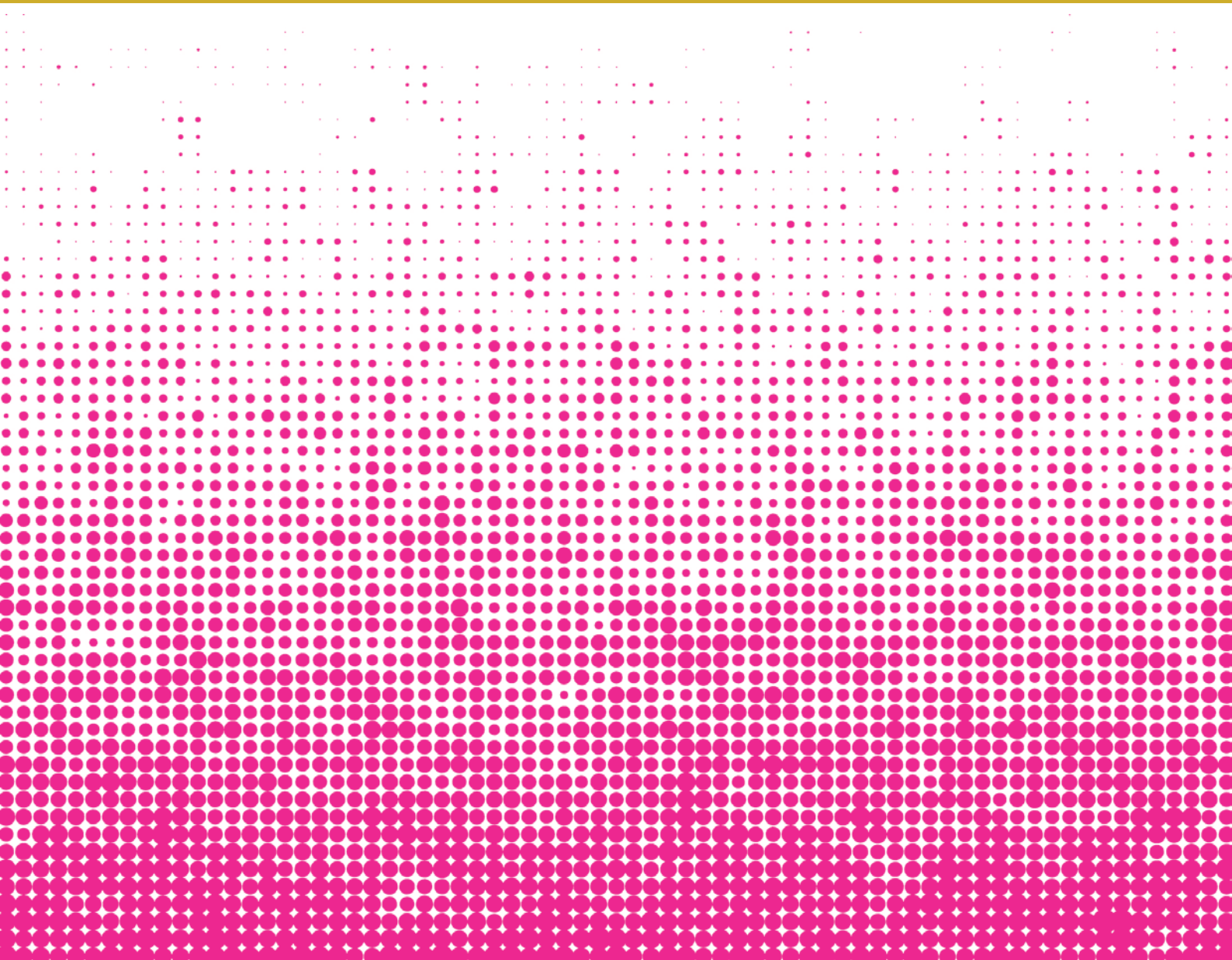


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Performance of GLA Economics' employment projections

Melisa Wickham

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For more information about this publication, please contact:

GLA Economics

Tel 020 7983 4922

Email glaeconomics@london.gov.uk

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Executive summary

GLA Economics (GLAE) has produced long-run projections of London's employment since 2002. These projections are trend based (relying on observed historic patterns) and set out the long-run (approximately two decades) path of employment considered most likely based on the historic data available at the time of construction. They are not designed to forecast the inherent short-run fluctuations of employment around its trend. As such, the trend projections are suitable for use in planning to provide capacity (such as in housing and transport) to accommodate the longer-term needs of the economy.

Given the importance of the GLA Economics' longer-term employment projections to GLA policy planning, and bearing in mind their intended purpose, this note looks at how the projections have performed since 2002 and how this compares to projections from other respected organisations.

Although there are no universally accepted criteria to assess projections, good medium/long-term employment projections should arguably exhibit three characteristics. They should:

- Not exhibit bias, ie, they should not consistently underestimate or overestimate on a regular basis;
- Be accurate or close to the actual data over the period under consideration; and
- Be relatively consistent (and thus reliable/predictable) over time, ie, show little variance/correction from one set of projections to another.

It is, therefore, along these criteria that GLA Economics' employment projections are assessed in this paper.

In assessing the performance of GLA Economics' employment projections with regard to the first two characteristics (not exhibit bias and be close to the actual data) it is important to bear in mind the purpose of the projections and subsequently the model employed. The projection model is not designed to be accurate in the short term (especially in terms of predicting short-term fluctuations). Instead, it is designed to show the longer-term path expected for employment. Its performance with regard to accuracy and bias is therefore best done when there are a many number of years against which to compare. As with the projections from other organisations, GLA Economics' employment projections exhibit a downward bias (ie, are consistently below outturn). However, much of this is the result of upward revisions to historic employment data, and when looking at the projected annual growth rate and average annual error in relation to employment outturn, GLA Economics projections perform relatively well. Further, the accuracy of the GLA Economics projections generally improves the longer the time period over which the estimates are analysed.

Given the revisions in historic data that underpin the GLA Economics employment projections model, it is unsurprising that there is some variability in the projections numbers over time. However, and by design, the revised projections are relatively consistent over time. Furthermore, the average revisions between iterations in GLA Economics' employment projections are relatively small, particularly when compared to that of other respected organisations that provide London employment projections. Indeed, the variability comparison with other organisations highlights the issues in attempting to incorporate economic cycles in long-term projections. Such models show high levels of volatility, particularly around turning points in the economic cycle. It, therefore, seems fair to conclude that GLA Economics' employment projections are relatively consistent over time.

Introduction

GLA Economics (GLAE) has produced long-run projections of London's employment since 2002. These projections set out the long-run (approximately two decades) path of employment considered most likely based on the historic data available at the time of construction. The projections are used to inform policies with a medium to long-term focus. In particular, they are used to inform the Mayor's London Plan and the latest projections underpin the estimates for skills demand created to inform the London Enterprise Panel Skills and Employment Working Group¹.

It should be noted that GLA Economics also produces shorter-term employment forecasts which cover the current year and the next two years. These are published every six months in *London's Economic Outlook*. It is important to distinguish between these shorter-term *forecasts* and the longer-term *projections* (the latter being the focus of this paper). The longer-term projections are trend based (relying on past observed patterns). They are not designed to forecast the inherent short-run fluctuations of employment around its trend. As such, the trend projections are suitable for use in planning to provide capacity (such as in housing and transport) to accommodate the longer-term needs of the economy. However, for business planning (for example the likely course of revenue), estimates of actual numbers of jobs at a point in time are required, and these are provided in the form of the GLA Economics shorter-term employment forecasts.

Given the importance of the GLA Economics' longer-term employment projections, and bearing in mind their intended purpose, this note looks at how the projections have performed since 2002 and how this compares to projections from other respected organisations.

Although there are no universally accepted criteria to assess projections, good medium/long-term employment projections should arguably exhibit three characteristics. They should:

- Not exhibit bias, ie, they should not consistently underestimate or overestimate on a regular basis;
- Be accurate or close to the actual data over the period in question; and
- Be relatively consistent (and thus reliable/predictable) over time, ie, show little variance/correction from one set of projections to another.

It is, therefore, along these criteria that we assess GLA Economics' employment projections. The paper begins by looking at statistical measures of variability of GLA Economics' projections over time, as well as that for other respected organisations that produce employment projections at the London level. It then goes on to look at measures of bias and accuracy of each projection produced, again for both GLA Economics' projections and that of other respected organisations.

¹ "London labour market projections", GLA Economics, April 2013.

Accuracy and bias of employment projections over time

Arguably, the most important requirements for good projections are that they should be accurate and unbiased over the period which they are projecting, ie, they should be close to the actual data over the period in question and should neither consistently underestimate nor overestimate. The main difficulty in achieving this with employment projections is that historic employment data (on which it is heavily reliant) is often subject to unpredictable revisions. This is an important caveat to the analysis that follows, particularly when assessing the accuracy and bias of *absolute* employment projections estimates.

Figures 1 and 2 show the employment projections published in 2013 for different organisations, including GLA Economics; Figure 1 shows employment *levels* whilst Figure 2 shows employment *growth rates*. Although it is too early to assess the accuracy of employment projections created in 2013 it is interesting to note that GLA Economics predicts the lowest absolute levels of employment in 2023 and the lowest growth rate for employment over the medium/long-term.

Figure 1: 2013 projected employment levels for London

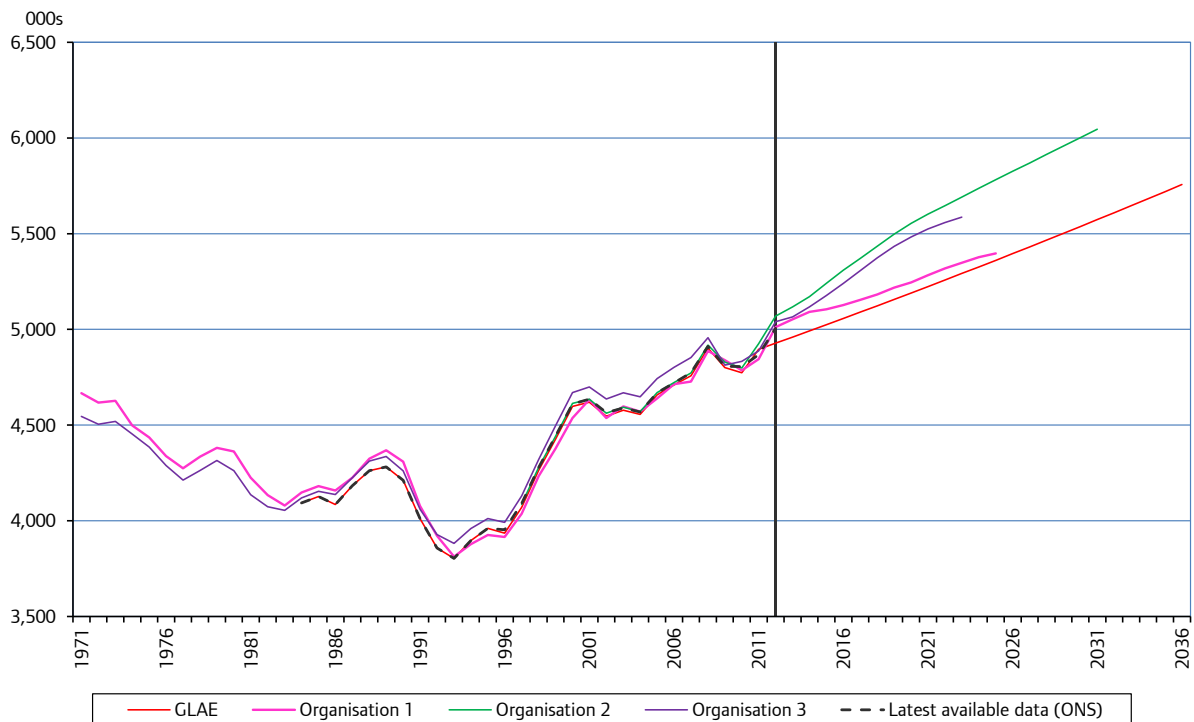
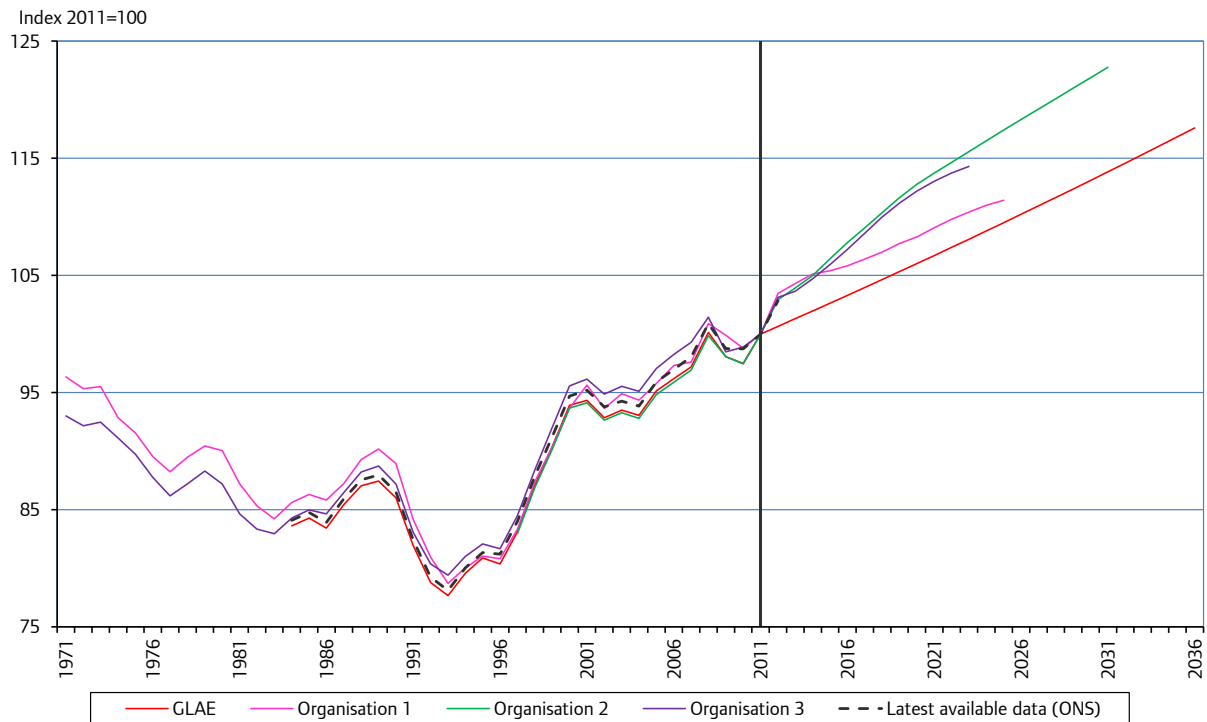


Figure 2: 2013 projected employment growth rates for London

Note: ONS, GLA Economics and Organisation 2's data covers employee and self-employed jobs only. Organisation 1's data also includes HM Forces jobs and Organisation 3's data includes both HM Forces jobs and Government supported trainees. GLA Economics data was published in April 2013, Organisation 1's data was published in February 2013, Organisation 2's data was published in May 2013, Organisation 3's data was published in Spring 2013 and the ONS data was published in September 2013 and goes up to June 2013.

Figures 3 and 4 show how the employment projections created in 2011 compared to one another and to what actually occurred. Again, with only two overlapping years (and three for Organisation 4) between projections and actual employment it is not really sensible to assess the accuracy of projections which have a long-term focus (such as those by GLA Economics). Similar to the 2013 projections, GLA Economics' 2011 projections estimated the lowest employment growth rate and one of the lowest absolute levels of employment in 2020.

Figure 3: 2011 projected employment levels for London

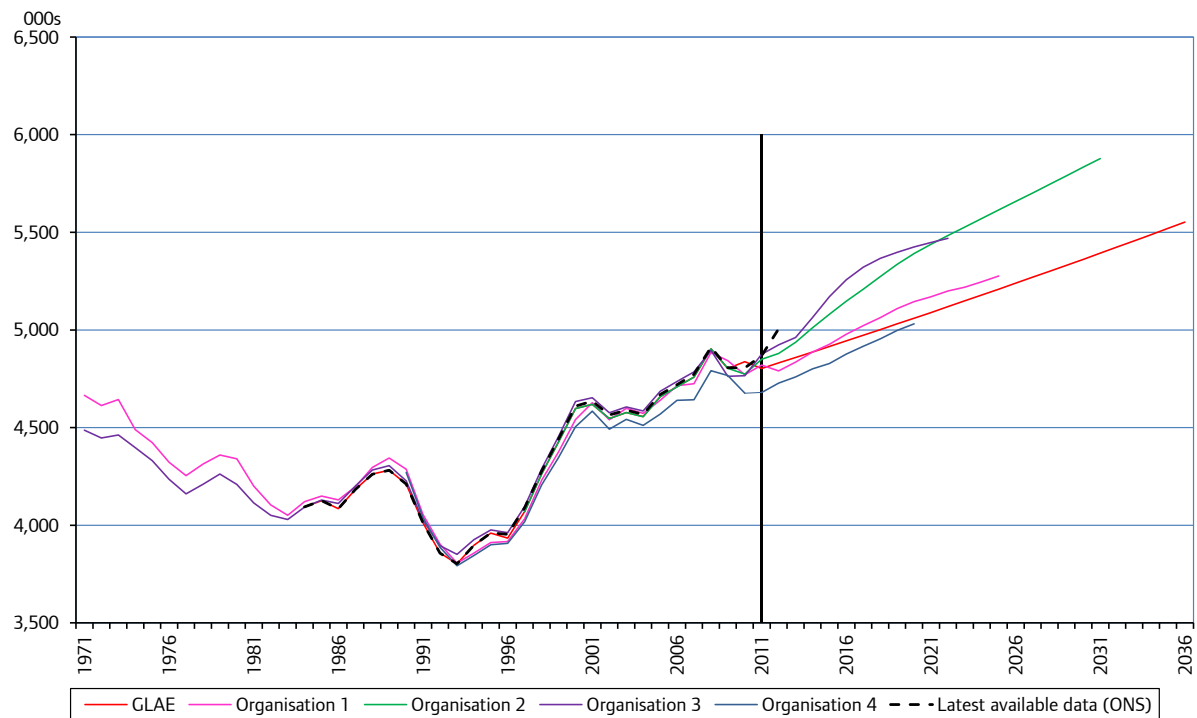
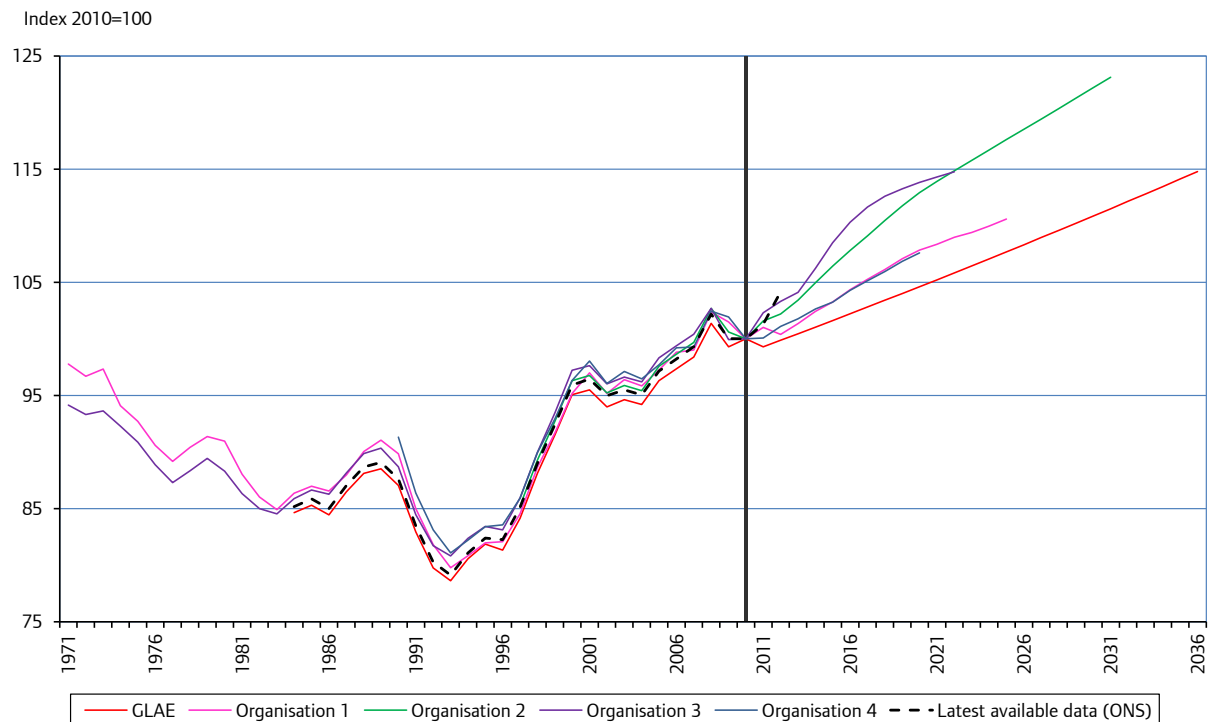


Figure 4: 2011 projected employment growth rates for London



Note: ONS, GLA Economics, and Organisations 2 and 4's data covers employee and self-employed jobs only. Organisation 1's data also includes HM Forces jobs and Organisation 3's data includes both HM Forces jobs and Government supported trainees.

GLA Economics data was published in December 2011, Organisation 1's data was published in February 2012, Organisation 2's data was published in January 2012, Organisation 3's data was published in Spring 2012, Organisation 4's data was published in December 2011 and the ONS data was published in September 2013 and goes up to June 2013.

Charts 5a to 6b below show the performance of projections created in 2009. It is important to note that there are only five years of data (six for Organisation 4) for which actual and 2009 projected employment overlaps. Projections which have a long-term focus (such as those by GLA Economics) are not designed to be accurate in the short-term (especially in terms of predicting short-term fluctuations) and so their performance against only five years of data should be treated with caution.

Figure 5a: 2009 projected employment levels for London

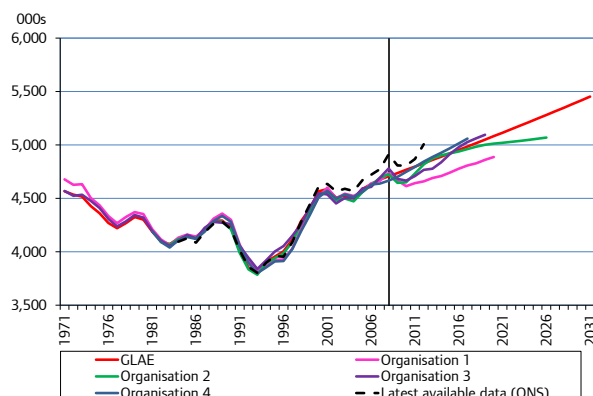


Figure 5b: GLA Economics 2009 projected employment levels for London

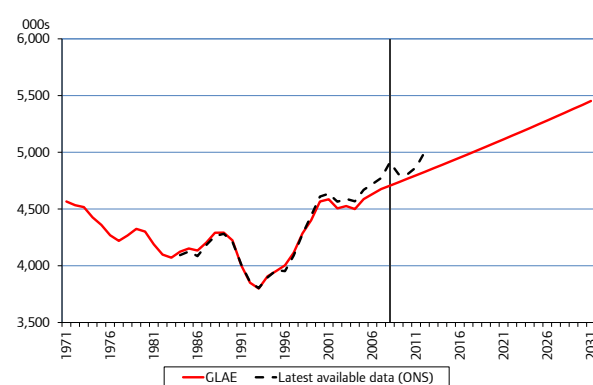


Figure 6a: 2009 projected employment growth rates for London

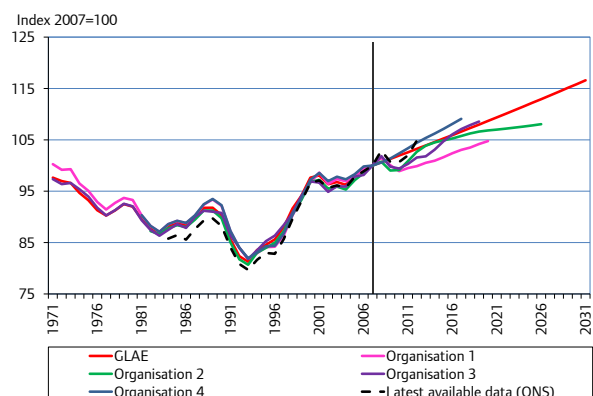
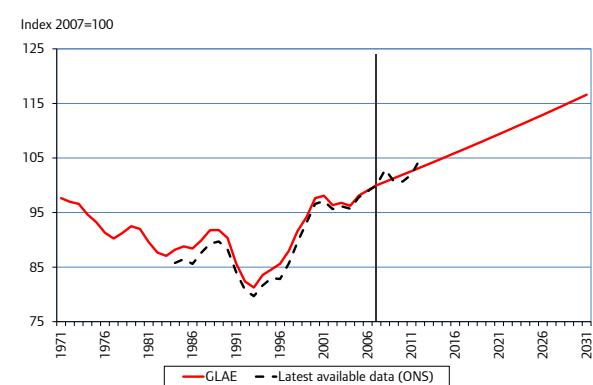


Figure 6b: GLA Economics 2009 projected employment growth rates for London



Note: ONS, GLA Economics, and Organisations 2 and 4's data covers employee and self-employed jobs only. Organisation 1's data also includes HM Forces jobs and Organisation 3's data includes both HM Forces jobs and Government supported trainees.

GLA Economics data was published in November 2009, Organisation 1's data was published in February 2009, Organisation 2's data was published in Spring 2010, Organisation 3's data was published in Spring 2010, Organisation 4's data was published in December 2008 and the ONS data was published in September 2013 and goes up to June 2013.

As might be expected given the short time period for comparison, the correlation coefficient (which measures how closely associated changes in one series are to another) between GLA Economics' projections and actual employment is low (see Table 1). Nonetheless, GLA Economics projections are the closest in size to actual employment. On average, GLA Economics projections were 113,000 (or 2.4 per cent) off outturn. However, over the period, GLA Economics' projections (as well as all other organisations' projections) were consistently below

outturn which suggests there may be some downward bias (although, looking at Figure 5a this is more likely to be due to an upward revision in historical data since the 2009 projections were published). GLA Economics' projections also performed well when considering the year-on-year growth rate of London employment (second only to Organisation 4).

Table 1: Statistical measures of 2009 forecast accuracy and bias

	GLA Economics	Organisation 1	Organisation 2	Organisation 3	Organisation 4	Latest available data (ONS)
Forecast CAGR compared to outturn (% point difference)	-0.3%	-1.0%	-0.4%	-0.6%	-0.2%	0.0%
Correlation Co-efficient	0.48	0.35	0.97	0.87	0.66	1.00
Cumulative sum of forecast errors	-564	-1,079	-828	-797	-782	-
Mean absolute deviation	113	216	166	159	130	-
Mean absolute percentage error (%)	2.4	4.6	3.5	3.4	2.8	-

Note: CAGR=compound annual growth rate, which measures the average year on year growth between two points in time. The forecast compared to outturn CAGR measures how much larger (or smaller) in percentage points terms the growth rate estimated by forecasters was compared to what actually happened. The correlation coefficient measures how closely (in direction and magnitude) the projected/forecast employment series follows what actually happened. The cumulative sum of forecast errors (which measures both accuracy and bias) adds up the difference in each year between projected/forecast employment and actual employment experienced. The mean absolute deviation measures the size of the average error each year (regardless of the direction of the error, ie, regardless of whether it was larger or smaller than outturn). The mean absolute percentage error measures the average of the percentage errors in each year and, thus, provides an indication of the scale of the error.

Figures 7a to 8b and Table 2 provide the same analysis for projections constructed in 2007. For these there are eight years of data to compare to employment outturn. Over this longer period, GLA Economics' projections show a significantly improved trend relationship with actual employment (as evidenced by the high correlation coefficient in Table 2).

GLA Economics' projections of the employment growth rate are also very close to the outturn (see Figures 8a and 8b). However, the difference between GLA Economics' projected employment *numbers* and outturn does not perform as well. The large negative cumulative sum of forecast errors (which simply adds the differences for each projected year) suggests that the GLA Economics estimates are negatively bias, ie, are consistently lower than the outturn. The mean absolute deviation and mean absolute percentage errors for GLA Economics' projections are also relatively large. However, much of this difference is due to an upward revision in employment numbers since the projections were published (although some is also due to short-term fluctuations in actual employment numbers).

Figure 7a: 2007 projected employment levels for London

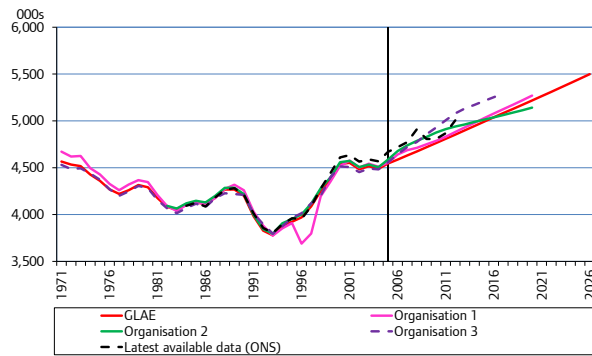


Figure 7b: GLA Economics 2007 projected employment levels for London

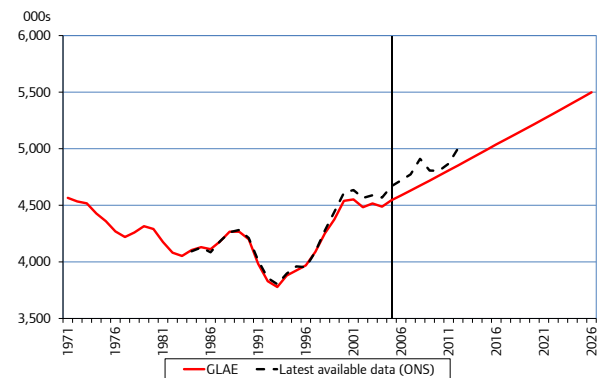


Figure 8a: 2007 projected employment growth rates for London

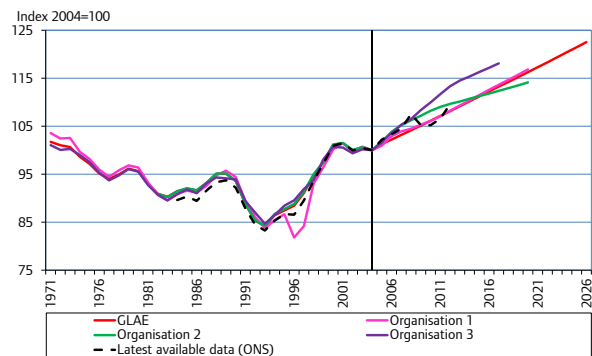
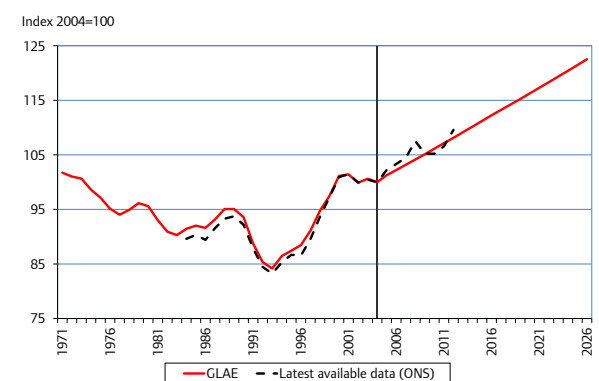


Figure 8b: GLA Economics 2007 projected employment growth rates for London



Note: ONS, GLA Economics and Organisation 2's data covers employee and self-employed jobs only. Organisation 1's data also includes HM Forces jobs and Organisation 3's data includes both HM Forces jobs and Government supported trainees.

GLA Economics data was published in February 2007, Organisation 1's data was published in February 2007, Organisation 2's data was published in Spring 2007, Organisation 3's data was published in February 2007 and the ONS data was published in September 2013 and goes up to June 2013.

Table 2: Statistical measures of 2007 forecast accuracy and bias

	GLA Economics	Organisation 1	Organisation 2	Organisation 3	Latest available data (ONS)
Forecast CAGR compared to outturn (% point difference)	-0.2%	-0.2%	0.0%	0.4%	0.0%
Correlation Co-efficient	0.84	0.86	0.84	0.84	1.00
Cumulative sum of forecast errors	-981	-719	-214	8	-
Mean absolute deviation	123	90	60	95	-
Mean absolute percentage error (%)	2.6	1.9	1.3	2.0	-

For projections constructed in 2005, Figures 9a to 10b and Table 3 show performances against outturn. For these projections there is a slightly longer outturn period of nine years to measure projection performances against. Compared to others, the accuracy of GLA Economics' projections in 2005 were very strong: the growth rate was only 0.1 percentage points below outturn, and estimates were, on average, only 2.2 per cent away from outturn.

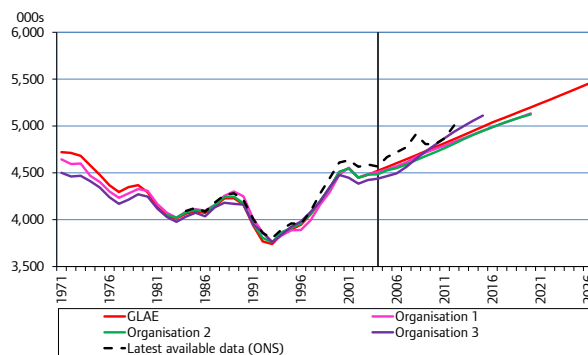
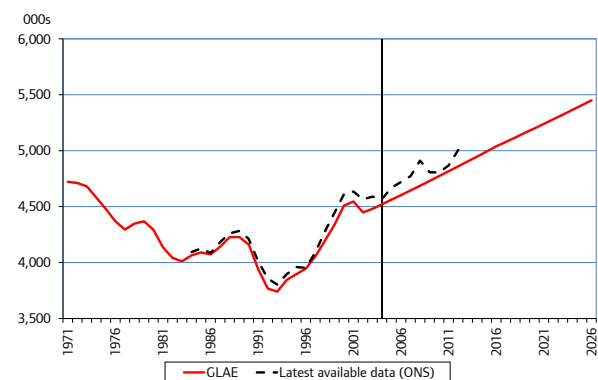
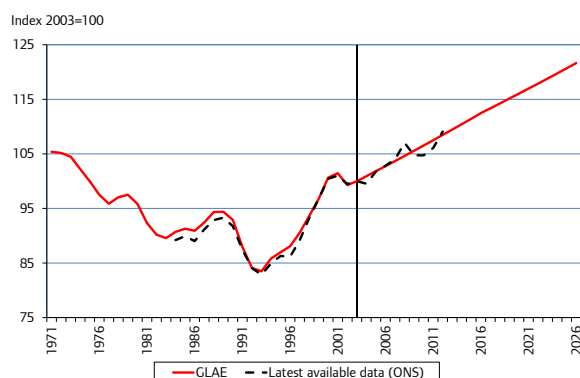
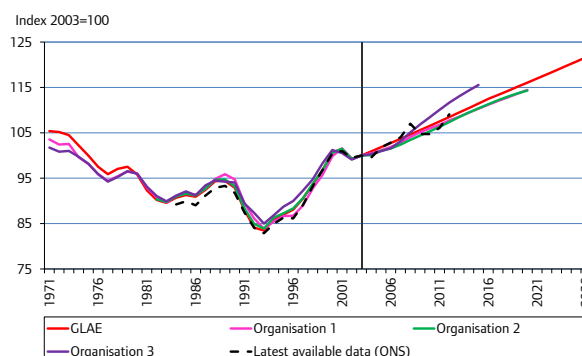
Figure 9a: 2005 projected employment levels for London**Figure 9b: GLA Economics 2005 projected employment levels for London**

Figure 10a: 2005 projected employment growth rates for London**Figure 10b: GLA Economics 2005 projected employment growth rates for London**

Note: ONS, GLA Economics and Organisation 2's data covers employee and self-employed jobs only. Organisation 1's data also includes HM Forces jobs and Organisation 3's data includes both HM Forces jobs and Government supported trainees.

GLA Economics data was published in December 2005, Organisation 1's data was published in February 2006, Organisation 2's data was published in Autumn 2005, Organisation 3's data was published in October 2005 and the ONS data was published in September 2013 and goes up to June 2013.

Table 3: Statistical measures of 2005 forecast accuracy and bias

	GLA Economics	Organisation 1	Organisation 2	Organisation 3	Latest available data (ONS)
Forecast CAGR compared to outturn (% point difference)	-0.1	-0.1	-0.2	0.3	0.0
Correlation Co-efficient	0.89	0.88	0.88	0.86	1.00
Cumulative sum of forecast errors	-931	-1,144	-1,370	-1,186	-
Mean absolute deviation	103	127	152	132	-
Mean absolute percentage error (%)	2.2	2.7	3.3	2.9	-

GLA Economics' projections are also available from 2002. However, there are no available comparisons for the organisations represented above. Figures 11 and 12 and Table 4 show how the 2002 GLA Economics projections have performed against actual employment for the 13 overlapping years of available data.

The cumulative sum of forecast errors for the 2002 GLA Economics' projections continue to show a downward bias, although the bias is significantly less than that of later forecasts. Again, this is perhaps unsurprising given the upward revisions in historic data (as evidenced in Figures 17 and 18) and the longer time period over which short-term fluctuations begin to balance out around trend. Nonetheless, as would be expected, with a relatively long employment series to compare against, the correlation coefficient between GLA Economics' projections and outturn is

high. Further, the projected year-on-year employment growth was only 0.1 percentage points above outturn and the mean absolute percentage error (which measures the scale of the difference between the projections and outturn) was only 1.3 per cent. Over this longer time period of analysis, GLA Economics' projections have therefore performed well, and this is especially true when accounting for revisions in the ONS historic data on which the projections are based.

Figure 11: 2002 projected employment levels for London

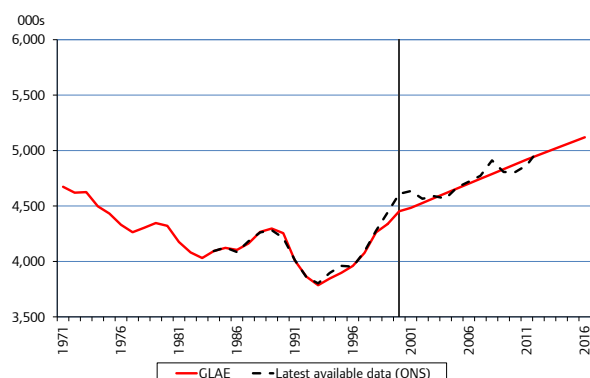
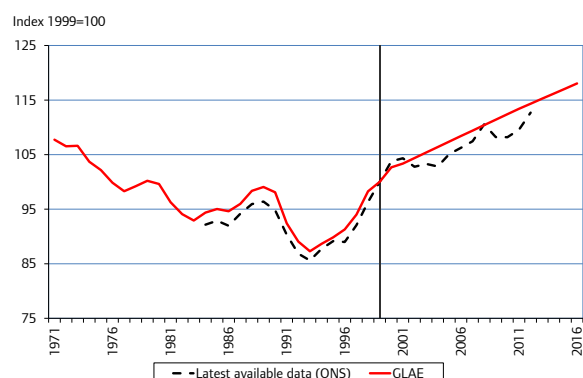


Figure 12: 2002 projected employment growth rates for London



Note: GLA Economics data was published in March 2002 and the ONS data was published in September 2013 and goes up to June 2013.

Table 4: Statistical measures of 2002 forecast accuracy and bias

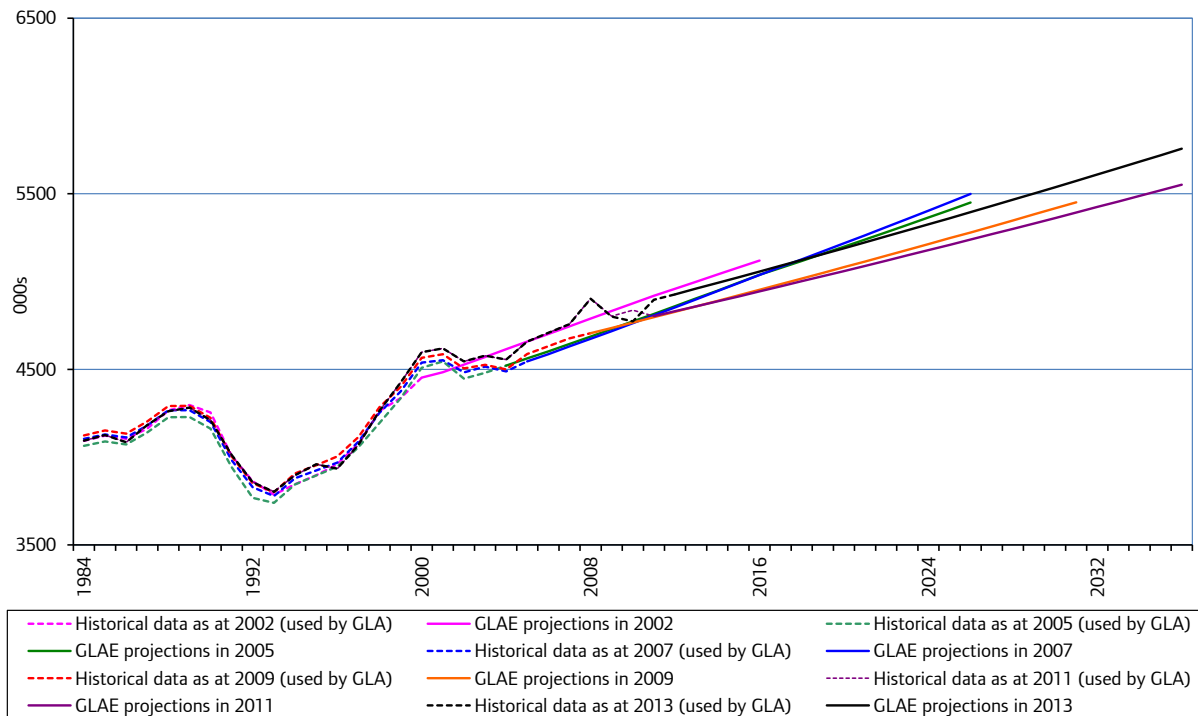
	GLA Economics	Latest available data (ONS)
Forecast CAGR compared to outturn (% point difference)	0.1	0.0
Correlation Co-efficient	0.90	1.00
Cumulative sum of forecast errors	-397	-
Mean absolute deviation	65	-
Mean absolute percentage error (%)	1.3	-

Variability of employment projections over time

In addition to being accurate and unbiased, in the absence of revised information, arguably, good projections should be relatively consistent and thus reliable/predictable over time. Figure 13 shows how GLA Economics' employment projections have changed since 2002. GLA Economics uses a trend-based method in its projections, driven by historic performance of employment (relative to output). As such, changes to historic data are the main factors that change employment projections from one publication to another. As can be seen in Figure 13 and Tables 5 and 6 there have been numerous revisions to the historic data that underpins the projections model, and so it is not surprising that there is some variability in the employment projection numbers over time.

Tables 5 and 6 show that the largest differences in historic data were between the data available in 2005 and the data available in 2009. These two historic series were on average 62,000 (or 1.5 per cent) apart in each year. The smallest difference between available historic employment data was between the data in 2011 and the data in 2013 (although this is largely because, unlike previous revisions, the historic data for the 2013 projections was only revised back to 1996²). Another point to note regarding ONS revisions to historic employment data is that the magnitude of adjustments does not generally increase with greater lengths of time between estimates. Indeed, it would seem sensible to assume that differences between ONS historic data would be smaller the closer in time they are produced to one another, ie, as time moves on, one would assume that more information becomes available creating an accumulation of adjustments that moves the new estimates increasingly further away from the original estimates. However this is not typically the case, for example between the estimates released in 2002 and the revised estimates released in 2005 the average revision was 39,000 (1.0 per cent) each year. Yet the estimates released five years on from the 2002 estimates, in 2007, were only revised by half this amount.

² Note that up to the 2011 GLA Economics' projections, estimates of historic employment data were provided by Experian Business Strategy. In 2011, ONS London regional statisticians produced a consistent London historic back series of employment for GLA Economics (used for both the 2011 and 2013 projections): <http://www.london.gov.uk/sites/default/files/wp52.pdf>. In essence, the estimates between 1984 and 1995 were modelled and data from 1996 onwards was/is data taken from the ONS Workforce Jobs series.

Figure 13: GLA Economics employment projections and ONS historic employment data since 2002

Note: GLA Economics projections in 2002 were published in March 2002 (http://legacy.london.gov.uk/mayor/planning/docs/plan_lon_grow2.pdf), projections in 2005 were published in December 2005 (http://www.london.gov.uk/mayor/economic_unit/docs/wp14_working_future.pdf), projections in 2007 were published in February 2007 (http://www.london.gov.uk/mayor/economic_unit/docs/wp_20_employment.pdf), projections in 2009 were published in November 2009 (http://www.london.gov.uk/archive/mayor/economic_unit/docs/wp_38.pdf), projections in 2011 were published in December 2011 (<http://www.london.gov.uk/sites/default/files/wp51.pdf>), and projections in 2013 were published in April 2013 (http://www.london.gov.uk/sites/default/files/llmp_0.pdf).

Table 5: Mean absolute deviation in ONS historical employment data (000s)

	2002	2005	2007	2009	2011	2013
2002	0					
2005	39	0				
2007	20	37	0			
2009	32	62	24	0		
2011	23	57	31	31	0	
2013	23	57	31	34	3	0

Note: the mean absolute deviation measures the average distance each year between historical ONS employment data available at two points in time, regardless of the direction of that difference (ie, regardless of whether it was larger or smaller).

Table 6: Mean absolute percentage change in ONS historical employment data

	2002	2005	2007	2009	2011	2013
2002	0					
2005	1.0	0.0				
2007	0.5	0.9	0.0			
2009	0.8	1.5	0.6	0.0		
2011	0.6	1.4	0.7	0.8	0.0	
2013	0.6	1.4	0.7	0.8	0.1	0

Note: the mean absolute percentage change measures the average of the percentage change in historic figures for each overlapping year, and provides an indication of the scale of adjustments made.

Tables 7 and 8 provide some quantitative analysis of the changes in GLA Economics' employment projections over time. Table 7 considers the correlation-coefficient between any two forecasts and provides a measure of how accurately one forecast can be predicted by knowing the other. The closer the correlation coefficient is to one the stronger is the linear relationship between the two series and thus the more closely associated changes in one series are with changes in another series. As mentioned above, in the absence of drastically revised information or evidence, arguably, a good forecast should have relatively predictable changes over time. This characteristic would be consistent with a high correlation coefficient. It is important to note that, in contrast to projections or forecasts from some other organisations, GLA Economics' employment projections are not designed to incorporate annual fluctuations in employment. As such, one would expect high correlation coefficients between projections and this is indeed the case.

Table 7: Inter-year correlation coefficients for GLA Economics employment projections

	2002	2005	2007	2009	2011	2013
2002	1.000					
2005	0.999	1.000				
2007	0.999	1.000	1.000			
2009	1.000	1.000	1.000	1.000		
2011	1.000	1.000	1.000	1.000	1.000	
2013	1.000	1.000	1.000	1.000	1.000	1.000

Note: Estimates rounded to three decimal places and cover overlapping forecast years only. The correlation coefficient measures how closely associated a change in one series is with a change in the other series. It does not provide any indication of the magnitude of the association between the two series.

Table 8 shows the average absolute change in estimates from one forecast year to another. This shows that the highest variation was between the projections in 2011 and the projections in 2013, where, on average, there was a 149,000 difference in each year the two projections overlap (ie, for each year between 2011 and 2016). In contrast, the lowest variation was between the 2005 and 2007 projections where the average difference was only 17,000.

Table 8: Mean absolute deviation of GLA Economics employment projections over time (000s)

	2002	2005	2007	2009	2011	2013
2002	0					
2005	96	0				
2007	106	17	0			
2009	128	87	101	0		
2011	146	118	133	26	0	
2013	47	30	48	110	149	0

Note: the mean absolute deviation measure the average distance between projections for all overlapping years, regardless of the direction of that difference (ie, regardless of whether it was larger or smaller).

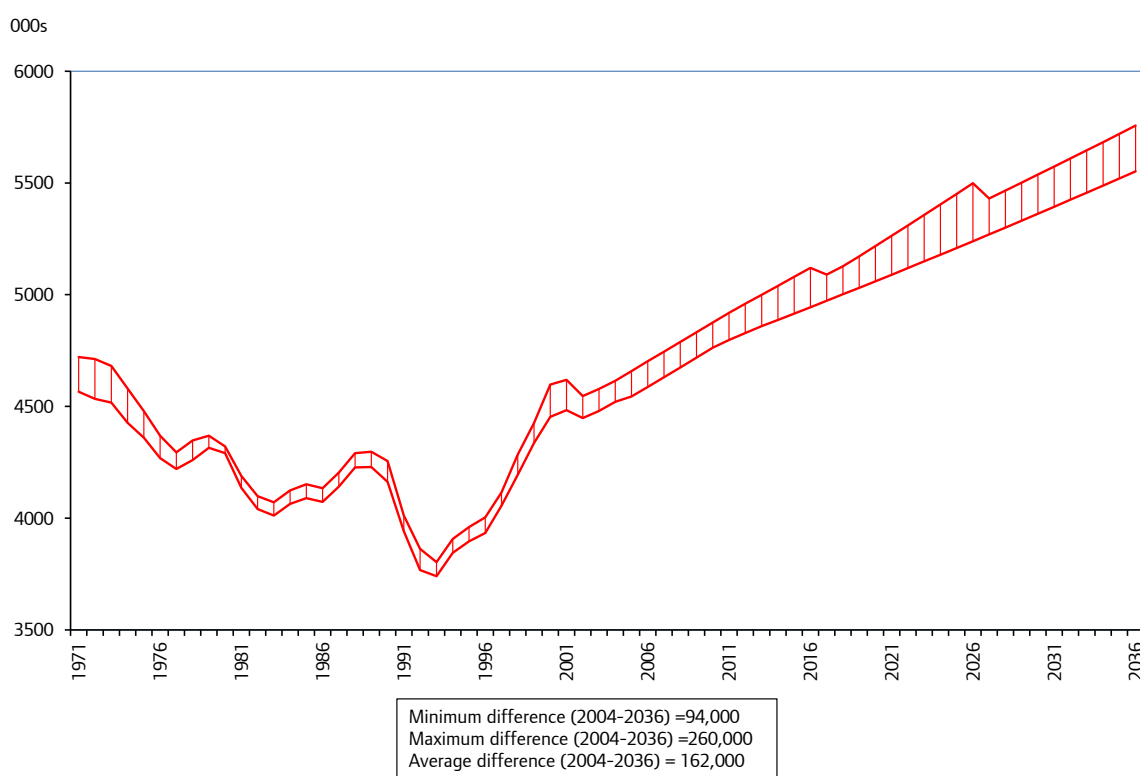
Table 9 provides an alternative way of analysing the variance in projections over time by looking at the average absolute percentage change in projections. As with Table 8 this provides a measure of the average distance between different projections for all overlapping years, but as it is a percentage it indicates the relative (rather than absolute) scale of adjustments made. As in Table 8 the greatest differences in employment projections were between those estimated in 2002 and 2011 where the average difference in projection values was 3.0 per cent for each overlapping projection year.

Table 9: Mean absolute percentage change in GLA Economics employment projections over time (%)

	2002	2005	2007	2009	2011	2013
2002	0					
2005	2.0	0				
2007	2.2	0.3	0			
2009	2.6	1.7	2.0	0		
2011	3.0	2.3	2.6	0.5	0	
2013	0.9	0.6	0.9	2.1	2.8	0

Note: the mean absolute percentage change measures the average of the percentage change in projection figures for each overlapping year, and provides an indication of the scale of adjustments made.

Comparing all six overlapping projections simultaneously (covering the years 2004 to 2036), the largest difference between projections in any one year was 260,000 (occurring in 2026 as the difference between projections constructed in 2007 and those constructed in 2011) with an average difference (between the highest and lowest projections in any year) of 162,000 (see Figure 14).

Figure 14: GLA Economics maximum and minimum estimates of employment

Note: the charted minimum and maximum estimates cover forecasts for 2002, 2005, 2007, 2009, 2011, 2013 and outturn (as well as revisions to the historical data). The minimum, maximum and average difference values relate to differences in projections from 2004 onwards (ie, from when overlapping projection years were available/began).

Figures 15 to 18 and Tables 10 to 21 provide similar variability analysis for other organisations that produce employment forecasts/projections for London. It is important to note that, in contrast to GLA Economics' projections, these organisations incorporate short term (or cyclical) forecasting in their estimates. As such, they are likely to exhibit high levels of volatility, particularly around turning points in the economic cycle.

The projections from Organisation 2 appear to be the most volatile over time, with an average difference between their minimum and maximum estimates for each overlapping forecast year of 345,000 (Figure 16), and with average revisions in the region of 1.0 per cent to 8.9 per cent (Table 15). Nonetheless, the high correlation coefficients amongst projections from Organisation 2 suggest that there is high predictability between forecasts.

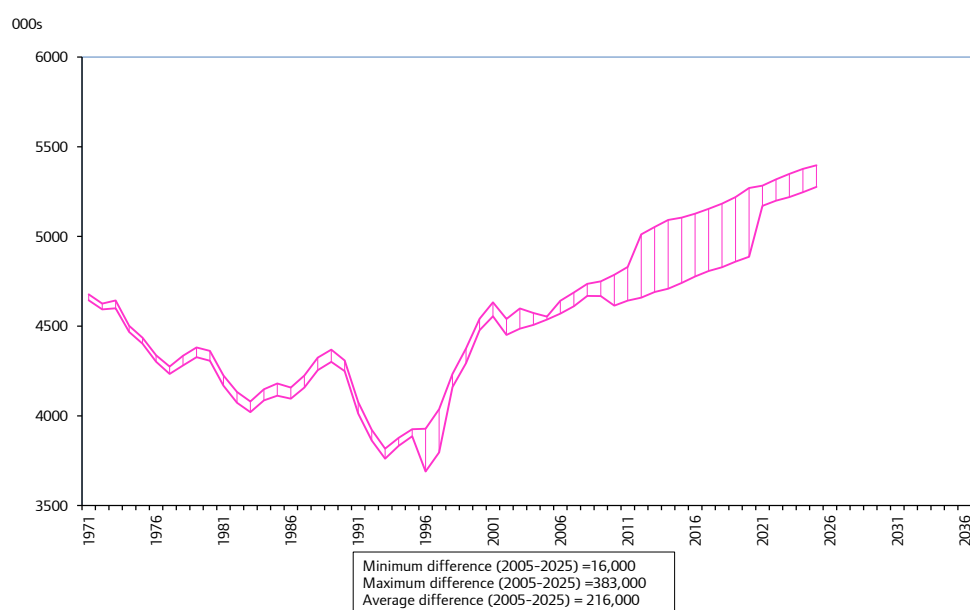
Employment projections from Organisations 1 and 3 also show greater variability from year to year compared to the GLA Economics projections. Their projections have an average difference (between maximum and minimum values across all forecasts) of 216,000 and 223,000 respectively (Figures 15 and 17), compared to 162,000 for GLA Economics (Figure 14). Between specific projections there are also large changes in estimates, ranging from 0.4 per cent to 7.0 per cent for Organisation 1 and between 0.5 per cent and 5.4 per cent for Organisation 3 (compared to a range of 0.3-3.0 per cent for GLA Economics). Perhaps unsurprisingly, the average percentage change between forecasts for these two organisations seems to be consistently greatest amongst series constructed not long after one another, and this is particularly true for the years in which there were turning points in the economic cycle (as a result of the recent financial crisis). For example, projections from Organisation 1 in 2009 and 2011 have an average difference of 4.0 per cent compared to only a 0.4 per cent difference

between projections generated in 2002 and those in 2011³. This demonstrates the difficulty of incorporating economic cycles into longer-term projections. These models lead to greater weight being placed on the recent historic annual employment and economic changes so that in periods of volatility there are large variations between estimates produced in relative proximity. Over a longer period of time, as the economy and employment steady back to 'trend', the forecasts realign with earlier iterations. Further, the correlation coefficients for Organisations 1 and 3 also suggest that predictability of forecasts from one year to another is not as high as that for GLA Economics.

Projection performances over time for a fourth organisation are also presented (Organisation 4). Unfortunately, there are only two sets of projections for these so comparing the variability of their projections to other organisations should be done with caution. Nonetheless, looking at the variability in projections from Organisation 4 in 2009 and 2011 the correlation coefficient for its two projections is lower than that for GLA Economics suggesting greater predictability in GLA Economics projections from one year to the next. Further, the average difference between the two series employment were 122,000 (or 2.5 per cent) for this organisation compared to 26,000 (or 0.5 per cent) for GLA Economics projections of the same years.

Finally, Table 22 shows the annual absolute and percentage growth in projected employment by organisations over time. The table illustrates again the issues that arise when attempting to incorporate the economic cycle in long-term projections and the risks of using such models for policy planning over long time horizons. In 2005, Organisations 1, 2 and 3 were estimating an annual employment growth double what they then estimated in 2009; in 2005, Organisations 1, 2 and 3 estimated employment would grow on average each year by 0.82 per cent, 0.84 per cent and 1.29 per cent respectively. By 2009, these estimates more than halved to 0.26 per cent, 0.39 per cent and 0.58 per cent respectively. A further four years on, in 2013, the annual growth rate for employment expected by these Organisations was then doubled. Indeed, the implied year-on-year growth rates from GLA Economics' employment projections over time exhibit one of the lowest levels of variation. Further, although the implied absolute annual change in GLA Economics' projected employment varies between projection vintages, the variation is lower than for any of the other organisations (as evidenced by the relatively low standard deviation in the annual employment change estimates).

³ The average percentage change for GLA Economics projections in 2013 also exhibits a similar trend, whereby the average percentage change is smaller when comparing to forecasts further away. However, this is true only for the 2013 forecasts and is partly due to the declining number of overlapping years (eg, there are only five overlapping years between the GLA Economics 2002 and 2013 projections, compared to 10 overlapping years between the 2005 and 2011 projections from Organisation 1).

Figure 15: Organisation 1 maximum and minimum estimates of employment**Table 10: Inter-year correlation coefficients for Organisation 1 employment projections**

	2005	2007	2009	2011	2013
2005	1.000				
2007	0.996	1.000			
2009	0.857	0.880	1.000		
2011	0.985	0.987	0.992	1.000	
2013	0.995	0.995	0.991	0.986	1.000

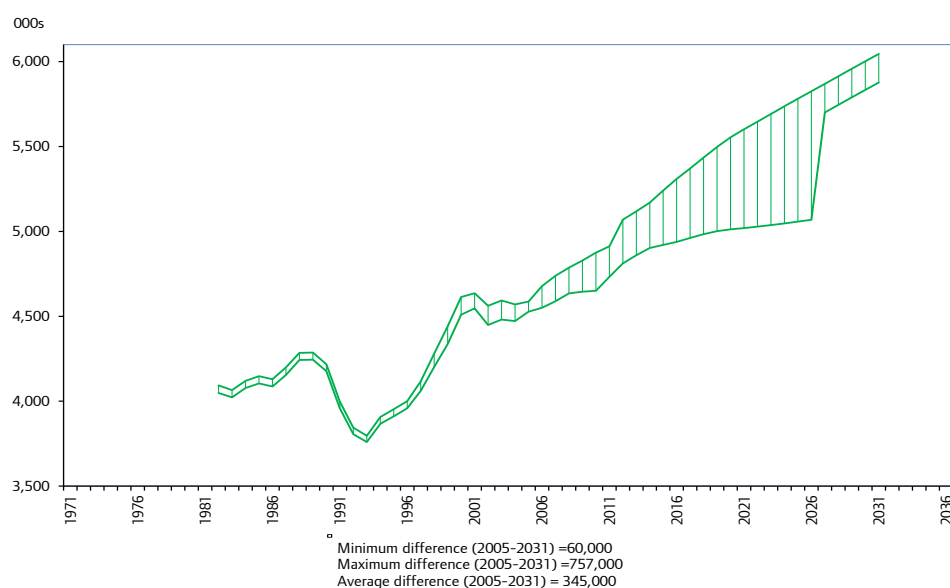
Table 11: Mean absolute deviation of Organisation 1 employment projections over time (000s)

	2005	2007	2009	2011	2013
2005	0				
2007	71	0			
2009	178	245	0		
2011	19	94	198	0	
2013	147	62	359	146	0

Table 12: Mean absolute percentage change in Organisation 1 employment projections over time (%)

	2005	2007	2009	2011	2013
2005	0.0				
2007	1.4	0.0			
2009	3.6	5.2	0.0		
2011	0.4	1.9	4.0	0.0	
2013	3.0	1.2	7.0	2.8	0.0

Note: Organisation 1 projections in 2005 were published in Feb 2006, 2007 projections were published in Feb 2007, 2009 projections in Feb 2010, 2011 were published in Feb 2012 and 2013 projections were published in Feb 2013.

Figure 16: Organisation 2 maximum and minimum estimates of employment**Table 13: Inter-year correlation coefficients for Organisation 2 employment projections**

	2005	2007	2009	2011	2013
2005	1.000				
2007	0.979	1.000			
2009	0.957	0.941	1.000		
2011	0.995	0.998	0.952	1.000	
2013	0.995	0.999	0.978	1.000	1.000

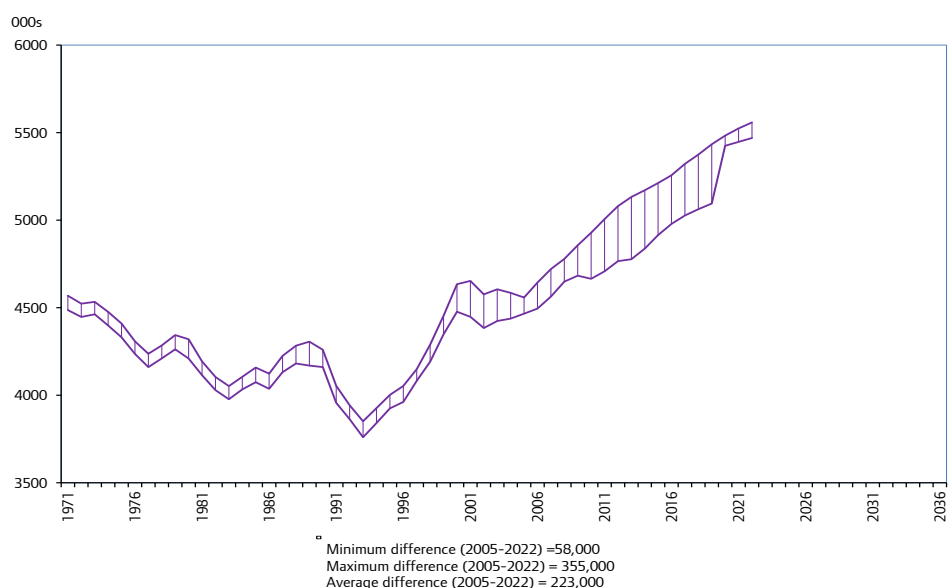
Table 14: Mean absolute deviation of Organisation 2 employment projections over time (000s)

	2005	2007	2009	2011	2013
2005	0				
2007	92	0			
2009	52	122	0		
2011	153	115	197	0	
2013	327	269	492	167	0

Table 15: Mean absolute percentage change in Organisation 2 employment projections over time (%)

	2005	2007	2009	2011	2013
2005	0.0				
2007	1.9	0.0			
2009	1.0	2.5	0.0		
2011	3.1	2.2	5.8	0.0	
2013	6.5	5.0	8.9	3.0	0.0

Note: Organisation 2 projections in 2005 were published in Autumn 2005, 2007 projections published in Spring 2007, 2009 projections were published in Spring 2012, 2011 projections published in Spring 2012, and 2013 projections in Spring 2013.

Figure 17: Organisation 3 maximum and minimum estimates of employment**Table 16: Inter-year correlation coefficients for Organisation 3 employment projections**

	2005	2007	2009	2011	2013
2005	1.000				
2007	0.996	1.000			
2009	0.713	0.808	1.000		
2011	0.966	0.970	0.998	1.000	
2013	0.982	0.986	0.988	0.972	1.000

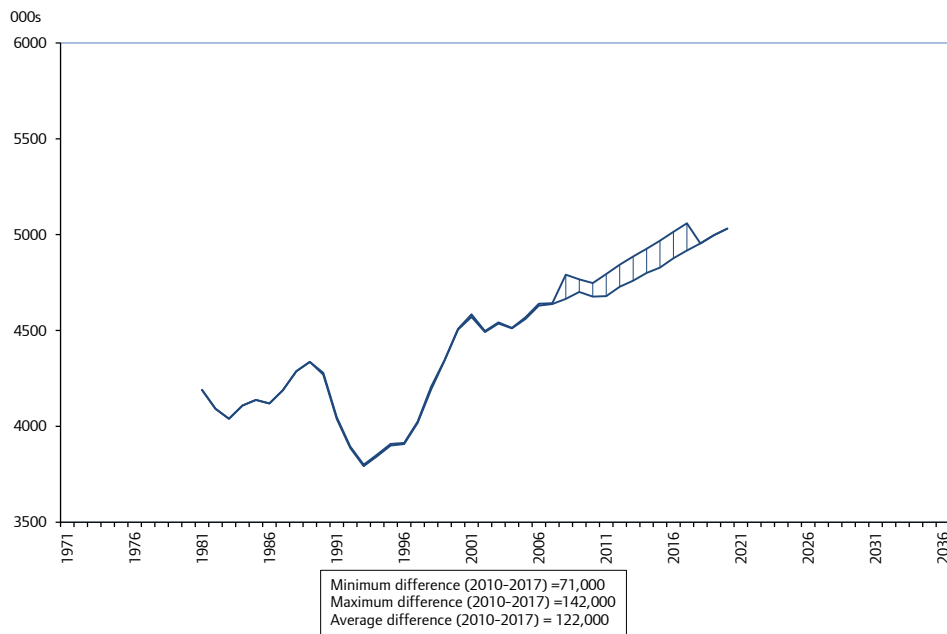
Table 17: Mean absolute deviation of Organisation 3 employment projections over time (000s)

	2005	2007	2009	2011	2013
2005	0				
2007	128	0			
2009	160	258	0		
2011	25	91	241	0	
2013	73	37	287	53	0

Table 18: Mean absolute percentage change in Organisation 3 employment projections over time (%)

	2005	2007	2009	2011	2013
2005	0.0				
2007	2.7	0.0			
2009	3.2	5.4	0.0		
2011	0.5	1.8	4.7	0.0	
2013	1.5	0.7	4.8	1.0	0.0

Note: Organisation 3 projections in 2005 were published in October 2005, 2007 projections were published in February 2007, 2009 were published in Spring 2010, 2011 were published in Spring 2012, and 2013 were published in Spring 2013.

Figure 18: Organisation 4 maximum and minimum estimates of employment**Table 19: Inter-year correlation coefficients for Organisation 4 employment projections**

	2009	2011
2009	1.000	
2011	0.992	1.000

Table 20: Mean absolute deviation of Organisation 4 employment projections over time (000s)

	2009	2011
2009	0	
2011	122	0

Table 21: Mean absolute percentage change in Organisation 4 employment projections over time (%)

	2009	2011
2009	0	
2011	2.5	0

Note: Organisation 4 estimates for 2009 were published in December 2008 and estimates for 2011 were published in December 2011

Table 22: Average annual employment growths projected over time

	Year of projection publication	Annual employment growth projected (CAGR)	Annual employment growth projected (absolute, 000s)	Projection start year:	Projection end year:
GLA Economics	2002	0.88%	46	2000	2016
	2005	0.85%	42	2004	2026
	2007	0.91%	46	2005	2026
	2009	0.64%	32	2008	2031
	2011	0.58%	28	2011	2036
	2013	0.65%	34	2012	2036
	<i>SD</i> ²	0.14%	7.75		
Organisation 1	2005	0.82%	38	2004	2020
	2007	0.98%	47	2005	2020
	2009	0.26%	17	2008	2020
	2011	0.65%	34	2011	2025
	2013	0.77%	39	2012	2025
	<i>SD</i> ²	0.27%	11.26		
Organisation 2	2005	0.84%	38	2004	2020
	2007	0.76%	40	2005	2020
	2009	0.39%	20	2008	2026
	2011	0.97%	53	2011	2031
	2013	1.03%	56	2012	2031
	<i>SD</i> ²	0.25%	14.30		
Organisation 3	2005	1.29%	57	2004	2015
	2007	1.26%	62	2005	2017
	2009	0.58%	33	2008	2019
	2011	1.05%	59	2011	2022
	2013	1.18%	61	2012	2023
	<i>SD</i> ²	0.29%	11.95		
Organisation 4	2009	0.87%	39	2007	2017
	2011	0.73%	24	2010	2020
	<i>SD</i> ²	0.10%	10.62		

¹ CAGR refers to the compound annual growth rate.

² SD refers to the standard deviation of the estimates. A low standard deviation indicates that the estimates are closer to the mean, ie, the estimates do not vary much from the average; a high standard deviation indicates that the estimates are spread out over a large range of values.

Summary

In assessing the performance of GLA Economics' employment projections with regard to the first two characteristics (not exhibit bias and be close to the actual data) it is important to bear in mind the purpose of the projections and subsequently the model employed. The projection model is not designed to be accurate in the short-term (especially in terms of predicting short-term fluctuations). Instead, it is designed to show the longer-term path expected for employment. Its performance with regard to accuracy and bias is therefore best done when there are many years against which to compare. As with the projections from other organisations, GLA Economics' employment projections exhibit a downward bias (ie, are consistently below outturn). However, much of this is the result of upward revisions to historic employment data. When looking at the projected annual growth rate and average annual error in relation to employment outturn, GLA Economics projections perform relatively well. Further, the accuracy of GLA Economics' projections generally improves the longer the time period over which the estimates are analysed.

Given the revisions in historic data that underpin the GLA Economics employment projections model, it is unsurprising that there is some variability in the projections numbers over time. However, and by design, the revised projections are relatively consistent over time. Furthermore, the average revisions between iterations in GLA Economics' employment projections are relatively small, particularly when compared to that of other respected organisations that provide London employment projections. Indeed, the variability comparison with other organisations highlights the issues in attempting to incorporate economic cycles in long-term projections. Such models show high levels of volatility, particularly around turning points in the economic cycle. It, therefore, seems fair to conclude that GLA Economics' employment projections are relatively consistent over time.

GLAECONOMICS

Greater London Authority
City Hall
The Queens Walk
London SE1 2AA

Tel 020 7983 4922
Fax 020 7983 4674
Minicom 020 7983 4000
Email glaeconomics@london.gov.uk

<http://www.london.gov.uk/gla-economics-publications>

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