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London labour market projections 2016

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Contents

Caveats and other issues

Projections and forecasts are typically based on a number of simplifying assumptions and are, in part at least, only as reliable as the data on which they are based.

These facts should not be underestimated when considering the employment projections (and associated occupation and qualification projections) set out in this report because there are both significant simplifying assumptions and data limitations (including quite frequent data revisions) associated with this analysis.

As a result, this report does not claim to illustrate the exact path of London's labour market into the future with associated, precise, estimations of the numbers of people required to be trained in various qualifications. Instead, the report provides a description of London's labour market as it stands today, together with a broad indication of the possible future path of London's labour market (and associated qualification requirements) based on a number of simplifying assumptions. The aim is that by being clear about the data limitations and simplifying assumptions used, readers can determine for themselves the amount of weight they place on the reported findings. Specifically the report does not make any assessment of possible future outcomes from the recent EU referendum result. In the absence of information about what the eventual economic relationship with the EU will be, the implicit assumption, at this stage, is that in the long run London's productivity performance (and so long-run employment prospects) are unchanged. This assumption will be kept under review for future reports.

These projections used the Workforce Jobs series for 1984-2015 published by ONS at March 2016. In June 2016 ONS revised upwards this historic series. This data revision has not been used.

More detail on some of the most significant limitations which readers should bear in mind when considering the results from this analysis are set out in Appendix 1.

Executive summary

London is specialised in a range of service activities ...

Over the past 30 years or so London has seen strong growth in employment of professional and business support services. Over the same period there has been a large decline in manufacturing employment.

London currently specialises in finance and insurance; professional, scientific and technical activities (eg management consultancy, legal activities and accountancy); information and communication (including computer programming, motion picture activities and publishing); real estate; and, business support services (cleaning and private security for example). It does not specialise in land-intensive activities such as agriculture; mining and quarrying; manufacturing; and electricity and gas.

... which tend to require a high level of qualifications.

Over 65 per cent of jobs in professional and business support services; public services; information and communication; and finance and insurance (which themselves account for 60 per cent of jobs in London) are in the manager and administrators; professional; or, associate professional and technical occupations.

These three occupation categories are currently filled in London with a high proportion of people holding an ordinary or higher degree (typically around 60 per cent or more for each occupation category).

Overall, just under half of all jobs in London are held by people holding an ordinary or higher degree.

London's output and output per job have been growing faster than national trends ...

The contribution of professional services, and finance and insurance to London output has increased, and London is benefiting from agglomeration economies from spillover effects from locating similar types of jobs in close proximity.

... and employment is projected to grow by over 1,200,000 over the next 25 years or so.

The number of jobs in London is projected to increase from 5,538,000 in 2015 to 6,748,000 in 2041. This equates to annual average growth of just over 45,000 jobs per year and results in over 1,200,000 more jobs in London by 2041.

Employment growth is projected to occur in some service sectors ...

In the next few years GLA Economics forecast employment growth in most sectors. Over the longer term, just over one third of all the employment increase expected in London in the period to 2041 is in the professional, real estate, scientific and technical activities sector. Information and communication, administrative and support service activities, and accommodation and food service activities are also expected to see large increases in employment numbers. This suggests a continuation of London's specialisation in these areas. Education and health activities are also expected to grow as London's population grows.

... but with continuing projected declines in manufacturing and some other sectors.

Primary and utilities, manufacturing, wholesale, transportation and storage, and public administration are all projected to see declines in employment in London over the period to 2041.

Projected growth in professional occupations and managers and administrators ...

This development of London's industrial structure is projected to increase jobs in professional occupations significantly in London (an increase of nearly 650,000 is projected by 2041). Managers and administrators are also projected to see a large rise in numbers (increasing by 424,000 over the same period). These two occupation groupings are projected to account for around 45 per cent of all jobs in London in 2041.

... but continuing decline in administrative and secretarial occupations ...

Administrative and secretarial occupations are the only occupation group expected to see a decline in demand in London over the period to 2041 (projected to decline by almost 200,000 jobs between 2014 and 2041). As a result, clerical and secretarial occupations are projected to decline to around 5 per cent of London's jobs by 2041.

... leading to increased demand for higher level qualifications.

These projected shifts in employment and occupations are projected to increase significantly the demand for ordinary and higher degree level qualifications over the period to 2041. Jobs requiring ordinary or higher degree level qualifications are projected to increase by 985,000. As a result, the proportion of jobs in London requiring either an ordinary or higher degree is projected to reach 54 per cent by 2041, with the proportion of jobs with no qualifications reaching less than 3 per cent.

Moreover, the annual level of turnover in the labour market is significant ...

Whilst such projections provide a useful indication of the likely trends in London's employment over time, on their own, it can be argued that such projections provide a misleading picture of the potential future job opportunities and qualification requirements for London's existing and future workforce. This is because the labour market is not a static entity; instead it is subject to significant flows.

Over the course of a year, for example, many people leave their jobs for various destinations. Some people will retire, some will choose to leave London (and not commute back in), some will take time off work to have children, some will shift from one occupation or sector to another, some will fall long-term sick and some will die. For the capital's economy to continue to function effectively all these moves out of employment have to be replenished.

... with at least 700,000 people leaving their occupation in 2015 in London ...

Analysis suggests that at least 700,000 people left their occupation in London in 2015. This illustrates that there is a potentially significant level of education and training requirements each and every year in London's labour market just from replenishing those that leave their occupation within a year. This requirement is well in excess of that illustrated through the analysis of employment stock projections (where a 'net' increase of just over 45,000 jobs a year is projected) and for a number of reasons is likely to be an underestimate of the actual level of turnover.

... with much of the replenishment coming from 'within' the labour market.

Much of this out-flow from occupations in any single year will be replenished by those who may be considered as being within the labour market, for example those moving into employment from other occupations, those moving back into employment from a period of 'economic inactivity' (for instance returning after a period of sickness or after a period of maternity leave), or those moving back into employment from a period of unemployment. However, part of the replenishment comes from what might be considered as 'outside' the labour market - from 'in-migration' (that is from outside London's borders) and from education for instance. In addition, much of the replenishment from 'within' the labour market may well have education and training requirements.

London's population is subject to significant flows ...

Turning to the supply of labour to London's economy, in each year over the past decade or so, more than 160,000 international migrants have moved to London. This inflow to London's population has been partly offset by an outflow of around 100,000 London residents emigrating overseas in each year. Domestically, on average in each year over the past decade or so, 180,000 people have moved to London from other regions of the UK. This inflow to London's population has been more than offset by around 250,000 London residents moving to other regions of the UK each year.

... with commuters adding to London's workforce.

In 2015, those that lived and work in London were supplemented by 869,000 commuters into the capital, equivalent to nearly 19 per cent of jobs in London. This is an increase of around 150,000 over the last decade or so.

London's working age population is projected to increase by 1,000,000 between now and 2041 ...

London's population aged between 16 and 64 (London's working age population) is projected to increase from 5.8 million in 2014 to over 6.8 million by 2041.

... and to become increasingly highly skilled.

The proportion of London's working age population, and population over 65 in employment, that is qualified to at least ordinary degree level is projected to increase over the projection period to 51 per cent (having sat at 28 per cent in 1996). The proportion without any qualifications is projected to more than halve from its 1996 share of 13 per cent to 4 per cent in 2036.

The projected growth in London's population in employment is similar to the projected growth in jobs in London …

The projected increase in the number of London residents in employment is around 1,100,000. The modelling reflects London's growing population, the rising working age employment rate in London and the closing of the gap with the national employment rate, and the trend for individuals to stay in the labour market at later ages from increases in the pension age, and less generous benefit and early retirement provision for working age people.

… and allowing as well for potential trends in commuting, the employment and population projections do not seem out of line with a balanced labour market (in terms of quantities).

Over the past decade and a half the ratio of commuters to resident workers in London has remained reasonably stable.

The projected growth in London's population in employment and qualified to at least ordinary degree level is broadly similar to the projected growth in London jobs at this qualification level …

The employment projections show an increase of 985,000 jobs requiring at least an ordinary degree over the projection period (2014 to 2041). The population projections show an increase in the number of London residents of working age population in employment and qualified to at least ordinary degree level of 960,000.

… suggesting that the recent increases in the rate at which young people seek degree level qualifications has reached a level broadly consistent with the projected needs of London's labour market.

There may also be a change in the number of commuters qualified to degree level or higher over the projection period, or the relatively less qualified may become more likely to stay in the labour market at older ages, or to meet the training requirement of replacement demand as individuals move between occupations. That is, the level of jobs projected for London's economy and the population projections are largely consistent with a balanced labour market (in terms of quantities).

1. Introduction

The objective of this work is to provide an overview of London's labour market and its likely short and long term path together with its potential future skills/qualifications requirements.

The paper starts with a consideration of how employment in London has evolved over time and the resulting specialisations in London's employment structure. The paper then looks at a long-run projection for London's employment (over the period of the London Plan), broken down by sector. The analysis also looks at the likely changes in occupations and required qualifications as a result of these projections. The final consideration in terms of London's labour market demand is an analysis of the level of annual churn in London's labour market and the potential qualification requirements deriving from this.

The paper then turns to the supply side of London's labour market focusing on how London's population has changed over time, how its qualification profile has changed and the types of degrees currently being studied in London. The projection for London's working age population over the London Plan period is then considered together with the potential future qualification profile of London's working age population.

The paper then briefly summarises the balance between the demand for and supply of labour suggested from this analysis.

A series of appendices provide more detail on the methodologies used in projecting employment and population numbers (and related occupation and qualification requirements), and provide scenarios. There are also explanations of approach behind the employment projections by London borough, and the development of a backcast employment series to 1971.

2. London's demand for labour

Main findings

- Over the past 30 years or so London has seen strong growth in employment of professional and business support services.
- Just under half (49%) of all jobs in London are held by people holding an ordinary or higher degree.
- In the longer term the number of jobs in London is projected to increase by, on average, 45,000 jobs per year – resulting in over 1,200,000 more jobs in London by 2041.
- Just over a third of all this employment increase is expected to come from the professional, real estate, scientific and technical activities sector.
- The demand for professional occupations is projected to increase significantly in London (by over half a million) in the period to 2041.
- As a result, the demand for ordinary and higher degree level qualifications are projected to increase significantly (by nearly 1,000,000) over the period to 2041.
- The proportion of jobs in London requiring either an ordinary or higher degree is projected to reach 54 per cent by 2041, with the proportion of jobs with no qualifications reaching less than 3 per cent.
- There is significant turnover in the labour market; analysis suggests that 700,000 people will leave their occupation in London in 2015 (although this is likely to be an underestimate of the actual level of turnover).
- This level of turnover suggests a potentially significant education and training requirement over time even in areas projected to decline in employment over the projection period.

Introduction

This section starts with a consideration of how employment in London has evolved over time and the resulting specialisations in London's employment structure. It then looks at a long-run projection for London's employment broken down by sector. The analysis also looks at the likely changes in occupations and required qualifications as a result of these projections. The section concludes with a consideration of the level of annual churn in London's labour market and the potential qualification requirements deriving from this.

London's economy and its impact on London's labour market[1]

In considering London's future employment trajectory and its associated demand for skills it is useful to have an understanding of the main forces impacting on the London economy. To that end, ultimately, growth in an economy's income per head depends very much on the ability to raise productivity, i.e., the economy's ability to produce more for a given level of resource. There are many spurs to productivity including improvements in the skills and abilities of an economy's workforce - the subject of this analysis. Another, important, spur to productivity, which has implications for the skills and qualifications required in an economy, is an economy's openness to trade. Indeed, both economic theory and evidence show that economies which trade more tend to grow faster[2].

Openness to trade increases the returns to innovation, itself a driver of growth and productivity, on account of increased market size and also enables the economy to benefit from access to new technology (by importing new technology from other places). Perhaps most importantly, openness to trade brings greater competition which encourages firms to be as efficient as possible. In effect it encourages different countries and/or regions to concentrate on different areas of production, focusing on their respective comparative advantage[3].

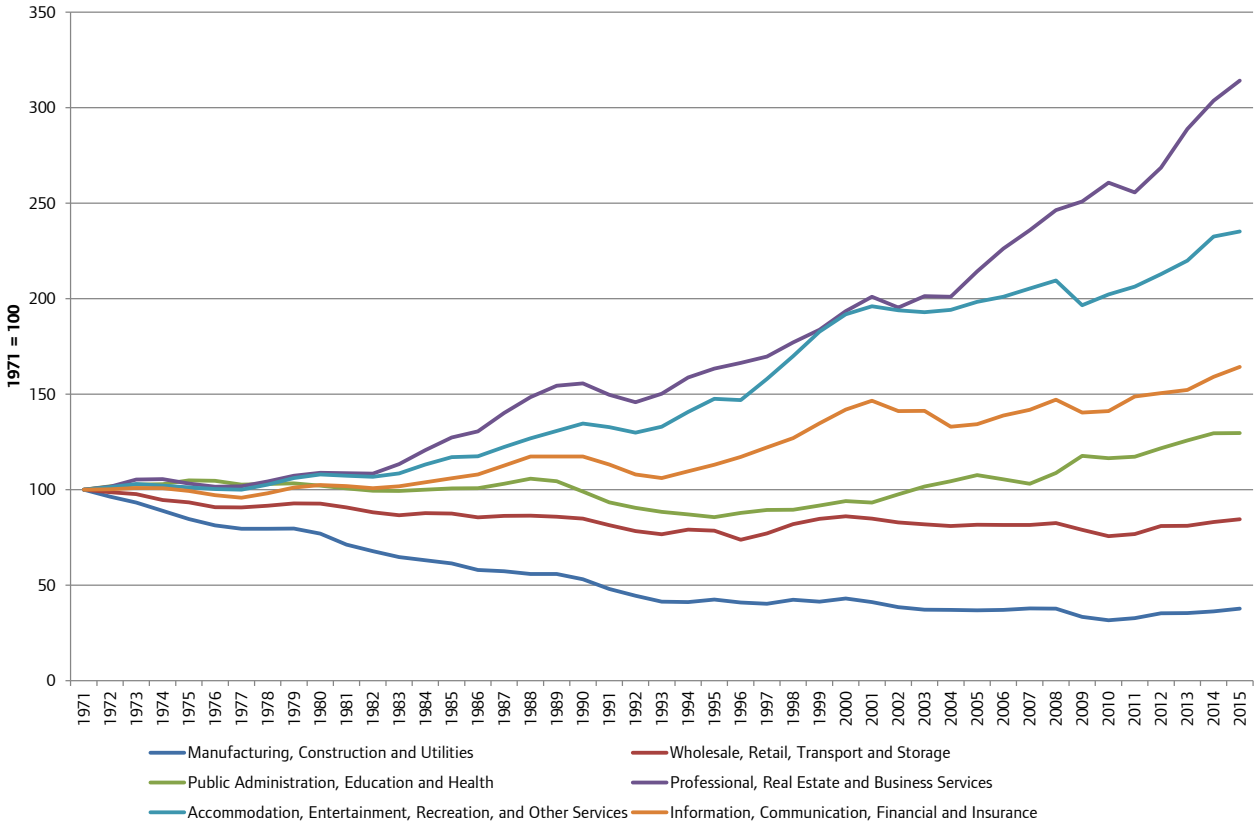
Further, the London economy may have benefited from agglomeration economies where there are spillover effects from locating similar types of jobs in close proximity. Notably, sectors such as professional services, and finance, and insurance tend to locate in central areas of London. As a consequence the London economy may have become less like the UK-economy as a whole as it has become increasingly specialised, and connected to the global economy.

Structural change and specialisation

This drive to higher productivity through competition, innovation and openness to trade has contributed to structural change in the UK economy (as elsewhere in the world), encouraging domestic resources to shift from less productive to more productive uses. As shown later, this shift has had significant consequences for the skills and qualifications workers need to work in London's economy.

As a result of such economic forces, London has seen a significant shift toward service activities over past decades[4]. This is shown in Figure 2.1.

Figure 2.1: Change in broad London sectors 1971-2015



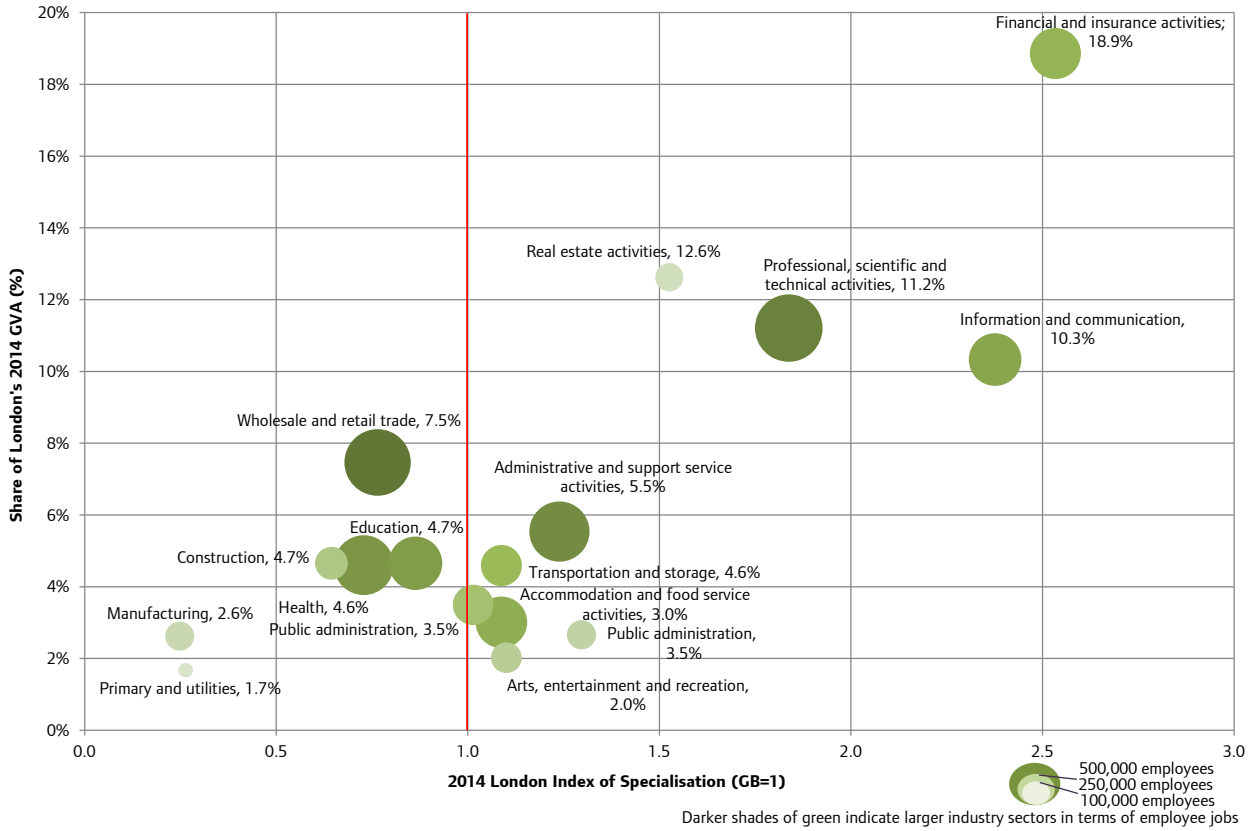
Source: 1996 to 2015: ONS Workforce Jobs series; before 1996: GLAE Economics using various ONS sources and modelling assumptions

The chart shows that over the past few decades employment in many service sector areas have shown strong growth (particularly business service type sectors). The professional, real estate and business service category includes activities such as management consultancy, legal, accountancy, architectural, real estate as well as business support services such as cleaning, private security and employment agencies for example. Significant activities within the accommodation, entertainment, recreation and other services category include restaurants, hotels, event catering, public houses, sports and personal services for example. Significant activities within the information, communication, financial and insurance category include financial and insurance activities, computer programming, motion picture activities and publishing. Over the same period employment in manufacturing has fallen significantly.

Appendix 2 provides charts on trends for individual sectors.

Figure 2.2 looks in more detail at the current industrial structure of London's economy. The chart shows that economic activity in London is concentrated in financial and insurance services, and some other business services.

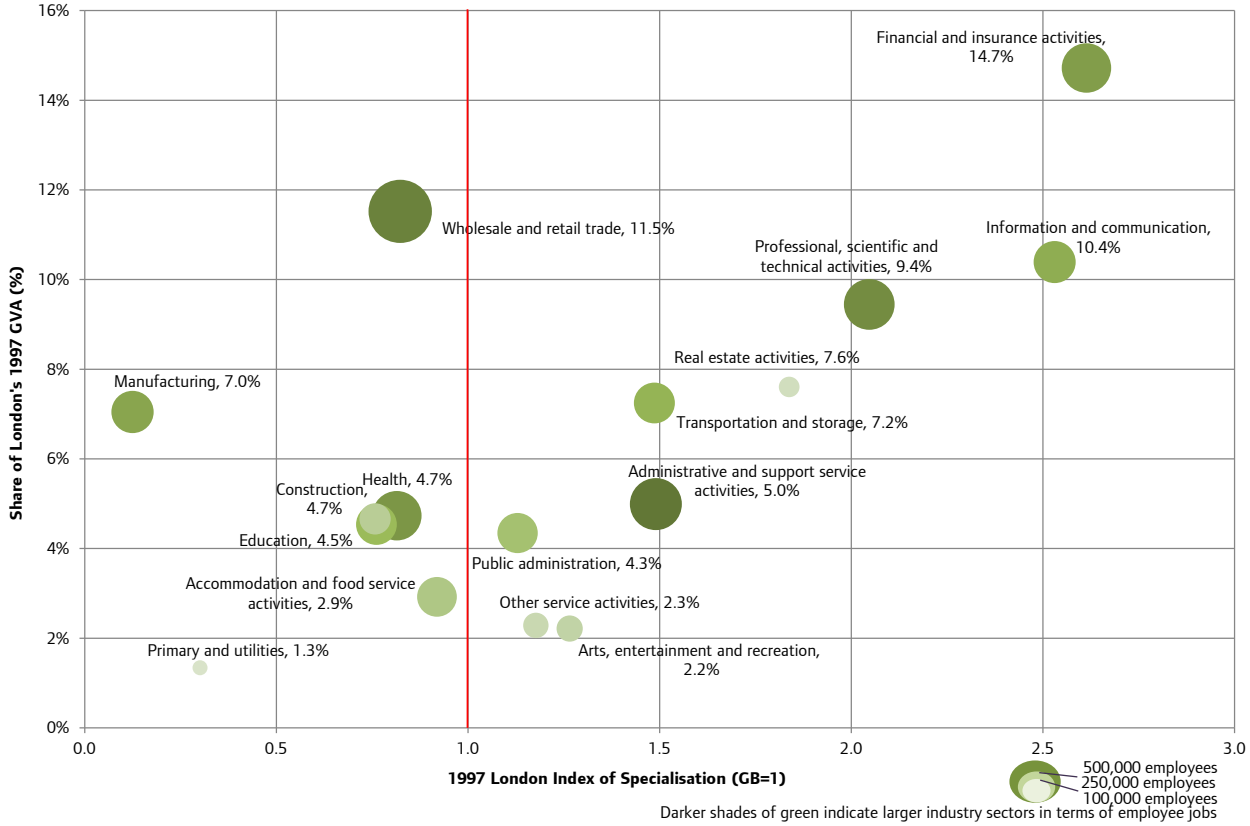
Figure 2.2: London's broad sectors: Index of Specialisation[5] (relative to the rest of Great Britain) and share of London's total output in 2014



Source: GLA Economics based on data from the ONS Business Register and Employment Survey (BRES) and ONS Regional Gross Value Added (GVA) series

Figure 2.3 provides a comparison with the industrial structure of London's economy in 1997. The chart shows that economic activity in London is concentrated in financial and insurance services, and some other business services. These are the sectors in which jobs in London have expanded over the last two decades, and their share of London's output has also risen.

Figure 2.3: London's broad sectors: Index of Specialisation[6] (relative to the rest of Great Britain) and share of London's total output in 1997



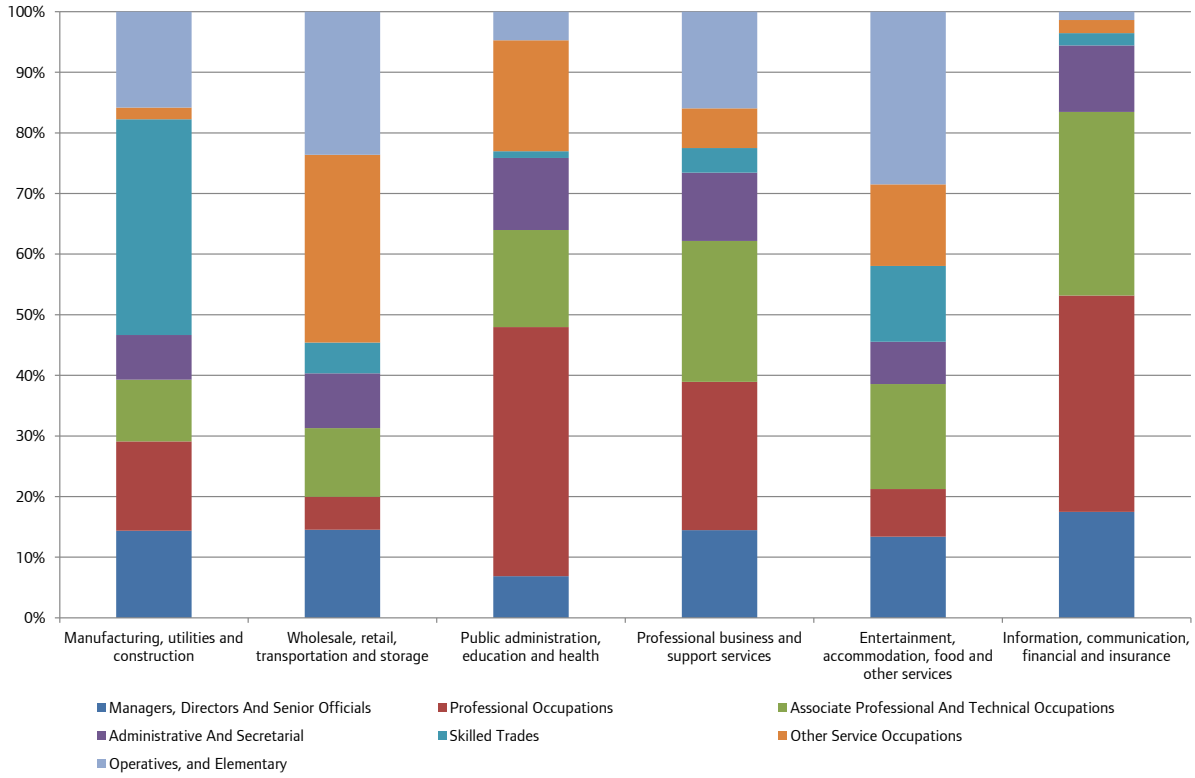
Source: GLA Economics based on data from the ONS Workforce Jobs (WFJ) and ONS Regional Gross Value Added (GVA) series

These broad sector headings hide a range of different economic activities and differing degrees of specialisation within particular sectors. When examined at a more disaggregated level, London specialises in such things as securities, fund management (amongst other financial services), media and other creative activities (for example: television, film, music, publishing, computer consultancy and programming) and other professional services (like legal, accountancy, management consultancy, advertising, market research and architectural activities). Its employment is not concentrated in land-intensive sectors such as agriculture, manufacturing, primary industries and freight transport.

Appendix 3 breaks down the employment data into more detailed sub-sectors (by Standard Industrial Classification [SIC] code) allowing for a more comprehensive analysis of the employment structure of London's economy.

This shift of employment into services has impacted on the types of occupations found in London's labour market. Analysis suggests that the growth in London's employment over the past two decades has been in managers, professionals and associate professional occupations. Figure 2.4 shows the occupation profile of London's broad sectors in 2014. The chart shows that managers, professional and associate professional occupations account for 60 per cent or more of all jobs in finance, insurance, information and communication services, professional business and business support services and public sector activities (with these three broad sectors accounting for 60 per cent of jobs in London in 2014).

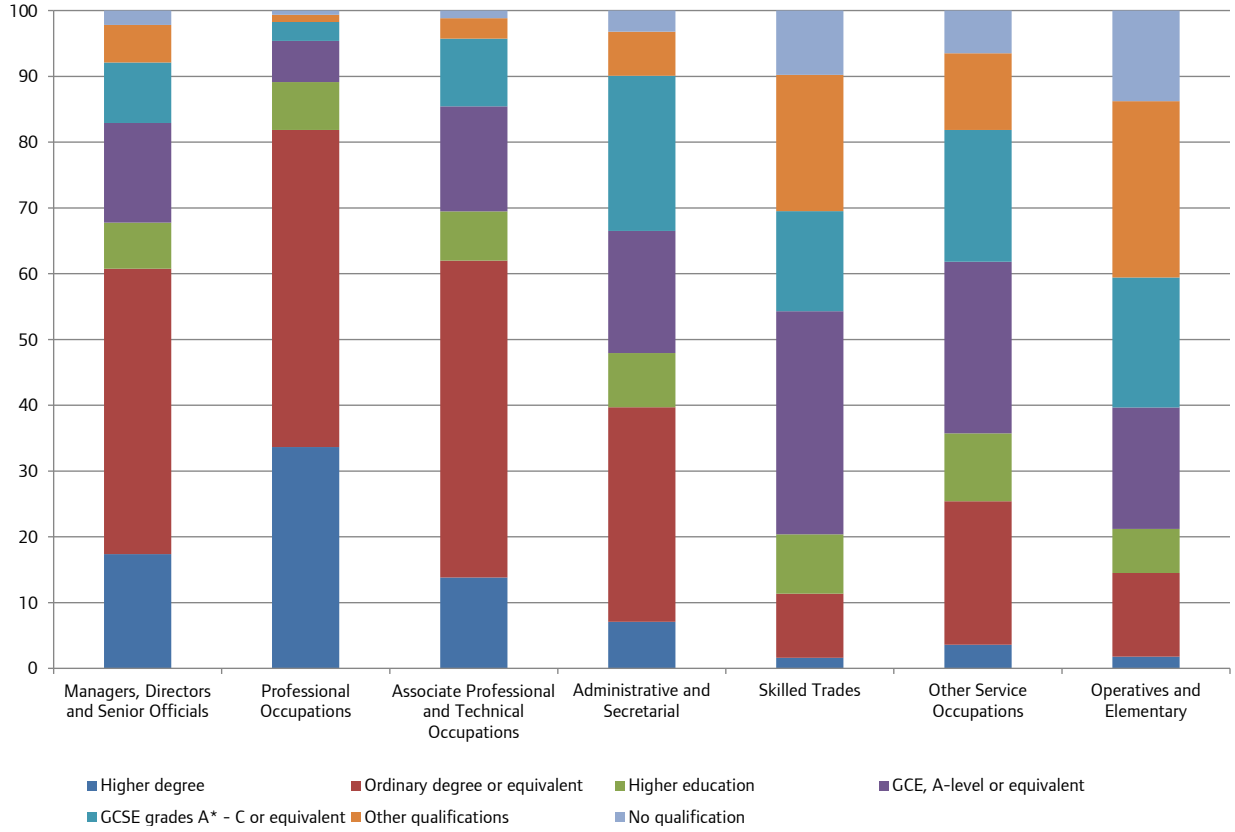
Figure 2.4: Share of occupations within broad sectors in London, 2014



Source: GLA Economics based on data from various ONS sources

As Figure 2.5 shows, these three occupations tend to employ a high proportion of highly qualified individuals. For example, almost 80 per cent of jobs in professional occupations are held by people educated to ordinary or higher degree level.

Figure 2.5: Share of qualifications within occupations in London, 2014

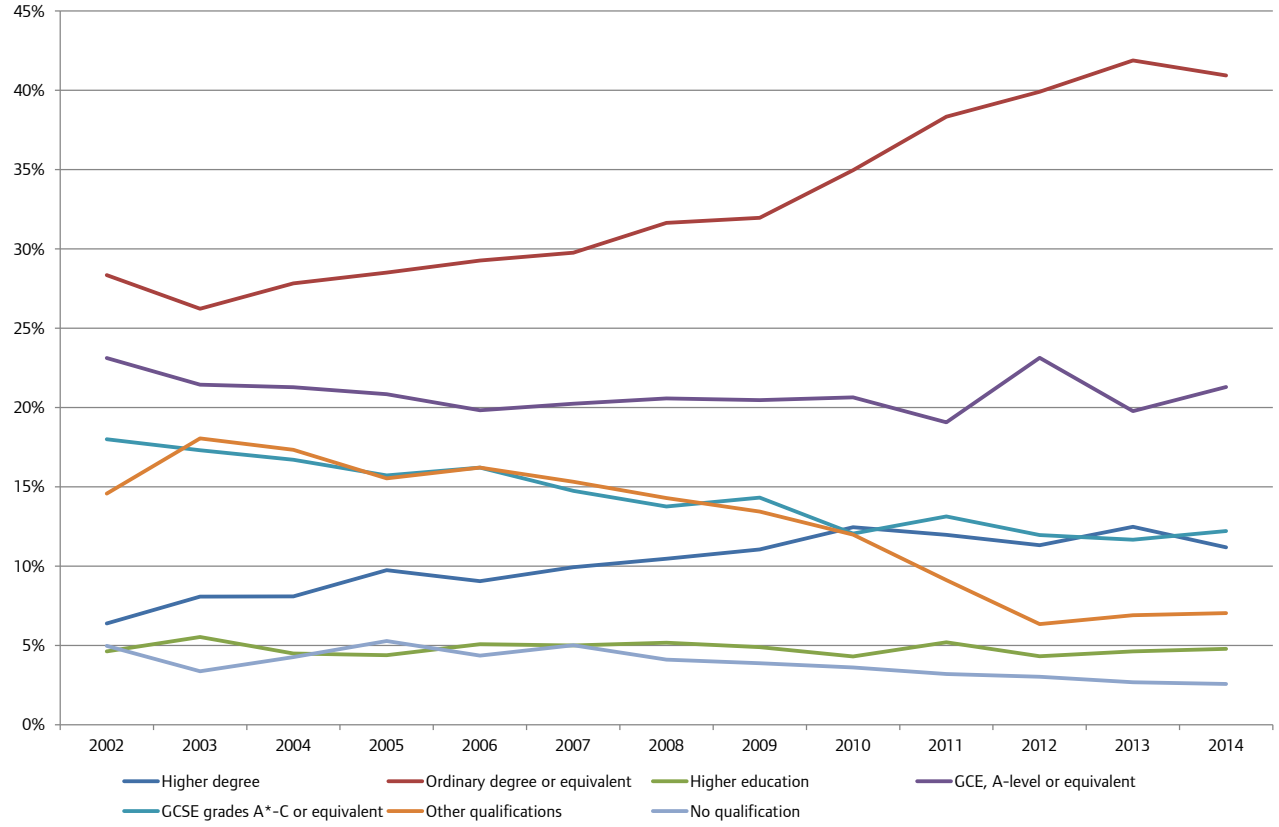


Source: GLA Economics based on data from various ONS sources

Just under half (49 per cent) of London's jobs in 2014 were filled by people holding ordinary or higher degree level qualifications.

This growth in the workforce with ordinary of higher degree level qualifications is likely to continue, as Figure 2.6 indicates. The proportion of 16-29 year olds in work in London with an ordinary degree has risen from a little over a quarter in 2003 to over 40% by 2014. In time these people will replace their relatively less well qualified predecessors as well as providing additional cohorts of highly qualified individuals.

Figure 2.6: Distribution of Highest Qualification of 16-29 Year Olds Working in London, 2002-2014



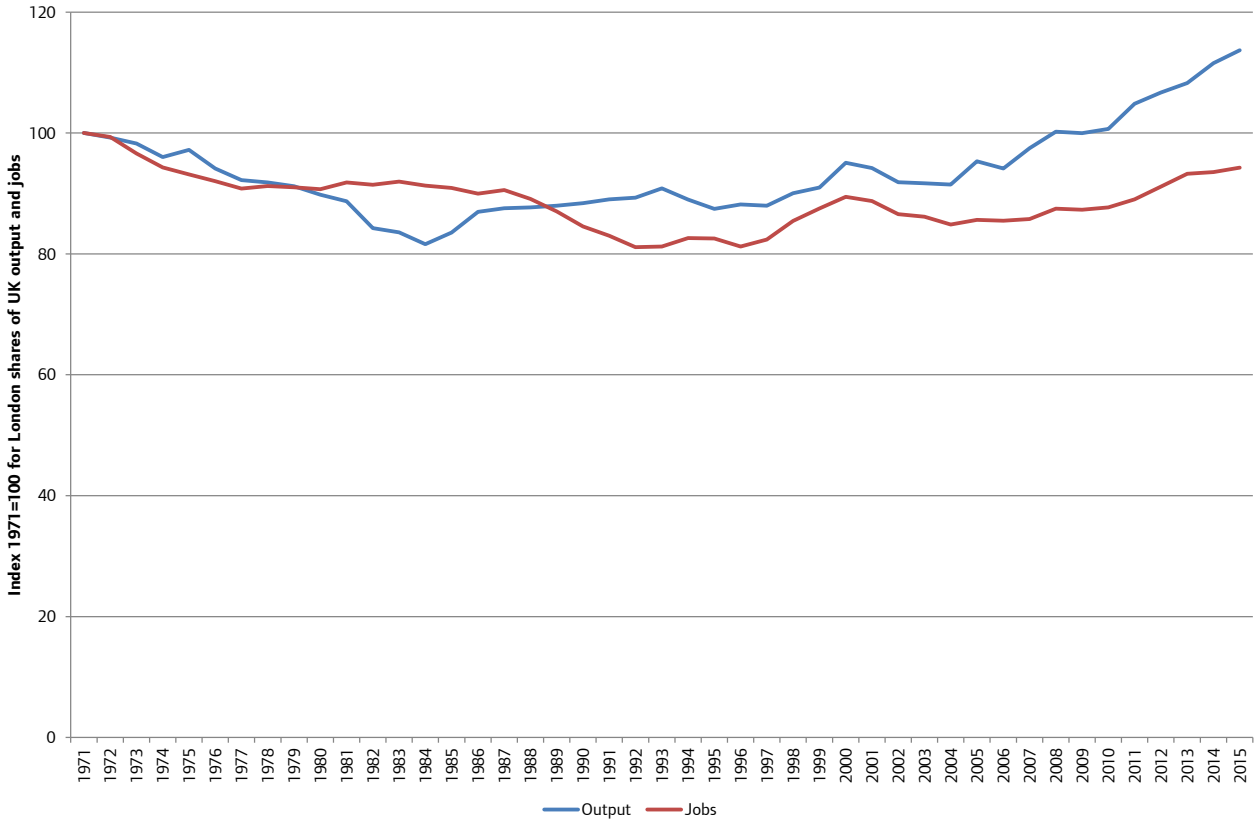
Source: Labour Force Survey

The growth in the number of graduates will also support growth in the occupations most likely to employ them, namely managers, professionals, and associate professionals.

Trends in the London and UK economies

The London economy has been making an increasing contribution to UK output, and taking a larger share of employment, over the last twenty years. In 2014 London accounted for 16.4% of jobs[7] in the UK, and 22.5% of output[8]. Prior to the mid-1980s, London had been in relative decline. The London share of UK output reached its 1971 level in 2008, and has risen further since, while the London share of UK jobs has yet to return to its 1971 level.

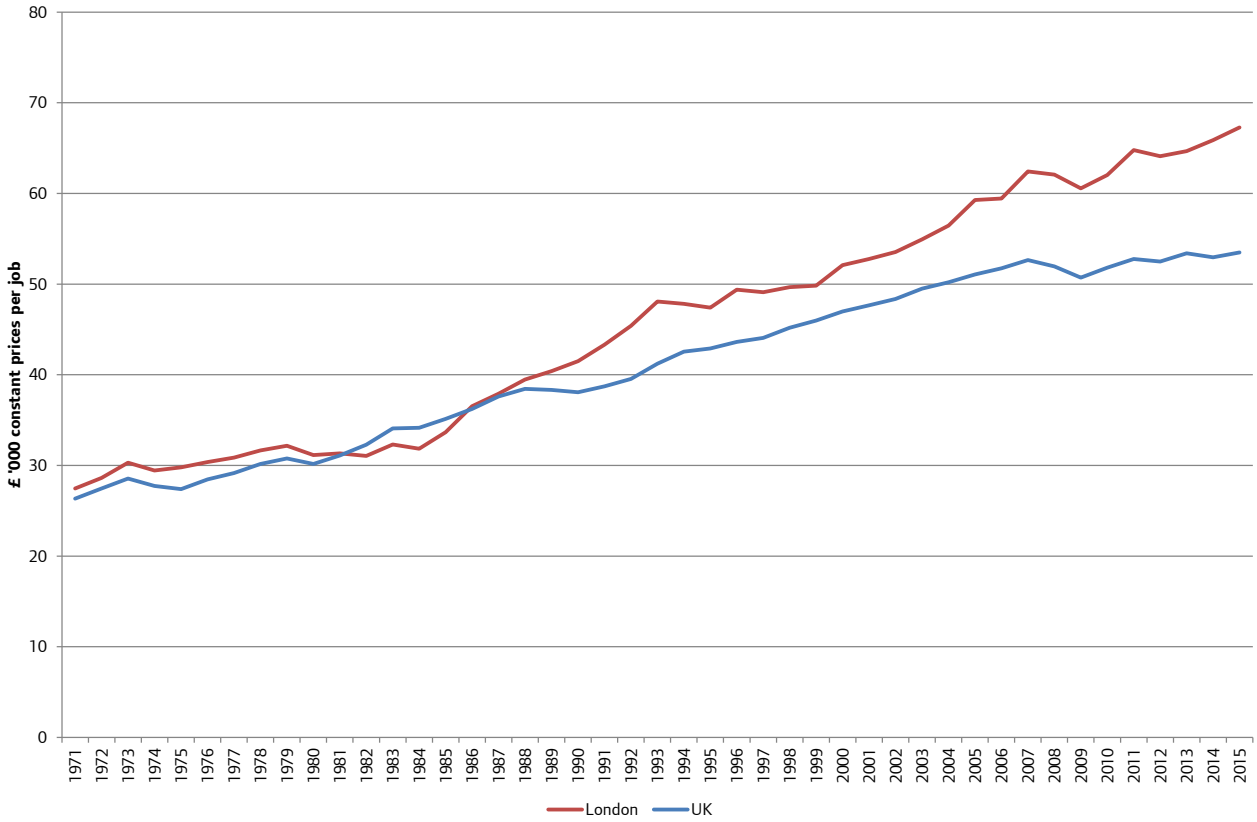
Figure 2.7: Trends in London shares of UK jobs and output 1971-2015



Sources: ONS National Accounts, Regional GVA and Workforce Jobs figures, and GLA Economics estimates

Figure 2.8 provides London and UK productivity trends as measured by output per workforce job. The levels were similar through the 1970s and 1980s, rising by around 45% for both geographic areas over this period. Subsequently, the trends have diverged. Since 1990 output per workforce job has risen by 60% in London, and 40% across the UK.

Figure 2.8: London and UK output per job trends



Sources: ONS National Accounts, Regional GVA and Workforce Jobs figures, and GLA Economics estimates

Table 2.1 compares the performance of London and UK economies across economic cycles since 1971. It does this for peak and trough years of UK GDP, and London jobs. There are some similarities. GDP growth for the whole period has been similar for London and the UK at 2.3% to 2.4%, whether measured from output peak to output peak, or across troughs. Job creation has improved from peak-to-peak, and for the more recent troughs the fall in jobs has declined arguably reflecting improved labour market flexibility. What distinguishes London is that output growth has been increasing across economic cycles while for the UK growth has been more even.

Table 2.1: Summary of output and labour market indicator performances for London and the UK over economic cycles (compound annual growth rates between different dates)

	GDP growth		Jobs growth	
	London	UK	London	UK
UK GDP peak-to-peak				
1973-1979	0.3%	1.5%	-0.7%	0.3%
1979-1990	2.2%	2.5%	-0.2%	0.5%
1990-2007	3.2%	2.6%	0.7%	0.6%
1973-2007	2.3%	2.3%	0.2%	0.5%
UK GDP trough-to-trough				
1975-1981	0.2%	1.7%	-0.7%	-0.4%
1981-1991	2.9%	2.9%	-0.4%	0.7%
1991-2009	2.9%	2.2%	1.0%	0.7%
1975-2009	2.4%	2.3%	0.3%	0.5%
London jobs peak-to-peak				
1971-1979	1.3%	2.5%	-0.7%	0.5%
1979-1989	2.3%	2.7%	-0.0%	0.4%
1989-2001	2.9%	2.3%	0.6%	0.5%
2001-2008	3.2%	2.3%	0.8%	1.0%
1971-2008	2.4%	2.4%	0.2%	0.6%
London jobs trough-to-trough				
1977-1983	0.2%	1.8%	-0.6%	-0.8%
1983-1993	3.4%	2.6%	-0.6%	0.6%
1993-2002	3.2%	3.1%	2.0%	1.3%
2002-2010	2.5%	1.3%	0.6%	0.5%
1977-2010	2.5%	2.3%	0.4%	0.5%
Current jobs cycle				
2008-2015	2.9%	1.1%	1.7%	0.6%

Sources: ONS National Accounts, Regional GVA and Workforce Jobs figures, and GLA Economics estimates

In the period since 2008 jobs in London have grown faster than jobs across the UK.

London's future economic and labour market performance will depend on whether it can continue to reap the benefit of specialisation and agglomeration economies, and address successfully the challenges of limited space and transport capacity, while negotiating effectively the effects of any adverse international developments which might affect it disproportionately.

London's projected demand for labour

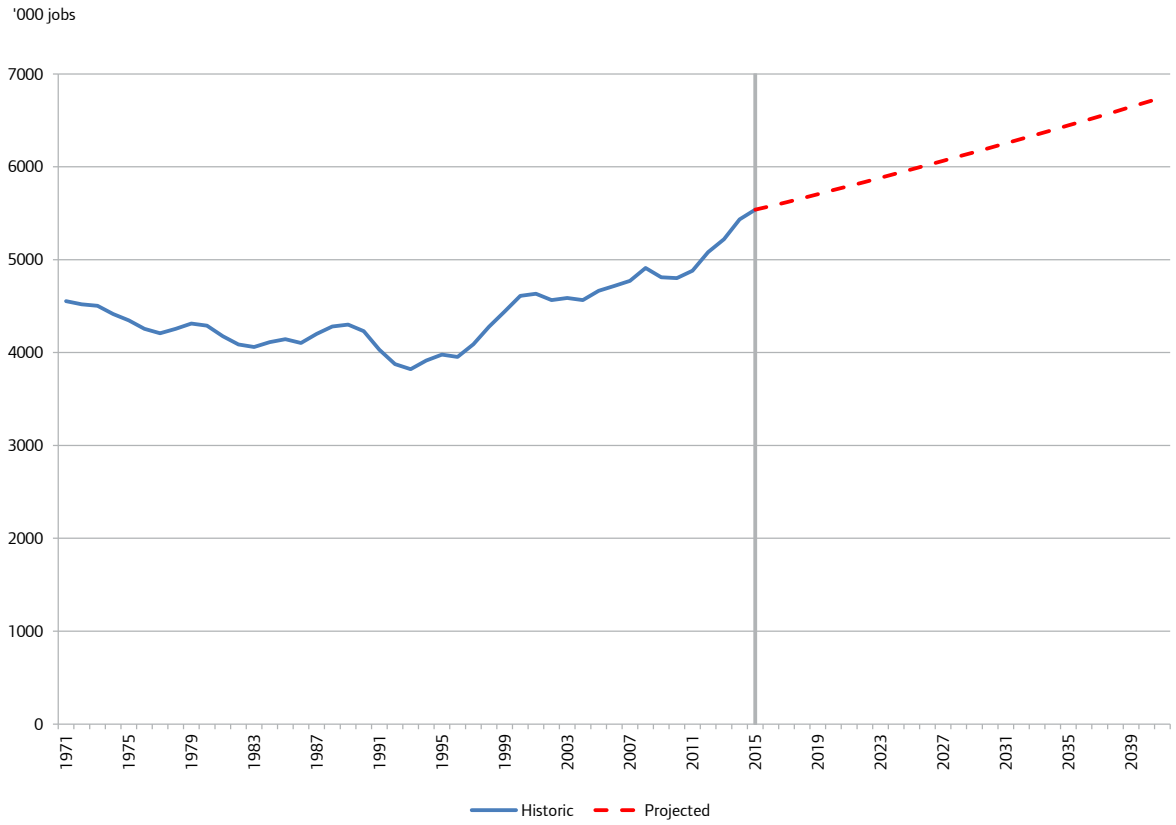
Employment projections

Looking at the longer term, GLA Economics project employment to grow by around 0.76 per cent per annum on average from 2015 to 2041, see Figure 2.9. This means that the number of jobs in London is projected to increase by 1,210,000 from the 2015 value of 5,538,000 to 6,748,000 in 2041 (this equates to annual average growth of 45,000 jobs per year). There is uncertainty at the moment around developments in the London economy, the UK economy, and the global economy, and the possible impacts on the London labour market. Appendix 4 sets out a higher and lower growth scenarios around this central projection. Appendix 5 combines these scenarios with a sensitivity analysis of the results from alternative approaches to modelling employment projections.

Box 2.1: Methodology for GLA Economics employment projections

GLA Economics' long-run employment projections use historic data on the relationship between employment and output together with an assumption of future output growth to project employment over the long term. As such the projections do not attempt to plot the exact path of employment over time, accounting for each and every economic cycle, but rather look at the likely long-term trend in employment. The projections for sectors are also constructed in this way, but to ensure that the sector level results add up to the London-wide employment projections they are constrained to that total. Further detail on the methodology is provided in Appendix 5.

Figure 2.9: London's historic and projected employment (1971-2041)



Source: GLA Economics calculations

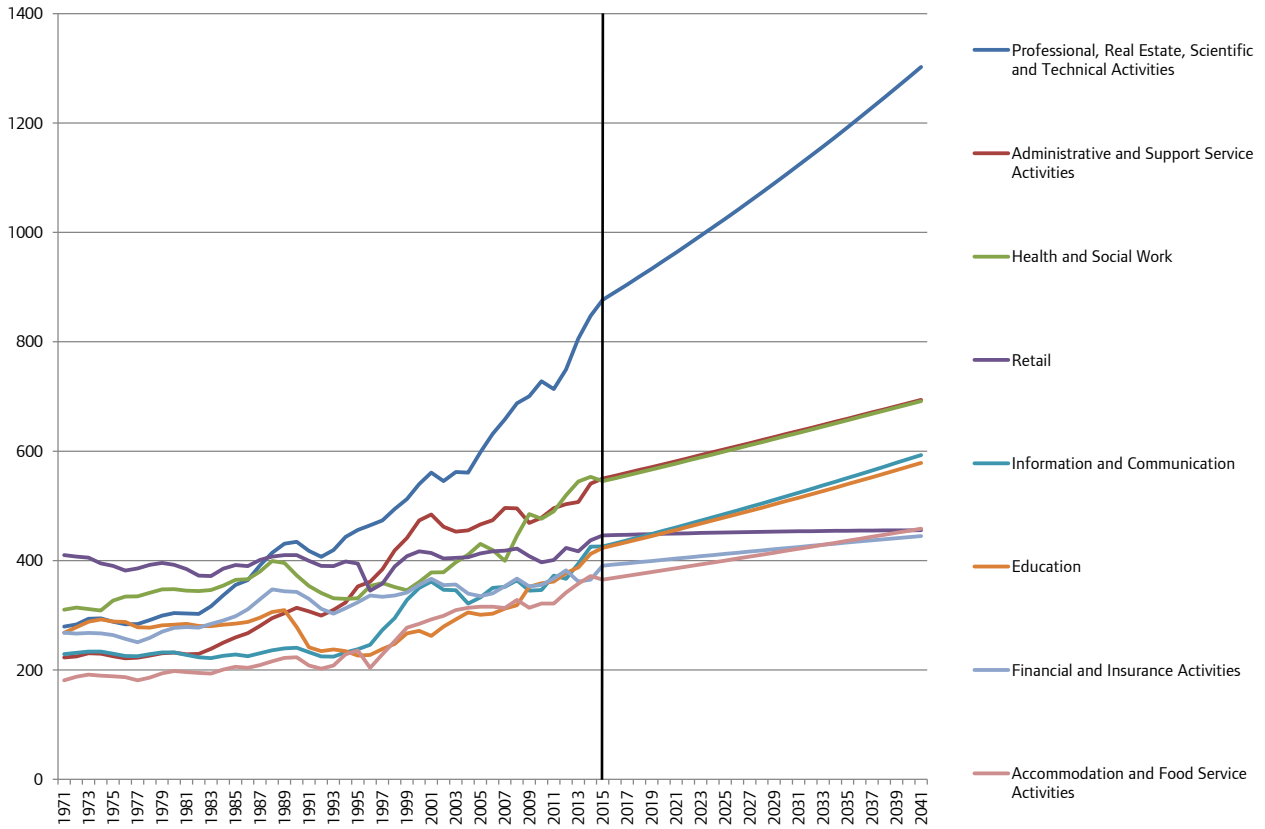
Whilst London-wide employment is projected to grow this is not the case for all sectors within London. Indeed, there are large differences in projected employment amongst sectors. Table 2.2 shows that employment growth for sectors is projected to range from 1.5 per cent year-on-year growth (for professional, real estate, scientific and technical activities) to a 2.0 per cent year-on-year decline (for manufacturing). Figures 2.10 and 2.11 also show how projected employment numbers differ across sectors. Professional, real estate, scientific and technical activities are projected to see an increase of 425,000 jobs by 2041. This accounts for a third of all the employment increase expected in London. Information and communication, and education, health and social work, and administrative and support service activities[9] are also expected to see large increases in employment numbers.

Table 2.2: Summary of employment projections by sector, 2015-2041

	Employment growth per annum with London output growth of 2.5% per annum	Absolute change in employment numbers ('000 jobs)
Professional, Real Estate, Scientific and Technical Activities	1.5%	425
Information and Communication	1.3%	167
Education	1.2%	155
Arts, Entertainment and Recreation	1.1%	70
Health and Social Work	0.9%	147
Administrative and Support Service Activities	0.9%	144
Accommodation and Food Service Activities	0.9%	93
Construction	0.8%	69
Total London Employment	0.8%	1210
Other Services	0.7%	30
Financial and Insurance Activities	0.5%	54
Retail	0.1%	9
Public Administration	-0.4%	-19
Transportation and Storage	-0.5%	-35
Primary & Utilities	-0.6%	-5
Wholesale	-0.9%	-41
Manufacturing	-2.0%	-53

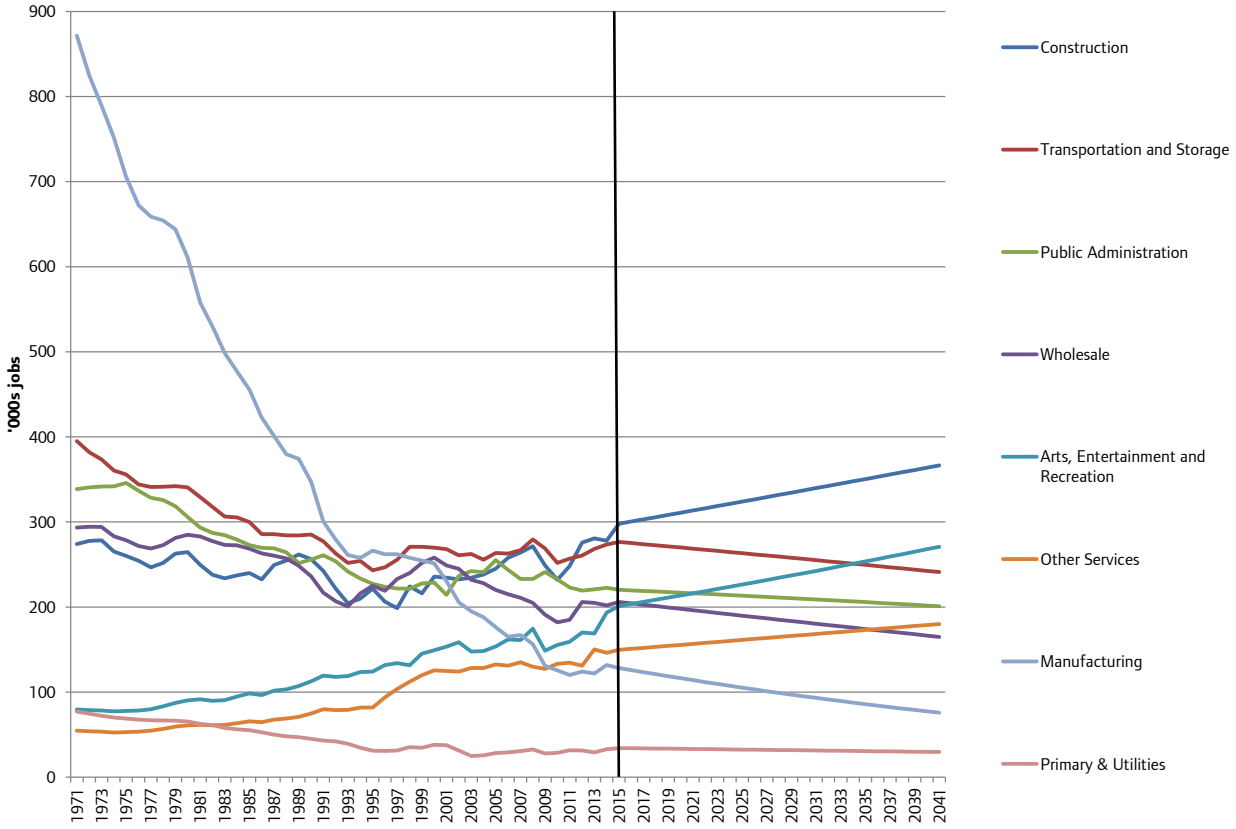
Source: GLA Economics calculations

Figure 2.10: Employment projections for London's larger sectors



Source: GLA Economics calculations

Figure 2.11: Employment projections for London's smaller sectors



Source: GLA Economics calculations

Occupation projections

The employment data used to inform analysis of London's employment structure and projections of London's employment does not contain information on occupations. Such information has to be derived from alternative sources. In order to provide information on occupations in London the Annual Population Survey (APS) has been used for 2004-11 together with the Labour Force Survey (LFS) for the earlier periods (2001-2003). However, it should be noted that these surveys, because of their sample size at the London level, produce less robust results than the employment surveys used for projecting employment. Moreover, the amount of historical data available on occupations is more limited than that for employment. It includes 2007-9 when there was a major recession, which have made it difficult to distinguish between shorter and longer-term trends. As a result, a relatively limited amount (of less robust) data has been used to project occupations when compared to the employment projections. For these reasons, caution is required when using the occupation projections - particularly over longer time horizons.

To construct occupation projections for London, the shares of occupation within sectors over time are used as a guide to future trends of occupation shares by sector. The occupation shares can then be applied to the sector employment results (derived from the employment projections) to derive absolute figures for occupations by sector. Further details of the methodology used can be found in Appendix 5.

A summary of the expected demand for occupations is presented in Tables 2.3 and 2.4 and Figure 2.12. Demand for professional occupations, and managers, directors and senior officials in London are projected to see the large increases accounting for three quarters, or 979,000, of additional jobs between 2014 and 2041. The number of managers, directors and senior officials is expected to increase by 424,000, a year-on-year increase of 1.7 per cent, while a total of 555,000 more jobs in professional occupations (equivalent to a 1.3 per cent year-on-year increase) is expected between 2014 and 2041. A quarter of the increase in professional occupations is expected to come from the

information and communication sector, and half of the increase in managers, directors and senior officials will be in the professional services sector.

Table 2.3: Average year-on-year change in occupations within sectors (2014 to 2041)

	Managers, Directors And Senior Officials	Professional Occupations	Associate Professional And Technical Occupations	Administrative And Secretarial Occupations	Skilled Trades Occupations	Caring, Leisure And Other Service Occupations; and Sales And Customer Service Occupations	Process, Plant And Machine Operatives; and Elementary Occupations	Total
Primary & utilities	1.0%	0.7%	0.3%	-4.2%	-3.5%	-5.7%	-1.4%	-0.4%
Manufacturing	-1.1%	-3.2%	-2.2%	-2.6%	-2.2%	-1.4%	-1.7%	-2.0%
Construction	0.6%	2.3%	-3.4%	-3.5%	0.4%	-6.7%	3.4%	1.0%
Wholesale	-0.9%	1.5%	-0.0%	-5.6%	-2.2%	-0.6%	-0.0%	-0.7%
Retail	0.5%	1.7%	1.2%	-0.1%	-1.7%	0.1%	-1.6%	0.2%
Transportation and Storage	-1.6%	1.2%	-2.0%	-0.5%	-3.8%	-0.3%	-0.3%	-0.5%
Accomodation and Food Service Activities	1.0%	-15.7%	-2.7%	-0.3%	-0.1%	3.0%	0.8%	0.8%
Information and Communication	3.2%	2.2%	-1.2%	-5.2%	-6.5%	-2.6%	0.1%	1.2%
Financial and Insurance Activities	1.7%	2.2%	0.3%	-3.9%	0.0%	-6.8%	-0.1%	0.7%
Professional, Real Estate, Scientific and Technical Activities	3.5%	1.1%	1.7%	-0.7%	3.6%	0.6%	-4.4%	1.6%
Administrative and Support Service Activities	1.8%	-2.8%	-4.2%	-3.3%	3.1%	-0.8%	2.4%	0.9%
Public Administration and Defence	-0.8%	1.4%	-1.0%	-1.8%	-7.9%	-0.7%	-2.7%	-0.4%
Education	1.6%	1.2%	1.4%	-0.5%	-1.1%	2.0%	1.3%	1.3%
Health	0.7%	1.1%	0.8%	-0.6%	0.9%	1.2%	-1.6%	0.8%
Arts, Entertainment and Recreation	2.4%	1.1%	1.0%	-2.8%	4.1%	1.4%	0.5%	1.3%
Other Service Occupations	0.9%	0.8%	1.7%	-2.8%	1.1%	1.4%	-3.5%	0.8%
Total London	**1.7%**	**1.3%**	**0.3%**	**-1.6%**	**0.6%**	**0.7%**	**1.0%**	**0.8%**

Source: GLA Economics calculations

Note: Base year in table is 2014, the last year of historic data, and so reported sector growth may be slightly different to employment projections, which have base year 2015

Note: Figures are for the sector of employment, which may not be the sector of activity. The industrial sector Administrative and Support Service Activities includes employment agencies, who may employ individuals whose day-to-day work is for an organisation in another sector

Table 2.4: Absolute change in occupation employment (jobs) by sector (000s, 2014 to 2041)

	Managers, Directors And Senior Officials	Professional Occupations	Associate Professional And Technical Occupations	Administrative And Secretarial Occupations	Skilled Trades Occupations	Caring, Leisure And Other Service Occupations; and Sales And Customer Service Occupations	Process, Plant And Machine Operatives; and Elementary Occupations	Total
Primary & utilities	1	2	0	-2	-2	-1	-2	-3
Manufacturing	-5	-11	-11	-7	-12	-2	-9	-56
Construction	6	32	-9	-10	14	-2	58	89
Wholesale	-9	5	-1	-16	-13	-4	-0	-37
Retail	10	11	15	-1	-4	3	-15	18
Transportation and Storage	-8	7	-9	-4	-5	-2	-12	-32
Accomodation and Food Service Activities	18	-3	-5	-2	-2	39	41	87
Information and Communication	81	154	-31	-20	-12	-5	0	168
Financial and Insurance Activities	44	71	11	-40	0	-6	-0	80
Professional, Real Estate, Scientific and Technical Activities	211	104	133	-19	30	6	-10	455
Administrative and Support Service Activities	41	-16	-62	-31	49	-12	183	153
Public Administration and Defence	-5	26	-18	-18	-1	-2	-4	-22
Education	7	84	16	-4	-1	50	14	166
Health	9	72	17	-10	2	54	-6	139
Arts, Entertainment and Recreation	19	9	28	-7	18	8	2	77
Other Service Occupations	4	7	13	-8	3	21	-7	34
Total London	**424**	**555**	**89**	**-197**	**66**	**146**	**232**	**1315**

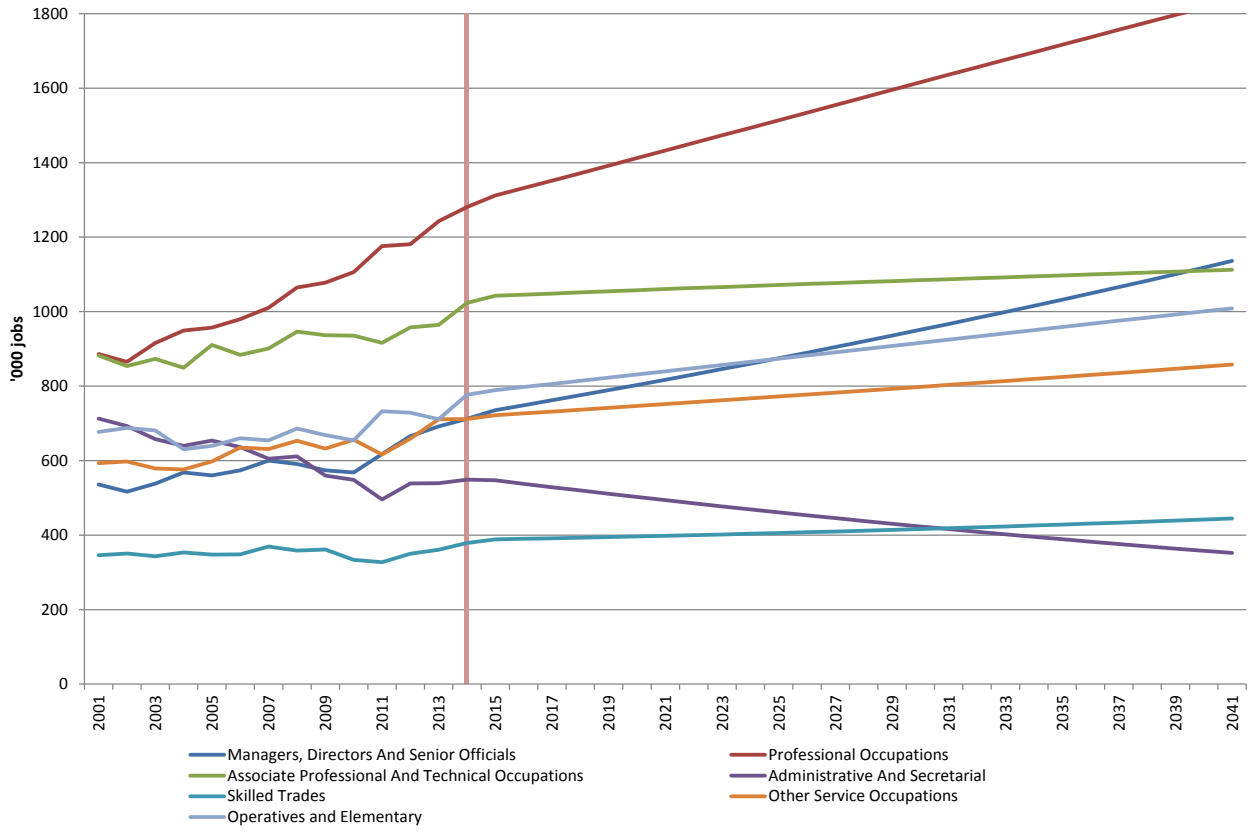
Source: GLA Economics calculations

Note: Base year in table is 2014, the last year of historic data, and so reported sector growth may be slightly different to employment projections, which have base year 2015

Note: Figures are for the sector of employment, which may not be the sector of activity. The industrial sector Administrative and Support Service Activities includes employment agencies, who may employ individuals whose day-to-day work is for an organisation in another sector

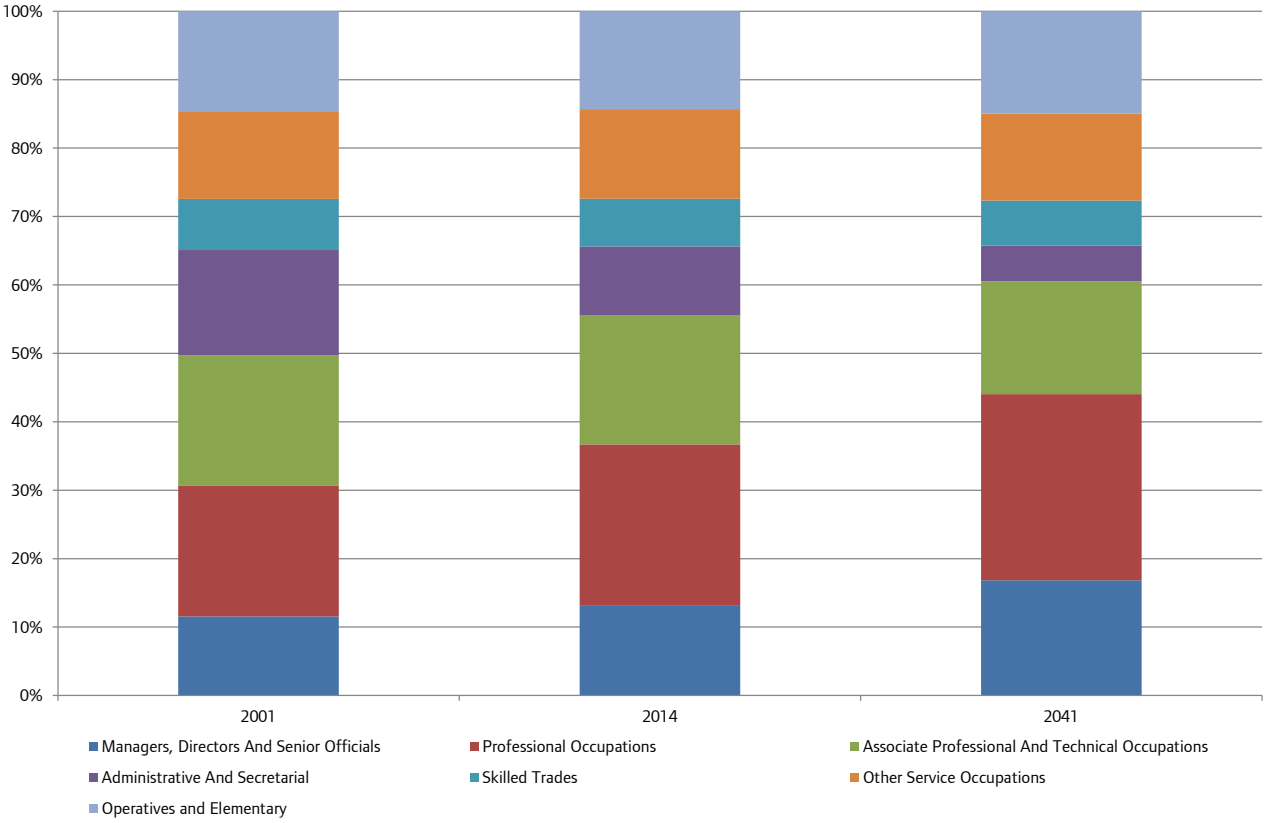
Administrative and secretarial occupations are the only occupation group expected to see a London-wide decline in demand. The number of jobs in this occupation group is projected to decline by 197,000 from 2014 to a total of 352,000 by 2041. This equates to a year-on-year decline of 1.6 per cent.

Figure 2.12: Changes in Occupation Demand (2001 to 2041)



Source: ONS Annual Population Survey, ONS Labour Force Survey, ONS Workforce Jobs series and GLA Economics calculations

Figure 2.13: Changes in occupation shares



Source: ONS Annual Population Survey, ONS Labour Force Survey, ONS Workforce Jobs series and GLA Economics calculations

Figure 2.13 shows the change in the shares of occupations in London's jobs over time. It shows that in 2001 just over 30 per cent of London's jobs were in managerial or professional occupations. This share is projected to increase to just under 45 per cent by 2041. In contrast administrative and secretarial occupations are projected to decrease from accounting for 15 per cent of London's jobs in 2001 to 5 per cent in 2041. As shown in Tables 2.3 and 2.4 this decline in administrative and secretarial occupations is seen across all London's sectors.

Qualification projections

Information on the qualifications held by those working in jobs in London is taken from the APS (for the same reason that this source was used for occupations data). It should be noted that in 2011, ONS changed the approach to collecting data on people's highest educational qualifications in order to obtain more information on qualifications obtained abroad, which had previously been reported as 'other'. This change produced a structural break in the time series. GLA Economics has developed a method to project this change backwards for earlier years (see Appendix 5 for more information).

To construct the likely projection of qualifications held by those working in jobs in London a slightly different methodology to that used for occupations was used. The shares of qualification held by occupation is used as a guide to future trends of qualification by occupation. However, given the growth in the numbers of people holding a degree or higher over the past decade or so, using this methodology without constraint would produce, by 2041, largely implausible results (because of the recent, very rapid, increases in the numbers holding a degree or higher, see Figure 2.6). For those occupations which employ the highest proportions of highly qualified individuals namely managers, directors and senior officials, and professional and associate professional occupations the distribution of qualifications of 16-44 has been held fixed. The modelling assumes that the trend for individuals to remain economically active as they get older will continue, and so an occupation will have a higher proportion of older, and relatively less qualified, workers over time. At the same time the qualification levels of this age group will improve as cohorts of better qualified younger people replace older people. Further details of the methodology used can be found in Appendix 5.

A summary of the expected demand for qualifications is presented in Tables 2.5 and 2.6 and Figure 2.14. It is projected that the number of jobs requiring degrees will increase by 642,000 between 2014 and 2041, and that the number of jobs requiring higher degrees will rise by 342,000. It is expected that there will be more graduate jobs in all occupations except administrative and secretarial occupations.

The number of jobs in London requiring higher degrees is projected to rise by 1.4 per cent per annum over the 2014 to 2041 period, and for jobs requiring ordinary degrees by 1.1%. The largest increase in both cases is in professional occupations, 204,000 jobs require higher degrees, and another 270,000 require degrees. It is also expected that there will be a significant expansion of graduates working as managers, directors and senior officials, 90,000 more jobs will require higher degrees while another 206,000 jobs will require ordinary degrees.

Table 2.5: Year-on-Year Change in Qualification Employment within Occupations (2014 to 2041)

	Higher degree	Ordinary degree or equivalent	Higher education	GCE, A-level or equivalent	GCSE grades A* - C or equivalent	Other qualifications	No qualification	Total
Managers, Directors And Senior Officials	2.0%	1.9%	2.4%	1.2%	1.8%	0.7%	-1.8%	1.7%
Professional Occupations	1.4%	1.4%	1.3%	1.1%	1.0%	0.3%	1.3%	1.3%
Associate Professional and Technical Occupations	0.6%	0.4%	0.6%	0.1%	0.3%	-1.2%	-1.5%	0.3%
Administrative and Secretarial Occupations	-0.8%	-0.8%	-1.3%	-2.0%	-2.1%	-4.3%	-5.5%	-1.6%
Skilled Trades Occupations	1.5%	1.7%	0.8%	-0.1%	0.8%	1.1%	-0.7%	0.6%
Caring, Leisure And Other Service Occupations; and Sales And Customer Service Occupations	1.9%	1.6%	1.2%	0.9%	-0.1%	-0.5%	-1.8%	0.7%
Process, Plant And Machine Operatives; and Elementary Occupations	2.2%	1.5%	1.9%	0.9%	1.2%	0.9%	-0.5%	1.0%
Total London	**1.4%**	**1.1%**	**1.1%**	**0.5%**	**0.4%**	**0.4%**	**-1.0%**	**0.8%**

Source: GLA Economics calculations

Note: Base year in table is 2014, the last year of historic data, and so reported employment growth may be slightly different to employment projections, which have base year 2015

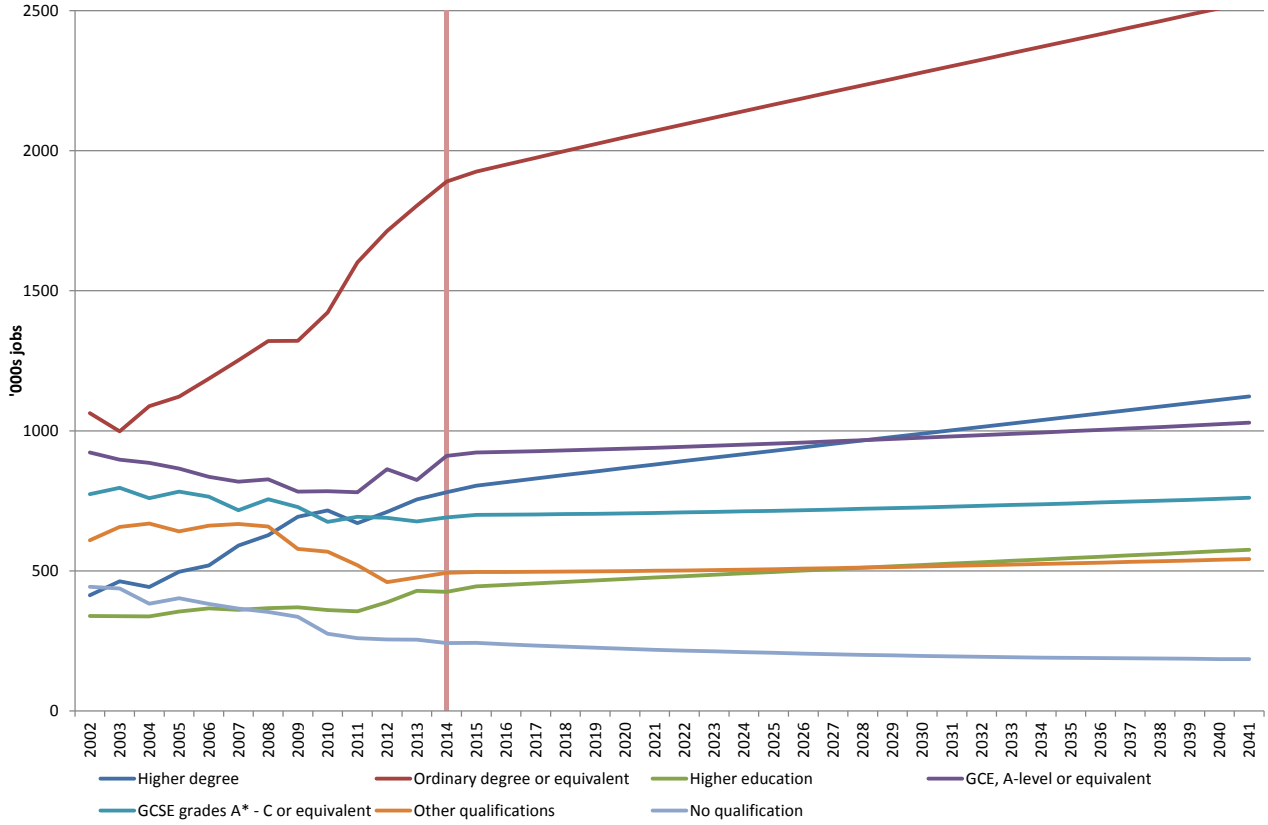
Table 2.6: Absolute change in qualification employment (jobs) by occupation (000s, 2014 to 2041)

	Higher degree	Ordinary degree or equivalent	Higher education	GCE, A-level or equivalent	GCSE grades A* - C or equivalent	Other qualifications	No qualification	Total
Managers, Directors And Senior Officials	90	206	44	42	40	8	-6	424
Professional Occupations	204	270	38	28	12	1	3	555
Associate Professional and Technical Occupations	25	53	12	3	8	-8	-4	89
Administrative and Secretarial Occupations	-7	-37	-13	-43	-57	-26	-14	-197
Skilled Trades Occupations	3	21	8	-2	14	28	-7	66
Caring, Leisure And Other Service Occupations; and Sales And Customer Service Occupations	17	81	28	51	-3	-10	-18	146
Process, Plant And Machine Operatives; and Elementary Occupations	11	48	34	40	57	56	-13	232
Total London	**342**	**642**	**151**	**119**	**70**	**50**	**-58**	**1315**

Source: GLA Economics calculations

Note: Base year in table is 2014, the last year of historic data, and so reported employment growth may be slightly different to employment projections, which have base year 2015

Figure 2.14: Changes in Qualification Demand (2002 to 2041)

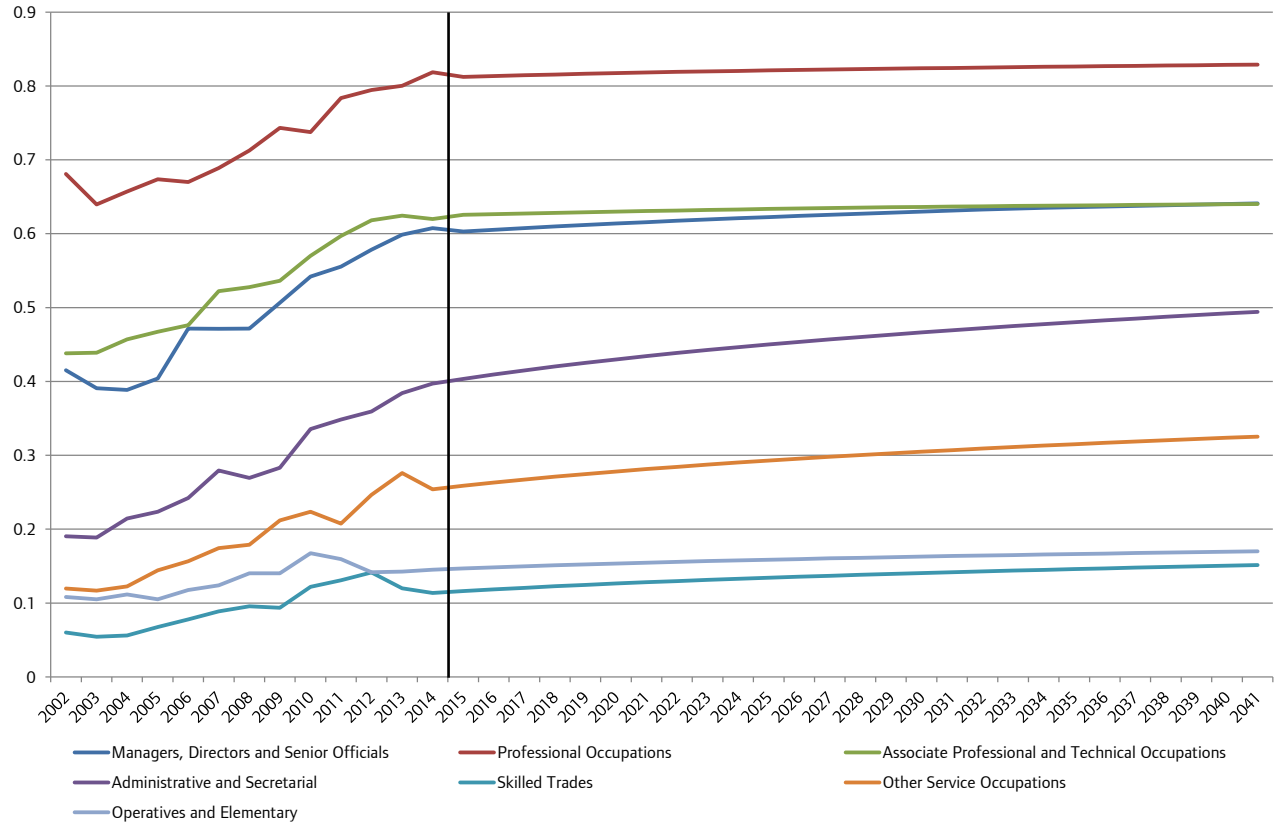


Source: ONS Annual Population Survey, ONS Workforce Jobs series and GLA Economics calculations

A summary of the distribution of qualifications across jobs is provided in Figures 2.15 and 2.16. For all professions the proportion with graduate level qualifications is increasing. This will not just be younger more qualified individuals taking new jobs, or replacing less qualified older people leaving the labour market. For administrative and secretarial occupations the number of jobs is expected to continue to decline, and the proportion of graduates in one of these roles is expected to grow further. This has been achieved through more older people leaving the occupation than younger, and more qualified, people joining.

The proportion of jobs in London requiring either an ordinary or higher degree is projected to reach 54 per cent by 2041 - up from 49 per cent in 2014, and 32 per cent in 2002. The proportion requiring a higher education qualification of some sort or another rises to just over 63 per cent by 2041 (ie over three out of every five jobs will require a higher education qualification) compared to 57 per cent in 2014, and 40 per cent in 2002.

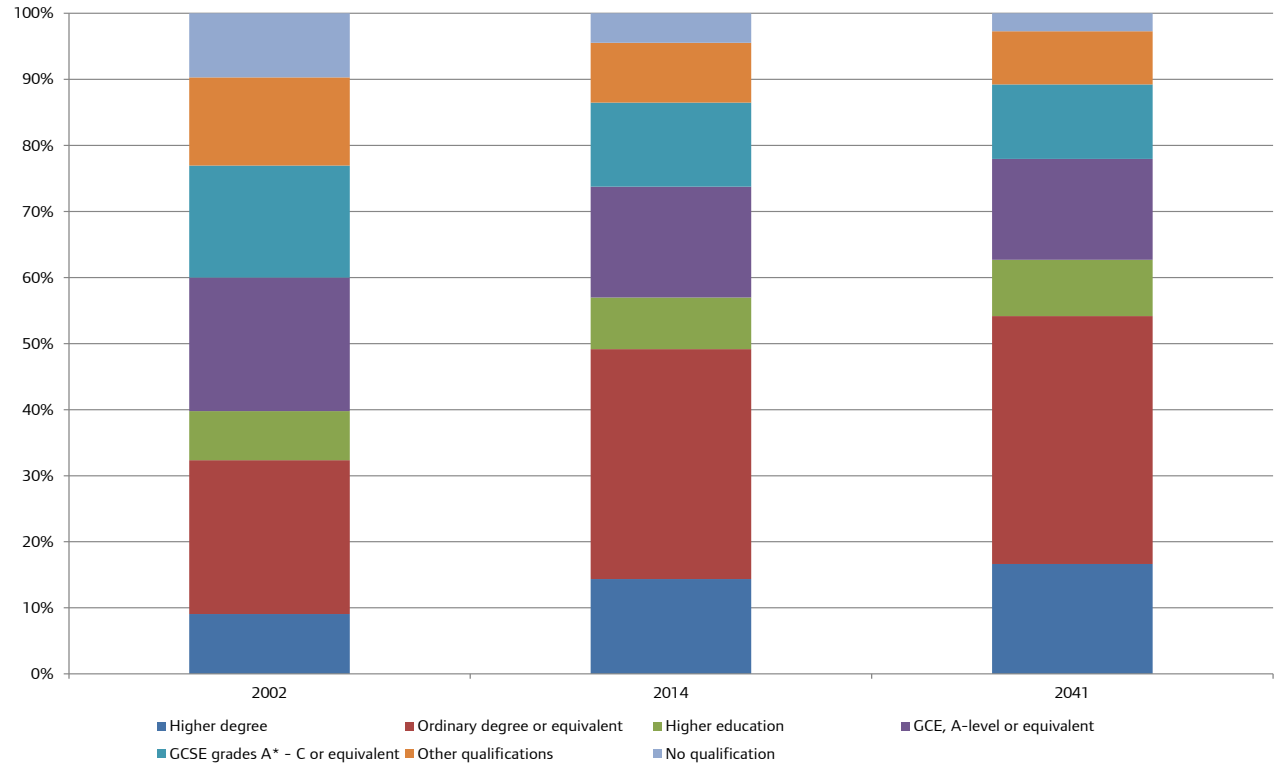
Figure 2.15: Changes in Proportions of Graduates in Occupations (2002 to 2041)



Source: ONS Annual Population Survey, ONS Workforce Jobs series and GLA Economics calculations

This compares with a fall in the proportion of jobs held by people with no qualifications from 9.7% in 2002 to 4.5% in 2014, and to 2.7% in 2041. This parallels the decline in the proportion of working 16-29 year olds reported in Figure 2.6.

Figure 2.16: Shares of qualifications as a percentage of all jobs



Source: ONS Annual Population Survey, ONS Workforce Jobs series and GLA Economics calculations

Labour market turnover

The earlier employment, occupation and qualification projection sections have provided an outline of the potential future path of the **stock** of employment. Whilst this provides a useful indication of the likely areas of change within the capital's economy, on their own, such projections would provide a misleading picture of the potential future job opportunities and qualification requirements for London's existing and future workforce. This is because the labour market is not a static entity; instead it is subject to significant **flows**.

Over the course of a year, for example, many people leave their jobs for various destinations. Some people will retire, some will choose to leave London (and not commute back in), some will take time off work to have children, some will shift from one occupation or sector to another, some will fall long-term sick and some will die. For the capital's economy to continue to function effectively all these moves out of employment will have to be replenished. The annual out-flow from employment, which needs to be replaced, is sometimes referred to as the level of gross replacement demand. The majority of this gross replacement demand is usually satisfied from within the labour market - for example, by people moving from one job to another, from people returning from long-term sickness or unemployment etc. However, an appreciation of these flows highlights that even in sectors or occupational classes which are projected to be in decline, new staff will be required to replenish those leaving employment and this is likely to derive some training, skill or qualification requirements.

Whilst the concept of labour market churn and replacement demand is a relatively easy one to comprehend, estimating it through modelling with existing data sources is rather more difficult. The methodology used by GLA Economics is outlined in Box 2.2.

Box 2.2: Methodology for modelling replacement demand

Employment flows within the London population aged 16 to 64 were examined between 2001 and 2015 utilising data provided by the ONS (the Labour Force Survey (April to June quarter) was used for this purpose). Data on the proportion of London's employed workforce who left their occupation and data on the proportion entering London's employed workforce was collected for each year. The data available suggest that, for the most part, the proportions leaving for various destinations (or joining from various origins) do not vary significantly over time (accepting some variation for the stage of the cycle). As a result, the proportions leaving employment, and joining employment were averaged over the 2001 to 2015 period. For the purposes of projecting the level of replacement demand, these average 'leaving' and 'joining' rates are assumed to remain constant in future years.

These proportions are then applied to the employment projections outlined earlier to estimate the number of jobs likely to 'turnover' (in terms of changes in occupation) in any single year. Whilst the figures relate to jobs, for ease of exposition, in this section we refer to people moving occupations (whilst accepting this is a simplification).

Turnover by occupation

Table 2.7: Summary of estimated average outflows from occupations in 2015 (using data from 2001 to 2015)

	Percentage outflow from occupation (%)	Absolute number leaving the occupation
Managers, Directors And Senior Officials	8.3%	59,000
Professional Occupations	9.3%	119,000
Associate Professional and Technical Occupations	12.5%	128,000
Administrative and Secretarial Occupations	14.3%	79,000
Skilled Trades Occupations	8.6%	33,000
Caring, Leisure And Other Service Occupations; and Sales And Customer Service Occupations	20.3%	145,000
Process, Plant And Machine Operatives; and Elementary Occupations	17.6%	137,000
TOTAL	**12.9%**	**699,000**

Source: GLA Economics calculations using data from Labour Force Survey (April to June quarters)

Table 2.7 shows that, using the average rate at which individuals left their occupation over the 2001 to 2015 time period and applying it to the number of jobs in London in 2015, a little under 700,000 people left their occupation in 2015. This illustrates that there is a potentially significant level of education and training requirements each and every year in London's labour market just from replenishing those that leave their occupation within a year - well in excess of that illustrated through the analysis of employment stock projections.

It should be noted that in this analysis, due to data limitations, occupations are used as a means of getting at the potential 'replacement demand' generated through labour market turnover in any given year. However, for a number of reasons, this may well underestimate the actual level of turnover that generates replacement demand and associated education and training requirements. First, this analysis does not pick up any individuals who leave their employment but subsequently take up another job in the *same* occupation. It is more than likely that at least some of these individuals will have education and training requirements. Second, the data source used for this analysis only looks at changes that occur over the period of a year. It may well be that many individuals change jobs or occupations more than once within the course of a single year, again potentially deriving education and training needs.

The main finding from the turnover work is that in any single year there will be a large level of turnover in London's labour market, across occupations and likely across the qualification spectrum as well. This is likely to result in potentially significant education and training requirements over time even in areas projected to decline in employment over time.

3. London's supply of labour

Main findings

- Over the past decade or so, more than 160,000 international migrants have moved to London each year
- This inflow to London's population has been partly offset by an outflow of at least 100,000 London residents emigrating overseas in each year.
- Domestically, in each year over the past decade or so, at least 180,000 people have moved to London from other regions of the UK.
- This inflow to London's population has been more than offset by the more than 250,000 London residents moving to other regions of the UK each year.
- In 2015, those that live and work in London were supplemented by over 850,000 commuters into the capital, equivalent to over 18 per cent of all jobs in London. This is an increase of around 150,000 over the last decade
- London's population aged between 16 and 64 (London's working age population) is projected to increase from 5.8 million in 2014 to 6.8 million by 2041.
- The highest qualification level of London's population is projected to continue to increase over time with 51 per cent of London's population (working age, or 65+ in employment) projected to have an ordinary degree or higher qualification by 2041 (up from 28 per cent in 1996).
- The economic activity projections suggest there will be an increase of 1,100,000 in the number of Londoners in employment between 2014 and 2041.

Introduction

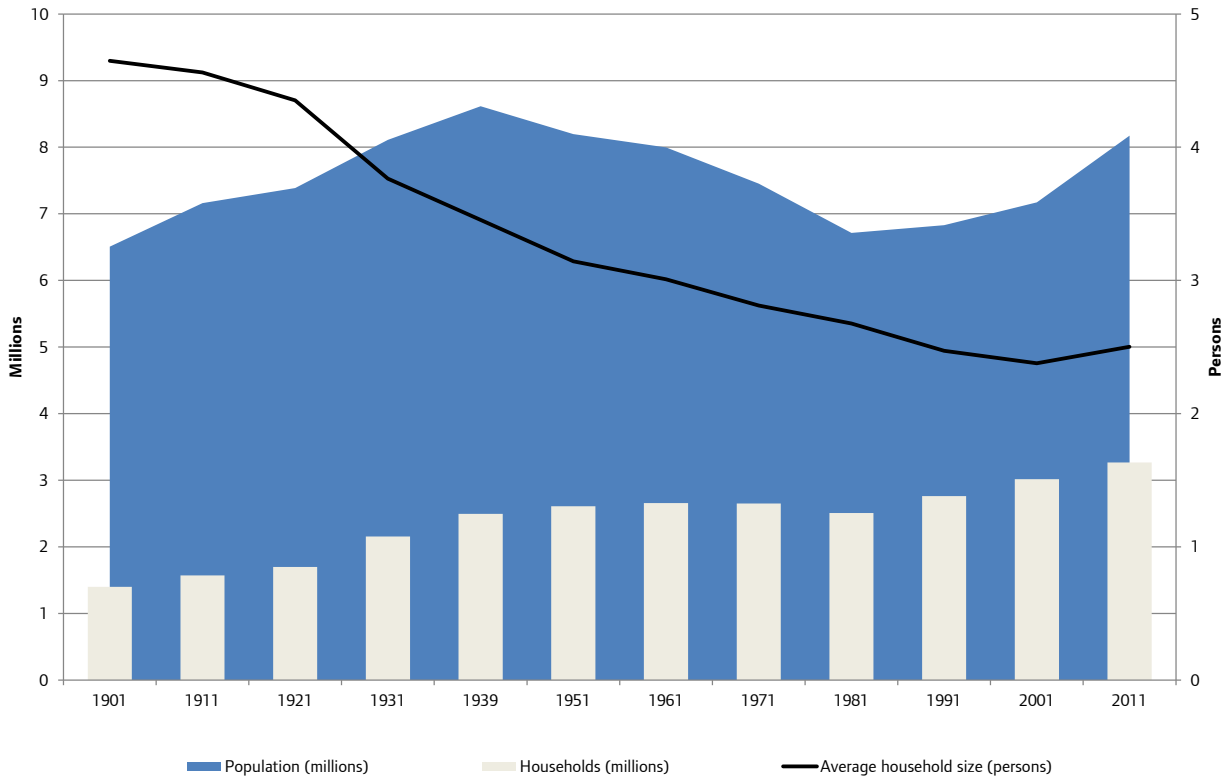
This section starts with a consideration of how London's population has evolved over time. It then looks at a long-run projection for London's working age population and breaks this down by an estimate of those likely to be in work and those likely to not be in work. The analysis also looks at the likely changes in qualifications of the working age population as a result of these projections (again broken down by an estimate of those likely to be in work and those likely to not be in work).

London's population over time

Following a peak in London's total population of 8.6 million in 1939, the post-war period saw the number of people living in London fall steadily to a low of 6.8 million in the early 1980s. Since then the population has followed an upward trend. According to the 2011 Census, London's total population stood at 8.2 million, an increase of 1 million people (or 14 per cent) on the 2001 estimate.

The way people live has also changed dramatically over this period. The London of the 1930s was characterised by larger households with 8.6 million people housed in just 2.5 million households at an average of 3.5 persons per household. In contrast, today's population make up 3.27 million households at an average of 2.5 persons per household.

Figure 3.1: Trends in London's individual and household populations 1901-2011



Source: Census

Of the 8.2 million total, 5.7 million people are aged 16-64; in what follows this group is referred to as the working age population (see Box 3.1). Between 1992 and 2011 the working-age population grew at an average annual rate of just under 1 per cent with a peak of over 2 per cent in 2001 and a low of 0 per cent in 1993.

Box 3.1: Changes affecting the point at which people retire

There are a number of, relatively recent, changes which are likely to increase the age at which people stop working, and choose to retire.

Over the period 2010-18 the State Pension Age for women is being equalised with that of men at 65, from 2019 this will be increased to 66, and from 2022 to 67.

Recent years have also seen a significant decline in the availability of final salary pension schemes and their replacement with, arguably, less generous defined contribution schemes. Payment out of some of these schemes may be linked to the State Pension Age.

The introduction of Employment and Support Allowance from 2008 tightened the gateway onto incapacity benefits, and access to benefit income to support early retirement.

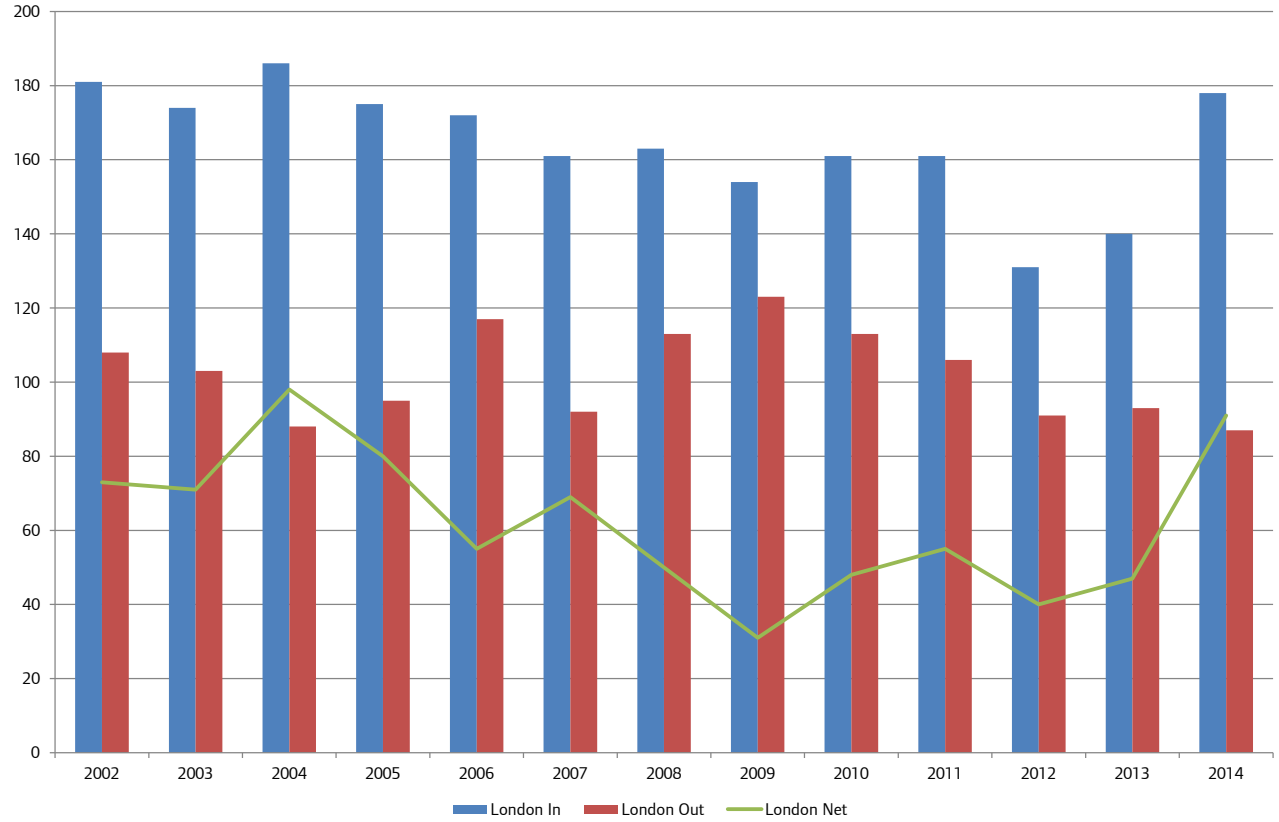
Recent changes around the 'default retirement age' (the Employment Equality (Repeal of Retirement Age Provisions) Regulations 2011) mean that it is possible that many people aged over 65 will continue to work.

These changes are relatively recent such that statistics on their combined impact are rather limited at this stage. In particular, it is difficult to interpret what the exact long-term impact is likely to be.

It is acknowledged that the over 65 age group is likely to play a greater part in London's labour market in the future than it has to date. The number of London residents over 65 in employment rose from 2004 to 2015 by 70,000 to 128,000. This corresponds to an increase in the proportion of 16+ London residents in employment from 1.6% to 2.9%.

The components of change in London's population are complex. The 2011 Census showed London continues to see the results of high fertility rates manifested in the size of the pre-school aged population, with six local authorities in the top ten nationally in terms of the proportion of the population aged 0-4. This is the continuation of a decade long trend which will contribute to a swelling working-age population in the coming years. The capital also continues to be a net importer of long-term international migrants (LTIMs). In 2014, inflows of LTIMs to London totalled 178,000 while outflows amounted to 87,000 generating a net inflow of just over 90,000 migrants (see Figure 3.2). On average, over the period 2002-14, inflows of LTIMs to London were over 160,000 a year, while outflows were a little over 100,000 a year, generating a net inflow of just over 60,000 a year.

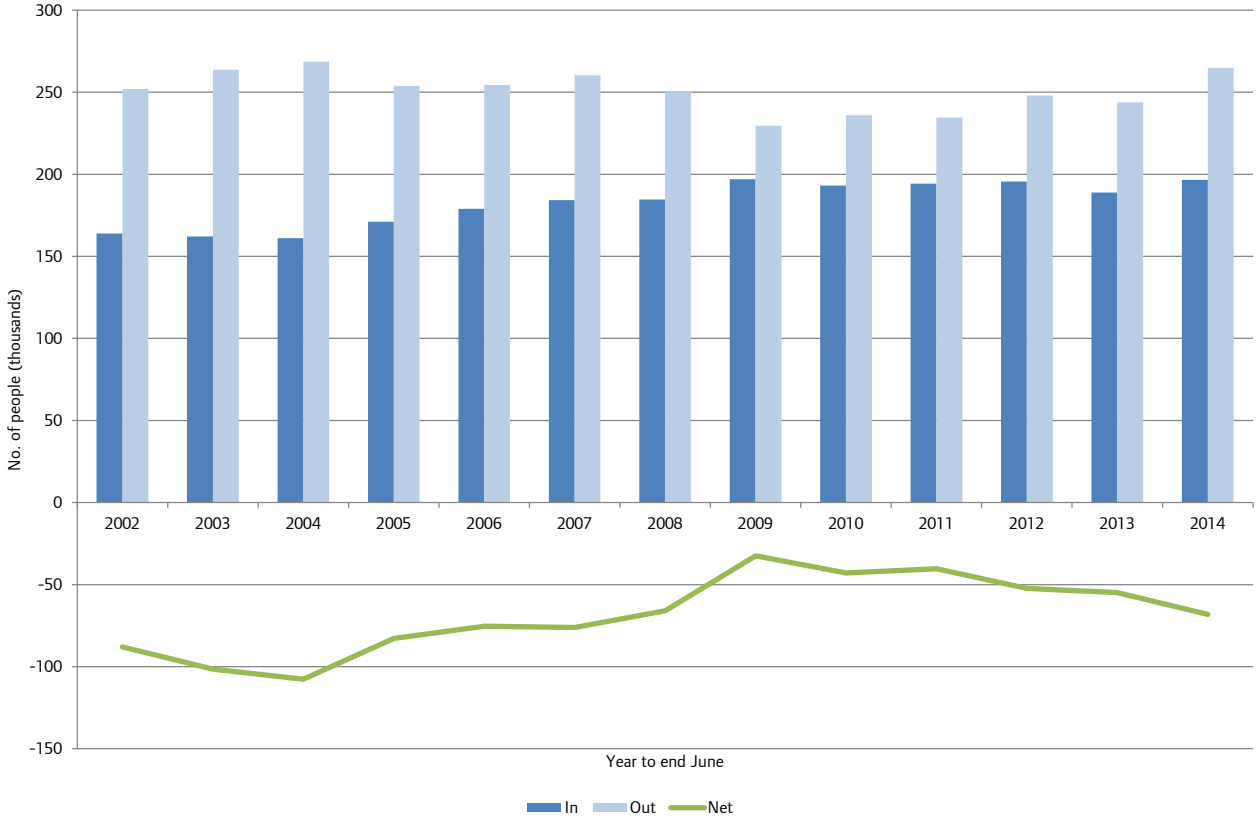
Figure 3.2: Long-Term International Migration, London, 12-month periods ending at quarter 4 of year given, thousands



Source: Long-Term International Migration (LTIM) estimates year ending December , ONS

In terms of domestic long-term internal migrants, London has traditionally been a large exporter. Trends in the numbers arriving in and leaving the capital converged in recent years resulting in a much smaller outflow of people, although outflows have risen since 2014. In 2004 net outflow totalled 108,000, by 2009 this had fallen to 32,000, although it has risen again since to 68,000 by 2014 (see Figure 3.3). On average, over the period 2002-14, domestic inflows to London were a little over 180,000 a year, while domestic outflows were 250,000 a year, generating a net outflow of just over 70,000 a year.

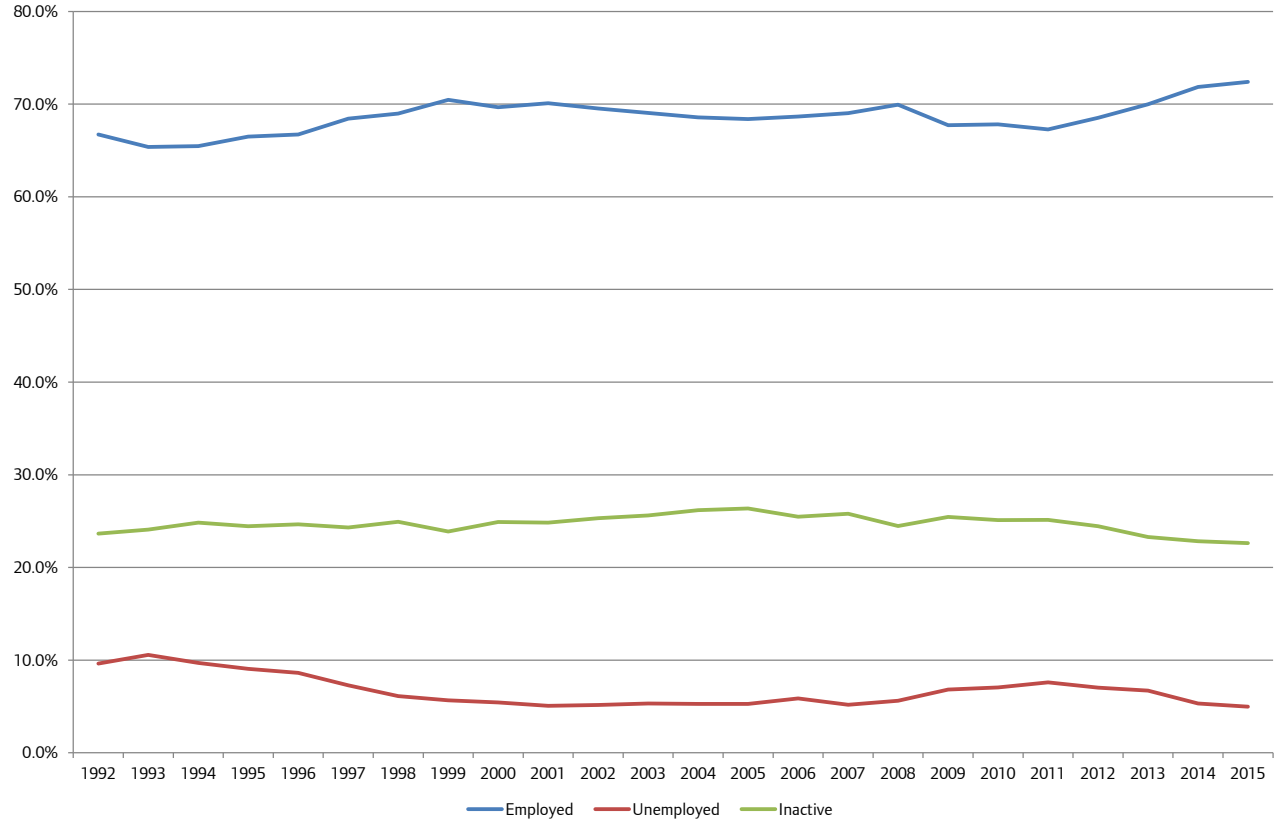
Figure 3.3: Internal (England and Wales) migration, London, 12-month periods ending at quarter 2 of year given, thousands



Source: NHS Central Register moves within England and Wales year ending June 2014, ONS/Patient Register Data Service

Figure 3.4 shows London's working aged population by economic status between 1992 and 2014. In 1992, following the 1990s recession, 66.7 per cent of working age Londoners were in employment. This share rose steadily to a 2001 employment rate of 70.1 per cent before falling back during the early part of the last decade and then climbing again to a pre-recession peak of 69.9 per cent in 2008. By 2011, the employment rate stood at 67.3 per cent, the lowest since 1996. Since then employment has picked up and the rate has reached an all-time high, being at 72.4% in 2015.

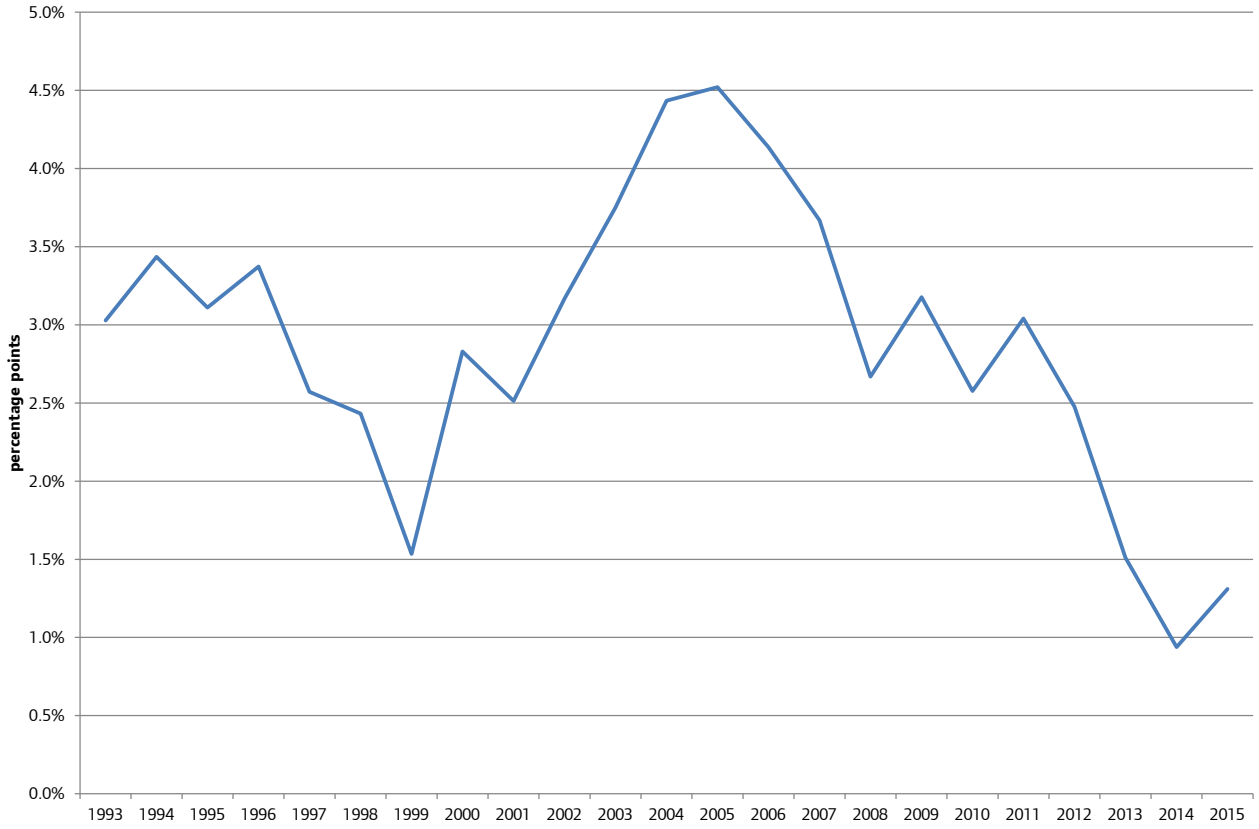
Figure 3.4: London's population aged 16-64 by economic status, 1992-2015, four quarter averages



Source: Labour Force Survey, ONS

Figure 3.5 reports on the difference between the London employment rate for 16-64 year olds and the UK rate. In the period 1993-9 the improvement in the London employment rate was faster than the UK rate, and the employment rate gap closed from 3.0 percentage points to 1.5 percentage points before rising again to 4.5 percentage points in 2005. Over the last ten years the trend has been for the gap to close, and it stood at 1.3 percentage points in 2015.

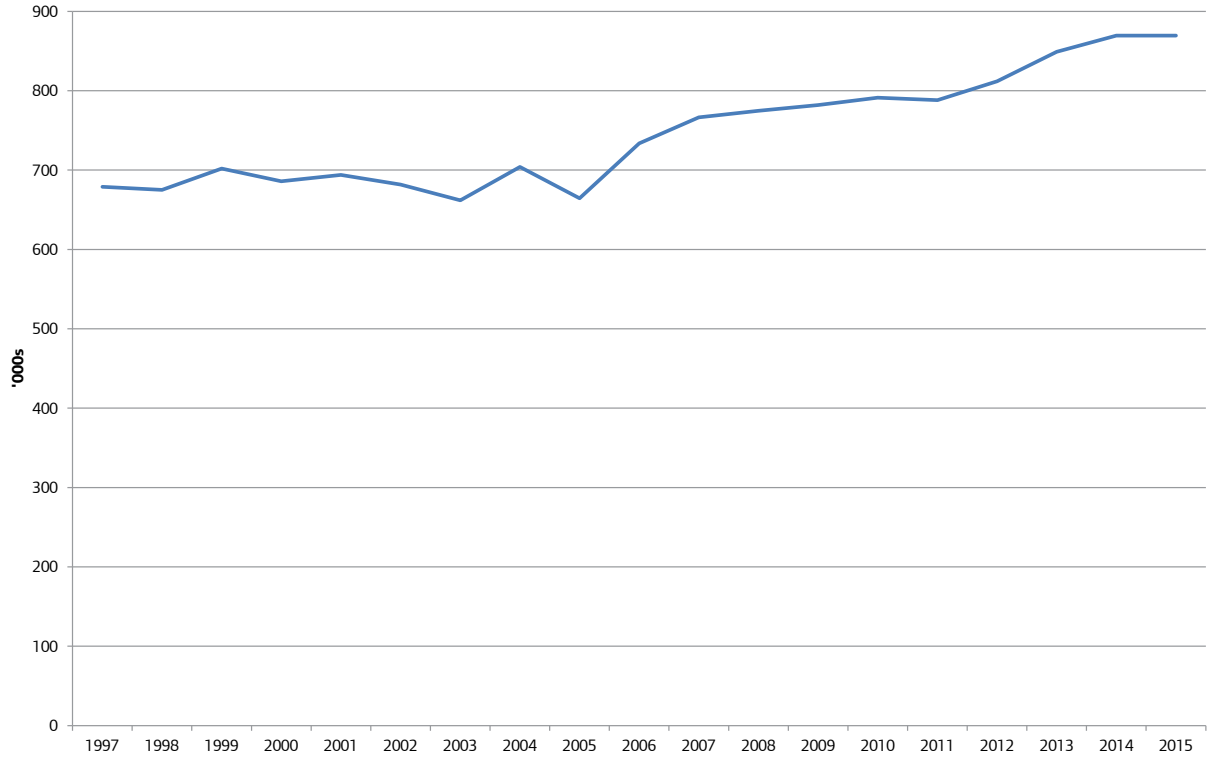
Figure 3.5: 16-64 Employment rate gap between London and UK



Source: Labour Force Survey

However, supply to London's labour market is not restricted to the population resident within its boundaries. In 2015, those that live and work in London were supplemented by over 869,000 commuters into the capital, equivalent to around 18.7 per cent of workers in London (see Figure 3.6). The increase in commuters over the last ten years may be related to a faster rate of jobs growth in London compared to other parts of the country.

Figure 3.6: Working-age (16-64) commuters to London, 1997 – 2015



Source: Labour Force Survey

London's projected supply of labour

Population projections

London's working age population (16-64) has risen from 4.5 million in 1992 to 5.8 million in 2014. It is expected to reach 6 million in 2017, and 6.8 million by 2041. This is a result of the rates-based approach used for modelling internal migration and is a feature shared with equivalent projections produced by ONS[10] (see Figure 3.7).

Box 3.2: GLA Population Projections – Methodology

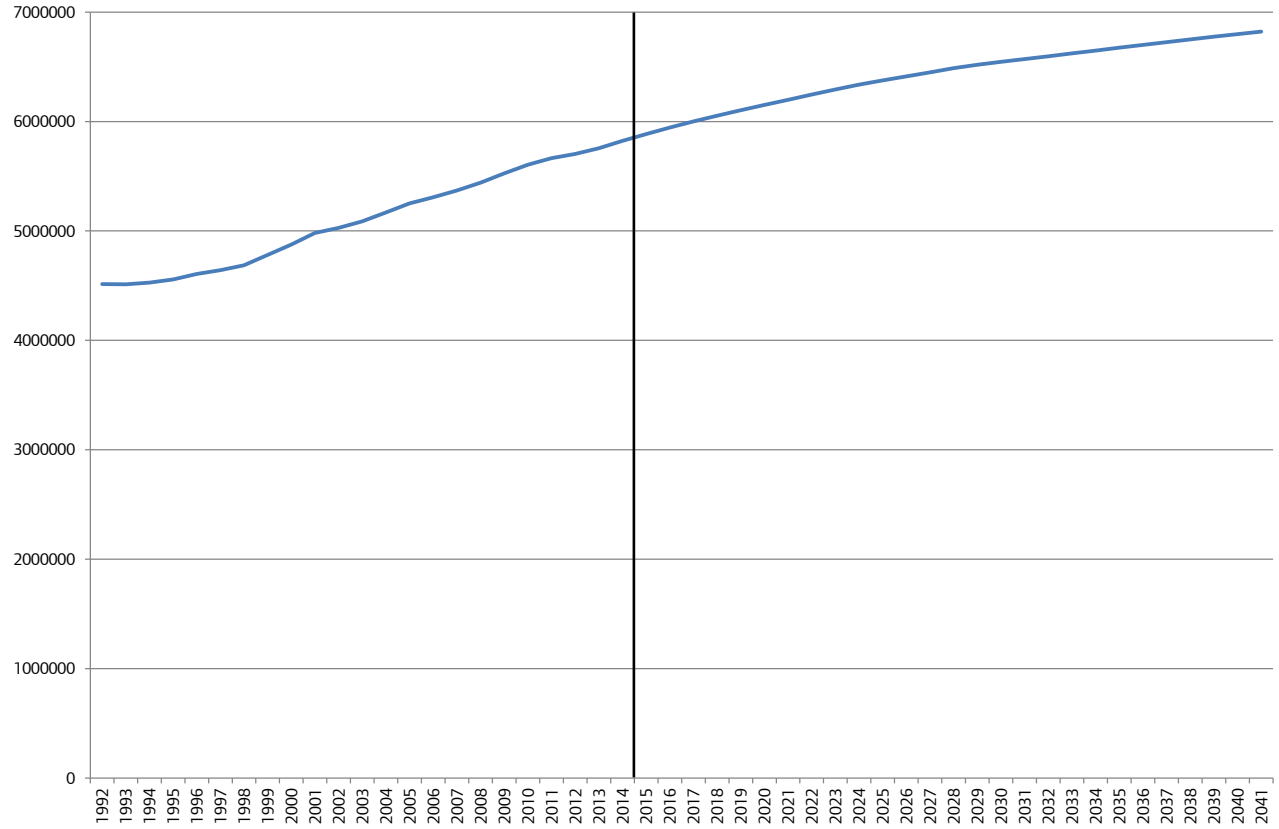
The GLA produces population projections at local authority level for Greater London. The projections are produced using a multi-region cohort component model incorporating data from ONS mid-year estimates, internal migration estimates, and national and subnational projections.

Births and deaths are projected forward by applying age-specific fertility and mortality rates to the population each year. The initial rates uses are based on recent estimates. The projected rates are modified in line with ONS assumptions about future changes in fertility and mortality rates taken from their national population projections.

With the exception of international inflows, migration is projected by applying age and sex-specific rates to the population which reflect the likelihood of a person making a move from one location to another. Projections of international inflows are based on an average of past flows rather than being rates-based. The rates and flows projected forwards are based on averages of estimated past data from 2001-02 onwards. This is in contrast to ONS's equivalent subnational projections, which typically use five to six years of past data to determine the rates projected forward. More detail on this methodology is set out in Appendix 6.

It is important to bear this feature of the projections in mind when interpreting the results of projecting London's labour market supply and its skills profile since projected shares of economic status and qualification levels are applied to these base populations.

Figure 3.7: London's population aged 16-64



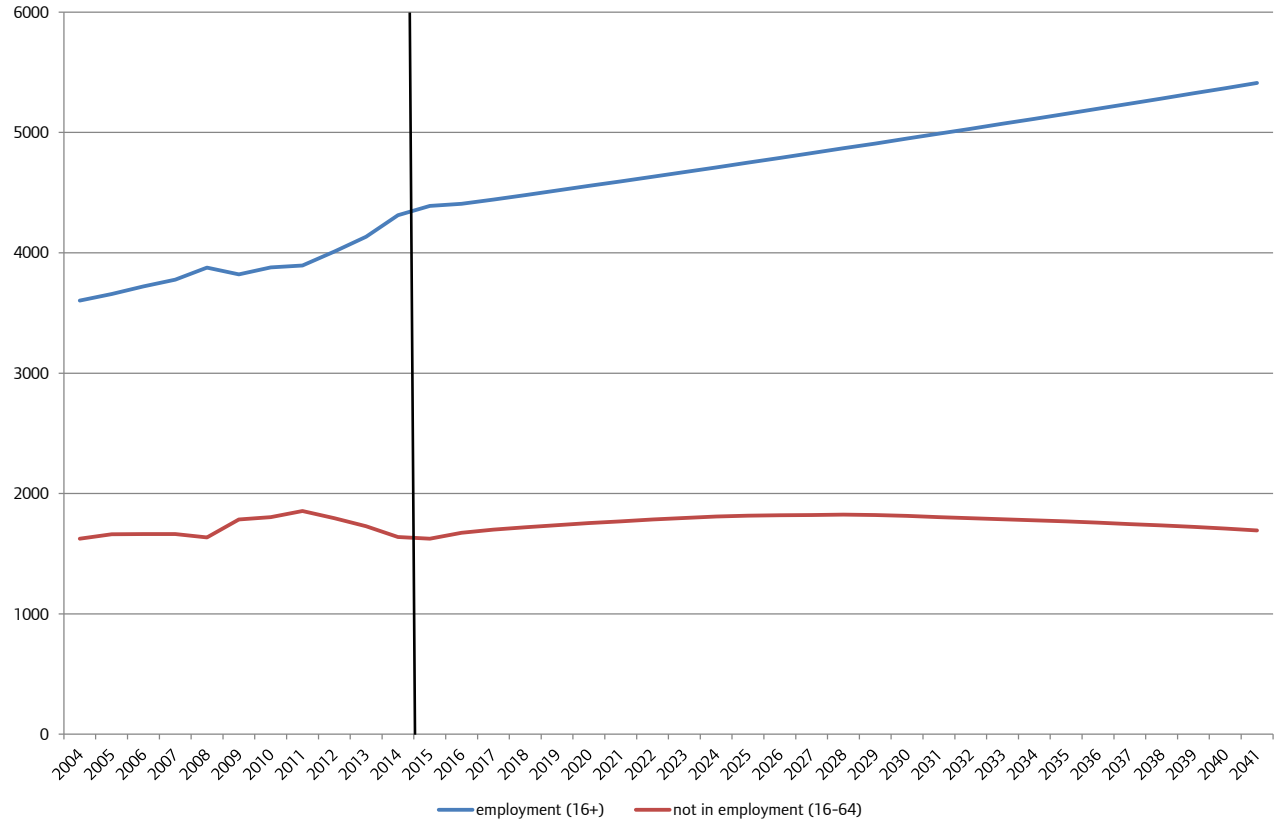
Source: ONS Mid-Year Population Estimates 1992-2000, GLA Population Projections 2001-2041

Economic activity projections

The earlier sections have identified developments within the last ten years which increase the uncertainty around a set of economic activity projections notably changes which may affect the point at which people retire, and the narrowing of the gap in employment rates between London residents and the UK population. While these developments help explain a rising employment rate it is not clear to what extent recent developments will continue over the next 25 years. Against this there has been a decline in economic activity amongst younger people whose participation rates in higher education have risen sharply. The expectation is that this cannot continue at the same rate, and so the dampening effect on the overall employment rate from lower activity will diminish. This, again, is by no means certain. This paper provides economic activity projections which project forward recent trends to inform discussion about how the London population might respond through increased labour supply to rising labour demand, and the role that might be played by commuting. While both factors have played their part in helping to fill additional jobs over the last ten years this analysis is indicative rather than definitive in suggesting what may happen in the future.

Over the period 2014 to 2041 employment of London residents is expected to continue to rise with the working age population, and at a faster rate (Figure 3.8)[11]. Of the 1.1 million more people in work 155,000 will be 65 or over. It is likely that some of these people will work outside London, while others will commute into London to fill the available jobs. The remaining part of the working age (16-64) population, that is the unemployed or economically inactive, increases slightly by 50,000 over the period.

Figure 3.8: Changes in economic activity of London residents 2004-2041



Source: ONS Labour Force Survey, and GLA Economics projections

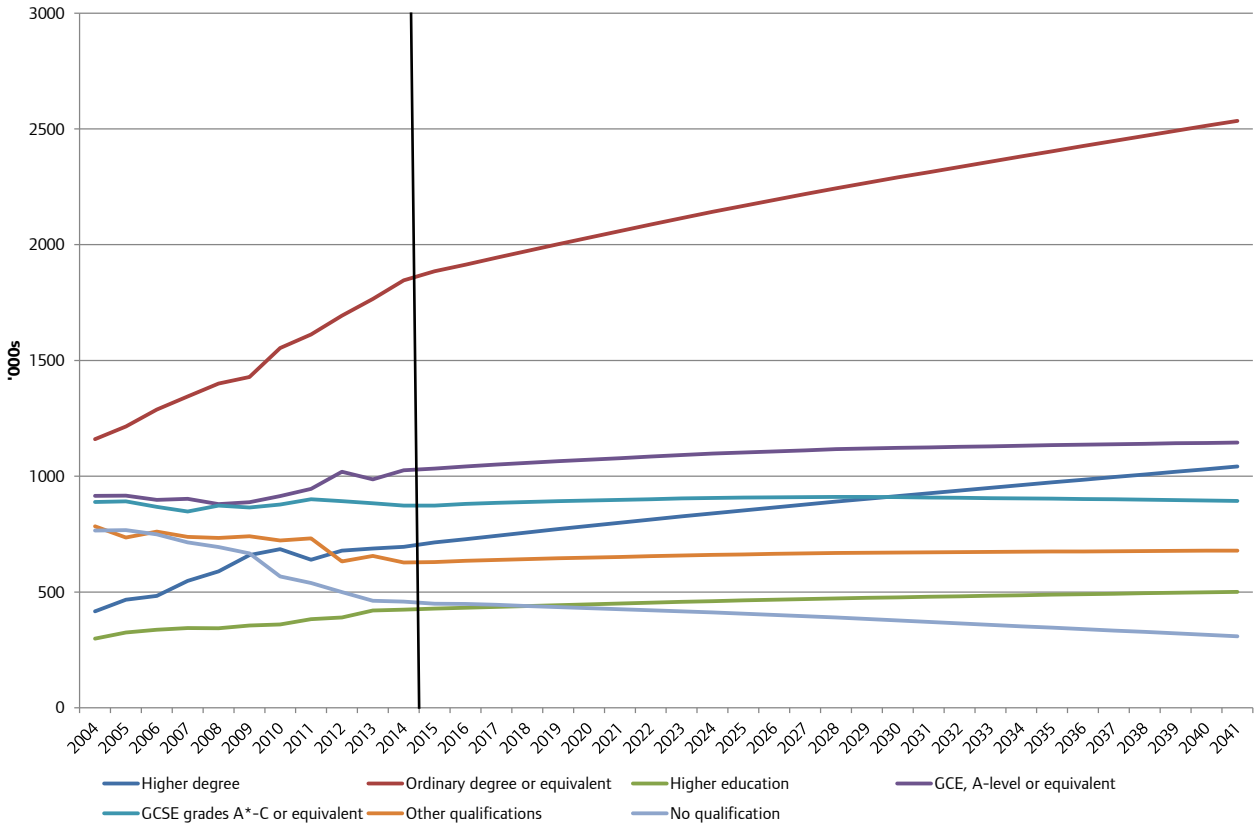
Qualification projections

These projections are also indicative as they make use of the labour supply projections, and reflect current trends in the acquisition of qualifications in the London population. As noted earlier, changes to the approach to collecting data on people's highest educational qualifications in 2011 resulted in a structural break in the qualifications time series (see Appendix 5 for more details).

Qualifications of the working age population

London's supply of labour will be more highly qualified in 2041 than it was in 2014. As Figure 3.9 and Tables 3.1 and 3.2 show, the strongest growth in terms of qualifications will occur in the higher and ordinary degree categories with average annual growth rates of 1.5 and 1.2 per cent respectively. This growth will yield an increase of more than 1,036,000 individuals qualified to at least ordinary degree level between 2014 and 2041. The only qualification category to see a decline in numbers over this period is the no qualification group, where an average year on year change of -1.5 per cent will lead to a reduction of 150,000 in the numbers of people who do not have qualifications by the end of the period.

Figure 3.9: Changes in qualification of the population aged 16-64 and 65+ in employment, London, 2004 – 2041



Source: GLA estimates and projections based on data from the Labour Force Survey and the Annual Population Survey, ONS

Table 3.1: Average year on year change in numbers within qualifications, population aged 16-64 and 65+ in employment, London, 2014-2041, per cent

Higher degree	Ordinary degree or equivalent	Higher education	GCE, A-level or equivalent	GCSE grades A* - C or equivalent	Other qualifications	No qualification	Total
1.5%	1.2%	0.6%	0.4%	0.1%	0.3%	-1.5%	0.7%

Source: GLA Projections

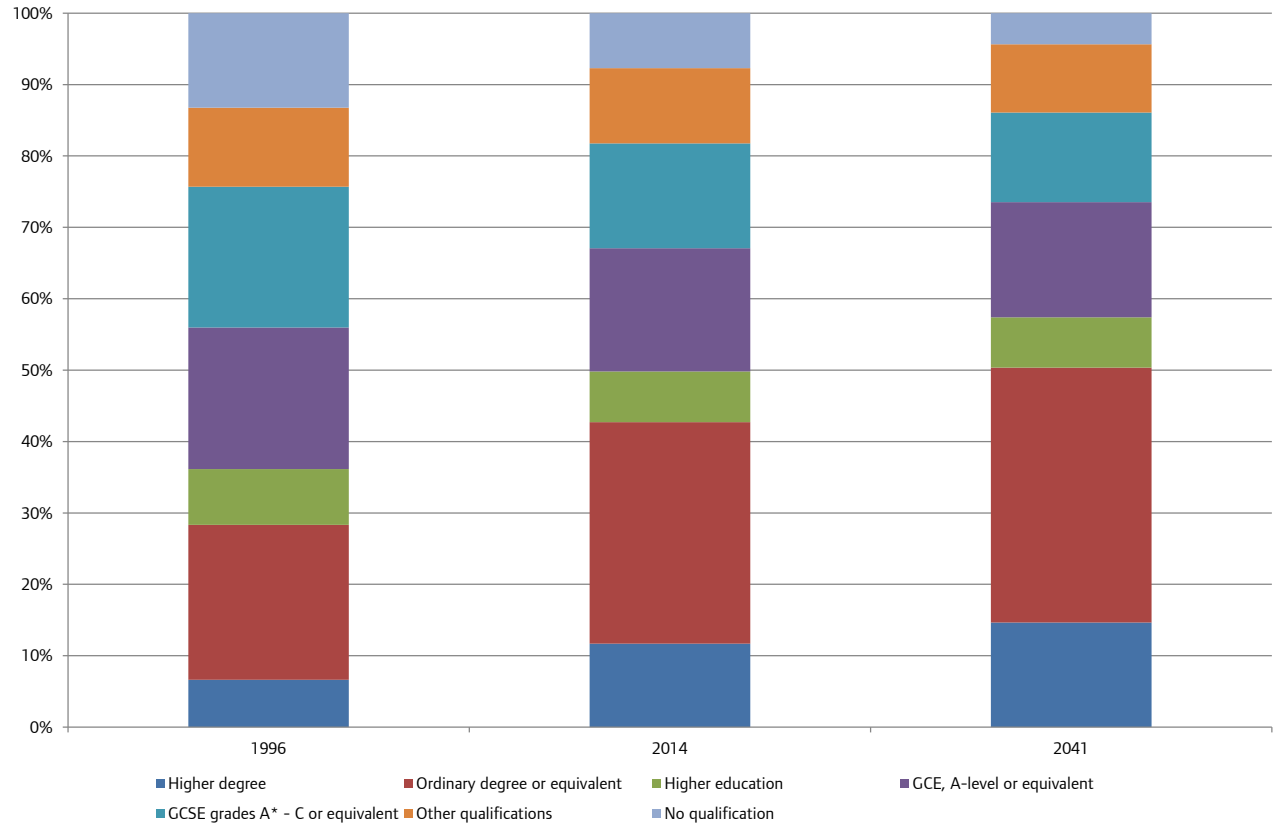
Table 3.2: Absolute change in qualifications of the population aged 16-64 and 65+ in employment, London, 2014-2041, thousands

Higher degree	Ordinary degree or equivalent	Higher education	GCE, A-level or equivalent	GCSE grades A* - C or equivalent	Other qualifications	No qualification	Total
347	689	77	119	20	52	-150	1154

Source: GLA Projections

As a result of the above, the two qualification categories which see the largest increases in their share of the total are ordinary and higher degree (Figure 3.10). In 1996, the two categories accounted for 28 per cent of the total. By 2014, 43 per cent of the population aged 16-64 or 65+ in employment were qualified to at least ordinary degree level and by 2041 this will increase still further to 50 per cent. In contrast the largest reduction in terms of qualification share will be those with no qualifications. The proportion without any qualifications will have more than halved from its 1996 share of 13 per cent to 4 per cent in 2041.

Figure 3.10: Qualification share as a percentage of population aged 16-64 and 65+ in employment, London, 1996, 2014, 2041

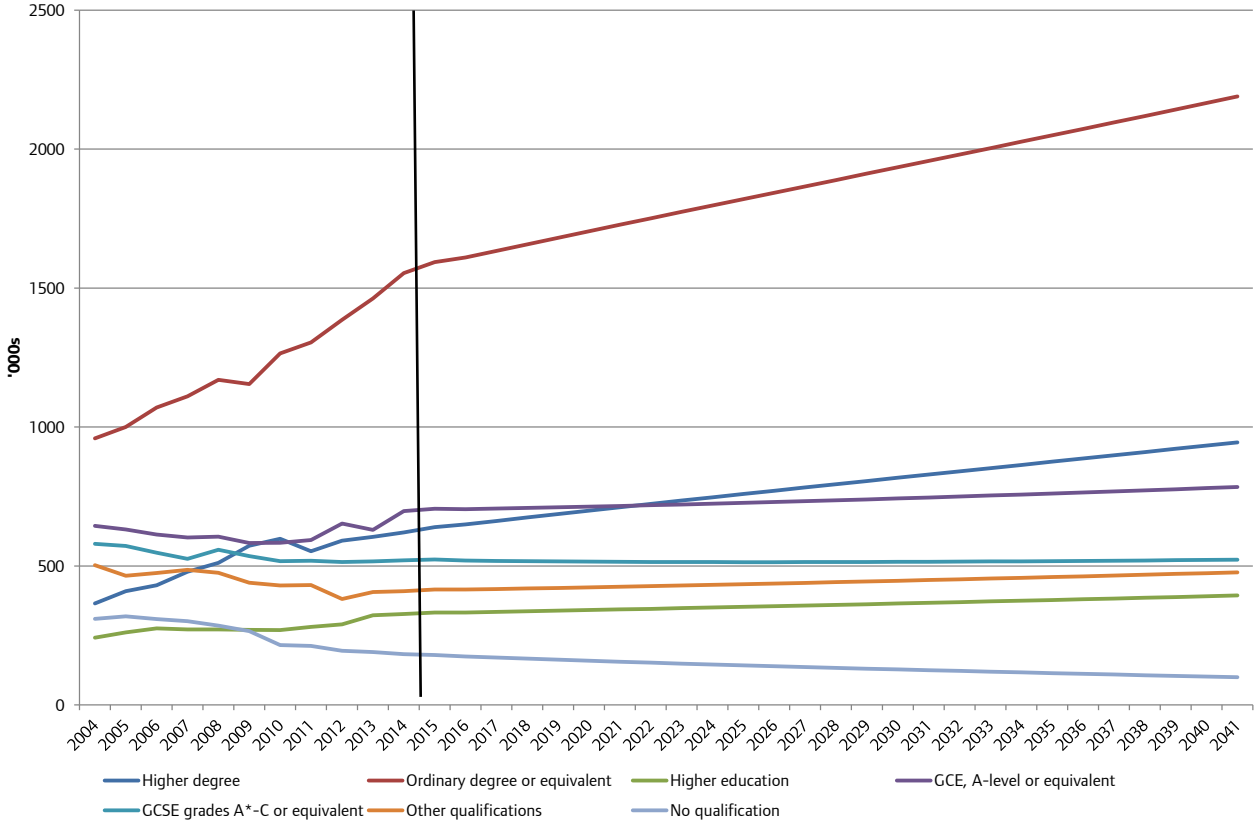


Source: GLA estimates and projections based on data from the Labour Force Survey and the Annual Population Survey, ONS

Qualifications of the in-employment group

There are significant differences within the population in terms of skills profile, with those in work more highly qualified than those who are not in work (Figure 3.11 and Tables 3.3 and 3.4). As noted earlier, the number of Londoners in work is projected to increase in absolute terms over the projection period. For instance, those qualified to at least ordinary degree level are projected to increase by 960,000, however, those who do not have qualifications are projected to see a fall in absolute terms of 80,000.

Figure 3.11: Changes in qualification of the in-employment population, London, 2004 – 2041



Source: GLA estimates and projections based on data from the Labour Force Survey and the Annual Population Survey, ONS

Table 3.3: Average year on year change in numbers within qualifications, in-employment population, London, 2014-2041, per cent

Higher degree	Ordinary degree or equivalent	Higher education	GCE, A-level or equivalent	GCSE grades A* - C or equivalent	Other qualifications	No qualification	Total
1.6%	1.3%	0.7%	0.4%	0.0%	0.6%	-2.2%	0.8%

Source: GLA Projections

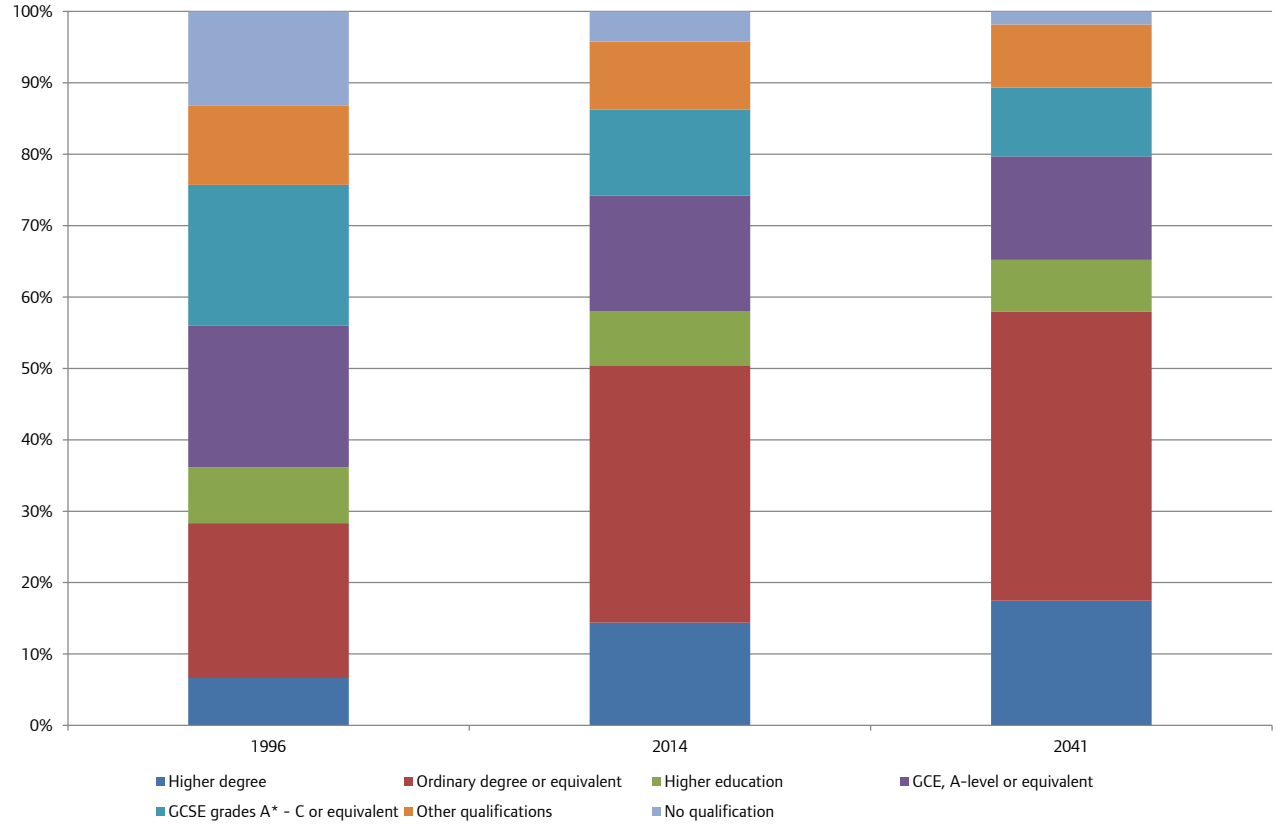
Table 3.4: Absolute change in qualifications, in-employment population, London, 2014-2041, thousands

Higher degree	Ordinary degree or equivalent	Higher education	GCE, A-level or equivalent	GCSE grades A* - C or equivalent	Other qualifications	No qualification	Total
324	635	67	86	3	68	-83	1100

Source: GLA Projections

In 1996, taken together, those with an ordinary or higher degree accounted for less than 30 per cent of the total in-employment population, by 2014 this had risen to 50 per cent, reaching 58 per cent in 2041. Again those with no qualifications is projected to see the largest proportional fall in their share of the in-employment total going from 13 per cent to 2 per cent between 1996 and 2041 (Figure 3.12).

Figure 3.12: Qualification share as a percentage of in-employment population, London, 1996, 2014, 2041



Source: GLA estimates and projections based on data from the Labour Force Survey and the Annual Population Survey, ONS

4. Assessment of the balance between demand and supply of labour in London

Main findings

- The employment projections show an increase in the number of jobs in London of 1,200,000 between 2015 and 2041.
- London's working age population, is projected to increase by 1,000,000 between 2014 and 2041.
- Taking account of potential future trends in the employment of older workers and commuting, suggests that the level of jobs projected for London's economy and the population projections are largely consistent with a balanced labour market (in terms of quantities).
- The employment projections show an increase in the number of jobs requiring degree level or higher qualifications of 985,000 between 2014 and 2041.
- The number of London residents qualified to degree level or higher and in employment is projected to increase by 960,000 between 2014 and 2041, allowing for potential future trends in the employment of older workers.
- This suggests that the level of jobs projected for London's economy and the population projections are largely consistent with a balanced labour market (in terms of quantities), recognising that there is also commuting in and out of London.

Introduction

This section brings together the employment projection analysis set out in Section 2 and the population projection analysis set out in Section 3 to consider the extent to which the demand for and supply of labour are in balance over the projection period.

Overall balance of demand and supply for labour

The employment projections set out in Section 2, show an increase in the number of jobs in London of 1,200,000 over the projection period.

Section 3 shows that London's working age (16-64) population is projected to increase by almost 1,000,000 over the 2014 to 2041 period. The economic activity assumptions used in that Section suggests this breaks down into an increase of 1,100,000 more London residents in work, of which there is an increase in employment of 155,000 of the 65+ age group, and also a rise of 50,000 in residents not in employment.

It is also the case that some individuals hold more than one job, and that some jobs will be taken by people commuting into London, offset by some London residents working outside the city. The means by which the London labour market will be in balance will depend on these factors, and ongoing

trends in labour market participation. This analysis, suggests that, broadly speaking, the employment projections and population projections do not appear to be wildly inconsistent with one another in terms of London's future labour market balance.

The demand and supply for degree or higher qualifications

In terms of qualifications, the employment projections suggest an increase in demand for degree or higher level qualifications of 985,000 over the projection period. The population projections suggest an increase in the number of London residents at degree or higher, in-work, of 960,000.

Again, this suggests that current employment trends in London, if maintained, would be sufficient to meet the demand for 'extra jobs' requiring higher qualifications.

Whilst, the mechanism by which the labour market will be in balance in 2041 will depend on a range of factors, this analysis suggests that, broadly speaking, the employment projections and population projections do not appear to be wildly inconsistent with one another in terms of London's future labour market balance at this qualification level.

Glossary

Claimant count unemployment
The claimant count records the number of people claiming Jobseeker's Allowance (JSA). People claiming JSA must declare that they are out of work but capable of, available for, and actively seeking work during the week in which the claim is made. This administrative measure will be affected by the forthcoming transition to Universal Credit.

Claimant count unemployment rate
The number of claimant count unemployed residents in an area expressed as a percentage of the sum of claimants and workforce jobs in the area. Published at national or regional level.

Commuter
In this document a commuter is someone who crosses over the Greater London boundary for the purposes of accessing a workplace on a regular basis.

Default Retirement Age
Between October 2006 and September 2011 a Default Retirement Age of 65 was in force, meaning that employers could not retire employees below age 65 unless the decision could be 'objectively justified'. In October 2011, the Default Retirement Age was abolished and it became illegal to retire an employee of any age without objective justification.

Demography/Demographics
Demography refers to the scientific discipline that deals with aspects of population – including change, births, deaths, and migration. It often involves making projections of future populations levels and structural compositions.

Economic activity
Economically active people are those adults who are actively engaged in the economy and are in, or are seeking work. In strict terms we include people of working age who are either in employment, or are unemployed but actively seeking work and are available for work.

Economic activity rate
The economic activity rate is the proportion of a population engaged in economic activity. It is conventionally measured by dividing the economically active by the population of working age. Activity rates can also be calculated for specific groups such as males or females or for age groups.

Economic growth
The increase in the value of goods and services produced by an economy and usually measured (at the London level) by GVA.

Economic inactivity
Economically inactive people are those adults who are not employed or actively engaged in seeking work such as retirees, students, people looking after the family home and the sick and disabled. In strict terms, the economically inactive includes those not in employment, not classified as unemployed (by the ILO measure), or not either actively seeking work or available for work.

Economic inactivity rate
The economic inactivity rate is the number of economically inactive people expressed as a percentage of the total working age population. It can be calculated for any population group.

Employee
Someone who works for a person or organisation other than themselves. The relationship between employee and employer is usually defined by a contract of employment, which sets out the obligations of each party. An employee job is one held by an employee, or which is vacant, waiting to be filled. An employee may hold more than one employee job (e.g. two part-time jobs).

Employment
Generally, employment includes both those who are contracted into employment (employees) and the self-employed. There are also two ways of looking at employment: the number of people in employment or the number of jobs. These two concepts represent slightly different things, as one person can have more than one job. People aged 16 or over are classed as employed by the Labour Force Survey (LFS), if they have done at least one hour of work in the reference week surveyed or are temporarily away from a job (e.g. on holiday). Employed people can be classified into one of four categories: employees, self employed, unpaid family worker (doing unpaid work for a family-run business) or participating in a government supported training programme. Much of the demand side analysis in this document uses the concept of jobs.

Employment rate
Employment rates can be presented for any population group as the proportion of that group who are in employment. The main presentation of employment rates is the proportion of the population of working age who are in employment.

Expansion demand
Expansion demand is the need for new employees as a result of net growth in economy. It is a product of both expansion and contraction in total employment in employing organisations. For example, if in the London economy the manufacturing sector decreased employment by 30,000 employees, yet the financial services were expanding their total number of employees by 80,000 – the economy's total expansion demand would be the difference of the two: 50,000 employees.

Forecasting
Forecasting is concerned with the production of estimates of future events. They can be based on the output of econometric models, based on previous performance and patterns, assumed to be a guide to the future, or they can be based on individuals' (e.g.employers, analysts) views on what is likely to happen. Forecasts should always be used with care, increasingly so as they become more detailed or localised, or try to look further into the future. It is never possible to predict the future with absolute certainty: there are many uncertainties, as well as gaps in our knowledge and understanding of past and present performance as a guide to future events. Sudden shocks or changes are also by their nature unpredictable.

Gross value added (GVA)
GVA is the total value of output of goods and services produced in an area less 'intermediate consumption' (the value of goods and services used to produce the output).

Household
A single person or group of people living at the same address as their only or main residence, who either share one meal a day together or share the living accommodation (i.e. a living room).

Human capital
Human capital is a loose catch-all term for the practical knowledge, acquired skills and learned abilities of an individual that make them potentially productive and thus equip him or her to earn income in exchange for labour. Varying levels of past investment in human capital provides one of the main explanation for the size of wage and salary differentials among individuals.

ILO unemployment
The ILO (International Labour Organisation) definition of unemployment is the internationally agreed definition, used by the Statistical Office of the European Union (Eurostat), the Organisation for Economic Co-operation and Development (OECD), and many other countries, including the UK. Under ILO guidelines, all people aged 16 and over can be classified into one of three states: in employment; ILO unemployed; or economically inactive. ILO unemployed people are:

- without a job, want a job, have actively sought work in the last four weeks and are
- available to start work in the next two weeks or
- out of work, have found a job and are waiting to start it in the next two weeks.

In general, anybody who carries out at least one hour's paid work in a week, or who is temporarily away from a job (e.g. on holiday) is in employment. Those who are out of work but do not meet the criteria of ILO unemployment are economically inactive.

Index
A method of showing numbers relative to a fixed base (often 1 or 100). In labour market data, it is often used to show changes in a variable (e.g. unemployment) in different areas over a period of time, starting from a fixed point, e.g. January 2010. Using employment as an example, if an index over three years were created, with January 2010 chosen as the first point (i.e. set as 100), and unemployment halved over the period to January 2012, the index value at that point would be 50.

Industry
Industry is used in economics terms to categorise the activity of an employing organisation and is also referred to as a sector of the economy.

Labour demand
Demand is generally the quantity of a good or service that people wish to buy. Labour demand refers to the total number of workers or even working hours required by employers, and is usually measured in this document by the number of jobs. Demand is influenced by the customer's (employer's) purchasing power, the price of the good or service (the wages and other costs of employing someone) and the availability of alternatives (e.g. machines).

Labour force
The labour force is the number of people potentially available for work and is sometimes also called the economically active population. The size of the economically active population is given as those people on the labour market at any time, and includes those in work and those seeking work. It does not have to be restricted to working age people. Often, some people that are older than retirement age remain economically active.

Labour market

Labour refers to actual and potential people's input into economic production. Actual in terms of people in work, potential in terms of people who are not in work but could notionally work. A market is an organised exchange between buyers and sellers of a good or service. The labour market is the mechanism, or market place in which buyers and sellers of labour engage. The term labour market is not so strictly defined in practice and usage though – it is used widely in its broadest sense to cover a wide range of issues that are concerned with labour and the market for labour over time, and generally is concerned with elements of labour supply and labour demand, and how these interact. For example, we are still interested in children and the subjects they study as this has implications for labour supply in the future.

Labour supply

The labour supply is made up of the total of workers making their services available to employers. The supply of labour is determined by a number of factors, including the population of working age, their economic activity rate, the number and nature of available jobs, wage levels and the influence of alternative sources of income. Individuals can offer varying levels of times and days they will work, skills and experiences they can potentially provide an employer with, or attach various conditions to making their labour available (such as working hours, pay and other benefits).

Labour turnover

Labour turnover is the total of both the inflow and outflow of workers employed by an enterprise. Workers may leave an employer for reasons of changing job, caring responsibilities, retirement, or even death. Employers may dismiss their employees because of poor performance, or because they are no longer required due to changes in technology or demand. Even where a company's headcount is static, a significant percentage of the workforce will often leave and be replaced over the course of a year.

London Plan

The Mayor's spatial development strategy for Greater London.

Migration

Migration is the movement of people between different areas. There can be "push" and "pull" reasons for migration. In labour market usage, the availability of suitable employment opportunities is a major factor influencing migration.

'Not in work'

All those of working age who are either unemployed or who are in some way economically inactive. This is a far wider definition than just those who are 'unemployed'.

Occupation

Occupation is a classification or description of a job, type of job, job title or job role. For example, 'nursing' would be described as an occupation. When discussing occupations, their names usually infer details about the kind of work performed or job – a set of tasks or duties, usually structured by employers; and the levels and types of skill deployed in the job.

Officially, the UK government sets out systematic classifications of occupations in its Standard Occupational Classification (SOC). When analysing the labour market and aspects of employment, SOC is often used to divide up people or employees by the types of job they do.

Office for National Statistics (ONS)

The Office for National Statistics is the UK government agency responsible for collection and publication of official statistics. In 2008, ONS became independent and answerable to the UK Statistics Authority. As the UKs largest statistical producer, it is at the centre of the UK statistical system. A wide range of information, guides and statistics can be accessed at: http://www.ons.gov.uk/ons/index.html

Productivity

The value of output (goods and services) produced per unit of input (productive resources) used. Thus an increase in productivity means producing more goods and services with the same amount of resources, or producing the same goods and services with fewer resources, or some combination of these two possibilities. While productivity is often measured or referred to only in terms of the productivity of labour (output per man-hour), a more precise and complete view of the sources of productivity incorporates the effects of all inputs to production, including capital, land and materials.

Projections

Projections is a term often used to refer to estimates of future values of future performance of the economy. Projections can commonly be an extension of existing trends. They are commonly differentiated from forecasts - which may include fluctuations and cycles - by being linear and constant. Projections are often used for demographics, which are much less subject to short-term fluctuations and changes than business and economic trends.

Qualifications

In a labour market context, a qualification is an endowment or achievement (often formally certified) that demonstrates an individual's competence and proficiency in a specified area of activity. Qualifications are often used as conditions of entry to particular jobs, and sometimes as a proxy for measuring the broader and more amorphous concept of skills. However, not all skills require or lead to qualifications, and vice versa.

Replacement demand

Replacement demand is demand for new employees created by the need to replace employees that permanently leave their jobs because they retire, are deceased, migrate from the area, or move to another occupation.

Sampling error/variability

When surveys of people, organisations and businesses, are conducted most of the time only a proportion of them are surveyed. It is often unrealistic to survey absolutely everyone – they may not all respond and reply, and it may be too costly. So a sample of the population is taken and the results are interpreted as indicative of the whole population. However, there is a risk that surveying a subset of the population cannot be guaranteed to be exactly representative of the full group's views, actions, or characteristics. Therefore there is the likelihood of some kind of variability or sampling error. Careful design of surveys and choice of sampling techniques can reduce the likely extent of variability but it can never be eliminated. The likely size of sampling error can be estimated using mathematical and statistical techniques.

Seasonally adjusted

Features of the labour market that statistics are collected on, such as unemployment are affected by seasonal influences like weather, the opening and closing of schools, holidays and other seasonal events. Seasonal events will hide underlying trends that could be significant for interpreting an economic time series. Removal of seasonal influences from the statistical counts should allow for assessing only the real changes over time, thus allowing for a better analysis of the more important underlying reasons for month-to-month changes.

Self-employment

Self-employed individuals work for themselves and generally pay their National Insurance themselves. The self-employed can be sole traders, or business owners, including partners. Unlike those with employee-status jobs, the self-employed generally will not have a formal contract of employment with the organisation contracting their services.

Skill(s)

At its broadest level, a skill is a special ability to do something. In the context of the labour market it relates to a special ability to perform a task in work. In defining what a skill is, it is not a clear and unambiguous concept – for example a skill may be a personal characteristic such as friendliness (for use in work tasks that require customer contact); or it may be learnt such as numeracy. A skill can be simple and easy to learn, or it may be very complex and require many years to learn.

As a result, skills can be difficult to measure – qualifications are sometimes used to indicate types and levels of skill, but the two concepts are not the same. An individual can have a skill without it being represented by a qualification. Some skills are hard to accredit to qualifications, especially personal characteristics or attributes.

Standard deviation

The standard deviation offers some measure of the 'closeness of fit' of a calculated average to the population or set of values that it is calculated from. For example, calculating the standard deviation in the weekly hours of full time employees will show how well the average (40 hours in 2002) captures the diversity of working weeks: if the cases are clustered together (i.e. most people work close to the average of 40 hours), the standard deviation is small. When the examples are spread far apart (i.e. if the average is based on a wide variety of results) there is a large standard deviation.

Standard error

The standard error is an estimate of the scale of the standard deviation, and a means of expressing the accuracy and reliability of results from a random sample survey. The standard error of a statistic depends on the sample size. In general, the larger the sample size the smaller the standard error, although the error cannot be completely removed.

Standard Industrial Classification (SIC)

Standard Industrial Classifications (or SIC) is a method of classifying industries into certain groups or categories by activity according to an established standard set by the UK government. The Standard Industrial Classification sometimes uses letters or codes as shorthand to describe the type of industry – for example, you may find an industry referred to as SIC61 rather than by its name or title (Telecommunications). This analysis has used SIC(2007).

Standard Occupational Classification (SOC)

The Standard Occupational Classification (SOC) is a classification system used to define occupational areas and job types according to an established standard set by the UK government. The structure of the SOC is based on two main concepts:

- the kind of work performed or job – a set of tasks or duties, usually structured by employers
- the concept of skill – defined for as the skill level - the complexity of the tasks and duties to be performed; and skill specialisation – the field of knowledge required for competent, thorough and efficient conduct of the tasks.

State pension age
The age at which someone can claim a state pension, although people can choose to defer the receipt of their state pension beyond this age. Currently the state pension age for men is 65. It was 60 for women until 5 April 2010, but women's state pension age began to increase thereafter and will reach 65 by November 2018. In reality, people do not necessarily retire at state pension age – they can and do retire if they are younger or older.

Time series data
Time series data are values or results obtained over intervals of time. They are usually gained from the measurement of one variable (e.g. the number of people in employment), using the same method over consistent intervals of time. An example of time series data would be the Labour Force Survey (LFS) results that have been used to track unemployment on a consistent basis every quarter since 1992.

Training
Training is the process of coaching in or accustoming an individual to a mode of behaviour or performance; or to make proficient with specialized instruction and practice. In the labour market context it refers to the process of improving workforce skills, either by employer instruction or by educational institutions, on or off the job, and with or without formal qualifications.

Unemployment
Unemployment, in terms of its use to describe a group of people whom we may be concerned about, it is more correctly described as 'people who are not in work or employment but who want to work'. However, there are a variety of ways of precisely classifying and measuring it. Unemployment has long been one of the most difficult and contentious of labour market statistical measures. In the UK there are two key statistical measures of unemployment - that of the International Labour Organisation (ILO) and the Claimant Count.

The most widely recognised definition of unemployment is that of the ILO, the measure used by the Labour Force Survey. This records as unemployed, those who have undertaken no paid work in reference week (i.e. when they are interviewed), are starting, or are available to start work in the next fortnight and have actively sought work in the preceding four weeks. No account is taken of the individual's age, family status or eligibility for unemployment related benefits. This definition is commonly referred to as ILO unemployment.

The Claimant Count is an administrative measure of those eligible for unemployment related benefits, i.e. Jobseekers Allowance, National Insurance credits. Those eligible for these benefits do not include all those in the ILO measure and the eligibility criteria for the relevant benefits have been altered over time. Therefore, the claimant count is often seen as a partial measure of unemployment. It is, however, free from sampling errors (it is a 100% count) and is available for very small geographical areas and by age and duration of benefit claim.

Unit wage costs
The Office for National Statistics calculates unit wage costs as the average of total wages and salaries per job.

Wages
Wages (and earnings) relate solely to financial income from paid work, e.g. salaries and bonuses but not including non-financial perks. These terms are not synonymous with income, which is a more widely encompassing definition, including benefits, share dividends and bank/building society interest, etc. Only limited official information is available on earnings at the local level, mostly related to average hourly and weekly earnings.

Workforce
The number of people available for work. A generic term that can be used in reference to a country or area, a particular type of work, or even an individual organisation.

Workforce jobs
Workforce jobs are calculated by summing employee jobs, self-employment jobs from the Labour Force Survey, HM Forces and government-supported trainees. They are a measure of jobs rather than people. For example if a person holds two jobs, each job will be counted in the workforce jobs total.

Working age
Working age is defined in this work as all those aged between 16 and 64.

Workplaces
A specific site or geographic location where people are employed. Workplaces differ from enterprises, employers or organisations - which may be a collection of workplaces controlled from a central point. This can affect the way statistics are gathered: for example, employees at a local workplace may be recorded by their employer's registered address, which may be in a different area.

Office for National Statistics data sources

Annual Population Survey (APS)

The APS uses data combined from two waves from the main Labour Force Survey (LFS) with data collected on a local sample boost. The data sets comprise 12 months of survey data and are disseminated quarterly. The achieved sample size is approximately 320,000 respondents. The APS provides information on the same topics as the LFS but, because of the larger sample size, more detailed breakdowns can be produced including analyses of industry sector and occupation at the London level.

Business Register Employment Survey (BRES)

BRES publishes employee and employment estimates at detailed geographical and industrial levels. It collects comprehensive employment information from businesses in England, Scotland and Wales. Independently collected Northern Ireland data are then combined to produce estimates on a UK basis. BRES uses the IDBR as its sampling frame.

BRES is regarded as the definitive source of employee and employment statistics by industry. Employment is obtained by adding the number of working owners to the number of employees employed by a business. In terms of data, the survey sample of approximately 80,000 businesses is weighted up to represent the GB economy covering all sectors.

One of the strengths of BRES is that estimates are provided at detailed geographical levels. It should be noted BRES is a sample survey and produces estimated employment figures. These estimates are of a good quality at higher levels of geography (for example region), but the quality of the estimates deteriorates as the geographies get smaller.

BRES is an annual publication. The first BRES estimates were for 2009 and were published in December 2010. Both BRES, and the Annual Business Inquiry part 1 (ABI/1) which it replaced, are snapshots; they are not designed to be used as time series figures.

Inter Departmental Business Register (IDBR)

The IDBR is a list of about two million businesses registered in the UK and contains data on employment, business size and financial performance. It is used for selecting samples for surveys of businesses and to produce analyses of business activity, location and size. It is maintained largely by updates from HM Revenue & Customs, Companies House and surveys conducted by ONS specifically for maintaining the Register.

The IDBR covers all parts of the economy, but misses some very small businesses and some non-profit making organisations. It provides more than 99% coverage of economic activity. For research purposes, the IDBR allows detailed analysis of employing organisations and workplaces in terms of numbers of enterprises, employment and turnover. Further analysis can be undertaken by industrial classification, location and legal status.

Labour Force Survey (LFS)

The LFS is the largest regular household survey in the UK. It collects information about the personal and economic circumstances of those interviewed, including age, gender, employment and unemployment, skills and qualifications and pay.

The sample is made up of approximately 41,000 responding UK households per quarter. Respondents are interviewed for five successive waves at three-monthly intervals and 20% of the sample is replaced every quarter. The LFS is designed to be representative of the entire population of the UK.

The LFS is conducted using standardised techniques under the auspices of the International Labour Organisation (ILO), making EU and international comparisons possible. It provides the official measure of unemployment using the ILO definition (see Glossary).

Mid-Year Population Estimates

The Mid-Year Population Estimates refer to the population that is usually resident on 30 June of the reference year. They are published annually. This product is the official set of population estimates for the UK and its constituent countries, the regions of England and Wales and for local authorities, consisting of a consistent time series of annually published estimates from 1981 onwards. The estimates are compiled using the cohort component method and a combination of registration, survey and administrative data sources.

Estimates for Mid-2011 are based on results of the 2011 Census, updated to the mid-year reference date. Estimates for Mid-2002 to Mid-2010 for England and Wales have been revised in line with the 2011 Census and were published on 13 December 2012. Revisions for estimates at sub-national level are planned for publication in Spring 2013.

Regional Gross Value Added (GVA) statistics

Regional Gross Value Added (GVA) is a legal requirement of the European Union (EU) statistical body, Eurostat. Estimates are compiled in compliance with the European System of Accounts 1995 and are consistent with the standards set out in the United Nations System of National Accounts 1993. They are published annually in December.

GVA is the value generated by any unit engaged in the production of goods and services. It is measured at current basic prices, excluding taxes (less subsidies) on products. GVA plus taxes (less subsidies) on products is equivalent to Gross Domestic Product (GDP).

Regional GVA is measured using the income approach, which involves adding up the income generated by resident individuals or corporations in the production of goods and services. It is calculated gross of deductions for consumption of fixed capital, which is the amount of fixed assets used up in the process of production in any period.

The GVA estimates are shown by Nomenclature of Units for Territorial Statistics (NUTS) regions. NUTS is a hierarchical classification of spatial units that provides a breakdown of the EU's territory for producing comparable regional statistics.

Workforce Jobs (WFJ) series

WFJ is a quarterly measure of jobs in the UK and is the preferred measure of short-term employment change by industry. It is a compound measure that draws on a range of sources and is the sum of Employee Jobs (EJ), Self-Employment Jobs (SEJ), Government-Supported Trainees (GST) and Her Majesty's Forces (HMF). The London jobs series compiled by GLA Intelligence uses the EJ and SEJ components of the WFJ series.

The WFJ series is a measure of jobs rather than people. For example if a person holds two jobs, both jobs will be counted in the total.

The components of the WFJ series come from different sources: EJ is measured primarily by employer surveys, SEJ is from the LFS and GST and HMF are from administrative sources. EJ, which is by far the largest component, comes mainly from the Short Term Employment Surveys (STES). The sample for STES is approximately 24,100 businesses per quarter. In common with other business surveys conducted by ONS, the sampling frame for WFJ is the IDBR.

Further information on ONS sources is available at:

https://www.ons.gov.uk/methodology/methodologytopicsandstatisticalconcepts/qualityinofficialstatistics/qualityandmethodologyinformation

Appendix 1: Caveats and other issues

This appendix sets out some of the most significant limitations which readers should bear in mind when considering the results from the analysis in this paper.

GVA data

Data on London's GVA is used in developing the employment projections. However, there is no official source of real GVA available at the regional level. Instead, nominal GVA data is produced by the Office for National Statistics (ONS) on an annual basis (although with a significant lag - London's nominal GVA for 2014 was released in December 2015 for example). The regional GVA series is available from 1997 onwards. As a result, a number of assumptions about London's GVA have to be made in the development of employment projections - namely how to produce a real GVA series for London for available data and how to best estimate London's GVA prior to 1997 (and for most recent data where this is not available from official sources).

Employment data

The time horizon to be considered by the next London Plan is the period to 2041 - around two and a half decades away. To project employment over this period with a reasonable degree of confidence, a significant historical period of data would be desirable. Instead, official data on London's employment over time is only available on a consistent basis back to 1996. As a result, using official data only, 20 years of historic data would be used to project employment over 20 years into the future. GLA Economics has developed a consistent employment time series for London jobs back to 1971. Whilst this provides over 40 years of historical data, this length of data is still less than ideal when projecting forward employment over a long timeframe. Similar issues are encountered when producing estimates of employment by industry sector on a consistent basis over time.

Occupation data

The ONS's Workforce Jobs series – which is the main source of data for the historical series of London jobs by sector – does not contain information on occupations. Such information has to be derived from alternative survey sources: ONS's Labour Force Survey and the Annual Population Survey. These only provide a time series for occupations on a consistent basis from 2001. In addition, whilst estimates of occupations by sector can be produced from this source, because of its sample size at the London level, some of these estimates are subject to significant sampling variability. As a result, a relatively limited amount of data has been used to project occupations when compared to the employment projections. This means that the occupation projections (and the qualification projections which are derived from these projections) should be treated with even more care than the employment projections because of the additional data limitations and necessary simplifying assumptions.

Qualification data

Data on highest educational qualification is taken from the same sources as the occupation data: the Labour Force Survey and the Annual Population Survey. In 2011, the ONS improved the questions on people's educational qualifications in order to obtain more information on qualifications obtained abroad, which had previously been reported as 'other'. This produced a structural break in the time series between 2010 and 2011. To produce the consistent time series required for its projections, GLA Economics needed to find a way to deal with this structural break. It developed a method of projecting the change backwards for earlier years, making a number of assumptions (see Appendix 5).

Turnover analysis

To fully understand the dynamics of the labour market it would be useful to have data on individuals moving between jobs. Unfortunately such data does not exist. Instead, in order to provide an indication of the level of turnover in the labour market only, changes in broad occupations have been used. However, this may well underestimate the actual level of turnover in the labour market. First, this analysis does not pick up any individuals who leave their employment but subsequently take up another job in the same occupation. Second, the data source used for this analysis only looks at changes that occur over the period of a year. It may well be that many individuals change jobs or occupations more than once within the course of a single year. As a result, the thrust of the labour market turnover analysis is to illustrate the fact that there are likely to be substantial and on-going education and training needs across London's workforce - although the absolute scale is likely to be underestimated.

Model and methodological simplifications

The models and methodologies used in this analysis are aimed at providing a simplified model of the real world in order to provide a best estimate of what is likely to occur in the future. It is important to appreciate that such models/methodologies are, therefore, subject to a number of simplifying assumptions: the appendices set these out. The projections, therefore, aim to provide a broad indication of the future path of London's labour market (and associated qualification requirements) based on a number of transparent, simplifying assumptions. Nevertheless, the results from projecting labour market indicators are likely to be subject to particular uncertainty at the moment given the general level of uncertainty in a number of areas – for instance debate about the underlying level of productivity growth in the labour market; the impact of tuition fees on the take up of higher education in the longer term; the impact of changes (and future changes) to legislation on migration to the UK; the impact of changes in state pension age, the nature of state and private pensions and the default retirement age; and, more generally uncertainty as to the future path of economic growth for example.

All of this suggests that this analysis should be treated with a degree of caution when interpreting the results.

Appendix 2: Historic and projected sector employment and borough employee trend charts, 1971 to 2041

As part of the development of these projections GLA Economics has backcast employment data series – Appendix 7 explains the methodology followed. This has provided a richer data source to inform the judgements made for projections, and explained at Appendix 5.

Figure A.2.1 Primary & utilities employment, 1971-2041

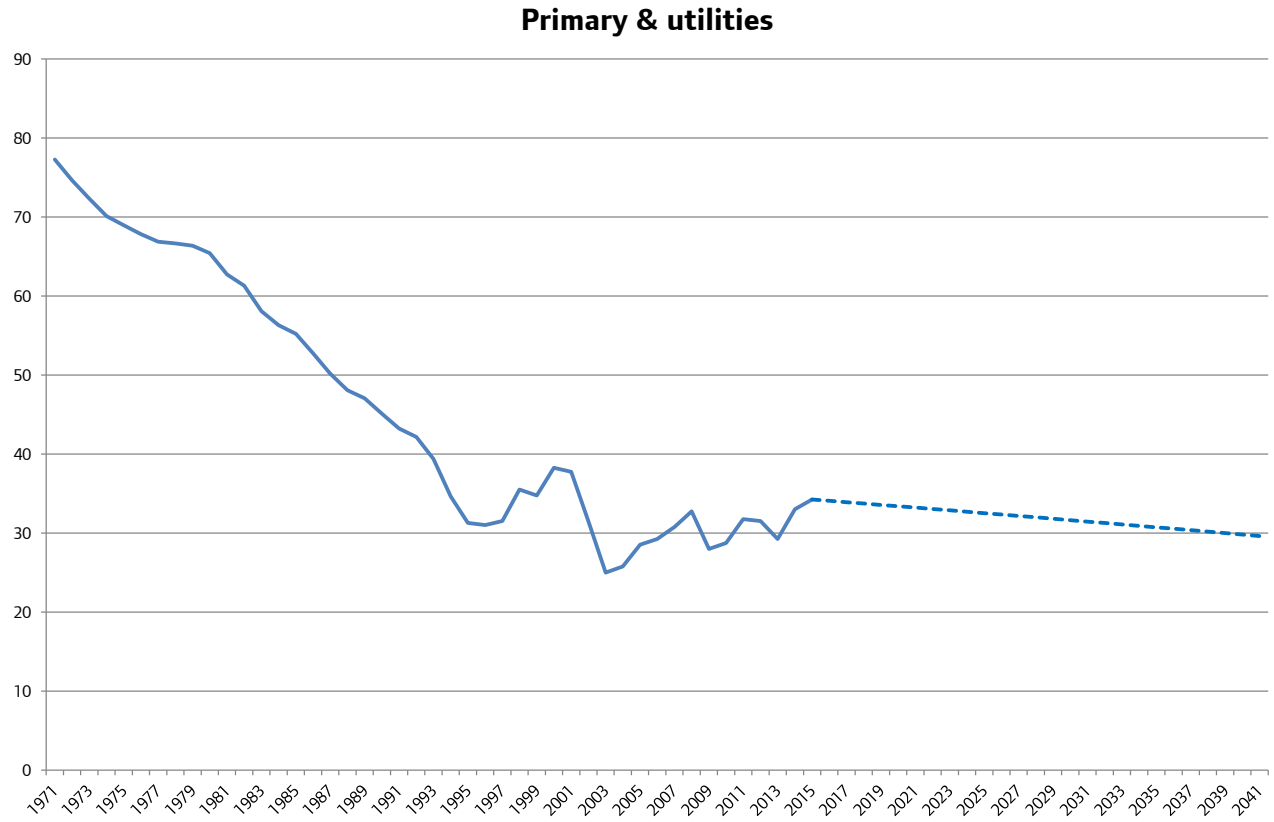


Figure A.2.2 Manufacturing employment, 1971-2041

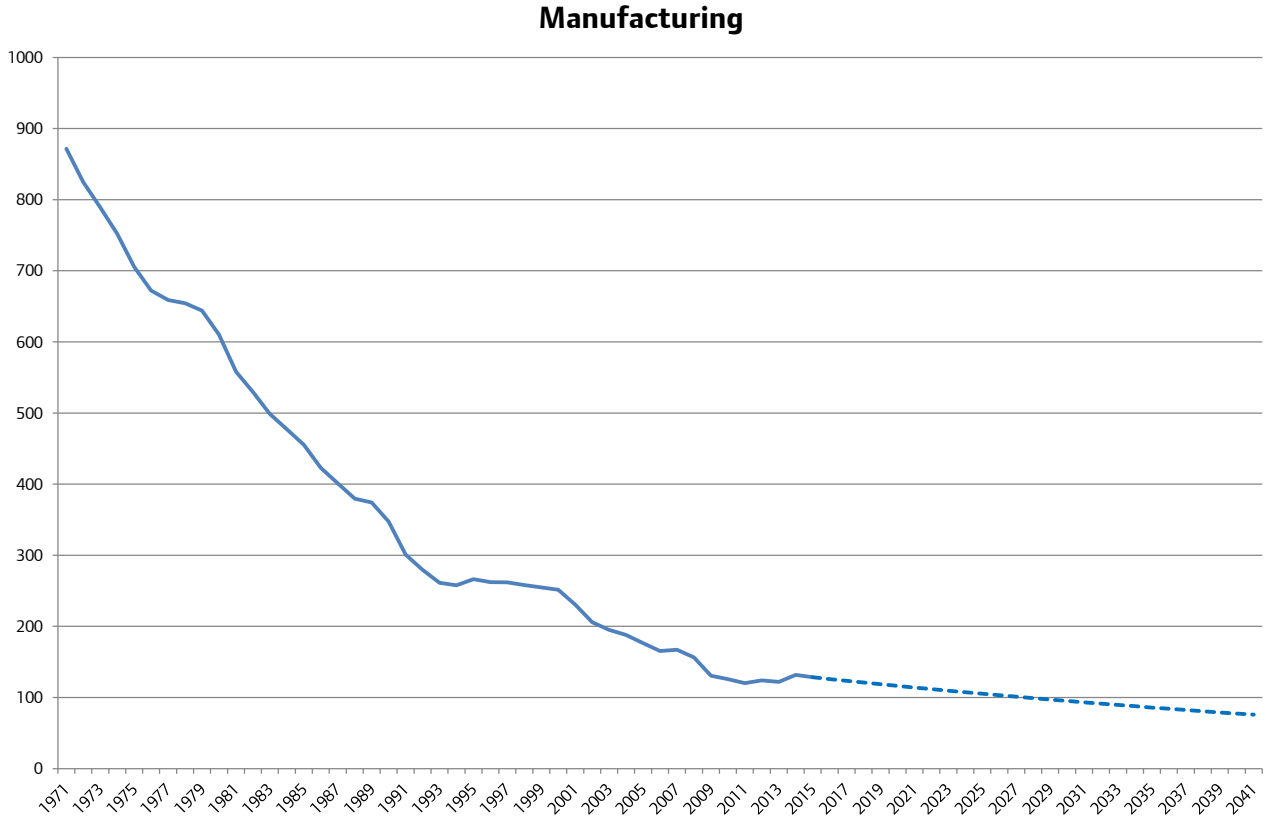


Figure A.2.3 Construction employment, 1971-2041

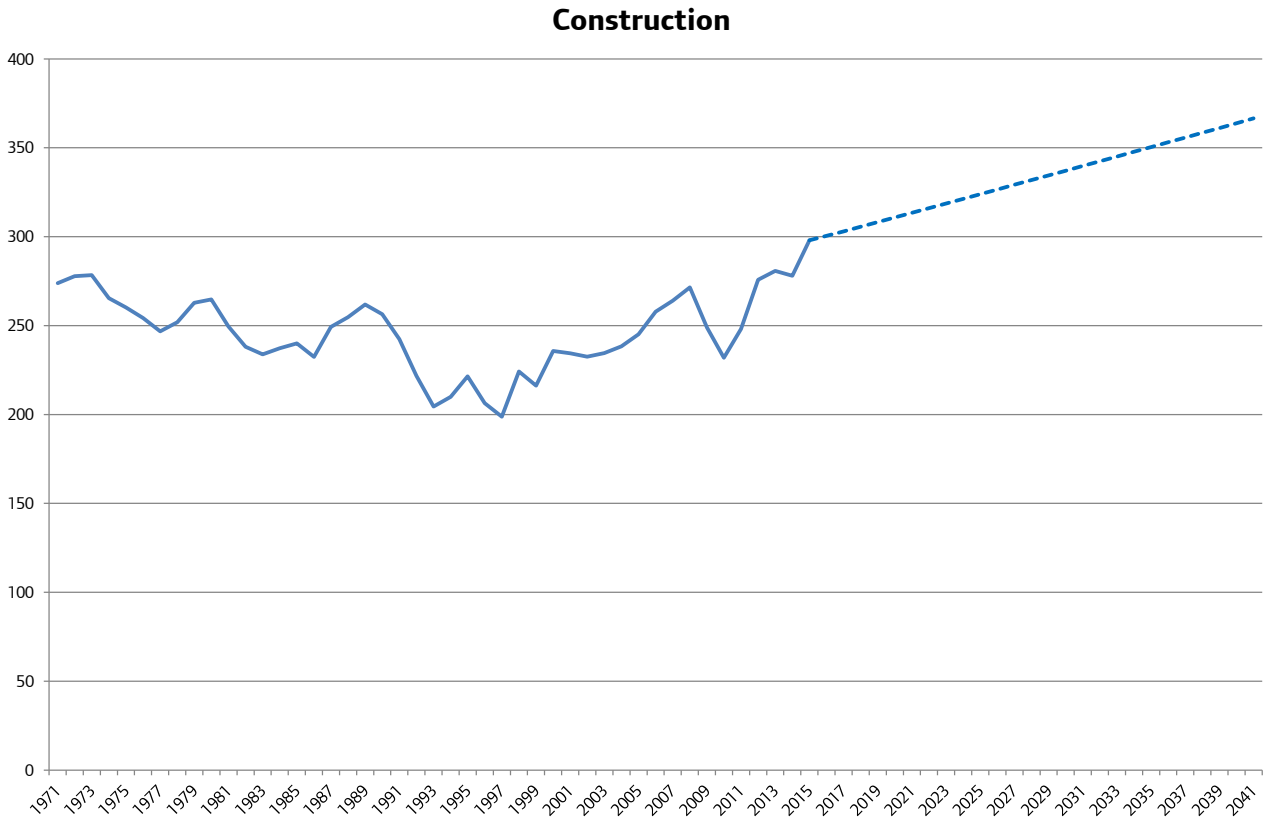


Figure A.2.4 Wholesale employment, 1971-2041

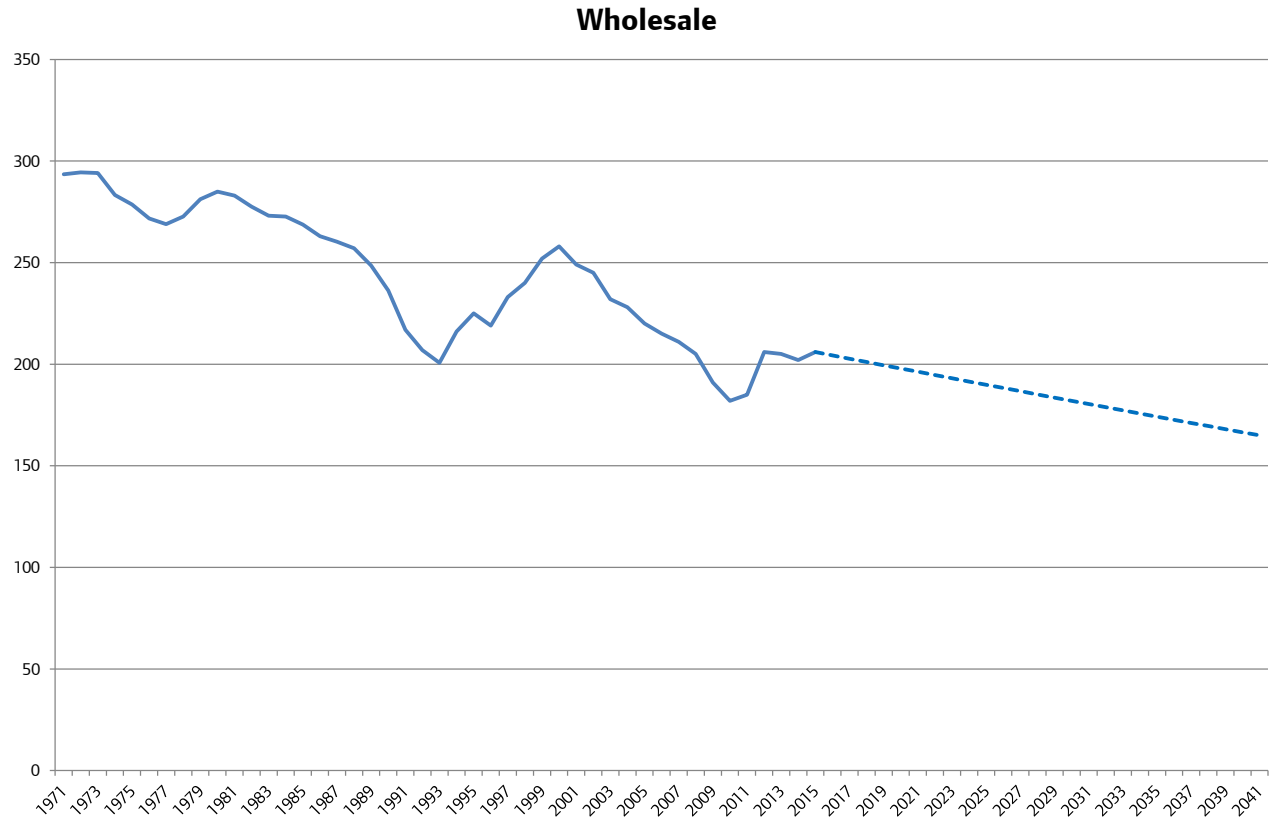


Figure A.2.5 Retail employment, 1971-2041

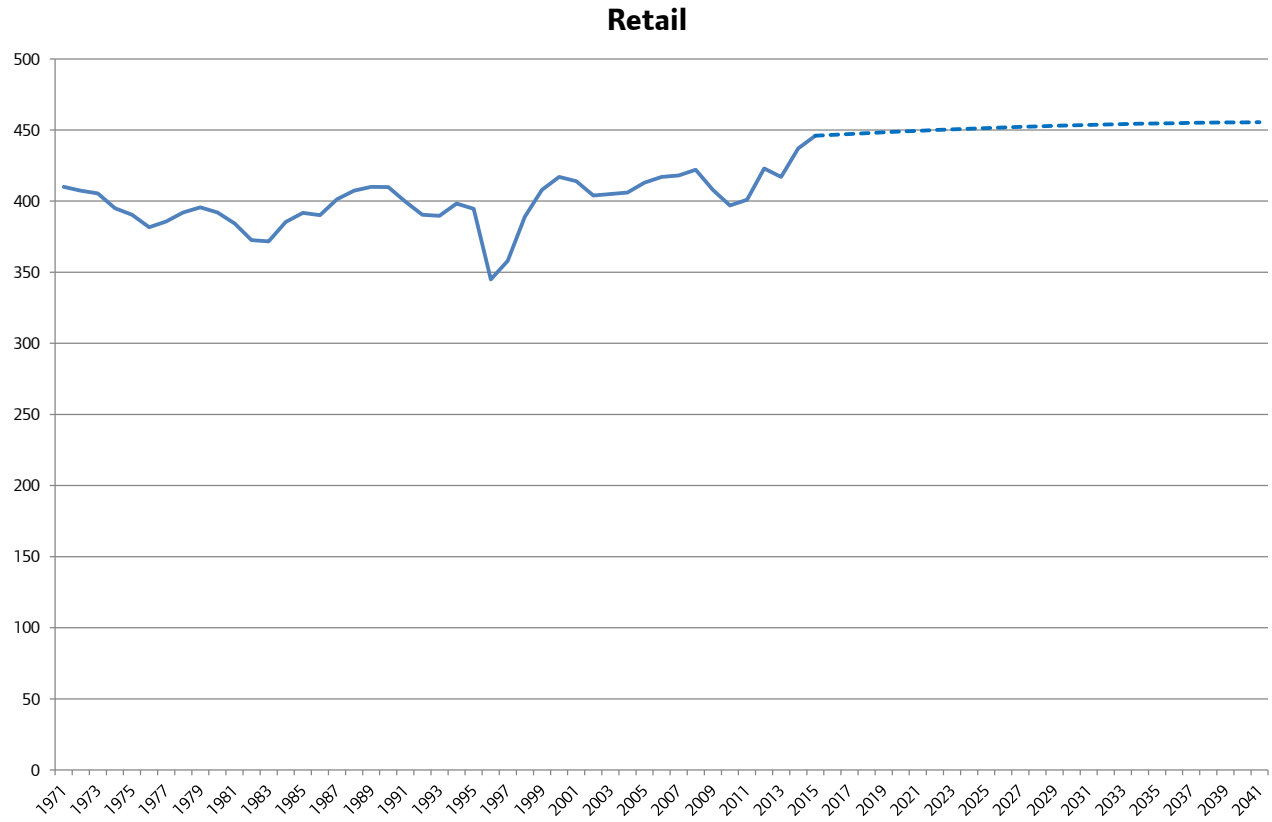


Figure A.2.6 Transportation and storage employment, 1971-2041

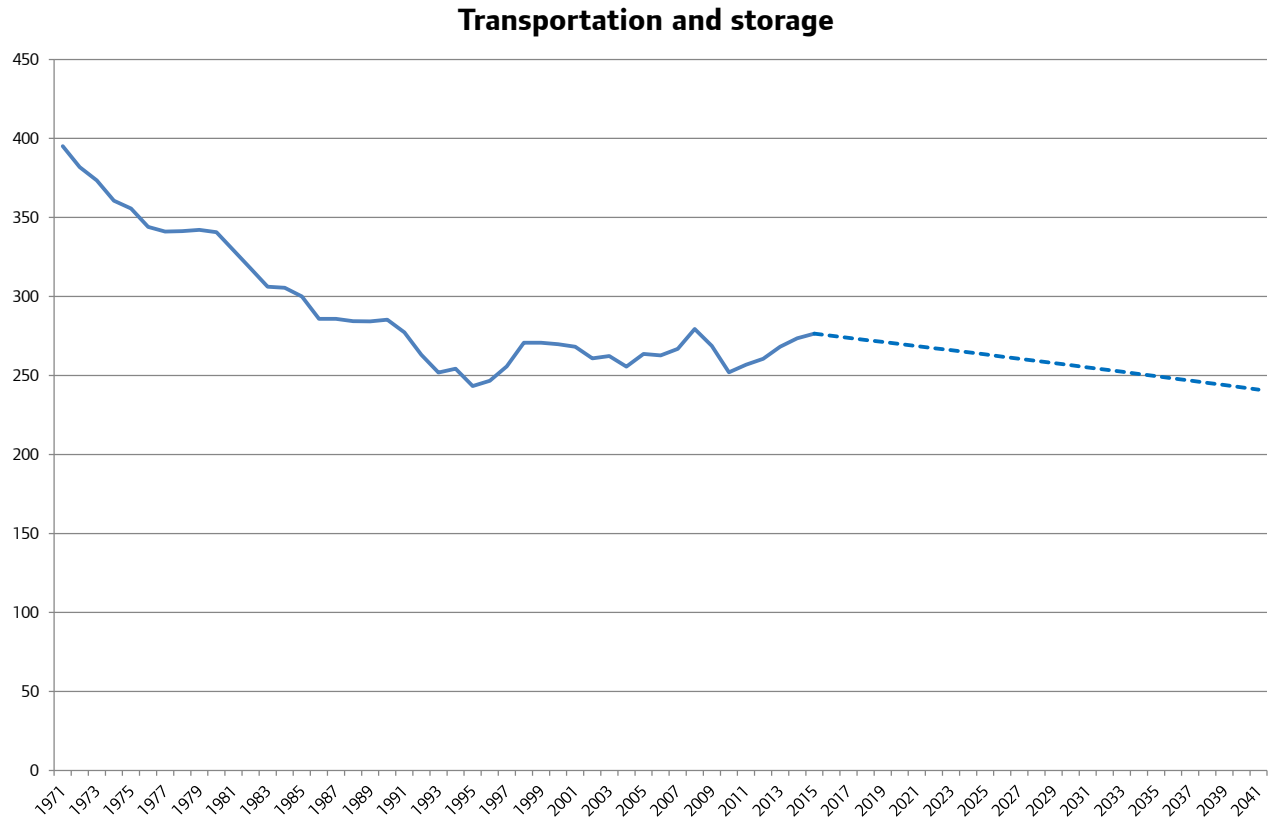


Figure A.2.7 Accommodation and food service activities employment, 1971-2041

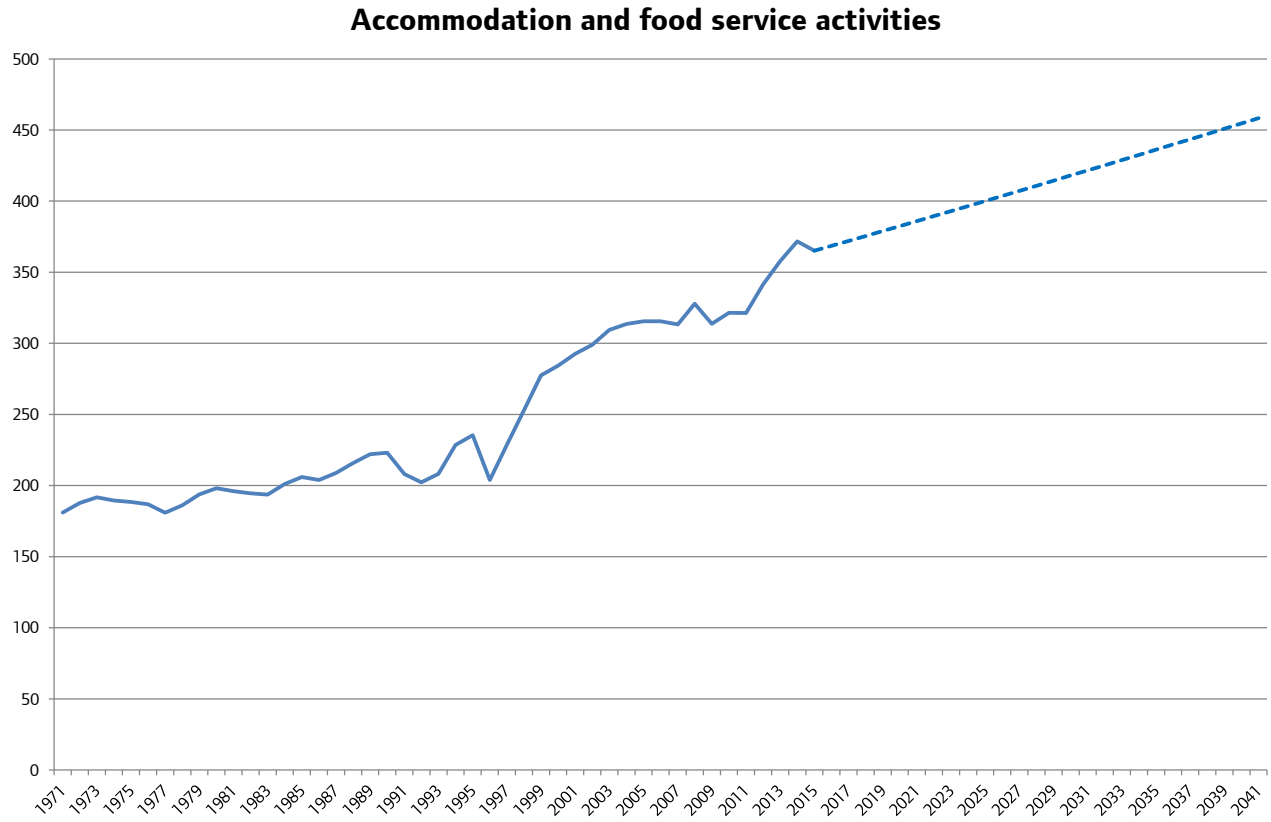


Figure A.2.8 Information and Communication employment, 1971-2041

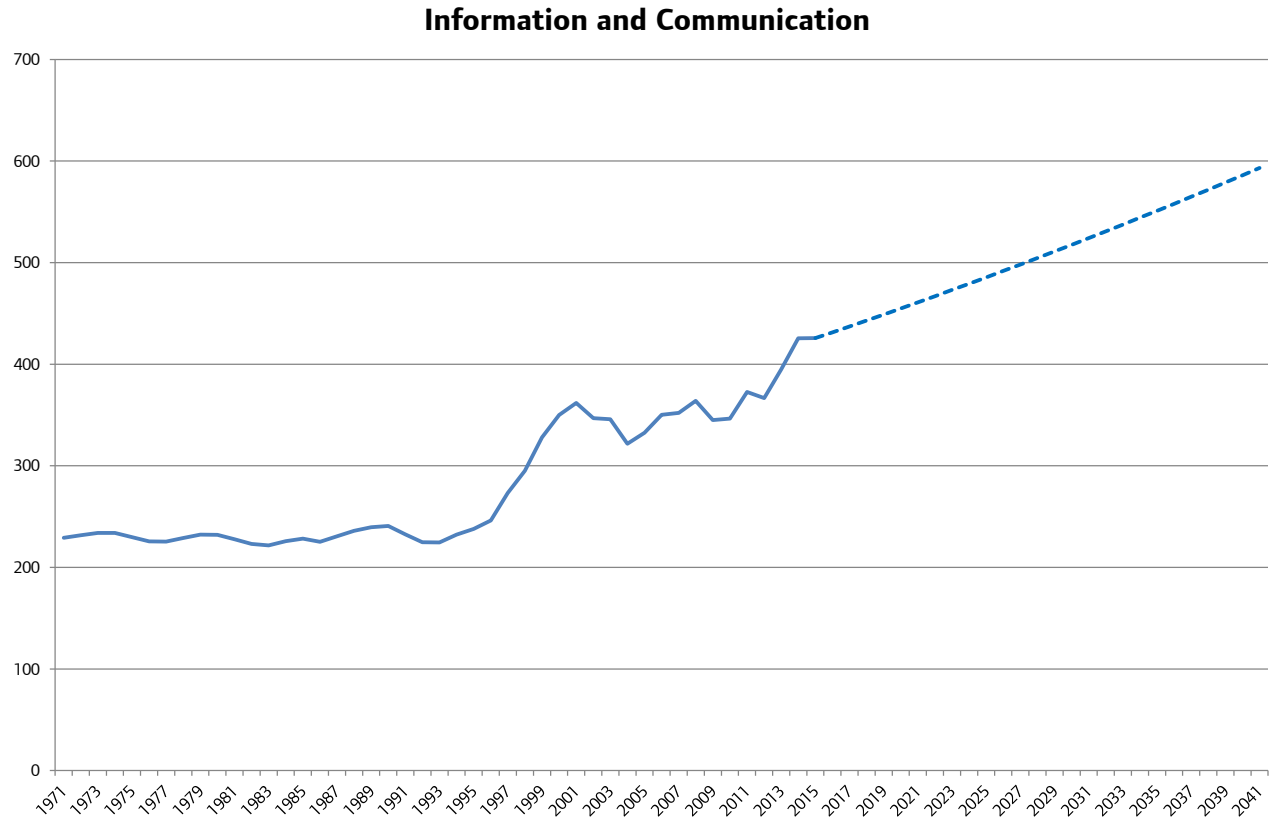


Figure A.2.9 Financial and insurance activities employment, 1971-2041

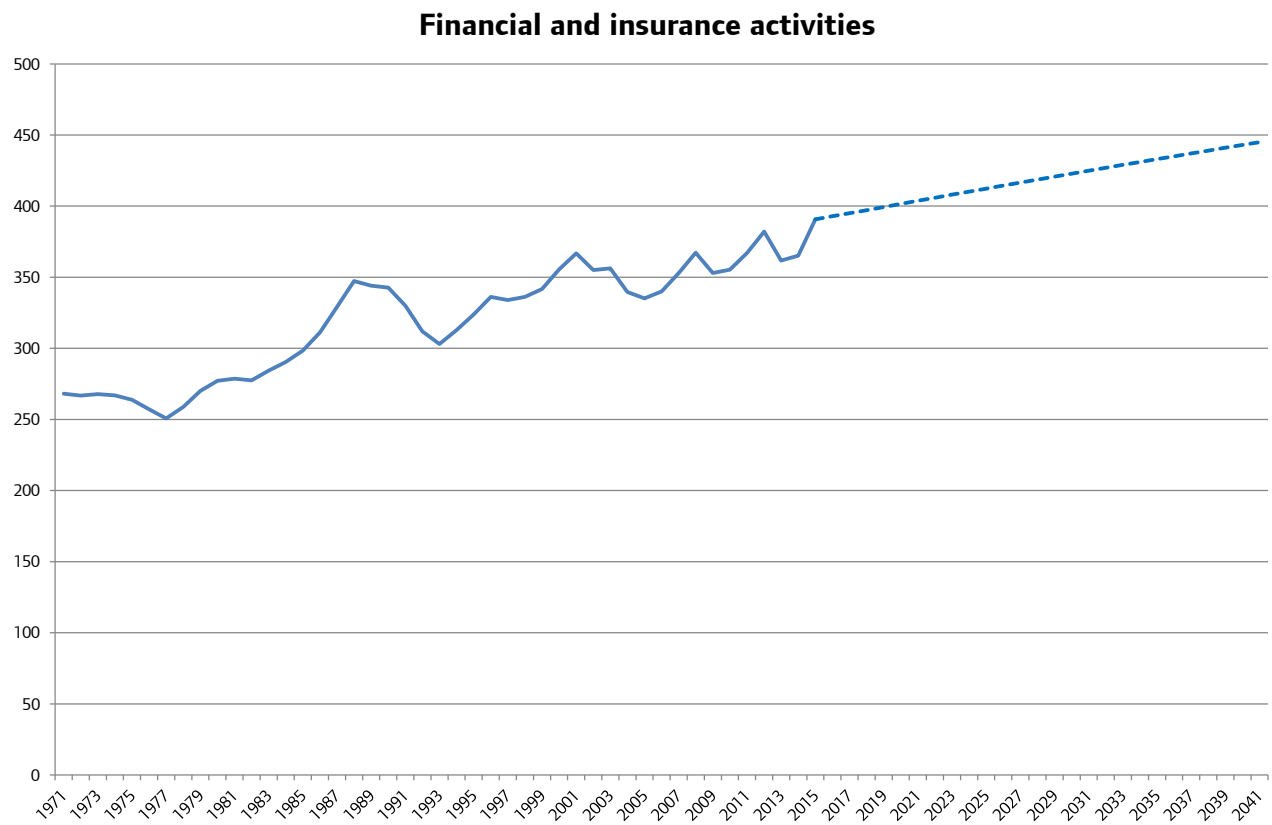


Figure A.2.10 Professional, Real Estate, Scientific and technical activities employment, 1971-2041

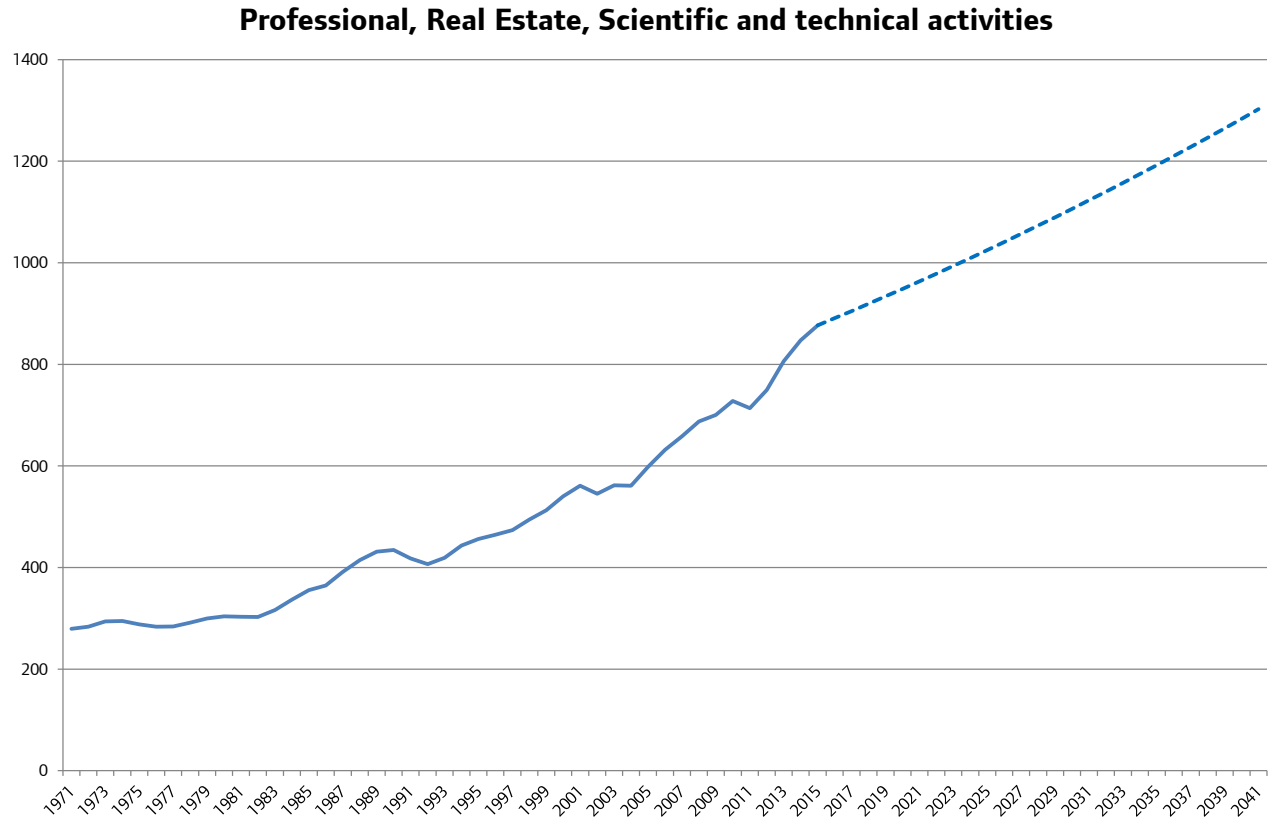


Figure A.2.11 Administrative and support service activities employment, 1971-2041

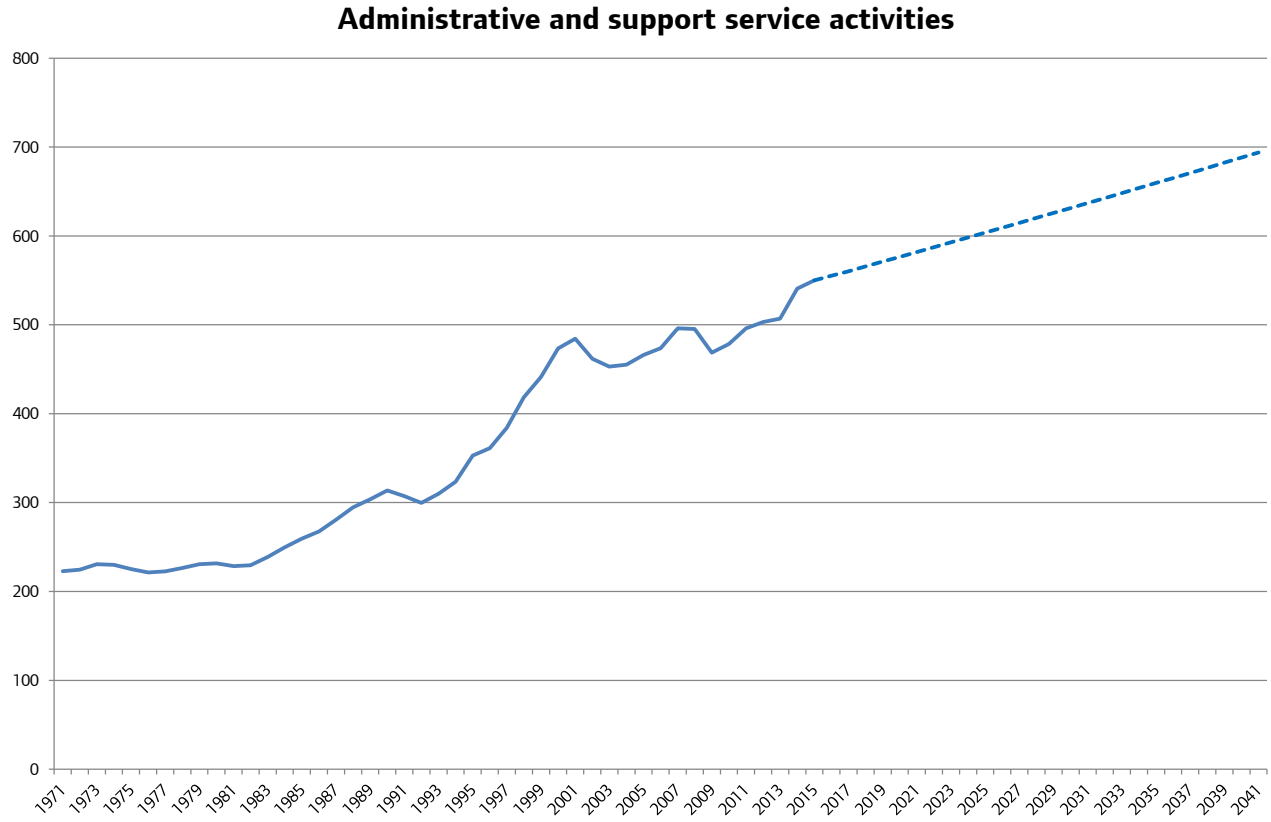


Figure A.2.12 Public administration and defence employment, 1971-2041

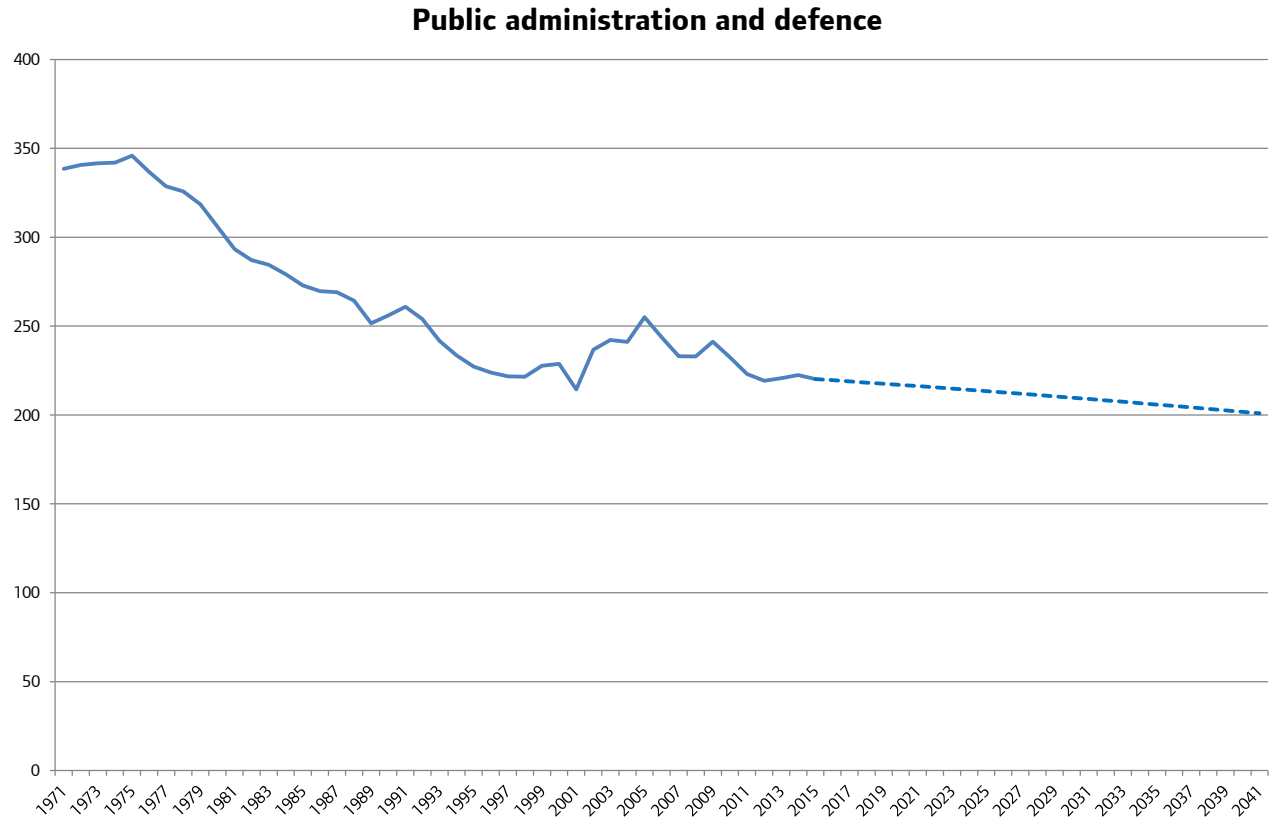


Figure A.2.13 Education employment, 1971-2041

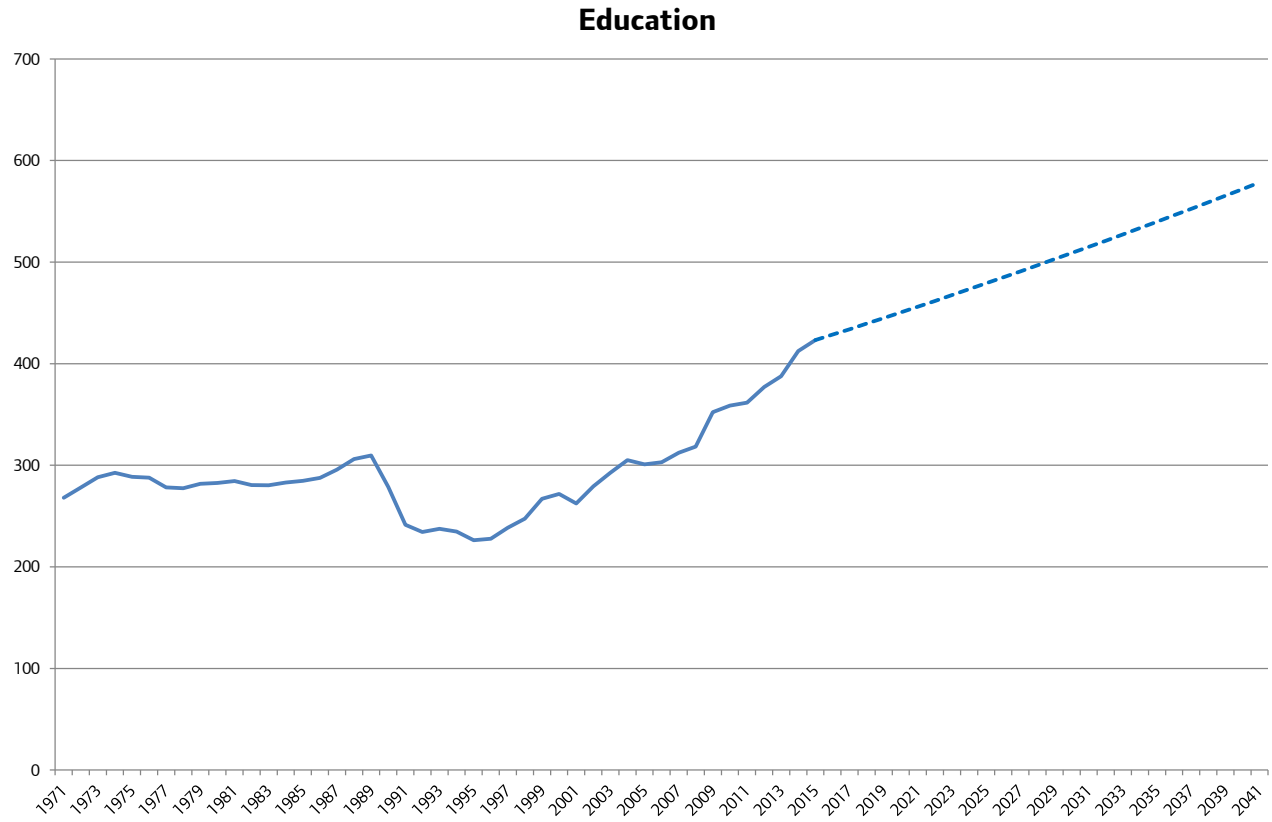


Figure A.2.14 Health employment, 1971-2041

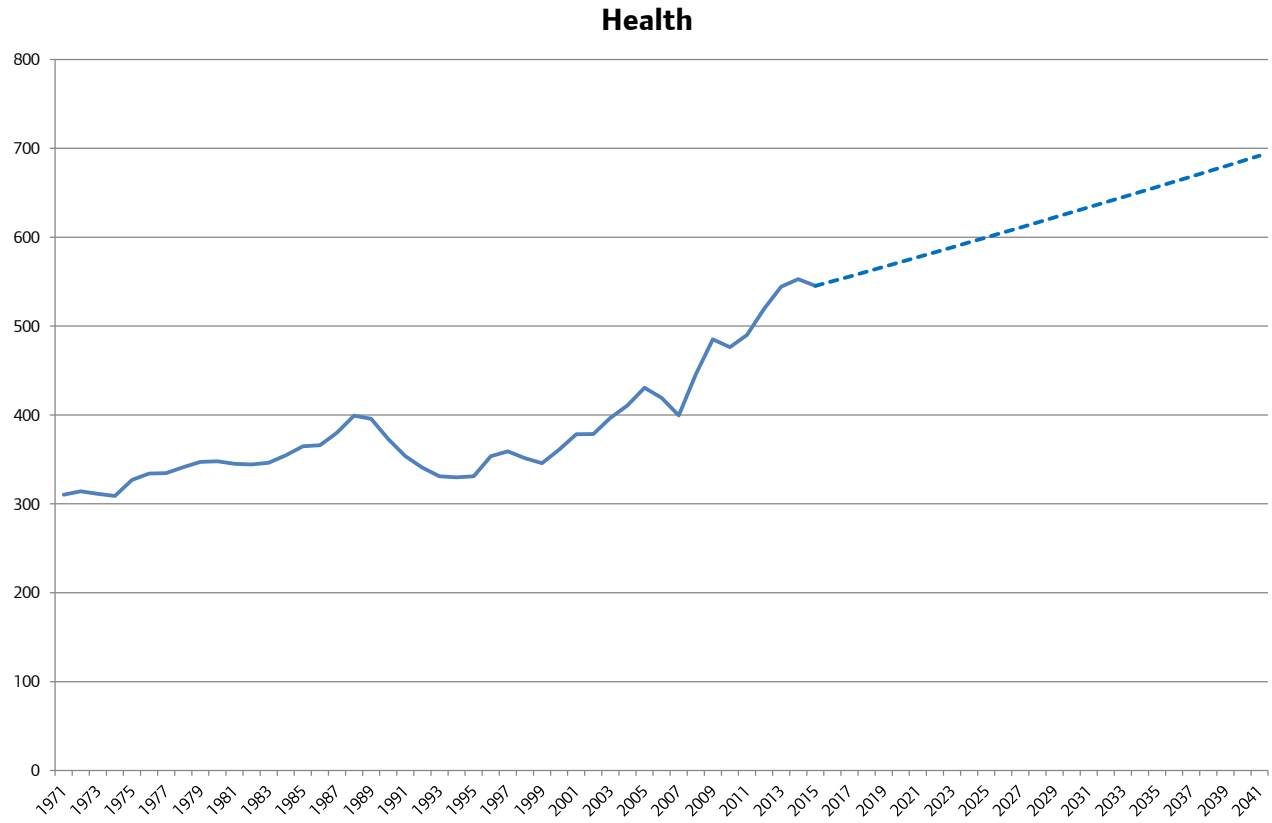


Figure A.2.15 Arts, entertainment and recreation employment, 1971-2041

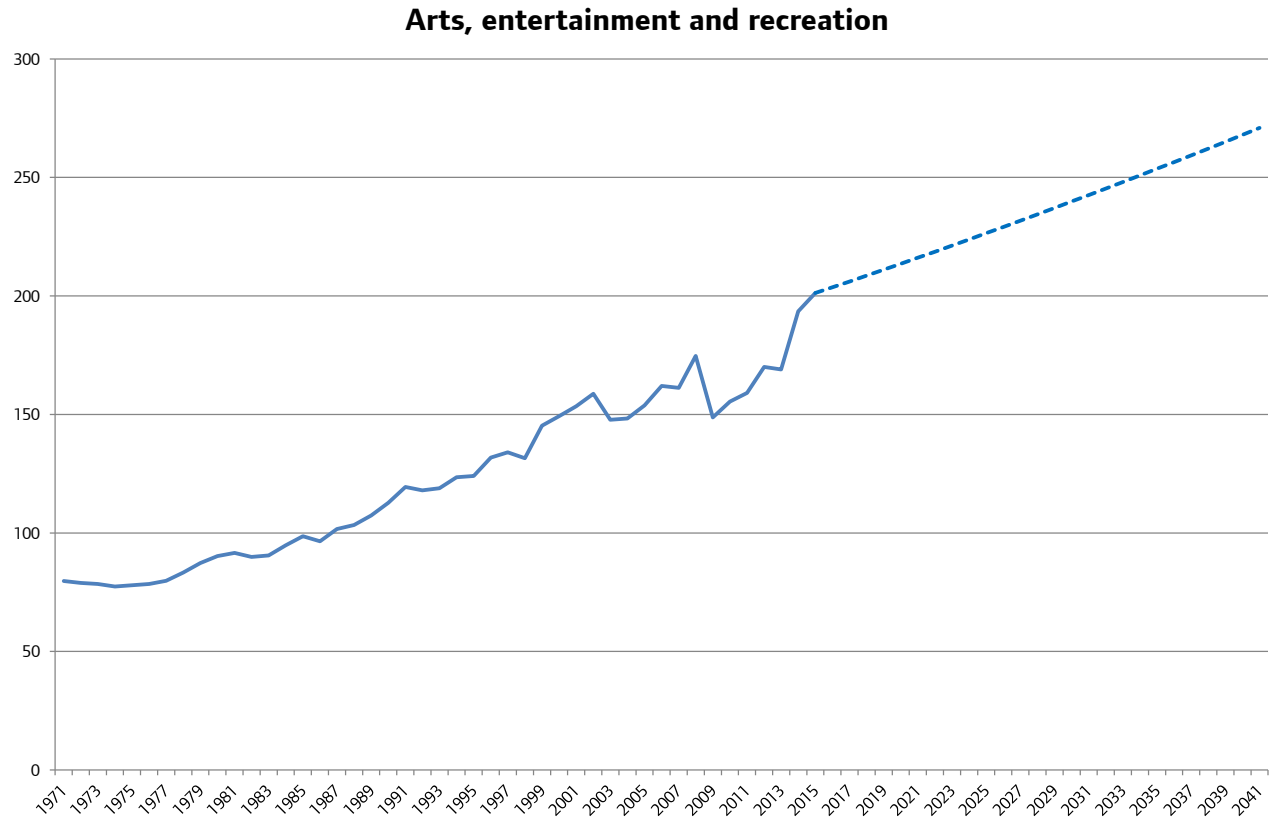


Figure A.2.16 Other services employment, 1971-2041

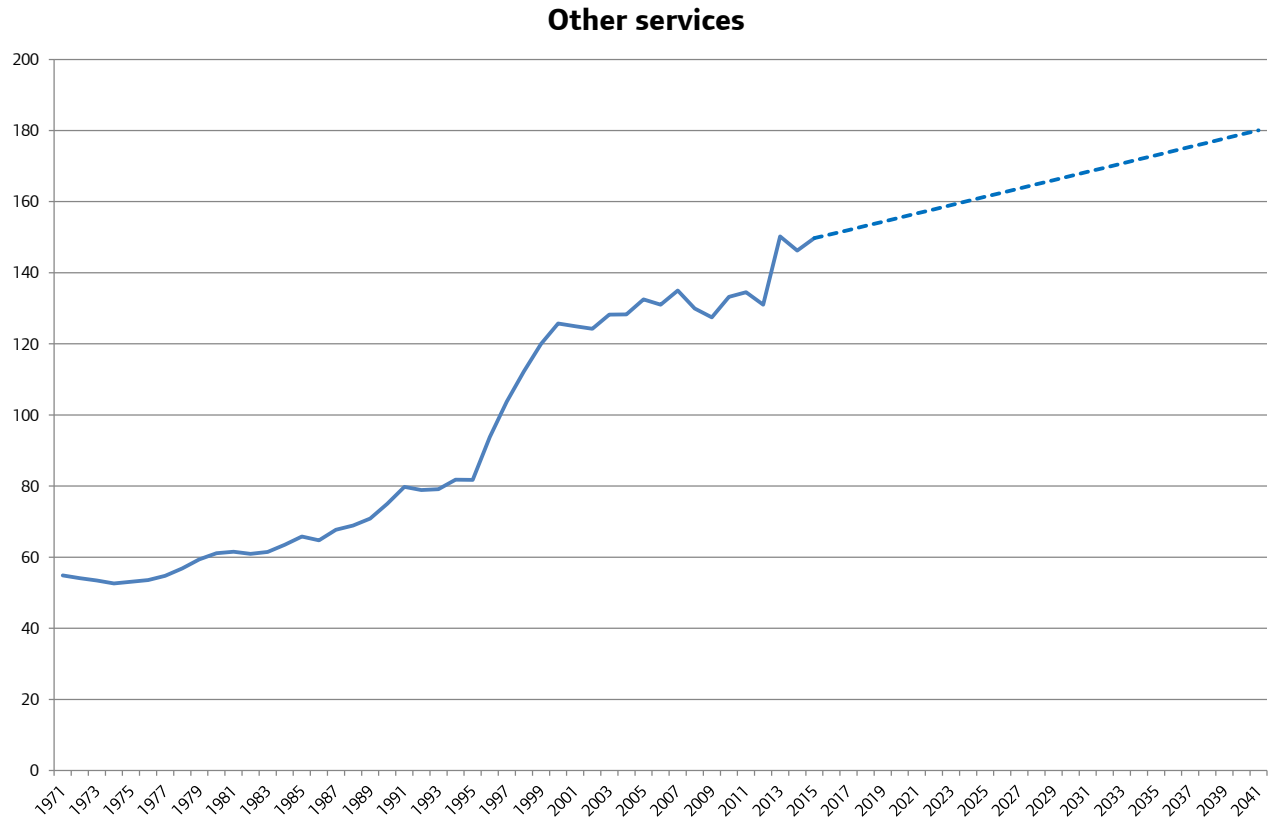


Figure A.2.17 Barking and Dagenham employee trend, 1971-2041

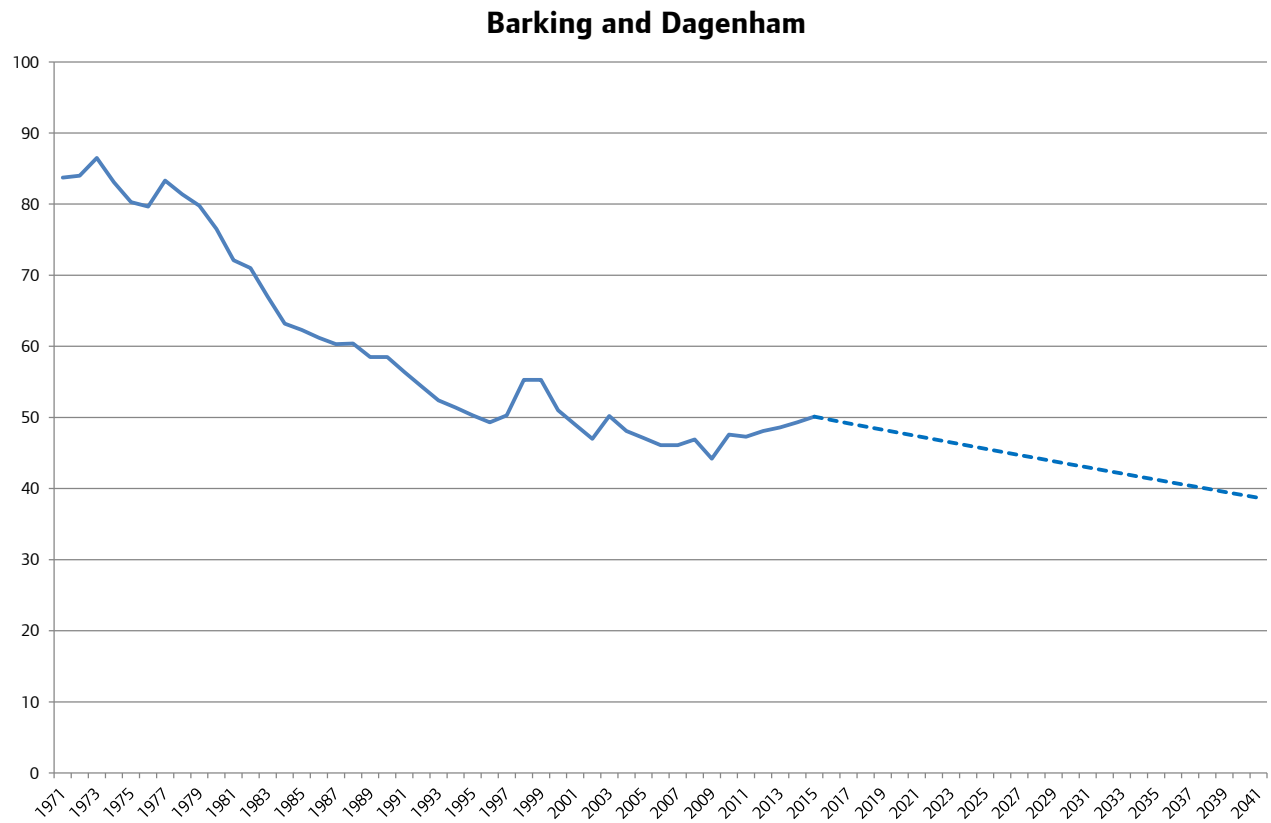


Figure A.2.18 Barnet employee trend, 1971-2041

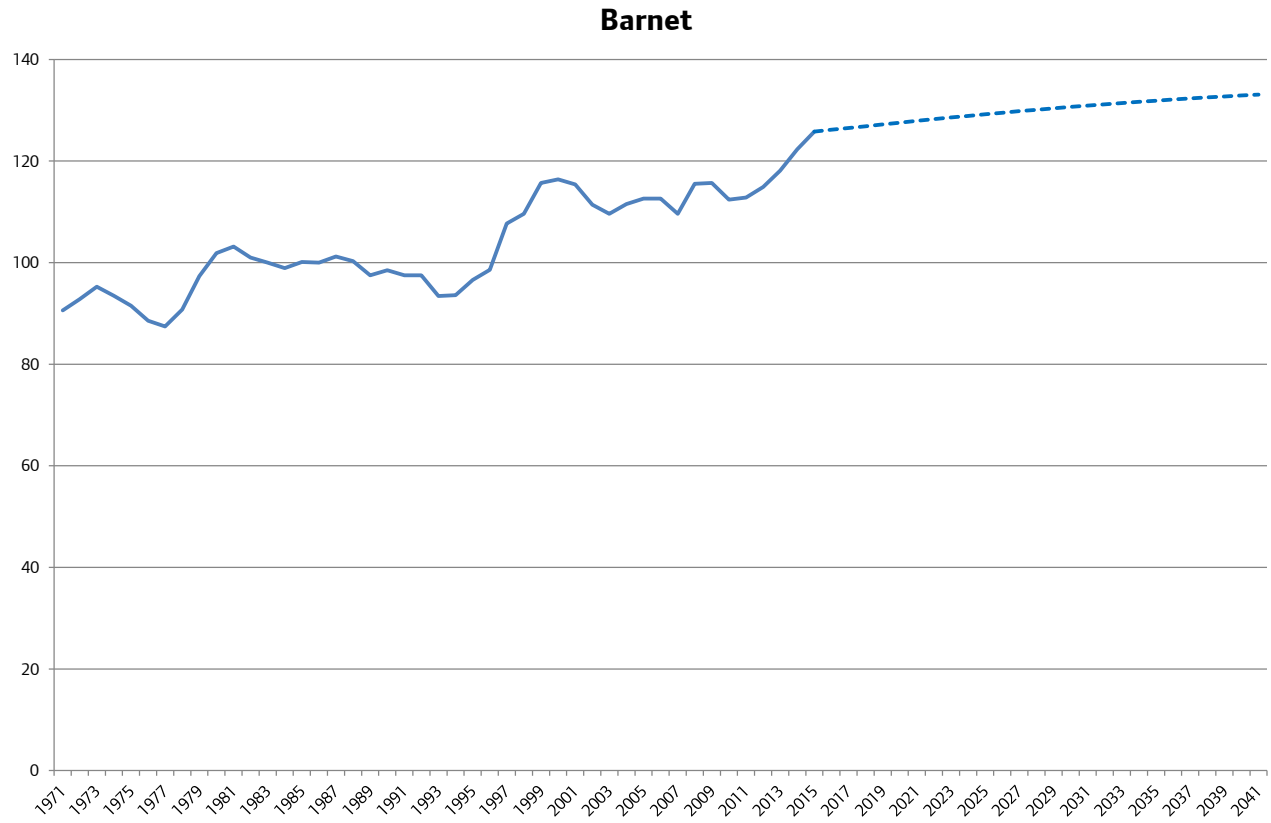


Figure A.2.19 Bexley employee trend, 1971-2041

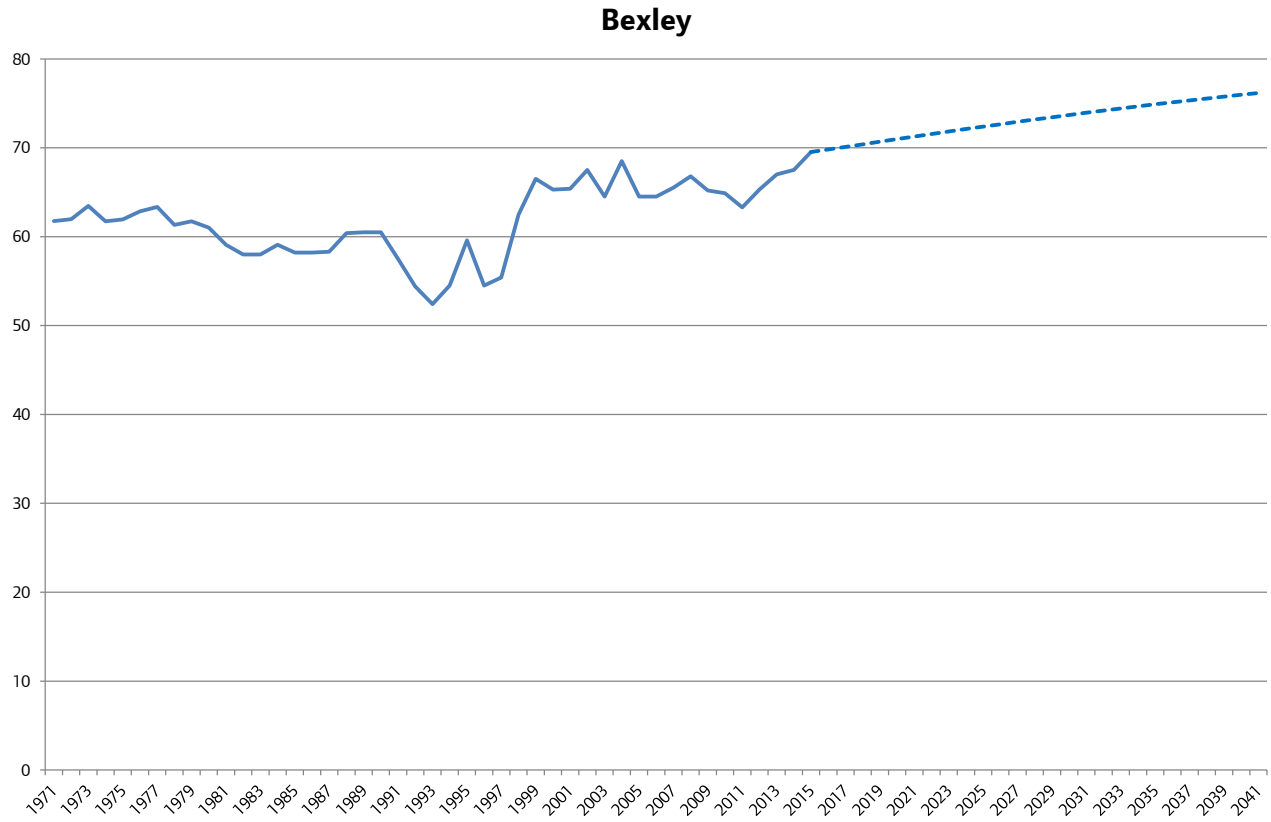


Figure A.2.20 Brent employee trend, 1971-2041

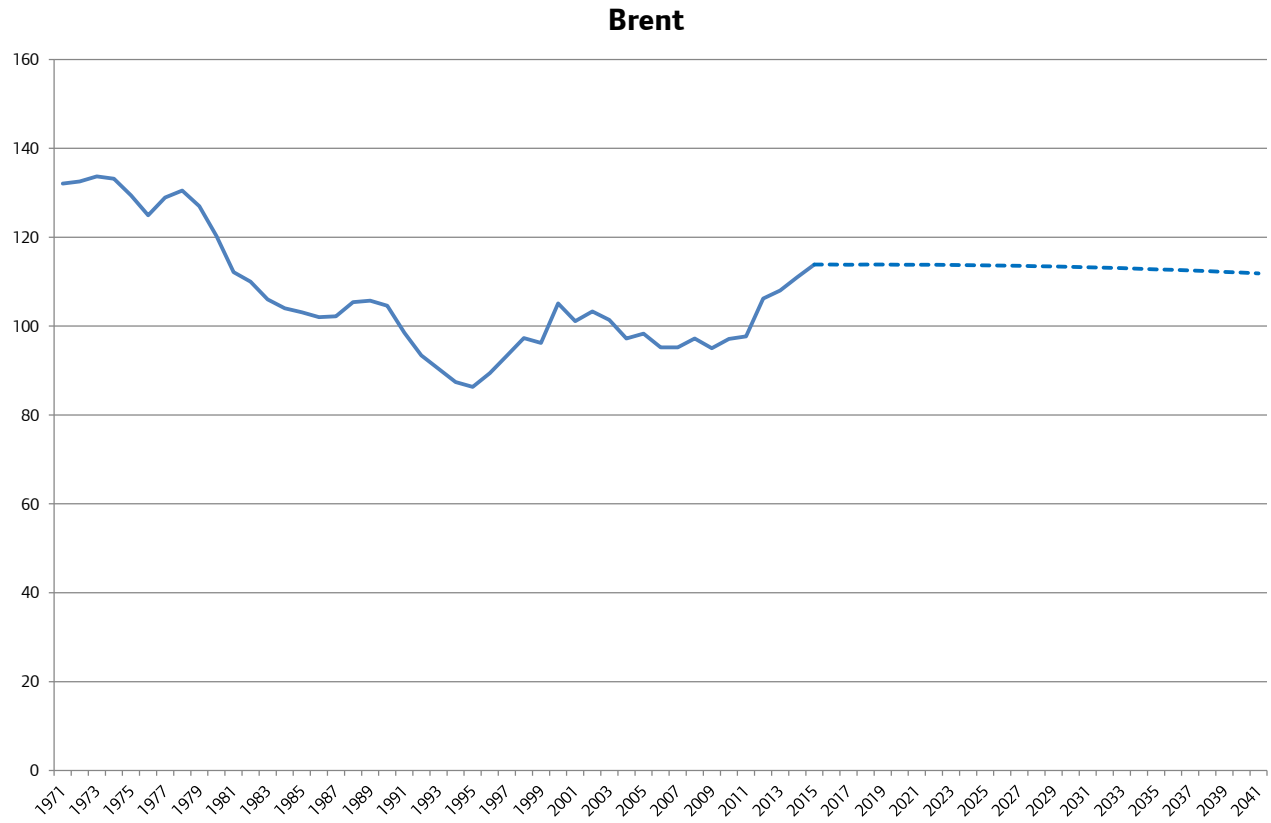


Figure A.2.21 Bromley employee trend, 1971-2041

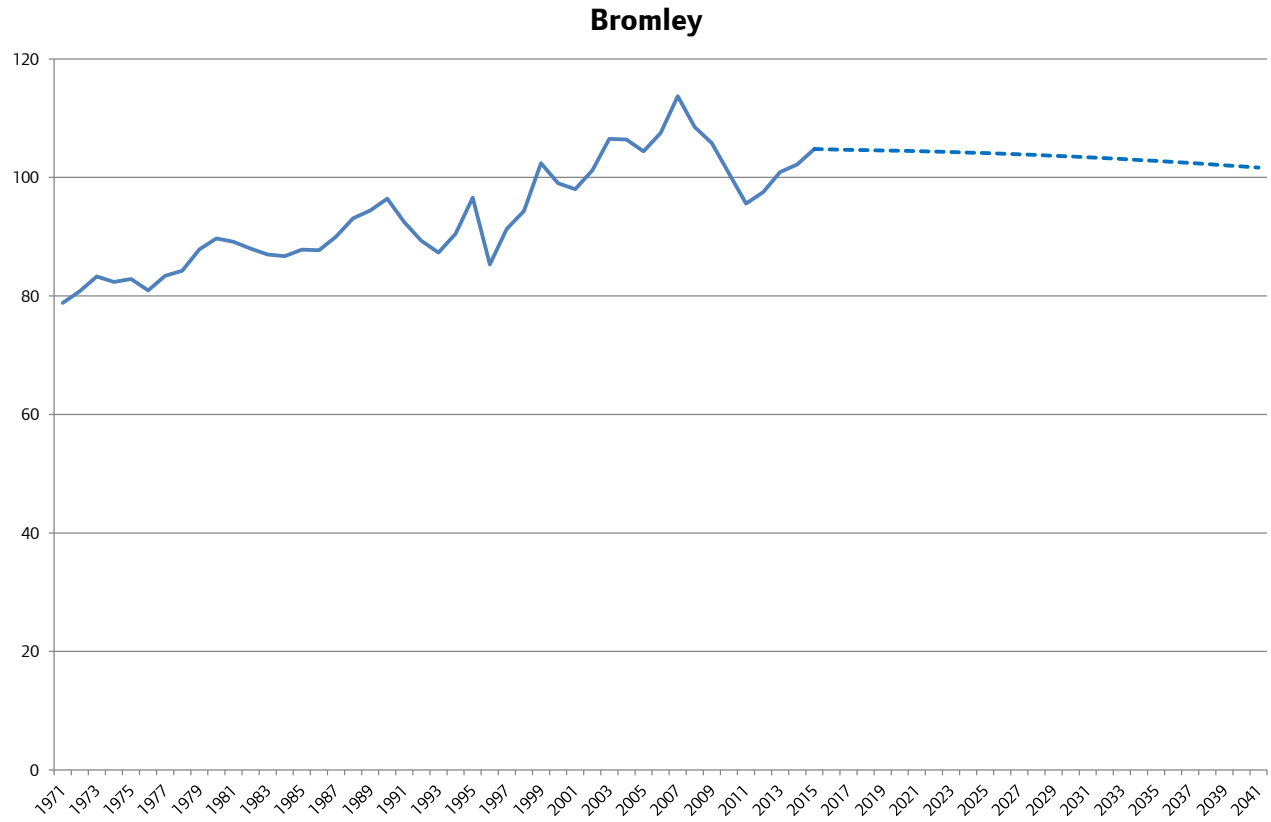


Figure A.2.22 Camden employee trend, 1971-2041

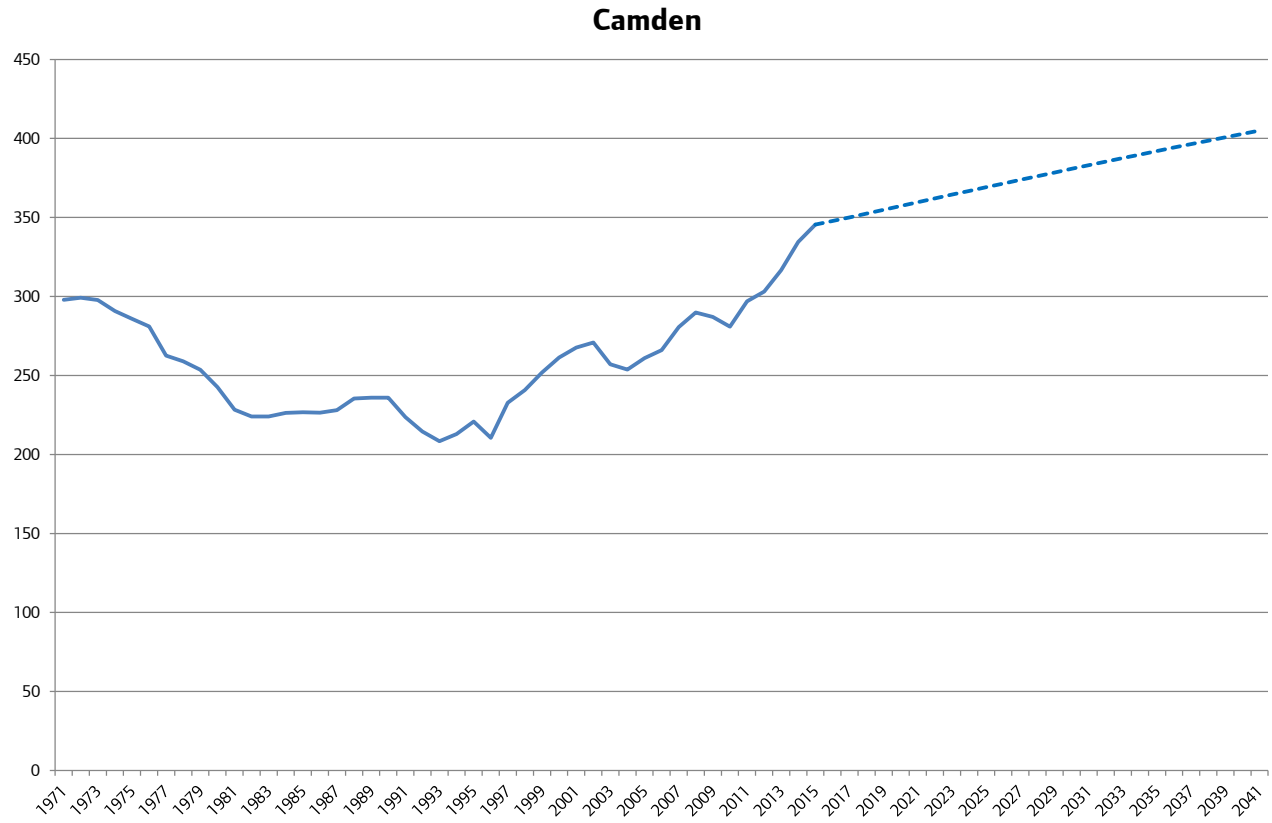


Figure A.2.23 City of London employee trend, 1971-2041

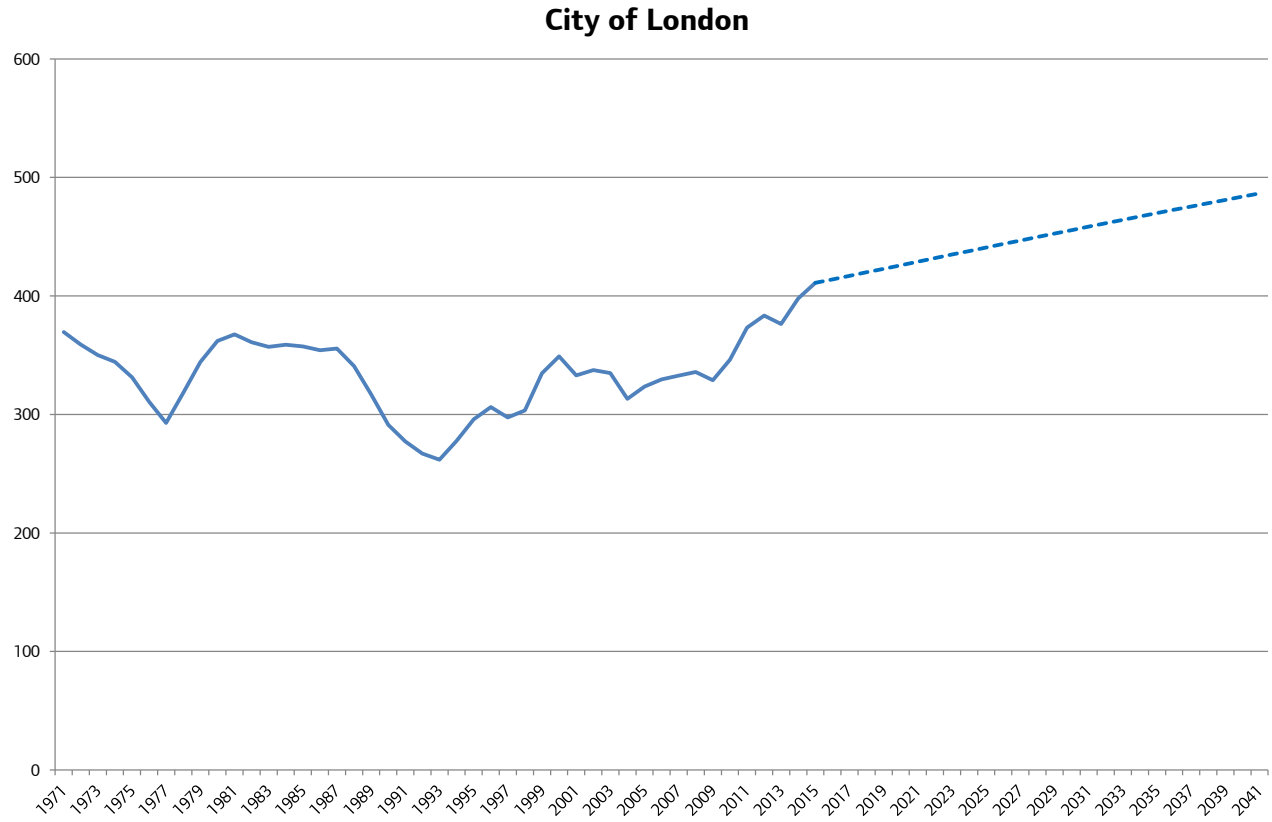


Figure A.2.24 Croydon employee trend, 1971-2041

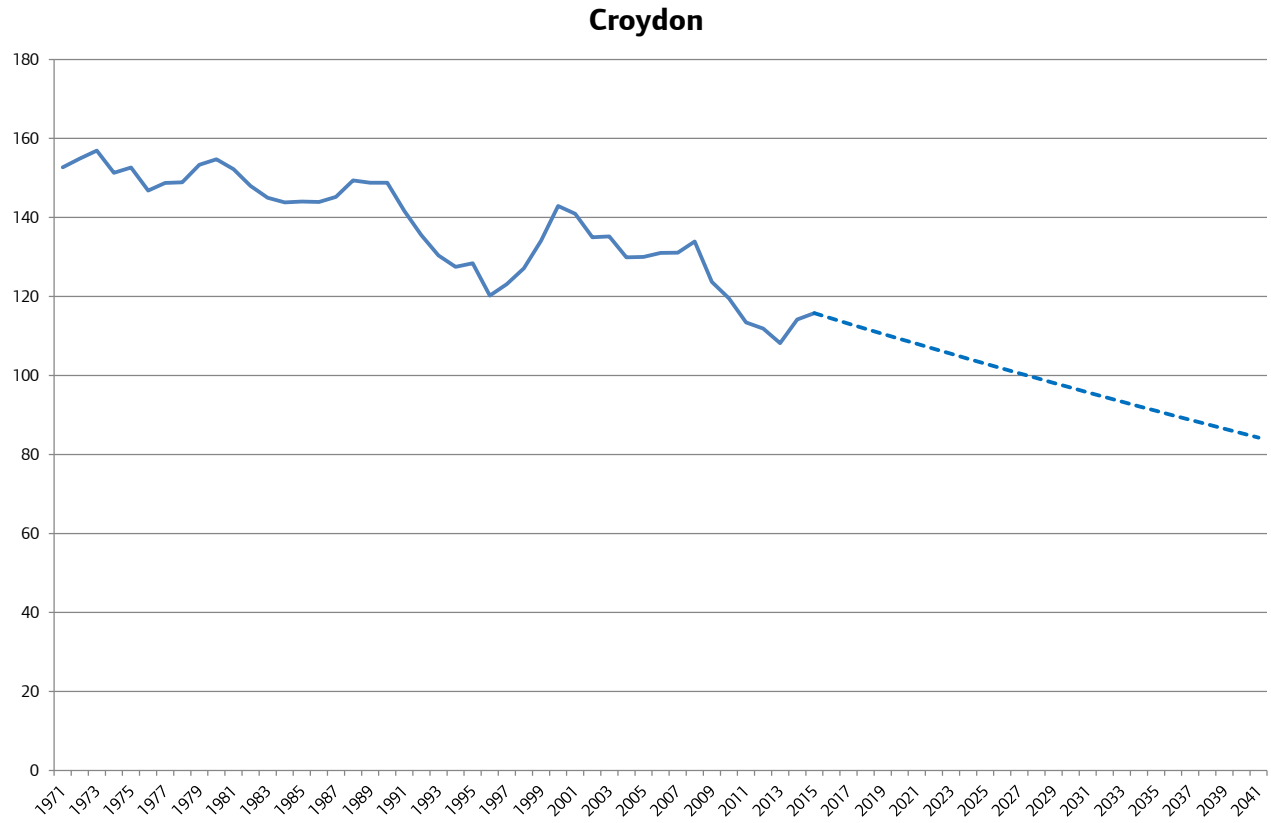


Figure A.2.25 Ealing employee trend, 1971-2041

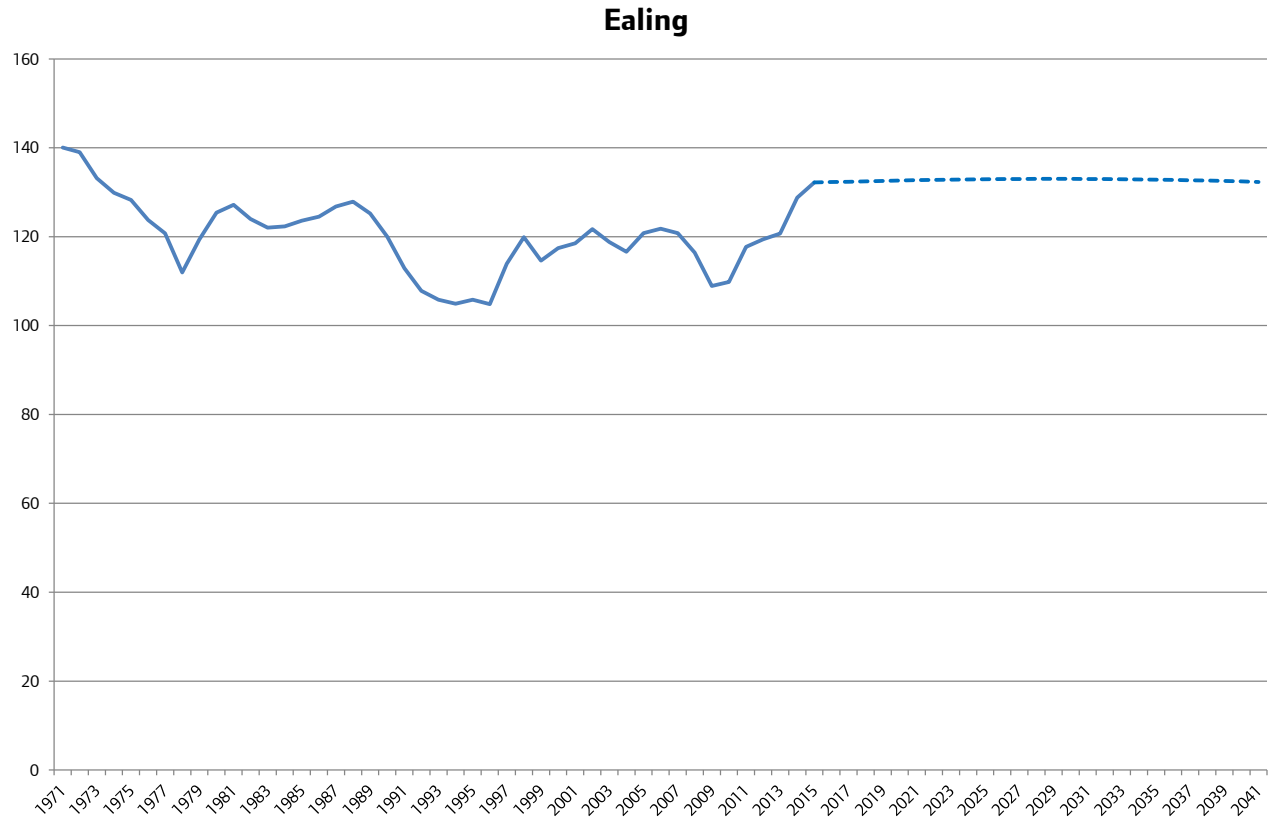


Figure A.2.26 Enfield employee trend, 1971-2041

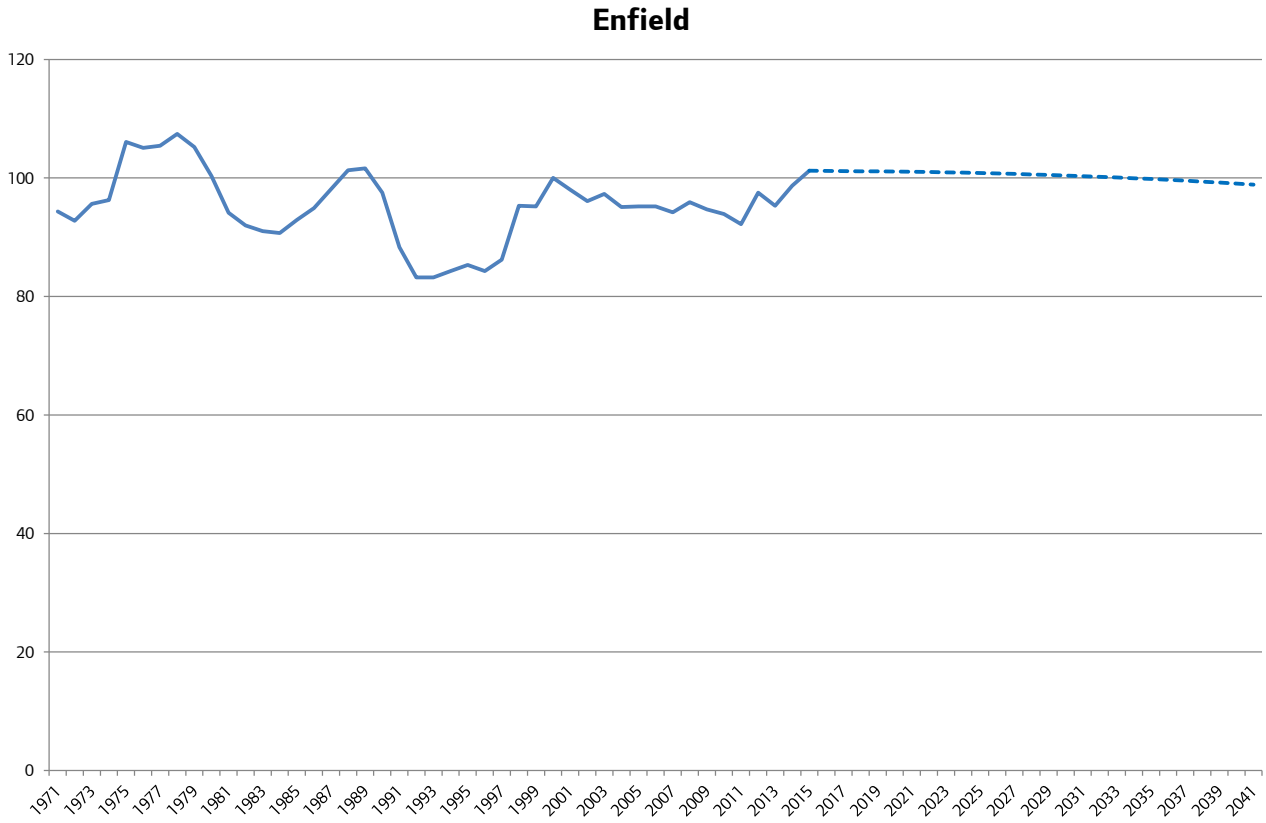


Figure A.2.27 Greenwich employee trend, 1971-2041

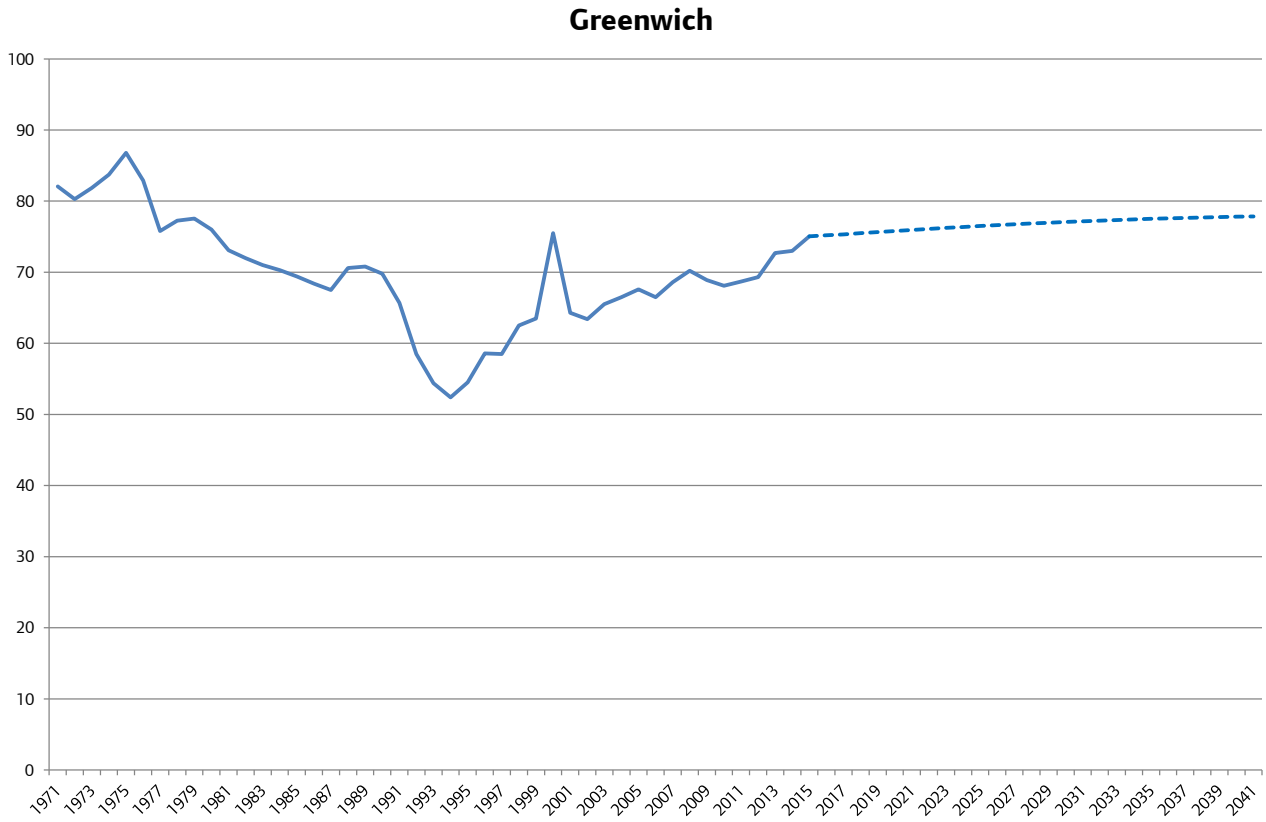


Figure A.2.28 Hackney employee trend, 1971-2041

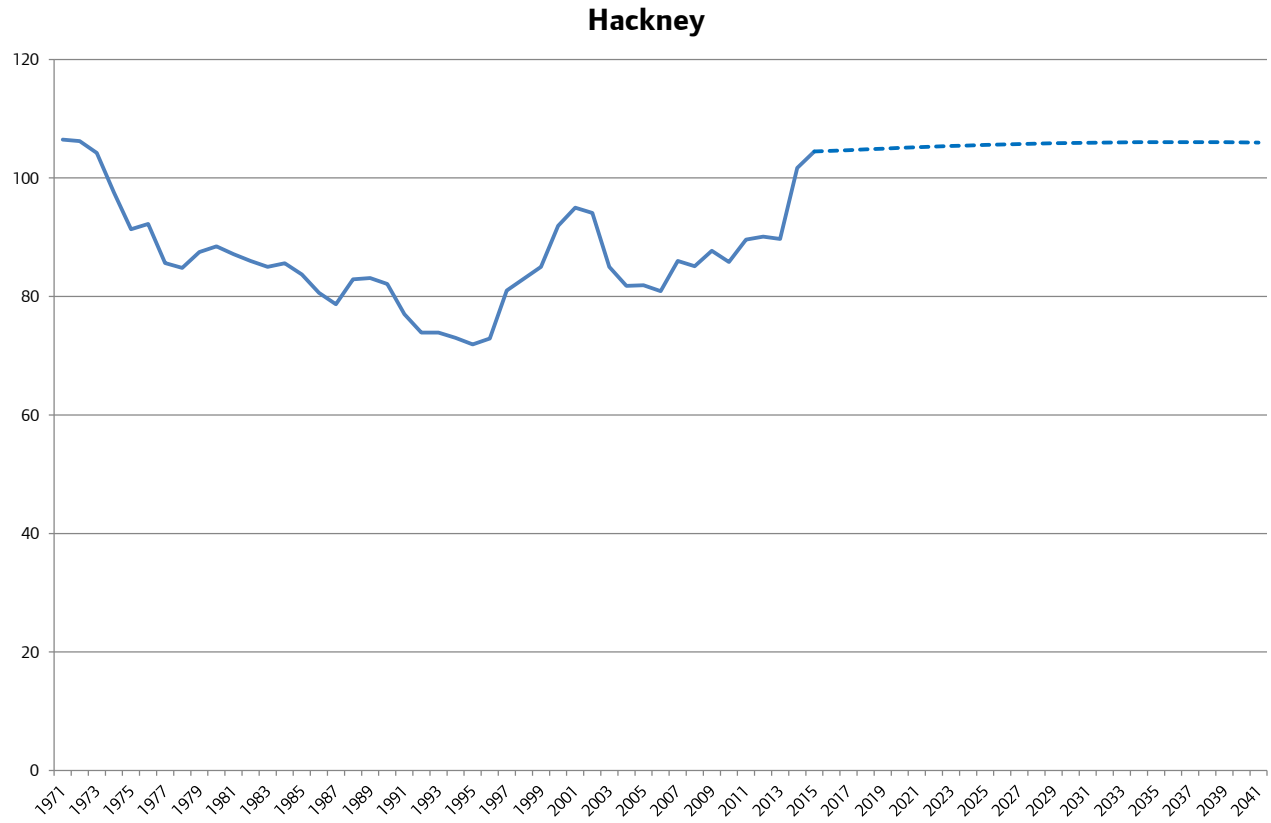


Figure A.2.29 Hammersmith and Fulham employee trend, 1971-2041

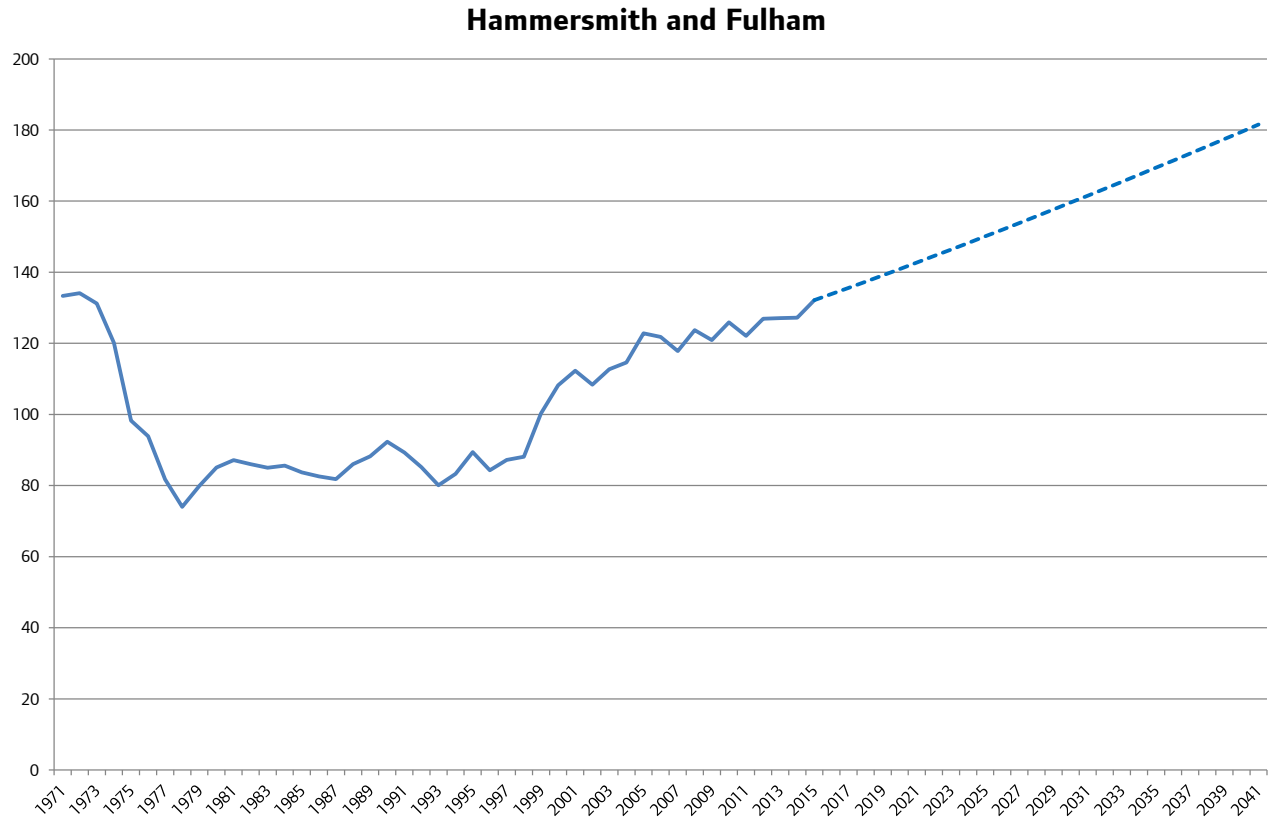


Figure A.2.30 Haringey employee trend, 1971-2041

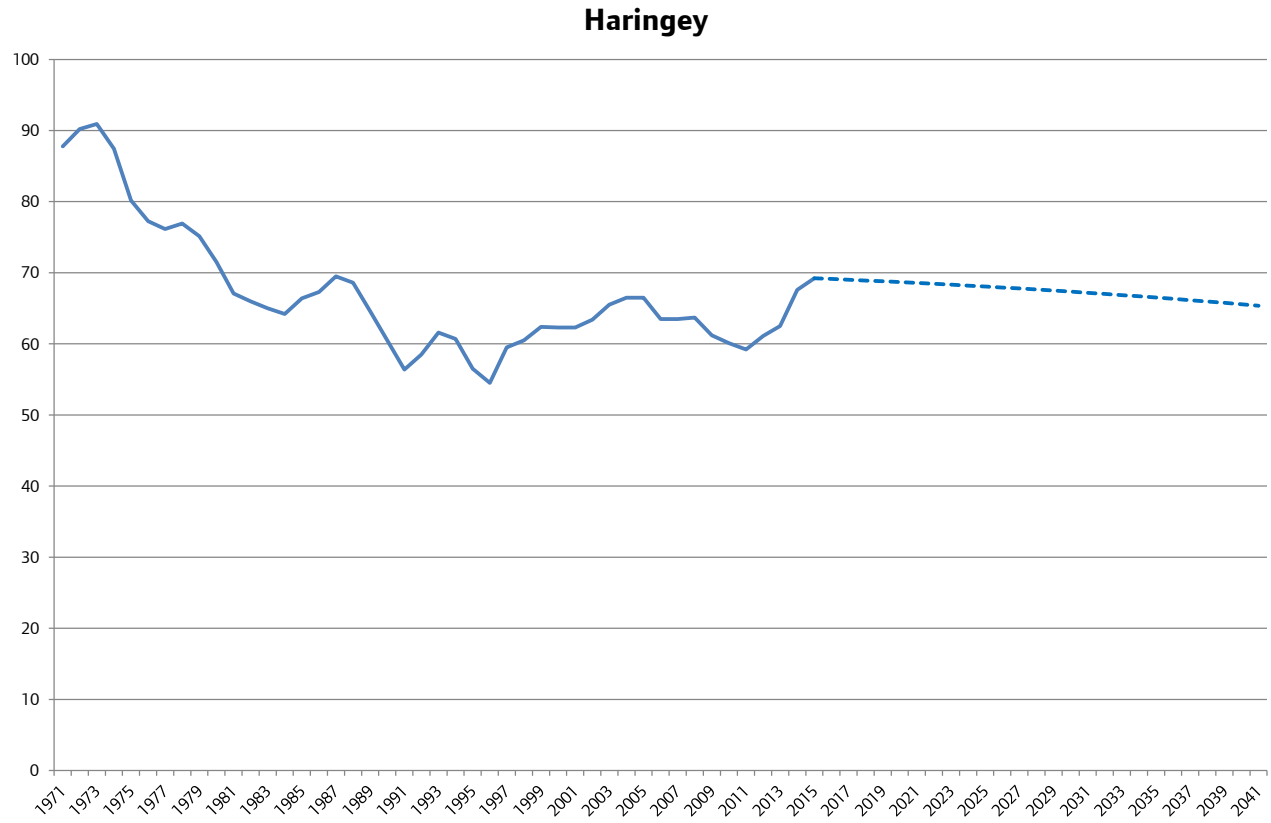


Figure A.2.31 Harrow employee trend, 1971-2041

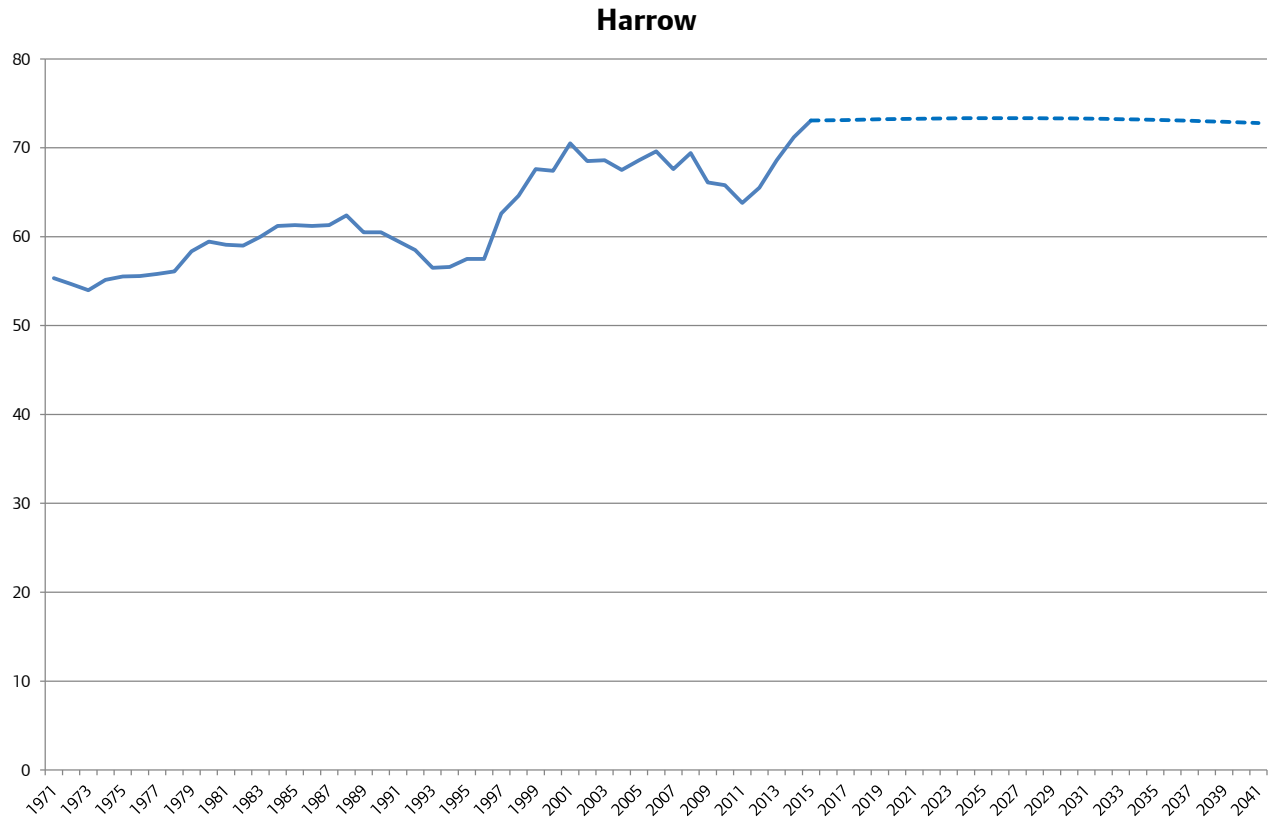


Figure A.2.32 Havering employee trend, 1971-2041

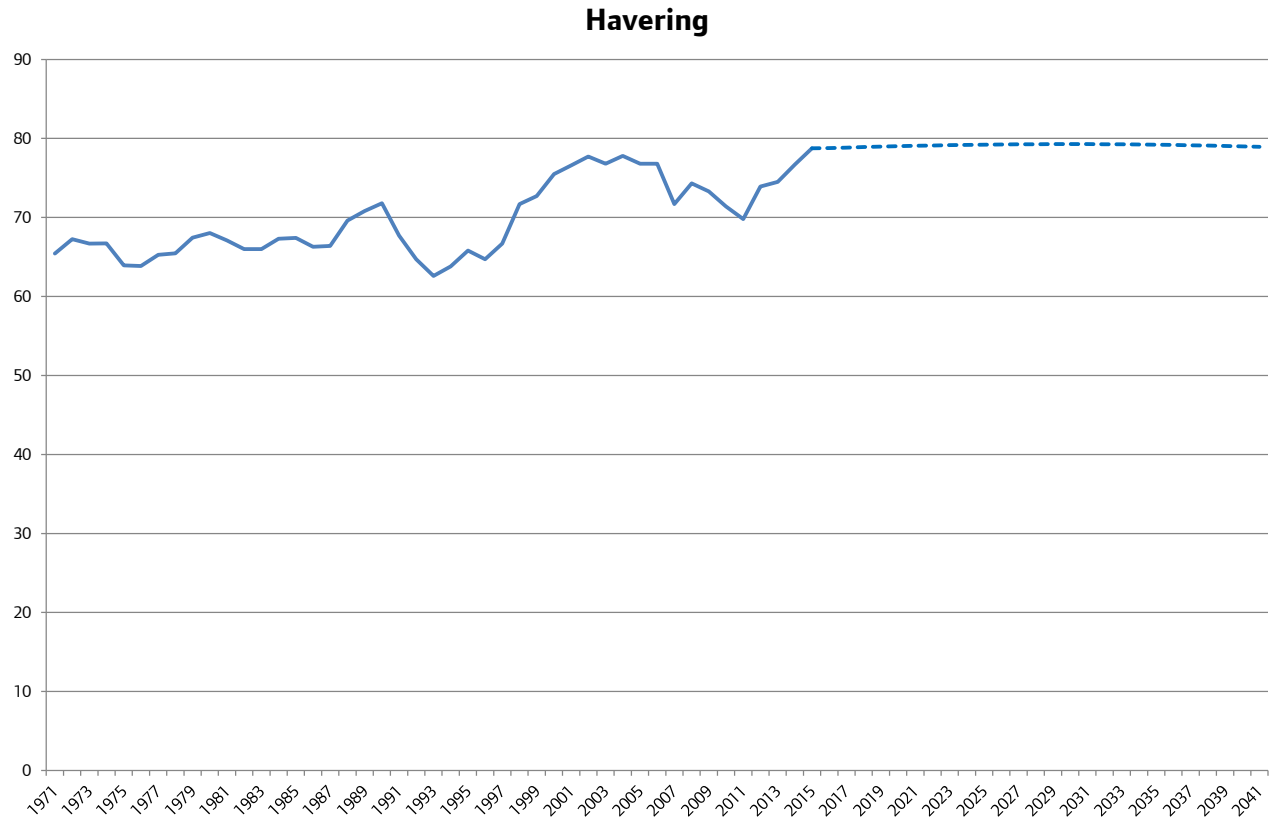


Figure A.2.33 Hillingdon employee trend, 1971-2041

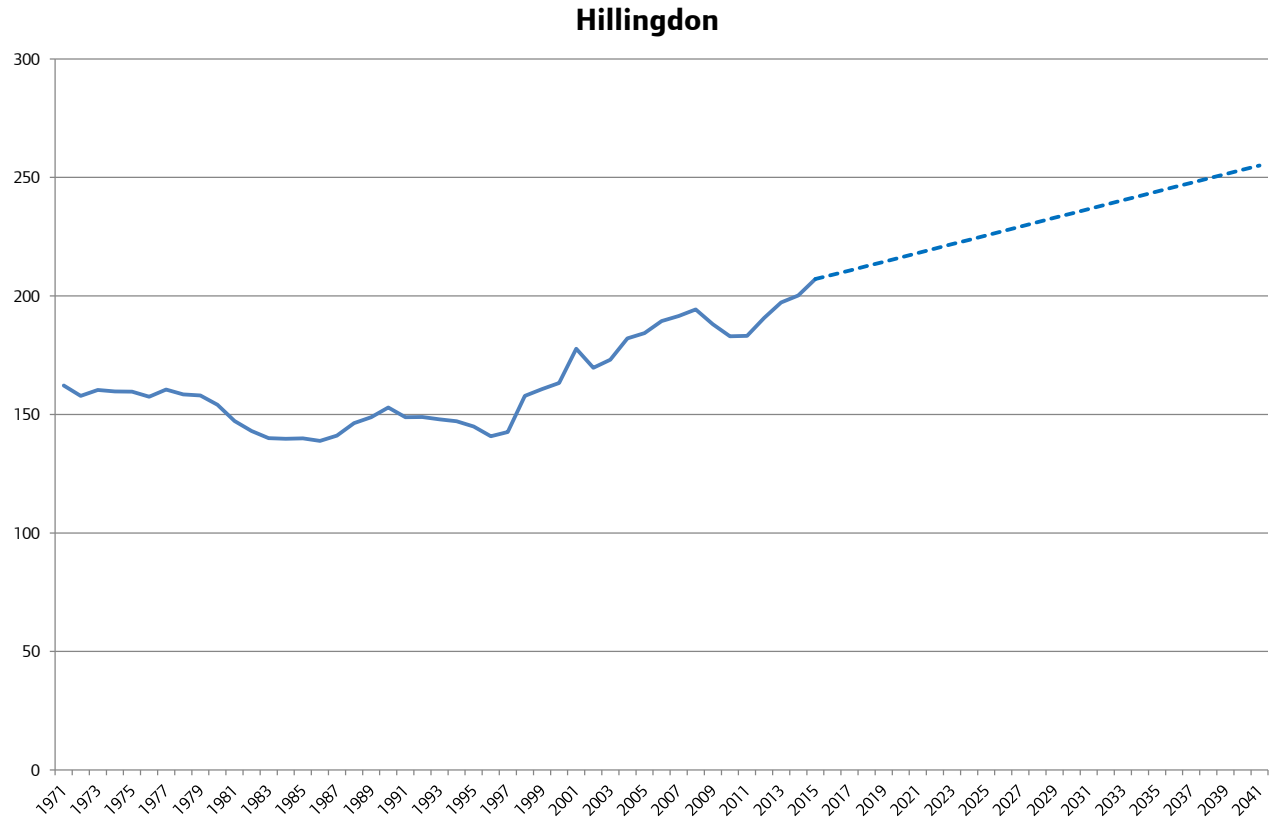


Figure A.2.34 Hounslow employee trend, 1971-2041

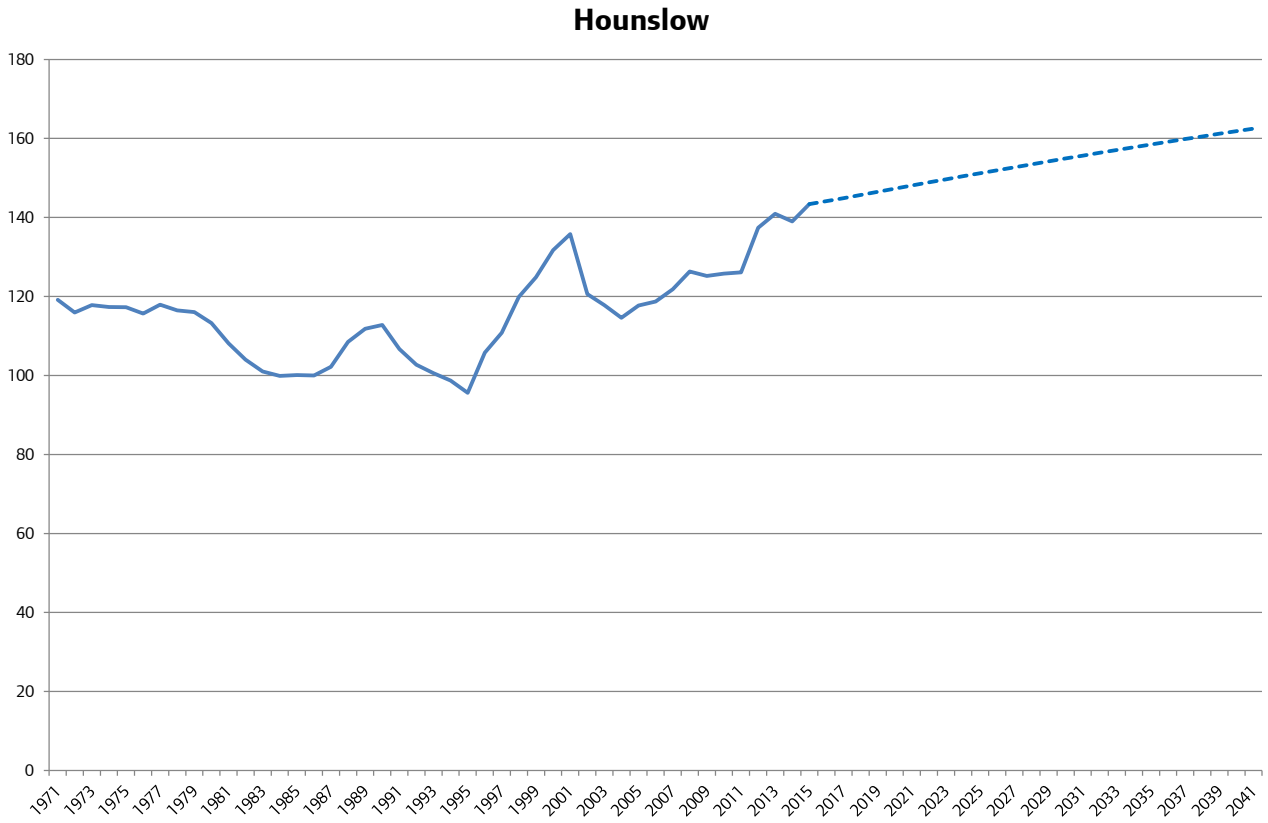


Figure A.2.35 Islington employee trend, 1971-2041

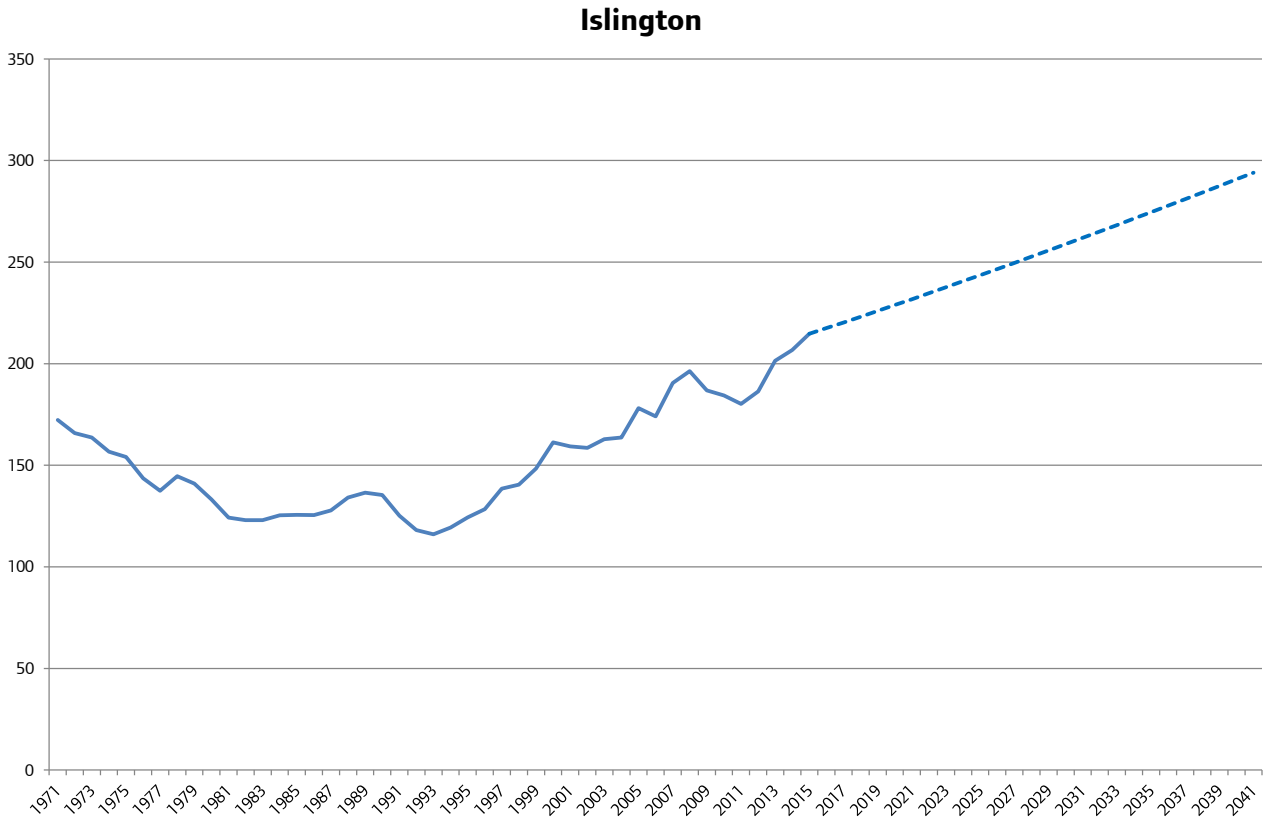


Figure A.2.36 Kensington and Chelsea employee trend, 1971-2041

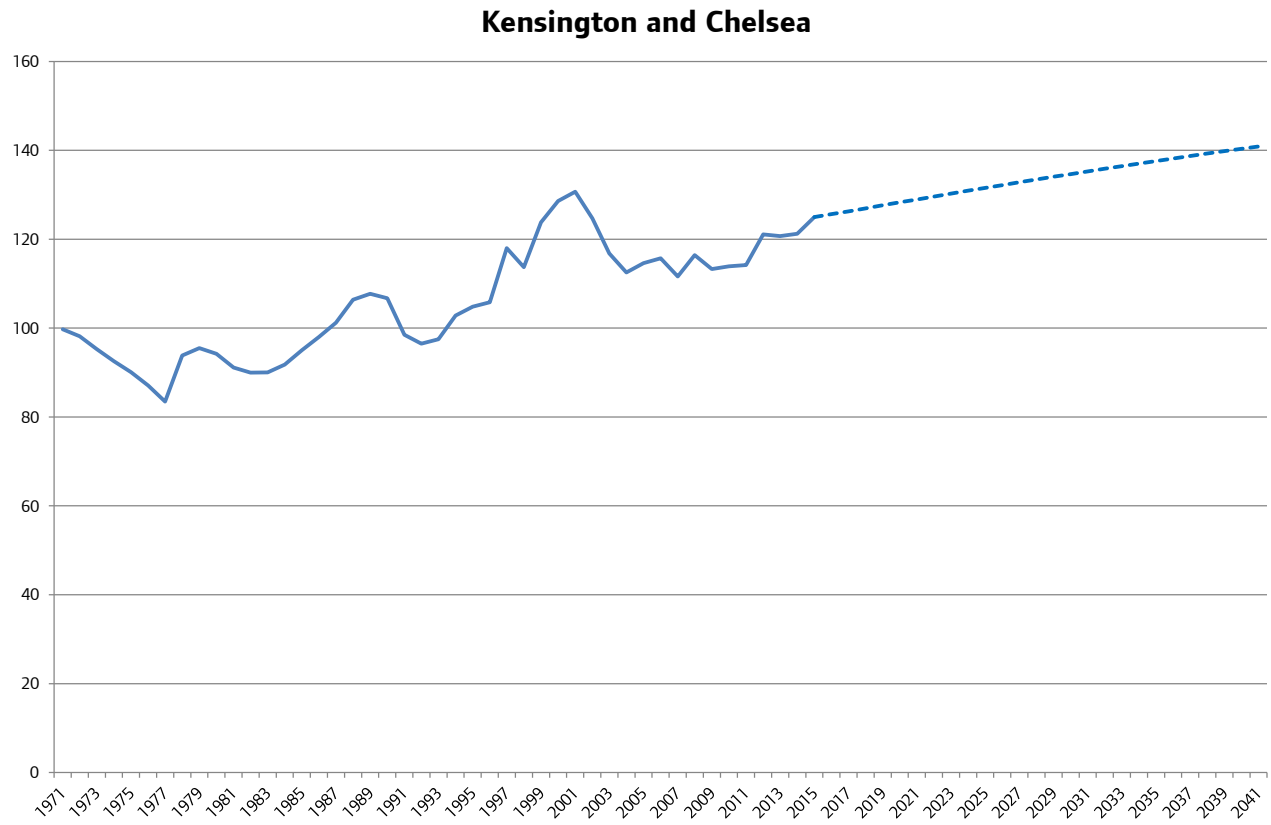


Figure A.2.37 Kingston-upon-Thames employee trend, 1971-2041

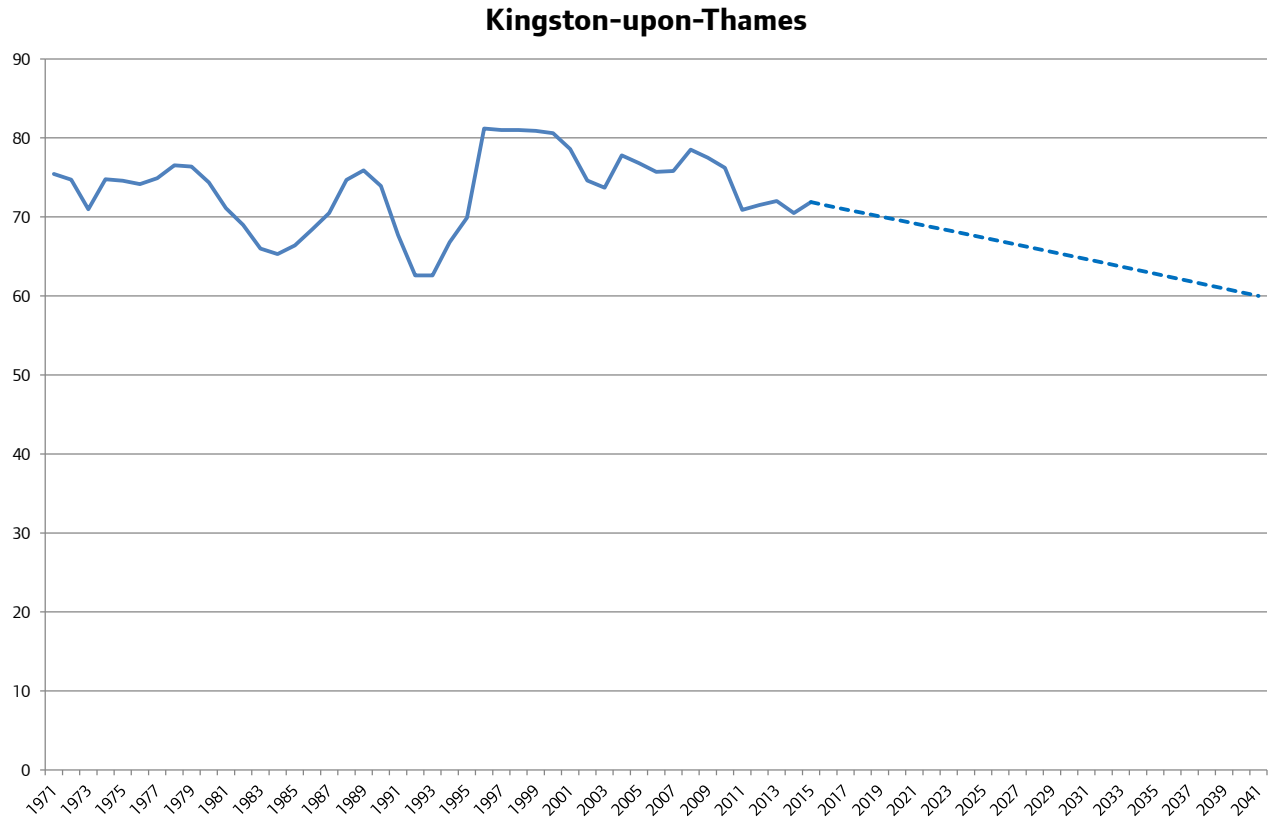


Figure A.2.38 Lambeth employee trend, 1971-2041

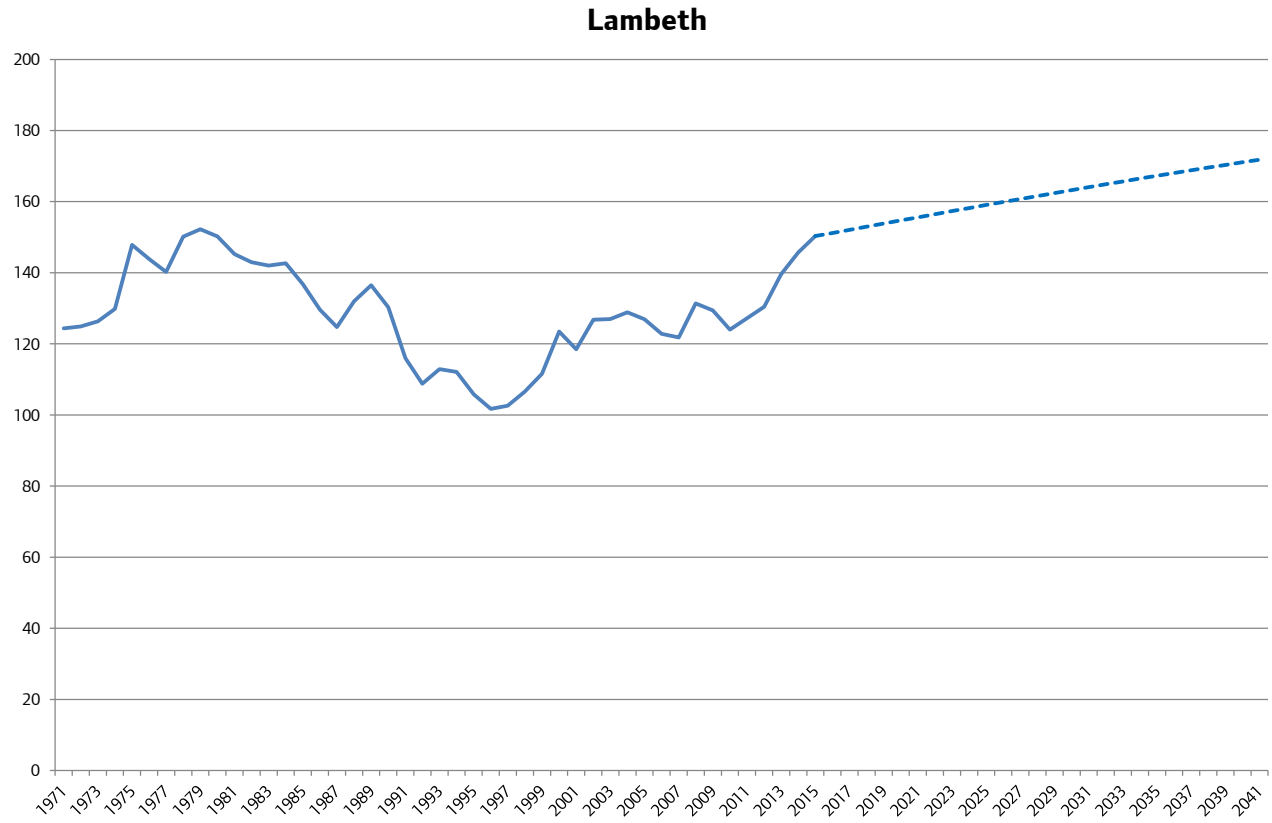


Figure A.2.39 Lewisham employee trend, 1971-2041

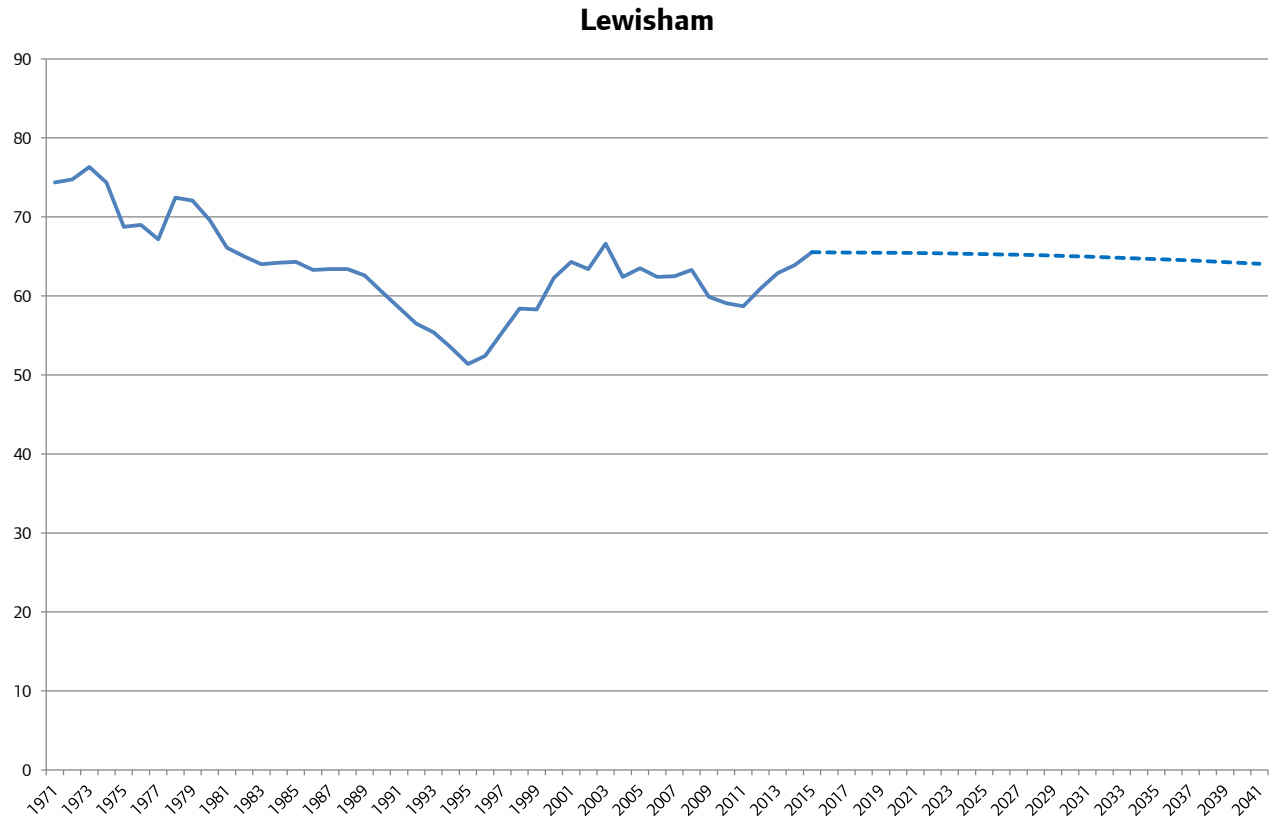


Figure A.2.40 Merton employee trend, 1971-2041

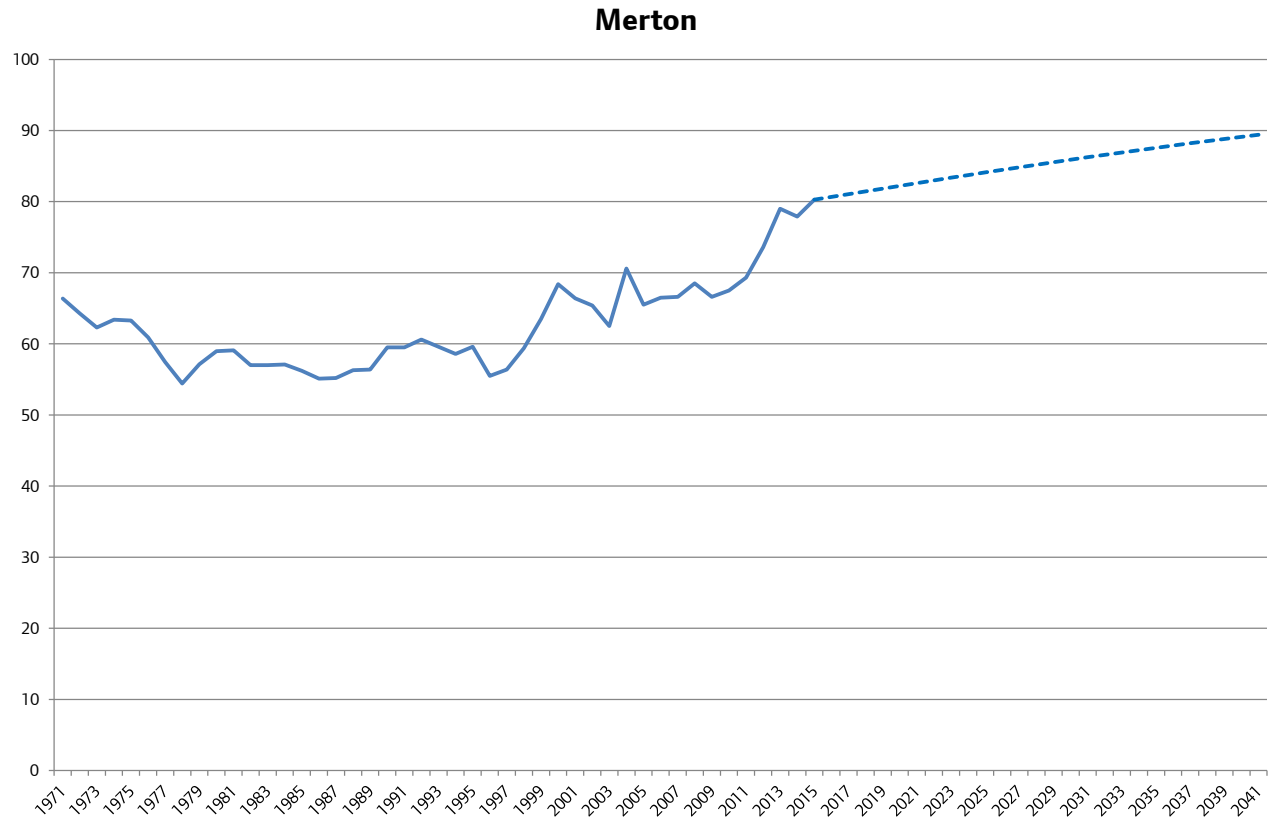


Figure A.2.41 Newham employee trend, 1971-2041

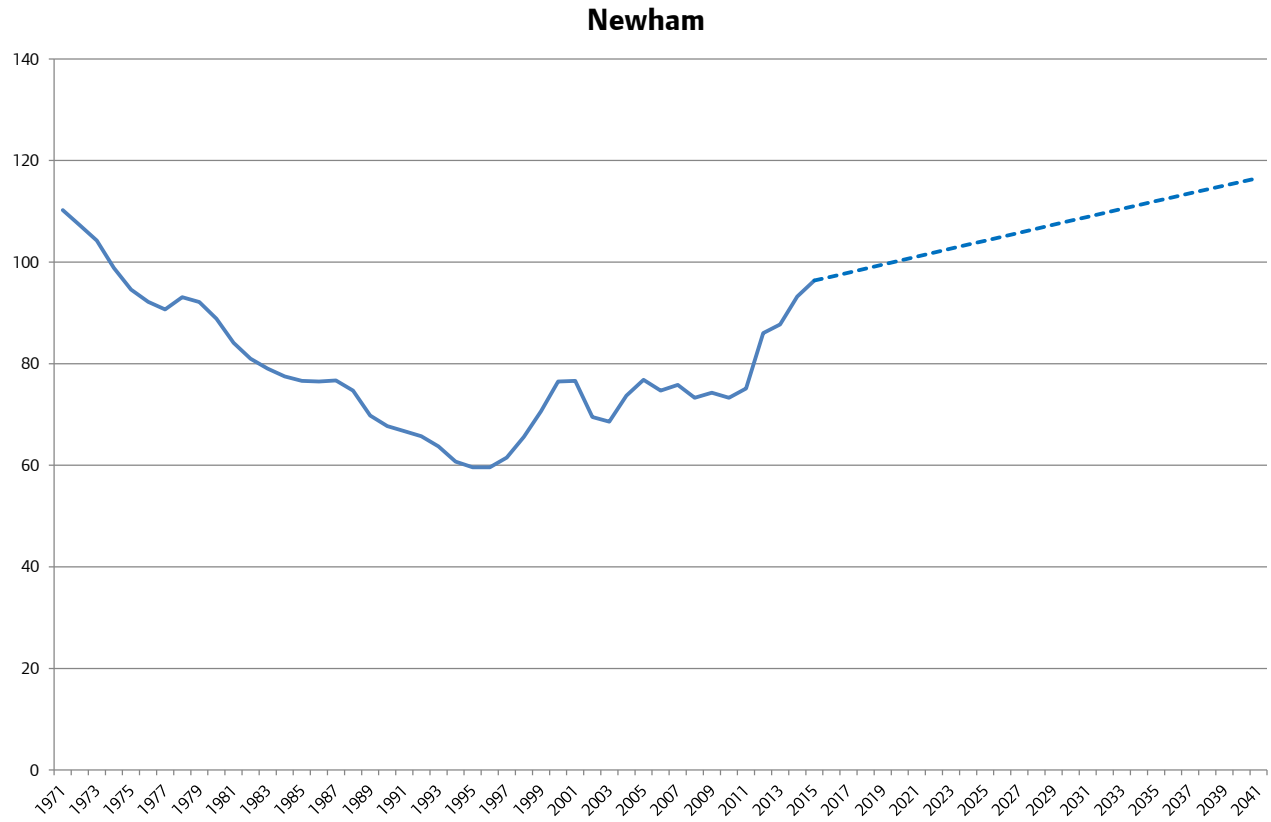


Figure A.2.42 Redbridge employee trend, 1971-2041

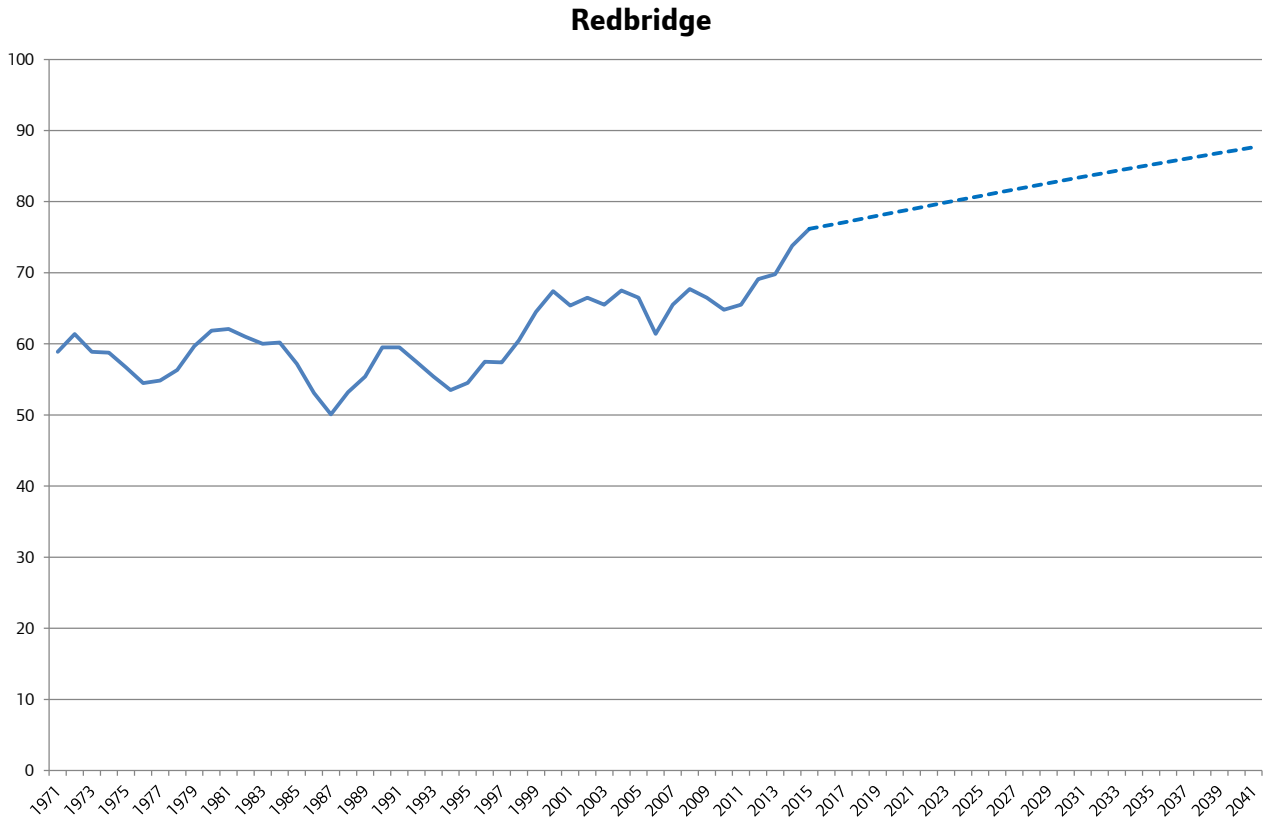


Figure A.2.43 Richmond-upon-Thames employee trend, 1971-2041

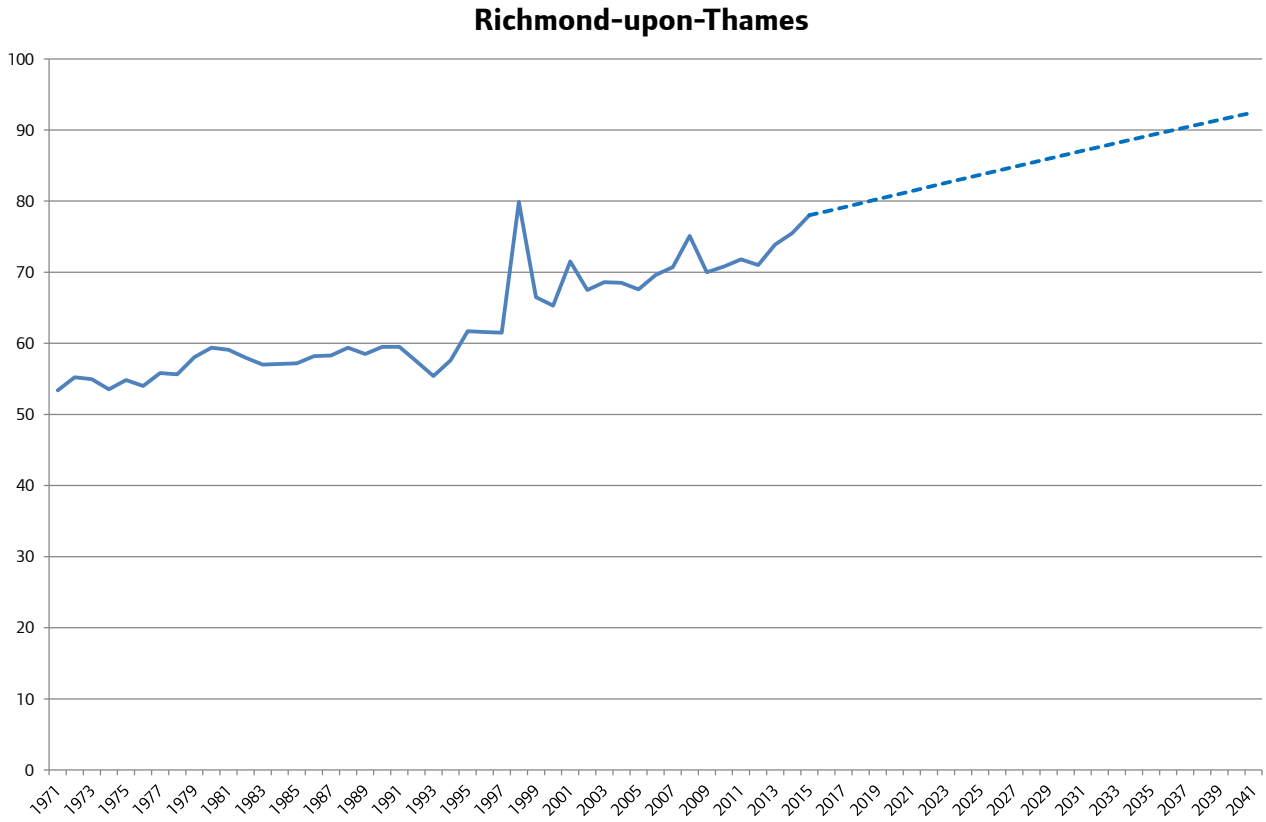


Figure A.2.44 Southwark employee trend, 1971-2041

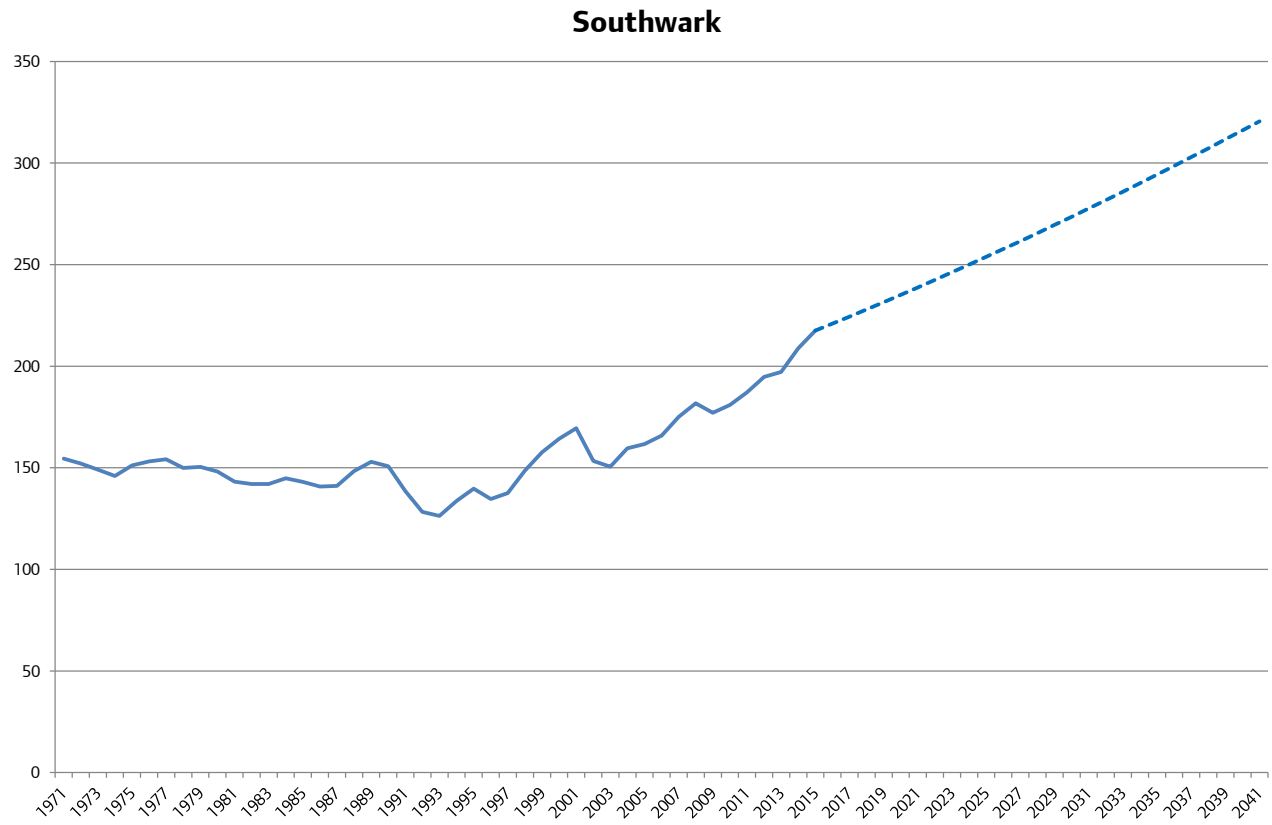


Figure A.2.45 Sutton employee trend, 1971-2041

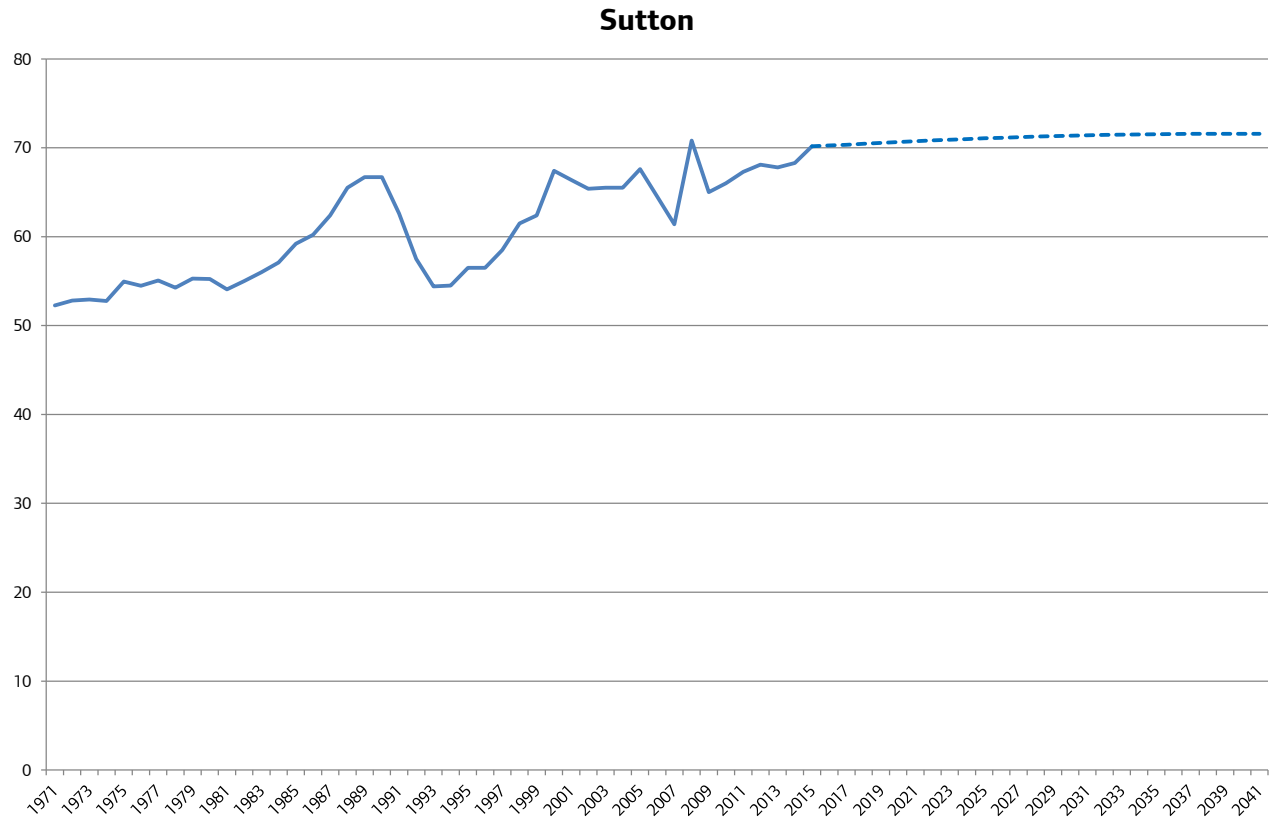


Figure A.2.46 Tower Hamlets employee trend, 1971-2041

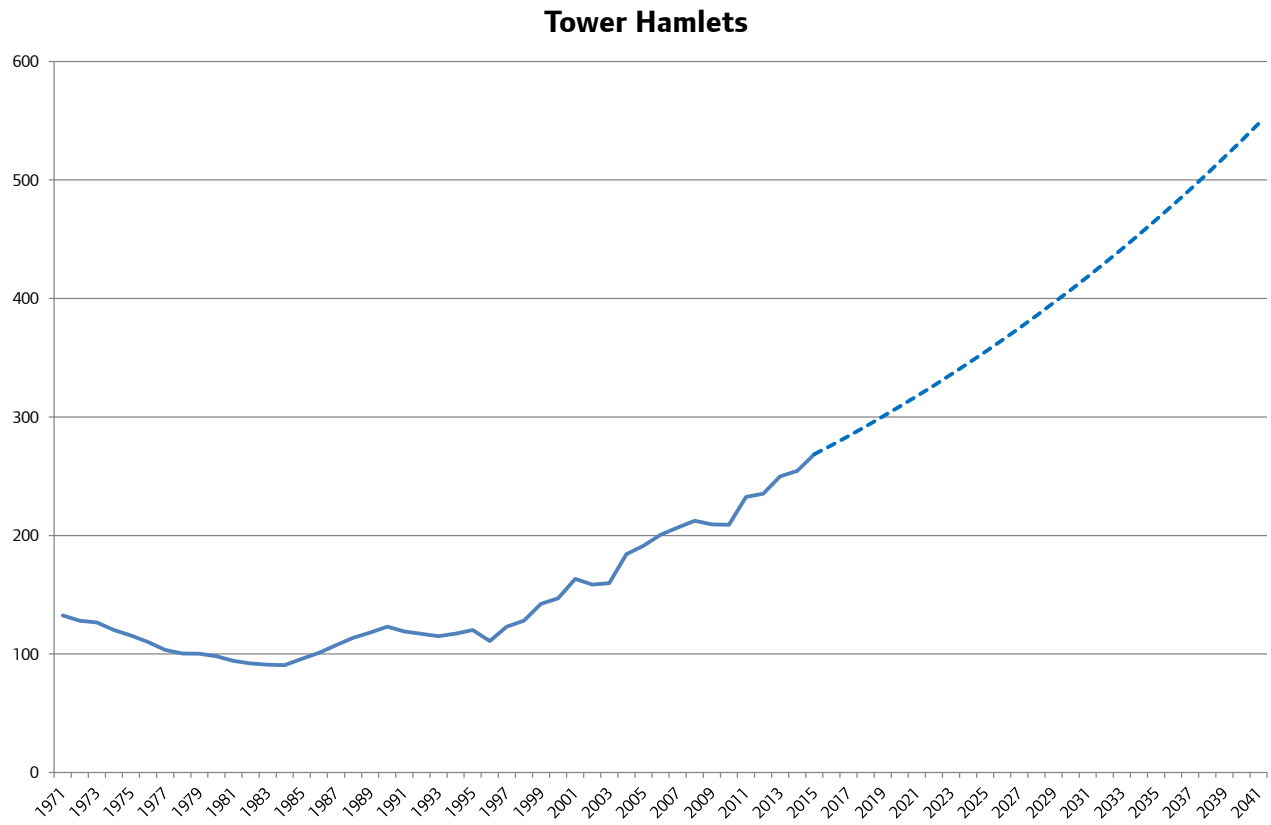


Figure A.2.47 Waltham Forest employee trend, 1971-2041

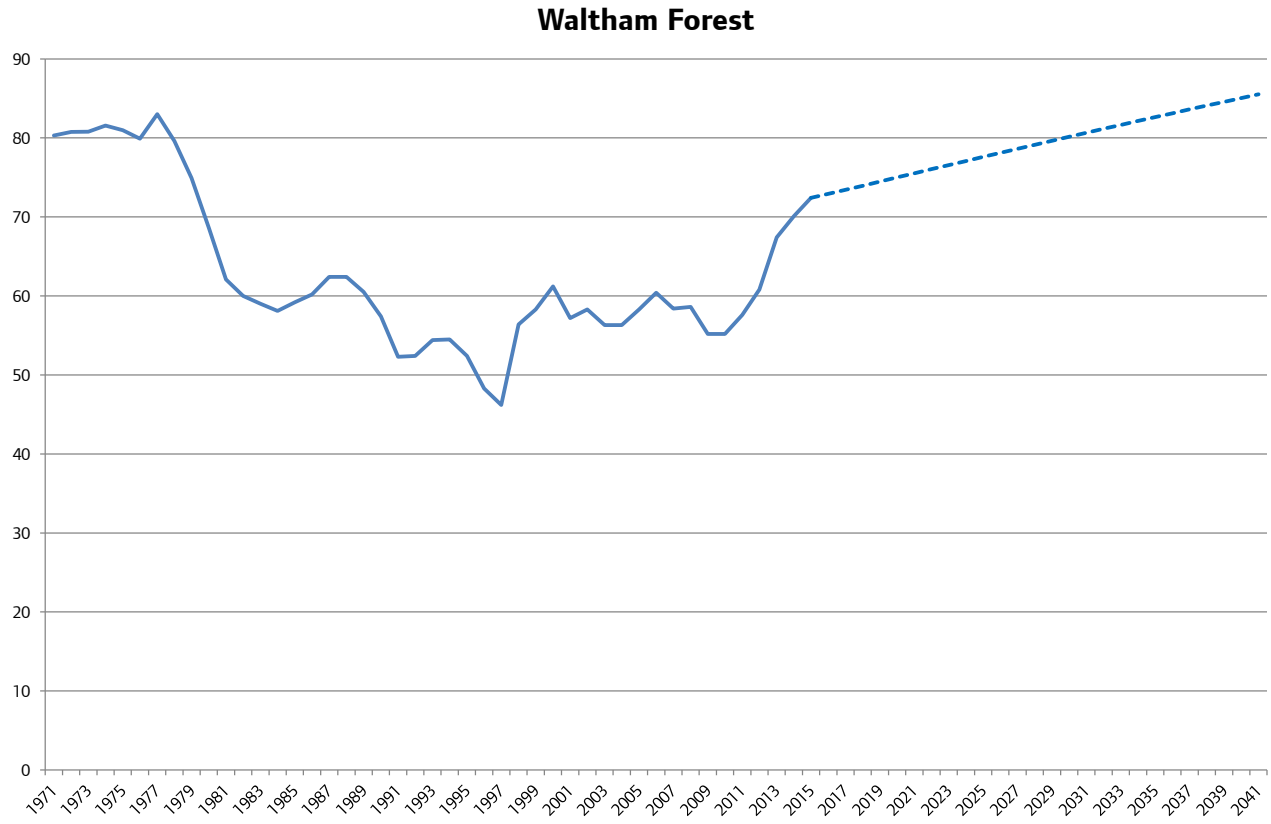


Figure A.2.48 Wandsworth employee trend, 1971-2041

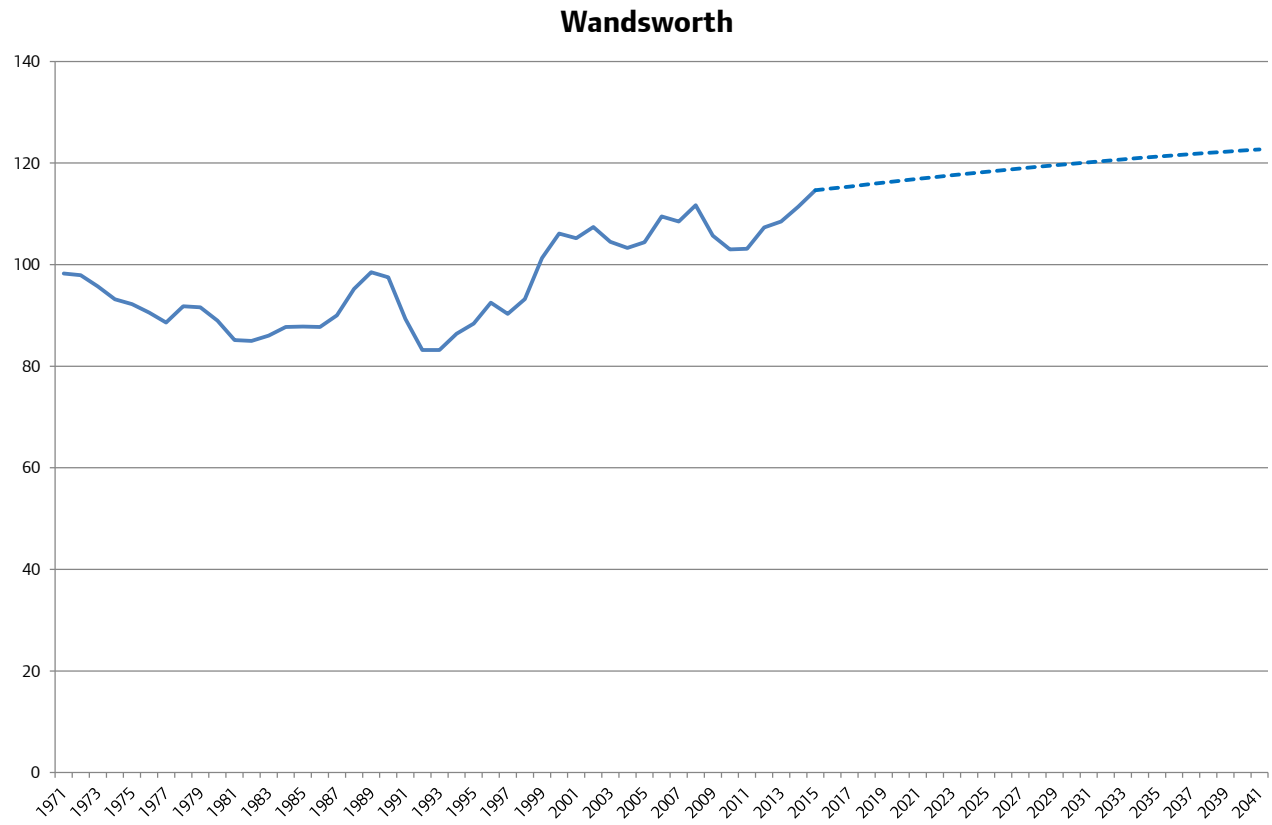
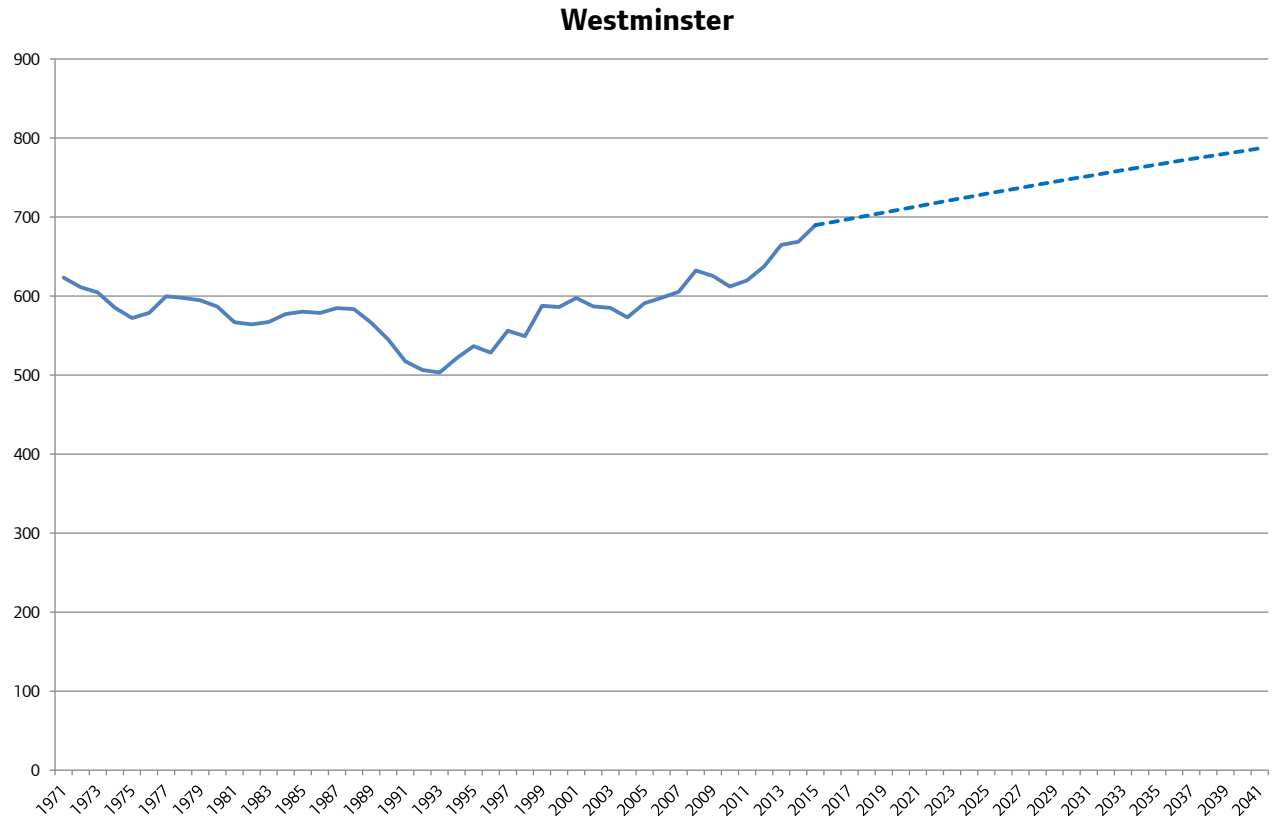


Figure A.2.49 Westminster employee trend, 1971-2041



Appendix 3: London's detailed employment (employees) structure and index of specialisation

Table A.3.1: London's industrial structure and main specialisation, 2014

Sector	London employee jobs	Share of total London employee jobs	London share of rest of GB employee jobs	Index of specialisation
Total London	4,732,800	100.0%	16.9%	1.0
Primary and utilities (Sections A, B, D and E)	28,800	0.6%	5.1%	0.3
C : Manufacturing	113,300	2.4%	4.8%	0.2
F : Construction	144,800	3.1%	11.6%	0.6
G : Retail	406,700	8.6%	14.6%	0.8
G : Wholesale and retail trade, repair of motor vehicles and motorcycles	187,900	4.5%	11.6%	0.7
H : Transportation and storage	227,300	4.8%	18.2%	1.1
I : Accommodation and food service activities	358,000	7.6%	18.1%	1.1
J : Information and communication	372,800	7.9%	32.6%	2.4
K : Financial and insurance activities	351,900	7.4%	34.1%	2.5
L : Real estate activities	107,600	2.3%	23.7%	1.5
M : Professional, scientific and technical activities	613,900	13.0%	27.3%	1.8
N : Administrative and support service activities	490,600	10.4%	20.2%	1.2
O : Public administration and defence; compulsory social security	220,000	4.6%	17.1%	1.0
P : Education	385,700	8.1%	15.0%	0.9
Q : Human health and social work activities	483,700	10.2%	12.9%	0.7
R : Arts, entertainment and recreation	125,200	2.6%	18.3%	1.1
S : Other service activities	114,600	2.4%	20.9%	1.3

Source: Business Register and Employment Survey, ONS. Sector letter prefixes relate to sector codes within the Standard Industrial Classification, SIC2007

Table A.3.2: London's detailed industrial structure and main specialisation, 2014

Sector	London employee jobs	Share of total London employee jobs	London share of rest of GB employee jobs	Index of specialisation
Total London	4,732,800	100.0%	16.9%	1.0
K : Financial and insurance activities	351,900	7.4%	34.1%	2.5
of which				
6630 : Fund management activities	28,200	0.6%	71.0%	12.0
6612 : Security and commodity contracts brokerage	25,500	0.5%	65.1%	9.1
6430 : Trusts, funds and similar financial entities	6,900	0.1%	54.3%	5.8
6419 : Other monetary intermediation	140,300	3.0%	35.0%	2.6
6619 : Other activities auxiliary to financial services, except insurance and pension funding	46,000	1.0%	34.0%	2.5
6499 : Other financial service activities, except insurance and pension funding, n.e.c.	13,200	0.3%	31.0%	2.2
6629 : Other activities auxiliary to insurance and pension funding	24,700	0.5%	30.3%	2.1
6622 : Activities of insurance agents and brokers	32,500	0.7%	29.8%	2.1
6512 : Non-life insurance	13,400	0.3%	19.9%	1.2
6511 : Life insurance	4,300	0.1%	13.9%	0.8
J : Information and communication	372,800	7.9%	32.6%	2.4
of which				
5913 : Motion picture, video and television programme distribution activities	4,500	0.1%	83.3%	24.5
6391 : News agency activities	7,700	0.2%	81.1%	21.0
6020 : Television programming and broadcasting activities	22,100	0.5%	79.8%	19.4
5912 : Motion picture, video and television programme post-production activities	8,600	0.2%	76.1%	15.6
5920 : Sound recording and music publishing activities	5,700	0.1%	70.4%	11.7
5911 : Motion picture, video and television programme production activities	35,900	0.8%	63.9%	8.7
6010 : Radio broadcasting	7,300	0.2%	61.9%	8.0
6312 : Web portals	4,400	0.1%	59.5%	7.2
5814 : Publishing of journals and periodicals	19,800	0.4%	50.5%	5.0
5811 : Book publishing	11,000	0.2%	45.1%	4.0
5813 : Publishing of newspapers	13,300	0.3%	33.9%	2.5
5819 : Other publishing activities	5,500	0.1%	32.7%	2.4
6120 : Wireless telecommunications activities	5,100	0.1%	31.5%	2.3
6201 : Computer programming activities	39,900	0.8%	27.0%	1.8
6202 : Computer consultancy activities	88,500	1.9%	26.6%	1.8
6209 : Other information technology and computer service activities	31,900	0.7%	26.1%	1.7
6190 : Other telecommunications activities	37,500	0.8%	22.5%	1.4
6311 : Data processing, hosting and related activities	9,600	0.2%	22.5%	1.4

M : Professional, scientific and technical activities	613,900	13.0%	27.3%	1.8
of which				
7021 : Public relations and communication activities	11,500	0.2%	58.4%	6.9
7312 : Media representation	7,500	0.2%	51.0%	5.1
7311 : Advertising agencies	42,400	0.9%	45.7%	4.1
7320 : Market research and public opinion polling	19,800	0.4%	40.9%	3.4
7410 : Specialised design activities	17,300	0.4%	36.2%	2.8
7111 : Architectural activities	23,500	0.5%	33.3%	2.5
6910 : Legal activities	86,400	1.8%	32.5%	2.4
7420 : Photographic activities	5,600	0.1%	32.2%	2.3
7022 : Business and other management consultancy activities	135,100	2.9%	30.9%	2.2
6920 : Accounting, bookkeeping and auditing activities; tax consultancy	87,000	1.8%	29.7%	2.1
7010 : Activities of head offices	75,100	1.6%	29.0%	2.0
7490 : Other professional, scientific and technical activities n.e.c.	24,600	0.5%	24.9%	1.6
7219 : Other research and experimental development on natural sciences and engineering	17,000	0.4%	15.9%	0.9
7500 : Veterinary activities	6,600	0.1%	13.6%	0.8
7112 : Engineering activities and related technical consultancy	46,100	1.0%	12.7%	0.7
7120 : Technical testing and analysis	4,100	0.1%	7.9%	0.4
L : Real estate activities	107,600	2.3%	23.7%	1.5
of which				
6832 : Management of real estate on a fee or contract basis	28,200	0.6%	31.4%	2.2
6831 : Real estate agencies	38,300	0.8%	26.6%	1.8
6820 : Renting and operating of own or leased real estate	39,100	0.8%	18.4%	1.1
S : Other service activities	114,600	2.4%	20.9%	1.3
of which				
9411 : Activities of business and employers membership organisations	7,800	0.2%	55.3%	6.1
9412 : Activities of professional membership organisations	16,100	0.3%	54.4%	5.9
9491 : Activities of religious organisations	16,300	0.3%	26.2%	1.7
9601 : Washing and (dry-)cleaning of textile and fur products	6,000	0.1%	21.1%	1.3
9499 : Activities of other membership organisations n.e.c.	20,400	0.4%	17.9%	1.1
9602 : Hairdressing and other beauty treatment	19,900	0.4%	17.0%	1.0
9609 : Other personal service activities n.e.c.	14,300	0.3%	15.8%	0.9

Source: Business Register and Employment Survey, ONS

Note: London data are based on 4-digit Standard Industrial Classification level data (SIC2007)

Appendix 4: Long-run employment projection scenarios

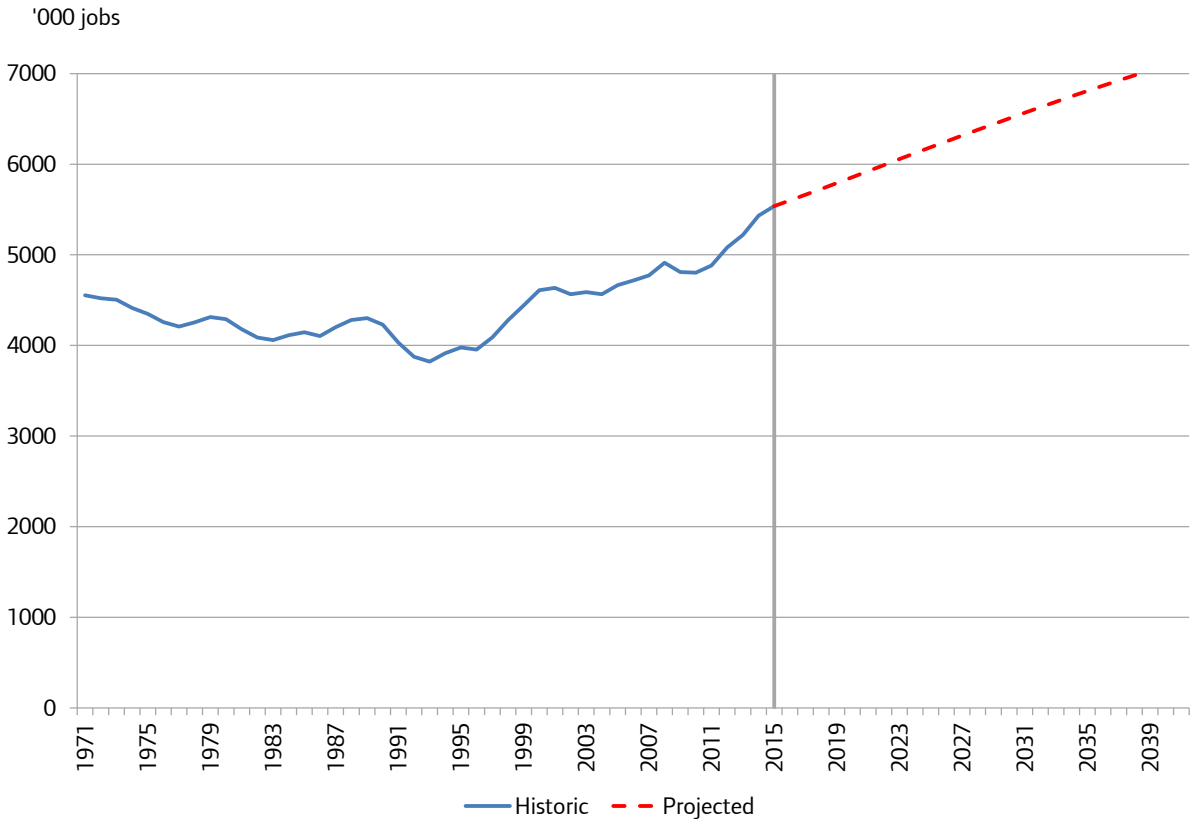
This appendix looks at two scenarios around the GLA's central projections for employment over time. The first scenario looks at a scenario where growth is faster than is assumed in the central projections whilst the second scenario looks at the projection if growth is slower than assumed.

Scenario 1: Faster than assumed growth

The methodology for the two scenarios considered is the same as that for the central scenario (explained in Appendix 5) except rather than assume a year-on-year growth rate in London's output of 2.5 per cent the faster growth scenario assumes a growth rate of 2.9 per cent and the slower growth scenario assumes 2.1 per cent up to 2017. Thereafter in both scenarios the growth rate tapers steadily to a 2.5 per cent rate in 2041. The results from the two scenarios show how sensitive our central projection results are to the growth assumption.

If London's output were to grow at 2.9 per cent before slowing over time, year-on-year employment would be projected to grow at 1.0 per cent each year from 2016 to 2041. This means that the number of jobs in London will increase by 1,609,000 from the 2015 value of 5,538,000. This equates to a 29.0 per cent increase.

Figure A.4.1: London's historic and projected employment with faster growth (1971-2041)



Whilst London-wide employment is projected to grow even more this is still not the case for all sectors within London. Large differences are still expected across sectors. Table A.4.1 shows that employment growth for sectors is projected to range from 1.8 per cent year-on-year growth (for Professional, Real Estate, Scientific and Technical Activities) to a 1.8 per cent year-on-year decline (for Manufacturing). Figures A.4.2 and A.4.3 also show how projected employment numbers differ across sectors. Professional, real estate, scientific and technical activities are projected to see an increase of 503,000 jobs by 2041. This accounts for nearly a third of all the employment increase expected in London. Information and communication, education, health and social work, administrative and support service activities, and accommodation and food service activities are also expected to see large increases in employment numbers.

Table A.4.1: Summary of employment projections by sector, 2015-2041

	Employment growth per annum with London output growth of 2.5-2.9% per annum	Absolute change in employment numbers ('000 jobs)
Professional, Real Estate, Scientific and Technical Activities	1.8%	503
Information and Communication	1.5%	203
Education	1.4%	189
Arts, Entertainment and Recreation	1.4%	86
Health and Social Work	1.1%	187
Administrative and Support Service Activities	1.1%	185
Accommodation and Food Service Activities	1.1%	120
Construction	1.0%	90
Total London Employment	1.0%	1609
Other Services	0.9%	41
Financial and Insurance Activities	0.7%	81
Retail	0.3%	36
Public Administration	-0.1%	-7
Transportation and Storage	-0.3%	-21
Primary & Utilities	-0.3%	-3
Wholesale	-0.6%	-31
Manufacturing	-1.8%	-48

Figure A.4.2: Employment projections for London's larger sectors

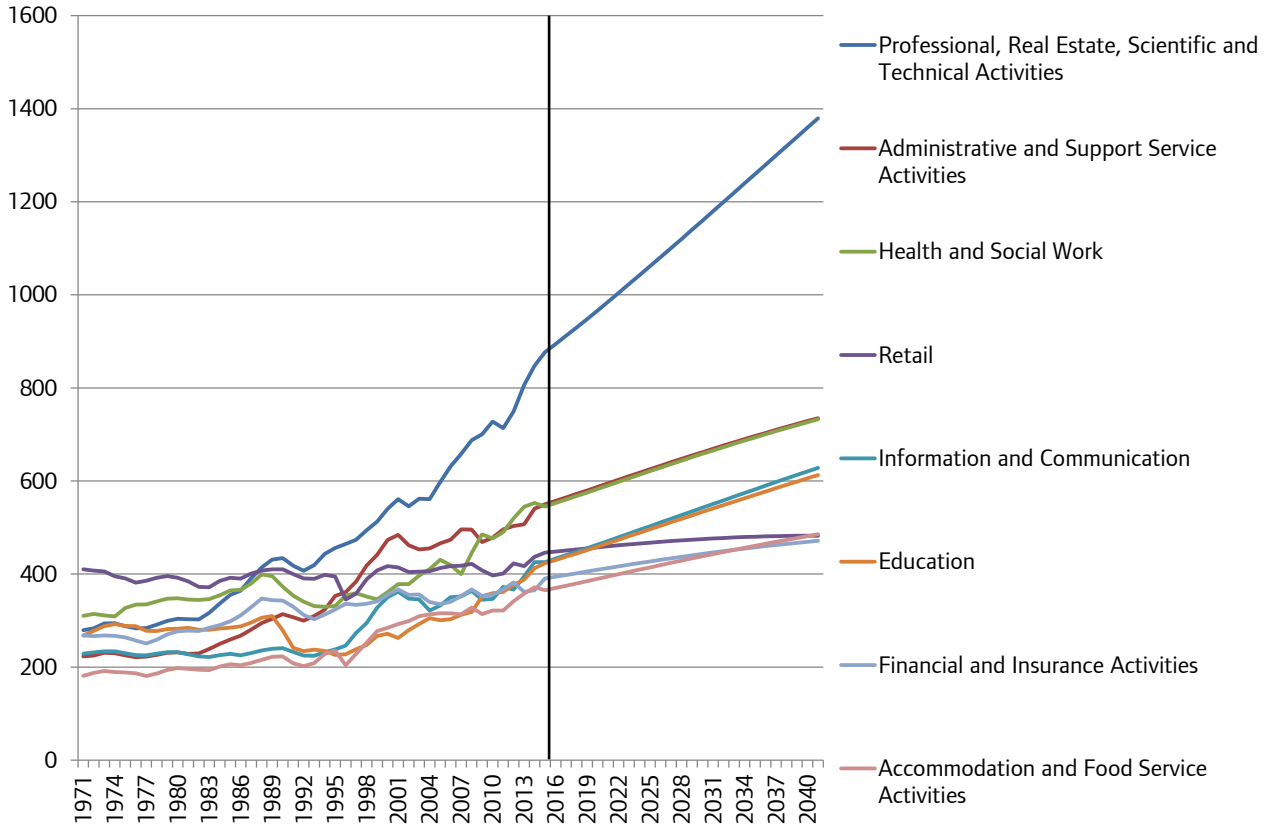
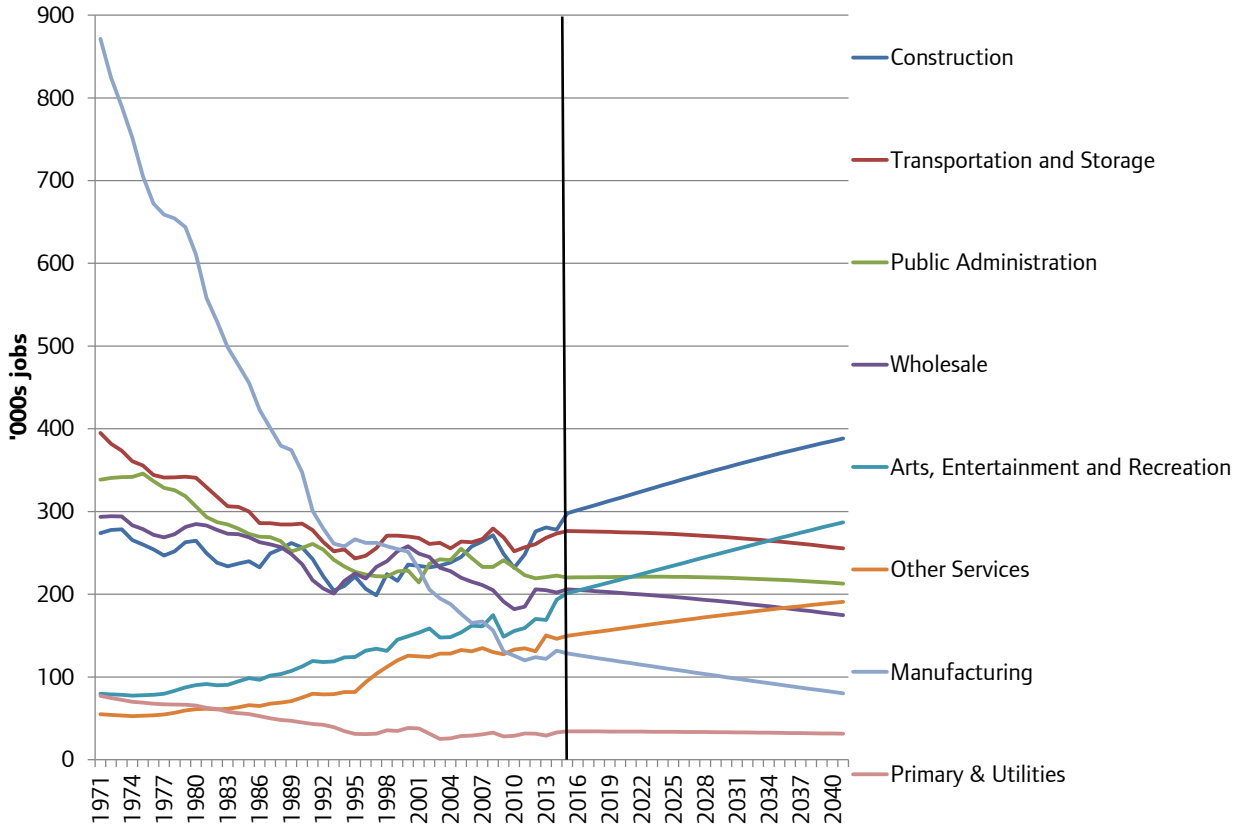


Figure A.4.3: Employment projections for London's smaller sectors



Scenario 1: Occupation Projections (faster growth)

The methodology used to construct occupation projections for sectors is the same as the central scenario (see Appendix 5) except that the faster growth scenario employment projections are used.

A summary of the expected demand for occupations is presented in Tables A.4.2 and A.4.3 and Figure A.4.4. Demand for professional occupations in London is projected to see a large increase from its current position. A total 664,000 more jobs (equivalent to a 1.6 per cent year-on-year increase) is expected between 2014 and 2041 (Table A.4.2). This makes up nearly two fifths of the total job increases expected in London over this period. A large proportion of the increase in Professional Occupations (over a quarter) is expected to come from the Information and Communication sector (Table A.4.3).

The fastest growing occupation is managers, directors, and senior officials which is projected to grow at 2.0 per cent a year, and create 491,000 more jobs, or more than a quarter of all new jobs. Nearly one half of these 491,000 jobs will be in professional, real estate, scientific and technical activities.

Table A.4.2: Year-on-Year Change in Occupation Employment within Sectors (2014 to 2041)

	Managers, Directors And Senior Officials	Professional Occupations	Associate Professional And Technical Occupations	Administrative And Secretarial Occupations	Skilled Trades Occupations	Caring, Leisure And Other Service Occupations; and Sales And Customer Service Occupations	Process, Plant And Machine Operatives; and Elementary Occupations	Total
Primary & utilities	1.2%	0.9%	0.5%	-4.0%	-3.3%	-5.5%	-1.2%	-0.2%
Manufacturing	-0.9%	-3.0%	-1.9%	-2.4%	-2.0%	-1.2%	-1.5%	-1.8%
Construction	0.8%	2.5%	-3.2%	-3.3%	0.6%	-6.5%	3.6%	1.2%
Wholesale	-0.7%	1.7%	0.2%	-5.4%	-2.0%	-0.4%	0.2%	-0.5%
Retail	0.7%	1.9%	1.4%	0.1%	-1.5%	0.3%	-1.4%	0.4%
Transportation and Storage	-1.4%	1.5%	-1.8%	-0.3%	-3.6%	-0.0%	-0.1%	-0.3%
Accomodation and Food Service Activities	1.2%	-15.5%	-2.5%	-0.1%	0.1%	3.2%	1.0%	1.0%
Information and Communication	3.4%	2.4%	-1.0%	-5.0%	-6.3%	-2.4%	0.3%	1.5%
Financial and Insurance Activities	1.9%	2.4%	0.5%	-3.7%	0.2%	-6.6%	0.1%	0.9%
Professional, Real Estate, Scientific and Technical Activities	3.7%	1.3%	1.9%	-0.5%	3.9%	0.8%	-4.2%	1.8%
Administrative and Support Service Activities	2.1%	-2.6%	-4.0%	-3.1%	3.4%	-0.6%	2.6%	1.1%
Public Administration and Defence	-0.6%	1.6%	-0.8%	-1.6%	-7.7%	-0.5%	-2.5%	-0.2%
Education	1.8%	1.4%	1.6%	-0.3%	-0.9%	2.2%	1.6%	1.5%
Health	0.9%	1.3%	1.0%	-0.4%	1.2%	1.4%	-1.4%	1.0%
Arts, Entertainment and Recreation	2.6%	1.3%	1.2%	-2.6%	4.4%	1.6%	0.7%	1.5%
Other Service Occupations	1.1%	1.1%	1.9%	-2.6%	1.3%	1.6%	-3.3%	1.0%
Total London	2.0%	1.6%	0.5%	-1.4%	0.8%	0.9%	1.2%	1.0%

Note: Base year in table is 2014, the last year of historic data, and so reported sector growth may be slightly different to employment projections, which have base year 2015

Table A.4.3: Absolute change in occupation employment by sector ('000s, 2014 to 2041)

	Managers, Directors And Senior Officials	Professional Occupations	Associate Professional And Technical Occupations	Administrative And Secretarial Occupations	Skilled Trades Occupations	Caring, Leisure And Other Service Occupations; and Sales And Customer Service Occupations	Process, Plant And Machine Operatives; and Elementary Occupations	Total
Primary & utilities	2	2	1	-2	-2	-1	-2	-2
Manufacturing	-5	-10	-10	-6	-11	-1	-8	-51
Construction	9	36	-9	-10	22	-2	63	110
Wholesale	-7	6	2	-16	-12	-3	2	-27
Retail	15	13	18	1	-4	16	-14	45
Transportation and Storage	-7	9	-8	-2	-5	-0	-5	-18
Accomodation and Food Service Activities	22	-3	-4	-0	2	44	54	114
Information and Communication	89	175	-26	-20	-12	-5	1	203
Financial and Insurance Activities	51	80	19	-38	0	-6	0	106
Professional, Real Estate, Scientific and Technical Activities	231	129	155	-13	33	8	-10	532
Administrative and Support Service Activities	47	-15	-60	-30	55	-9	206	194
Public Administration and Defence	-4	31	-15	-16	-1	-1	-4	-10
Education	8	103	20	-2	-1	57	16	200
Health	12	88	23	-6	3	65	-5	180
Arts, Entertainment and Recreation	21	12	35	-7	20	9	3	93
Other Service Occupations	5	9	15	-7	4	25	-7	44
Total London	491	664	155	-176	92	197	292	1714

Note: Total London may not add to total from London-wide employment projections due to rounding.
Base year in table is 2014, the last year of historic data, and so reported sector growth may be slightly different to employment projections, which have base year 2015

Administrative and Secretarial Occupations are still the only occupation group expected to see a London-wide decline in demand (Figure A.4.4). These are projected to decline by 176,000 from 2014 to a total of 373,000 by 2041. This equates to a year-on-year decline of 1.4 per cent. Their share of jobs falls from 15% in 2001 to 5% in 2041 (Figure A.4.5). In contrast the proportion of London's jobs in managerial or professional occupations rises from 30% to just under 45% over the same period.

Figure A.4.4: Changes in Occupation Demand (2001 to 2041)

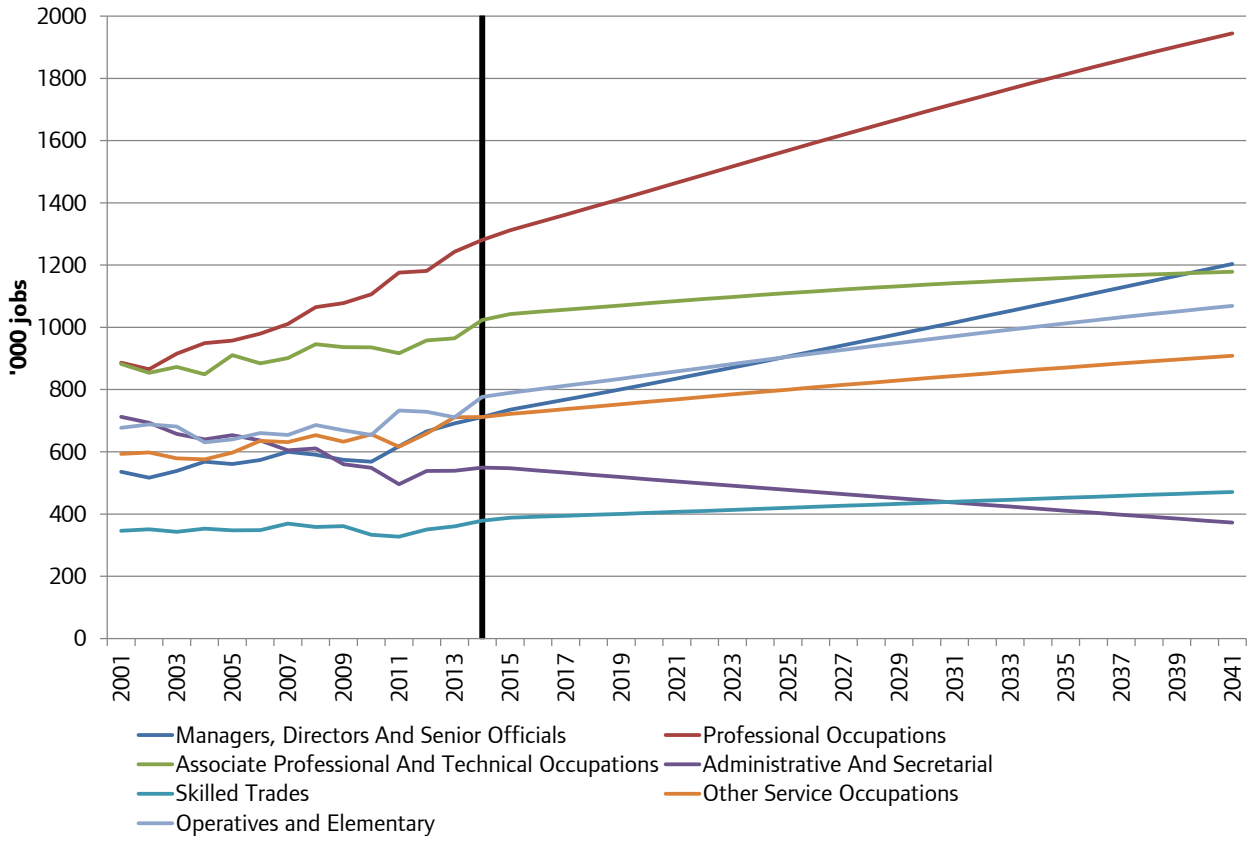
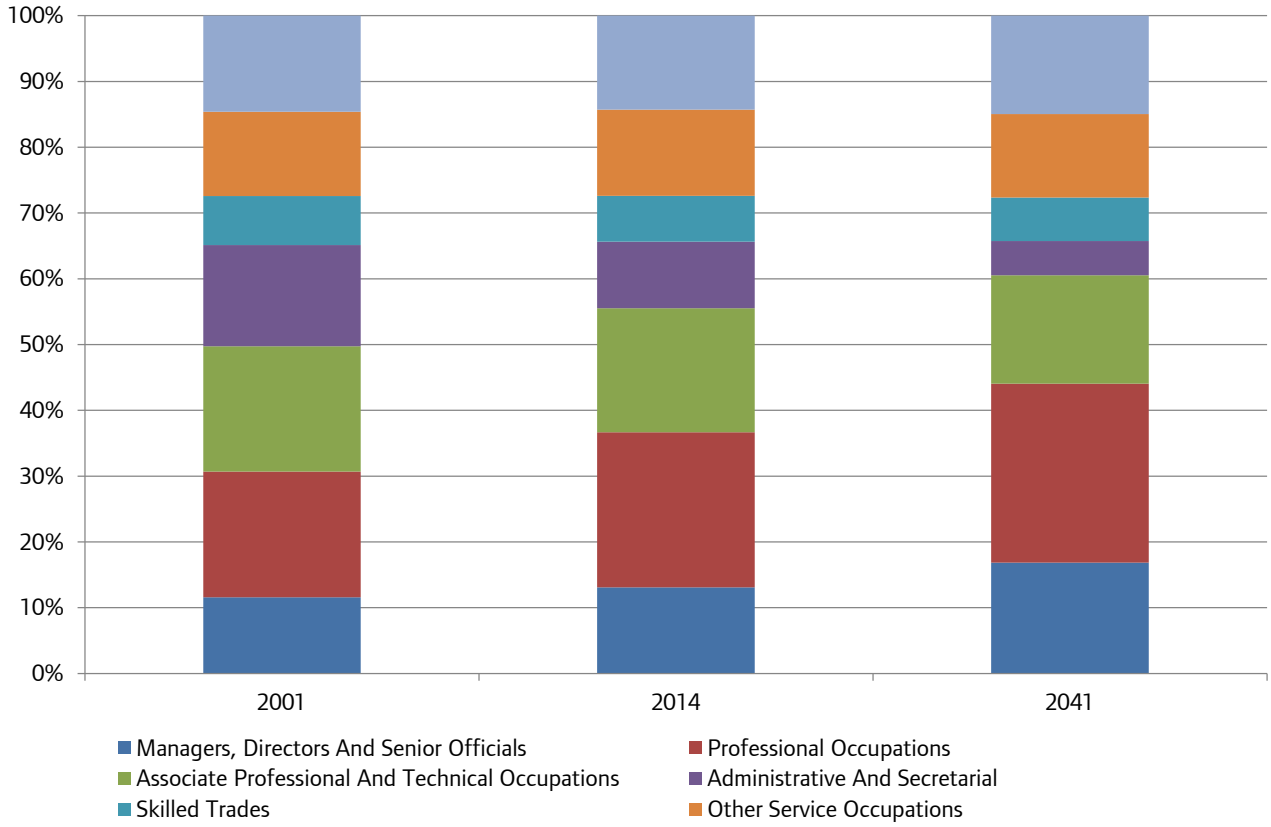


Figure A.4.5: Changes in occupation shares



Qualification Projections (faster growth)

A summary of the expected demand for qualifications is presented in Tables A.4.4 and A.4.5 and Figure A.4.6. The highest growth rate of any qualification class is in higher degrees, where growth of 1.6 per cent per annum is projected for the 2014-2041 period (see Table A.4.4).

Table A.4.4: Year-on-Year Change in Qualification Employment within Occupations (2014 to 2041)

	Higher degree	Ordinary degree or equivalent	Higher education	GCE, A-level or equivalent	GCSE grades A* - C or equivalent	Other qualifica-tions	No qualifi-cation	Total
Managers, Directors And Senior Officials	2.3%	2.1%	2.6%	1.4%	2.0%	0.9%	-1.6%	2.0%
Professional Occupations	1.7%	1.6%	1.5%	1.3%	1.2%	0.5%	1.5%	1.6%
Associate Professional and Technical Occupations	0.8%	0.6%	0.8%	0.3%	0.5%	-0.9%	-1.2%	0.5%
Administrative and Secretarial Occupations	-0.6%	-0.6%	-1.1%	-1.8%	-1.9%	-4.1%	-5.2%	-1.4%
Skilled Trades Occupations	1.7%	1.9%	1.0%	0.2%	1.0%	1.3%	-0.5%	0.8%
Caring, Leisure And Other Service Occupations; and Sales And Customer Service Occupations	2.1%	1.8%	1.4%	1.1%	0.1%	-0.3%	-1.6%	0.9%
Process, Plant And Machine Operatives; and Elementary Occupations	2.4%	1.7%	2.1%	1.1%	1.4%	1.1%	-0.3%	1.2%
Total London	1.6%	1.3%	1.3%	0.7%	0.6%	0.6%	-0.8%	1.0%

Note: Base year in table is 2014, the last year of historic data, and so reported employment growth may be slightly different to employment projections, which have base year 2015

In terms of absolute increases, ordinary degree or equivalent holders are projected to see the greatest absolute increase in numbers (increase of 792,000, equal to 45 per cent of total increase in jobs). This growth is largely driven by the growth in professional occupations, and managers, directors, and senior officials (see, Table A.4.5).

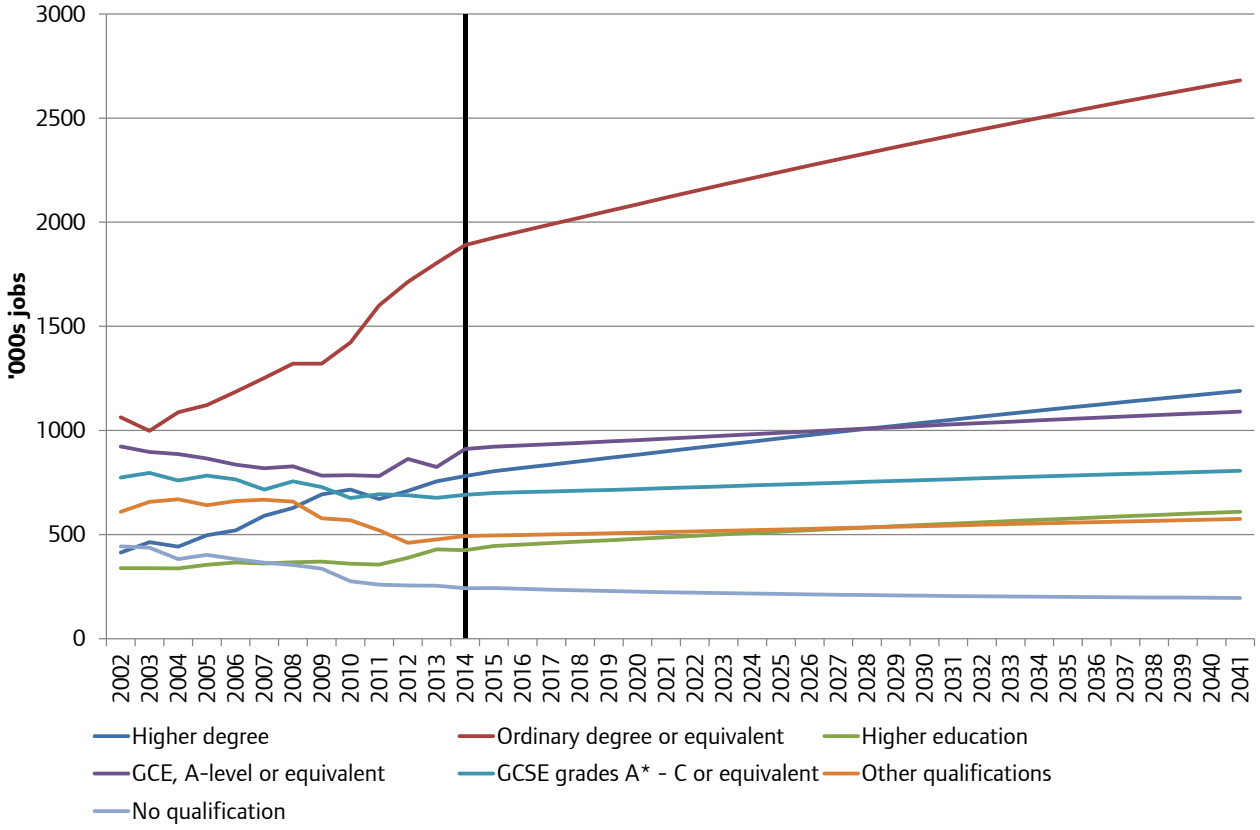
Higher degree holders are also projected to see large increases in numbers, an increase of 409,000 over the projection period. Again, this is largely driven by demand from professional occupations, and managers, directors, and senior officials.

Table A.4.5: Absolute change in qualification employment by occupation ('000s, 2014 to 2041)

	Higher degree	Ordinary degree or equivalent	Higher education	GCE, A-level or equivalent	GCSE grades A* - C or equivalent	Other qualifica-tions	No qualifi-cation	Total
Managers, Directors And Senior Officials	103	236	49	51	47	11	-5	491
Professional Occupations	241	322	46	34	14	2	4	664
Associate Professional and Technical Occupations	35	85	18	13	14	-7	-3	155
Administrative and Secretarial Occupations	-5	-28	-11	-40	-53	-25	-13	-176
Skilled Trades Occupations	4	25	11	5	18	34	-5	92
Caring, Leisure And Other Service Occupations; and Sales And Customer Service Occupations	20	95	34	65	6	-6	-16	197
Process, Plant And Machine Operatives; and Elementary Occupations	12	57	39	51	69	72	-8	292
Total London	409	792	185	180	115	82	-47	1714

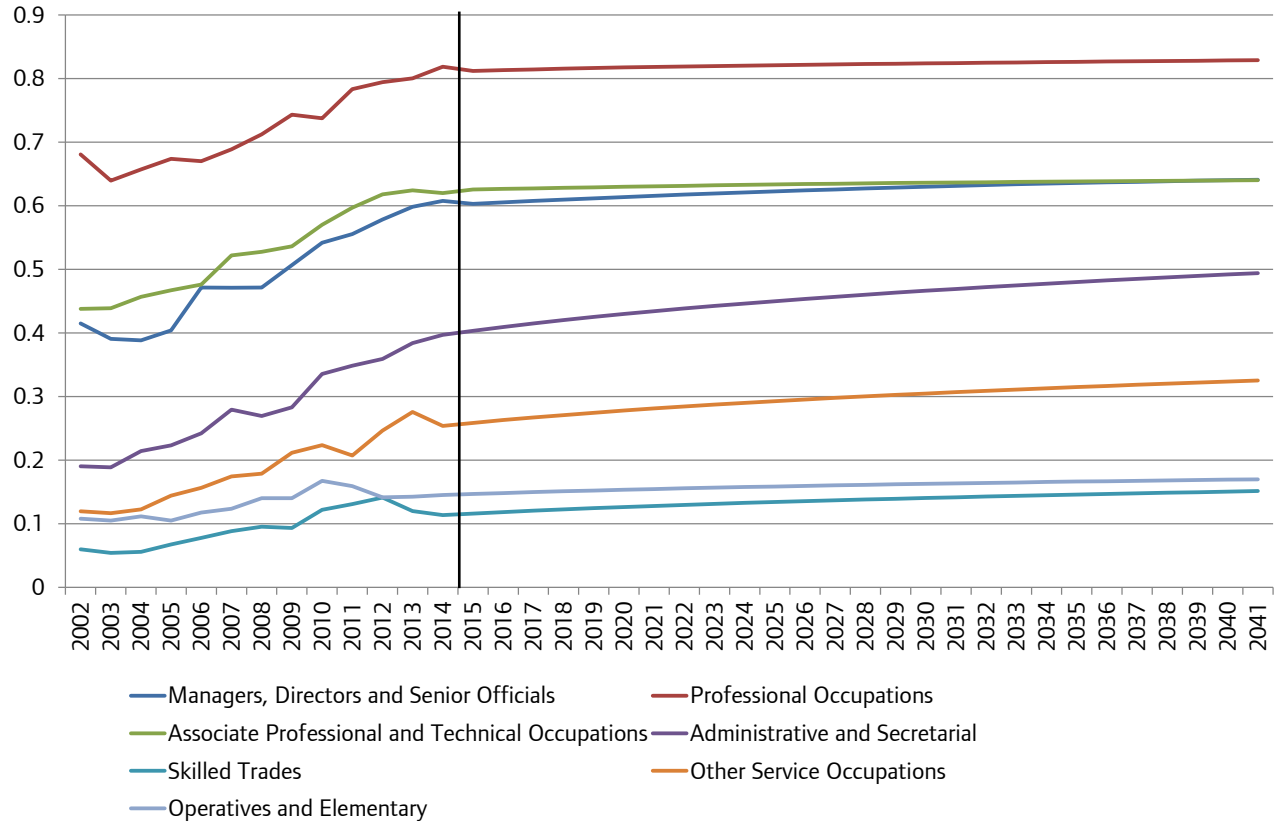
Note: Base year in table is 2014, the last year of historic data, and so reported employment growth may be slightly different to employment projections, which have base year 2015

Figure A.4.6: Changes in Qualification Demand (2002 to 2041)



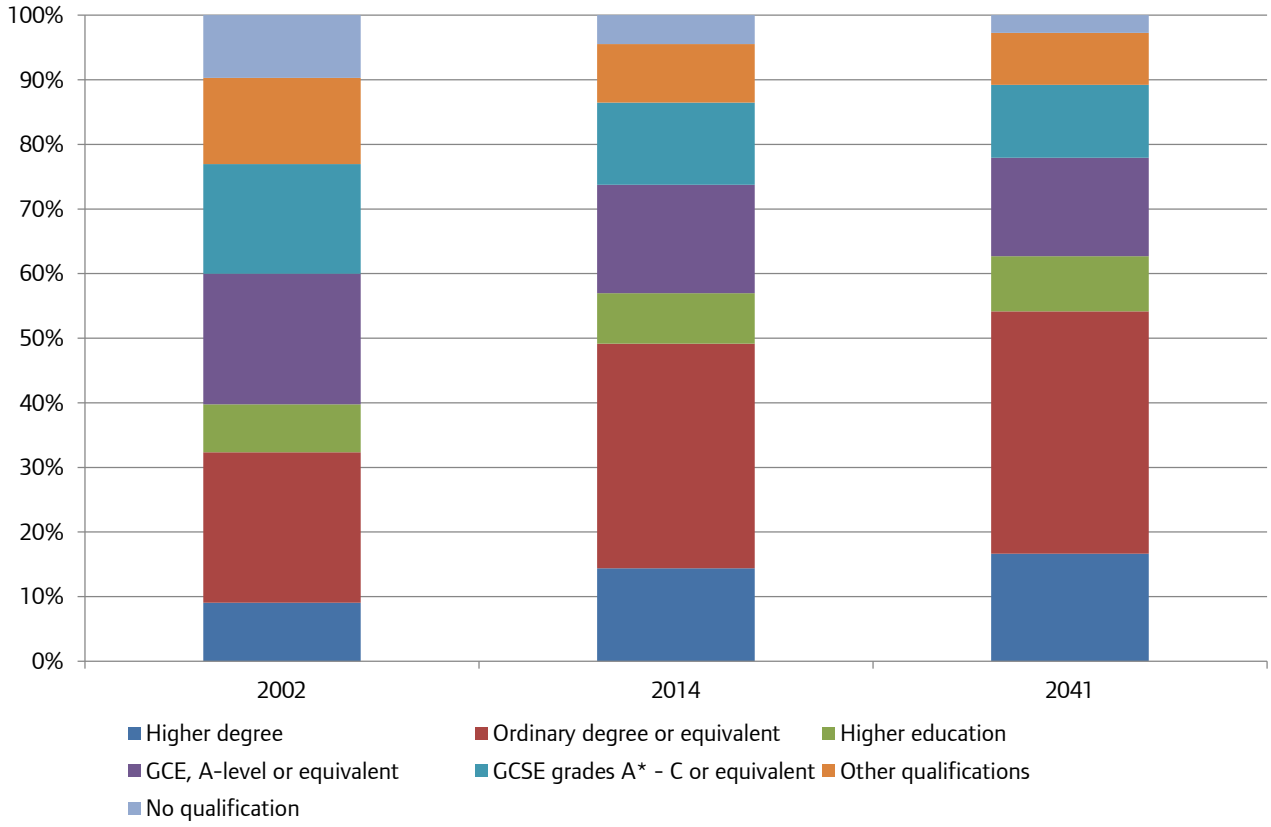
A summary of the distribution of qualifications across jobs is provided in Figures A.4.7 and A.4.8.

Figure A.4.7: Changes in proportion of graduates in occupations (2002-2041)



In 2014, 49 per cent of jobs had the highest qualification of higher degree or ordinary degree/ equivalent. This share is projected to reach 54 per cent by 2041 (figure A.4.8). The share of jobs requiring a higher educational qualification of some sort rises to just under 63% by 2041 compared to 57% in 2014. These proportions are unchanged from the central projection in the main text, although the associated numbers of jobs are different.

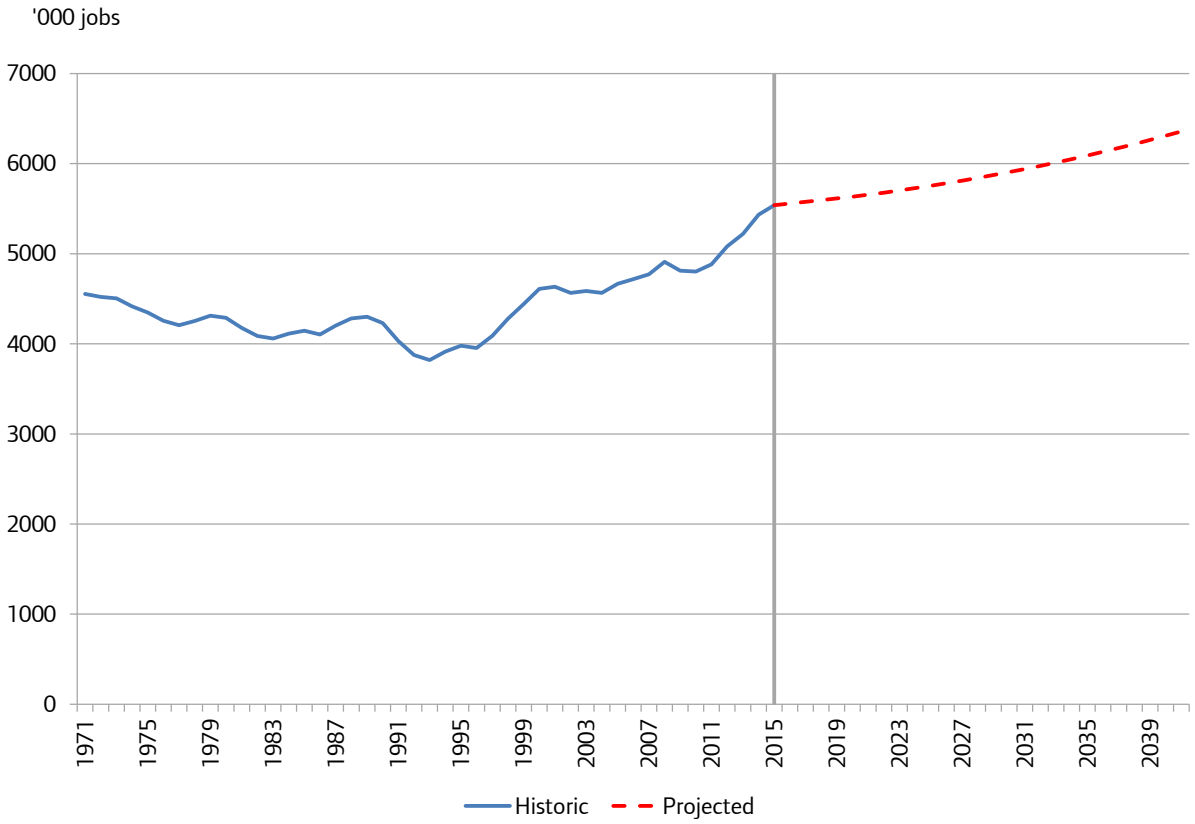
Figure A.4.8: Shares of qualifications as a total of all jobs



Scenario 2: Slower growth assumption

If London's output were to grow at 2.1 per cent year-on-year until 2017, and increase gradually year-on-year reaching 2.5 per cent in 2041 (as compared to the central projection assumption of 2.5 per cent year-on-year) employment would be projected to grow at 0.5 per cent each year from 2016 to 2041. This means that the number of jobs in London will increase by 820,000 from the 2015 value of 5,538,000. This equates to a 14.8 per cent increase.

Figure A.4.9: London's historic and projected employment with slower growth assumption (1971-2041)



Whilst London-wide employment is projected to grow this is not the case for all sectors within London. Indeed, there are large differences in expected employment amongst sectors. Table A.4.6 shows that employment growth for sectors is projected to range from 3.5 per cent year-on-year growth (for Professional, Real Estate, Scientific and Technical Activities) to a 2.2 per cent year-on-year decline (for Manufacturing). Figures A.4.10 and A.4.11 also show how projected employment numbers differ across sectors. Professional, real estate, scientific and technical activities are projected to see an increase of 350,000 jobs by 2041. This is almost two fifths of the total change in jobs across London sectors. Information and communication, education, health and social work, administrative and support service activities, and accommodation and food service activities are also expected to see large increases in employment numbers.

Table A.4.6: Summary of employment projections by sector, 2014-2041

	Employment growth per annum with London output growth of 2.1-2.5% per annum	Absolute change in employment numbers ('000 jobs)
Professional, Real Estate, Scientific and Technical Activities	1.3%	350
Information and Communication	1.1%	133
Education	1.0%	122
Arts, Entertainment and Recreation	0.9%	54
Health and Social Work	0.7%	106
Administrative and Support Service Activities	0.7%	104
Accommodation and Food Service Activities	0.6%	67
Construction	0.6%	47
Total London Employment	0.5%	820
Other Services	0.5%	20
Financial and Insurance Activities	0.3%	29
Retail	-0.1%	-17
Public Administration	-0.6%	-31
Transportation and Storage	-0.8%	-49
Primary & Utilities	-0.8%	-6
Wholesale	-1.1%	-51
Manufacturing	-2.2%	-57

Figure A.4.10: Employment projections for London's larger sectors

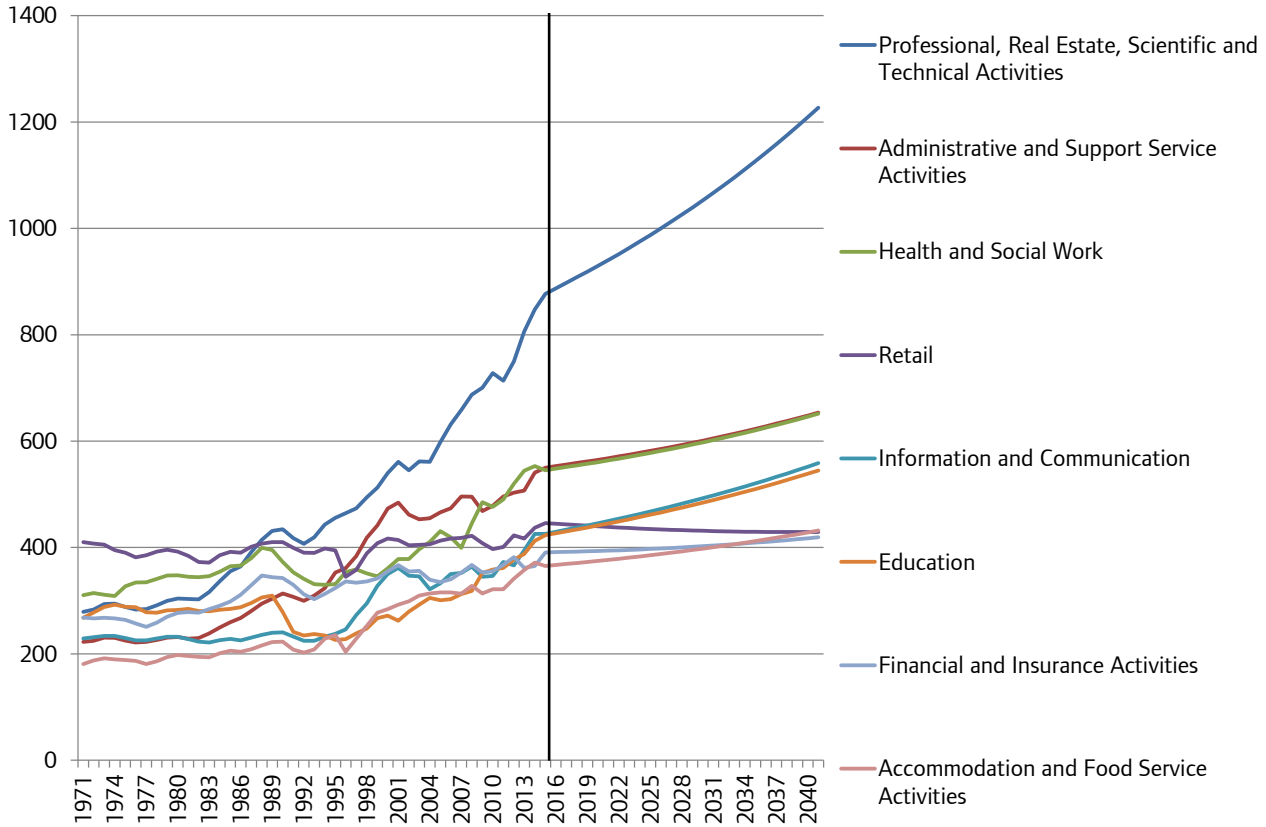
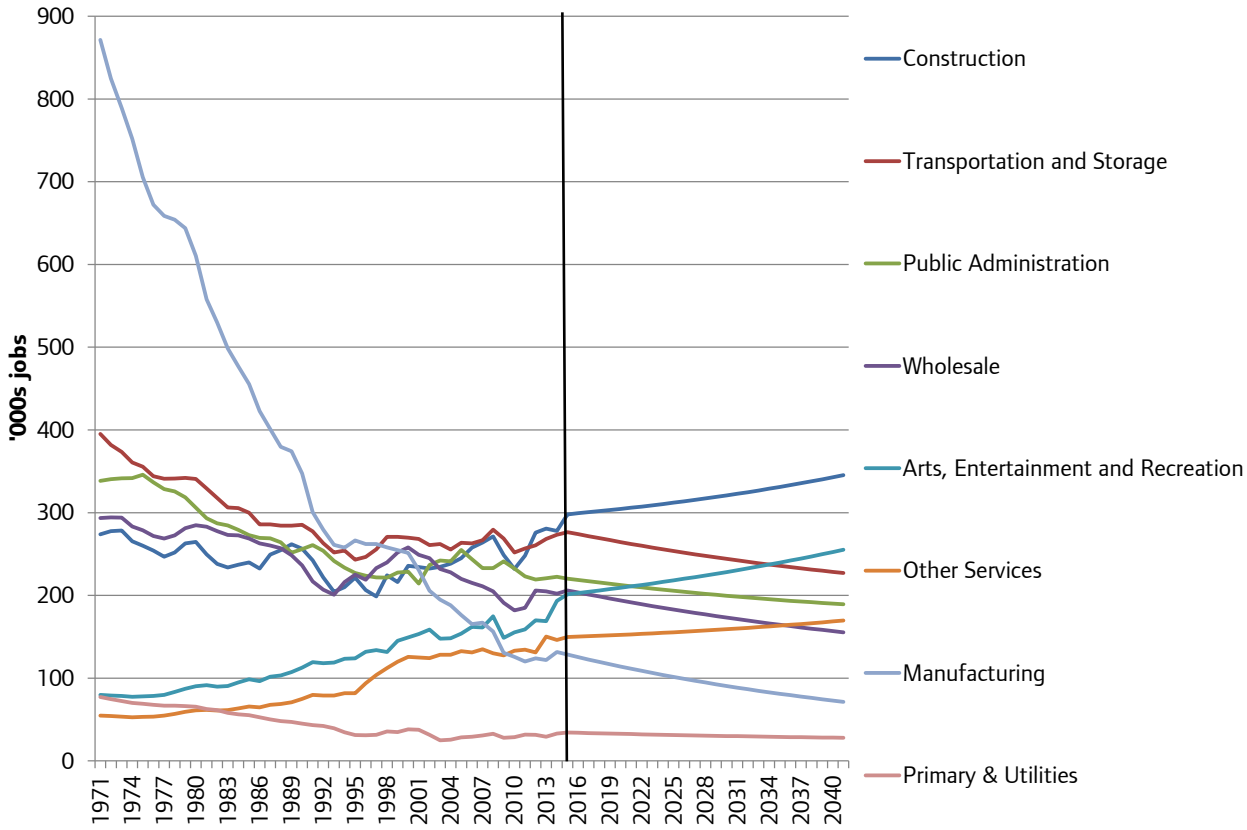


Figure A.4.11: Employment projections for London's smaller sectors



Scenario 2: Occupation Projections (slower growth)

The methodology used to construct occupation projections for sectors is the same as the central scenario (see Appendix 5) except that the slower growth scenario employment projections are used.

A summary of the expected demand for occupations is presented in Tables A.4.7 and A.4.8 and Figure A.4.12. Demand for professional occupations is projected to see the largest increase from its current position. A total 449,000 more jobs (equivalent to a 1.1 per cent year-on-year increase) is expected between 2014 and 2041 (Table A.4.7). This is just under half the total job increase projected in London over this period in this scenario. A large proportion of the increase in professional occupations (a little under 30%) is expected to come from the Information and Communication sector (Table A.4.8).

Managers, directors and senior officials is projected to be the fastest growing occupation at 1.5 per cent year-on-year, or by 358,000 people between 2014 and 2041. Over half of this increase is in employment in professional, real estate, scientific, and technical activities.

Table A.4.7: Year-on-Year Change in Occupation Employment within Sectors (2014 to 2041)

	Managers, Directors And Senior Officials	Professional Occupations	Associate Professional And Technical Occupations	Administrative And Secretarial Occupations	Skilled Trades Occupations	Caring, Leisure And Other Service Occupations; and Sales And Customer Service Occupations	Process, Plant And Machine Operatives; and Elementary Occupations	Total
Primary & utilities	0.8%	0.5%	0.0%	-4.4%	-3.7%	-5.9%	-1.6%	-0.6%
Manufacturing	-1.3%	-3.4%	-2.4%	-2.8%	-2.4%	-1.6%	-1.9%	-2.2%
Construction	0.4%	2.0%	-3.6%	-3.7%	0.2%	-6.9%	3.2%	0.8%
Wholesale	-1.1%	1.2%	-0.3%	-5.8%	-2.5%	-0.8%	-0.3%	-1.0%
Retail	0.3%	1.5%	0.9%	-0.4%	-1.9%	-0.2%	-1.8%	-0.1%
Transportation and Storage	-1.8%	1.0%	-2.2%	-0.7%	-4.0%	-0.5%	-0.6%	-0.7%
Accomodation and Food Service Activities	0.8%	-15.9%	-3.0%	-0.5%	-0.3%	2.8%	0.5%	0.6%
Information and Communication	2.9%	2.0%	-1.4%	-5.4%	-6.7%	-2.8%	-0.1%	1.0%
Financial and Insurance Activities	1.5%	2.0%	0.1%	-4.1%	-0.2%	-7.0%	-0.3%	0.5%
Professional, Real Estate, Scientific and Technical Activities	3.3%	0.9%	1.5%	-0.9%	3.4%	0.4%	-4.6%	1.4%
Administrative and Support Service Activities	1.6%	-3.0%	-4.4%	-3.5%	2.9%	-1.0%	2.2%	0.7%
Public Administration and Defence	-1.1%	1.2%	-1.2%	-2.0%	-8.1%	-0.9%	-2.9%	-0.6%
Education	1.4%	1.0%	1.1%	-0.7%	-1.3%	1.8%	1.1%	1.0%
Health	0.4%	0.9%	0.5%	-0.8%	0.7%	1.0%	-1.8%	0.6%
Arts, Entertainment and Recreation	2.2%	0.9%	0.8%	-3.1%	3.9%	1.2%	0.3%	1.0%
Other Service Occupations	0.7%	0.6%	1.4%	-3.0%	0.8%	1.2%	-3.7%	0.6%
Total London	**1.5%**	**1.1%**	**0.1%**	**-1.9%**	**0.4%**	**0.5%**	**0.7%**	**0.6%**

Note: Base year in table is 2014, the last year of historic data, and so reported sector growth may be slightly different to employment projections, which have base year 2015

Table A.4.8: Absolute change in occupation employment by sector ('000s, 2014 to 2041)

	Managers, Directors And Senior Officials	Professional Occupations	Associate Professional And Technical Occupations	Administrative And Secretarial Occupations	Skilled Trades Occupations	Caring, Leisure And Other Service Occupations; and Sales And Customer Service Occupations	Process, Plant And Machine Operatives; and Elementary Occupations	Total
Primary & utilities	1	1	0	-2	-2	-1	-3	-5
Manufacturing	-6	-11	-12	-7	-12	-2	-10	-60
Construction	4	28	-9	-11	5	-2	52	67
Wholesale	-11	4	-3	-17	-13	-5	-2	-47
Retail	5	10	11	-3	-5	-10	-17	-8
Transportation and Storage	-8	6	-10	-5	-5	-5	-19	-46
Accomodation and Food Service Activities	13	-3	-5	-3	-6	35	28	60
Information and Communication	73	134	-35	-20	-12	-5	0	133
Financial and Insurance Activities	37	61	3	-41	0	-6	0	54
Professional, Real Estate, Scientific and Technical Activities	191	80	112	-24	27	3	-10	380
Administrative and Support Service Activities	35	-17	-64	-32	44	-15	161	113
Public Administration and Defence	-6	21	-22	-19	-1	-2	-4	-33
Education	6	66	13	-5	-1	43	11	132
Health	6	56	12	-13	2	43	-6	99
Arts, Entertainment and Recreation	17	7	21	-8	16	6	1	62
Other Service Occupations	3	5	11	-8	3	17	-7	23
Total London	**358**	**449**	**25**	**-218**	**40**	**96**	**174**	**924**

Note: Total London may not add to total from London-wide employment projections due to rounding.
Base year in table is 2014, the last year of historic data, and so reported sector growth may be slightly different to employment projections, which have base year 2015

The only occupation expected to decline in numbers under the slower growth scenario is administrative and secretarial occupations (see Figure A.4.12) falling by 218,000 between 2014 and 2041, at a rate of 1.9 per cent a year. Their share of jobs falls from 15% in 2001 to 5% in 2041 (Figure A.4.13). In contrast the proportion of London's jobs in managerial or professional occupations rises from 30% to just under 45% over the same period.

Figure A.4.12: Changes in Occupation Demand (2001 to 2041)

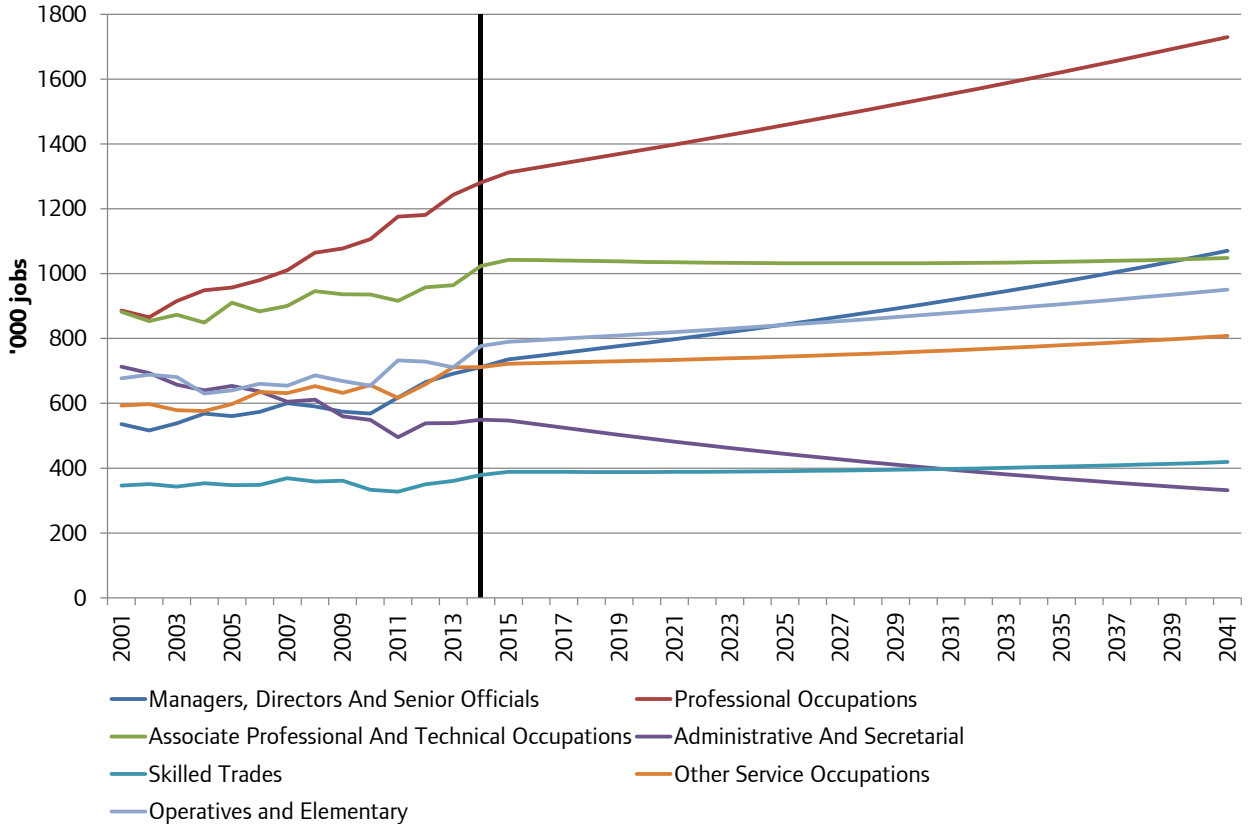
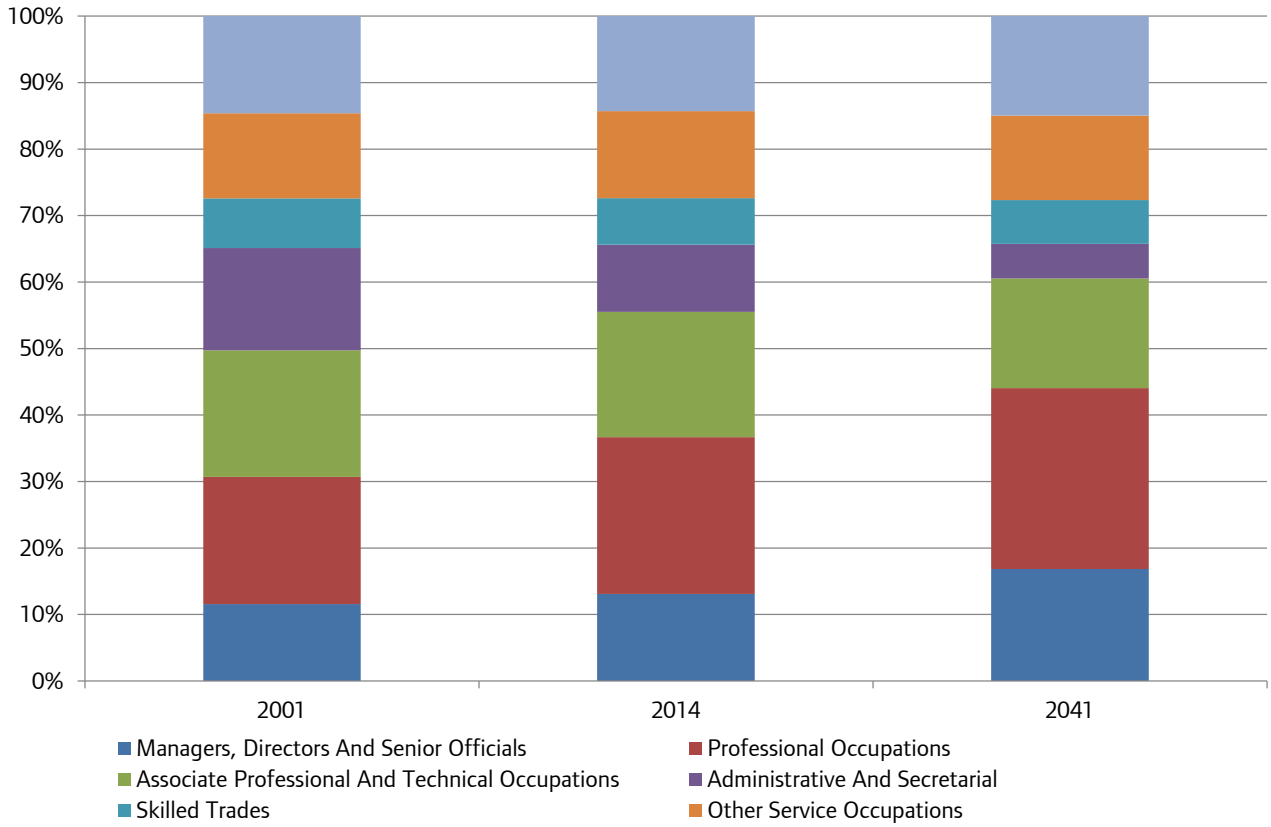


Figure A.4.13: Changes in occupation shares



Qualification Projections (slower growth)

A summary of the expected demand for qualifications is presented in Tables A.4.9 and A.4.10 and Figure A.4.14. The highest growth rate is for higher degrees (with growth equivalent to 1.1 per cent per annum over the 2014 to 2041 period) (Table A.4.9).

Table A.4.9: Year-on-Year Change in Qualification Employment within Occupations (2014 to 2041)

	Higher degree	Ordinary degree or equivalent	Higher education	GCE, A-level or equivalent	GCSE grades A* - C or equivalent	Other qualifica-tions	No qualifi-cation	Total
Managers, Directors And Senior Officials	1.8%	1.7%	2.1%	1.0%	1.6%	0.5%	-2.0%	1.5%
Professional Occupations	1.2%	1.1%	1.0%	0.9%	0.8%	0.1%	1.1%	1.1%
Associate Professional and Technical Occupations	0.4%	0.2%	0.3%	-0.1%	0.0%	-1.4%	-1.7%	0.1%
Administrative and Secretarial Occupations	-1.0%	-1.1%	-1.5%	-2.2%	-2.4%	-4.5%	-5.7%	-1.9%
Skilled Trades Occupations	1.3%	1.5%	0.6%	-0.3%	0.6%	0.9%	-0.9%	0.4%
Caring, Leisure And Other Service Occupations; and Sales And Customer Service Occupations	1.7%	1.3%	1.0%	0.7%	-0.3%	-0.7%	-2.0%	0.5%
Process, Plant And Machine Operatives; and Elementary Occupations	1.9%	1.2%	1.6%	0.7%	0.9%	0.7%	-0.7%	0.7%
Total London	**1.1%**	**0.9%**	**0.9%**	**0.2%**	**0.1%**	**0.1%**	**-1.2%**	**0.6%**

Note: Base year in table is 2014, the last year of historic data, and so reported employment growth may be slightly different to employment projections, which have base year 2015

Ordinary degree or equivalent is projected to see the greatest absolute increase in numbers with an increase of 495,000 over the projection period. This is largely driven by growth in the numbers in professional occupations, as well as managers directors, and senior officials.

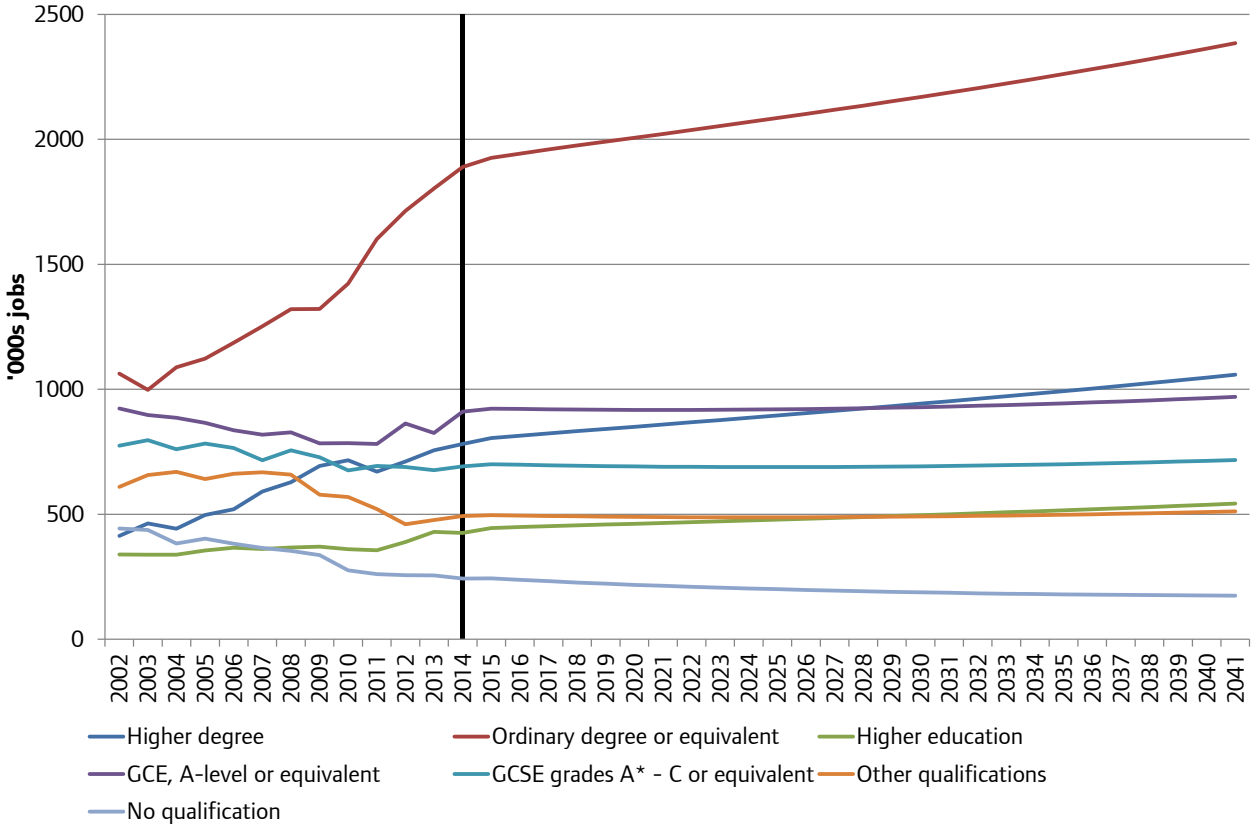
Higher degrees are also projected to see large increases in numbers of around 277,000 from 2014 to 2041 (Table A.4.10). Again, this is largely driven by the growth in numbers in professional occupations, as well as managers, directors, and senior officials.

Table A.4.10: Absolute change in qualification employment by occupation ('000s, 2014 to 2041)

	Higher degree	Ordinary degree or equivalent	Higher education	GCE, A-level or equivalent	GCSE grades A* - C or equivalent	Other qualifica-tions	No qualifi-cation	Total
Managers, Directors And Senior Officials	78	176	38	33	34	6	-6	358
Professional Occupations	167	218	30	22	9	0	3	449
Associate Professional and Technical Occupations	15	21	7	-6	1	-10	-4	25
Administrative and Secretarial Occupations	-9	-45	-15	-47	-62	-26	-14	-218
Skilled Trades Occupations	2	18	6	-9	10	22	-8	40
Caring, Leisure And Other Service Occupations; and Sales And Customer Service Occupations	15	67	22	37	-11	-14	-20	96
Process, Plant And Machine Operatives; and Elementary Occupations	9	39	29	29	44	41	-19	174
Total London	**277**	**495**	**117**	**59**	**26**	**18**	**-69**	**924**

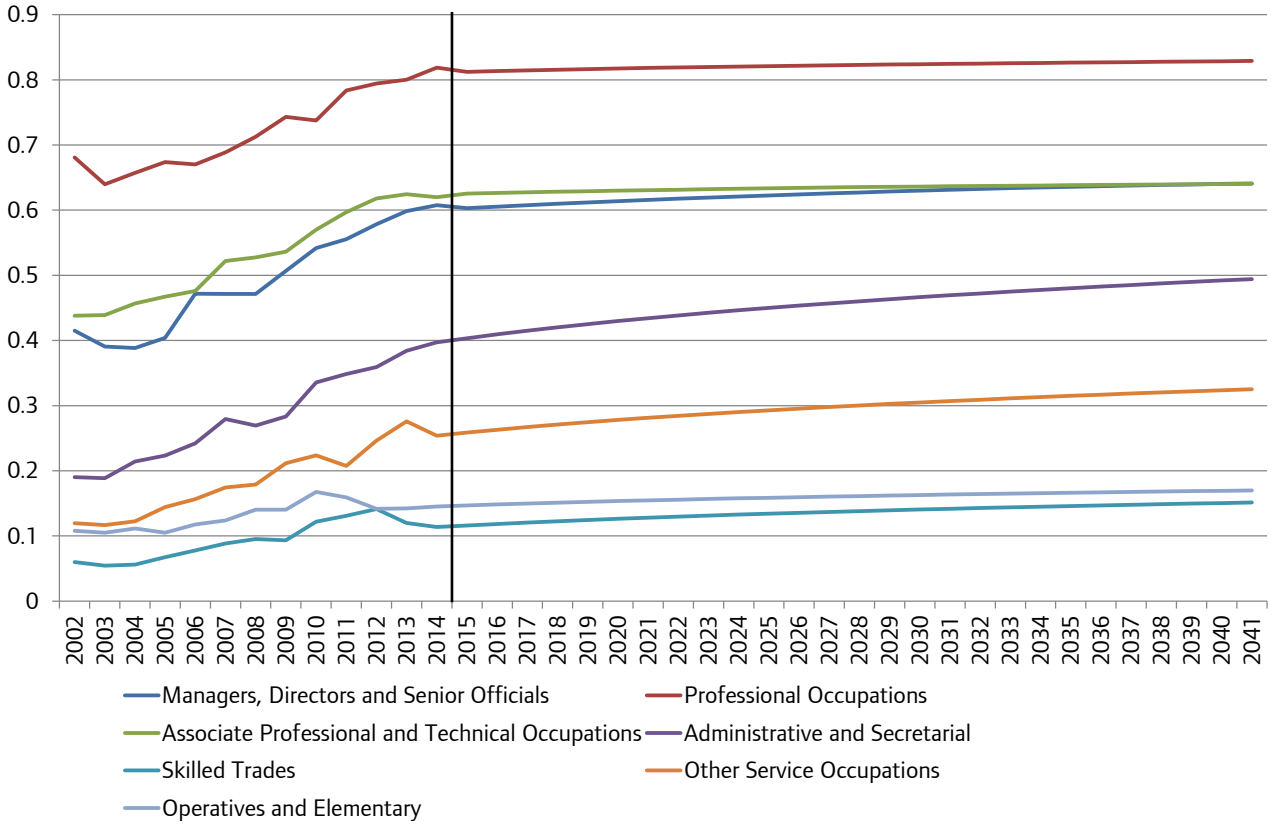
Note: Base year in table is 2014, the last year of historic data, and so reported employment growth may be slightly different to employment projections, which have base year 2015

Figure A.4.14: Changes in Qualification Demand (2002 to 2041)



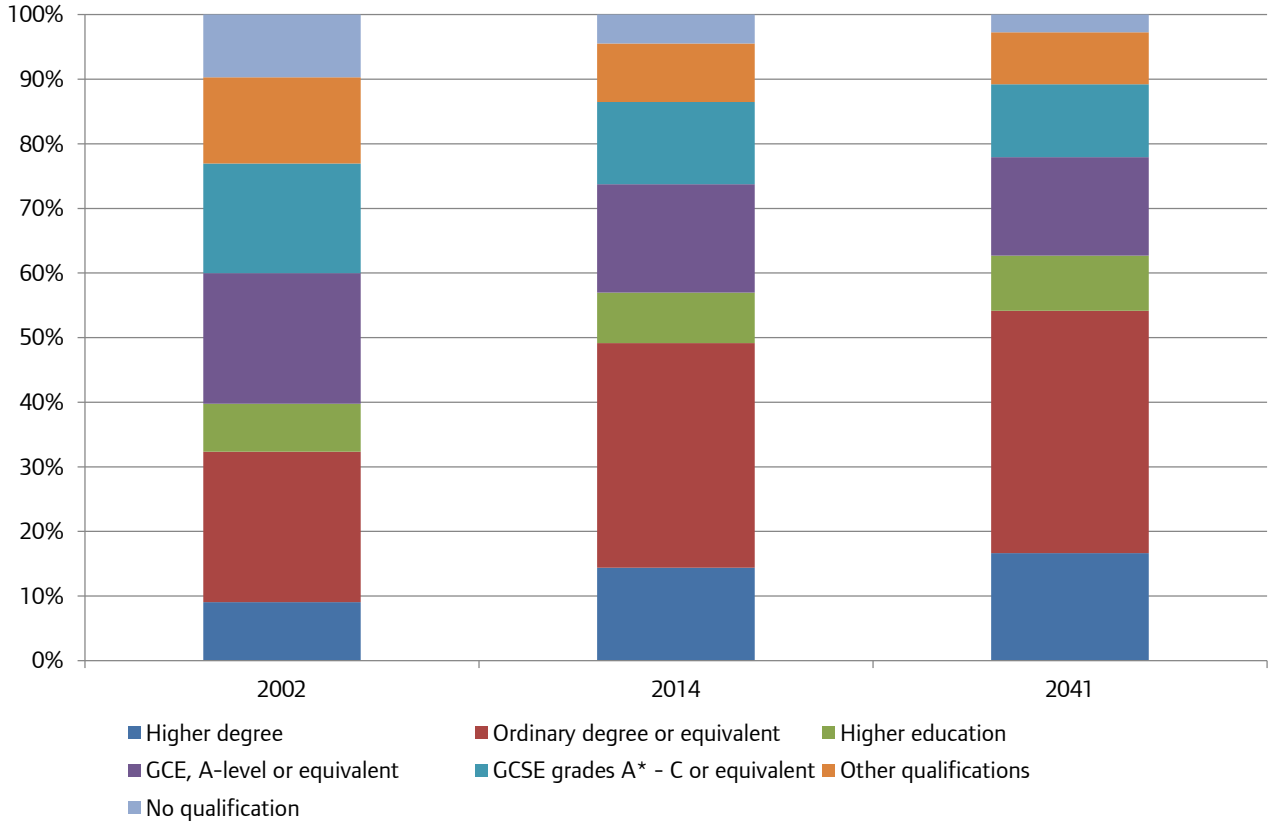
A summary of the distribution of qualifications across jobs is provided in Figures A.4.15 and A.4.16.

Figure A.4.15: Changes in proportions of graduates in occupations (2002 to 2041)



In 2014, 49 per cent of jobs had the highest qualification of higher degree or ordinary degree/ equivalent. This share is projected to reach 54 per cent by 2041 (figure A.4.16). The share of jobs requiring a higher educational qualification of some sort rises to just under 63% by 2041 compared to 57% in 2014. These proportions are unchanged from the central projection in the main text, although the associated numbers of jobs are different.

Figure A.4.16: Shares of qualifications as a total of all jobs



Appendix 5: Employment projections methodology

Total London employment projections

To construct long-term employment projections for London, GLA Economics use a trend-based methodology. This looks at the historical relationships between output and employment (or productivity) to ascertain the future relationship between the two. This provides an indication of the output growth required to keep employment in London stable (or for the employment *growth rate* to be zero). Combined with an assumed output growth rate for London, these two assumptions determine the projected employment growth.

Appendix 7 compares employment and output, or Gross Value Added (GVA), data for this and the last set of employment projections for the common years of historic data, namely 1984-2014. The appendix also provides the methodology used to backcast employment and output, or GVA, data to 1971. In summary estimated productivity has improved for 2011-14 because employment has been revised downwards, and GVA has been revised upwards. While for 1984-92 estimated productivity has worsened as there has been a small increase in employment, and GVA is lower.

Figure A.5.1 shows the logged ratio of employment to output (the inverse of productivity) for London-wide employment underlying both the current and previous projections. The chart also includes a fitted local regression curve to highlight the historic trend. As a log, the negative gradient is equal to the output growth that would be required to maintain stable employment i.e. a gradient of -1.0 suggests that an annual output growth of 1.0 per cent would maintain zero employment growth.

Figure A.5.1: Log of total employment as a proportion of total output growth in London – current and previous estimates (1971/1984-2015/14)

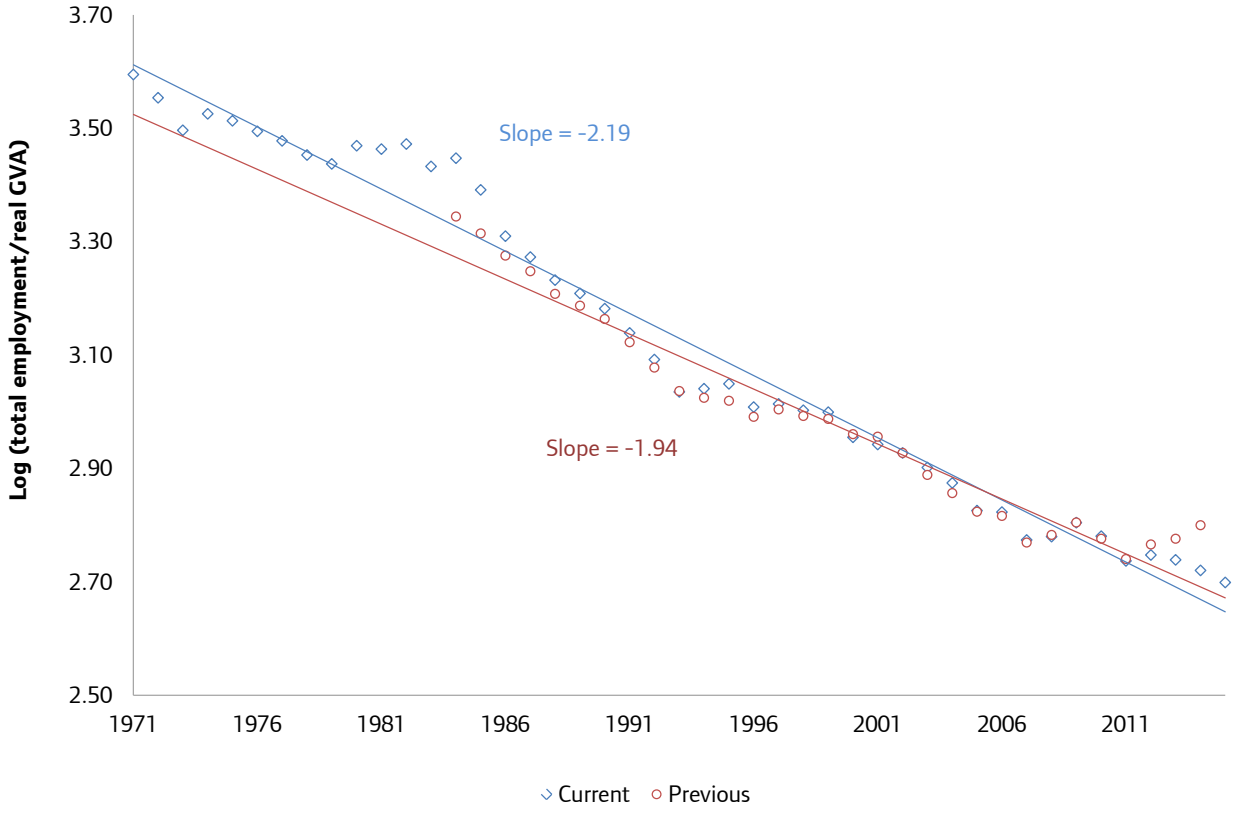
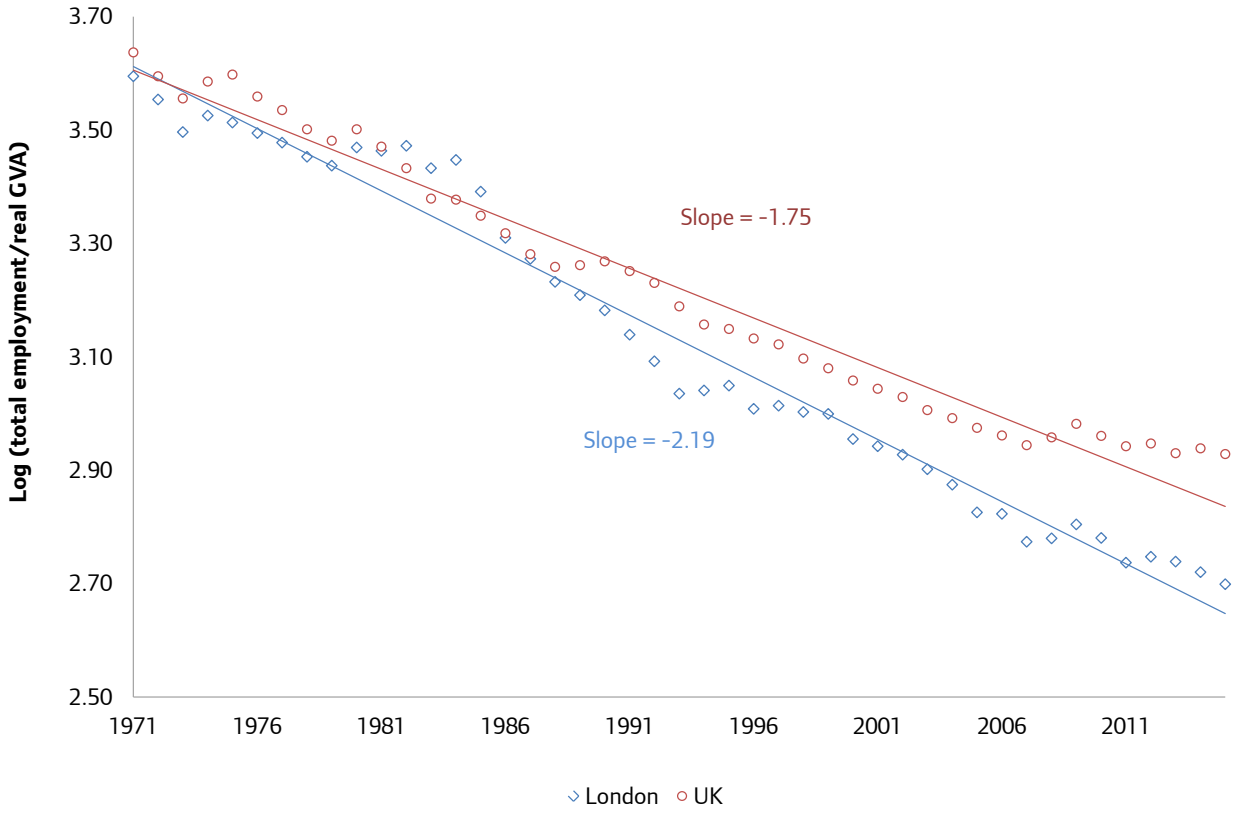


Figure A.5.1 shows that the other impact of the data changes, both revisions and backcasting, is to increase the historic productivity *trend growth* across history. In other words, productivity grows at a slightly higher rate such that the output growth needed to maintain zero employment growth is higher (2.19 per cent compared to the previously estimated 1.94 per cent). Similarly, the revision implies that for a given output growth in the future the employment required will be lower should this new long-run productivity trend continue (as opposed to the pre-revised trend).

Figure A.5.1 shows that, in most years, productivity is close to trend (where trend is represented by the fitted regression line) with it moving closely around trend depending on the economic cycle. Recently, however, productivity growth has been above trend – data revisions mean it is closer to trend than estimated for the last set of projections. Figure A.5.2 shows the logged ratio of employment to output (the inverse of productivity) for London-wide (as for Figure A.5.1) and UK employment. For both geographic areas, since 2011 growth in employment has been exceptionally strong compared to output growth, such that productivity growth has been below trend. In the case of the UK (but not London with the latest data) this has resulted in negative productivity growth (such that productivity has been declining or moving increasingly away from trend). This recent trend in productivity has been puzzling many respected organisations and economists and its implication for the projections in this paper is explored further in Box 1.

Figure A.5.2: Log of total employment as a proportion of total output growth in London and UK (1971-2015)



As with the previous projections, the current projections generate productivity projections by weighting trends. These projections have a medium term projection to 2017, which is a 100% of the trend from 1992-2015, and a longer term projection to 2041, which weights the productivity trends from 1989-2015, and 2001-15. This is set out in Table A.5.1.

Table A.5.1: Summary of trends used for London employment projections

	trend year 1	weight	trend year 2	weight
projections 2016-17	1992	100.0%		
projections 2018-41	1989	30.0%	2001	70.0%

The projected productivity trends from these weights is then combined with an assumed output growth of 2.5 per cent per annum to create the medium and long-run employment projections for London. This rate of output growth is consistent with what the Office for Budget Responsibility (OBR) estimate for the UK's long-term output potential[12].

The results of the projection are presented in Figure 2.9 of the main paper. The projections estimate that employment will grow by an annual average rate of 0.76 per cent, equivalent to 45,000 per year, to reach 6.748 million in 2041.

Box A.5.1: Should the employment projections 'jump-off' from the 2015 level of employment?

The trend methodology used to construct the projections in this paper is based on the premise that a variables history includes the effects of everything that has driven it. In other words, to get to its current level, employment has been impacted by economic growth, population, migration, changes in sectoral growth, technology, working practices and so on. The relationship between all these drivers and employment is implicit in the historic employment data.

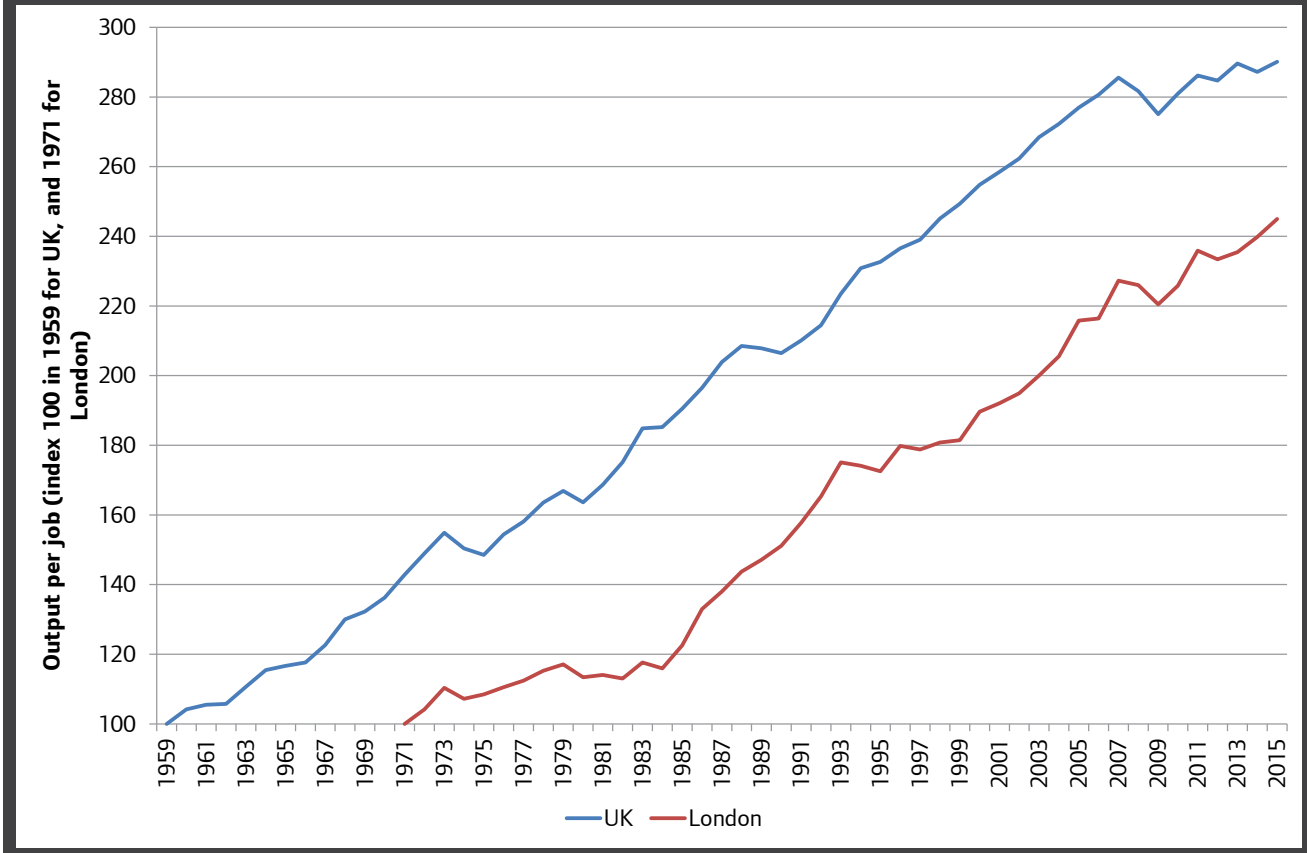
Although, as many other forecasters do, it is possible to look at each of these drivers individually to assess their impact and model them individually there are likely to be so many drivers that attempting to model them would likely only partially explain the history. Moreover, to model the drivers requires an understanding of the drivers of those drivers that results in a myriad of variables each supposedly impacting on employment. For example, if international migration is thought to affect employment then it is necessary to consider what affects international migration (so things like conditions in the individuals' home country, relative output growth, cost of travel and so on). It is then necessary to be able to say how these factors are likely to change in 20 years, or so, time, such that the employment forecasts also depend heavily on these necessary underlying assumptions. This approach may be reasonable when considering what employment may be in the short-term. However, the further into the future one goes the greater the compound error is likely to be on the forecasts for the drivers of employment. The cumulative effect of this across all the drivers can then raise doubts as to the reliability of the future employment estimates that are dependent on them.

The trend-based methodology that GLA Economics adopts is arguably a reasonable approach so long as (a) the variable is not random (in other words, it follows a relatively stable path) and, (b) as long as future shocks or structural changes do not differ in magnitude to those in the past. Applying this to productivity (which is used as the basis for our projections given the mathematical relationship between employment and output whereby Δ in employment = Δ in output – Δ in productivity), as can be seen in Figure A.5.1, productivity is not a random variable and has historically followed a trend. Regarding structural changes, this is ultimately a point of judgement. Whilst Figure A.5.1 does not suggest clearly structural changes in the productivity trend, there have been questions as to whether more recently the trend in productivity is reflective of a new trend/structural change. It is also not clear, as Figure A.5.2 demonstrates, if there have been common factors driving developments in London and UK, and whether, for example, specialisation in certain sectors and agglomeration economies are playing a distinctive role in London's development.

In the four years since 2011 alone, employment has grown by 13.4 per cent, which equates to an annual average growth rate of 3.2 per cent of 164,000 jobs per year. This contrasts starkly to a total growth of 6.0 per cent, or an annual average growth rate of 0.8 per cent of 40,000 jobs per year, over the seven years from 2001 to 2008, or the total growth of 7.9 per cent, at an annual growth rate of 0.2 per cent of 10,000 jobs per year, over the thirty seven year period from 1971 to 2008. At the same time, however, output in London has grown by an average annual rate of 4.2 per cent over the last four years, which is also faster than historic trends.

The impact of these relative changes in employment and productivity growth is, perhaps, particularly stark when looking at productivity over the long run and over a number of economic cycles, and in comparison to the UK (see figure A.5.A).

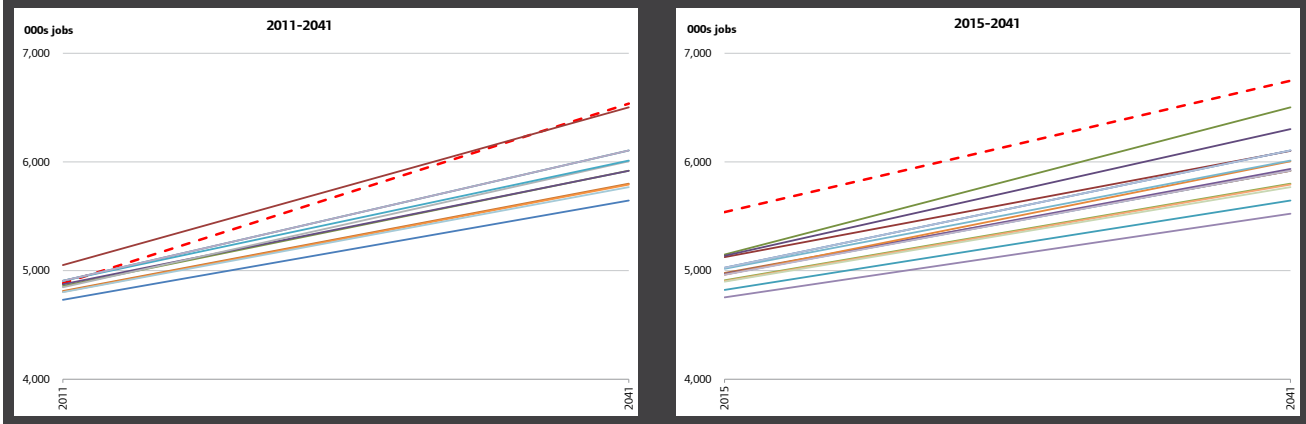
Figure A.5.A: Productivity in London and the UK over the long-run



London's productivity performance has been worse in the last few years than it has been in previous periods, even if it has been better than that of the UK. It is not clear if the recent exceptional growth in employment is sustainable, and might be followed by a period of more muted growth, and raises the question of where the GLA Economics projections should start from – or from what year they should 'jump off' from. This is something that the projections have previously considered (most recently for the 2015 projections, but see also, for example, Working Paper 38 page 6) and has become an increasingly important issue with the recent productivity trend. So the question of what the jumping-off point for the projections should be comes down to whether the 2015 level of employment is representative of an 'on-trend' point in the economic cycle, and if not, what year is?

To understand this better GLA Economics looked at a series of economic commentators to see when they estimated the economy to be on trend. The corresponding employment levels in these periods were then trended to produce a range of on-trend employment projections (see Appendix 5.B for further details). In the balance of that work, 2011 appears to be the last year that London's employment was 'on-trend'. This can also be seen by looking at Figure B below. The various solid lines show a range of potential on-trend employment levels through to 2036. The dotted red lines show how GLA Economics employment projections would sit within that range if they jump-off the on-trend 2011 estimate of employment (left hand) and if they jump-off the 2015 employment estimate (right hand).

Figure A.5.B: Performance of GLA Economics employment projections starting from different base years compared to a range of estimated on-trend projections



As Figure A.5.B shows, the projections which use the latest employment data point to jump off from are likely to both start and end above the existing estimates of trend, suggesting projected levels of employment in 2041 that may be too high.

At the same time projections which use the 2011 employment data as a jump-off point may underestimate the underlying rate of jobs growth in London.

A set of projections for London needs to strike a balance between macroeconomic and microeconomic factors. Estimates of output gaps and trend points in the economy are notoriously difficult to estimate and the likely future long-run path of productivity remains unclear. The London economy benefits from agglomeration economies in a way which the national economy does not. This is an area that GLA Economics, alongside others, continue to monitor closely. Given productivity has previously diverted from the trend line (albeit no more so than in the past) (see Figure A.5.1) and the remaining uncertainty, GLA Economics do not believe that revising the methodology for the purposes of interim projections for long-term planning would be either proportionate or appropriate. Nonetheless, as the situation evolves GLA Economics will continue to monitor the situation and review their methodology.

Sensitivity testing

Given the recent employment performance (see Box A.5.1), a number of alternative employment projection scenarios have been produced as a means of sensitivity testing the central scenario. These are based on alternative assumptions for the key underlying assumption in the 'central' projections presented in the main text, and are summarised in Table A.5.2 below. The scenarios in Appendix 4 follow the three growth assumptions in the table, and a 2015 jump-off point. The table also includes summary information on the historic employment growth experienced in London, from peak employment years of 1971, 1989 and 2001 – this helps to put these alternative scenarios into wider context.

Table A.5.2: Summary results from alternative assumptions

	2041 employment level (millions)	Per annum projected employment growth (2015-2041)	
		average %	level
Historic 1971 to 2015	-	0.45	22,390
Historic 1971 to 2011	-	0.17	8,230
Historic 1989 to 2015	-	0.98	47,560
Historic 1989 to 2011	-	0.58	26,400
Historic 2001 to 2015	-	1.28	64,550
Historic 2001 to 2011	-	0.52	24,800
Central growth assumption (2.5% pa)			
Central scenario, 2015 jump-off	6.75	0.76	46,540
2011 jump-off	6.54	0.64	38,410
High growth assumption (2.9% pa falling to 2.5% pa)			
2015 jump-off	7.15	0.99	61,900
2011 jump-off	6.92	0.86	53,290
Low growth assumption (2.1% pa rising to 2.5% pa)			
2015 jump-off	6.36	0.53	31,530
2011 jump-off	6.16	0.41	23,870

Note: 2041 employment levels have been rounded to the nearest 10,000; percentages have been rounded to the nearest 2 decimal places, and the per annum projected growth in employment numbers to the nearest 10.

One of the fundamental assumptions underpinning the projections is regarding the long-run annual rate of output growth in London. Under the 'central' scenario GLA Economics assumes a growth rate of 2.5 per cent per annum. This is consistent with what bodies such as the Office for Budget Responsibility assume for the UK's long run output growth rate. As such, it assumes that London grows at the same rate as the UK in long run – if a higher growth rate was assumed for London this would suggest that in the very long-run the size of London's economy would overtake the UK (something that is clearly not possible). On the other hand, an output growth for London that is lower than that for the UK would suggest that London's share of the UK's output tends to 0 per cent in the very long-run (something which is not very likely).

It should be remembered that the factors which driver the London economy in the medium term may not be the same as those which drive the UK economy. It is not clear to what extent London will continue to reap the benefits of agglomeration economies, or might be disproportionately affected by any adverse developments in the wider European and international economies because of its specialisation in internationally traded services. So, the growth scenarios assume that there is faster London growth at 2.9% per year, or slower growth at 2.1% per year, in the medium term to 2017, and thereafter the growth rate tapers steadily to reach 2.5% per year in 2041.

At the higher growth rate, and with employment projected to jump off from the 2015 level, employment grows at 0.99 per cent per annum – this is very marginally higher than the annual growth rate seen in employment from 1989 to 2015 (0.98 per cent) and somewhat higher than the growth rate seen from 1989 to 2011 (0.58 per cent). By 2041 employment in this scenario is projected to reach 7.15 million – equivalent to an additional 61,900 jobs per annum (30.2 per cent higher and 134.5 per cent higher than the annual employment growth experienced from 1989-2015 and 1989-2011 respectively, although lower than the jobs growth observed from 2001-2015). This level of employment in 2041 is 5.9 per cent higher than under the 'central' scenario.

The projections model has also been re-run under a low output growth scenario, and with a jump-off point of 2015. Under this assumption employment grows only at 0.53 per cent per annum, equivalent

to 31,530 jobs. By 2041 employment is estimated to reach 6.36 million under this scenario – 5.8 per cent lower than under the central scenario.

Another necessary assumption regarding these projections is in which year the projections should start (see Box A.5.1). Table A.5.2 presents summary numbers behind the scenario of projecting from the 2011 employment level in Box A.5.1. It also presents the results of combining the alternative 2011 jump-off year with the high and low output growth scenarios. Under the high output growth assumption employment is estimated to grow to 6.92 million by 2041 – this is 2.6 per cent (or 0.18 million) higher than the central scenario presented in this paper.

Box A.5.2: An alternative method of estimating future employment in London?
Chapter 3 considers the supply of labour to the London labour market by residents and through commuting.

In 2003 GLA Economics considered an alternative methodology to estimate long-run employment (Working Paper 4: Long-term Employment Projections for London, GLA Economics). The methodology employed is repeated here - using projections of the population and the employment rate - to see what it may suggest for employment levels in 2041. Under this alternative model the assumption is made to hold the employment rate constant. Chapter 3 considers at greater length the supply of labour to the London labour market by residents and through commuting, and this is a summary. Some may argue that results from such a model present a potential underestimate because of the likely impact from changes in the state pension age and abolition of the compulsory retirement age, and less generous state and private financial provision for older working age people who wish to leave the labour market. Indeed, the gap between the London and UK employment rates has been narrowing in recent years. However, such impacts would need to be balanced against factors that may reduce the employment rate, such as the raising of the participation age for young people, and increased participation in higher education. Nonetheless, given the complexity of the labour market, arguments suggesting the long-run employment rate may move in either direction, and the historic trends in London's employment rate, which prior to the recession in 2008 had been around 70% for a decade, this could be considered a reasonable alternative approach against which to benchmark the central projections in this paper.

Under this alternative methodology (further details are provided in Appendix A.5.C) jobs in London are estimated to reach 6.42 million in 2041 – representing an average annual increase of 0.57 per cent, or an additional 33,840 jobs per annum. This estimate lies within the range of those in the sensitivity testing. Indeed, as this alternative method is based on the working age population it may be considered a cautious alternative, but nonetheless suggests that the jobs projected seems reasonable (particularly when balanced against the latest GLA population projections).

London's Sector Employment Projections

Employment projections for London's sectors are constructed in a similar way to the London-wide projections. GLA Economics begins by examining the historic trend of employment (employees and self-employed jobs) for each sector, against London level GVA (or, more specifically, logged sector employment over London GVA). Depending on the characteristics of the historic productivity trends in each sector a judgement is made on the trends that are most likely to direct future developments. To reconcile the forecasts that this method produces with that produced for London as a whole, the sector forecasts are constrained to the London total using the sector forecast proportions. The results of this method and the trend periods used in the projections are summarised in Table A.5.3.

Table A.5.3: Summary of trends used and results for sector employment projections

	Trend for projections to 2041	Resultant productivity trend (per cent per annum)	Employment growth per annum with London output growth of 2.5% per annum	Annual average growth in jobs with London output growth of 2.5% per annum
Primary & utilities	1/2 trend from 1984 to 2015 1/2 trend from 2003 to 2015	3.0%	-0.6%	-180
Manufacturing	1/2 trend from 2008 to 2015 1/2 trend from 2009 to 2015	4.5%	-2.0%	-2030
Construction	from 1993 to 2015	1.7%	0.8%	2640
Wholesale	7/10 trend from 1993 to 2015 3/10 trend from 2010 to 2015	3.3%	-0.9%	-1580
Retail	1/2 trend from 1992 to 2015 1/2 trend from 2007 to 2015	2.4%	0.1%	370
Transportation and Storage	1/2 trend from 1984 to 2015 1/2 trend from 2002 to 2015	3.0%	-0.5%	-1360
Accomodation and food service activities	from 1989 to 2009	1.6%	0.9%	3580
Information and Communication	3/5 trend from 1984 to 2015 2/5 trend from 1999 to 2015	1.2%	1.3%	6440
Financial and insurance activities	from 1976 to 2015	2.0%	0.5%	2090
Professional, Real Estate, Scientific and technical activities	4/5 trend from 1984 to 2011 1/5 trend from 2009 to 2011	1.0%	1.5%	16360
Administrative and support service activities	1/5 trend from 1971 to 2015 4/5 trend from 1999 to 2015	1.6%	0.9%	5530
Public Administration and defence	from 1995 to 2011	2.8%	-0.4%	-740
Education	1/2 trend from 1984 to 2015 1/2 trend from 1990 to 2015	1.3%	1.2%	5970
Health	3/4 trend from 1984 to 2015 1/4 trend from 1991 to 2015	1.6%	0.9%	5630
Arts, entertainment and recreation	3/20 trend from 1971 to 2015 17/20 trend from 1999 to 2015	1.3%	1.1%	2680
Other services	from 1998 to 2015	1.8%	0.7%	1170
Total London Employment	**medium term** (2015 to 2017) from 1992 to 2015 **long term** (2017 to 2041) 3/10 trend from 1989 to 2015 7/10 trend from 2001 to 2015	1.7%	0.8%	46540

Note: Resultant productivity trend is the weighted trends estimated from the relationship between employment and output for the periods selected in the previous column

London's Occupations by Sector

The methodology used to estimate occupational demand by sector is similar to the methodology used for sector employment. The method begins by analysing the relationship between employment in each occupation and London total employment (specifically, log of employment by occupation over total employment). This is done separately for each sector and for the SOC 2010 occupations listed in Table A.5.4. It should be noted that the data for employment by occupation within sectors are only available on a consistent basis from 2001 onwards[13].

As the time series of data is relatively short there is not necessarily a definitive trend for employment shares for each occupation, and judgements have been made to distinguish between trends due to the economic cycle, and longer term underlying trends. These judgements have reflected the characteristics of a sector, and the distribution of occupations within it. Summing across occupations will provide a sector employment projection, and to reconcile these projections with those for London as a whole, the projections for occupations within a sector are constrained to the London sector projection.

Table A.5.4: SOC 2010 Occupation Groups Used

1	Managers, Directors and Senior Officials
2	Professional Occupations
3	Associate Professional and Technical Occupations
4	Administrative and Secretarial Occupations
5	Skilled Trades Occupations
6 + 7	Caring, Leisure and Other Service Occupations; and Sales And Customer Service Occupations
8 + 9	Process, Plant And Machine Operatives; and Elementary Occupations

The results from this method provide GLA Economics with estimates based on the ONS LFS and APS. However, this is different to the data for London-wide and sector level employment projection. Employment for London as a whole and by sector comes from GLA Economics' London historic jobs series. In order to make the occupation level analysis consistent, the shares of employment by occupation for each sector have been applied to the historic jobs series (as recommended by the ONS). This has been done for both the historic and projected occupation employment (using the *projected* employee and self-employed jobs for the latter).

London level occupation projections are then derived by summing numbers across individual sectors.

London's Qualification by Occupation

Historic data on the highest qualification held by those employed comes from the same source as the data for occupation employment i.e. from the ONS LFS/APS and is available from 2001 to 2014. The qualification groups which are used in this work are listed in Table A.5.5. However, in 2011 the ONS changed the approach to collecting data on people's highest educational qualifications in order to obtain more information on qualifications obtained abroad, such as the international baccalaureate, which had previously been reported as 'other'. This produced a structural break in the time series between 2010 and 2011. GLA Economics developed a method to project this change backwards for earlier years (see Figure A.5.3).

Table A.5.5: Highest Qualification Categories Used

1	Higher degree
2	Ordinary degree or equivalent
3	Higher education
4	GCE, A-level or equivalent
5	GCSE grades A*-C or equivalent
6	Other qualifications
7	No qualification

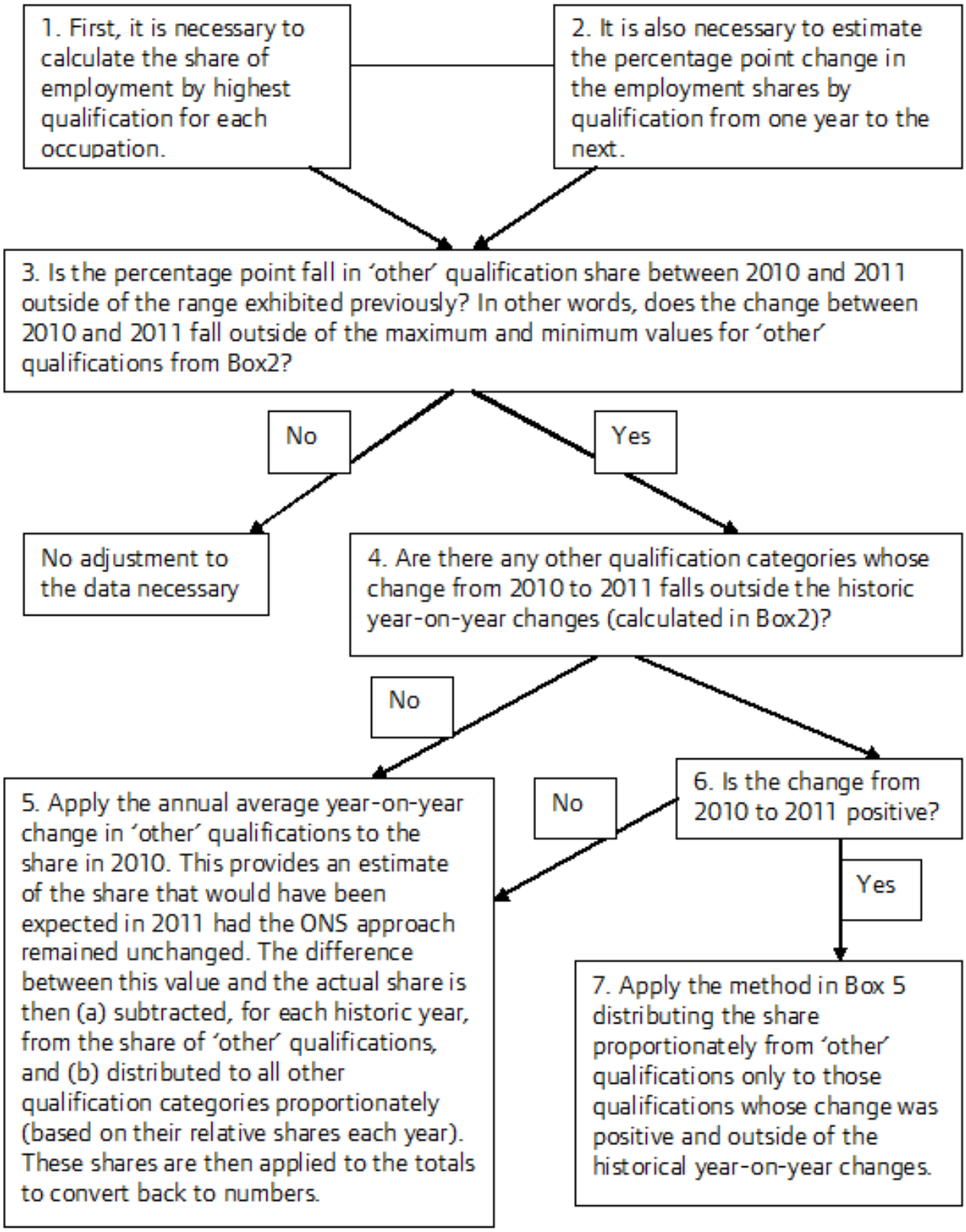
Once the historic data has been adjusted (so that it is consistent with the 2011 ONS method) the trend for each qualification is modelled according to one of two approaches depending on occupation and age group.

For the occupations of managers, directors and senior officials; professional occupations; and, associate professional and technical occupations the populations were split into the age bands of 16-29; 30-44; and, 45+. The shares for each age-group were projected forwarded using a log-linear regression on data for 2001 to 2014, and the sum of the shares constrained to 100% for each year – from the projection for each occupation it was possible to derive a projection for the numbers of each age group. For the 16-29 and 30-44 age groups the proportion with each category of highest qualification was fixed at the average for 2012-14 over the period of the projections to 2041. This is because these professions have a high graduate intake, and the expectation is that the strong rise in the proportion of young people graduating in recent years would not be sustained. For the 45+ age group the share of each category of highest qualification was projected forward using a log-linear regression on data from 2001 to 2014 – the numbers in this age group with a particular highest qualification in a year is the product of the share and the total in the age group. This is a means to capture the effect that younger people reaching 45 are more likely on average to have higher qualifications than older people leaving the labour market. Total numbers with a particular highest qualification in one of these occupations is the sum across age groups.

For the remaining occupations of administrative and secretarial occupations; skilled trade occupations; other service occupations; and elementary occupations the modelling has been completed for the whole occupation. This is because the proportion of graduates in these populations has been more stable. The share of each category of highest qualification was projected forward using a log-linear regression on data from 2001 to 2014 – the numbers with a particular highest qualification in a year is the product of the share and total in the occupation.

London total qualification projections are then taken as the sum of each qualification across occupations. Note that since the occupation projections were reconciled to be consistent with the historic London jobs series this process ensures that the qualification projections (based on LFS/APS employment) are also consistent with the London jobs projections.

Figure A.5.3: Smoothing method to control for 2011 step change in ONS 'highest qualification' method



Triangulated Borough Employment Projections

Triangulated borough employment projections are generated by developing a set of rules to integrate three separate projections for borough jobs based on:

- Continued historic trends,
- Transport accessibility, and
- Workplace capacity.

The rationale is that trend-based projections for employment in the boroughs need to be "reality checked" against projections for transport accessibility (to get employees to jobs) and projections for workspace capacity (to accommodate employees once they have arrived).

Our analysis indicated that there are a number of boroughs where the increase in transport accessibility might not be sufficient to fulfil the trend or workplace capacity led projection of employment. However the accessibility measure does not provide a comprehensive assessment of the total capacity of the network and its ability to cater for commuting numbers. It is considered that, though the employment projections would lead to significant public transport crowding in the future, there is not enough evidence to determine how the future location of jobs suggested by the trend or workplace capacity would be affected by crowding. Therefore the previously used rules around transport accessibility have been relaxed on the assumption that TfL will use the analysis to inform the development of future transport schemes to address potential constraints (currently the transport accessibility work uses funded schemes to the early 2020s and only limited further changes).

As a result, the final projections will not include transport accessibility and instead will only include the trend and workplace capacity. The relative reliance on trend and workplace capacity will vary by location. In central and areas of inner London, where agglomeration economies have proved important, borough employment is assumed to rise by the growth in workplace capacity (or slightly in excess of this where the historic trend suggests future capacity could be 'insufficient' to accommodate future growth). For most other boroughs where there is no single clear alternative explanation for the future path of employment, the employment projection will be set at the trend projection. In exceptional cases, where there is significant additional employment space capacity coming on stream but a lower trend in employment growth, the projection gives equal weight to trend and capacity projections.

Trend-based borough employment

In order to construct borough employment projections it is necessary to first construct projections for London as a whole for employees only. This is done using a similar method described above for London jobs. First, we look at the historic trend of London employee jobs and GVA (or productivity) as well as the implied self-employment jobs (taken as the difference of London employee and self-employed jobs and London employee jobs only) and GVA to ascertain the future relationship for employees and self-employed (separately) with GVA. For the implied self-employment jobs the trend from 1989 onwards is used to project forward. For employee jobs, the trend from 1984-2015 has a 40% weight and the trend from 2004-2015 has a 60% weight. A forecast 2.5 per cent per annum GVA growth rate is then applied to determine employment growth rates. To reconcile the projections that this method produces with that produced for London employees and self-employed combined, the forecasts are constrained using the employee to self-employed forecast proportions. This method produces a 0.64 per cent year-on-year growth rate for employee jobs in London from 2015 to 2041.

The borough-level employee jobs are then estimated using the same method to project sector-level employment. In other words, the historic trends of employment by borough against London GVA are analysed. Depending on the characteristics of the historic productivity trends in each borough a judgement is made on the trends that are most likely to direct future developments (ignoring transport and workplace capacity constraints). The results are then constrained to the total London-wide employee job projections (as estimated above) using the borough forecast proportions.

The results of this method and the trend periods used in the projections are summarised in Table A.5.6. Appendix 2 provides charts of historic employment levels and projected trends by borough. There are a range of factors which might have affected trends for individual boroughs such as the importance of manufacturing, population changes which have impacted on jobs in education, health, or in the retail sector, or specific developments such as the expansion of Heathrow airport. For this reason, separate judgements have been made for each borough on the characteristics of historic productivity trends.

Table A.5.6: Summary of trends used and results for borough employee projections

	Trend for projections to 2041	Resultant productivity trend (per cent per annum)	Employee growth per annum with London output growth of 2.5% per annum	Employee change from 2015 to 2041 with London output growth of 2.5% per annum
Barking and Dagenham	1/4 trend from 1996-2014 3/4 trend from 2009-2014	2.6	-0.02%	-10
Barnet	7/10 trend from 1981-2014 3/10 trend from 2002-2014	2.4	0.23%	290
Bexley	1/10 trend from 1981-2014 9/10 trend from 1992-2014	2.3	0.36%	260
Brent	7/10 trend from 1981-2014 3/10 trend from 2006-2014	2.4	0.20%	230
Bromley	3/4 trend from 1971-2014 1/4 trend from 2010-2014	2.3	0.30%	330
Camden	from 1981 to 2014	2.0	0.62%	2330
City of London	1/5 trend from 1981-2014 4/5 trend from 1990-2014	2.0	0.66%	2950
Croydon	1/2 trend from 1971-2014 1/2 trend from 2012-2014	3.5	-0.84%	-880
Ealing	1/2 trend from 1981-2014 1/2 trend from 2006-2014	2.6	0.01%	20
Enfield	2/5 trend from 1971-2014 3/5 trend from 1993-2014	2.6	0.00%	0
Greenwich	1/2 trend from 1981-2014 1/2 trend from 2001-2014	2.5	0.15%	120
Hackney	1/4 trend from 1989-2014 3/4 trend from 1996-2014	2.4	0.24%	260
Hammersmith and Fulham	from 1971 to 2014	2.0	0.66%	950
Haringey	1/4 trend from 1991-2014 3/4 trend from 2006-2014	2.5	0.09%	60
Harrow	1/4 trend from 1981-2014 3/4 trend from 2005-2014	2.6	-0.01%	0
Havering	3/4 trend from 1993-2014 1/4 trend from 2007-2014	2.4	0.23%	190
Hillingdon	from 1983 to 2014	1.8	0.81%	1860
Hounslow	4/5 trend from 1981-2014 1/5 trend from 1995-2014	2.1	0.49%	750
Islington	from 1981 to 2014	1.4	1.22%	3080
Kensington and Chelsea	3/5 trend from 1981-2014 2/5 trend from 2004-2014	2.2	0.47%	620
Kingston-upon-Thames	from 1984 to 2014	2.7	-0.12%	-80
Lambeth	3/10 trend from 1981-2014 7/10 trend from 1996-2014	2.1	0.52%	840
Lewisham	1/10 trend from 1981-2014 9/10 trend from 1996-2014	2.7	-0.08%	-50

Merton	from 1981 to 2014	2.2	0.42%	360
Newham	3/10 trend from 1981-2014 7/10 trend from 1995-2014	1.9	0.74%	790
Redbridge	from 1989-2014	2.1	0.55%	450
Richmond-upon-Thames	from 1987 to 2014	2.0	0.67%	570
Southwark	3/5 trend from 1981-2014 2/5 trend from 2004-2014	1.3	1.33%	3410
Sutton	from 1981 to 2014	2.5	0.09%	60
Tower Hamlets	3/4 trend from 1971-2014 1/4 trend from 1996-2014	0.1	2.54%	9460
Waltham Forest	1/4 trend from 1984-2014 3/4 trend from 1996-2014	2.2	0.43%	330
Wandsworth	3/5 trend from 1981-2014 2/5 trend from 2007-2014	2.4	0.27%	320
Westminster, City of	1/10 trend from 1981-2014 9/10 trend from 1993-2014	2.1	0.52%	3810
All London Employees	2/5 trend from 1984-2015 3/5 trend from 2004-2015	1.9	0.64%	33660

Note: Resultant productivity trend is the weighted trends estimated from the relationship between employment and output for the periods selected in the previous column

Borough employment based on transport accessibility

Volterra produced these projections, and their report, covering the methodology in full, is at Appendix 8. Broadly speaking, a relationship is established for each borough between employment density and transport accessibility – as expected central boroughs have both the highest density, and are the most accessible. Using data from TfL of funded transport schemes, and so improvements in accessibility, it is possible to project changes in employment by borough from estimated changes in employment density.

In some cases the trend or workplace capacity projection exceeds the transport accessibility projection for jobs. From the analysis conducted, challenges in transport provision have been identified for certain boroughs:

- Tower Hamlets, which includes the Isle of Dogs
- City of London
- Westminster
- Hillingdon, which includes Heathrow airport
- Hounslow
- Newham, specifically to support developments in areas other than Stratford such as the Royal Docks

The accessibility measure does not provide an absolute cap on the number of people who could commute and do business in each location. Therefore it is considered that there is not enough evidence to determine how the future location of jobs suggested by the trend or workplace capacity would be affected by crowding.

TfL will use the Volterra analysis, alongside other information, to inform the development of its future transport plans. On the basis that additional transport schemes would be brought forward and delivered to meet future capacity pressures, therefore supplementing the funded schemes used in the Volterra analysis, it is considered, for the purposes of this work, that transport accessibility will not be a constraint on the location of additional jobs in London. For this reason the transport accessibility projections do not feature in the rules to allocate employee jobs across boroughs.

Borough employment based on workplace capacity

CAG consultants produced borough level projections of additional employment site capacity, and their report is at Appendix 9.

Employment space capacity may well be a constraint to the development of central areas of London, especially for the projected levels of jobs growth. There has been a trend to make more intensive use of employment space through approaches such as hotdesking, flexible working, and increased self-employment, or working from home. It is likely that this is subject to diminishing returns, and at some point will become less important as a means to support jobs at a particular location.

In the past there have been concentrations of employment space development to support the creation of clusters of employment opportunities. This has been in central areas of London which have the strongest transport links to benefit from agglomeration economies, and Hillingdon, which is the location of Heathrow airport. Table A.5.7 reports borough employment growth across peak employment years in London (1971, 1989, 2001, and 2008), and for the most recent period. There are a range of factors that might influence the trend in other boroughs such as the decline in manufacturing, or an increase in education, health and retail jobs supporting an expanding local population.

Table A.5.7: Growth in Borough Employee Jobs for various time periods

	1971-2008		1989-2001		2001-2008		2001-2014		
	average jobs growth	CAGR	average jobs growth	CAGR	average jobs growth	CAGR	average jobs growth	CAGR	agglomeration area
Barking and Dagenham	-995	-1.6%	-792	-1.5%	-300	-0.6%	23	0.0%	no
Barnet	674	0.7%	1492	1.4%	14	0.0%	531	0.4%	no
Bexley	136	0.2%	408	0.7%	200	0.3%	162	0.2%	no
Brent	-942	-0.8%	-383	-0.4%	-557	-0.6%	762	0.7%	no
Bromley	802	0.9%	300	0.3%	1500	1.5%	323	0.3%	no
Camden	-214	-0.1%	2633	1.1%	3186	1.2%	5146	1.7%	yes
City of London	-907	-0.3%	1325	0.4%	429	0.1%	5000	1.4%	yes
Croydon	-508	-0.4%	-658	-0.5%	-1000	-0.7%	-2054	-1.6%	no
Ealing	-639	-0.5%	-558	-0.5%	-300	-0.3%	792	0.6%	no
Enfield	42	0.0%	-300	-0.3%	-300	-0.3%	54	0.1%	no
Greenwich	-320	-0.4%	-542	-0.8%	843	1.3%	669	1.0%	no
Hackney	-578	-0.6%	992	1.1%	-1414	-1.6%	515	0.5%	yes
Hammersmith and Fulham	-260	-0.2%	2008	2.0%	1629	1.4%	1146	1.0%	yes
Haringey	-651	-0.9%	-192	-0.3%	200	0.3%	408	0.6%	no
Harrow	380	0.6%	833	1.3%	-157	-0.2%	54	0.1%	no
Havering	240	0.3%	483	0.7%	-329	-0.4%	8	0.0%	no
Hillingdon	868	0.5%	2408	1.5%	2371	1.3%	1731	0.9%	no
Hounslow	193	0.2%	2000	1.6%	-1357	-1.0%	246	0.2%	no
Islington	649	0.4%	1900	1.3%	5286	3.0%	3646	2.0%	yes
Kensington and Chelsea	451	0.4%	1917	1.6%	-2043	-1.6%	-731	-0.6%	yes
Kingston upon Thames	83	0.1%	225	0.3%	-14	-0.0%	-623	-0.8%	no
Lambeth	189	0.1%	-1500	-1.2%	1843	1.5%	2092	1.6%	yes
Lewisham	-299	-0.4%	142	0.2%	-143	-0.2%	-31	-0.0%	no
Merton	58	0.1%	833	1.4%	300	0.4%	885	1.2%	no
Newham	-998	-1.1%	567	0.8%	-471	-0.6%	1277	1.5%	no
Redbridge	238	0.4%	833	1.4%	329	0.5%	646	0.9%	no
Richmond upon Thames	587	0.9%	1083	1.7%	514	0.7%	308	0.4%	no
Southwark	738	0.4%	1383	0.9%	1757	1.0%	3023	1.6%	yes
Sutton	501	0.8%	-25	-0.0%	629	0.9%	146	0.2%	no
Tower Hamlets	2160	1.3%	3783	2.7%	7014	3.8%	7008	3.5%	yes
Waltham Forest	-586	-0.8%	-275	-0.5%	200	0.3%	992	1.6%	no
Wandsworth	364	0.3%	558	0.5%	929	0.9%	477	0.4%	yes
Westminster	245	0.0%	2600	0.4%	4957	0.8%	5462	0.9%	yes
London	**1708**	**0.0%**	**25563**	**0.6%**	**25786**	**0.6%**	**40096**	**0.9%**	

Source: GLA Economics estimates, and various ONS sources
Note: CAGR is compound annual growth rate
Note: Agglomeration areas are boroughs which have the current infrastructure to benefit from agglomeration economies

Rules for borough employment projections
The steps to construct borough employee projections are:

- Borough trend self-employment trends are deducted from employment site workplace capacity projections to produce employee level workplace capacity projections

- Central London boroughs are assumed to be (a) at capacity if trend is less than capacity; or, (b) at trend (if trend is less than capacity + 10%); otherwise, (c) at capacity + 10% (ie where trend is more than capacity + 10%). The capacity is phased in to maintain the trend London employee jobs total. These areas have established employment centres reaping agglomeration economies, and so are likely to continue to be attractive. The boroughs meeting these criteria, and to which these rules apply on an individual basis, are either in the centre of London, have some area in the Central Activity Zone, or contain the Isle of Dogs. They are: Camden, City of London, Hackney, Hammersmith and Fulham, Islington, Kensington and Chelsea, Lambeth, Southwark, Tower Hamlets, Wandsworth, and Westminster

- The projections for Croydon and Newham give equal weighting to trend and capacity projections. This is because these boroughs have significant plans for additional employment space capacity which could change the attractiveness of the area as a place for new jobs. As these areas are either not yet fully established as employment centres or have not shown growth in recent years, there remains some uncertainty about the pace at which additional capacity would be taken up.

- Borough projections for the remaining outer boroughs are at trend. As there has been a significant volume of applications to convert employment space to residential use there is flexibility in the use of land in these boroughs, and this is expected to continue in managing the competing pressures of commercial and residential land use.

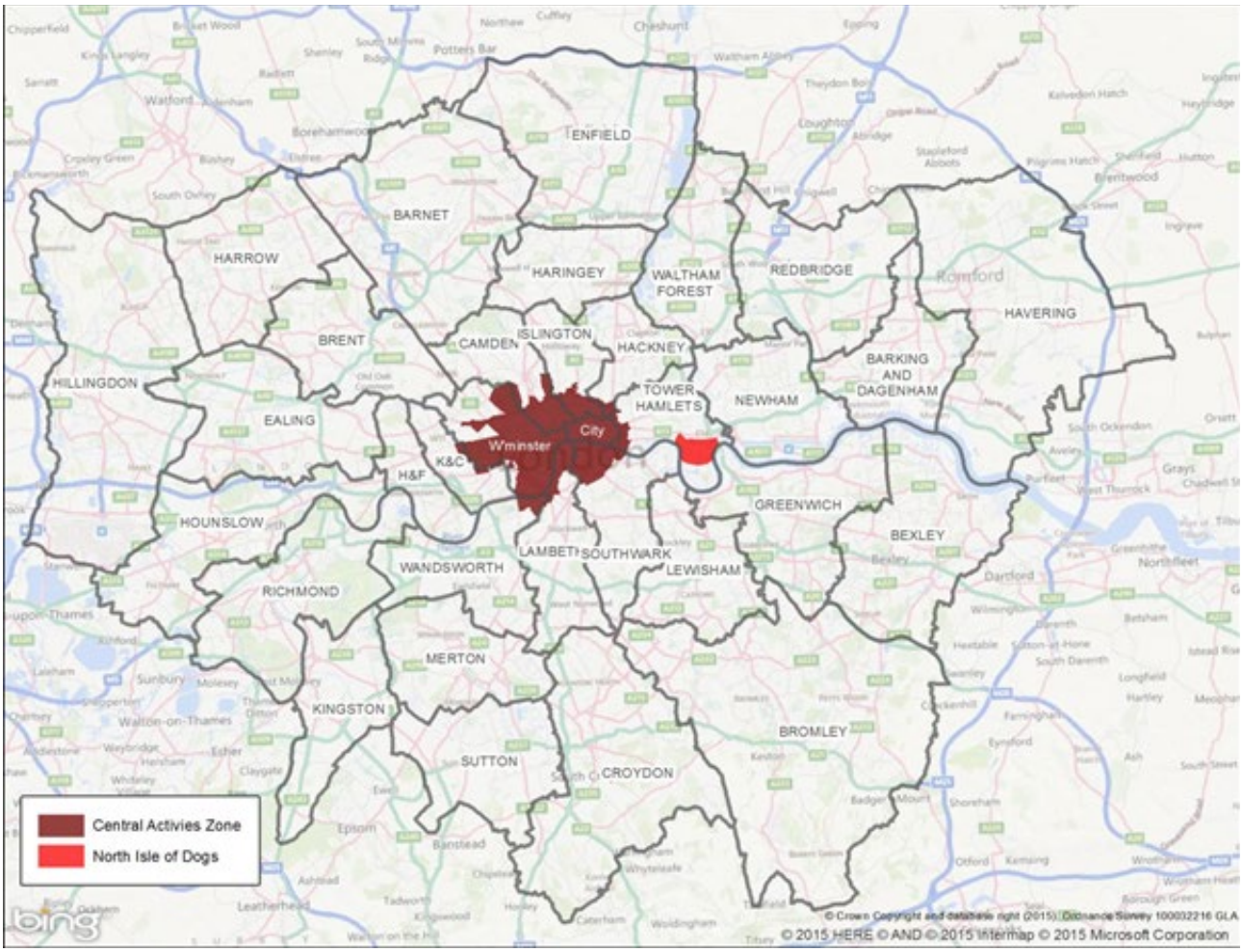
Borough employment projections are the sum of the rules-based employee projections and the trend self-employment projections.

Trend-based employment projections for London's Central Activity Zone (CAZ) and North Isle of Dogs (NIoD)

The Central Activities Zone (CAZ) contains a unique cluster of vitally important activities including central government offices, headquarters and embassies, and a large concentration of high value adding business activity. This clustering also occurs in the northern part of the Isle of Dogs[14] (NIOD). These two areas are thus of strategic importance to the GLA.

CAZ covers portions of the London boroughs of Camden, Hackney, Islington, Kensington and Chelsea, Lambeth, Southwark, Tower Hamlets, Wandsworth, and Westminster, as well as the total area of the City of London. NIoD lies entirely within Tower Hamlets. Map A.5.1 shows the geographic location of these two policy areas[15].

Map A.5.1: Location of CAZ and NIoD

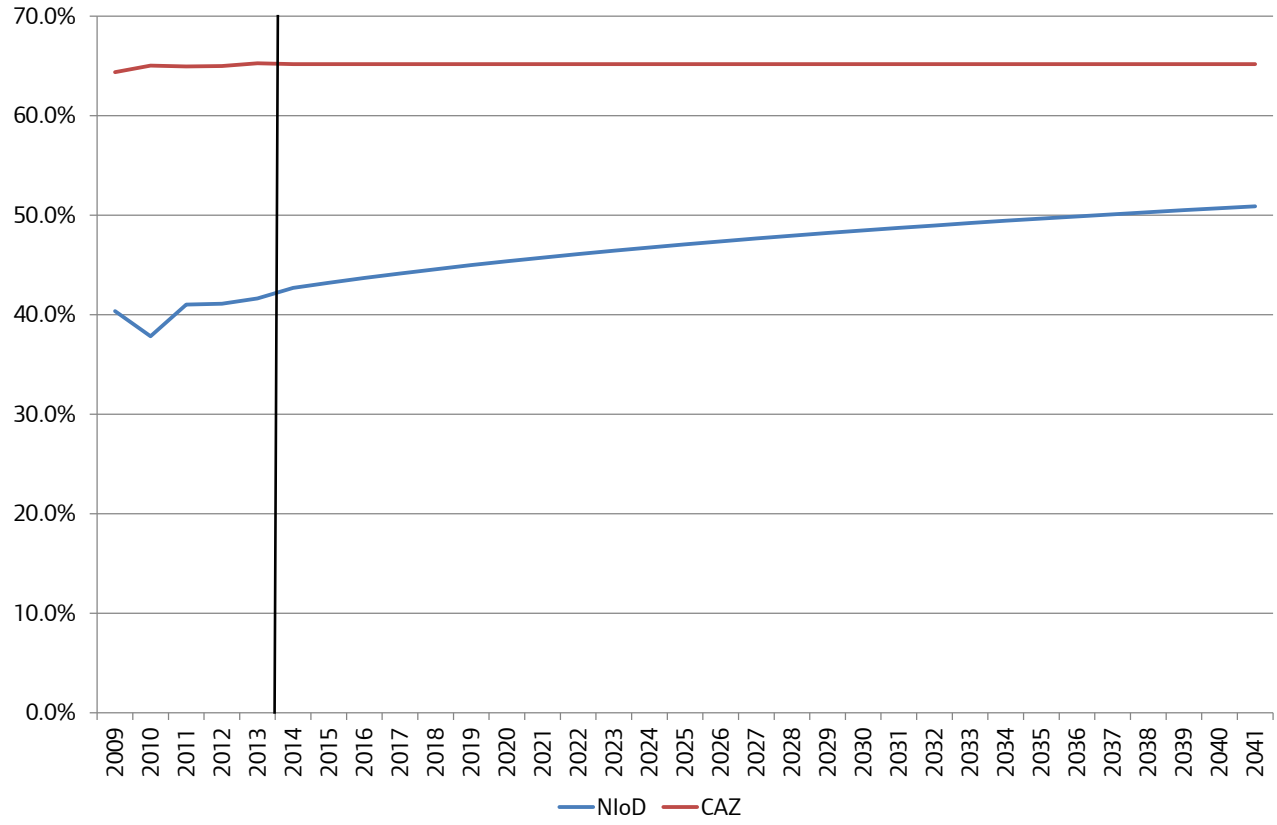


In order to construct projections for these policy areas GLA Economics firstly applies the share of CAZ and NIoD land that lies within a lower-super output area (LSOA) to the estimate of employee jobs in that LSOA (using data from BRES, ONS). In order to estimate the proportion of boroughs' jobs that falls within the policy areas, the policy area employee estimates in each LSOA is then summed across each borough and divided by BRES employee jobs estimates for the borough.

This is done for each of the years for which data is available (2009 to 2014). For CAZ the share has been relatively constant at around 65%, while the share of Tower Hamlets employee jobs in NIoD has risen from 49.8% in 2009 to 53.3% in 2014. As a sense check on possible future trends GLA Economics conducted an analysis of the London Employment Sites Database to assess additional employment site capacity in CAZ, the CAZ boroughs, NIoD, and Tower Hamlets. This indicated that over the period of the projections around 60% of the additional capacity in the CAZ boroughs would lie in CAZ, and that around 85% of additional capacity in Tower Hamlets would lie in NIoD.

Consequently, the CAZ share of employee and employment jobs in CAZ boroughs has been set at 65% over the period of the projections. The NIoD share of employee and employment jobs in Tower Hamlets has been projected forward using a log-linear projections of the historic share of employee jobs over 2009-14. The trend results are presented in Figure A.5.4 and the tri-angulated employment projections summarised in Table A.5.8.

Figure A.5.4: Historic and projected employment shares in CAZ and NIoD (000s), 2009-2041



Note: Shares are of employee jobs in boroughs in which CAZ and NIoD lie respectively

Table A.5.8: Summary of CAZ and NIoD employment projections 2014-41

	Employment growth per annum with London output growth of 2.5% per annum	Annual average growth in jobs with London output growth of 2.5% per annum
CAZ	0.75%	15,670
NIoD	2.60%	4,330

Appendix A.5.A: Methodology for GLA Economics' trend-based medium-term projections

Box A.5.1 considers the rationale for the trend-based methodology GLA Economics' employs for its medium-term projections. Below is the algebra underlying the model:

Starting with a simple production function:

$$Y = ALe^{\beta t} \quad (1)$$

where Y is output and L is employment.

It is assumed that in the medium term the rate of growth of potential output is given by:

$$Y_{trend} = Y(0)e^{\gamma t} \quad (2)$$

Following the Office for Budget Responsibility (OBR) estimate for the UK's long-term output potential[16], it is assumed that $\gamma = 0.025$.

In the absence of constraints[17], in the medium term actual output is assumed to be equal to potential. So (1) can be re-written as:

$$Y(0)e^{\gamma t} = ALe^{\beta t} \quad (3)$$

and solving for the potential level of demand for employment, subsuming the constant terms Y(0) and A as appropriate into a single term, k1.

$$L_{trend} = k1\ e^{(\gamma - \beta)t} \quad (4)$$

This is the level of employment which would enable the trend rate of growth to be sustained.

The parameter β is not however time-invariant in the model. Instead, historical data is used to inform a linear function for projecting β into the future.

Appendix A.5.B: Methodology for producing a range of on-trend employment projections

As mentioned in Box A.5.1, GLA Economics looked at a number of economic commentators to see when they estimated the UK economy to be on trend to produce a range of possible on-trend employment projections. Specifically, GLA Economics looked at the output gap estimates from the following organisations:

- European Commission (EC):
  - Hodrick-Prescott (HP) filter based estimates
  - Production function based estimates
- IMF
- OECD
- Office for Budget Responsibility (OBR)

These estimates were then assessed using three methodologies to try to attain employment levels which correspond to the economy being on-trend. These three methods were:

1 Taking the on-trend years (and employment in those corresponding years) as those where the estimated output gap changed sign between two consecutive years and taking the year where the absolute value of the estimated gap is closest to zero,

2 Taking the on-trend year as all those where the absolute value of the estimated output gap is less than or equal to 0.5 per cent,

3 Combining the resulting years from the two methods above.

Once the year's corresponding to the three methods above had been collated the corresponding employment in those years was selected and interpolated to generate estimates for in-between years. Finally, a line of best fit was applied to these and projected forward. Outlier trends from the results were then excluded.

In addition to the estimates generated from the methodology above two additional estimates were created using historic employment data alone. The first of these took both the peak and trough levels of employment over time and interpolated between them (i.e. interpolated between each peak to peak employment level and each trough to trough employment level separately). A line of best fit was then applied through each and forecasted forwarded and the average of the two lines was taken. The second estimate took the average between the interpolated peak to peak and trough to trough lines before a line of best fit was applied and projected forward.

Appendix A.5.C: Further information on an alternative method of estimating future employment in London

The methodology for the alternative method of estimating future employment works as follows:

Let Jik = Jobs in location i filled by people from location k.

and G (x) = growth of the variable x

Then, with the subscripts (L) denoting London and (N) denoting locations outside London,

London's employment on a residence basis is given by:

$E_L = J_{LL} + J_{NL}$ (1)

Similarly London's employment on a workplace based (J_L) basis is given by:

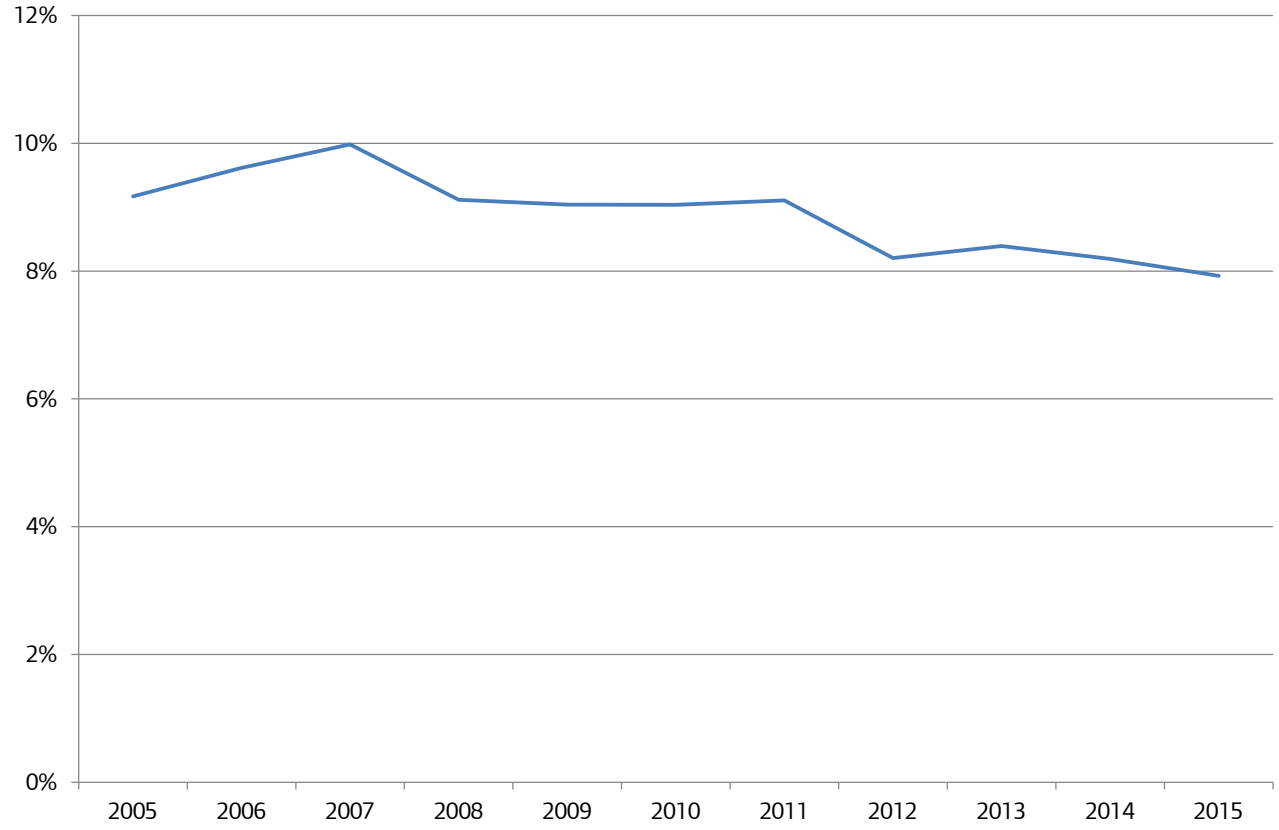
$J_L = J_{LL} + J_{LN}$ (2)

Now $G(E_L) = G(J_{LL}) = G(J_{NL})$ (3), if J_{LL}/E_L is constant over time. This is equivalent to saying that J_{NL} / E_L is also constant over time, i.e. the proportion of Londoners employed who fill jobs out of London is constant. Figure A.5.C.1 shows that the share of jobs filled by Londoners working outside of London (out-commuting) has been relatively constant, although it appears to have declined slightly in the recent history[18].

Similarly $G(J_L) = G(J_{LL}) = G(J_{LN})$, (4) if J_{LL}/J_L or equivalently J_{LN} / J_L is constant over time. Note J_{LN} / J_L is the proportion of jobs in London that are filled by non-Londoners commuting into London. Figure A.5.C.2 shows the share of jobs in London filled by those in-commuting. Again, apart from a slight dip in 2005, this share has indeed been relatively constant over time.

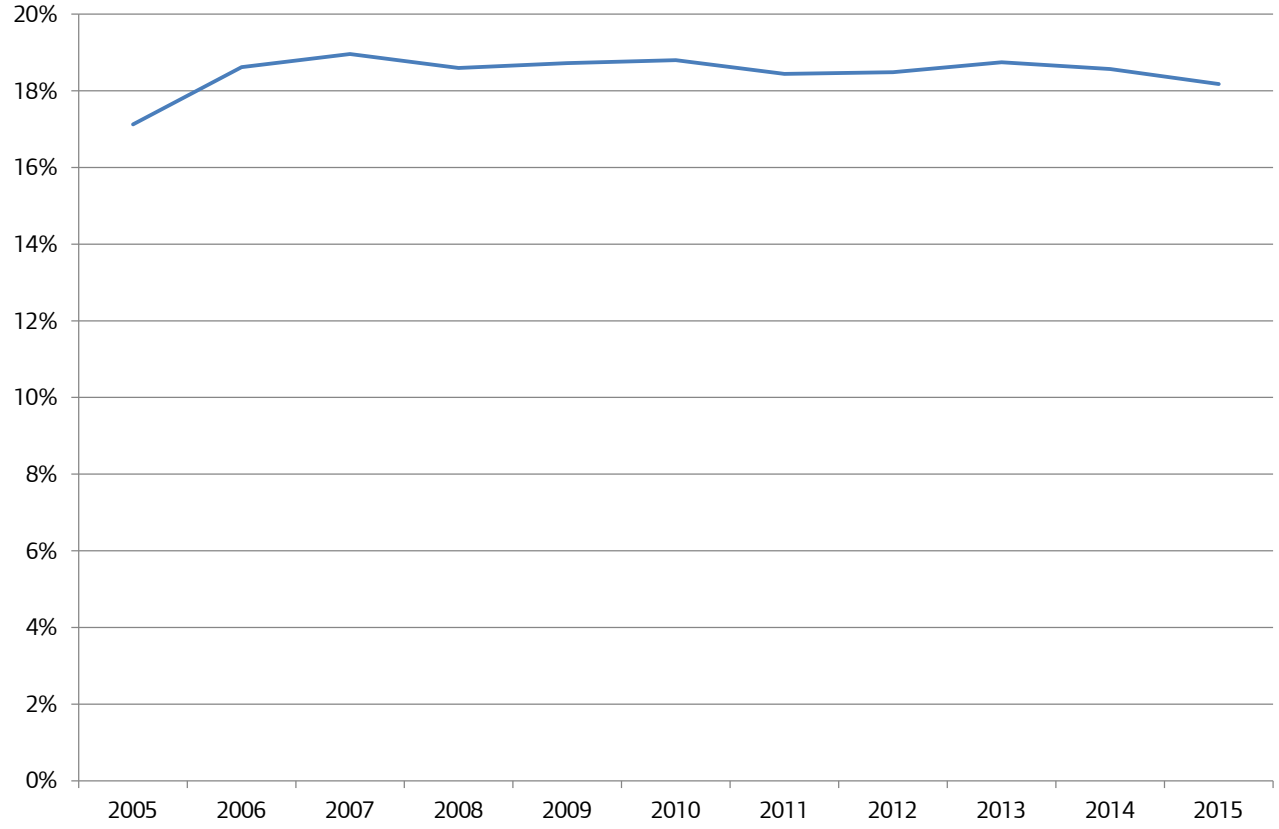
If both equations (3) and (4) above hold it follows that since both $G(E_L)$ and $G(J_L)$ equal $G(J_{LL})$ then $G(E_L)$ and $G(J_L)$ are also equal to each other. That is that the growth in employment in London on a workplace basis is equal to the growth in employment in London on a residence basis.

Figure A.5.C.1: Jobs not in London filled by working age Londoners as a proportion of all working age people employed London residents



Source: APS, January-December, ONS

Figure A.5.C.2: Share of jobs in London filled by working age non-Londoners in-commuting



Source: APS, January-December, ONS

In other words, employment in London on a workplace basis can be estimated by estimating employment in London on a residence basis. The latter itself can be estimated by applying a projected employment rate to projections of London's population. For this, the working age employment rate is assumed constant at the 2015 rate. This is then applied to the working age population projection from the GLA 2015 round of demographic projections (trend-based population projections, long-term migration scenario)**.** Since the employment estimate has been confined to the working age population alone the results from this methodology may be considered a cautious alternative.

Appendix 6: Population projections methodology

Population Projections: Projection process explained

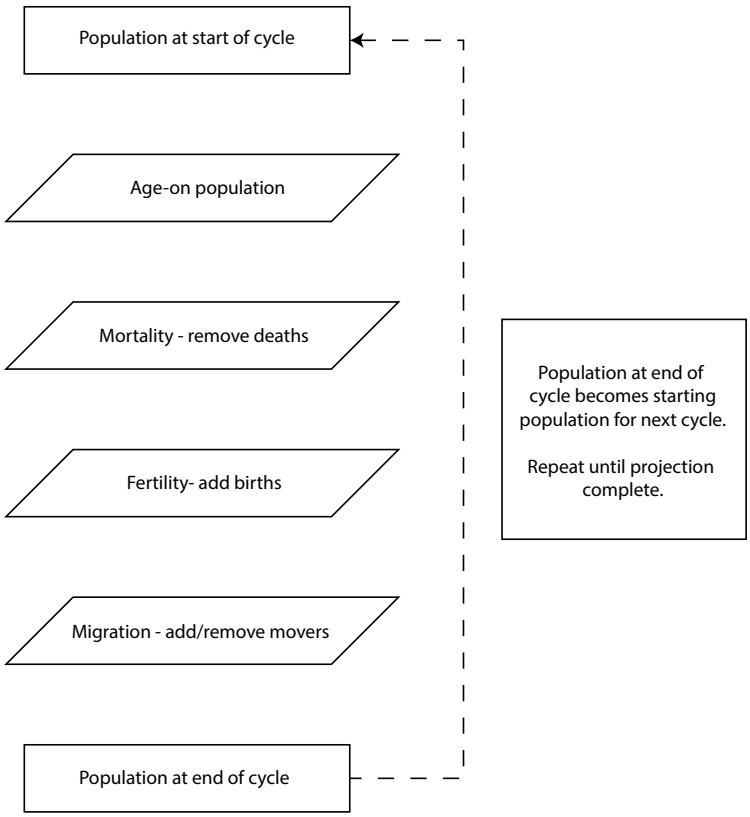
The GLAs borough-level population projections are produced using a multiregional cohort component projection model. Estimates and projections are produced from the starting point of the 2014 mid-year estimate. This starting population is aged-on a year, and deaths, births and migration flows are accounted for such that an estimated population for mid-year 2015 is arrived at. This process is repeated, using the final population calculated in each loop as the starting population for the next.

Beyond the last year with actual data available, values for births, deaths and migration flows are projected using age specific probabilities for fertility, mortality and migration generated from historical trends.

This process is undertaken for each local authority in England as well as Wales, Scotland and Northern Ireland as whole countries. The London total is an aggregation of the results for its constituent local authorities.

Figure A.6.1 illustrates the process of producing the GLAs borough-level projections.

Figure A.6.1 Process of producing the GLAs borough-level projections.



The data used in the 2015 round of trend-based population projections are listed below:

Births and Deaths
Total births and deaths by single year of age and gender were taken from ONS mid-year estimates (MYE).

Births by age of mother were taken from the detailed components of change accompanying the 2012-based ONS subnational projections. These are used to derive age specific fertility rates.

Future fertility and mortality trends
Age Specific Fertility Rate (ASFR) and Age Specific Mortality Rate (ASMR) trends beyond 2014 are based on the "Principle" assumptions used in the 2012-based ONS National Population Projections (NPP) for England. Proportional changes in these rates are used to roll estimated ASFRs and ASMRs forward to the end of the projection period.

Population estimates
Population estimates for mid-2001 to mid-2014 are taken from the ONS MYE series.

Migration data
Domestic flows
For 2002 to 2014, domestic migration flows were taken from ONS's annual internal migration estimates.

International flows
For 2002 to 2014, international flows were based on the ONS MYE values.

Future migration trends
International inflows are assumed constant beyond 2014 and fixed at the mean inflow for the last twelve years of historic data.

All other migration flows are projected forward using constant age and gender specific probabilities based on the previous twelve years of estimated flows

Appendix 7: Backcasting data series to 1971

This paper describes the data and methodology used to construct an experimental back series on London's jobs and output back to 1971. This work extends previous GLA Economics reports for a London Jobs series[19] and a London Workforce Employment series[20], to provide a backcast employment series for the purpose of producing long-term employment projections.

Understanding the history and relationship between jobs and output in London forms a key part of producing long-run employment projections for London, as well as long-term trends in key London sectors and London boroughs.

There are no official statistics providing a consistent or detailed time series of London jobs, or for individual boroughs or industries; nor is there a consistent series for London's output, as measured by gross value added (GVA), back to 1971.

This work addresses the information gap by providing an experimental time series for London's jobs, and by sector and by borough, and for London GVA. Where possible official statistics have been used, however where they have not been available, alternative sources have been investigated to estimate historical jobs and output. The results from this work have been compared with a variety of sources, including series produced by other economic forecasters, to 'sense check' the results.

This appendix covers:

- The comparison of current and previous series for jobs-based employment;
- The data sources used in constructing a jobs series back to 1971 and the approach to comparing these series;
- The backcasting approach adopted to create the long-run jobs series required to produce long-term employment projections;
- The comparison of current and previous series for GVA;
- The data sources used in constructing a GVA series back to 1971 and the approach to comparing these series; and,
- The backcasting approach for a London level GVA series.

The section for each respective series considers available ONS data, and series produced by other forecasters, and details how these sources have been used to develop a backcasting methodology. Methods and assumptions used are clearly stated.

1 Comparison of current and previous series for jobs-based employment

The trend-based employment projections methodology relies heavily on historic data data for London, with changes to the historic series causing changes to the projections. Table A.7.1 show how the most recent historical employment data, as developed by the backcasting approach set out in this Appendix, differs to the employment data that formed the basis of the projections in Working paper 67[21].

Table A.7.1: Total London employment – previous and revised data

Employment (000s)	Current estimates (as at March 2016)	Working paper 67 (GLA, 2015)	Difference (new less old)	Percentage difference
1984	4,112	4,094	18.7	0.46%
1985	4,145	4,126	18.9	0.46%
1986	4,104	4,085	18.7	0.46%
1987	4,202	4,183	19.1	0.46%
1988	4,281	4,262	19.5	0.46%
1989	4,301	4,282	19.6	0.46%
1990	4,230	4,211	19.3	0.46%
1991	4,030	4,012	18.4	0.46%
1992	3,875	3,858	17.6	0.46%
1993	3,820	3,803	17.4	0.46%
1994	3,915	3,897	17.8	0.46%
1995	3,978	3,960	18.1	0.46%
1996	3,953	3,952	1.5	0.04%
1997	4,090	4,091	-0.8	-0.02%
1998	4,278	4,280	-1.2	-0.03%
1999	4,442	4,443	-0.8	-0.02%
2000	4,610	4,610	-0.5	-0.01%
2001	4,634	4,636	-2.0	-0.04%
2002	4,565	4,564	0.8	0.02%
2003	4,588	4,588	-0.8	-0.02%
2004	4,565	4,564	1.5	0.03%
2005	4,666	4,665	1.3	0.03%
2006	4,717	4,717	0.2	0.01%
2007	4,772	4,771	0.8	0.02%
2008	4,911	4,912	-1.0	-0.02%
2009	4,811	4,809	1.5	0.03%
2010	4,802	4,804	-1.8	-0.04%
2011	4,882	4,877	5.3	0.11%
2012	5,081	5,087	-6.8	-0.13%
2013	5,221	5,250	-29.5	-0.57%
2014	5,433	5,520	-86.5	-1.59%
2015	5,538			

Source: Workforce Jobs, ONS and GLA Economics estimates.

The source of the historic employment data remains the ONS Workforce Jobs (WFJ) series for data from 1996 onwards combined with updated GLA Economics' estimates (as presented in Working Paper 52[22]).

As Table A.7.1 shows, the revision in the jobs history has varied over the 1984 to 2014 period. Upwards historical revisions have been made to the data over the 1984 to 1995 period. These are relatively small in scale, ranging from 17,000 (0.5%) to 20,000 (0.5%). Over the period 1996 to 2013, historical revisions to the WFJ series have been relatively small, ranging from -30,000 in 2013 (0.6%),

to 5,000 in 2011 (0.1%). Most recently, the WFJ series has been revised significantly in 2014, by -87,000 on earlier estimates, or a downwards revision of 1.6%. Recent changes to the data represent adjustments resulting from benchmarking to the latest estimates from the annual Business Register and Employment Survey (BRES); these revisions go back to 2011[23].

2 Employment data sources, and definitions

GLA Economics' long-run employment projections have previously drawn on the ONS' WFJ series for data on employment from 1996 onwards, combined with LFS microdata to provide estimates for data from 1984 to 1995, to provide London's jobs history back to 1984.

To provide a longer time series on which to forecast long-run employment projections, the user requirements were for series on:

- London-level employment, employee and self-employment
- London employment by sector
- Employee jobs by borough
- Self-employed jobs by borough (using ONS Annual Population Survey data from 2004)

There is no single official data source that covers the entire period from 1971 onwards, and there is no data source that provides the range of data items required by GLA Economics to support the employment projections.

The methodology draws on a number of data sources to create a consistent jobs series at the London, sector and borough level back to 1971. This section lists the official sources of employment data, and data series provided by other forecasters. It provides definitions of the available data, and the period of coverage.

Employment data can either refer to jobs or people measures, ie. people can have more than one job, and jobs may be shared by more than one person. Employment data can also be recorded on a workplace or residence basis. GLA Economics' employment projections focus on jobs in the workplace regardless of whether they are filled by London residents or commuters.

Official data sources

The official data sources used are listed below:

1. ONS Workforce jobs (WFJ)

- Regional/ London level employment by jobs (employee jobs + self-employed jobs) 1996-2015
- Employee jobs 1981-2015, workplace basis
- Self-employed jobs 1996-2015, residence basis
- SIC 2007 Section level, with selected division level breakdowns for total jobs[24] (more detail below)

The WFJ series is the ONS' preferred measure of jobs by industry at the regional level, and provides a quarterly time series on jobs-based employment, employee jobs and self-employed, at the London level, by SIC 2007 section.[25]

The Workforce jobs series is benchmarked annually to align the quarterly series with annual estimates from BRES.

Defining workforce jobs
Workforce jobs relate to the number of jobs in London, whether or not they are taken by London residents. The figures discussed here relate to jobs located in London; this difference is important as some people may have more than one job.

The ONS' definition of Workforce jobs is as follows:
Workforce jobs = employee jobs + self-employed jobs + HM forces + Government supported trainees

In London, employee jobs and self-employed jobs account for over 99 per cent of the total Workforce jobs. Historically, GLA Economics have excluded HM Forces and Government supported trainees from jobs analysis, and for consistency these components are not included in the time series presented here, with employment therefore defined as employee jobs and self-employed jobs.

GLA Economics sectors
The London Jobs series is based on the SIC 2007 classification. SIC 2007 comprises 21 Sections (denoted by a single letter from A to U). ONS Business Surveys cover 19 of these 21 Sections, excluding T (activities of households as employers) and U (activities of extra-territorial organisations). Sections T (activities of households as employers) and U (activities of extra-territorial organisations) have been excluded from the London jobs series as these sections are not covered by ONS business surveys.

The GLA combines Sections A, B, D and E into a new category, 'Primary and utilities', and sections L and M are combined into 'Professional, Real Estate, Scientific and technical activities'.

A Wholesale/Retail split is also provided to divide the SIC 2007 Section 'Wholesale and retail trade; repair of motor vehicles and motorcycles'. Motor trades are included within wholesale for this split.

SIC 2007 Section level	GLA Economics sector
A: Agriculture, forestry and fishing	Primary and utilities
B: Mining and quarrying	
D: Electricity, gas, steam and air conditioning supply	
E: Water supply; sewerage, waste management and remediation activities.	
C: Manufacturing	Manufacturing
F: Construction	Construction
G: Wholesale and retail trade	Wholesale [including motor trades]
	Retail
H: Transportation and storage	Transportation and storage
I: Accommodation and food service activities	Accommodation and food service activities
J: Information and communication	Information and Communication
K: Financial and insurance activities	Financial and insurance activities
L: Professional, scientific and technical activities	Professional, Real Estate, Scientific and technical activities
M: Real estate activities	
N: Administrative and support service activities	Administrative and support service activities
O: Public administration and defence; compulsory social security	Public administration and defence
P: Education	Education
Q: Human health and social work activities	Health
R: Arts, entertainment and recreation	Arts, entertainment and recreation
S: Other service activities	Other services

For consistency, this analysis uses the same SIC 2007 groupings, referred to as 'sectors' throughout the paper.

2 ONS Business survey data

The WFJ series benchmarks employee jobs annually to the main ONS business survey, currently the Business Register and Employment Survey (BRES). To provide a higher level of detail than WFJ for industry at the London Level and also for borough data, GLA Economics' Working paper 52 developed a methodology for linking these surveys, and similarly we have used or considered using historic ONS business survey data including the following:

Business Register and Employment Survey (BRES)
- Employee jobs, workplace basis
- 2009-2014, SIC 2007
- Regional and sub-regional geography, including borough level.

BRES is an annual business survey that collects employee jobs data at a local unit level from businesses across the UK for each site that they operate. Data is available on a consistent basis from 2009 to 2014, and the employee jobs component of WFJ is benchmarked annually to BRES data.

BRES is the ONS' recommended source of information of employee jobs by detailed geography and detailed industry. For employment projections GLA Economics aligns BRES employee jobs totals to Workforce Jobs employee numbers at a London level.

Annual Business Inquiry (ABI)
- Employee jobs, workplace basis
- 2007 to 2008, SIC 2007
- 1998 to 2007, SIC 2003 (and SIC 1992)
- Regional and sub-regional geography, including borough level

Census of Employment (CoE) employee analysis
- Employee jobs, workplace basis
- 1971 to 1978 in SIC 1968
- Regional and sub-regional geography, by Job Centre area only

3 ONS Labour Force Survey (LFS)

- London level self-employed jobs, workplace basis
- 1984-, SIC 2007

The LFS is a survey of the employment circumstances of the UK population. It is the largest household survey in the UK and provides the official measures of employment and unemployment. It provides data on employment both on a people and jobs basis. LFS microdata data has been used in the London Jobs series to provide a workplace based jobs measure of self-employment.

From 2004, the LFS has been a component of the Annual Population Survey.

4 ONS Annual Population Survey (APS)[26]

- Self-employed jobs by borough, workplace basis
- 2004-2015

5 Historical Census data

- People-based employment, workplace basis
- 1971, 1991 and 2011, SIC 2007 with sections R, S, T and U combined
- Historical data has been re-allocated to London borough boundaries in 2011.

The Census asks respondents to provide information on their main job (whether an employee or self-employed)[27], hence it counts the number of people in employment. The Census also records information about the industry and location of the respondent's main job.

6 London Jobs series (2015)

- A London level series which includes Employee Jobs and Employment from 1984 to 2015, with industries by sector (based on SIC 2007 groupings as outlined above), and a wholesale/retail jobs split
- A borough level employees series, from 1981 to 2014, on a consistent post-2009 local authority basis

The methodology used to construct the London Jobs series is provided in Working Paper 52: London's jobs history – a technical paper.[28] In short, to provide a London level jobs series back to 1984, WFJ employee data from 1981 onwards is combined with self-employment estimates from the LFS from 1984 to 1995, to provide a complete jobs series from 1984 onwards.

Other historical time series

Other historical time series, previously published by the GLA and from other respected organisations, have been reviewed, on the basis that they:

- Provide data on London's jobs from 1971 onwards; and,
- Maintain a consistent definition of jobs, industrial sectors and geographical boundaries over a period of time.

The GLA published a London Workforce Employment Series, to estimate jobs-based employment over the 1971 to 2007 period. The series provides a long-run data set on employee jobs, self-employment and total workforce jobs, by sector and by borough. Further information on the methodology used to construct the London Workforce Employment Series is available in the associated report.[29]

The London Workforce Employment series

- Employees and self-employment, 1971-2007, 12 sector breakdown based on SIC 1992 sections, with a wholesale/retail split
- Employees, 1971-2005, 30 sector breakdown based on SIC 1992 divisions
- Regional and sub-regional geography, 1991 local authority boundaries

The development of the series made use of available official statistics at the time of publication, 2003. Within the total workforce jobs estimates, the London Workforce Employment series makes a correction for London-based members of the armed forces (about 20,000) and government trainees (about 10,000), but these adjustments are not allocated to boroughs or sectors.

The historical time series of other organisations, have been reviewed for the purposes of constructing back series to 1971. These other organisations are referred to as 'Forecaster A' and 'Forecaster B' throughout the Appendix. Both Forecasters A and B have estimates of employment in London over time although each have more detail in different areas, for instance one forecaster has more information on the sectoral breakdown than the other.

3 Basis for comparison between time series

Wherein the course of the analysis there are comparisons between time series, these use a number of tests previously employed by GLA Economics[30] to evaluate the performance of employment projections and measure the extent to which the respective time series:

- Do not exhibit bias, ie. not consistently underestimate or overestimate established series on a regular basis; and
- Are accurate or close to the established series (in this case, ONS WFJ employment from 1996 to 2007, and the revised London Jobs series from 1984 to 1995) over the period under consideration.

The statistical measures used to evaluate the series are:

1 Compound annual rate of growth (CAGR) – the average year on year growth between two points in time.

2 Difference in CAGR – the series' CAGR compared with the established series' CAGR.

3 Correlation coefficient – measures how closely (in direction and magnitude) the series follows the London Jobs series.

4 Cumulative sum of difference – adds up the difference in each year between estimated and actual employment.

5 Mean absolute deviation – measures the size of the average difference between the series and the official statistics each year (regardless of the direction of the error).

6 Mean absolute percentage difference – measures the average of the percentage differences in each year, and thus provides an indication of the scale of the difference.

4 The backcasting approach for a London-level jobs series for employment, employee jobs and self-employed

This Section sets out the approach to backcasting a London-level jobs series for employment, employee jobs, and self-employed jobs, back to 1971.

The subsection for each respective series covers the issues in available data, and how these issues were addressed in the adopted backcasting approach.

London level employment

There is no consistent time series of total employment at the London level, back to 1971. A review of the available data sources found the following:

- The ONS' Workforce Jobs series provides a complete employment measure back to 1996 only.
- The GLA's London Jobs series extends London's jobs history back to 1984, however is not consistent with historical revisions to WFJ (April 2013) for 1984 to 1995, so cannot be spliced[31] with other series to create a backcasted series to 1971.
- The Workforce Employment Series, Forecaster A and Forecaster B's series cannot be compared on a like-for-like basis due to differences in definition between the series (ie. inclusion of HM forces and government-supported trainees in one of the forecaster's employment series for example).

To address these issues in the backcasting employment methodology, the following steps have been taken:

- Assessing the impact of the April 2013 WFJ revision to London-level employment.
- Adjusting the London Jobs series to reflect WFJ revisions back to 1984, so it can be spliced.
- Comparing the revised London Jobs series, the Workforce Employment series, Forecaster A's employment series and Forecaster B's employment series, over the 1984 to 2000 period.
- Splicing the preferred back series with the revised London Jobs series at 1984.

The following subsections provide more detail on the backcasting method.

The impact of the April 2013 WFJ revision on London-level employment

In April 2013, the ONS published guidance on historical revisions made to the WFJ series[32]. These revisions are summarised below:

- Change in the treatment of working owners in BRES, resulting in an upwards revision to employee jobs and an exactly offsetting downward revision to self-employed jobs, from 1959 onwards. This revision was incorporated in the 2015 employment projections[33], and is discussed in further detail in Working paper 66[34].
- Changes to estimates of public sector employment, affecting employee jobs from 1991. This revision was also incorporated in the 2015 employment projections.
- Introduction of a seasonal adjustment process for each industry on a region by region basis, affecting regional employment back to 1981.

The ONS has not provided separate estimates of the size of these effects either by year or for employment, employee and self-employed jobs.

Adjusting the London Jobs series to account for the WFJ revisions

To adjust the London Jobs series in line with the WFJ employment revision, the series as at the 2013 employment projections was compared with the most recently available data. The correlation coefficient between the two series was 0.999, indicating a strong relationship between the two series.

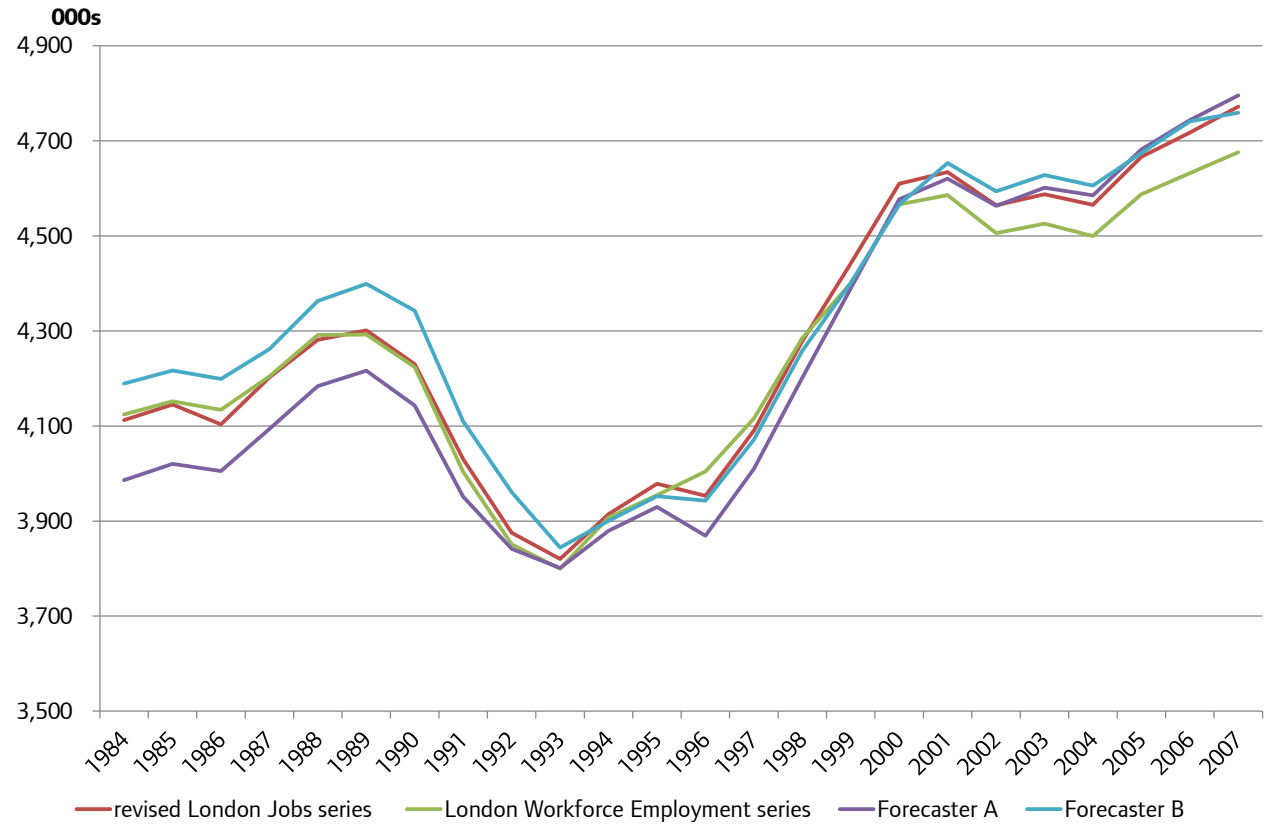
A linear regression was performed on the two series, to establish whether possible to predict London level employment from 1984 to 1995, with the values from WFJ employment from 1996 to 2011, using the 2013 series as the independent variable and the 2016 data as the dependent variable.

The results from the regression indicated a statistically significant relationship between the two series; with the t-stat of the coefficient and the intercept being above 1.96 (126.6 and 2.1 respectively). This was considered sufficient evidence to suggest that we could predict the revised 1984 to 1995 series for of London employment, using the 1984 to 1995 London Jobs series. The series were spliced at the 1996 point, and backcasted to 1984 using London Jobs series growth rates. This provided a revised London Jobs series back to 1984, consistent with WFJ revisions.

Comparing London employment time series

The revised London Jobs series was compared with the other time series highlighted in Section 2, for the years in which we have comparable data, ie. 1984 to 2007. Figure A.7.1 shows total London employment as estimated by various historical time series.

Figure A.7.1: Total London employment – comparison of historical series, 1984 - 2007



The series converge over the 1990s, and the Workforce Employment Series somewhat diverges from the other series from 2000 onwards. The Workforce Job Series is a composite of other data source, and it may be not consistent with other series for estimating jobs. For this reason much of the analysis of this paper of the Workforce Employment Series uses the period up to 2000, when trends where more closely aligned.

The series have also been compared using the tests outlined in Section 3. The results of this comparison are shown in Table A.7.2.

Table A.7.2: Results of comparison of London level employment data between revised London Jobs series and other series, 1984-2007

1984-2007	Revised London Jobs series	London Workforce Employment series	Forecaster A	Forecaster B
CAGR	0.65%	0.55%	0.81%	0.56%
Difference in CAGR	0.00%	-0.10%	0.16%	-0.09%
Correlation coefficient	1	0.995	0.993	0.987
Cumulative sum of forecast difference	0	-552	-1,186	759
Mean absolute deviation	0	35	58	47
Mean percentage difference (%)	0.0	0.8	1.4	1.1

The Workforce Employment series has the strongest relationship with the revised London Jobs series across most measures; with the strongest correlation coefficient, the lowest cumulative sum of forecast difference, lowest mean absolute deviation, and the lowest mean percentage difference. However, Forecaster B has the closest CAGR to the revised London Jobs series.

The series have also been compared across the 1984 to 2000 period, before the Workforce Employment series diverges from the other series, with results shown in Table A.7.3.

Table A.7.3: Results of comparison of London level employment data between London Jobs series and other series, 1984-2000

1984-2000	London Jobs series	London Workforce Employment series	Forecaster A	Forecaster B
CAGR	0.72%	0.64%	0.87%	0.54%
Difference in CAGR	0.00%	-0.08%	0.15%	-0.18%
Correlation coefficient	1.000	0.993	0.988	0.963
Cumulative sum of difference	0	-58	-1,270	609
Mean absolute deviation	0	20	75	56
Mean percentage difference (%)	0.0	0.5	1.8	1.3

Over the 1984 to 2000 period, the London Workforce Employment series has the strongest relationship with the London Jobs series across all measures.

Table A.7.4 compares the results of a linear regression between the London Jobs series and London Workforce Employment series over both periods, using the London Jobs series as a dependent variable and the London Workforce Employment series as an independent variable.

Table A.7.4: Statistical and regression results, 1984-2007 and 1984-2000

Employment	1984-2007	1984-2000
CAGR London Workforce Employment series	0.55%	0.64%
CAGR London Jobs series	0.65%	0.72%
Difference in CAGR	0.10%	0.08%
Correlation coefficient	0.995	0.993
accept null hypothesis y=x	Accept	Accept
statistically significant relationship (ie t>1.96)	49.1	31.7
accept null hypothesis intercept is zero	Reject	Accept
statistically significant relationship (ie t>1.96)	-4.2	-0.6

For both the 1984 to 2007 period, and the 1984 to 2000 period, the relationship between the two series is statistically significant. The hypothesis that the intercept includes zero at the 95% confidence interval is not accepted for the 1984 to 2007 period, but is for the 1984 to 2000 period, even though the tested relationship is not statistically significant. For this reason, the 1984 to 2000 data series is preferred.

Conclusion – adopted backcasting methodology for employment

On the basis of the evidence from the statistical tests and the regression, the revised London Jobs series is backcast using the growth rates of the London Workforce Employment series.

1971-1983
London Workforce Employment series growth rates

1984-1995
Former London Jobs series growth rates

1996-2015
ONS London level WFJ series (employee jobs + self-employed jobs)

London level employees

There is no consistent time series of employee jobs at the London level, back to 1971. A review of the available data sources found the following issues in historical employee time series:

- The ONS' Workforce Jobs series provides a complete employee jobs measure back to 1981, benchmarked to ONS business surveys and incorporating the April 2013 WFJ revision, so can be spliced with a backcasted series to 1971.

- ONS data on employee jobs is available from the CoE employee analysis from 1971 to 1981, however a number of methodological changes to ONS' business surveys mean that this series is not comparable with later business survey data.

- The Workforce Employment employee series, Forecaster A and Forecaster B's series cannot be compared on a like-for-like basis due to differences in definition between the series (ie. inclusion of government-supported trainees in one of the external forecaster's series and the lack of an employee/self-employed jobs split in one of the external forecasters' series).

To address these issues in the backcasting employees methodology, the following steps have been taken:

- Comparing the WFJ employee jobs series, the Workforce Employment employee series and the external forecaster's employee series over the 1981 to 2007 period.

- Splicing the preferred back series with the WFJ series at 1981.

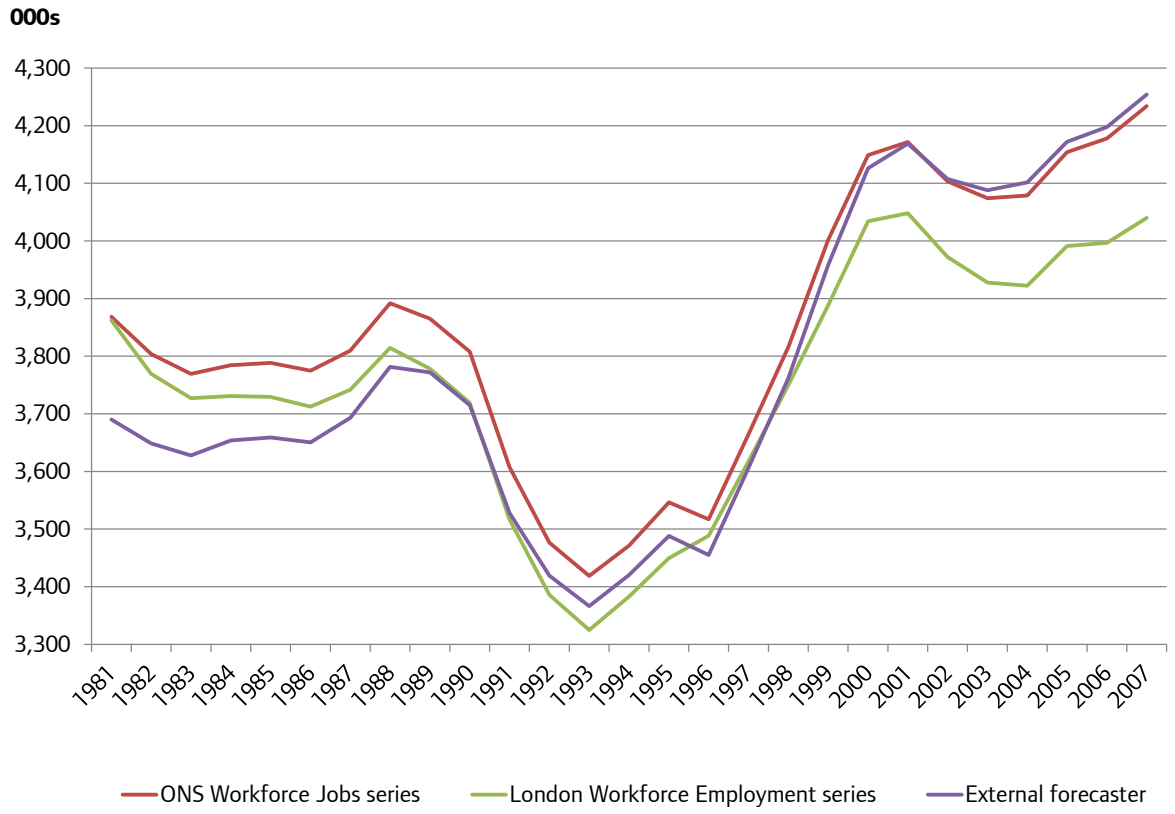
- Sense-checking the backcasted employee series against CoE employee analysis data for 1971 to 1981.

The following subsections provide more detail on the backcasting method.

Comparing London employee time series

The WFJ series was compared with the Workforce Employment series and one of the external forecaster's series, from 1981 to 2007. Figure A.7.2 shows total London employees as estimated by various historical time series.

Figure A.7.2: Total London employees – comparison of historical series



As with employment, the chart clearly shows a divergence between the London Workforce Employment series and the other series from 2000 onwards. For this reason, and for consistency with the London employment approach, the series have been compared over the 1981 to 2007, and 1981 to 2000 periods. Table A.7.5 and A.7.6 show the respective results of the statistical tests for both periods.

Table A.7.5: Results of comparison of London level employee data between the ONS Workforce Jobs series and other series, 1981-2007

1981-2007	ONS Workforce Jobs series	London Workforce Employment series	External Forecaster
CAGR	0.35%	0.17%	0.55%
Difference in CAGR	0.00%	-0.17%	0.20%
Correlation coefficient	1.000	0.986	0.982
Cumulative sum of difference	0	-2,504	-1,717
Mean absolute deviation	0	93	71
Mean percentage difference (%)	0.0	2.4	1.9

Although the London Workforce Employment series has a strong correlation with the ONS WFJ series and a closer growth rate than the external forecaster's series, the sum of difference is higher than the external forecaster's series, as is the mean percentage difference.

Table A.7.6: Results of comparison of London level employee data between the ONS Workforce Jobs series and other series, 1981-2000

1981-2000	ONS Workforce Jobs series	London Workforce Employment series	External Forecaster
CAGR	0.37%	0.23%	0.59%
Difference in CAGR	0.00%	-0.14%	0.22%
Correlation coefficient	1.000	0.988	0.974
Cumulative sum of difference	0	-1,408	-1,812
Mean absolute deviation	0	70	91
Mean percentage difference (%)	0.0	1.9	2.5

Over the 1981 to 2000 period, the Workforce Employment series has a closer growth rate, and a stronger correlation coefficient than the external forecaster's series. In addition, over the shorter time period the cumulative sum of difference, mean absolute deviation and percentage difference is lower than for the external forecaster's series.

Table A.7.7 compares the relationship between the WFJ series and London Workforce Employment series over both periods, and the results of linear regression between the series, using the latter as the independent variable and the former as the dependent variable.

Table A.7.7: Statistical and regression results, 1981-2007 and 1981-2000

Employees	1981-2007	1981-2000
CAGR London Workforce Employment series	0.17%	0.23%
CAGR ONS Workforce Jobs series	0.35%	0.37%
Difference in CAGR	0.17%	0.14%
Correlation coefficient	0.986	0.988
accept null hypothesis y=x	Accept	Accept
statistically significant relationship (ie t>1.96)	29.1	27.5
accept null hypothesis intercept is zero	Reject	Accept
statistically significant relationship (ie t>1.96)	-2.2	1.0

For both the 1981 to 2007 period, and the 1981 to 2000 period, the relationship between the two series is statistically significant. The hypothesis that the intercept includes zero at the 95% confidence interval is not accepted for the 1981 to 2007 period, but is for the 1981 to 2000 period, even though the result is not statistically significant. For this reason, the 1981 to 2000 data series is preferred.

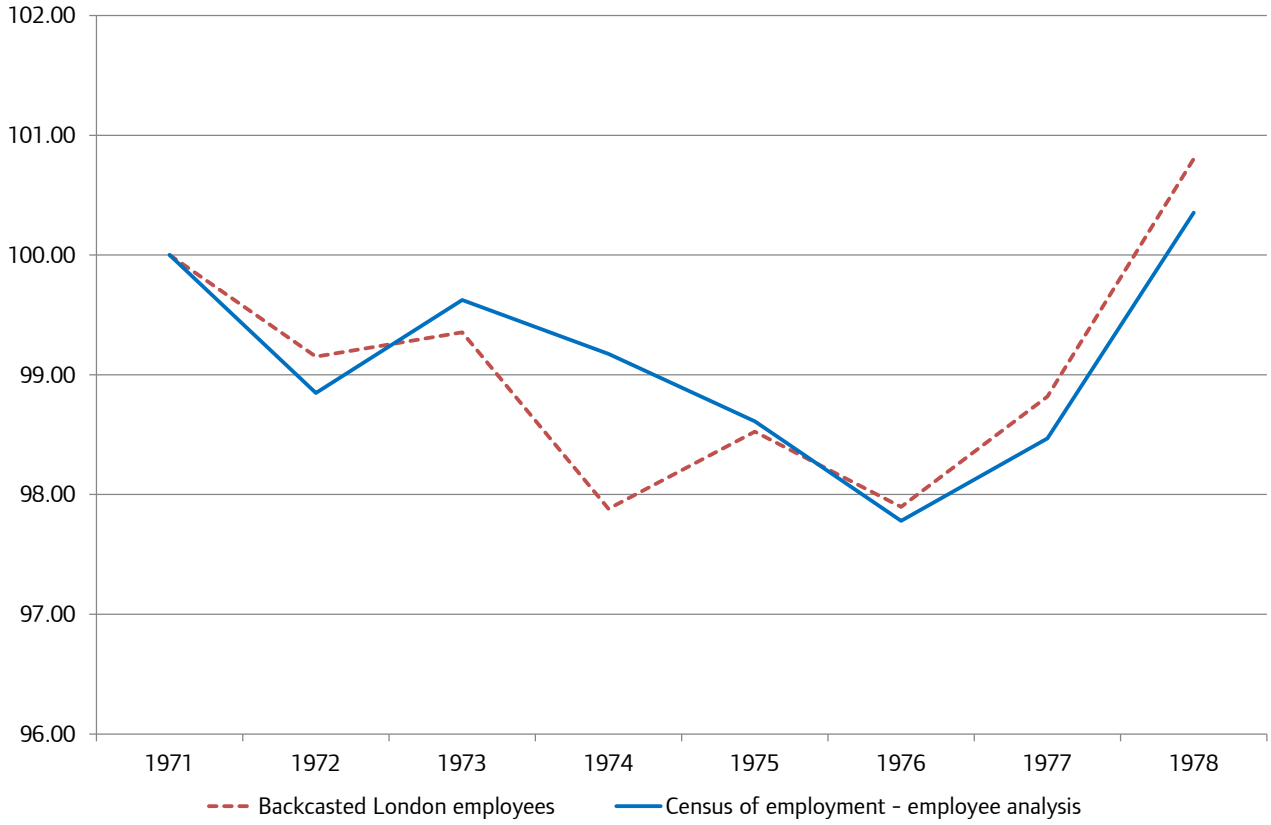
Comparing London employee jobs series 1971-1978

The backcasted London level employee series has been compared with the Census of employment employee analysis SIC68 series over the 1971 to 1978 period, as a sense check.

Figure A.7.3: Employee jobs series – comparison of backcasted London employee series with London Census of employment employee analysis, 1971 to 1978

To compare year-on-year changes, the indexed series are compared in Figure A.7.4. The two series follow a similar trend over the 1971 to 1978 period, with the exception of 1973-1974, where the Workforce Employment shows a higher relative decrease than the Census of employment employee jobs series.

Figure A.7.4: Indexed London employees – comparison of backcasted London series with Census of employment series, 1971 to 1978



The two series show sufficient similarity in terms of absolute levels and growth rates to suggest that the backcasted employee series reflects an accurate picture of employee jobs trends over the 1971 to 1978 period.

Conclusion – adopted backcasting methodology for employees

On the basis of the evidence from the statistical tests and the regression, the revised London Jobs series is backcast using the growth rates of the London Workforce Employment series.

1971-1980
London Workforce Employment series growth rates

1981-2015
ONS London level employee jobs series

London level self-employment

There is no consistent time series of self-employment at the London level, back to 1971. It is possible to construct a backcast series for self-employed jobs in London as the difference between employment and employee jobs. This section reviews whether this is a defensible procedure. A review of the available data sources found the following issues:

- The ONS' Workforce Jobs series provides a self-employment measure back to 1996 only.
- The GLA's London Jobs series extends London's self-employed jobs back to 1984, through use of LFS self-employment microdata, however is not consistent with recent, significant revisions to WFJ (April 2013).
- The Workforce Employment series and one of the external forecaster's series cannot be compared on a like-for-like basis due to differences in definition between the series; the Workforce Employment series record self-employment on a residence basis whereas one of the external forecaster's series records self-employment on a workplace basis.

To address these issues in the backcasting self-employment methodology, the following steps have been taken:

- Self-employment is treated as a residual of the preferred back series less WFJ employee jobs series, to provide a self-employment series from 1984 to 1995, that incorporates the impact of the April 2013 WFJ revision, spliced with ONS WFJ self-employment data at 1996.
- To determine whether treating self-employment as a residual is defensible, the results of this backcasted self-employed jobs approach are compared with the self-employment series from the Workforce Employment series and the external forecaster's self-employment series.

The following subsections provide more detail on the comparison of self-employment series, and the adopted backcasting approach.

Comparing London self-employment series

The self-employment estimates from the preferred backcasted employment series less ONS WFJ employee jobs, referred to as the 'residual self-employment series', were compared with self-employment estimates from other historical time series; the Workforce Employment series and the external forecaster.

These series have been compared over the 1984-2007 and 1984-2000 period, with the results shown in Table A.7.8 and A.7.9.

Table A.7.8: Results of comparison of London level self-employment data between residual self-employment series and other series, 1984-2007

1984-2007	Residual self-employment series	London Workforce Employment series	External Forecaster
CAGR	2.17%	2.11%	1.71%
Difference in CAGR	0.00%	-0.06%	-0.47%
Correlation coefficient	1.000	0.990	0.720
Cumulative sum of forecast difference	0	1,869	-2,272
Mean absolute deviation	0	78	95
Mean percentage difference (%)	0.0	15.2	29.4

The London Workforce series has the closest relationship with the residual self-employment series across all measures.

Table A.7.9: Results of comparison of London level self-employment data between London Jobs series and other series, 1984-2000

1984-2000	Residual self-employment series	London Workforce Employment series	External Forecaster
CAGR	2.15%	1.90%	1.56%
Difference in CAGR	0.00%	-0.25%	-0.59%
Correlation coefficient	1.000	0.981	0.146
Cumulative sum of forecast difference	0	1,267	-1,717
Mean absolute deviation	0	75	101
Mean percentage difference (%)	0.0	11.0	23.9

There appears to be a higher degree of variation between the residual self-employment series and London Workforce Employment series over the 1984 to 2000 period, as shown by an increased difference in CAGR and lower correlation coefficient.

Despite this, the Workforce Employment series shows the strongest relationship with the London Jobs series over the 1984 to 2007 period, and the 1981 to 2007 period. Table A.7.10 provides a comparison of the results over the two periods, and the results of linear regression between the series, using the Workforce Employment series as the independent variable and the residual self-employment series as the dependent variable.

Table A.7.10: Statistical and regression results, 1984-2007 and 1984-2000

Self-employment	1984-2007	1984-2000
CAGR London Workforce Employment series	2.11%	1.90%
CAGR London Jobs series	2.17%	2.15%
Difference in CAGR	0.06%	0.25%
Correlation coefficient	0.990	0.981
accept null hypothesis y=x	Accept	Accept
statistically significant relationship (ie t>1.96)	25.0	14.5
accept null hypothesis intercept is zero	Reject	Reject
statistically significant relationship (ie t>1.96)	-4.4	-3.6

The results show that over both time periods there is a statistically significant relationship between the variables, but the hypothesis that the intercept is zero is rejected with statistical significance.

Conclusion – adopted backcasting methodology for self-employment

On the basis of the evidence from the statistical tests and the regression for London employment and employees, self-employment is backcast using the difference between the backcasted employment and backcasted employee jobs series.

The various splicing points for the series, dependent on the start point of the backcasted series, are listed below:

1971 - 1980
Backcasted self-employment = backcasted employment – backcasted employees

1981 – 1983
Backcasted self-employment = backcasted employment – WFJ employees

1984 – 1995
Self-employment = revised London Jobs – WFJ employees

Summary

This section has documented the approach to backcasting series on London's employment, London's employees, and London's self-employment.

Time series have been compared on a consistent basis to establish which time series with the closest relationship to the revised London job series, official statistics on employee jobs, and the residual of these, for employment, employee jobs and self-employment respectively. The Workforce Employment series, with the closest relationship to employment and employee jobs data over the period, has been used as the basis for backcasting.

The backcasted London employment series is used in creating a sector-level employment series, and the backcasted London employee series is used in creating a borough level employee series.

5 The backcasting approach for a sector-level employment series

This Section sets out the approach to backcasting a time series for London employment by sector, back to 1971, for the purpose of understanding the longer-term trends in London's key sectors. For consistency with series used in earlier employment projections, the requirement is London jobs by GLA Economics sector, based on the SIC 2007 groupings outlined in Section 2, referred to here as 'sectors'.

There is no consistent time series of total employment at the London level, by sector, back to 1971. A review of the available data sources found the following:

- The ONS' Workforce Jobs series provides employment by SIC 2007 section measure back to 1996 only.

- The GLA's London Jobs series extends London's jobs history by sector back to 1984, however is not consistent with recent, significant revisions to WFJ (April 2013), so cannot be spliced with a backcasted series to 1971.

- The Workforce Employment series, which has been used as a basis for backcasting employment and employees, is on a SIC 1992 basis and therefore not directly comparable with the revised London Jobs series.

- Forecaster A and Forecaster B's series can be compared with the revised London Jobs series on a like-for-like basis as they are on a SIC 2007 section level basis.

- The wholesale/retail split requires data at a division level, ie. below the section level available from WFJ data, and the ONS provides this split back to 1996 only.

- Previous wholesale/retail split estimates from the London Jobs series have not been adjusted for the April 2013 WFJ revision.

- The Workforce Employment series and one of the external forecasters provide a wholesale/retail split, however these cannot be compared on a like for like basis due to different industrial classifications (SIC 1992 and SIC 2007 respectively).

To address these issues in the backcasting employment by sector methodology, the following steps have been taken:

- Adjusting the London Jobs by sector series to reflect the April 2013 WFJ revisions back to 1984, so the series can be spliced.

- Comparing the revised London Jobs by sector series with Forecaster A and B's employment series (ie. those on a consistent SIC 2007 basis), to determine which has the closest relationship with the revised London jobs series.

- As the comparison was not conclusive, the adopted approach was to backcast components of employment (ie. employees and self-employment) separately, and summing these components to calculate employment. This approach allows comparisons with the available published statistics and provides consistency with the data source (the Workforce Employment series on a SIC 1992 basis) used for backcasting at the London level and borough level.

    - **Employees** – to check the reliability of the Workforce Employment employee series, the series was compared with available official statistics on a consistent basis (ie. the ABI employee analysis on SIC 1992 basis), from 1998 to 2007. The results provided evidence that the Workforce Employment series had a statistically significant relationship with official statistics.

    - The next step was to convert the Workforce Employment employee series to a SIC 2007 sector basis, for the years 1984 to 2005.

    - The results for employees were compared with ONS WFJ employee jobs by sector over the 1984 to 2005 period, which provided evidence of a relationship between the two series.

    - This provided a basis for backcasting employees by sector using the converted Workforce Employment employee series, with results constrained to the London employees totals for 1971 to 1980.

    - **Self-employment** – the residual of the revised London Jobs series less ONS WFJ employee jobs by sector was calculated from 1984 to 1995, and WFJ self-employment by sector from 1996 to 2000, to provide a self-employment by sector series that reflects the WFJ April 2013 revision.

    - Shares of self-employment by sector were calculated for the 1984 to 2000 period.

- Linear regression was used to backcast the self-employment by sector shares from 1971 to 1983, and these shares applied to the backcasted London self-employment total (acting as a constraint).

- **Employment** – treated as the sum of employees and self-employed by sector from 1971 to 2015, consistent with approach to London level employment as sum of London level employees and self-employment.

- The correlation coefficients of the backcasted employment by sector with Forecaster A and Forecaster B's series respectively were calculated by sector, from 1971 to 2007, as a sense check on the conversion. The results provided evidence of correlation between both Forecaster A and Forecaster B's series, for each sector.

- The final stage was to provide a wholesale/retail split for the backcasted employment by sector series, for 1971 to 2015. This was achieved using the following steps:

  - Comparing the ONS' Workforce Jobs division level wholesale/retail estimates, 1996 to 2011[35] with previous estimates in 2013 employment projections to estimate the impact of April 2013 WFJ revision;

  - Using linear regression of the percentage change between the two sets of estimates from 1996 to 2011, to project wholesale and retail jobs from 1984 to 1995;

  - Calculating the respective shares of wholesale and retail jobs for 1984 to 1995 and constraining to the revised Wholesale and Retail division total to provide constrained wholesale and retail estimates from 1984 to 1995, and splicing with ONS estimates from 1996 to 2015;

  - Constrained wholesale and retail estimates compared with Workforce Employment series from 1984 to 2007 to establish whether a statistically significant relationship exists, despite different industrial classifications; and,

  - Constrained wholesale and retail estimates backcasted using Workforce Employment series growth rates from 1971 to 1983, constrained to 1971 to 1983 backcasted estimates for Wholesale and Retail section, and spliced with constrained wholesale and retail estimates from 1984 to 1995, and ONS WFJ division level estimates from 1996 to 2015, to provide a consistent series.

- The correlation coefficients of the backcasted wholesale and retail employment series and one of the external forecaster's wholesale and retail employment series from 1971 to 2007 were used as a sense check on estimates, and provided evidence of correlation.

The London Jobs series by sector

Working paper 52 provided a London jobs by sector series back to 1984, based on GLA Economics sector groupings, on a SIC 2007 basis, with a wholesale/retail split. However, the series cannot be spliced in the backcasting method as it does not incorporate the impact of the April 2013 WFJ revision.

Adjusting the London Jobs by sector series to reflect the April 2013 WFJ revisions back to 1984, so the series can be spliced

As with London-level employment, the series used in the 2013 employment projections was compared with the most recently available Workforce Jobs data (March 2016), by sector, over the period 1996

to 2011. At this stage, the 'Wholesale' and 'Retail' sectors were treated as one sector due to the WFJ series being available at section-level only.

The series were compared by sector, using correlation coefficients and linear regression to establish the strength of relationship between the two series, with the 2013 estimates as the independent variable and the 2016 WFJ estimates as the dependent variable. The correlation coefficient and regression results are shown in Table A.7.11.

Table A.7.11: Correlation coefficient and regression results of current WFJ estimates (March 2016) compared with 2013 estimates by GLA Economics sector, 1996 to 2011

GLA Economics sector (Wholesale and Retail combined)	Correlation coefficient	accept null hypothesis y=x	statistically significant relationship (ie t>1.96)	accept null hypothesis intercept is zero	statistically significant relationship (ie t>1.96)
Primary & utilities	0.995	Accept	35.8	Accept	-0.3
Manufacturing	0.999	Accept	80.7	Accept	-1.1
Construction	0.985	Accept	21.7	Reject	2.7
Wholesale + retail	0.988	Accept	24.2	Accept	-0.8
Transportation and Storage	0.985	Accept	21.4	Accept	-0.4
Accomodation and food service activities	0.973	Accept	15.9	Accept	1.7
Information and Communication	0.997	Accept	46.6	Accept	1.5
Financial and insurance activities	0.997	Accept	51.6	Accept	0.6
Professional, Real Estate, Scientific and technical activities	0.998	Accept	53.8	Reject	2.5
Administrative and support service activities	0.984	Accept	20.6	Accept	-0.1
Public Admin and defence	0.997	Accept	51.2	Accept	1.0
Education	0.998	Accept	61.4	Reject	-2.5
Health	0.998	Accept	58.2	Reject	4.6
Arts, entertainment and recreation	0.997	Accept	45.0	Accept	-0.3
Other services	0.944	Accept	10.7	Accept	-1.4

The correlation coefficients by sector, were in the range of 0.944 (Other Services) to 0.999 (Manufacturing), indicating a strong relationship between the two series by sector.

The t-stats indicate a statistically significant relationship between the two series, with the t-stat of the coefficient being above 1.96 for each sector. The hypothesis that the intercept includes zero at the 95% confidence interval is accepted for the majority of sectors, although the results are not statistically significant; the exceptions being Construction, Professional services, Education and Health.

Taken together, this suggests that a sufficiently strong relationship exists between the series to predict the values of a revised London jobs series by sector from 1984 to 1995, using the London Jobs series as in the 2013 employment projections.

The series was spliced with current WFJ employment by sector, to provide a consistent London jobs by sector series from 1984 to 2015.

Comparison of the adjusted London Jobs by sector series with other time series

The next stage was to compare the revised London Jobs by sector series with Forecaster A and Forecaster B's employment by sector (on a SIC 2007 basis) series. The Workforce Employment Series couldn't be used for this purpose because this series is on a SIC 1992 basis. Forecaster A and

Forecaster B's series have been used to provide a comparison of absolute levels of jobs by sector, and share of jobs by sector. The results are summarised in Table A.7.12, which shows which of the series (ie. Forecaster A, Forecaster B, Forecaster A's share or Forecaster B's share) has the closest relationship with the London Jobs series, by sector, over the 1984 to 2007 period.

Table A.7.12: Comparison of time series with London Jobs series, results by sector, 1984-2007

GLA Economics sector (Wholesale and Retail combined) 1984-2007	Correlation coefficient	Cumulative sum of forecast difference	Mean absolute deviation
Primary and utilities	Forecaster A	Forecaster A share	Forecaster A
Manufacturing	Forecaster B share	Forecaster B share	Forecaster B share
Construction	Forecaster A share	Forecaster B share	Forecaster B share
Wholesale and retail trade; repair of motor vehicles and motorcycles	Forecaster A share	Forecaster B	Forecaster A share
Transportation and storage	Forecaster B	Forecaster B	Forecaster B
Accommodation and food service activities	Forecaster B	Forecaster A	Forecaster B
Information and communication	Forecaster B share	Forecaster B	Forecaster B
Financial and insurance activities	Forecaster A share	Forecaster B	Forecaster B
Professional, Real Estate, Scientific and technical activities	Forecaster B share	Forecaster B share	Forecaster B share
Administrative and support service activities	Forecaster A	Forecaster B	Forecaster B
Public administration	Forecaster A	Forecaster A	Forecaster A
Education	Forecaster B	Forecaster A	Forecaster B
Health	Forecaster A	Forecaster B	Forecaster B
Arts, entertainment and recreation	Forecaster B share	Forecaster B share	Forecaster B share
Other service activities	Forecaster A share	Forecaster B share	Forecaster B share

Note: This table shows which of the series tested has the closest relationship with the London Jobs series, using the following measures: maximum correlation coefficient, minimum cumulative sum of forecast difference and minimum mean absolute deviation. The count for each series are as follows: Forecaster A=9, Forecaster B=16, Forecaster A share=6, Forecaster B share=14.

There is no one series that exhibits the closest relationship with the London Jobs series consistently over sectors. The analysis was repeated over the 1984 to 2000 period and again there is no one series which exhibits a close relationship with the London Jobs series consistently across sectors. There is no basis for preferring either Forecaster A or Forecaster B to provide a backcast series for London sector employment.

Instead, the Workforce Employment series has been used to backcast employment by sector as it is the same source as that used for backcasting London and borough level series.

Backcasting components of employment by sector

Employees by sector

The London Workforce Employment employee series was compared with official statistics available on a consistent basis, ie. the Annual Business Inquiry employee analysis data, on a SIC 1992 section level basis, from 1998 to 2007. To test the relationship between the two series over the period, a linear regression was performed between the series, by sector. The results are shown in Table A.7.13.

Table A.7.13: Regression of London Workforce Employment series with ABI employee analysis, results by sector, 1998-2007

London Workforce Employment series section	accept null hypothesis y=x	statistically significant relationship (ie t>1.96)	accept null hypothesis intercept is zero	statistically significant relationship (ie t>1.96)
Primary & utilities	Accept	4.0	Accept	0.7
Manufacturing	Accept	27.0	Accept	0.3
Construction	Accept	2.2	Accept	1.4
Wholesale & retail	Accept	5.8	Reject	2.2
Hotels & restaurants	Accept	10.0	Accept	-0.5
Transport & communications	Accept	2.2	Accept	0.1
Financial services	Accept	4.4	Accept	0.9
Business services	Accept	8.5	Accept	0.8
Public administration	Accept	2.4	Reject	3.2
Health & education	Accept	36.9	Reject	7.5
Other services	Accept	7.3	Accept	0.8

Note: 'Primary and utilities' includes SIC 1992 Section A: Agriculture, hunting and forestry, Section B: Fishing, Section C: Mining and quarrying, and Section E: Electricity, gas and water supply. 'Business services' equates to SIC 1992 Section K: Real estate, renting, business activities. Section P and Q have been omitted due to not being covered by ABI employee analysis data or the London Workforce Employment series.

The results suggest the relationship is statistically significant across all sectors. The hypothesis that the intercept includes zero at the 95% confidence interval is accepted for the majority of sectors; the exceptions being Wholesale & retail, Public administration, and Health & education. This may reflect issues in the reporting of public sector employment in the official series, corrected for in the Workforce Employment series.[36]

This suggests that the London Workforce Employment employee series by section is consistent with official statistics, and therefore can be used as a basis for backcasting employee jobs back to 1971, when converted to SIC 2007.

Converting the Workforce Employment employee series from SIC 1992 to SIC 2007

This involves two changes in industrial classification, as set out below:

Change from the SIC 1992 to SIC 2003
The ONS has produced detailed guidance on classification changes between SIC 1992 and SIC 2003[37], and the impact of these changes. Nearly all of the effects are at the 4 and 5 digit levels of the SIC.[38] At the section level, there is little difference between SIC 1992 and SIC 2003, as shown in Table A.7.15, with the exception of 'Operation of coin-operated photographic machines' moving from code 74.81/1(Section K), to 93.05/1 (Section O). The impact of this change is likely to be relatively small at the London level. Working paper 52 also refers to the relatively small changes between SIC 1992 and SIC 2003.[39]

SIC 2003 also introduced the reclassification of head offices; under SIC 1992 head offices were allocated to the primary activity of the enterprise to which they belonged, while under SIC 2003 head offices are classified with holding companies under code 7415[40], part of Section K.

The ONS guidance has not set out the scale of the transfer of jobs from other sections to Section K and for this reason we have compared ABI results for those years where it is available on both a SIC 1992 and SIC 2003 basis, that is 1998 to 2007 at an employee level.

At the section level, there was no difference between the numbers of employees in a section according to the SIC 1992 basis, compared with the corresponding section on a SIC 2003 basis over the 1998 to 2007 period. As discussed in the London Workforce Employment series working paper[41], the Workforce Employment series uses the ABI data to estimate annual employee jobs, which confirms that it was not necessary to convert the Workforce Employment series from SIC 1992 to SIC 2003 due to a lack of material difference between these two industrial classifications at the section level.

Other work by GLA Economics has modelled the impact of changes from SIC 1992 to SIC 2003 at the 4 and 5 digit level back to 1998, and working paper 66 describes the methodology used[42]. However, the Workforce Employment employee series is available only at a 12 or 30 sector level of detail (further detail provided in Table A.7.17), which broadly equates to SIC section level detail.

A summary of section-level changes is set out in Table A.7.14.

Table A.7.14: Changes between SIC 1992 and SIC 2003 at the section level

		SIC 1992																
		Agriculture, Hunting and Forestry	Fishing	Mining and Quarrying	Manufacturing	Electricity, Gas and Water Supply	Construction	Wholesale and Retail Trade	Hotels and Restaurants	Transport, Storage and Communication	Financial Intermediation	Real Estate, Renting and Business Activities	Public Administration and Defence	Education	Health and Social Work	Other Community, Social and Personal Service Activities	Private Households Employing Staff and Undifferentiated Production Activities of Households for Own Use	Extra - territorial organisations and bodies
SIC 2003		A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
Agriculture, Hunting and Forestry	A	X																
Fishing	B		X															
Mining and Quarrying	C			X														
Manufacturing	D				X													
Electricity, Gas and Water Supply	E					X												
Construction	F						X											
Wholesale and Retail Trade	G							X										
Hotels and Restaurants	H								X									
Transport, Storage and Communication	I									X								
Financial Intermediation	J										X							
Real Estate, Renting and Business Activities	K											X						
Public Administration and Defence	L												X					
Education	M													X				
Health and Social Work	N														X			
Other Community, Social and Personal Service Activities	O											X				X		
Private Households Employing Staff and Undifferentiated Production Activities	P																X	
Extra - territorial organisations and bodies	Q																	X

Change from the SIC 2003 to SIC 2007
In 2007, there was a significant change in the SIC to reflect the growing importance of service activities and developments in information and communications technologies (ICT). This change was particularly relevant for London as it resulted in a greater breakdown of services sector data, an important sector for London's economy.

The change involved the creation of a new section; Section J (Information and communication), and SIC 2003 Section K (Real estate, renting and business activities) has been split into three sections in SIC (2007): Section L (Real estate), Section M (Professional, scientific and technical activities) and Section N (Administrative and support service activities).[43]

Working Paper 52 by GLA Economics published in 2011 outlined how these changes in SIC affected the total employee estimates at a section level between the two industrial classifications, using 2008 ABI data available on a SIC 2003 and SIC 2007 basis.[44] Table A.7.15 shows a comparison of 2008 ABI data for the sectors highlighted above.

Table A.7.15 A comparison of 2008 ABI data on SIC 2007 and SIC 2003 for selected sectors

ABI 2008 SIC 2007 21 Sections:		ABI 2008 SIC 2003 17 Sections:	
F : Construction	140,500	F : Construction	122,500
H : Transportation and storage	236,900	I : Transport, storage and communication	307,400
J : Information and communication	295,100		
L : Real estate activities	79,200	K : Real estate, renting and business activities	1,116,200
M : Professional, scientific and technical activities	473,000		
N : Administrative and support service activities	451,400		
L, M, N Total:	1,003,600		

Table A.7.16 provides a complete mapping between sections for SIC2003 and SIC2007.

Table A.7.16: Changes between SIC 2003 and SIC 2007 at the section level

		SIC 2003																
		Agriculture, Hunting and Forestry	Fishing	Mining and Quarrying	Manufacturing	Electricity, Gas and Water Supply	Construction	Wholesale and Retail Trade	Hotels and Restaurants	Transport, Storage and Communication	Financial Intermediation	Real Estate, Renting and Business Activities	Public Administration and Defence	Education	Health and Social Work	Other Community, Social and Personal Service Activities	Private Households Employing Staff and Undifferentiated Production Activities of Households for Own Use	Extra-territorial organisations and bodies
	SIC 2007	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
Agriculture, forestry and fishing	A	X	X															
Mining and quarrying	B			X														
Manufacturing	C	X		X	X													
Electricity, gas, steam and air conditioning supply	D					X												
Water supply; sewerage, waste management and remediation activities	E				X	X										X		
Construction	F						X					X						
Wholesale and retail trade; repair of motor vehicles and motorcycles	G							X										
Transportation and storage	H									X								
Accommodation and food service activities	I								X									
Information and communication	J				X					X		X				X		
Financial and insurance activities	K										X							
Real estate activities	L											X						
Professional, scientific and technical activities	M											X			X			
Administrative and support service activities	N	X								X		X						
Public administration and defence; compulsory social security	O												X					
Education	P													X				
Human health and social work activities	Q														X			
Arts, entertainment and recreation	R															X		
Other service activities	S							X								X		
Activities of households as employers	T																X	
Activities of extraterritorial organisations and bodies	U																	X

Converting the Workforce Employment employee series
We have done a single conversion from SIC1992 to SIC2007 on the basis that changes at the section level between SIC1992 and SIC2003 were relatively small. Consistent with the approach outlined in Working paper 52, we have used the ONS' SIC 2003 to SIC 2007 conversion matrix[45], which uses probabilities to convert division (2 digit) level employee numbers from SIC 2003 to SIC 2007, based on Inter-departmental Business Register data from 2009. However, there are a number of issues in using the conversion matrix in the approach to backcasting, outlined below:

- The conversion is for employees only – as the conversion matrix uses probabilities derived from the inter-departmental business register, it covers employee jobs only, as opposed to total employment (including self-employment). As a result we have converted employee numbers from the Workforce Employment Series only.

- The conversion is at the 2-digit division level – we have previously been using the 12-sector Workforce Employment series, which can be broadly matched to the SIC 1992 section level. However the conversion matrix requires a more detailed SIC. To address this, we have used the 30-sector Workforce Employment series, available from 1971 to 2005, which enables us to convert at the section level using some approximations (shown in Table A.7.17).

- Probabilities have been derived using IDBR data from 2009 – the ONS has calculated its conversion probabilities on the basis of data from 2009, which may not be the same over time. The Workforce Employment 30 sector employee series covers 1971 to 2005. This suggests that the ONS probabilities may be more heavily weighted towards service sectors, which are likely to account for a higher proportion of jobs in 2009 than in 1971.

- The conversion is at the UK level – whereas the backcasting methodology uses London level data.

It is important to bear these caveats in mind when using the conversion matrix.

Sector mapping in the Workforce Employment series

As discussed above, the Workforce Employment series is available at a 12 or 30 sector level of detail. The latter broadly equates to SIC 2003 sections.

Table A.7.17 Sector mapping between Workforce Employment employee 30-sector series and SIC 2003 Sections

Workforce Employment series 30 sector		SIC 2003	
Number (refers to SIC divisions)	Description	Section	Description
		A	Agriculture, Hunting and Forestry
1-2&5	Agriculture, Forestry & Fishing	B	Fishing
10&12-14	Other Mining	C	Mining and Quarrying
11	Oil & Gas Extraction		
15-16	Food, Drink & Tobacco	D	Manufacturing
17-19	Textiles & Clothing		
20	Wood & Wood Products		
21-22	Paper, Printing & Publishing		
23	Fuel Refining		
24	Chemicals		
25	Rubber & Plastics		
26	Minerals		
27-28	Metals		
29	Machinery & Equipment		
30-33	Electrical & Optical equipment		
34-35	Transport Equipment		
36-37	Other manufacturing		
40-41	Gas, Electricity & Water	E	Electricity, Gas and Water Supply
45	Construction	F	Construction
50-51	Wholesaling	G	Wholesale and Retail Trade
52	Retailing		
55	Hotels & Catering	H	Hotels and Restaurants
60-63	Transport	I	Transport, Storage and Communication
64	Communications		
65-67	Banking & Insurance	J	Financial Intermediation
70,71,73	Other Financial & Business Services	K	Real Estate, Renting and Business Activities
72,74	Business Services		
75	Public Admin. & Defence	L	Public Administration and Defence
80	Education & Health	M	Education
85	Health	N	Health and Social Work
90-95	Other Services	O	Other Community, Social and Personal Service Activities

Comparing the converted Workforce Employment employee series with WFJ data

The converted Workforce Employment employee series was compared with the WFJ employee jobs series on a sector basis, from 1981 to 2005, to provide a sense check for the conversion method.

Regressions were performed by section between the two series for the period 1981 to 2005, and 1981 to 2000, using the converted Workforce Employment series as the independent variable and the WFJ employee series as the dependent variable. The results are summarised by sector in Table A.7.18.

Table A.7.18: Regression of converted London Workforce Employment employee series with WFJ employee jobs, results by GLA Economics sector, 1981-2005 and 1981-2000

GLA Economics sector (Wholesale and Retail combined)	T-stat of statistically significant relationship	
	1981-2005	1981-2000
Primary and utilities	14.2	17.7
Manufacturing	116.3	112.6
Construction	17.1	22.8
Wholesale and retail trade; repair of motor vehicles and motorcycles	5.6	5.0
Transportation and storage	29.6	30.3
Accommodation and food service activities	32.0	16.5
Information and communication	13.7	8.4
Financial and insurance activities	53.0	42.1
Professional, Real Estate, Scientific and technical activities	33.2	24.0
Administrative and support service activities	74.3	73.1
Public administration	17.2	19.5
Education	31.9	41.5
Health	19.5	18.6
Arts, entertainment and recreation	30.3	20.9
Other service activities	31.9	22.9

The t-stats for each sector were over 1.96, suggesting a statistically significant relationship for the WFJ series and the converted London Workforce Employment employee series. Table A.7.19 shows the results of the test that the hypothesis does not include zero The results were statistically significant for most sectors, excluding Public administration, Education and Health.

Table A.7.19: Regression of converted London Workforce Employment employee series with WFJ employee jobs, results by GLA Economics sector, 1981-2005 and 1981-2000

GLA Economics sector (Wholesale and Retail combined)	1981-2005			1981-2000		
	Lower 95% confidence interval	Upper 95% confidence interval	T-stat	Lower 95% confidence interval	Upper 95% confidence interval	T-stat
Primary and utilities	-85121	-52800	-8.8	-67325	-43419	-9.7
Manufacturing	6071	17053	4.4	11877	24125	6.2
Construction	32796	60242	7.0	26097	48915	6.9
Wholesale and retail trade; repair of motor vehicles and motorcycles	85821	352818	3.4	6179	348029	2.2
Transportation and storage	-45981	-7670	-2.9	-39921	-2200	-2.3
Accommodation and food service activities	25723	49980	6.5	30130	69726	5.3
Information and communication	-16265	50502	1.1	5749	92566	2.4
Financial and insurance activities	8920	32165	3.7	3030	32393	2.5
Professional, Real Estate, Scientific and technical activities	43709	84255	6.5	44616	95338	5.8
Administrative and support service activities	-27823	-8123	-3.8	-35097	-16004	-5.6
Public administration	-15604	41210	0.9	-45208	12995	-1.2
Education	-10193	22414	0.8	-1481	23092	1.8
Health	-40467	31769	-0.2	-9007	59876	1.6
Arts, entertainment and recreation	6997	17576	4.8	10535	23858	5.4
Other service activities	-25395	-12444	-6.0	-20899	-5120	-3.5

Conclusion – adopted backcasting methodology for employees by sector

The WFJ employee jobs series was spliced at the 1981 point, incorporating April 2013 revisions to employee numbers, and the series was backcast using the growth rates from the converted Workforce Employment employee series back to 1971.

The estimates of employee jobs by sector were then constrained to the backcasted London level employee jobs total, to provide a consistent employee jobs by sector series back to 1971.

1971 – 1980
Employees by sector backcast using converted London Workforce Employment employee series growth rates, constrained to backcasted London employees series

1981-2015
ONS WFJ employee jobs by sector

Self-employment by sector

The London Jobs series has previously used microdata supplied by the ONS to provide a self-employment by sector back to 1984, however this does not incorporate the effect of the April 2013 WFJ revision, meaning the series cannot be spliced as is.

The residual of the revised London Jobs series less ONS WFJ employee jobs by sector was calculated from 1984 to 1995, and WFJ self-employment by sector from 1996 to 2000, to provide a self-employment by sector series that reflects the WFJ April 2013 revision.

In order to backcast the self-employment by sector series from 1984, back to 1971, self-employment by sector shares were projected back, using a linear regression on the basis of the shares between 1984 to 2000, consistent with the period over which we had assessed the relationship between series on London level employment (and self-employment).

Conclusion – adopted backcasting methodology for self-employment by sector

Linear regression was used to backcast the self-employment by sector shares from 1971 to 1983, and these shares applied to the backcasted London self-employment total (acting as a constraint). The backcasted series was spliced with the revised London Jobs series less ONS WFJ employee jobs by sector from 1984 to 1995, and WFJ self-employment data by sector from 1996 to 2015.

1971 – 1983
Self-employment by sector shares backcast using linear regression and applied to London self-employment backcasted series.

1984-1995
Self-employment by sector calculated by residual of revised London Jobs by sector less ONS WFJ employee jobs by sector.

1996-2015
Self-employment by sector using WFJ self-employment series.

Conclusion – adopted backcasting methodology for employment by sector

Consistent with our approach in treating employment as the sum of employee jobs and self-employment, employment by sector was calculated by summing employee jobs and self-employed by sector. As the London-level employee jobs and self-employment backcast series were used as a constraint to derive these two components, the total employment by sector series was consistent with backcasted London level employment to 1971.

1971-1980
Sum of backcasted employees by sector and backcasted self-employment by sector

1981-1983
Sum of WFJ employee jobs by sector and backcasted self-employment by sector

1984-1995
Revised London Jobs by sector

1996-2015
WFJ London Jobs (employees + self-employed) by sector

Comparison of backcasted employment by sector with Forecaster A and Forecaster B

Forecaster A and Forecaster B series' on jobs by sector have been compared with the backcasted employment by sector series to provide a sense check, and the results are presented in this sub-section.

Table A.7.20 shows the correlation coefficient of the backcasted employment series, compared with the time series for Forecaster A and B, by sector.

Table A.7.20: Comparison of backcasted employment series with other forecasters' series by GLA Economics sector, 1971-1995

GLA Economics sector (Wholesale and Retail combined)	CAGR			Difference in CAGR		Correlation coefficient		Cumulative sum of forecast difference		Mean absolute deviation		Mean percentage difference (%)	
	Backcasted series	Forecaster A	Forecaster B	Forecaster A	Forecaster B	Forecaster A	Forecaster B	Forecaster A	Forecaster B	Forecaster A	Forecaster B	Forecaster A	Forecaster B
Primary and utilities	-3.7%	-3.3%	-3.8%	-0.4%	0.1%	1.0	0.9	-71695	98200	3635	5121	6	9
Manufacturing	-4.8%	-4.6%	-5.4%	-0.3%	0.6%	1.0	1.0	-2548759	396933	101950	18069	23	3
Construction	-0.9%	-0.7%	-1.1%	-0.2%	0.2%	0.9	0.9	294401	307554	12229	12769	5	5
Wholesale and retail trade	-0.5%	-0.5%	-0.9%	-0.0%	0.3%	1.0	1.0	-495655	519927	19826	21278	3	3
Transportation and storage	-2.0%	-2.0%	-2.6%	0.0%	0.6%	1.0	1.0	-231324	533611	9253	22060	3	6
Accommodation and food service activities	1.1%	1.8%	1.2%	-0.7%	-0.1%	1.0	1.0	-190715	-145198	9854	5993	5	3
Information and communication	0.2%	-0.7%	1.4%	0.9%	-1.2%	0.3	0.1	141750	-444709	8274	18285	3	10
Financial and insurance activities	0.8%	1.3%	0.9%	-0.5%	-0.1%	1.0	1.0	-323368	-31391	12935	3113	5	1
Professional, Real Estate, Scientific and technical activities	2.1%	2.5%	1.6%	-0.4%	0.5%	1.0	1.0	-775221	429837	31009	17887	11	5
Administrative and support service activities	1.9%	1.4%	2.0%	0.5%	-0.1%	1.0	1.0	-43927	-199156	6673	8272	3	4
Public administration	-1.7%	-1.6%	-1.9%	-0.1%	0.3%	1.0	1.0	375113	675164	15005	27007	5	8
Education	-0.7%	-0.3%	-0.5%	-0.5%	-0.2%	0.9	0.9	-202067	-40947	9099	6369	3	2
Health	0.3%	0.4%	0.6%	-0.1%	-0.4%	1.0	1.0	213253	-475888	10549	19036	3	6
Arts, entertainment and recreation	1.9%	1.5%	2.0%	0.4%	-0.1%	1.0	1.0	23033	73233	3153	3441	4	4
Other service activities	1.7%	1.4%	1.5%	0.2%	0.2%	1.0	1.0	472116	543329	18885	21733	23	25

The backcasted employment series shows strong correlation with the series produced by Forecaster A and B across all sectors, over the 1971 to 1995 period, and the CAGR for each sector lies within the range suggested by Forecaster A and B's CAGRs, with the exception of Financial and insurance activities, Education, and Other service activities.

The backcasted series' correlation coefficients with Forecaster A and B are over 0.9 for all sectors, with the exception of the Information and Communication sector. Despite this, the backcasted Information and Communication sector's CAGR and cumulative sum of forecast difference lies within the range suggested by Forecaster A and B, and Table A.7.18 shows a statistically significant relationship between the backcasted employee series and the WFJ employee series for the sector.

The results provided confidence that over the backcasted period, the backcasted employment series by sector results are consistent with series produced by other forecasters.

Wholesale/retail split

The final stage was to provide a wholesale/retail split for the backcasted employment by sector series, for 1971 to 2015. The steps taken to estimate the wholesale/retail split are explained below:

1 Comparing the ONS' Workforce Jobs division level wholesale/retail estimates, 1996 to 2011 with previous estimates in 2013 employment projections to estimate the impact of April 2013 WFJ revision.

The ONS provides annual estimates of the number of employee jobs and self-employed in London from 1996 to 2015 based on quarterly Workforce Jobs series data, with breakdowns by industry (SIC 2007 sections A to S). This provides a breakdown of Section G, Wholesale and Retail, into Wholesale and motor trades (divisions 45 and 46), and Retail (division 47).[46]

Consistent with our approach to backcasting London employment and the employment by GLA sectors series, the first step was to compare the ONS' 2016 estimates with the Wholesale and Retail jobs estimates previously published in the 2013 employment projections, to look at the impact of the WFJ revisions over the years for which we have consistent data, ie. 1996 to 2011 (the last data point of the 2013 employment projections).

2 Using linear regression of the percentage change between the two sets of estimates from 1996 to 2011, to project wholesale and retail jobs from 1984 to 1995;

Linear regression was then used to estimate the percentage difference between the 2013 employment projections estimates of Wholesale and Retail jobs, and the actual WFJ data from 2016, which provided estimates of Wholesale and Retail jobs from 1984 to 1995, consistent with the revisions to WFJ.

3 Calculating the respective shares of the Wholesale and Retail divisions as a share of the constrained Wholesale and Retail total

The revised Wholesale and Retail jobs estimates from 1984 to 1995 were then summed together, and the respective shares of the Wholesale and Retail divisions calculated from this total from 1984 to 2015. These shares were then applied to the constrained GLA Economics Wholesale and Retail sector total over the 1984 to 1995 period. Splicing these estimates with the ONS WFJ data then provides a consistent series from 1984 to 2015.

4 Constrained Wholesale and Retail totals compared with Workforce Employment series to establish whether a statistically significant relationship exists

The constrained Wholesale and Retail totals were then compared with corresponding estimates on Wholesale and Retail employment from the Workforce Employment series, over the 1984 to 2000 period, consistent with the approach to comparisons with London employment and London employment by sector.

The results of the regression are shown in Table A.7.21.

Table A.7.21: Constrained Wholesale and Retail estimates and Workforce Employment series, regression results, 1984-2000

Regression results	Wholesale Jobs	Retail jobs
accept null hypothesis y=x	Accept	Accept
statistically significant relationship (ie t>1.96)	35.80	1.96
accept null hypothesis intercept is zero	Accept	Reject
statistically significant relationship (ie t>1.96)	-1.86	2.87

For both Wholesale and Retail jobs, there is a statistically significant relationship between the constrained estimates and the Workforce Employment series, while the hypothesis that the intercept is zero is accepted for Wholesale (but is not statistically significant), and rejected for Retail. The relationship between the variables suggest that the constrained Wholesale and Retail back to 1971 can be predicted using the Workforce Employment series.

5 Wholesale and Retail totals backcasted using Workforce Employment series growth rates, and constrained to backcasted Wholesale and Retail totals.

Evidence of statistical significance between the constrained Wholesale and Retail estimates and the Workforce Employment series has been used as a basis to backcast Wholesale and Retail estimates, using the latter series' growth rates, back to 1971. The backcasted Wholesale and Retail estimates were then constrained to the backcasted London employment by sector estimates for the Wholesale and Retail sector, to ensure consistency with the backcasted employment by sector series.

6 The approach to constructing a borough-level jobs series

This Section sets out, the approach to constructing a time series for employee jobs by London borough, back to 1971, for the purpose of understanding the longer-term trends in London's boroughs.

There is no consistent time series of employee jobs by borough back to 1971. A review of the available data sources found:

- The April 2013 WFJ revision affects estimates of employee jobs back to 1971. These revisions have been incorporated into the Borough Employee jobs series back to 1981, as used in the GLA's most recent employment projections, so the series can be spliced.

- The Workforce Employment series provides a breakdown of employees by borough, however this relates to administrative borough boundaries as at 1991. There have been a number of changes to borough boundaries since 1991, so the series cannot be spliced as they are.

- The most significant changes in employee jobs terms are[47]:
  - City of London - boundary changes in 1994.
  - Hillingdon– the transfer of London Heathrow Airport from Hounslow to Hillingdon in 1994.

- Forecaster A and Forecaster B's employee series do not provide a borough level breakdown of employee jobs, so cannot be used for the purposes of developing a borough level series.

To address these issues in the backcasting borough employees methodology, the following steps have been taken:

- Comparing the Borough Employee jobs series with the Workforce Employment employee series using the same criteria used previously in backcasting, by borough, over the 1981 to 2000 period, consistent with our approach to comparing London employee jobs data.

- Using linear regression, by borough, to determine whether there is statistical significance between the Borough Employee series and the Workforce Employment series, for the 1981 to 2000 period.

- Borough employee jobs were spliced at the 1981 point and backcasted to 1971 using Workforce Employment series growth rates.

- Combining Hillingdon and Hounslow and regressing on that basis gave a statistically significant relationship between the series.

- Hillingdon and Hounslow [combined] were backcasted to 1971 using the Hillingdon and Hounslow [combined] growth rates from the Workforce Employment series. Hillingdon and Hounslow's respective shares of this combined total from 1981 were then applied to the backcasted combined total to 1971.

- Employee jobs by borough estimates from 1971 to 1980 were constrained to the London employee jobs total for the same period.

The following subsections provide more detail on the backcasting method.

Borough level employee jobs

To compare employee jobs data on a like for like basis, consistent definitions of borough boundaries are required over the period, from 1971 to 2015.

The GLA's Employee Jobs series uses post-2009 borough boundaries, whereas the Workforce Employment series uses borough boundaries frozen at 1991.

There have been a number of changes to London boroughs and the Greater London boundary since 1991. This means that the series cannot be spliced as they are.

Borough boundary changes since 1991

Borough boundary changes are expected to have a more significant impact on employee jobs are set out in more detail below.

City of London boundary changes, 1994
Several changes were made to the City of London's boundaries in 1994[48], affecting several of the City's wards. According to City of London guidance, these changes had little to no impact on City

employment, involving boundary simplifications to avoid boundaries 'cutting through' redeveloped buildings, changes to housing estate boundaries, and mixed use site boundaries.

Heathrow Airport boundary changes, 1994
Heathrow Airport was brought entirely within the Greater London boundary[49], as well as an area of c.190 hectares (around Hatton Cross) transferred from Hounslow to Hillingdon. The affected ward had 2,500 transport workers and 2,000 workers in hotels and catering, retail and wholesale[50]. This suggests a transfer of jobs to Hillingdon in the region of 2,000 to 3,000, with Hounslow's employee jobs count being reduced by a corresponding amount.

Statistical tests and linear regression on the Borough Employee jobs series with the Workforce Employment series' borough level estimates have been used to ascertain whether estimates do differ, as a result of boundary changes.

Comparing the Borough Employee jobs series with the Workforce Employment employee borough-level series

Estimates on employee jobs by borough from the Borough Employee Jobs series were compared with the Workforce Employment series using the criteria used previously in backcasting, CAGR and correlation coefficient, over the 1981 to 2000 period, consistent with our approach to comparing total London employee jobs data.

The results, by borough are presented in Table A.7.22.

Table A.7.22: Results of comparison of employee jobs by borough from the Borough Employee Jobs series and the Workforce Employment series, 1981-2000

London borough	CAGR Workforce Employment series	CAGR Borough Employee Jobs series	Difference in CAGR	Correlation coefficient
Barking and Dagenham	-1.88%	-1.70%	-0.19%	0.897
Barnet	0.89%	0.67%	0.22%	0.976
Bexley	0.15%	0.67%	-0.52%	0.884
Brent	-0.73%	-0.19%	-0.54%	0.964
Bromley	0.30%	0.67%	-0.36%	0.810
Camden	0.91%	0.71%	0.20%	0.971
City of London	-0.37%	-0.45%	0.08%	0.976
Croydon	-0.60%	-0.25%	-0.35%	0.972
Ealing	-0.74%	-0.43%	-0.31%	0.973
Enfield	0.07%	0.33%	-0.26%	0.962
Greenwich	-0.71%	0.14%	-0.85%	0.930
Hackney	-0.48%	0.29%	-0.77%	0.881
Hammersmith and Fulham	0.99%	1.14%	-0.15%	0.951
Haringey	-0.62%	-0.41%	-0.22%	0.966
Harrow	0.74%	0.83%	-0.09%	0.962
Havering	0.40%	0.73%	-0.33%	0.895
Hillingdon	1.62%	0.58%	1.04%	0.814
Hounslow	-0.16%	1.34%	-1.50%	0.287
Islington	1.07%	1.32%	-0.25%	0.989
Kensington and Chelsea	1.75%	1.89%	-0.15%	0.992
Kingston-upon-Thames	0.50%	0.36%	0.14%	0.948
Lambeth	-1.18%	-0.86%	-0.32%	0.978
Lewisham	-0.65%	-0.33%	-0.33%	0.959
Merton	0.00%	1.27%	-1.27%	0.097
Newham	-1.07%	-0.66%	-0.41%	0.966
Redbridge	0.25%	0.79%	-0.54%	0.911
Richmond-upon-Thames	1.17%	0.51%	0.66%	0.720
Southwark	0.60%	0.63%	-0.02%	0.985
Sutton	1.10%	1.06%	0.04%	0.972
Tower Hamlets	2.31%	2.23%	0.08%	0.976
Waltham Forest	-0.91%	0.08%	-0.99%	0.712
Wandsworth	0.77%	1.32%	-0.55%	0.945
Westminster, City of	0.34%	0.10%	0.24%	0.943

With the exception of Hounslow and Merton, the CAGR differences and correlation coefficients for each borough indicate the two series are similar on a borough level basis.

The differences in CAGR by borough range from 0.19% (Barking and Dagenham), to 1.27% (Merton). The correlation coefficients by borough range from 0.097 (Merton) to 0.992 (Kensington and Chelsea), with a median correlation coefficient being 0.959.

Table A.7.23 shows the results of linear regression between the series, by borough, using the Workforce Employment series as the independent variable and the Borough Employee jobs series as the dependent variable.

Table A.7.23: Results of linear regression of employee jobs by borough from the Borough Employee Jobs series and the Workforce Employment series, 1981-2000

London borough	accept null hypothesis y=x	statistically significant relationship (ie t>1.96)	accept null hypothesis intercept is zero	statistically significant relationship (ie t>1.96)
Barking and Dagenham	Accept	8.63	Accept	0.08
Barnet	Accept	18.96	Reject	3.89
Bexley	Accept	8.03	Reject	-3.21
Brent	Accept	15.41	Reject	3.28
Bromley	Accept	5.85	Accept	-1.65
Camden	Accept	17.29	Reject	4.67
City of London	Accept	18.82	Accept	0.31
Croydon	Accept	17.48	Reject	5.24
Ealing	Accept	17.79	Reject	6.53
Enfield	Accept	14.99	Reject	-2.08
Greenwich	Accept	10.74	Accept	0.16
Hackney	Accept	7.90	Accept	1.72
Hammersmith and Fulham	Accept	13.11	Accept	-0.37
Haringey	Accept	15.77	Accept	1.91
Harrow	Accept	14.88	Reject	-2.42
Havering	Accept	8.50	Accept	-1.69
Hillingdon	Accept	5.94	Reject	-3.38
Hounslow	Reject	1.27	Reject	3.69
Islington	Accept	28.85	Accept	0.87
Kensington and Chelsea	Accept	33.95	Accept	-1.22
Kingston-upon-Thames	Accept	12.62	Reject	2.30
Lambeth	Accept	20.05	Accept	-0.25
Lewisham	Accept	14.42	Accept	1.72
Merton	Reject	0.41	Accept	1.15
Newham	Accept	15.83	Accept	-0.10
Redbridge	Accept	9.37	Reject	-2.59
Richmond-upon-Thames	Accept	4.41	Accept	0.74
Southwark	Accept	24.27	Reject	-3.23
Sutton	Accept	17.52	Accept	-1.31
Tower Hamlets	Accept	19.19	Accept	1.22
Waltham Forest	Accept	4.30	Reject	2.49
Wandsworth	Accept	12.25	Reject	-3.82
Westminster, City of	Accept	11.98	Reject	3.68

There was a statistically significant relationship between the series for all boroughs, with the exception of Hounslow and Merton. The hypothesis that the intercept includes zero is accepted for 17 boroughs and rejected for 16 boroughs.

The results of the statistical tests and the linear regression suggest that the Workforce Employment series can be used to backcast the employee jobs by borough for most London boroughs, but cannot be used to backcast borough level employee jobs for Hillingdon and Hounslow.

However, the linear regression was repeated combining Hillingdon and Hounslow, to mitigate the effect of the change in borders of Heathrow in 1994 from Hounslow to Hillingdon. Table A.7.24 shows the results of the linear regression.

Table A.7.24: Results linear regression of employee jobs for Hillingdon and Hounslow (combined) from the Borough Employee Jobs series and the Workforce Employment series, 1981-2000

1981-2000	Hillingdon and Hounslow (combined)
accept null hypothesis y=x	Accept
statistically significant relationship (ie t>1.96)	18.13
accept null hypothesis intercept is zero	Accept
statistically significant relationship (ie t>1.96)	0.87

There is a statistically significant relationship between the series, and the hypothesis that the intercept includes zero at the 95% confidence interval is accepted, but is not statistically significant. This suggests the Workforce Employment series can be used to backcast Hillingdon and Hounslow employee jobs over the 1971 to 1980 period.

In the case of Merton, unlike Hillingdon and Hounslow, there is no discernible reason why the Workforce Employment series' estimates would differ from the Borough Employee jobs series. For this reason, no similar adjustment was made for Merton.

Conclusion – adopted backcasting methodology for employees by borough

On the basis of the evidence from the statistical tests and the regression, the London Employee Jobs series is backcast using the growth rates of the London Workforce Employment series.

1971-1980
All London boroughs excluding Hillingdon and Hounslow:
London Workforce Employment series growth rates, constrained to backcasted London employee jobs series

Hillingdon and Hounslow:
Combined total backcasted using Workforce Employment series growth rates, Hillingdon and Hounslow's respective shares of this combined total from 1981 were then applied to the backcasted combined total to 1971.

7 The backcasting approach for a London level GVA series

This section sets out the approach to backcasting a London-level output (as measured by gross value added (GVA)) series back to 1971.

The section outlines available data sources, compares the current and previous GVA series, outlines the issues in available data, and how these issues were addressed in the adopted backcasting approach.

Comparison of current and previous series of GVA

The trend-based employment projections methodology relies heavily on historic data data for London, with changes to the historic series causing changes to the projections. Table A.7.25 show how the most recent historical GVA data, as developed by the backcasting approach set out in this Appendix, differs to the GVA data that formed the basis of the projections in Working paper 67.[51]

Table A.7.25: Total London output – previous and revised data

GVA (£ million)	Current estimates (as at March 2016) (2012 prices)	Working paper 67 (GLA, 2015)	Absolute difference (new less old)	Percentage difference
1984	131	144	-14	-10.3%
1985	140	150	-10	-7.5%
1986	150	154	-5	-3.0%
1987	159	163	-3	-2.1%
1988	169	172	-3	-2.0%
1989	174	177	-3	-1.7%
1990	176	178	-2	-1.4%
1991	175	177	-2	-1.2%
1992	176	178	-2	-1.0%
1993	184	183	1	0.6%
1994	187	189	-2	-1.1%
1995	189	193	-5	-2.6%
1996	195	199	-3	-1.7%
1997	201	203	-2	-1.0%
1998	212	215	-2	-1.1%
1999	221	224	-3	-1.2%
2000	240	239	1	0.5%
2001	245	241	3	1.3%
2002	244	244	0	0.0%
2003	252	255	-3	-1.3%
2004	258	262	-5	-1.8%
2005	277	277	0	-0.2%
2006	280	282	-2	-0.7%
2007	298	299	-1	-0.4%
2008	305	304	1	0.3%
2009	291	291	0	0.1%
2010	298	299	-1	-0.5%
2011	316	315	1	0.5%
2012	326	320	6	1.7%
2013	338	327	11	3.1%
2014	358	336	22	6.2%
2015[52]	373			

Source: Previous estimates: London GVA estimates from the ONS Regional Accounts (IGLG and DGPI variables for previous and current estimates respectively) for 1997 to 2010/13 for previous and current estimates respectively. GLA Economics estimates for all other years using ONS estimates for the UK GVA (ABML) and implied UK GVA deflator (CGBV). Current estimates: London GVA estimates from ONS Gross Value Added at basic prices (RAGV) as at 25th February 2016 for 1997 to 2014, and implied London deflators for 1997 to 2014 from ONS GVA (P) release. GLA Economics estimates for 1971 to 1996 use ONS Gross Value Added at basic prices (ABMM) and ONS Historical Regional GDP 1968 to 1970 and 1971 to 1996.

The previous estimates for London's real (inflation adjusted) output are based on a number of national statistics and derived via the following stages:

- London's nominal output for 1997 to 2013 inclusive is taken from the ONS Regional Accounts income measure, and applying the implied GVA deflator for London;
- Estimates for London's nominal output for 1984 to 1996 and 2014 inclusive are then created by applying the growth rate, adjusted for inflator by the implied GVA deflator, of the UK GVA from the ONS National Accounts;

The current estimates are based on the backcasting methodology, outlined in more detail below.

As Table A.7.25 shows, the changes in GVA have varied over the 1984 to 2014 period, due to the adoption of a new methodology for estimating GVA back to 1984 and revisions to ONS regional GVA estimates. Over the 1984 to 1996 period, revisions to London GVA have ranged from -£14 million (10.3%) in 1984, to an increase of £1million in 1993. From 1997 onwards, revisions have ranged from -£5million (1.8%) in 2004, to £22million (6.2%) in 2014.

Output data sources, and definitions

There are three ways to measure output:

- Income-based approach which measures the total income generated by the production of goods and services within the economy;

- Production-based approach which measures the sum of the value added created through the production of goods and services within the economy (our production or output as an economy); and,

- Expenditure-based approach which measures total expenditure on all finished goods and services produced within the economy.

At a UK-level the Office for National Statistics combines the three estimates into a single measure. Conceptually they are equivalent once you take account of trade effects with other countries as measured by the balance of payments.

Statistics for London output use an income measure, and this is a National Statistic. ONS has also developed a production measure, which currently is an experimental statistic. There is not an expenditure measure for London as it is not straightforward to attribute to residence or location. It would need to reflect that commuters and London residents might spend money outside London, and tourists and visitors would spend money in London.

Output can be measured by GVA or gross domestic product (GDP). The link between GVA and GDP can be defined as[53]:

- GVA (at current basic prices; available by industry only)
- plus taxes on products (available at whole economy level only)
- less subsidies on products (available at whole economy level only)
- equals GDP (at current market prices; available at whole economy level only)

GLA Economics' employment projections use GVA as a measure of output, a measure of the increase in the value of the economy due to the production of goods and services. It is measured at current basic prices, which include the effect of inflation, excluding taxes (less subsidies) on products.

There are four data series to support this analysis.

GLA Economics' London GVA estimates 1997-2015

Modelled estimates of real GVA for London based on regional ONS GVA estimates[54] using the income approach[55], deflated using implied London deflators from the GVA (P) release[56].

Data forecast for 2015 based on GLA Economics forecast model[57].

ONS Regional GDP

- Regional/London level GDP at factor cost, 1968-1970,1971-1996[58]

- These estimates can be used as a proxy for current regional Gross Value Added (GVA) estimates, but are not consistent with current regional GVA estimates due to the following factors:

    - They were compiled as GDP estimates rather than GVA estimates.
    - They use Standard Statistical Regions (SSR) rather than NUTS geographies.
    - They use industrial breakdowns as defined in Standard Industrial Classification (SIC) 1980 and SIC 1992, while current estimates use SIC 2007.
    - The accounting methodology has changed from the European System of Accounts (ESA) 1979 to ESA 2010.[59]

Forecasters A and B

- Regional/London level GVA, 1971-2015, on a constant price basis.

- Based on a combination of ONS Regional accounts and/or employment forecasts.

Backcasting London-level GVA

There is no consistent time series of GVA at the London level, back to 1971. A review of the available data sources found the following issues:

- The ONS' regional GVA series provides London output data back to 1997 only, whereas UK level GVA goes back to 1948.

- Applying UK GVA growth from the ONS National Accounts to estimate London's growth may overestimate the impact of sectors like Manufacturing, which account for a smaller proportion of jobs in London compared to the rest of the UK, and London's GVA has grown at a faster rate than the UK since 1997, when regional GVA series began.

- The ONS has published regional GDP estimates from 1968 to 1996, however this is not on a consistent basis with GVA estimates, so the series cannot be spliced as they are.

- The Workforce Employment series does not provide a regional GVA series.

- External forecaster's series are on a different price basis (2012 and 2011 respectively).

To address these issues in the backcasting GVA methodology, the following steps have been taken:

- Using GLA Economics' modelled estimates on London level GVA back to 1997.
- Exploring two possible approaches to create a backcasted series;
    1 Using linear regression to test whether the relationship between GLA Economics' estimates of London GVA and ONS UK GVA data can be used as a basis for backcasting.
    2 Using the ONS' GDP series to examine the relationship between London and the UK, and using this as basis to backcast London GVA.
- Comparing the GVA back series with GVA series from Forecaster A and Forecaster B, over the 1971 to 1996 period.

The following subsections provide more detail on the backcasting method.

Backcasting GVA using regression and ONS' historical GDP estimates

Two approaches were explored to create a backcasted series of London GVA to 1971.

The first approach was to use linear regression to estimate London GVA from 1997 onwards, using UK GVA as the independent variable and GLA Economics' estimates as the dependent variable. However the years for which we have consistent data (1997-2014) was a period where London's economy grew at a faster rate than the UK.

To use this regression to backcast London GVA assumes that London GVA would grow at a faster rate (or decline at a faster rate) than UK GVA back to 1971, which implies that London's share of UK GVA would decrease over this period, declining to 16.7% in 1971 based on the estimates from the regression. This doesn't fit with our understanding of the London and UK economies over this time period.

The second approach was to use the ONS GDP to backcast GLA Economics' modelled London GVA estimates back to 1971.

London's share of UK GVA in 1997 has been backcasted using changes in the share of London's GDP as a percentage of UK GDP. The backcasting methodology makes the following assumptions:

1 London's share of UK GDP is representative of London's share of UK GVA.

2 London's share of UK GVA remains constant over the 1996 to 1997 period. The differences in measurement between GDP and GVA, as outlined above, mean that the GDP series cannot be spliced with the GLA Economics GVA estimates at 1997.

Comparing London level GVA series

The results of the two approaches were compared against estimates from Forecaster A and B. The results from the first (ie. regression) approach were significantly lower than results from the external forecasters. This is consistent with our understanding that the London economy grew more in-line with the UK economy over this period than it has since 1997. The second approach was more consistent with the estimates from the other forecasters, and in-line with our understanding of London economic activity over this period, suggesting that the second approach was the more suitable approach to use.

The backcasted GVA series using the second approach was compared with Forecaster A and B's London GVA series using the same criteria used previously in backcasting, over the 1971 to 1996 period (ie. before official regional GVA series).

Table A.7.26 shows the results of the comparison between GLA Economics' estimates of backcasted GVA with Forecaster A and B's estimates, after inflation.

Table A.7.26: Results of comparison of London GVA estimates between GLA Economics and Forecaster A and Forecaster B

1971-1996	GLA Economics	Forecaster A	Forecaster B
CAGR	1.80%	1.39%	1.80%
Difference in CAGR	0.00%	0.41%	0.00%
Correlation coefficient	1.000	0.988	0.991
Cumulative sum of forecast difference	0	880	-15,789
Mean absolute deviation	0	203,467	79,133
Mean percentage difference (%)	0.0	5.1	2.0

There is a strong correlation between GLA Economics' estimates and Forecaster A and B's. The series also have similar CAGRs, with GLA Economics' series having the same CAGR as Forecaster B. The cumulative sum of forecast difference also shows GLA Economics' estimates are lower than Forecaster A's but higher than Forecaster B's. These results provide a degree of confidence that the backcasted series falls within a realistic range.

Conclusion – adopted backcasting methodology for GVA

1971-1996
Backcasted using changes in London's share of UK GDP attributable applied to UK GVA estimates

1997-2015
GLA Economics' estimates of London level GVA

Appendix 8: Transport accessibility employment projections
Appendix 9: London employment sites capacity projections

GLA Economics – Accessibility and Employment Forecasts, Volterra Partners, April 2016

London Employment Sites Database, CAG Consultants, May 2016

Reports available electronically alongside this report on GLA Economics webpages.

Endnotes

1 The draft Economic Evidence Base 2016 https://www.london.gov.uk/business-and-economy-publications/draft-economic-evidence-base-2016 provides a fuller analysis of London's openness to trade, and economic specialisation (chapter 1), and the clustering of employment within the city to achieve agglomeration economies (chapter 2)

2 Trade and the Global Economy: The role of international trade in productivity, economic reform and growth', HM Treasury 2004 (chapter 2).

3 See for example, Krugman and Obstfeld (2003).

4 Figure 2.1 aggregates different SIC 2007 sector categories for ease of exposition. As a result, Manufacturing, construction and utilities consists of SIC codes A-F; Wholesale, retail, transportation and storage consists of SIC codes G-H; Public admin, health and education consists of SIC codes O-Q; Professional, real estate and business services consists of SIC codes L-N; Accommodation, entertainment, recreation and other services consists of SIC codes I and R-U; and, information, communication, financial and insurance consists of SIC codes J-K.

5 For the purposes of this work the index of specialisation is calculated as: (London employment in sector / London total employment) / (Rest of GB employment in sector / Rest of GB total employment). Therefore if the index of specialisation is greater than 1, then this shows that London has a greater share of its total jobs in the sector being examined than does the rest of GB. As such it can be regarded as an area in which London has some specialisation. The higher the index of specialisation above 1.00, the greater the degree of specialisation. By contrast if the index of specialisation is less than 1, then this shows that the rest of GB has a greater share of its total jobs in the sector being examined than does London. The closer the index of specialisation gets to zero, the smaller London's role in the sector being considered is compared to the rest of GB. The index of specialisation is calculated using employee data from the Business Register and Employment Survey (BRES) for 2014 (see Appendix 2). Regional GVA is 2014 (industry) data (released December 2015).

6 For the purposes of this work the index of specialisation is calculated as: (London employment in sector / London total employment) / (Rest of GB employment in sector / Rest of GB total employment). Therefore if the index of specialisation is greater than 1, then this shows that London has a greater share of its total jobs in the sector being examined than does the rest of GB. As such it can be regarded as an area in which London has some specialisation. The higher the index of specialisation above 1.00, the greater the degree of specialisation. By contrast if the index of specialisation is less than 1, then this shows that the rest of GB has a greater share of its total jobs in the sector being examined than does London. The closer the index of specialisation gets to zero, the smaller London's role in the sector being considered is compared to the rest of GB. The index of specialisation is calculated using employee data from the Business Register and Employment Survey (BRES) for 2011 (see Appendix 2). Regional GVA is 2010 (industry) data (released December 2012).

7 Measured as Workforce employee and self-employed jobs

8 See http://www.london.gov.uk/business-and-economy-publications/regional-sub-regional-and-local-gva-estimates-london-1997-2014 for more detailed information on London's output. This Gross Value Added series is in cash terms, while the numbers in figure 2.7 are after inflation. Appendix 7 explains how this conversion has been done, and the series extended back to 1971. The available series for UK output back to 1971 is Gross Domestic Product in constant prices. Appendix 7 also explains the reasons for differences in measures of output.

9 Official statistics record the sector of employment, and not the sector of activity. The industrial sector Administrative and Support Service Activities includes employment agencies, who may employ individuals whose day-to-day work is for an organisation in another sector

10 More information on GLA population projections is available at http://data.london.gov.uk/demography/population-projections/. The methodology of these population projections is also set out at Appendix 6.

11 The ratio of jobs to people is held constant for London residents over the period of the projections.

12 See the OBR's 'Economic and Fiscal Outlook', March 2016: http://cdn.budgetresponsibility.independent.gov.uk/March2015EFO_18-03-webv1.pdf

13 Data prior to 2001 are based on a Standard Occupational Classification 1990 (SOC 1990) for which there is no available conversion matrix. Data from 2001 to 2003 come from the ONS Labour Force Survey April-June quarter. Data from 2004-2011 are from the ONS Annual Population Data. Further details on the historical data is available on the ONS website (reference number 000344): http://www.ons.gov.uk/ons/about-ons/what-we-do/publication-scheme/published-ad-hoc-data/labour-market/august-2012/index.html.

14 An area that contains Canary Wharf.

15 More analysis on the characteristics of these areas is available at https://www.london.gov.uk/what-we-do/business-and-economy/business-and-economy-publications/wp-68-work-life-caz-north-part

16 See the OBR's 'Economic and Fiscal Outlook', March 2015: http://cdn.budgetresponsibility.independent.gov.uk/March2015EFO_18-03-webv1.pdf

17 Strictly speaking, it is implicitly assumed that whatever constraints may have existed in the past continue into the future. Hence it is any additional constraints which are relevant.

18 Although this slight change, in itself, should be treated with caution as it may simply be due to sampling variability.

19 The Greater London Authority, Working Paper 52: London's jobs history – a technical paper, December 2011. https://www.london.gov.uk/sites/default/files/gla_migrate_files_destination/wp52.pdf

20 The GLA's London Workforce Employment Series, 2009, http://legacy.london.gov.uk/mayor/economic_unit/docs/london_workforce_employment_series.pdf

21 Greater London Authority (2015), Working Paper 67: Updated employment projections for London by sector and trend-based projections by borough, https://www.london.gov.uk/what-we-do/business-and-economy/business-and-economy-publications/working-paper-67-updated

22 The Greater London Authority, Working Paper 52: London's jobs history – a technical paper, December 2011. https://www.london.gov.uk/sites/default/files/gla_migrate_files_destination/wp52.pdf

23 The most recent revisions to the WFJ series are described in detail in the ONS' methodological note, Revisions to Workforce Jobs, December 2015, https://www.ons.gov.uk/employmentandlabourmarket/peopleinwork/employmentandemployeetypes/methodologies/revisionstoworkforcejobsdecember2015

24 ONS, Workforce Jobs, Jobs in selected industries in London: 1996 to 2015 http://www.ons.gov.uk/employmentandlabourmarket/peopleinwork/employmentandemployeetypes/adhocs/005485jobsinselectedindustriesinlondon1996to2015

25 Further information on SIC 2007 and the industry hierarchy available here: http://www.neighbourhood.statistics.gov.uk/HTMLDocs/SIC/ONS_SIC_hierarchy_view.html

26 ONS, Annual Population Survey, Percentages of self-employment jobs in London boroughs, 2004 to 2015, http://www.ons.gov.uk/employmentandlabourmarket/peopleinwork/employmentandemployeetypes/adhocs/005508percentagesofselfemploymentjobsinlondonboroughs2004to2015

27 ONS, Census 2011 questionnaire, http://www.ons.gov.uk/census/2011census/howourcensusworks/howwetookthe2011census/howwecollectedtheinformation/questionnairesdeliverycompletionandreturn

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31 The term 'splicing' refers to the process of linking data series together on a given variable, generally involving the backward extrapolation of the most recently available series using the growth rate of an older series.

32 The April 2013 revision to the employee jobs and self-employed jobs components of the Workforce jobs series is described in detail here: http://webarchive.nationalarchives.gov.uk/20160105160709/http://www.ons.gov.uk/ons/guide-method/method-quality/specific/labour-market/articles-and-reports/revisions-to-workforce-jobs-april-2013.pdf

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34 Greater London Authority (2015), Working Paper 66: London's sectors: detailed jobs data & method, https://www.london.gov.uk/what-we-do/business-and-economy/business-and-economy-publications/working-papers-65-66-londons

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47 Full details of all London borough and Greater London boundary changes can be found here: http://www.lgbce.org.uk/__data/assets/pdf_file/0016/11419/627-the-boundaries-of-greater-london-and-the-london-boroughs.pdf

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