Table 12) and relative (Table 13) terms. This shows that the smallest variation was between our 2013 and 2005 rounds where the average difference in our long-run projections was only 4,000 jobs or 0.1% a year. Reflecting the impact of the post-crisis productivity puzzle, the highest variation was between the projections produced in 2011 and those produced in 2017.[18]

Table 12: Mean absolute annual deviation for GLAE long-run projections (000s)

	2002	2005	2007	2009	2011	2013	2015	2016	2017
2002									
2005	-97								
2007	-104	10							
2009	-134	-90	-102						
2011	-146	-118	-133	-25					
2013	-51	-4	-22	111	151				
2015	477	552	530	692	751	595			
2016	459	554	530	710	783	626	27		
2017		822	795	995	1,067	907	306	260	

[17] Note again that, in contrast to forecasts from some other organisations, our long-run projections focus on the average path for future employment growth and are not designed to incorporate year-on-year variations in employment.
[18] There was a difference, on average, of over 1 million or 20.3% in the number of jobs we estimated to be in the capital for the two decades of overlapping projection data (i.e. on average, in each year between 2017 and 2036).

Table 13: Mean percentage annual deviation for GLAE long-run projections

	2002	2005	2007	2009	2011	2013	2015	2016	2017
2002									
2005	-6.7%								
2007	-2.1%	-0.1%							
2009	-2.7%	-1.7%	-1.9%						
2011	-2.9%	-2.3%	-2.5%	-0.5%					
2013	-1.0%	-0.1%	-0.4%	2.2%	2.9%				
2015	9.4%	10.6%	10.1%	13.3%	14.3%	11.0%			
2016	9.0%	10.6%	10.1%	13.6%	14.9%	11.6%	0.4%		
2017		15.6%	15.0%	19.1%	20.3%	16.7%	5.1%	4.2%	

Note: the mean projection deviation is the annual average change in figures for overlapping projection years. It provides an indication of the scale of divergence – in absolute terms (Table 12) or percentage terms (Table 13).

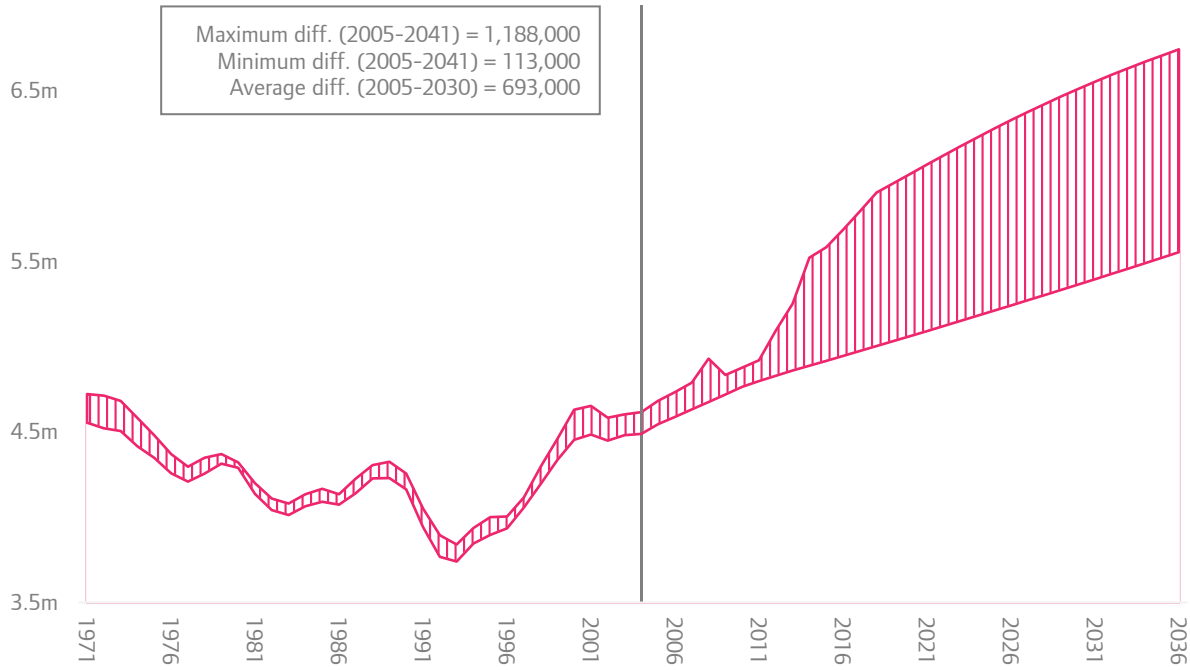
What changed between these rounds? As well as upward revisions to historic data, there was unexpectedly strong jobs growth in the intervening period. Our 2011-round was produced in the aftermath of the financial crisis, when expectations for jobs growth in London were more subdued. Since then productivity growth has remained significantly below pre-crisis trends while employment has risen to record levels. These are trends that few predicted a decade ago.[19] The result is that our 2017-round both started from a far higher level of employment than had been predicted[20] and incorporated expectations of a higher rate of jobs growth.

Figure 22 compares all our projection rounds simultaneously. It shows that the largest difference in any one year occurs in 2036 – again between our 2011 and 2017 rounds. It also shows that the average annual difference between the highest and lowest GLAE projections since 2005, when our first overlapping projection occurs, and 2030, the latest year that allows a comparison to be drawn with each of our three external counterparts, is 693,000 jobs.

[19] At the national level Office for Budget Responsibility employment forecasts have also repeatedly surprised on the upside. Reflecting on these trends, the Resolution Foundation recently described employment as reaching 'levels no-one thought possible a decade ago'. See: Resolution Foundation (2019) Feel poor, work more: Explaining the UK's record employment

[20] At the time of constructing the 2017 projection round, the latest WFJ series we had available suggested that there were 739,000 more jobs in London than we had predicted in 2011.

Figure 22: GLAE maximum and minimum estimates of employment



Note: the charted minimum and maximum estimates cover the nine sets of GLAE projections from 2002 to 2017 and the latest outturn WFJ estimates (as well as revisions to the historical data). The minimum, maximum and average difference values relate to differences in projections from 2005 onwards (i.e. from when overlapping projection years were available/began).

Figures 23 to 26 and Tables 14 to 22 provide similar variability analysis for the forecasts produced by our three external organisations. It is important to note that, compared to GLAE, these organisations incorporate more short-term fluctuations into their estimates. As such, they are likely to exhibit higher levels of volatility in the short to medium-term, particularly around turning points in the economic cycle. This is reflected in the relatively sharp falls in correlation coefficients for the overlapping years of external forecasts produced in 2009 and before (Tables 14, 17, 20).

It is also significant that our external counterparts tend not to produce forecasts as far into the future as GLAE.[21] This means that for GLAE projections our analysis of minimum and maximum values incorporates more data points, stretching further back in time. Whereas for forecasts produced by external organisations 'older' employment estimates are dropped from this analysis more quickly. This suggests relatively less scope for divergence between the minimum and maximum estimates – which is what can be seen in Figures 23, 24 and 25.

[21] For example, whereas GLA Economics first produced employment estimates for 2036 in our 2011-round, the external forecasts included in this analysis only did that from their 2017-rounds.

Figure 23: External 1 maximum and minimum estimates of employment

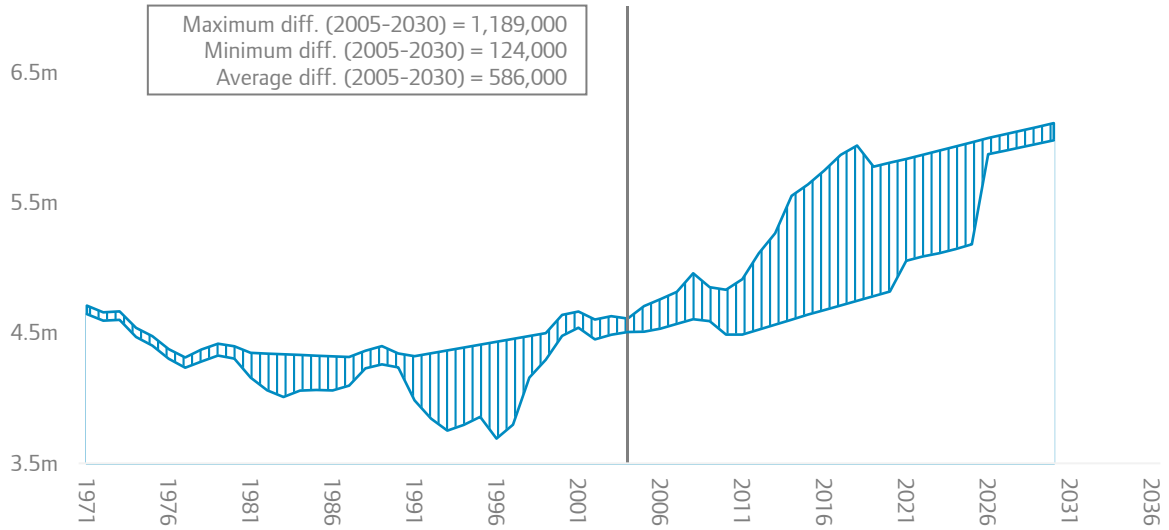


Table 14: Inter-year correlation coefficients for External 1 forecasts

	2002	2005	2007	2009	2011	2013	2015	2016	2017
2002									
2005	0.999								
2007	0.995	0.997							
2009	0.594	0.633	0.936						
2011	0.996	0.994	0.999	0.999					
2013	0.959	0.960	0.995	0.994	0.993				
2015			1.000	0.999	0.998	0.998			
2016			0.998	0.998	0.997	0.998	0.999		
2017			0.998	0.999	0.997	0.996	0.998	0.999	

Table 15: Mean absolute annual deviation for External 1 forecasts (000s)

	2002	2005	2007	2009	2011	2013	2015	2016	2017
2002									
2005	-82								
2007	53	135							
2009	-271	-185	-369						
2011	-101	-13	-194	202					
2013	184	271	47	455	244				
2015	652	736	535	956	762	526			
2016			574	1,000	789	557	26		
2017			486	919	692	462	-72	-107	

Table 16: Mean percentage annual deviation for External 1 forecasts

	2002	2005	2007	2009	2011	2013	2015	2016	2017
2002									
2005	-1.7%								
2007	1.1%	2.9%							
2009	-5.6%	-3.9%	-7.3%						
2011	-2.1%	-0.3%	-3.8%	4.3%					
2013	3.8%	5.6%	0.9%	9.7%	4.9%				
2015	13.2%	15.2%	10.4%	20.2%	15.2%	10.0%			
2016			11.1%	21.1%	15.7%	10.6%	0.5%		
2017			9.4%	19.3%	13.7%	8.8%	-1.2%	-1.8%	

Figure 24: External 2 maximum and minimum estimates of employment

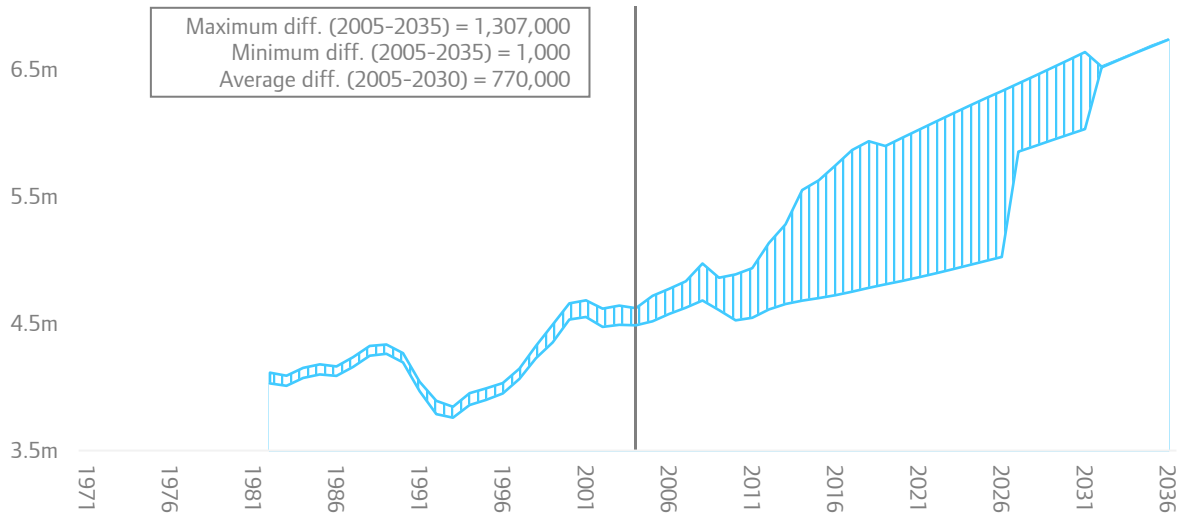


Table 17: Inter-year correlation coefficients for External 2 forecasts

	2002	2005	2007	2009	2011	2013	2015	2016	2017
2002									
2005	0.968								
2007	0.983	0.997							
2009	0.120	0.699	0.941						
2011	1.000	0.988	0.997	0.987					
2013		1.000	0.999	0.997	0.993				
2015			0.999	0.998	0.981	0.998			
2016			0.998	0.999	0.981	0.997	0.999		
2017			1.000	0.999	0.963	0.995	0.998	0.999	

Table 18: Mean absolute annual deviation for External 2 forecasts (000s)

	2002	2005	2007	2009	2011	2013	2015	2016	2017
2002									
2005	-2								
2007	100	93							
2009	-224	-243	-325						
2011	-188	-221	-249	76					
2013		196	259	656	576				
2015			710	1,134	1,049	483			
2016			679	1,061	975	373	-115		
2017			662	1,050	965	362	-131	-9	

Table 19: Mean percentage annual deviation for External 2 forecasts

	2002	2005	2007	2009	2011	2013	2015	2016	2017
2002									
2005	0.0%								
2007	2.1%	1.9%							
2009	-4.7%	-5.0%	-6.5%						
2011	-3.9%	-4.5%	-5.0%	1.6%					
2013		4.0%	5.1%	13.5%	11.7%				
2015			13.9%	23.3%	21.2%	8.5%			
2016			13.3%	21.8%	19.7%	6.6%	-1.8%		
2017			12.9%	21.5%	19.4%	6.3%	-2.1%	-0.1%	

Figure 25: External 3 maximum and minimum estimates of employment

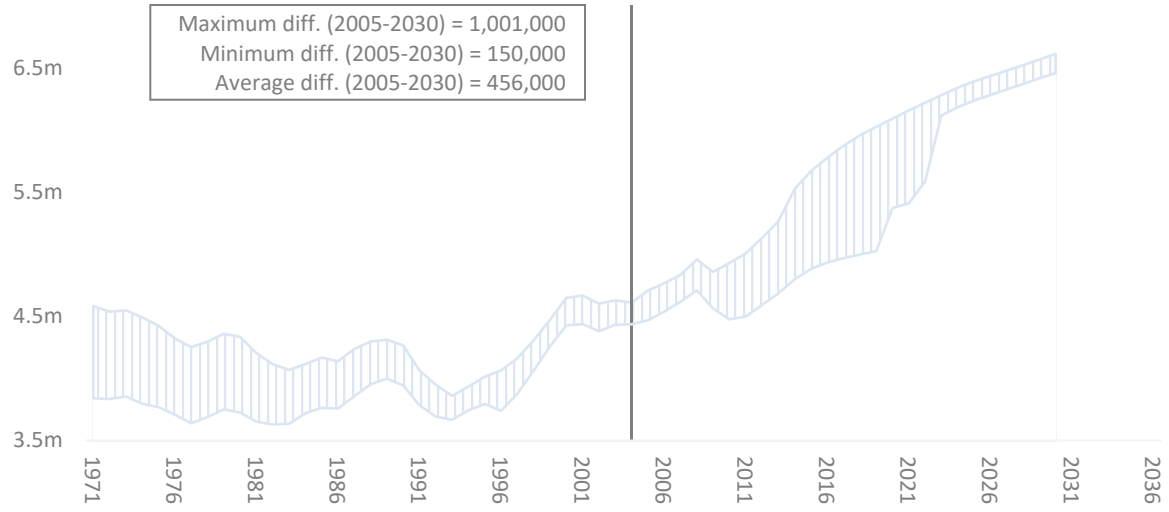


Table 20: Inter-year correlation coefficients for External 3 forecasts

	2002	2005	2007	2009	2011	2013	2015	2016	2017
2002									
2005	0.999								
2007	0.998	0.994							
2009	0.275	0.844	0.886						
2011	1.000	0.987	0.971	0.986					
2013		1.000	0.997	0.940	0.959				
2015			1.000	0.998	0.985	0.998			
2016				1.000	0.978	0.986	0.997		
2017				0.998	0.963	0.951	0.996	0.999	

Table 21: Mean absolute annual deviation for External 3 forecasts (000s)

	2002	2005	2007	2009	2011	2013	2015	2016	2017
2002									
2005	-28								
2007	83	93							
2009	-336	-333	-403						
2011	-238	-220	-247	214					
2013		19	-46	350	122				
2015			489	899	657	570			
2016			401	774	505	420	-142		
2017				773	487	397	-170	-27	

Table 22: Mean percentage annual deviation for External 3 forecasts

	2002	2005	2007	2009	2011	2013	2015	2016	2017
2002									
2005	-0.6%								
2007	1.7%	1.9%							
2009	-6.9%	-6.7%	-7.9%						
2011	-4.8%	-4.4%	-4.8%	4.4%					
2013		0.4%	-0.9%	7.2%	2.4%				
2015			9.3%	18.1%	12.4%	10.5%			
2016			7.6%	15.5%	9.5%	7.7%	-2.3%		
2017				15.5%	9.1%	7.3%	-2.7%	-0.4%	

The forecasts produced by External 2 show particular variation over time on these measures. For overlapping forecasts produced for the years between 2005 and 2030, the average annual difference between their minimum and maximum estimates was 770,000 (Figure 24). This is above the average difference (between maximum and minimum values) for GLAE's long-run projections (693,000) and higher than Externals 1 and 3 (586,000 and 456,000 respectively).

Perhaps unsurprisingly, the average percentage change between forecasts is greatest for series constructed near turning points in the economic cycle – particularly in the aftermath of the financial crisis. For example,

External 2's forecasts between 2009 and 2015 have an average difference of 23.3% per year. External 1 shows a similar pattern, with a 21.1% annual average difference between the forecast produced in 2009 and 2016 (Table 16), and to a lesser extent External 3 does as well (Table 22). This highlights the difficulties that all organisations face when trying to incorporate changes in the economic context into longer-term projections.

Consistency of projections – employment growth

As a final measure of consistency, we can compare predictions about annual jobs growth from different organisations over time. This is useful since it partly adjusts for differences in the length of projection/forecast periods and isolates judgements made about the future. On this basis Table 23 sets out the annual absolute and percentage growth in employment predicted by each organisation over time; Figure 26 illustrates the annual percentage growth rates predicted by GLAE and our external counterparts with a simple average of their growth rates.

We can see that there is a degree of variation in growth rates between GLAE rounds. It is notable that projections made in the post-crisis period have a lower annual growth rate than both earlier and later projection rounds. In 2011, following two years where jobs numbers had been heading downwards, our projected compound annual growth rate (CAGR) for 2011-2036 was only 0.53%, whereas all other rounds have a CAGR somewhere between 0.64% and 0.89%.

Yet we can also see that successive GLAE projections of annual jobs growth exhibit more consistency between rounds than with forecasts produced by external organisations. As Table 23 shows, the standard deviation of annual growth rates from all our projection rounds between 2002 and 2017 is lower than for forecasts produced by our external counterparts. This indicates that our estimates of future jobs growth tend to remain closer to their average between rounds. In contrast, the forecasts made by External 3 show the greatest degree of variation in annual average growth rates and second highest in terms of absolute levels.

Greater consistency between rounds may be desirable for use in planning to provide capacity to accommodate the longer-term needs of the economy. Note, however, this analysis is still not exactly a like-for-like comparison between organisations. As noted above, the variance of projections/forecasts is likely to be greater in the short to medium-term, particularly around turning points in the economic cycle.[22] It is therefore unsurprising that forecasts with a more short-term horizon tend to incorporate more of this variance as forecasters seek to respond to and incorporate changes in the economic cycle into their judgements about future growth.

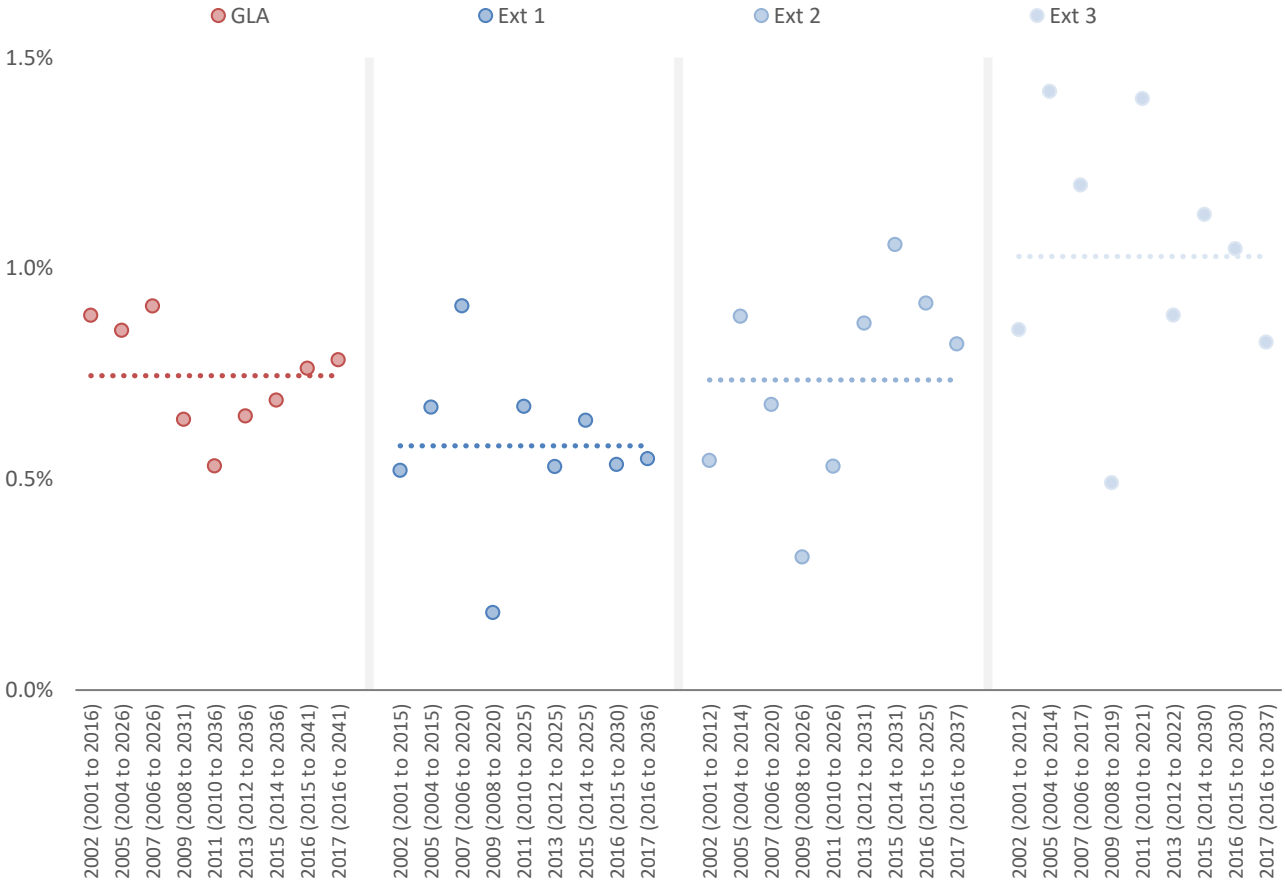
[22] To illustrate this point, External 3 – which has the shortest average forecast period in our sample – was predicting an annual rate of jobs growth of 1.40% per year in their 2011-round, almost three times higher than the rate of jobs growth predicted in their 2009-round (0.49% per year). External 1 shows a similar pattern, albeit to a lesser degree.

Table 23: Average annual employment growth projected/forecast over time

	Publication/ start year	Annual employment growth projected/ forecast (CAGR)[1]	Annual employment growth projected/ forecast (absolute, 000s)	Projection/forecast end year
GLAE	2002	0.89%	42	2016
	2005	0.85%	42	2026
	2007	0.91%	46	2026
	2009	0.64%	32	2031
	2011	0.53%	28	2036
	2013	0.65%	35	2036
	2015	0.69%	41	2036
	2016	0.76%	47	2041
	2017	0.78%	49	2041
	SD[2]	0.13%	7	
Ext 1	2002	0.52%	25	2015
	2005	0.67%	31	2015
	2007	0.91%	45	2020
	2009	0.18%	9	2020
	2011	0.67%	33	2025
	2013	0.57%	30	2025
	2015	0.64%	37	2025
	2016	0.54%	31	2030
	2017	0.42%	24	2036
	SD[2]	0.20%	10	
Ext 2	2002	0.54%	25	2012
	2005	0.89%	42	2014
	2007	0.68%	33	2020
	2009	0.30%	15	2025
	2011	0.55%	26	2025
	2013	0.92%	50	2031
	2015	1.06%	64	2031
	2016	0.92%	56	2035
	2017	0.82%	51	2037
	SD[2]	0.24%	16	
Ext 3	2002	0.85%	40	2012
	2005	1.42%	67	2014
	2007	1.20%	59	2017
	2009	0.49%	24	2019
	2011	1.40%	70	2021
	2013	0.98%	52	2022
	2015	1.13%	68	2030
	2016	1.05%	63	2030
	2017	0.82%	51	2037
	SD[2]	0.29%	15	

Notes: [1]CAGR refers to the compound annual growth rate. [2] SD refers to the standard deviation of the estimates.

Figure 26: Compound annual growth rate (CAGR) projected/forecast over time



Source: CAGR = compound annual growth rate – the average year on year growth between two points in time

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