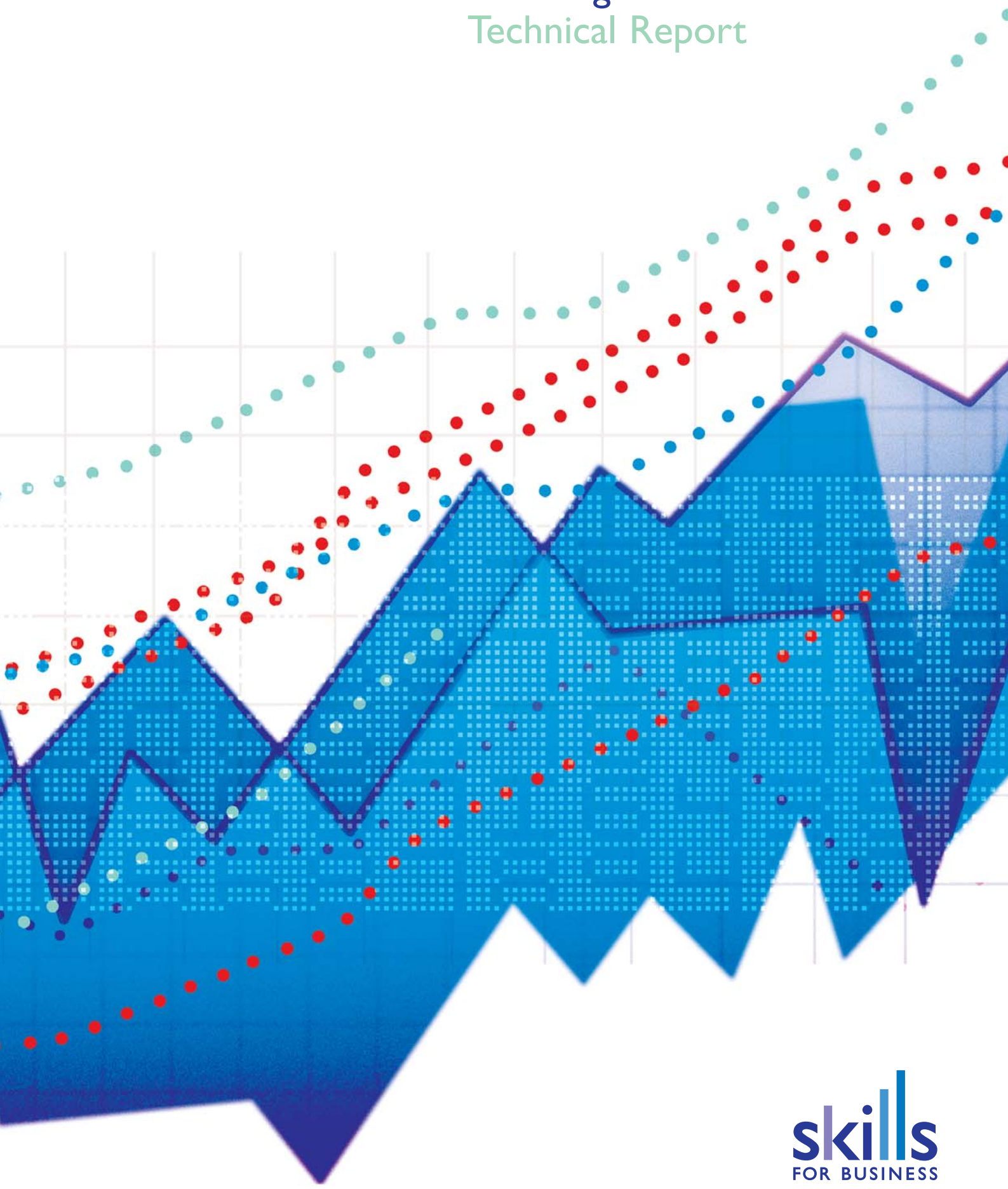
Working Futures 2004-2014
Technical Report



skills FOR BUSINESS

Working Futures 2004-2014:

TECHNICAL REPORT ON SOURCES AND METHODS

R. Wilson, K. Homenidou and A. Dickerson
January 2006

Institute for Employment Research, University of Warwick, Coventry CV4 7AL
tel: 024 765 23283 fax: 024 765 24241 E-mail r.a.wilson@warwick.ac.uk

Preface and acknowledgements

The authors are grateful to the SSDA and the LSC for funding this research. Special thanks are due to the project Steering Group, comprising Lesley Giles (SSDA), Richard Garrett (SSDA), Joyce Findlater and Nathan Dodd (LSC), Mark Deas (EEDA on behalf of the RDAs), Geoffrey Shoesmith and Gary Clarkson (DfES) and Lauren Sadler (of Cogent, representing the Sector Skills Councils (SSCs)).

This has been a team effort, involving a large number of people. Rachel Beaven, Geoff Briscoe, Andrew Holden, Peter Millar all made important contributions to the data analysis and processing. Thanks are also due to Amanda Kerry for word processing and related assistance and to Jackie Wilson for help in proof reading. The responsibility for any remaining errors is the authors.

The projections are presented at a variety of different sectoral levels using two main types of definition:

- **broad sectoral definitions** based on groups of 6, 14 or 27 sectors, and defined by Standard Industrial Classification (SIC) codes. These preserve the traditional manufacturing, services and public sector groupings of the economy. They are hierarchically related, with the 6 broadest sectors being a more aggregated grouping of the 14 industries, and so on. The 14 and 27 groups have been adopted by the SSDA in their Sector Skills Matrix database and hence are referred to as the Sector Matrix Industries (SMI). These are not coterminous with the SSCs' footprints; and

- **Sector Skills Councils definitions** which employ SIC code groupings that most closely match the SSC footprints. These definitions are a 'best fit' of each SSC's core business sectors. These specify the *core* SIC codes that are undisputed and do not overlap with any other SSC. The extent to which this is an exact fit varies between SSCs. In some cases, the use of the core SIC codes excludes elements of the SSC footprint because they are included in other areas. SSCs can provide further depth analysis of skills and future employment within their sector (see their individual websites for details).

The results should be regarded as indicative of likely trends given a continuation of past patterns of behaviour and performance, rather than precise forecasts of what will inevitably happen. They should be regarded as a robust benchmark for debate and used in conjunction with a variety of other sources of LMI. The opinions expressed in this report are those of the authors and do not necessarily reflect the views of the SSDA, the LSC, DfES, RDAs nor individual SSCs.

Sector Skills Development Agency
Wath on Dearne

ISBN 0-9552029-1-4

Contents Page

Contents (continued) **Page**

Contents (continued) **Page**

Contents (continued) **Page**

List of Tables

List of Figures

1 Introduction

1.1 The new projections

This document provides a technical description of the sources and methods used to generate the set of occupational employment projections presented in *Working Futures 2004-2014.*[1] These projections have been prepared by the Institute for Employment Research (IER) and Cambridge Econometrics (CE) on behalf of the Sector Skills Development Agency (SSDA). They update those produced in 2001. [2]

This document explains the methodological approach employed to generate the detailed historical employment ***Database***, as well as the models and procedures used to produce the projections.[3] This includes: information about the working assumptions adopted; the limitations of the estimates produced; and comparisons with other projections.

The full results of the projections may be found in the following documents:

- The **National Report** for the whole of the UK, which summarises the main findings. This describes the key employment trends and findings from the analysis. It includes tables of data for selected years, together with a written commentary explaining and interpreting the forecasts. This document also includes more detailed material, using the SSDA's Sector Matrix Industries for summary reporting;

- In addition to the main report, further detailed industrial analysis is provided using Sector Skills Council (SSC) footprints in the **Sectoral Report**. This provides information on key trends and prospects for each of the SSCs;

- The **Spatial Report**, which discusses the projections for the individual countries and regions within England that together make up the UK. This also includes some LLSC "league table" type information, including a number of key indicators for LLSCs;

- The **Qualifications Report** presents implications of trends in the qualification structure of employment and likely developments in the numbers of those qualified.

1.2 Structure of this document

The remainder of the present document is structured as follows:

- Section 2 outlines, in general terms, the models used to develop the employment scenario.

- Section 3 describes, in more detail, the methods used to model the UK economy, including detailed sectoral prospects.

- Section 4 deals with the modelling of regional employment.

- Section 5 covers Labour Supply.

---

[1] Wilson *et al*. (2006) *Working Futures 2004-2014,* SSDA: Wath on Dearne.

[2] Wilson *et al*. (2003) *Working Futures: New Projections of Occupational Employment by Sector and Region,* SSDA: Wath on Dearne.

[3] The term ***Database*** has been used throughout this document to refer to the time series data on employment and output, cross classified by detailed sector (and in the case of employment by gender, status and occupation). It is indicated by the use of bold italicised script.

- Section 6 presents the categories and classifications used for defining industries and sectors, including those used for reporting. This section also describes how the results for SSC categories were derived.

- Section 7 covers the treatment of employment by gender and status.

- Section 8 deals with occupational employment structure, including development of views about the likely nature of projected structural changes.

- Section 9 deals with the methods used to generate replacement demands for occupations (covering losses due to retirements, etc).

- Section 10 deals with the projections of qualifications which are a new feature in *Working Futures 2004-2014*. This is a major new development which warrants detailed discussion. Section 10 provides a brief summary. Further details are provided in a separate **Qualifications Technical Report**.[4]

- Section 11 describes the main employment and Output ***Database,*** including how these have been developed.

- Section 12 describes, in more general terms, the data sources and methods used to produce the historical ***Database***.

- Section 13 describes the detailed estimates prepared for LLSCs and SSCs. These provide the most detailed information available from the projections.

- Section 14 covers issues relating to statistical precision and the robustness of the estimates.

- Section 15 presents some warnings about confidentiality when accessing the more detailed data.[5]

- Section 16 deals with comparisons of the new projections with those presented in *Working Futures 2002-2012*.

- Section 17 covers comparisons with projections conducted by selected SSCs.

The various sections of this report are designed to be read independently. They have therefore been written so that they can stand alone, with only limited cross-referencing. Inevitably this leads to a certain level of duplication and repetition. The authors hope that the benefits outlined above will outweigh any disadvantages that the latter may bring.

[4] Wilson *et al.* (2006)

[5] Access to the most detailed results is limited to those working for Sector Skills Councils (SSCs) and Local Learning and Skills Councils, (LLSCs) who are covered by a Chancellor of the Exchequer's Notice.

2 The Models Used

2.1 The need for a macroeconomic model

Labour market projections should be firmly grounded on an understanding of how the economy as a whole is changing. Changes in employment structure are intimately tied up with the development of the economy more generally. This has been operationalised in the form of the multi-sectoral dynamic model of the economy (MDM) developed by Cambridge Econometrics (CE). Details of MDM and its relationship with other model components are given in Figure 1.

The figure summarises the models used by CE/IER for employment forecasting. MDM is described in more detail in Section 3. It has a Keynesian structure incorporating an input-output system and concentrates on the determination of changes in the real sector of the economy. Each region is modelled separately, with UK results being obtained by summation. The level of disaggregation of commodities and industries is considerable by the standards of other models of the UK economy. Primarily because of the degree of disaggregation, the model is a large one and comprises over 5,000 behavioural and technical relationships (excluding accounting identities). Its main components are equations explaining consumption, investment, employment, exports, imports, and prices. At its heart is an input-output matrix, which deals with the flows of goods and services between industries and determines total industrial outputs. These equations are all solved together so that the final results are consistent with the various identities required by the national accounts. There are currently 41 main employing activities distinguished. These categories are based on the limitations of data available from the input-output tables. These are expanded to 67 industries using methods as described below.

2.2 The employment output relationship

A key relationship is that between industry employment and output. In the vast majority of cases the results suggest that an 'error correction' formulation can be applied, so this model was imposed in all industries. In this form, the residuals from the first stage 'cointegrating regression', (which represents the long-run relationship between employment and its determinants) are used in a 'second stage' dynamic specification, which incorporates various lagged terms to reflect adjustment lags.[6] The inclusion of the residuals from the 'first stage' ensures that the long-run solution, given by the cointegrating regression, is imposed. To complement the employment equations, a set of hours equations by industry have also been estimated, which relate average weekly hours worked by industry to normal hours and capacity utilisation.

2.3 Other model components

The links between the main macroeconomic model and the other forecasting models are illustrated in the figure. The macroeconomic model is, generally speaking, based upon quite sophisticated econometric analysis of long time series data sets. It is characterised by many feedbacks from one set of equations to another. By contrast, the other sub-models relating to occupational employment and replacement demands are based on much more limited data and do not feed back into the main macroeconomic model. This includes the models used to develop projections of occupational structure and qualifications.

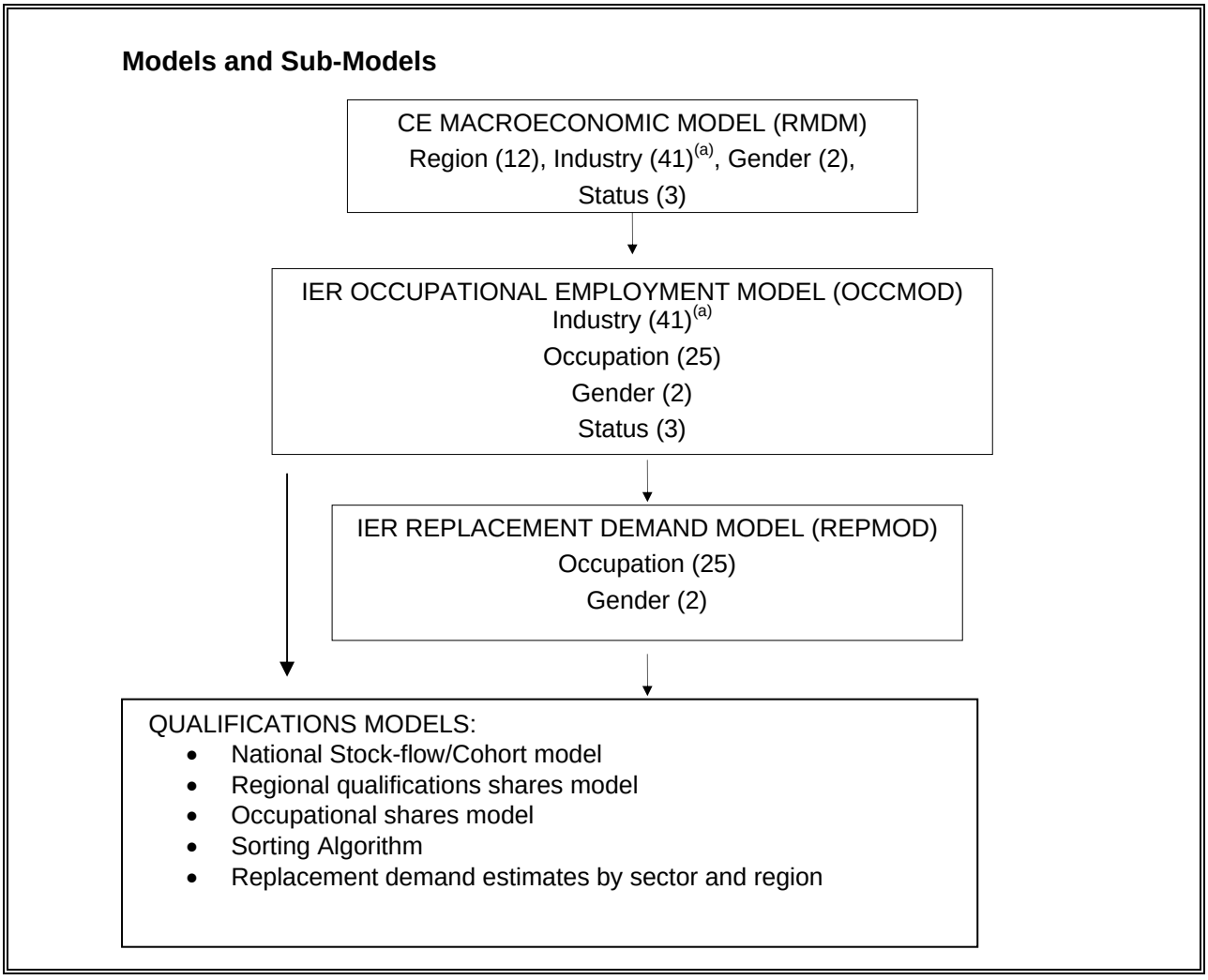
[6] For an example see Briscoe and Wilson (1991).

The projections also involve further procedures, which allow for even greater detail. These include:

- Extension from 41 to 67 sectors;
- Development of results for SSCs;
- Development of results for all 47 LLSC areas, as well as the countries and regions of the UK.

These are described in greater detail in the following sections.

Figure 1: The Multisectoral Dynamic Macroeconomic Model, Occupational Model and Replacement Demand Models



Notes: (a) These are extended to cover all two digit SIC categories, as described in Sections 3 & 4.

3 Modelling the UK Economy

3.1 Introduction

As outlined in Section 2, the macroeconomic model used to develop the underlying scenario for the employment projections is based on a detailed analysis of economic and other behavioural relationships, statistically estimated using robust econometric methods. The current version of the model is based on a "bottom-up" treatment of regional economic prospects. The model offers a combination of great detail, and a high level of sophistication. The use of a fully-specified, formal macroeconomic regional multi-sectoral model provides a number of advantages over more *ad hoc* extrapolation methods. These include enforcement of logical and accounting constraints, and emphasis on making explicit the underlying assumptions built into the projections. The importance of using such methods, and further information about the approach, are set out in Barker and Peterson (1987) and Wilson (1994).

The forecasts for *Working Futures 2004-2014* were prepared using the latest version of the Cambridge Multisectoral Dynamic Model (MDM01R1) which is based on the 2003 Standard Industrial Classification (SIC2003). The most recent National Accounts data (with chained volume measures, with reference year 2001), along with a consistent 2001 input-output table and classification converters, have been incorporated into MDM01. All the main equation sets in the model, including the regional equations, were re-estimated on the latest data using a standard cointegrating technique. The estimation and model solution procedures were programmed in a common framework, with software facilities incorporated for checking the results and identifying errors.

3.2 The latest version of MDM (MDM01R1)

MDM underwent a substantial programme of sectoral modelling development in 2004. The programme of work was drawn up to improve all of CE's sectoral-regional models (the European model E3ME, the global model E3MG and the UK model MDM) and implemented changes required to make the models consistent with the most recent data and methods.

The first phase of the development reviewed and updated the model classifications to take account of changes in the provision of official data, to provide sufficient detail for informative analysis and to create synergies across the sectoral models. The number of industries is chosen to give a balanced representation of the structure of the economy. As that structure changes over time, the model is reviewed and revised. The industry classification, i.e. the list of industries distinguished in the model, has been revised. A few of the manufacturing industries have been merged, because their importance in the economy has declined, and the definitions of some of the financial and business services have been refined. The new industry classification is common to all the CE sectoral-regional models (the European model E3ME, the global model E3MG and the UK model MDM) and so has improved the procedures for making international comparisons and consistency checks.

The second phase constructed the MDM database required for the updated model classifications and incorporated the chained volume measure (CVM) data first published in the 2003 UK National Accounts (see Section 3.3).

The third phase incorporated more up-to-date input-output estimates and revised projections to take account of the changing structure of the UK economy.

The fourth phase reprogrammed and made improvements to the procedures used to estimate the model's cointegrating equations.

3.3 Incorporating National Accounts data in CVM form

The 2003 National Accounts saw the introduction of 'annual chain-linking', a method for constructing aggregate volume measures of economic growth which better reflect the changing structure of industry and patterns of expenditure. The latest version of MDM (MDM01R1) has been updated to incorporate the National Accounts data in CVM form.

Previously the detailed estimates for growth for different industries were summed to a total by using information on how important each industry was in a fixed base year and according to the price structure in that base year (most recently 1995). Changes in relative prices and industry weights subsequent to the base year were not incorporated. The year from which this information on relative prices and industry weights was drawn was updated at 5-yearly intervals. This method produced constant-price series and is described as 'fixed base aggregation'.

The new method, 'annual chain-linking', replaces the constant-price series with CVMs which use information for the price structure updated every year to give each industry the most relevant weight which can be estimated. CVM estimates of growth should therefore provide a more accurate picture of changes to the economy's structure. CVM indices are referenced to the most recent year for which a price structure is available; later years are compiled in the same way as constant-price data.

The move to annual chain-linking involves some loss of additivity in the components of aggregate totals in the years prior to the reference year. For example, if GVA for each industry is summed through simple addition the total across the industries will not correspond to the CVM estimate of total GVA. A more complex method of weighting the series together is required.

3.4 Input-output table for 2001

An input-output table for 2001 in basic prices has been estimated from official data to provide the detail needed to model inter-industry purchases and sales. The additional work required to adjust the original ONS input-output supply and use tables (which are in purchasers' prices) mainly entails (1) the reallocation of the duties on alcohol, tobacco and petrol to final consumers and (2) the reallocation of distribution and other margins from the valuation of each commodity's demand to wholesale and retail distribution commodity output. Associated classification converters have been constructed using the available ONS data.

3.5 ONS gross output and value added data

The forecast also incorporates data from the ONS on gross output and value added. CVMs of value added by industry are constructed from ONS SIC2003 indices of output data (see section 3.3). Input-output balances provide data for gross output by SIC2003 in the reference year 2001. A time series for gross output has been constructed based upon 1994-vintage gross output data, originally collected at the 123-industry level of detail corresponding to that of the 1990 input-output tables, which have been aggregated and reclassified to the MDM industry definitions (see Table 2). These data have been updated in line with short-term indicators for more recent years.

3.6 Reconciling final demand time series with ONS National Accounts

Since the introduction of the European System of (National) Accounts (ESA95), investment data are published at a much reduced level of detail. ONS has reduced the number of investing sectors for which investment data are available and so to reflect this, and because there is no supplementary information available to disaggregate the investing sectors further, the number of investing sectors distinguished in MDM has been reduced from 38 to 27. ONS no longer publishes investment data by investing sector and asset. Therefore, only total investment by each of the six assets is now modelled, where previously investment by investing sector for each asset was distinguished.

In the ESA95 household final consumption expenditure is classified by 51 categories of purpose. The 51-functional category level for 'household' expenditure (which includes final consumption expenditure of non-profit institutions serving households) has been incorporated. Historical data published in detail in the UK National Accounts and Consumer Trends have been incorporated into the model.

The latest data from the ONS for exports and imports have also been incorporated into this forecast. These were linked to earlier data which had previously been reclassified, converted to 2001 CVMs and matched with 2001 data from the supply and use input-output tables for 2001.

The time-series data for years after 1990 were reconciled at an aggregate level with data from the ONS's Blue Book and more recent press releases.

3.7 Intermediate demand

Estimating intermediate demand was less straightforward. First, input-output coefficients were calculated for commodities absorbed in production by industries from the input-output tables and aggregated to the MDM groups. These coefficients were then projected one year at a time to allow for known and expected technical and other changes. The coefficients for any year were applied to estimates of gross output for that year to give intermediate demand.

3.8 Detailed employment data consistent with the ABI

Employment data by gender and status and by industry consistent with the ONS Annual Business Inquiry (ABI) were processed as described in Section 9. The data refer to mid-year (June) levels.

3.9 Analysing and forecasting changes in economic structure

The economic model is designed to analyse and forecast changes in economic structure. To do this, it disaggregates industries, commodities and household and government expenditures, as well as foreign trade and investment. In fact it disaggregates all of the main variables that are treated as aggregates in most macroeconomic models. The detailed variables are linked together in an accounting framework based on the United Nations System of National Accounts. This framework ensures consistency and correct accounting balances in the model's projections and forecasts.

The model is a combination of orthodox time-series econometric relationships and cross-section input-output relationships. Although it forms aggregate demand in a Keynesian manner, with a consumption function and investment equations, it also includes equations for average earnings by industry and region. Other aspects of the supply side come in through the export and import equations, in which capacity utilisation affects trade performance, as well as a set of employment equations which allow relative wage rates and interest rates to affect employment and therefore industry-level productivity growth.

The main exogenous variables of the model are as follows:

- world growth in GDP
- world inflation in GDP deflators and in prices of traded goods such as crude oil
- UK population, labour force and natural resources (the main natural resources being coal, oil and natural gas)
- current and capital spending of the UK government
- UK tax rates and allowances
- the sterling-dollar and other exchange rates
- UK and US interest rates

3.10 Adjustments made to RMDM

The main adjustments made to the model in order to produce a forecast were as follows:

- Recent data on outcomes and short-term industrial forecasts for 2004 are included directly in the model solution with multiplicative errors between model calculations and actual values being estimated.
- Time trends are not included in the long-term component of the equations unless based on theoretical grounds. Constants are included in the dynamic components of the equations, so that the forecast will settle down to a steady growth path, unless there are long-term effects, such as the effect of accumulated investment.
- Cyclical variables were phased out by holding the variables constant at 'normal' values after the first year or so of the forecast.
- Special assumptions are made for forecasts of investment in the oil & gas, electricity, gas and water industries.
- Expectations of consumer price inflation are included in the price and wage equations at the Government's target rate of 2% pa from 2005 onwards.

The multiplicative errors from the cointegrating equations and most of the other estimated residuals in the model are held constant at values for the last year for which data or short-term forecasts and estimates were available, unless they are changed to allow the model to incorporate expert views or updated forecasts.

3.11 The reliability of the forecast and improvements to output and trade data

The reliability of the forecast partly reflects the reliability of the data. In recent years, the implementation of ESA95 has been an important driver of improvements to the National Accounts. Full implementation is scheduled for the end of 2005. Output and trade data have seen some of the biggest revisions. Resources have been invested in the production of annual input-output supply and use tables and these tables, and the associated analyses, are now incorporated in the annual estimates of the National Accounts published in the Blue Book.

The measurement of economic growth has been improved by the introduction of chainlinked estimates of GVA and its components in the 2003 National Accounts. These changes have improved the international comparability of UK data and reduced the size of revisions that occur when data are rebased to a new reference year.

Trade data have been improved through the inclusion of estimates for smuggled alcohol and tobacco and adjustments for the impact of VAT Missing Trader Intra-Community (MTIC) fraud.

The result of these changes has been a succession of substantial revisions to the data, especially in the area of foreign trade and output. These revisions are in addition to those of the National Accounts and any statistical adjustment. In this situation it is important to keep as up to date as possible, to cross-check data with those from alternative sources where possible and to question any exceptional figures.

The forecast should be seen as providing a reasonably consistent, comprehensive and sustainable view of the development of the economy which is built up from projections of individual industries. Part of the plausibility comes from the fact that strong trends over history, such as the extraordinary growth in household expenditure 1983-89, have not been thought to be sustainable because of their implications for the balance of payments and for inflation. Assumptions are made in the projections about changes in policy or behaviour, which produce changes in such trends and credible outcomes for both the macroeconomy and the individual industries.

The forecasts for individual industries are much less certain than those for the aggregates. Some indication of the errors involved is given by the residuals in the tables for short-term estimates. These are the industrial counterparts to the ONS's residual errors for the whole economy, published in the Blue Book.

3.12 Impact of ESA95

The introduction of the European system of (national) accounts (ESA95) made redundant several commonly used terms and conventions. The output measure of GDP value added at factor cost (i.e. excluding all taxes and subsidies on production) is no longer part of the system. The concept is replaced by value added at basic prices, which excludes taxes like excise duties, but not taxes like business rates that are not attributable per unit sold. Hence, the 'headline' measure of GDP becomes GDP at market prices (including all taxes less subsidies), while the key concept for industry analysis is GVA (gross value added) at basic prices.

3.13 Processing the UK output data and forecasts for 67 sectors

This section describes how the data and forecasts for UK output (value-added in chained volume measures) were processed for the 67 sectors analysed in this project. As mentioned above, MDM distinguishes 41 industries, defined by the 2003 Standard Industrial Classification (SIC2003) (see Table 2, p26, below). The data by the 67 sectors were processed to be consistent with the MDM industry data and forecasts. Of the 67 sectors, 26 directly matched the MDM industry definition and so no further processing was required. The other 15 MDM industries had to be disaggregated further to match the remaining 41 SSDA detailed industry definitions. For example, the MDM other transport equipment industry was disaggregated into two subsectors: aerospace and other transport equipment. Further details are given in Section 11.

Table 1a lists the MDM industries that were disaggregated to construct the detailed SSDA industries. For each MDM industry, and the corresponding SSDA industry, the table summarises the data availability.

The GDPO and IoP series are constant price indices of value added output (2001=100). The 2001 level of output for the SSDA industries was calculated by applying the 2001 weights to the level of total output. The GDPO or IoP index (2001=100) was then multiplied by the 2001 level of output to calculate a time series of value added output in £2001m. Generally the more detailed the disaggregation of the data, the less robust the results are. Therefore, to ensure consistency with the more robust MDM industry data, output for the corresponding SSDA industries was scaled to add up to output of the MDM industry. In some cases the GDPO or IoP data were not available for the full time series, e.g. the IoP series to distinguish electrical engineering and instruments were only available as far back as 1978. In such cases, the change in the SSDA industry shares of MDM industry output was estimated over the period for which detailed data were available. Data were then constructed for the earlier years by applying SSDA industry shares of MDM output, assuming that the change in the industry shares in the earlier years followed the same trend as it did over the years for which detailed data were available.

The input–output supply and use tables, (SUTS), provide current price data for gross value added 1992-2002. Using these data the SSDA industry shares of MDM output were calculated, measured in current prices. To disaggregate the MDM industry into detailed SSDA industries, these shares were applied to the constant price output of the MDM industry. This methodology assumes that the changes in price for all of the SSDA industries were the same as for the MDM industry. Although this may not be a realistic assumption, no further data were available to construct more accurate estimates. As with the data constructed using GDPO and IoP series, the data for the earlier years (1971-91) were

constructed by applying SSDA industry shares of MDM output, assuming that the changes in the industry shares in these years followed the same trend as they did over the years for which detailed data were available (1994-2004).

3.14 Constructing the UK output forecasts for the detailed industries

Output series for sub-industries are forecast, taking account of past relative performance and the forecast for the related RMDM industry. The results are then scaled to the RMDM 41 industries at the UK level. The methodology used to create output forecasts for the regions for the new industries is described in Section 4. A RAS procedure is used to ensure consistency between UK and regional totals.[7]

The general rule used to construct the output forecast for the SSDA industries was the same as that used to construct the data in the years for which there was no detailed information. That is, to first calculate the average change in the SSDA industry shares in MDM industry output over the years for which there were complete data for the SSDA industries. Then the SSDA industry shares in MDM industry output were projected by assuming that the changes in the industry shares in the forecast years would follow the same trend as they did over the years for which there were detailed data. These projections of changes in industry shares were reviewed. If it was considered that the projected trends were not sustainable over the long-term, then the shares were adjusted to give an acceptable profile. The projections of industry shares were then applied to the MDM industry output to generate the forecasts of output by SSDA industry.

3.15 Employment data and forecasts for the detailed industries

Employment estimates for the detailed 67-level industries were based on information provided by ONS including the ABI. Details are given in Section 9.

The starting point is the forecasts of employment for the 41 industries produced from MDM as described above. The next step was to produce projections of total employment for the detailed 67-level industries consistent with the output forecasts for these industries and with the employment forecasts derived from the model.

There were three stages in producing forecasts for total (i.e. across all gender/status categories) employment for the 67 level industries:

- The historical productivity trend in the detailed industry relative to the corresponding MDM industry was extrapolated over the forecast period;
- These productivity estimates were used, together with the output forecasts for the detailed industries, to create initial estimates of total employment in these industries;
- These first estimates of total employment were then scaled to be consistent with the forecasts for the 41 MDM industries derived from the model.

[7] RAS is an iterative procedure to ensure elements in an array match row and column totals. For further details see Section 12.

Table 1: Disaggregation of MDM Industries to Detailed Industries

MDM41	Ind67	Ind67 name	SIC2003	ONS series	Data available since	2001 Weights	Input-output data 1994-2004
1	1	Agriculture	01	GDPO, constant price, 2001=100	1948-	yes	yes
1	2	Forestry	02	GDPO, constant price, 2001=100	1948-	yes	yes
1	3	Fishing	05	GDPO, constant price, 2001=100	1948-	yes	yes
3	5	Oil and gas	11	n/a	n/a	n/a	n/a
3	6	Uranium mining	12	n/a	n/a	n/a	n/a
4	7	Metal ores	13	n/a	n/a	n/a	yes
4	8	Other mining	14	IoP, constant price, 2001=100	1978-	yes	yes
5	9	Food	15.1-15.8	IoP, constant price, 2001=100	1986-	yes	yes
5	10	Drink	15.9	IoP, constant price, 2001=100	1986-	yes	yes
5	11	Tobacco	16	IoP, constant price, 2001=100	1986-	yes	yes
6	12	Textiles	17	IoP, constant price, 2001=100	1978-	yes	yes
6	13	Clothing	18	IoP, constant price, 2001=100	1978-	yes	yes
6	14	Leather	19	IoP, constant price, 2001=100	1948-	yes	yes
7	15	Wood and wood products	20	IoP, constant price, 2001=100	1948-	yes	yes
7	16	Paper and paper products	21	IoP, constant price, 2001=100	1978-	yes	yes
17	26	Computers and office machinery	30	IoP, constant price, 2001=100	1978-	yes	yes
17	28	TV and radio	32	IoP, constant price, 2001=100	1978-	yes	yes
18	27	Electrical engineering	31	IoP, constant price, 2001=100	1978-	yes	yes
18	29	Instruments	33	IoP, constant price, 2001=100	1978-	yes	yes
20	31	Aerospace	35.3		1978-	yes	yes
20	32	Other transport equipment	35 (ex 35.3)		Only for SIC 35: 1978-	yes	yes
21	33	Manufacturing nes	36	IoP, constant price, 2001=100	1978-	yes	yes
21	34	Recycling	37	IoP, constant price, 2001=100	1994-	yes	yes
26	39	Distribution relating to motors	50	GDPO, constant price, 2001=100	1978-	yes	yes
26	40	Distribution nes	51	GDPO, constant price, 2001=100	1973-	yes	yes
29	43	Rail transport	60.1		Only for SIC 60: 1986-	yes	yes
29	44	Other land transport	60.2, 60.3		Only for SIC 60: 1986-	yes	yes
29	47	Other transport services	63		1986-	yes	yes
32	48	Postal and courier services	64.1		Only for SIC 64: 1948-	yes	yes
32	49	Telecommunications	64.2		Only for SIC 64: 1948-	yes	yes
33	50	Banking and Finance	67	GDPO, constant price, 2001=100	1968-	yes	yes
33	52	Financial support services	73	GDPO, constant price, 2001=100	1973-	yes	yes
36	53	Real estate	70		1973-	yes	yes
36	54	Renting of goods	71		Only for SIC 74:1976-	yes	yes
36	56	Research and development	73		1973-	yes	yes
36	57	Professional services nes	74.1-74.4		1978-	yes	yes
41	62	Waste disposal	90	GDPO, constant price, 2001=100	1978-	yes	yes
41	63	Membership organisations	91	GDPO, constant price, 2001=100	1986-	yes	yes
41	64	Culture and sport	92	GDPO, constant price, 2001=100	1948-	yes	yes
41	65	Other services	93	GDPO, constant price, 2001=100	1986-	yes	yes
41	66	Private household	95	GDPO, constant price, 2001=100	1986-	yes	yes
41	67	Extra-territorial organisations	99	n/a	n/a	n/a	n/a

Sources: a) GDPO, Constant price, 2001 prices, 2001=100, Input-Output Supply and Use tables,
b) Current price GVA £m, Constant price, 2001 prices, 2001=100 Input-Output Supply and Use tables,
c) n/a indicates not applicable.

The final stage of producing UK employment forecasts at the detailed 67-level was the construction of employment projections by type (gender/status). Again there were three stages:

- Historical trends in the proportions of employment by type in total employment were extrapolated over the forecast period, taking care to reduce the speed of increase/decline in the share in cases where the proportions were approaching either zero or one;
- These proportions were applied to the projections of total employment in the industry concerned to generate initial estimates of employment by type;
- These initial estimates of employment by type in each industry were made consistent with total employment in the industry and employment by type in the corresponding MDM industry. These were achieved by scaling the results in blocks (RAS).
- In a number of cases, including: construction; hotels and catering; and computing services, proportions by gender/status were assumed to be fixed at 2002 levels, since extrapolation of recent trends led to implausible outcomes.

4 Modelling the Regional Dimension

4.1 Modelling the UK Regional Economies

A distinctive feature of the regional data and forecasts is that they are based on a fully specified and coherent model of the UK regional economies. The regionalized version of MDM (RMDM) and the data underlying the regional analysis were developed by Cambridge Econometrics.

The model has a clear economic structure allowing incorporation of incomplete and partial data in a similar manner to the procedure followed in general equilibrium modelling, but at the same time validating the model's projections against the available data for employment and output. RMDM is a development of the Cambridge Multisectoral Dynamic Model of the UK economy (MDM). Barker and Peterson (1987) provide an account of version 6 of the model and Barker et al (2001) provide a recent account of the RMDM. The latter is a time-series, cross-section (input-output) model distinguishing, *inter alia*, 41 industries and 51 categories of household expenditure. The constituent countries of the UK and the English regions are treated as one of several classifications in the model, with several commodity, industry and employment variables regionalised according to the availability of data. The current version of the model (MDM01R1) has been re-estimated on the latest Regional Accounts data and the 2004 National Accounts (chained volume measures with reference year 2001) using a consistent 2001 input-output table and classification converters.

4.2 Development of a UK Regional Econometric Input-Output Model

Due to the absence of inter-regional trade data and the generally poor quality of regional data, a model of the regional economies of the UK with significant economic content inevitably entails a substantial exercise in data construction. Some considerable reduction of data requirements can be made by adopting Leontief's approach, in which each region trades with all the rest as a group rather than with each other region separately, but there remains a need for data on each region's exports and imports in total. The data requirements involved in a full inter-regional model are of a higher order of magnitude (Polenske, 1980). However the approach does allow important economic relationships to be embedded in the model. For example, in the input-output model, regional output can be determined from regional exports and domestic demand (depending on tradability); and regional employment can be determined from output.

The construction of such a model has been ambitious in relation to the available data and the resources required. The approach has been to build up a regional econometric input-output model and database, as an integral part of the MDM model and MDM database. The model has a clear economic and accounting structure, uses incomplete and partial data, and applies techniques drawn from general equilibrium modelling. The forecasts and projections for the recent past are calibrated so as to reproduce the available data for employment and output. A sensible direction of economic causation for employment is an inherent feature of the model.

An important guiding principle is that the classifications adopted in the regional submodel are as far as possible those of MDM, and that the regional variables and data are consistent with the UK variables and data. This means that a 41-industry classification has been adopted for the commodity and industry variables in the regionalised MDM (such as gross output, GVA, employment, regional exports and imports).

4.3 Advantages of Modelling the Regional Markets

Regional output responds to changes in regional final demand. Thus, for example, the link between a slump in household spending in the South East and output in the same region, or other regions, is explicitly identified.

The treatment allows the calculation of full regional accounting balances for commodity supply and demand, exactly corresponding to the balances for the whole UK including the Continental Shelf. These balances cover inter-regional trade and an allocation of the UK commodity imbalances across the regions. They are in current prices and chained volume measures (CVMs), under the assumption that annual changes in prices for each commodity are the same for all the regions. These commodity balances provide an important consistency check on any forecasts of regional output and the components of regional final demand.

The approach also allows full feedback from the regional economies to the UK economy. This facility is especially important in modelling those areas of economic life where markets are restricted by costs of travel or other costs associated with distance. For example, it is clear from the data that there are distinct regional differences in patterns of saving and spending; this approach allows total household expenditure by region to be estimated and solved and UK household expenditure to be formed as the sum of the regional expenditures. Another example is in the operations of the labour market which tend to be restricted to travel-to-work areas; here it has been possible to estimate regional employment and wage rate equations to reflect different conditions in each of the regional labour markets. UK employment and the UK rate of wage inflation can then, in principle, be derived from the regional rates.

Such feedbacks, however, are an option in the software and in the current version of the model they are only operative in the case of employment. The regional forecasts depend on the UK forecasts and if necessary they are scaled to add up to the UK forecasts.

4.4 Incorporation of Distance and Location Effects

In the regionalised MDM, distance and location have three main influences:

- Economic distance determines the regional export activity indices, such that the closer one region is to another in economic distance, the more its domestic demand affects the other region's exports;
- For certain location-based activities, such as transport and distribution, the location of the infrastructure in the form of transport links and warehousing determines the regional supply;
- The locations of large new investment projects, e.g. tidal barrages, are introduced directly into the regional investment projections.

4.5 Inter-Industry Links and the Use of Partial Regional Information

One of the great strengths of I-O models is their simulation of inter-industry links, allowing the calculation of industrial multiplier effects. These multipliers show the effects on the industrial structure of changes in exogenous variables, or in behaviour, for example an increase in the propensity to save in one particular region. They show, under simplifying assumptions, how extra demand is transmitted from one industry to another. For example increases in output of cars from the Nissan plant in Sunderland will have effects on suppliers of parts, and in turn effects on steel and glass production and imports.

It is also much easier to incorporate partial and incomplete information into a fully specified economic model than into a reduced form model. For example, estimates are available for costs and impacts of infrastructure projects such as the Channel Tunnel rail link or the Severn Barrage. These will have strong regional effects. If investment is fully specified in the model, such exogenous increases can be introduced explicitly into the forecast. Similarly, estimates of the local multiplier effects of, for example, the Nissan car plant in Sunderland can be directly implemented in the model.

4.6 Problems with Regional Data

This approach has not been adopted by most forecasters, despite the obvious advantages, because of the poor quality (if not the absence) of much of the required regional data. In developing a regional model for the UK, the data problems have been tackled as follows.

Where the data are of suspect quality, three checks have been done. First, all sources have been used to cross-check data where possible. Second, the UK totals have been used to control the regional data in as much detail as possible. And third, the views of regional experts are sought.

Where no data exist, they have been imputed from other regional data, as in the case of trade flows, or from UK data, as in the case of the input-output coefficients. The methods adopted have been applied systematically for all the Government Office Regions and this provides a further check in the case of Scotland, Wales and Northern Ireland, where more detailed data are available.

4.7 Commodity and Trade Balances in the Regional Model

The model comprises: the accounting balances; the various fixed allocations to the regions of UK government expenditure, stock levels and commodity residuals; and 7 sets of time-series econometric equations (commodity exports, total household expenditure, disaggregated household expenditure, industrial fixed investment, industrial employment, industrial wage rates and population change). In general, the regional equations follow their UK counterparts in terms of the explanatory variables, with the UK totals added as a further variable.

Commodity balances for each region are given by equating regional output plus imports (commodity supply) with commodity demand, where the values for the components are chained volume measures with reference year 2001. Regional demand for each commodity comprises household expenditure, government final current expenditure, investment in fixed assets, exports, industrial absorption, stockbuilding, and residual imbalance. The latter term is determined by the aggregate UK commodity imbalance, which is allocated across the regions according to their share in total supplies. Using the current price magnitudes of the supply and demand components, regional commodity balances can be expressed in current prices.

There is also an accounting balance for net regional trade (the inter-regional export-import balance) and UK trade with the rest of the world. In other words, taking all UK regions together, regional imports plus imports of the rest of the world (i.e. UK exports) are equal to regional exports plus exports of the rest of the world (i.e. UK imports). This balance is enforced in the projections of the model, as an adding-up constraint on regional exports.

4.8 Employment

Employment is treated as a demand for labour, derived from the regional demand for goods and services. Regional employment equations were estimated, relating industrial employment in each industry to its output in the region, to wage rates in the region relative to output prices and to national variables such as average hours worked. Long-run cointegrating relationships were identified and estimated and dynamic error-correction equations estimated to allow for short-run effects. In general the equations were well determined and the parameters were of the expected sign and magnitude.

4.9 Average Wage Rates

In general, wage rates in the UK are formed as the outcome of a bargaining process between employers, sometimes organised into employer organisations, and employees, sometimes organised into trade unions. The government affects the process as a major employer and as a source of legislation affecting all aspects of the process: the legal standing of the parties; the taxes imposed at various stages in the earning and spending of

wages; the provision of benefits to the unemployed and the non-employed; and the direct legislation of permitted or recommended wage rates via income policies or minimum wages. The dependent variable in the wage equation in RMDM is the gross nominal wage, that is, the contractual wage which is a common component of real wages for the main players in the labour market. The external influences on wage bargaining in an industry are divided into those from other industries in the same region, and those from the same industry in other regions. Regional average wage rates by industry are also determined by national price inflation, benefit rates and regional unemployment rates. The treatment was described in more detail in Cambridge Econometrics (1996).

4.10 Data for Regional Employment, Unemployment and Nominal GVA

The model and forecast are based on the latest National Accounts (chained volume measures with reference year 2001) and a consistent 2001 input-output table. The ONS publishes annually a series of Regional Accounts consistent with the UK National Accounts. Regional Accounts data published in December 2004 and consistent with the 2004 National Accounts have been incorporated in the forecasts.

Data for nominal GVA, household expenditure and household incomes are included for the Government Office regions, Wales, Scotland and Northern Ireland. These data are available only since 1989. Previous regional accounts (for Standard Statistical regions) have been available since 1971 with some disaggregated series available only since 1978. Some data at disaggregated level exist for 1971-78 but these are on the 1968 SIC and much other data are on the 1980 SIC; in the process of creating long-term series these were all translated to 2003 SIC categories and Government Office regions.

The source for employment and unemployment data is also the ONS. Employment is defined as the total of employees in employment, self-employment and HM Forces and is the June count seasonally unadjusted. Unemployment is defined by the annual average, seasonally adjusted, of benefit claimants aged 18 and over. Other data such as regional population, working-age population and migration are obtained from the ONS and the Registrars General for Scotland and Northern Ireland.

4.11 Processing the Regional output data

GVA data for the regions were obtained from the ONS for some 30 sectors. These data were disaggregated to the MDM 41 industries using information from other sources, such the census of production and the ABI, and information from the more detailed employment data and other detailed information available for the UK. Current price data at the 41 industry level were deflated using the corresponding national deflators.

4.12 Constructing Regional Employment Data for the detailed industries

The regional employment data were based on official estimates published by ONS. Detailed estimates for employees in employment for the 67 categories drew upon ABI data. These were used to expand the more aggregate data to the full set of 67 industries. Self employment estimates for detailed industries were based on an assumption of common ratios of self employment to employees to those at more aggregate levels. A series of iterative RAS procedures were used to ensure that the final data set was consistent with all totals published by ONS[8]. Further details of the development of the employment database are given in Section 11.

[8] RAS procedures are described in Section 12.

4.13 Econometric Modelling of Employment at Regional Level

Regional econometric modelling adopts the same procedures as at the UK level, and as outlined in general terms in Section 4.9 above. The employment measure used is establishment based (workplace/jobs), as described in Section 4.10. These estimates are consistent with the official ONS published figures. Output is the residence based GVA measure, as summarized in Section 4.10. This is again consistent with the official ONS published data. There are no official estimates of output by sector on an establishment basis, although aggregate measures across all sectors are available. In practice, GVA under both definitions is essentially the same in all regions apart from London, South East and East of England. The discrepancy is highest for London and East of England, reflecting the significance of large commuting flows.

Although not ideal from a modelling perspective, this slight difference in spatial coverage of the employment and output measures does not have any major consequences for the modelling and projection of employment, since any changes in the short- or long-run relationship between (workplace-based) employment and (residence-based) output will be captured by changes in the other variables in the model (wages, hours and the time trend) and in the error term. The systematic component of the relationship is captured within the model coefficients. This implicitly assumes no significant changes in commuting patterns between countries and regions within the UK that are not captured implicitly by such measures.

4.14 Regional Employment forecasts for the detailed industries

Regional estimates for the 67 sectors were obtained by analogous methods to those for the UK. These used historical trends to obtain initial estimates. A RAS procedure was then used to ensure consistency with regional and UK totals for more aggregate sectors.[9]

Regional employment forecasts for the 67 industries were created as follows:

- Historical trends in proportions in employment in the detailed industry relative to the corresponding MDM industry for each region were extrapolated over the forecast period to create initial estimates of total employment;
- These estimates were made consistent with the UK projections for the detailed sectors and the regional projections for the MDM sectors;
- Historical trends in employment by type (gender/status) were used to make initial projections of employment by type in the regions;
- Results were made consistent across the regions and across type of employment, with the forecasts for the 41 industries and the UK projections of employment by type.

4.15 Regional Output data and projections for the detailed industries

For output, initial estimates were created using regional employment for the detailed sectors and relative UK productivity for these sectors

These initial estimates were then made consistent with the UK results for the detailed sectors and the output projections from the model for the 41 industries in the regions. The resulting forecast for output series were checked to ensure that they were plausible compared with the trends in the historical data.

[9] RAS is an iterative procedure to ensure elements in an array match row and column totals. For further details see Section 12.

4.16 Projections for the LLSCs

The LLSC projections were developed in a similar fashion.

- The total employment forecasts for the LLSCs for the 41 sectors were produced using historical relationships with the equivalent UK or regional category;
- Employment forecast for the LLSCs by gender and status, for the 41 sectors, were created using multi-local area procedures as developed by CE/IER for the Local Economy Forecasting Model (LEFM). These procedures have as a starting point historical trends in employment by gender and status in the LLSCs and the UK and regional forecasts for the 41 industries by gender and status;
- The employment data and forecasts were expanded to cover the additional sectors (67 in total) using similar methods to creating forecasts for the 67 regional sectors.

Further details are given in Section 11 below.

5 Labour Supply

5.1 Introduction

This section describes the methodology used to develop CE's Multi-Sectoral Dynamic Model of the UK economy (MDM) to provide more detailed projections of economic activity rates, labour supply and unemployment, for each of the Countries and Regions of the UK. The projections provide an aggregate analysis, focussing upon total labour supply by gender but not distinguishing age. The full CE model, as described below, also includes a breakdown by age but this additional information is not included in the *Working Futures 2004-2014* projections.

5.2 Specification of the regional model

The key stages to determine the labour supply indicators

A new set of stochastic equations to forecast economic activity rates by region and age-band/gender has been estimated and incorporated into MDM. The specification of the equations draws upon earlier work that IER undertook on behalf of DfEE[10] which underlies the systems currently used by DfES to construct the official projections of economic activity rates published in *Labour Market Trends.*[11] The remainder of the model required to construct the projections of labour supply indicators consists of a number of accounting equations to derive labour supply and unemployment from the existing labour market and demographic projections in MDM.

The key stages to determine the labour supply indicators can be summarised as follows:

- workplace based employment jobs is determined using the existing MDM equations (see Section 4);
- the regional labour force is determined by activity rates multiplied by the population of working-age;
- regional activity rates (by age-band/gender) are modelled as a function of unemployment and other variables, e.g. house prices relative to wages
- regional unemployment (ILO) = is determined from regional unemployment (claimant count);
- the Labour Force Survey measure of employment (employed residents) is determined from regional labour force minus regional unemployment (ILO);
- the labour market residual (one component of which is net commuting) is determined from workplace employment minus the Labour Force Survey measure of employment (employed residents).

Box 5.1 presents definitions of the various terms used. The model is expressed more formally in the remainder of this section.

[10] Briscoe, G and R Wilson (1992) 'Forecasting economic activity rates', *International Journal of Forecasting*, pp201-217.

[11] The most recent official projections were published in 1998 (*Labour Market Trends*, June, pp 281-297). ONS states that revised United Kingdom projections will be published in mid-2005; it is not known when updated regional projections will be published.

Key to prefixes and variable names

The prefixes used and the variable names are as follows:

LA	7 age-bands (0-15; 16-24; 25-34; 35-44; 45-59; 60-64; 65+) and 2 genders
L	2 gender categories
R	12 English Government Office Regions, Wales, Scotland and Northern Ireland
RLAW	Working-age population by region and age-band/gender
RLAE	Economic activity rates by region and age-band/gender
RLAF	Labour force (as reported by LFS) by region and age-band/gender
RLF	Labour force (as reported by LFS) by region and gender
RLIU	ILO unemployment by region and gender
RLUN	ILO unemployment rate by region and gender
RLGT	Work-related government training by gender (exogenous)
RLE	Employment (as reported by LFS) by region and gender
RE	Employment (workplace-based) by region and type
RLRS	Labour market residual by region and gender
RUNE	Claimant count unemployment by region
UNEM	Claimant unemployment (scalar)
UNER	Residual between claimant and ILO unemployment levels

Construction of historical data

Historical data are determined as follows:

- RLE = RLF-RLGT-RLIU
- RLRS = sum to genders (RE) – RLE
- RLAE = RLAF/RLAW
- RLUN = 100*RLIU/RLF
- UNER = sum across regions and genders (RLIU) – UNEM

Derivation of the projections

The projections are derived as follows:

RLIU = f(RUNE)

RLUN = 100*RLIU/RLF

RLAE = f(RLIU, other variables such as house prices relative to wages)

RLAF = RLAE*RLAW

RLF = sum across age-bands (RLAF)

RLE = RLF – RLUN

RLRS = RE – RLE

As noted above, the difference between the Labour Force Survey (LFS) measure and the workforce measure of employment is accounted for in the labour market residual (RLRS). As the LFS is a survey of private households, employment estimates reflect the area of residence of people with jobs. The surveys used to compile the workforce estimates of employment are surveys of employers, and so the figures at a regional level reflect the location of workplace and jobs, not the place of residence of the worker. One element of the labour market residual is therefore net commuting which results from people travelling from

their place of residence, across regional boundaries to their place of work. Both the LFS and the workplace measures of employment are determined in the model and the labour market residual is calculated as the difference. Differences between the labour supply and labour demand pictures are taken up in the labour market accounts residuals, including net commuting across geographical boundaries and "double jobbing".

In MDM, total working-age population for each region is determined by the natural increase in working-age population plus net working-age migration. Regional in and out-migration of working-age population are both assumed to be affected by the same economic factors. The migration is modelled as occurring from the region to the outside world and vice versa. The explanatory variables used include a measure of regional surplus labour relative to the UK, the mortgage rate, relative wages and a linear time trend.

ONS projections of population are used to calculate shares by gender and by age-band. These shares are applied to the MDM forecasts of total population to produce projections of population by gender and by age-band.

5.3 Estimation of the regional equations and programming the model code

The exact form of the stochastic equations to forecast the economic activity rates by region and age-band/gender (RLAE) includes a number of explanatory variables including unemployment. These are generally *regional*-specific variables, rather than age-band/gender specific. The differences between age-bands/genders are picked up in a constant specific to those groups. A strong effect coming from the characteristics of the region is incorporated (notably, how tight the labour market is, and how expensive it is to live there). The equations are estimated across regions, since that is where the variation is largest.

The equations are estimated using the Ox software and the model solution is programmed in FORTRAN. The estimation and model solution procedures are programmed in a common framework, with software facilities incorporated for checking the results and identifying errors.

The full set of labour supply equations has not yet been implemented. Once this is completed it will alter some of the results slightly. However, estimates of employment: are unlikely to be changed by this model development. Unemployment is also unlikely to be changed. There will be some amendments to the estimates of the labour force. Total population and working-age population estimates will be affected (the final estimates will incorporate the latest 2003-based population projections). Differences between the labour supply and labour demand pictures will be taken up in the labour market accounts residuals, including net commuting across geographical boundaries.

5.4 Labour Force Projections for the LLSCs

The projections of the labour force by Local Learning and Skills Council (LLSC) area built up from projections made at unitary authority (UA) and local authority district (LAD) level. The projections are produced by age-band (0-15, 16-24, 25-34, 35-44, 45-59, 60-64, 65+) and gender for each UA/LAD, and are then aggregated to labour force by gender for each LLSC area.

The starting point for the projections are the 2001 Census of Population activity rates by age band and gender for each UA/LAD. These activity rates are projected forwards, to 2014, using the activity rate projections for the appropriate Government Office Region (GOR), as produced by Cambridge Econometrics' (CE) Regionalised Multi-Sectoral-Dynamic (MDM) model of the UK economy.

These activity rate data and projections are then applied to Office for National Statistics (ONS) 2003-based sub-regional population projections (by age-band, gender and UA/LAD) to generate labour force estimates for 2001-2015. The ONS population projections for

UA/LAD have been updated with the latest mid-year population estimates to 2003 and have been made consistent to CE's regional population projections constructed by MDM.

The final projections of the labour force by age-band, gender for the UA/LADs are then aggregated to provide labour force by gender for the LLSCs.

Box 5.1: Definitions of Employment and Related Labour Market Indicators

Alternative Definitions
There are various ways of looking at employment. For example, a distinction can be made between the number of people in employment (head count) and the number of jobs. These two concepts represent different things, as one person may hold more than one job. In addition, a further distinction can be made between area of residence and area of workplace. Similarly there are various different definitions of unemployment, the labour force, workforce and population. In *Working Futures 2004-2014* the following definitions are used:

Residence basis: measured at place of residence (as in the Labour Force Survey (LFS)).
Workplace basis: measured at place of work (as in the Annual Business Inquiry (ABI)).

Workplace employment (number of jobs): these are typically estimated using surveys of employers, such as the ABI, focussing upon of the numbers of jobs in their establishments. In this report references to employment relate to the number of jobs unless otherwise stated.
Employed residents (head count): the number of people in employment. These estimates are based primarily on data collected in household surveys, e.g. the LFS. People are classified according to their main job. Some have more than one job.

ILO unemployment: covers people who are out of work, want a job, have actively sought work in the previous four weeks and are available to start work within the next fortnight (or out of work and have accepted a job that they are waiting to start in the next fortnight).
Claimant Unemployed: measures people claiming Job Seeker's Allowance benefits.

Workforce: the total number of workforce jobs, and is obtained by summing workplace employment (employee jobs and self-employment jobs), HM Forces, government-supported trainees and claimant unemployment.
Labour Force: employed residents plus ILO unemployment.
Labour market participation or **Economic activity rate**: the number of people who are in employment or (ILO) unemployed as a percentage of the total population aged 16 and over.

Labour Market Accounts Residual: workplace employment minus Residence employment. The main cause of the residual at national level is "double jobbing". At a more disaggregated spatial level, net commuting across geographical boundaries is also very significant. The difference will also reflect data errors and other minor differences in data collection methods in the various sources.

Total Population: the total number of people resident in an area (residence basis).
Population 16+: the total number of people aged 16 and above (residence basis).
Working-age population: the total number of people aged 16-65 (males) or 16-60 (females), (residence basis).

6. Detailed Industry Categories and Choice of Sectors for Reporting

6.1 Background

The sectoral analysis derives directly from the multi-sectoral regional macroeconomic model of the economy (RMDM) as described in Sections 3 and 4. This extended version of MDM was used to generate estimates for output and productivity for the main industrial sectors and projections of total employment by industry at a regional level. The industries used are based on the 2003 Standard Industrial Classification (SIC). In all, 41 industries are distinguished in the standard version of RMDM, as set out in Table 2.

The estimates and projections of employment produced are consistent with official data published by the Office for National Statistics (ONS). The latest figures incorporate information from the 2003 Annual Business Inquiry (ABI) and its predecessors (as published in *Labour Market Trends*). Further details of general data sources are given in Section 13 below, while a full description of the employment Database is provided in Section 12.

6.2 Extension of the number of industries in the models

The standard version of RMDM provides forecasts for 41 industries, covering the Government Office Regions (GORs) of England, as well as Wales, Scotland and Northern Ireland. These were extended to form the basis for a disaggregated set of projections of sectors at the more detailed SIC2003 2-digit level. These, more detailed, 67 industries are shown in Table 3. This was achieved using a sub-modelling approach linking the two industrial classifications, as described in Sections 3 and 4. The methodology ensures that the results of the sub-model of SIC2003 2-digit outcomes are consistent, both with existing historical data at 2-digit level and the forecast results for the 41 industries produced by the RMDM. Historical data for output for sub-industries were created for the UK using available information from time series data and/or from information derived from the ONS input-output tables. Regional series were created consistent with the UK data and using available information for the regions.

Further details about how the historical ***Database*** was developed are provided in Section 9. The remainder of this section presents the various industrial and sectoral classifications used for reporting.

6.3 Treatment of results for Sector Skills Councils

The Skills for Business network has involved the setting up of a number of new Sector Skills Councils (SSCs). These organizations are charged with representing the views of employers in the areas they cover on all matters pertaining to skills. Following discussions with the SSDA, "footprints" for the SSCs, based on their coverage in terms of SIC categories has now been agreed. [12]

In all cases the SSCs "footprint" agreed with the SSDA has now been in terms of the Standard Industrial Classification based on existing 4 digit SIC codes. In some cases, SSCs have a footprint that is better defined by reference to occupational rather than industrial categories. No attempt is made here to define the SSCs in this way.

Generally speaking, historical data time series data do not exist for these categories.

[12] For details see Table 5.

However the detailed results available from the *Working Futures 2004-2014* database enable an initial assessment to be made of both historical trends and future prospects for these categories. This is done by combining together the results from the 67 detailed industries which underlie the results presented above. These have the advantage of being based on a consistent assessment of the demand for the goods and services provided by these various industries, taking into account the situation across all industries simultaneously.

Ideally, this would require that the *Working Futures 2004-2014* database of employment data be defined at the same 4-digit level. In practice the current database is not quite as detailed as this. The 67 industry-level data does however get quite close to what is needed in most cases. Where more detailed information is needed ABI and LFS data have been used to construct a detailed map from the 67-level categories to SSCs. Some 67-level categories are split between SSCs based on shares taken from the ABI or the LFS. Effectively, a set of fixed convertors are used to translate from SIC to SSC categories.

The employee convertors are constructed using data from the ABI 2003. For self-employment various LFS data are used, (Sep-Nov 2002, 2003 and 2004 averaged). In a few cases the LFS does not distinguish relevant SIC categories in sufficient detail. In such cases the results for full-time employees are used to develop the relevant convertor. The conversion from 67 industries to SSC is therefore done using 6 convertors in total, distinguishing male and female by employment status (FTE/PTE/SE).

SIC '45 Construction' is divided between SSCs ConstructionSkills and SummitSkills. SummitSkills includes '45.31 Installation of electrical wiring and fittings' and '45.33'Plumbing'. The LFS does not give any breakdown of SIC 45. In this case the full-time employee proportion is used to allocate between the two SSCs. SIC '51 Wholesale Trade' is divided between 3 SSCs but with most, (about 86 per cent) of employees, going to the unallocated, non-SSC category. Again the LFS does not make a proper distinction within SIC 51 and the full-time employee proportion from the ABI is used to allocate between the three SSCs and the unallocated non-SSC groups.

Table 5 below shows how the footprints of the SSCs have been defined in terms of SIC2003. There is a quite large part of employment that is not represented by an SSC *per se*. These are allocated to 3 other industry groupings.

When employment in all SSCs is added together plus the three otherwise unallocated categories, the result sums to total employment.

Despite these refinements, the conversion process is necessarily rather crude. This is necessary in order to achieve a consistent picture across all the other dimensions of employment considered in *Working Futures 2004-2014*.

The *Working Futures 2004-2014* database is designed to match headline constraints at regional, sectoral and other levels but it cannot replicate every nuance of the LFS. Point estimates based on the LFS for a particular SSCs employment structure will therefore inevitably differ from the detailed estimates presented here. These differences will reflect in part "noise in the data" (the LFS sample, although large in total, is often not adequate to guarantee very precise estimates at a detailed sectoral level, especially when cross-classified by other dimensions). The *Working Futures 2004-2014* results by SSC should however offer a useful guide to trends over time, especially for the future.

In terms of employment coverage the largest SSCs are *Construction Skills*, *Skillsmart retail*, *People 1st* and *Skills for Health*, each of which covers over 2 million people. A number of other SSCs represent over a million, including *SEMTA* which is the largest SSC covering

manufacturing type industries. Over 6 million are not covered by an SSC as such, the most significant of these being represented by the category Non-SSC employers (Business and Public services).

6.4 Choice of Sectors for analysis and reporting

Given the large number of stakeholders with an interest in the findings from this project, a variety of outputs have been designed. The detail to be provided in the various reports reflects various considerations (including those outlined in Sections 12 and 13 below):

- Confidentiality
- Statistical robustness and precision
- Practical considerations, including transparency and digestibility.

6.5 Reporting at national (UK) level

The SSDA have adopted 27 industry categories for their *Sector Matrix*. As opposed to the SSCs, these Sector Matrix Industries (SMIs) categories are defined precisely in terms of the SIC2003. They are shown in Table 4. These categories are the main ones used for UK National reporting of the *Working Futures 2004-2014* projections. Results based on SSCs are reported in the *Sectoral Report.*

The 27-fold categorization has obvious attractions from the point of view of consistency with the previous set of *Working Futures 2004-2014* results as well as various other activities the SSDA and LSC have been engaged in. However, a number of the categories used in Table 4 (and also in Table 1c) are very small (notably mining & quarrying, wood & paper, manufacturing n.e.s., and electricity, gas & water). These pose problems in terms of obtaining statistically reliable historical and projected employment data, especially when breaks are required by occupation.

The 27 industry level of detail shown in Table 4 is within the guidelines adopted by ONS for headline statistics on employment (i.e. total numbers of employees). The concern here is that within the *National Report*, SSDA required even more detailed breaks within these categories (e.g. by gender and status, especially self-employment and by detailed occupation category). This stretches the data well beyond the limits which ONS would normally regard as acceptable for statistical purposes and for publishing as authoritative estimates, with a “public” seal of approval.

For the purpose of reporting the projections in the *National Report* (for the UK), a slightly more aggregated set of categories (as shown in Table 6) was adopted. There are 25 industries here, most of which correspond to those in Table 4. Even so, categories 2 (mining & quarrying and utilities), 4 (textiles and clothing) and 10 (manufacturing n.e.s) remain uncomfortably small, especially when reporting on breaks by occupation. As noted in Section 14, ONS recommend using minimum cell sizes of 10,000 (grossed up), when presenting data based on the LFS. Given that there are 25 occupations to be distinguished in each sector, this suggests a minimum size for an industry **at UK level** of at least 250,000.

6.6 Reporting at Sectoral level

In addition, the categories defined by the footprints of the new SSCs as described in the previous section are becoming increasingly used. The LSC have adopted the SSC categories in their latest *National Employer Skills Survey.* The *Sectoral Report* focuses on this set of categories.

6.7 Reporting at regional level

At regional level, the categories published by ONS for "Government Office Regions" are shown in Table 7. These are even more aggregated than those for the UK for obvious reasons. This level of categorization does not present *any* detail for manufacturing industries.

In order to provide *some* detail within manufacturing, the categories set out in Table 8 were developed in *Working Futures 2002-2012*. These allow for some sub-manufacturing detail, while maintaining the minimum cell sizes required for statistical reliability across the regional dimension. Note that these are **NOT** those based on the groupings used by ONS for the "Standard Regions". The latter do not correspond very closely with the aggregations used in Table 6. In particular, the DL category adopted by ONS cuts across the engineering grouping used there. ONS category DL includes only SIC 1992 sectors 30-33, with mechanical engineering (SIC 1992, 29) included in the remainder of manufacturing. The DL category and the residual "remainder of D" adopted by ONS, have therefore been replaced by two categories based on aggregations of those used in Table 6. As shown in Table 8, it is possible to define "engineering" (category 4, DL+, in Table 8, and the corresponding residual of the remainder of manufacturing).

These guidelines potentially involve a number of "cells" below the 10,000 minimum cell size advocated in Section 14. Care needs to be taken in interpreting such estimates, especially trends over time. It is not possible to present detailed data for all the sectors in Table 8, as noted in the footnotes to that Table.

6.8 Headline reporting at national (UK) level

For summary/ headline reporting, on grounds of brevity, a 6-fold categorization is used. This is shown in Table 9. The purpose of the reporting at this level is to give an overview of the main sectoral developments rather than provide sectoral detail (which is presented later in the report). This was the main "aggregate" categorization used in previous reports produced for DfES, which facilitates comparison with previous analyses. It represents a practical compromise, which can be replicated across regions for comparability, without becoming too burdensome for the reader. Table 9 also shows the other groupings used in previous reports produced for DfES for comparison.

The more detailed 16-fold categorization used for the regions has also been adopted for selected tables in the *National Report*.

More detailed information by industry is available in the *National Report,* using the more detailed 25 fold and 67 fold aggregations described above. These are summarised in Tables 3 and 6.

The relationship between the broad sectors, 25/27 industries and 49 MDM industries is shown in Table 9a.

Table 9b shows the relationship between the 67 detailed industries and the 25-fold categorization.

Table 2: Classification of Industries in RMDM

Industries		SIC2003	25 industries	27 industries
1.	Agriculture	01,01,05	1	1
2.	Coal etc.	10	2	2
3.	Oil & Gas	11,12	2	2
4.	Other Mining	13,14	2	2
5.	Food, Drink & Tobacco	15, 16	3	3
6.	Textiles, Clothing & Leather	17, 18, 19	4	4
7.	Wood & Paper	20, 21	5	5
8.	Printing & Publishing	22	5	6
9.	Manufactured Fuels	23	6	7
10.	Pharmaceuticals	24.4	6	7
11.	Chemicals nes	24 (ex 24.4)	6	7
12.	Rubber & Plastics	25	6	7
13.	Non-Metallic Mineral Products	26	6	7
14.	Basic Metals	27	7	8
15.	Metal Goods	28	7	8
16.	Mechanical Engineering	29	8	9
17.	Electronics	30, 32	8	9
18.	Electrical Engineering & Instruments	31, 33	8	9
19.	Motor Vehicles	34	9	10
20.	Other Transport Equipment	35	9	10
21.	Manufacturing nes	36, 37	10	11
22.	Electricity	40.1	2	12
23.	Gas Supply	40.2, 40.3	2	12
24.	Water Supply	41	2	12
25.	Construction	45	11	13
26.	Distribution	50, 51	12, 13	14, 15
27.	Retailing	52	14	16
28.	Hotels & Catering	55	15	17
29.	Land Transport	60, 63	16	18
30.	Water Transport	61	16	18
31.	Air Transport	62	16	18
32.	Communications	64	17	19
33.	Banking & Finance	65, 67	18	20
34.	Insurance	66	18	20
35.	Computing Services	72	20	22
36.	Professional Services	70, 71, 73, 74.1-74.4	19	21
37.	Other Business Services	74.5-74.8	21	23
38.	Public Administration & Defence	75	22	24
39.	Education	80	23	25
40.	Health & Social Work	85	24	26
41.	Miscellaneous Services	90-99	25	27
42.	Unallocated			

Table 3: Classification of Industries in RMDM

Ind67	Ind67 name[13]	SIC2003	SAM41 (MDM)	25 industries
1	Agriculture	01	1	1
2	Forestry	02	1	1
3	Fishing	05	1	1
4	Coal mining	10	2	2
5	Oil and gas	11	3	2
6	Uranium mining	12	3	2
7	Metal ores	13	4	2
8	Other mining	14	4	2
9	Food	15.1-15.8	5	3
10	Drink	15.9	5	3
11	Tobacco	16	5	3
12	Textiles	17	6	4
13	Clothing	18	6	4
14	Leather	19	6	4
15	Wood and wood products	20	7	5
16	Paper and paper products	21	7	5
17	Publishing and printing	22	8	5
18	Manufactured fuels	23	9	6
19	Pharmaceuticals	24.4	10	6
20	Chemicals nes	24 (ex 24.4)	11	6
21	Rubber and plastics	25	12	6
22	Non-metallic mineral products	26	13	6
23	Basic metals	27	14	7
24	Metal goods	28	15	7
25	Mechanical engineering	29	16	8
26	Computers and office machinery	30	17	8
27	Electrical engineering	31	18	8
28	TV and radio	32	17	8
29	Instruments	33	18	8
30	Motor vehicles	34	19	9
31	Aerospace	35.3	20	9
32	Other transport equipment	35 (ex 35.3)	20	9
33	Manufacturing nes	36	21	10
34	Recycling	37	21	10
35	Electricity	40.1	22	2
36	Gas supply	40.2, 40.3	23	2
37	Water supply	41	24	2
38	Construction	45	25	11
39	Sale and maintenance of motor vehicles	50	26	12
40	Distribution nes	51	26	12
41	Retailing nes	52	27	14
42	Hotels and catering	55	28	15
43	Rail transport	60.1	29	15
44	Other land transport	60.2, 60.3	29	15
45	Water transport	61	30	15
46	Air transport	62	31	15
47	Other transport services	63	29	15
48	Post and courier services	64.1	32	16
49	Telecommunications	64.2	32	16
50	Banking and finance	65	33	18
51	Insurance	66	34	18
52	Financial support services	67	33	18
53	Real estate	70	36	19
54	Renting of goods	71	36	19
55	Computing services	72	35	20
56	Research and development	73	36	19
57	Professional services nes	74.1-74.4	36	21
58	Other business services	74.5-74.8	37	21
59	Public administration and defence	75	38	22
60	Education	80	39	23
61	Health and social work	85	40	24
62	Waste disposal	90	41	25
63	Membership organisations	91	41	25
64	Culture and sport	92	41	25
65	Other services	93	41	25
66	Private household	95	41	25
67	Extra-territorial organisations	99	41	25

[13] They are abbreviated from the full names used by ONS.

Table 4: Classification of 27 SSDA *Sector Matrix* Industries

	Industries	SIC2003
1.	Agriculture, etc	01-02, 05
2.	Mining & quarrying	10-14
3.	Food, drink & tobacco	15-16
4.	Textiles & clothing	17-19
5.	Wood, pulp & paper,	20-21
6.	Printing & publishing	22
7.	Chemicals, & non-metallic mineral products	23-26
8.	Metals & metal goods	27-28
9.	Machinery, electrical & optical equipment	29-33
10.	Transport equipment	34-35
11.	Other manufacturing & recycling	36-37
12.	Electricity, gas & water	40-41
13.	Construction	45
14.	Sale & maintenance of motor vehicles	50
15.	Wholesale distribution	51
16.	Retailing	52
17.	Hotels & restaurants	55
18.	Transport	60-63
19.	Communications	64
20.	Financial services	65-67
21.	Professional services	70, 71, 73
22.	Computing services	72
23.	Other business services	74
24.	Public administration & defence	75
25.	Education	80
26.	Health & social work	85
27.	Other services	90-99

Table 5: Defining SSCs in terms of SIC2003

SSCs		SIC2003
1	Lantra	01, 02, 05.02, 85.2, 92.53
2	Cogent	11, 23, 24.11-24.2, 24.41-24.63, 24.65,24.66, 25.13-25.24, 50.5
3	Proskills	10, 12-14, 21, 22.2, 24.3, 26.1, 26.26, 26.4-26.8, 40.3
4	Improve	15.11-15.91, 15.93-15.98, 51.38
5	Skillfast-UK	17-19, 24.7, 51.16, 51.24, 51.41, 51.42, 52.71, 93.01
6	SEMTA	25.11, 25.12, 27.4-28.3, 28.5-28.7, 29-35
7	Energy & Utility Skills	37, 40.1, 40.2, 41, 51.54, 51.55, 60.3, 90
8	ConstructionSkills	45.1, 45.2, 45.32, 45.34, 45.4, 45.5, 71.32, 74.2
9	SummitSkills	45.31, 45.33, 52.72
10	Automotive Skills	50.1-50.4, 71.1
11	Skillsmart Retail	52.1-52.6
12	People 1st	55.1, 55.21, 55.23, 55.3-55.5, 63.3, 92.33, 92.71
13	GoSkills	60.1, 60.21-60.23, 61, 62.1, 62.2, 63.2, 80.41
14	Skills for Logistics	60.24, 63.1, 63.4, 64.1
15	Financial Services Skills Council	65-67
16	Asset Skills	70, 74.7
17	e-skills UK	22.33, 64.2, 72, 74.86
18	Central Government	75.1, 75.21, 75.22, 75.25, 75.3
19	Skills for Justice	75.23, 75.24
20	Lifelong Learning UK	80.22, 80.3, 80.42, 92.51
21	Skills for Health	85.1
22	Skills for Care and Development	85.3
23	Skillset	22.32, 24.64, 74.81, 92.1, 92.2
24	Creative & Cultural Skills	22.14, 22.31, 36.3, 74.4, 92.31, 92.32, 92.34, 92.4, 92.52
25	SkillsActive	55.22, 92.6, 93.04
26	Non-SSC employers (Primary)	05.01, 15.92, 16, 20, 22.11-22.13, 22.15, 26.21-26.25, 26.3, 27.1-27.3, 28.4, 36.1, 36.2, 36.4-36.6
27	Non-SSC employers (Wholesale / Retail)	51.11-51.15, 51.17-51.23, 51.25-51.37, 51.39, 51.43-51.53, 51.56-51.90, 52.73, 52.74
28	Non-SSC employers (Business services / Public services)	62.3, 71.2, 71.31, 71.33, 71.34, 71.4, 73, 74.1, 74.3, 74.5, 74.6, 74.82, 74.85, 74.87, 80.10, 80.21, 91, 92.72, 93.02, 93.03, 93.05

Table 6: General Classification for Presenting Sectors in *National Report*

	Industries	SIC2003	MDM Industries
1.	Agriculture, etc	01-02, 05	1
2.	Mining & quarrying; Electricity, gas & water	10-14,40-41	2-4, 22-24
3.	Food, drink & tobacco	15-16	5,
4.	Textiles & clothing	17-19	6
5.	Wood, pulp & paper; Printing & publishing	20-22	7,8
6.	Chemicals, & non-metallic mineral products	23-26	9-13
7.	Metals & metal goods	27-28	14,15
8.	Machinery, electrical & optical equipment	29-33	16-18
9.	Transport equipment	34-35	19,20
10.	Other manufacturing & recycling	36-37	21
11.	Construction	45	25
12.	Sale & maintenance of motor vehicles	50	26 (part)
13.	Wholesale distribution	51	26 (part)
14.	Retailing	52	27
15.	Hotels & restaurants	55	28
16.	Transport	60-63	29-31
17.	Communications	64	32
18.	Financial services	65-67	33,34
19.	Professional services	70, 71,73	36 (part)
20.	Computing services	72	35
21.	Other business services	74	36 (part), 37
22.	Public administration & defence	75	38
23.	Education	80	39
24.	Health & social work	85	40
25.	Other services	90-99	41

Note: (a) Most of these sectors are identical to the 27 categories in Table 4. The exceptions are industries 2 and 5, which are aggregates of 2 such categories.

Table 7: Industries for which ONS supply data for the Government Office Regions (employees only)

		SIC 2003		SAM41 (MDM)
1	Agriculture, hunting, forestry, fishing	(AB)	01 to 05	1
2	Mining & quarrying	(C)	10-14	2-4
3	Manufacturing	(D)	15-37	5-21
4	Electricity gas & water supply	(E)	40/41	22-24
5	Construction	(F)	45	25
6	Personal household goods	(G)	50 to 52	26,27
7	Hotels & restaurants	(H)	55	28
8	Transport storage & communication	(I)	60 to 64	29-32
9	Financial intermediation	(J)	65 to 67	33,34
10	Real estate renting & business activities	(K)	70 to 74	35-37
11	Public admin. & defence; compulsory social security	(L)	75	38
12	Education	(M)	80	39
13	Health & social work	(N)	85	40
14	Other community, social & personal service activities; private households organisations & bodies	(O,P,Q)	90 to 99	41

Table 8: Sectoral Categories for Regional Reporting

		SIC 2003		SAM41 (MDM)	Broad Sector Group
1	Agriculture, etc [a]	(AB)	01 to 05	1	1
2	Mining & quarrying [a]	(C)	10-14	2-4	1
	Manufacturing, of which: [b]	(D)	15-37	5-21	2
3	Food drink & tobacco	(DA)	15-16	5	2
4	Engineering	(DL+)	29-33	16-18	2
5	Rest of manufacturing	(rest of D)		6-15,19-21	2
6	Electricity, gas & water [a]	(E)	40/41	22-24	1
7	Construction	(F)	45	25	3
8	Retail, distribution	(G)	50 to 52	26,27	4
9	Hotels & restaurants	(H)	55	28	4
10	Transport & communication	(I)	60 to 64	29-32	4
11	Financial services [b]	(J)	65,66,67	33,34	5
12	Other business activities [b]	(K)	70 to 74	35-37	5
13	Public admin. & defence	(L)	75	38	6
14	Education	(M)	80	39	6
15	Health & social work	(N)	85	40	6
16	Other services	(O,P,Q)	90 to 99	41	5

Notes: a) Although these categories are shown here, small sample sizes preclude producing some, more detailed, breaks for these sectors.

b) These categories are modified from those adopted by ONS for regional reporting in order to avoid cutting across the categories used in Table 7.

Table 9: Aggregate Sectors (and comparison with Industry Groups used in previous projections)

Broad Sector	Old Industry Group [a]	MDM Industries
1. Primary sector and utilities	1. Agriculture	1
	2. Mining etc.	2,3,4
	9. Utilities	22-24
2. Manufacturing	3. Food, drink and tobacco	5
	4. Textiles and clothing	6
	5. Chemicals	9-12
	6. Metals, and mineral products	13-15
	7. Engineering	16-20
	8. Other manufacturing	7,8,21
3. Construction	10. Construction	25
4. Distribution, transport etc.	11. Distribution, hotels etc.	26-28
	12. Transport and communication	29-32
5. Business and other services	13. Banking and business services	33,34,37
	14. Professional services	36
	15. Other services	42
6. Non-marketed services	16. Health and education services	39,40
	17. Public administration and defence	38

Note: (a) As used in Wilson (2001a).

Table 10: Broad Sectors, Sector Matrix, Industries and RMDM Industries

Broad Sector	25 / 27 industries[a]	RMDM Industries
1. Primary sector and utilities	1. Agriculture, etc	1
	2. Mining & quarrying	2-4
	Electricity, gas & water[a]	22-24
2. Manufacturing	3. Food, drink and tobacco	5
	4. Textiles and clothing	6
	5. Wood, pulp & paper	7
	Printing & publishing[a]	8
	6. Chemicals, non-metallic min. prods.	9-12
	7. Metals and metal goods	13-15
	8. Machinery, electrical & optical eq.	16-18
	9. Transport Equipment	19-20
	10. Other manufacturing & recycling	21
3. Construction	11. Construction	25
4. Distribution, transport etc.	12. Sale & maintenance of motors	26 (part)
	13. Wholesale distribution	26 (part)
	14. Retailing	27
	15. Hotels & restaurants	28
	16. Transport	29-31
	17. Communications	32
5. Business and other services	18. Financial services	33,34
	19. Professional services	36 (part)
	20. Computing services	35
	21. Other business services	37 (+ part of 36)
	25. Other services	41
6. Non-marketed services	22. Public administration & defence	38
	23. Education services	39
	24. Health & social work	40

Note: (a) Most of these sectors are identical to the 27 categories in Table 4. The exceptions are industries 2 and 5, which are aggregates of 2 such categories.

Table 11: Relationship between Industry (25) and Detailed Industry (67)

	Industry		Detailed Industry	SIC2003
1	Agriculture, etc	1	Agriculture	01
		2	Forestry	02
		3	Fishing	05
2	Mining & quarrying; Electricity, gas & water	4	Coal mining	10
		5	Oil and gas	11
		6	Uranium mining	12
		7	Metal ores	13
		8	Other mining	14
		35	Electricity	40.1, 40.3
		36	Gas supply	40.2
		37	Water supply	41
3	Food, drink and tobacco	9	Food	15.1-15.8
		10	Drink	15.9
		11	Tobacco	16
4	Textiles and clothing	12	Textiles	17
		13	Clothing	18
		14	Leather	19
5	Wood, pulp & paper; Printing and publishing	15	Wood and wood products	20
		16	Paper and paper products	21
		17	Publishing and printing	22
6	Chemicals and non-metallic mineral products	18	Manufactured fuels	23
		19	Pharmaceuticals	24.4
		20	Chemicals nes	24 (ex 24.4)
		21	Rubber and plastics	25
		22	Non-metallic mineral products	26
7	Metals & metal goods	23	Basic metals	27
		24	Metal goods	28
8	Machinery, electrical & optical equipment	25	Mechanical engineering	29
		26	Computers and office machinery	30
		27	Electrical engineering	31
		28	TV and radio	32
		29	Instruments	33
9	Transport equipment	30	Motor vehicles	34
		31	Aerospace	35.3
		32	Other transport equipment	35 (ex 35.3)
10	Other manufacturing & recycling	33	Manufacturing nes	36
		34	Recycling	37
11	Construction	38	Construction	45
12	Sale and maintenance of motor vehicles	39	Distribution relating to motors	50
13	Wholesale distribution	40	Distribution nes	51
14	Retailing	41	Retailing nes	52
15	Hotels & restaurants	42	Hotels and catering	55
16	Transport	43	Rail transport	60.1
		44	Other land transport	60.2, 60.3
		45	Water transport	61
		46	Air transport	62
		47	Other transport services	63
17	Communications	48	Post and courier services	64.1
		49	Telecommunications	64.2
18	Financial services	50	Banking and finance	65
		51	Insurance	66
		52	Financial support services	67
19	Professional services	53	Real estate	70
		54	Renting of goods	71
		56	Research and development	73
20	Computing services	55	Computing services	72
21	Other business services	57	Professional services nes	74.1-74.4
		58	Other business services	74.5-74.8
22	Public administration & defence	59	Public administration and defence	75
23	Education	60	Education	80
24	Health & social work	61	Health and social work	85
25	Other services	62	Waste disposal	90
		63	Membership organisations	91
		64	Culture and sport	92
		65	Other services	93
		66	Private household	95
		67	Extra-territorial organisations	99

7 Modelling Gender and Status

7.1 Historical estimates

All official data on employment include breaks by gender. Employment status is more problematic. Office for National Statistics (ONS) estimates, based on the Annual Business Inquiry (ABI), include a distinction between full and part-time status for employees. However, the published information, including such breaks, is much more limited than for all employees. Self employment estimates are available from the Labour Force Survey (LFS) and the Census of Population (CoP). The former is the main source of time series information, although the latter is crucial for benchmarking. Given the much smaller numbers involved compared to employees, together with the much smaller sample size of the LFS compared with the ABI, the level of detail published on self employment is much lower than for employees. This poses real problems in trying to obtain comprehensive and consistent estimates across all the dimensions needed. Details of how this was done, the limitations of the estimates, and restrictions on publication, are dealt with in Sections 11-15. below.

7.2 Method of projection of gender & status shares

As described in Section 2, forecasts of total employment by (MDM 41) industry, by region, were produced using econometric equations. Changes of employment by gender and status were projected by extrapolating recent trends. First, the change over the past seven years in the shares of employment by gender and status was calculated. These changes were then applied to current shares to generate projections of shares of employment by gender and status. The projected shares were then applied to the forecasts of total employment to calculate levels of employment by gender and status. This was done for each (MDM 41) industry and region. Aggregates (e.g. UK totals) were calculated by summing the component parts.

Employment forecasts by type (gender/status) for the additional sectors were formed by:

- Using historical trends in proportions (using a functional form which reduces the rate of decline as the proportion approaches zero, or the rate of increase as the proportion approaches 1). This relationship was used to make initial estimates of employment by type over the forecast period.
- A RAS procedure was used to ensure consistency with total employment by MDM industry in the regions and total employment by gender and status for the UK (for each year a matrix of 67 industries by 6 gender/status categories, using the RAS procedure in blocks).[14]

Results for the LLSCs were obtained by analogous methods.

[14] RAS is a widely used iterative technique, which ensures that elements in a two-dimensional data array match target row and column totals. In many of the examples quoted, multi-dimensional arrays are used but the principles are the same. For further details see Section 12.

8 Occupational Projections

8.1 Historical estimates

The Annual Business Inquiry (ABI) and its predecessors do not include information on occupational employment. Generating such estimates relies upon other sources such as the Labour Force Survey (LFS) and the Census of Population (CoP). Because of the infrequent nature of the CoP and the small sample size of the LFS, such estimates are much less robust than those for industrial employment.

Estimates from the LFS and CoP are combined with industry employment data (distinguishing gender and status), in order to develop a comprehensive set of estimates. These are in the form of detailed industry (SIC) occupation (SOC) matrices. Details of how this is done are given in Section 8.2.

Effectively a series of SIC-SOC employment matrices were developed. The new ***Database*** uses SOC 2000 categories, based on conversion of data from previous surveys on to the latest classification.[15] This was done using detailed converters developed by IER in collaboration with ONS.[16] These converters were applied in such a manner as to reflect differences across sectors, which make the application of a common converter inappropriate.

The main ***Database*** provides breakdowns to the 41 industry level used in MDM. This was extended, as described in Section 11, to cover the full set of 67 industries and the 47 LLSC areas.

The 2001 Census has provided important new data on changes in occupational structure in recent years. These data have now been fully incorporated into the present analysis and used to calibrate recent historical trends.

8.2 Projections of occupational structure

The methods for projecting occupational employment change are also based on less sophisticated procedures than for total employment. The present methodology is set out in Figure 2. It is based on the use of the SOC 2000 classification as set out in Table 12. Projections were developed for the 25 Sub-major Groups.

In theory it would be desirable to develop a full model of supply and demand for different occupations, taking into account the various behavioural factors which may influence future developments. In practice, severe data limitations preclude such an ambitious approach. Throughout the world, most occupational employment forecasts are based on simplistic extrapolation of past trends.[17]

The availability of time series data from the Labour Force Survey has offered the possibility of a more sophisticated approach, based on econometric analysis of occupational shares (see Briscoe and Wilson (2003)). In practice, although this analysis offers some insight into the sensitivity of the projections to certain key economic indicators, the results suggest that underlying trends are dominated by technological and organisational shifts, which can best

[15] For further details see Section 11.

[16] Professor Peter Elias of IER has played a leading role in the development of SOC 2000.

[17] For a review, see Wilson (2001c).

be proxied by simple time trends. Moreover, they cannot be extended to the more detailed sectoral and spatial level required here due to data limitations. The present projections are therefore still based on more conventional approaches, involving extrapolation of historical patterns of change at a very detailed industrial level.

The occupational employment projections were generated, therefore, by linking the industry employment results from RMDM to the IER's occupational models, which generate projections of occupational employment shares based on such extrapolative methods. The occupational by industry employment share (SIC-SOC) matrices were used to develop projections of occupational employment levels in selected future years. The occupational shares in each industry were applied to the industry forecasts from the macroeconomic model. Details of the basic procedures were otherwise as described in Figure 2.

Changes in occupational employment levels between years both historical and projected can be analysed using shift-share analysis. This assesses the effects of aggregate employment change, changes in the industrial mix and a residual effect reflecting shifts in occupational structure within industries due to organisational and technological change.

Projections of occupational share at this level, place considerable demands on the data available and the situation on the ground can be changed rapidly and substantially by technological and other changes. It is important to appreciate the assumptions used and the range of factors which it is felt are likely to influence immediate future trends, including, how these may diverge from previous patterns of change. These issues are discussed in more detail in the *National Report*.

8.3 Projections for the more detailed sectors and for the LLSC areas are developed using analogous procedures.

A RAS procedure was used to ensure totals correspond when aggregated from 67 to the 41 sectors and the standards regions and countries of the UK.[18] For further details see the discussion in Sections 11-15.

[18] RAS is an iterative procedure to ensure elements in an array match row and column totals. For further details Section 12.

Figure 2: The IER's Occupational Employment Model

The approach to projecting occupational employment structure involves two stages. First, projections of the likely changes in industrial employment by region are made using the multisectoral dynamic macroeconomic model of the economy. Second, projections of the occupational structure of employment within each industry are made using material from the Censuses of Population (basically extrapolations of past trends). These occupational coefficients are then combined with the projected levels of industrial employment to obtain projected levels of employment by occupation. All this is undertaken at a regional level for the 25 Sub-major Groups.

The occupational employment projections are therefore based on a sub-model which takes as input the regional/industrial projections produced by the macroeconomic model. It is a 'top-down" approach, the industrial and regional employment projections being disaggregated into the 25 occupational categories for each industry.

The overall changes in aggregate occupational structure arise through a combination of shifting patterns of industrial employment structure and the changing occupational composition of employment within industries. The former can be regarded as primarily a reflection of the way in which the changing pattern of demands for commodities by consumers and companies impinges on occupational structure, while the latter is more a reflection of technological and organisational changes affecting the manner in which goods and services are provided. The level of employment in a particular occupation can, therefore, change for two main reasons; either because the industries in which it is concentrated grow or decline, or because of changes in occupational composition within industries. The former may be termed the industrial effect, the latter the occupational effect.

The so-called occupational effect may arise for a number of reasons. Medium-term developments in technology may affect the structure of demand for certain skills. Demand may also change in response to changes in the relative rates of pay associated with certain trades, which may in turn be affected by the supply side of the labour market. In the short term the level of employment in each industry may depend upon the cyclical position in which it finds itself. Certain skills may be regarded as 'fixed' rather than 'variable' inputs in the production process for technological reasons. Furthermore, it is apparent that the costs of hiring and firing (that is costs associated with changing the level of employment) differ considerably between different occupations. Finally, the actual levels of employment observed at any particular time will reflect the balance of supply and demand; shortages for certain skills may result in divergence from the long-run structure of employment desired by firms. This again will be dependent upon current rates of pay, the scope for substitution of one skill for another in the production process, and the flexibility of wages.

In the absence of a formal econometric model encapsulating these behavioural influences, they are built into the projections in a more *ad hoc* fashion, using professional judgement based on a reading of the most important current developments. A particularly important element here is the use of data from recent Labour Force Surveys (LFS). However, a variety of other sources are also used including some more qualitative data.

This information is used to calibrate the occupational model over the recent past and to modify the projections. The LFS data are used to make an estimate of occupational structure in the base year. This is then compared with that emerging from the occupational model. The results of this exercise are used to modify the projected changes in the light of recent and current developments in occupational structure that may not reflect a simple continuation of long-term trends in the 1980s and 1990s.

The results take account of data from the 2001 Census of Population. This has had some impact on perceptions of change over the 1990s as well as likely future developments. The results should be regarded as indicative of general trends and not precise forecasts of what will happen in particular cases.

Table 12: SOC 2000 Classification of Occupational Categories (Sub-major Groups)

	Sub-major groups	Occupations	Occupation minor group number[a]
11	Corporate managers	Corporate managers and senior officials; production managers; functional managers; quality and customer care managers; financial institution and office managers; managers in distribution and storage; protective service officers; health and social services managers	111, 112, 113, 114, 115, 116, 117, 118
12	Managers/proprietors in agriculture and services	Managers in farming, horticulture, forestry and fishing; managers and proprietors in hospitality and leisure services; managers and proprietors in other service industries	121, 122, 123
21	Science and technology professionals	Engineering professionals; information and communication technology professionals	211, 212, 213
22	Health professionals	Health professionals, including medical and dental practitioners and veterinarians	221
23	Teaching and research professionals	Teaching professionals, including primary and secondary school teachers and higher and further education lecturers; research professionals (scientific)	231, 232
24	Business and public service professionals	Legal professionals; business and statistical professionals; architects, town planners, and surveyors; public service professionals; librarians and related professionals	241, 242, 243, 244, 245
31	Science and technology associate professionals	Science and engineering technicians; draughtspersons and building inspectors; IT service delivery occupations	311, 312, 313
32	Health and social welfare associate professionals	Health associate professionals, including nurses and other paramedics; therapists; social welfare associate professionals	321, 322, 323
33	Protective service occupations	Protective service occupations	331
34	Culture, media and sports occupations	Artistic and literary occupations; design associate professionals; media associate professionals; sports and fitness occupations	341, 342, 343, 344
35	Business and public service associate professionals	Transport associate professionals; legal associate professionals; financial associate professionals; business and related associate professionals; conservation associate professionals; public service and other associate professionals	351, 352, 353, 354, 355, 356
41	Administrative and clerical occupations	Administrative/clerical occupations: government and related organisations; finance; records; communications; general	411, 412, 413, 414, 415
42	Secretarial and related occupations	Secretarial and related occupations	421
51	Skilled agricultural trades	Agricultural trades	511
52	Skilled metal and electrical trades	Metal forming, welding and related trades; metal machining, fitting and instrument making trades; vehicle trades; electrical trades	521, 522, 523, 524
53	Skilled construction and building trades	Construction trades; building trades	531, 532
54	Other skilled trades	Textiles and garment trades; printing trades; food preparation trades; skilled trades n.e.c.	541, 542, 543, 549
61	Caring personal service occupations	Healthcare and related personal services; childcare and related personal services; animal care services	611, 612, 613
62	Leisure and other personal service occupations	Leisure and other personal service occupations; hairdressers and related occupations; housekeeping occupations; personal service occupations n.e.c.	621, 622, 623, 629
71	Sales occupations	Sales assistants and retail cashiers; sales related occupations	711, 712
72	Customer service occupations	Customer service occupations	721
81	Process plant and machine operatives	Process operatives; plant and machine operatives; assemblers and routine operatives	811, 812, 813
82	Transport and mobile machine drivers and operatives	Transport drivers and operatives; mobile machine drivers and operatives	821, 822
91	Elementary occupations: trades, plant and machine related	Elementary occupations: agricultural trades related; process and plant related; mobile machine related	911, 912, 913, 914
92	Elementary occupations: clerical and services related	Elementary occupations: clerical related; personal services related; cleansing services; security and safety services; sales related	921, 922, 923, 924, 925

Notes: (a) Standard Occupational Classification. ONS 2001.

Table 13: SOC 1990 Classification of Occupational Categories (Sub-major Groups)

	Sub-major groups	Occupations	Occupation minor group number[a]
1.1	Corporate managers and administrators	General managers and administrators in national and local government, large companies and organisations; executive officers in the civil service; production managers in manufacturing, construction mining and energy industries; specialist managers; financial institution and office managers; managers in transport and storing; protective service officers; managers and administrators n.e.c.	10, 11, 12, 13, 14, 15, 19
1.2	Managers/proprietors in agriculture and services	Managers and proprietors in service industries; managers in farming, horticulture, forestry and fishing	16, 17
2.1	Science and engineering professionals	Natural scientists; engineers and technologists.	20, 21
2.2	Health professionals	Health professionals, including medical and dental practitioners and veterinarians.	22
2.3	Teaching professionals	Teaching professionals, including primary and secondary school teachers and higher and further education lecturers	23
2.4	Other professional occupations	Legal professionals; business and financial professionals; architects and surveyors; professional occupations n.e.c.	24, 25, 26, 27, 29
3.1	Science and engineering associate professionals	Draughtspersons, scientific technicians, quantity and other surveyors; systems analysts and computer programmers; associate professional and technical occupations n.e.c.	30, 31, 32
3.2	Health associate professionals	Health associate professionals, including nurses and other paramedics.	34
3.3	Other associate professional occupations	Legal associate professionals; business and financial associate professionals; social welfare associate professionals; literary artistic and sports associate professionals; librarians and related associate professionals	33, 35, 36, 37, 38, 39
4.1	Clerical occupations	Administrative/clerical officers and assistants in the civil service and local government; numerical clerks and cashiers; filing and general clerks; clerks (not elsewhere specified); stores and despatch clerks, storekeepers; clerical and secretarial occupations n.e.c.	40, 41, 42, 43, 44, 49
4.2	Secretarial occupations	Secretaries, personal assistants, typists, word processor operators; receptionists, telephonists and related occupations	45, 46
5.1	Skilled construction trades	Building trades.	50
5.2	Skilled engineering trades	Metal machining, fitting and instrument making trades, electrical/ electronic trades	51, 52
5.3	Other skilled trades	Textile, garments and related trades; printing and related trades; woodworking trades; metal making, welding and related trades; vehicle trades; food preparation trades; other trades n.e.c.	53, 54, 55, 56, 57, 58, 59
6.1	Protective service occupations	NCOs and other ranks, armed forces; security and protective service occupations (including the police and fire brigade)[b]	60, 61
6.2	Personal service occupations	Catering occupations (including chefs); travel attendants and related occupations; health and related occupations; childcare and related occupations; hairdressers, beauticians and related occupations; personal service occupations n.e.c.	62, 63, 64, 65, 66, 67, 69
7.1	Buyers, brokers and sales representatives	Buyers, brokers and related agents; sales representatives and agents.	70, 71
7.2	Other sales occupations	Sales assistants and check-out operators; mobile, market and street sales persons; sales occupations n.e.c.	72, 73, 79
8.1	Industrial plant and machine operators, assemblers	Food, drink and tobacco process operatives; textiles and tannery process operatives; chemicals, paper, plastics and related process operatives; metal working process operatives; assemblers/line workers; other routine process operatives; machine and plant operatives n.e.c.	80, 81, 82, 83, 84, 85, 86, 89
8.2	Drivers and mobile machine operators	Road transport operatives; other transport, and machinery operatives.	87, 88
9.1	Other occupations in agriculture, forestry and fishing	Other occupations in agriculture, forestry and fishing	90
9.2	Other elementary occupations	Other occupations: in mining and manufacturing; in construction; in transport and in services; postmen/women, mail sorters, messengers; other occupations n.e.c.	91, 92, 93, 94, 95, 99
82	Transport and mobile machine drivers and operatives	Transport drivers and operatives; mobile machine drivers and operatives	821, 822
91	Elementary occupations: trades, plant and machine related	Elementary occupations: agricultural trades related; process and plant related; mobile machine related	911, 912, 913, 914
92	Elementary occupations: clerical and services related	Elementary occupations: clerical related; personal services related; cleansing services; security and safety services; sales related	921, 922, 923, 924, 925

Notes: (a) Standard Occupational Classification. OPCS (1990).

9. Replacement Demands

9.1 The importance of replacement demands

Estimates of replacement demands have been a key feature of IER occupational projections for many years. Net changes in occupational employment (or expansion demand as they are referred to in the main reports) are only one indicator of future changes in the pattern of demand for skills. Another measure, which is equally important for assessing education and training provision, is the replacement demand needed to offset outflows due to retirements, occupational mobility, etc.

The analysis of occupational trends and prospects provides predictions of the changes in the number of people employed in particular occupational categories. However, education and training requirements are not simply dependent on which occupations are growing rapidly. The projected net change in employment (expansion demand) tells only a part of the story in terms of future skill requirements. It is crucial to recognise that there will be many job openings and important education and training requirements for many occupations where employment levels are expected to fall. These arise because of the need to 'replace' the existing skills that will be 'lost' as a result of retirements and other aspects of the normal process of labour turnover. Even in those occupations where employment levels are expected to decline substantially, there may be a need to train, simply to maintain the existing stock of skills at the required level. In addition to examining likely net changes in the numbers in each occupational category, it is also important, therefore, to assess replacement demands. These represent the numbers needed to maintain the existing stock of skills due to losses resulting from retirements and other outflows.

The scale of replacement demand typically outstrips the scale of expansion demand, in the present projection by a factor of around ten to one. This varies across occupations and sectors but, even where substantial job losses are projected, the replacement demand elements are usually more than sufficient to offset this. It is essential, therefore, for employers, education and training providers, and public agencies to recognise the different characteristics and requirements of these two different components of future skill needs.

9.2 Methods of estimating replacement demands

IER has developed procedures to produce such estimates, linked to the main occupational projections. These are summarised in Figure 3. The various elements of replacement demand depend upon the rates of flows from employment due to factors such as retirement and occupational and geographical mobility, as set out in Figure 3. The main source of information on the various flows (as well as information on age structure), which are used to generate replacement demand estimates, is the LFS. This used to generate information on outflows over the past 12 months. Such estimates account, therefore, for some but not all labour turnover (since many jobs are filled within a 12 month period). The total number of job openings is likely to be substantially greater than the estimates developed here. Nevertheless they provide a useful benchmark for thinking about the number of new entrants to jobs that will need to be found.

While the LFS can provide useful information across all sectors and regions combined, its sample size is inadequate to provide specific data for particular sectors and regions at a detailed level. The 2001 CoP offers the potential for obtaining more robust estimates, at a much more detailed level. However, these results are already becoming somewhat dated. The present analysis draws upon both sets of data, using the more robust Census data to

get a better fix on different patterns at a point in time while relying more upon the LFS to reveal how these patterns are changing over time.

In principle, there is no problem in providing such estimates in considerable detail, distinguishing sector, gender/status and geographical area. It is possible to generate customised estimates of replacement demand for any industry or spatial area, recognising unique features, including the age structure of the workforce and rates of flow. Such estimates are likely to vary significantly, depending upon these factors.

In practice, it is very difficult to obtain reliable data on these factors, which would enable such customised estimates to be produced. The current analysis is based on LFS data on labour market flows at national level. Even attempting a breakdown for the countries and English regions within the UK or for broad sectoral groups at a UK level, poses problems of empty cells in the LFS analysis. The LFS, even with its enhanced size, does not provide a sufficiently large sample to generate sensible estimates for individual sectors at a rather broad level, let alone breaks by region or LLSC area. Indeed, as noted below, the estimates of occupational mobility from the LFS proved inappropriate for use at all but the most aggregate national level. The lack of availability of data from national sources therefore severely limits the extent to which such estimates can be customised for particular groups (sectors, geographical areas, etc.).

However, this should not be seen as an insurmountable problem. The key point in producing replacement demand estimates is to emphasise the importance of replacing those retiring, even in declining sectors and occupations. While these results are, of course, sensitive to the particular assumptions adopted, they can be regarded as indicative. For those with access to the more detailed data, a range of alternatives can be provided. Such users can explore alternatives based on their own assumptions. Results are therefore provided at a considerable level of detail, based on a set of benchmark assumptions about age structures and flow rates. The main replacement demand (RD) estimates in the published reports use a "standard" set of assumption about flow rates, which are common to all sectors and geographies.[19]

Occupational mobility estimates were used initially in calculating overall replacement demands at national level. However, when attempts were made to use the same assumptions about flow rates for individual sectors and regions, this led to implausible results. This is because of the very different occupational structures across sectors and the imprecision of some of the flow estimates, even at national level. In order to provide a comparable set of results at all levels, the occupational mobility estimates were therefore set by assumption to zero (as was the case for geographical mobility).

The estimates published in the various reports are therefore based on the heroic assumption that the general patterns of age structure and rates of flow are common across all sectors and regions. This enables a certain level of consistency. In particular, it ensures that disaggregated estimates will sum to more aggregate totals. These benchmark estimates provide a starting point for thinking about such issues. In particular, they emphasise the quantitative importance of replacement demands compared with the structural changes projected.

The estimates of replacement demands for 2004-2014 presented in the reports are generally near to a third of the opening stock (employment levels in 2004).

[19] In principle, such assumptions could be differentiated at a much more detailed level, distinguishing individual sector, gender status category and LLSC area (there are around 18,000 such separate cases).

This proportion depends on:

i. the length of period covered (the longer it is the greater the outflows);
ii. the age structure in each occupation (older work forces will see greater outflows, all else equal);
iii. Outflow rates (these are age and gender specific but may also vary across other dimensions).

ii. and iii are (initially) assumed to be common to all industrial and geographical categories although they might vary a lot in reality. The reasons for this are not that it is thought that such differences are unimportant. It is simply that the LFS data used to measure ii and iii are inadequate to measure these differences *systematically and consistently* across all the dimensions of the database.

In practice, it is likely that patterns of age structure and rates of flow will be very different for particular sectors or locations. The procedures and tools developed allow those with access to the more detailed data to explore alternative scenarios, by using industry specific or area specific assumptions about age structures or flow rates. These can draw on non-official data as well as the limited range of alternatives directly provided. In this manner users can, for example, explore alternative scenarios, based on "local" knowledge about particular difficulties faced where a workforce is rapidly ageing.

Figure 3: Estimating Replacement Demand by Occupation

Measuring Replacement Demand
The projections of occupational employment focus on the total numbers of people that are expected to be employed in such jobs in the future. While such estimates can provide a useful indication of areas of change, highlighting the likely 'gainers' and 'losers', they can give a misleading impression of job opportunities and skill requirements. Even where the projections indicate significant employment decline over the medium term, there may nevertheless be quite good career prospects with significant numbers of new job openings. This is because, as long as significant numbers are still likely to be employed in the future, then employers will need to replace those employees who leave because of retirement, career moves, mortality or other reasons. This so called 'replacement demand' may often dwarf any 'structural demand' resulting from growth in employment in a particular category and can easily outweigh any negative changes due to projected employment decline.

While the concept of replacement demand is simple enough to grasp, estimating it is a rather different matter. The main problem is that official statistics place much more emphasis on measuring stocks of people in particular states rather than flows from one state to another. Yet it is measurement of such flows which is essential to estimating replacement demands.

However, use can be made of readily available statistics in order to provide indicative estimates. Ideally, one requires a full set of demographic accounts which trace people's movement from one socio-economic position (e.g. employment in a particular occupation) to another (e.g. retirement). In practice, such a complete set of accounts does not exist even at national level. However, the Labour Force Survey now provides a sufficiently large sample to obtain rough estimates of the main elements at national level. The key components are:

- information on the age and gender structure of occupational employment;
- information on rates of outflows due to
- retirement (and other reasons for leaving the workforce);
- inter-occupational mobility;
- mortality.

Age Structure
Data on age structure are required since many of the flows, especially retirements and mortality, are age specific. Age structures vary significantly by occupation. For some groups such as corporate managers and administrators, experience is a key requirement and this is associated with age. The proportion in the 45-59 year old category is therefore relatively high. In contrast, in many other occupations the age structures are much more heavily biased to younger age groups. In sales occupations, for example, the age structure is much more heavily weighted towards younger age groups. Differences in age structure across occupations will clearly influence likely losses due to mortality and retirement which are age related.

Retirement Rates
Retirement rates vary by gender and by age. By using data for the whole of the UK estimates of likely rates of outflow can be made. Data are not distinguished for different occupational groups since sample numbers are too small to allow for meaningful estimates. The estimates are based on data from the LFS, which show the percentage of those employed one year ago who have retired from employment, either temporarily or permanently. For males the main outflows are associated with retirement *per se*. For females, in particular, there is significant outflow for younger age groups associated with family formation.

Mortality
Another potential outflow is due to mortality. Information on mortality rates is available by age and gender from ONS. While losses due to death are not great for individual age groups up to the age of 65, they can cumulate to produce significant losses over an extended period of time. The rates used are again based on data for the whole of the UK. However, mortality rates are unlikely to vary very much across the occupations.

Occupational Mobility
Occupational mobility is an important source of loss for some occupations although not for all. The full occupational mobility flow matrix indicates that some occupations such as corporate managers and administrators tend to gain employment as people are promoted from other occupations. This means that many of the losses due to retirement are 'automatically' dealt with by the normal process of promotion and upward occupational mobility. However, for those occupational categories which provide the people who are promoted this means that losses due to retirement will understate the overall replacement demands. These data are based on an analysis of information for the whole of the UK.

Replacement Demand
The overall scale of change is obviously dependent upon the length of period considered, as well as the opening stocks and the age structure of the current workforce. For the projections constant rates of flow are assumed. The tables in the main text provide estimates of replacement demands over the forecast period. The first column of the table indicates the scale of structural demand (which in some cases may be negative). Column 2 estimates losses due to retirement and mortality. It is notable that these figures are substantial in comparison with the expansion demand element and that in most cases they offset any negative change.

Customised Results for Particular Sectors or Geographies

The Replacement demand module enables the development of customised results for any sector or geographical area.

10 Qualifications

10.1 Introduction

Working Futures 2004-2014 includes an analysis of the implications of changing employment patterns for the demand for and supply of qualifications. This is a complex project in its own right and a separate document provides more complete details of the methodological approach adopted and data sources used. This section provides a brief overview.

The approach involves a number of inter-related modules which together cover various aspects of the supply of and demand for formal qualifications, at a national and more detailed level. Figure 4 summarises the main elements and how these relate to the other models used in producing the *Working Futures 2004-2014* results. The qualifications models comprise a number of separate elements contained in separate modules. These are described in more detail in Section 10.6.

10.2 Background and Context

Adding in a qualifications dimension raises a number of technical and conceptual issues. These can be addressed in a variety of ways, ranging from fairly simple "benchmark" type calculations to much more sophisticated modelling exercises. A range of approaches has been adopted, aimed at meeting a multiplicity of requirements.

Different users have different requirements for information of this kind. On the one hand, individuals making career choices may just need very basic information about typical qualification patterns in different jobs. For them it may be sufficient to know the current average and "marginal" qualification mix.[20] Policy makers, on the other hand may need more sophisticated information about unfolding patterns of both stocks and flows. In order to meet the needs of those with an interest in specific sectors and geographical areas, a further set of requirements emerges, which this part of the project has tried to address.

In combination the various qualifications modules provide *benchmark projections* of qualifications at local and sectoral level. At the most basic level, these include information about the *typical* qualifications profiles of those employed in different occupations (and by implication for different sectors or geographical areas). Such profiles are, of course, the result of a combination of both supply and demand factors. Moreover they are not fixed. However such information can provide some useful insights into the implications of the changing sectoral and occupational structures of employment for qualifications typically required.

At the same time the research provides a more comprehensive *analysis of stocks and flows*. This analysis covers the influence of both supply and demand factors, using all the available information on both stocks and flows through the system.

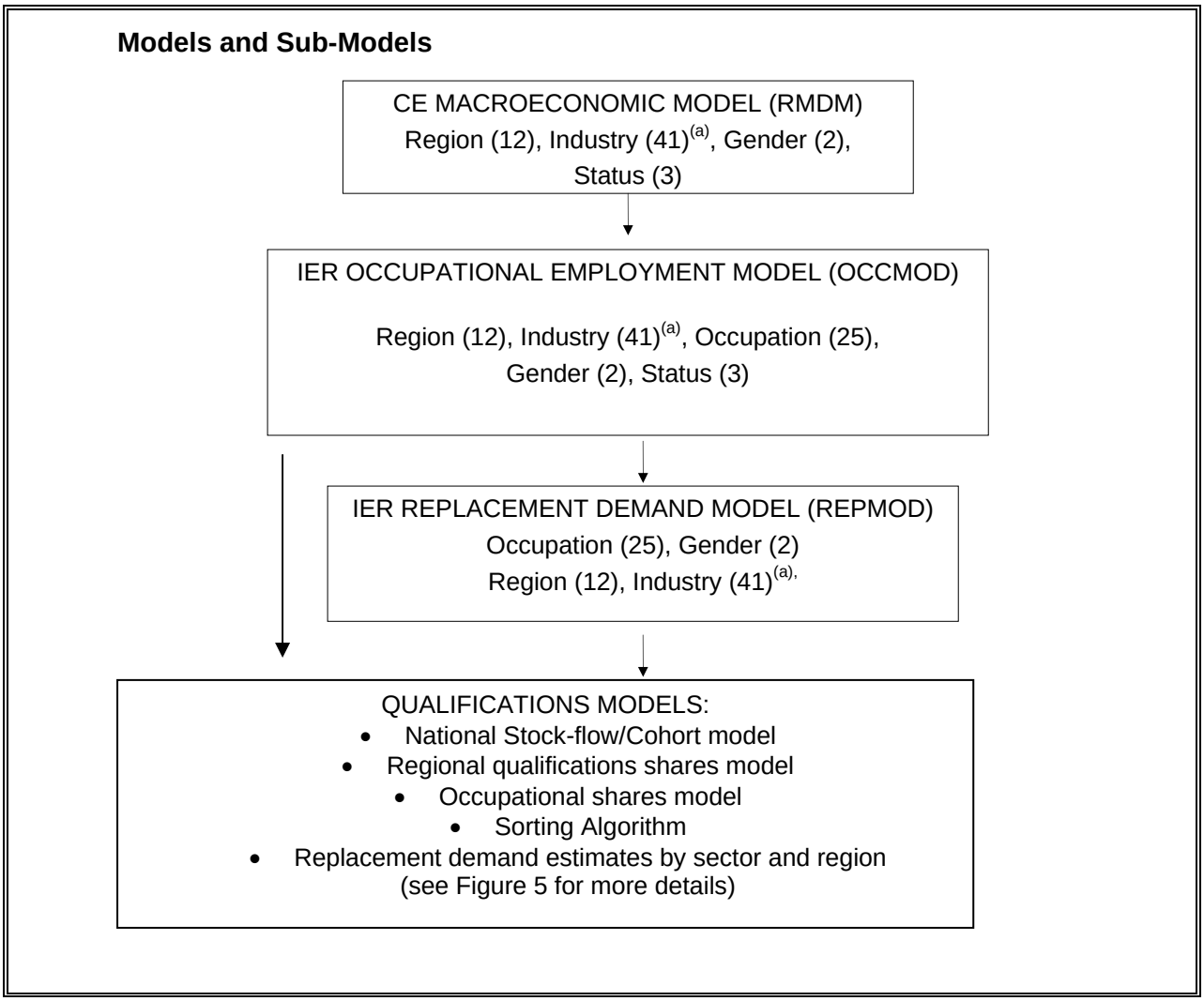
10.3 Distinguishing Demand and Supply

What is observed in official statistics on employment and related matters is the outcome of both supply and demand forces. Separating them out is a far from straightforward task. Recent trends have seen a sharp rise in the formal qualifications held by those in employment. There is some evidence that this reflects **demand** changes, with many jobs

[20] Marginal qualification mix is defined as the typical qualifications of new entrants as opposed to the average for the entire workforce.

requiring more formal higher level qualifications than used to be the case.[21] There are also indications that the returns to obtaining such qualifications have remained high (for a review see Wilson *et al.* (2004)). On the other hand it is clear that there have been major changes on the **supply** side, in part at least in response to government policies to increase participation in higher education. The latter has resulted in a big increase in the numbers emerging on to the labour market with formal qualifications. The proportion of young people with formal qualifications is much higher than for older people. There is therefore a strong **cohort** effect. This has been reinforced to some extent by increasing qualification rates for older people as well (an "**upskilling**" effect).

Figure 4: The Multisectoral Dynamic Macroeconomic Model, Occupational Model and Replacement Demand Models



Source: Figure 1 in this document.
Notes: (a) These are extended to cover all two digit SIC categories.

[21] The *Skills Surveys* undertaken by Felstead *et al.* (2002), as well as the analysis of graduate careers after graduation by Elias *et al.* (2004), ask questions about the skills and qualifications required in the jobs graduates do. However these do not provide an overall quantitative measure of the demand for graduates (numbers).

The observed patterns of employment (**stocks** of people in employment with formal qualifications) clearly reflect both the demand and supply side influences. Certain indicators are more informative about one than the other. In particular, there are various measures of the **flows** of people through the education system which can be regarded as primarily supply side indicators (although even these reflect decisions that people are making about education based on their perceptions of the overall balance of supply and demand for different qualifications).

10.4 Issues in Developing Stock- Flow Models

In principle, it is possible to develop quite sophisticated analyses of the numbers of qualified people at higher NQF level, using information on the **flows** of people through the education system (see for example the work conducted by IER in previous sets of projections for DfES/ National Skills Task Force and for the Treasury (Wilson 2001b & 2002)). This also makes use of **stock** information taken from the Censuses and the LFS.

The **overall** supply of people holding formal qualifications at higher level (NQF 4+) is relatively straightforward to conceptualise and model. NQF stands for National Qualification Framework. This covers both academic and vocational qualifications. Qualifications are classified into 5 levels NQF 1-5. However, there are considerable conceptual and practical difficulties in extending this:

i) to include lower level qualifications (NQF 1-3);
ii) to conceptualise the idea of supply to cover specific dimensions such as occupation, sector and geographical area.

These issues are discussed in turn.

Limitations by NQF level: The first problem to be addressed in extending this type of model to cover the full range of qualifications is the much more limited information available on lower level qualifications (NQF1-3). Ideally, stock-flow modelling requires a comprehensive set of *demographic accounts* showing how individuals progress through the educational system and the labour market over time. In practise such accounts do not exist, although there is a considerable amount of information on certain flows.

DfES and other agencies collect and publish a considerable amount of information on the higher educational system in particular. In principle, this can be used to develop estimates of the main flows involved and thereby develop stock-flow models of this process. In practice, this information is often disparate and far form comprehensive.

In the case of lower level qualifications, while there is an enormous amount of detailed information available on the acquisition of qualifications, there is much less information on what prior qualifications these individuals may have possessed. This makes it difficult, if not impossible, to develop stock-flow models analogous to those constructed for NQF levels 4+. The approaches adopted to get around it are set out below in Section 10.6.

Highest versus all qualifications held: The discussion so far has been on highest qualifications held. This can also cause some problems in interpretation and perception. For example, as more people acquire NQF level 4 and 5 qualifications, it is almost inevitable that the proportions with NQF level 1-3 as their highest qualification will fall. This can mean that, despite increases in those acquiring NQF level 1-3 qualifications, the numbers and proportions of people with these as their highest qualification may actually decline.

One way of dealing with this is to present additional information on the total numbers with different NQF level qualifications. This will recognise that most (if not all) of those with NQF level 4 or 5 qualifications also have NQF levels 1-3. Data are now available in the LFS which enable this distinction to be made explicitly. The results presented therefore make use of this, as well as information on the highest qualification held.

Problems in conceptualising supply into occupations or sectors: Most occupations are undertaken by people with a range of formal qualifications. This is partly a function of age, with older workers generally relying more upon experience than formal qualifications. However, even allowing for the age factor, there are enormous differences. This makes defining the **supply of people into an occupation** almost impossible. It is possible to identify some key elements, focussing on the flows of people through the education and training system, but boundaries are too blurred and transitory to enable quantitative modelling.

Much the same is true for the concept of **supply of labour to a sector**. This will depend upon the occupational mix of the sector and its geographical location. For some occupations the labour market may be worldwide. This is increasingly true of many high level managerial and professional groups. Ever increasing ease of transport now means that it is also a feature of the labour markets for many lower-level occupations (for example, construction and agricultural workers, as well as nurses). While individual sectors may be able to address these issues it is very difficult to develop a general approach that can cover all these aspects consistently for the whole economy.

The concept of supply at a disaggregated spatial level is somewhat more manageable. It is relatively straightforward to develop quantitative estimates and projections of population and the labour force for each geographical area. In principle, this can be extended to cover formal qualifications held. However, the data available here are much less robust than at a national (UK) level. Moreover the issues of commuting and migration flows become much more significant. While it is possible, in principle, to envisage the development of qualification supply models at individual country and English regional level (and indeed even at local LSC level) this would require considerable resources and a time frame going well beyond that available in the present project.

The present modelling therefore limits the more detailed and sophisticated stock-flow analysis to a national level, with a more limited analysis at regional level, reflecting the data constraints faced here. Further details are given below in Section 10.6.

10.5 Producing Benchmark Projections: Typical Qualification Profiles

There are various ways in which the structural changes that are impinging on the demand side can be highlighted. One of the key factors differentiating the qualification structure of employment within both sectors and geographical areas is their occupational employment mix. It is therefore important to focus upon the occupational dimension in rather greater detail than in the main *Working Futures 2004-2014* results, since there are significant differences between occupational categories in “typical” qualification patterns. This requires a more detailed analysis of occupational change than the SOC sub-major groups. In particular, changing projections of changing patterns of occupational structure for 3-digit occupational groups are required.

These more detailed occupational employment projections are linked to the main *Working Futures 2004-2014* occupational employment projections. Such an analysis focuses attention on shifting patterns of qualification mix within occupations. As well as driving the benchmark qualification projections, such estimates may be of interest to many users in their own right. This general approach builds upon previous similar research as set out in Wilson

(2001b and 2002). The method for producing the more detailed occupational results *Working Futures 2004-2014* are summarised briefly below.

"Benchmark" information on qualification structure by occupation, (as well as by sector and by geographical area, separately but not in combination) has been developed based on LFS and Census data. This focuses upon "outcomes", rather than supply or demand *per se*.[22]

The observed patterns vary across sector and region. However, given the limited sample sizes in the LFS, summary results have been developed focussing on these two dimensions (sector and region) separately. In view of the limitations of the data available, no attempt is made to cross-classify the full *Working Futures 2004-2014* employment database by qualification. At regional and individual country level (and at a sub-regional level), because of concerns about data quality, the focus is on SOC sub-major groups. Benchmark results have also been produced at LLSC level, however, these have not been locally customised.

Excel based software modules have been developed which enable users to customise the results for their own sector or geographical area. The module presents benchmark results based on using average qualification mixes and illustrate the sensitivity to alternative assumptions. To assist in this process, alternative sector and geographical specific input files have been provided to enable users to develop their own customised views.

10.6 *The Main Qualifications Models and Modules*

Various different modules and models have been developed in order to project numbers of people holding qualifications and qualification shares at various different levels. These are summarised in Figure 5.

They include the following:

I. ***a National level stock flow/cohort model,*** which extends previous work by IER and DfES to produce projections of qualifications numbers at broad NQF level;
II. a ***Regional qualification model,*** which produces equivalent regional results (including results all for the individual countries and regions within the UK);
III. a ***3 digit occupational model,*** which produces detailed occupational projections, linked to the main occupational forecasts;
IV. an ***Occupational/qualification shares model,*** which develops projections of qualification shares within these 3 digit occupations;
V. a ***Sorting algorithm,*** which sorts people into occupations such that the results from III and IV can be made consistent with those from I and II ; and finally,
VI. an extended ***Replacement demand module,*** which generates estimates of qualification numbers for detailed industries and geographical areas.

[22] As in the analysis provided by the Bureau of Labour Statistics in the USA, this could also be expanded in due course to include other labour market indicators such as pay, typical entry requirements, etc. Such information can help to meet the needs of those who require indicative material about "typical" qualification requirements in different jobs.

Figure 5: The Qualifications Models

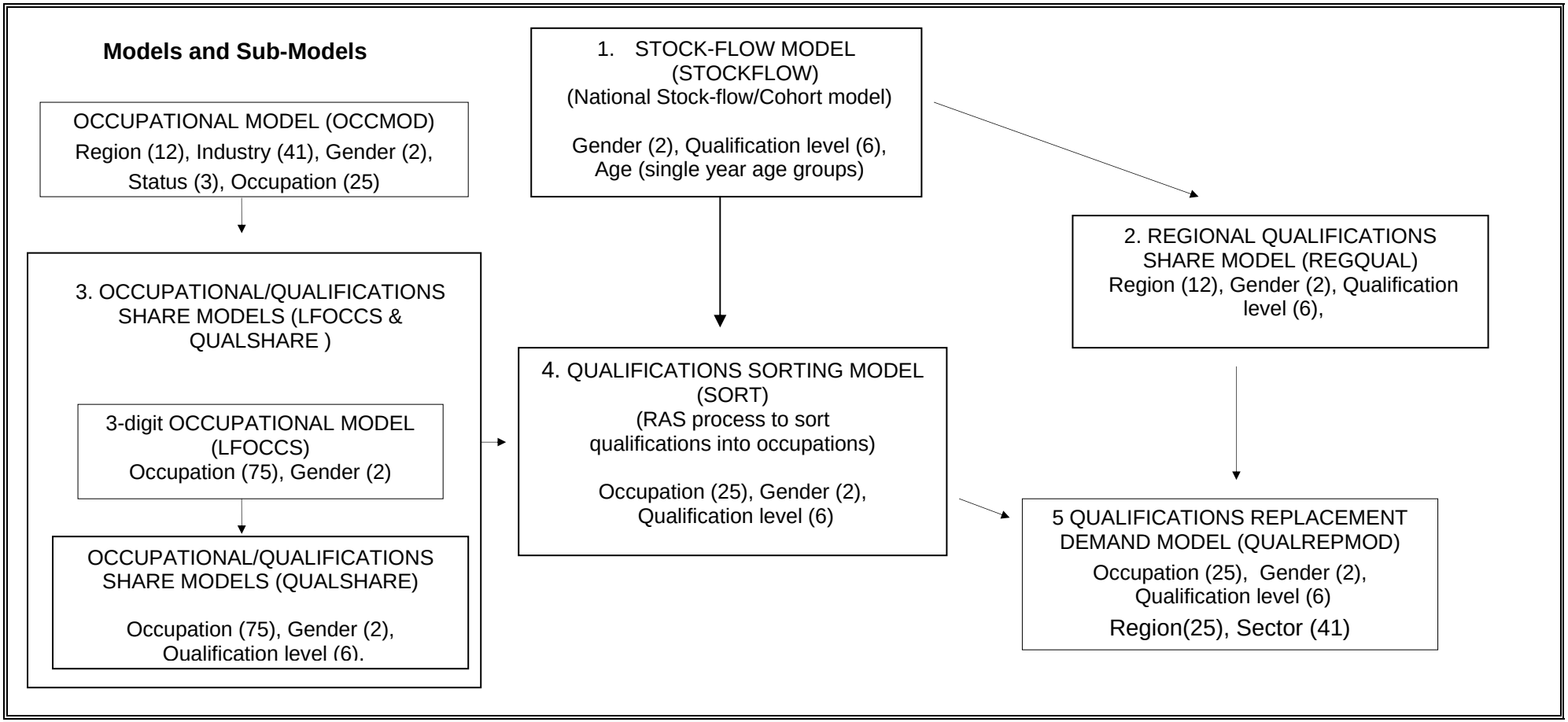


Figure 5.1: Stock Flow Model

1. STOCK-FLOW MODEL (STOCKFLOW)

This is a National (UK/GB) level Stock-flow/Cohort model, based on LFS data.

It covers the following dimensions:

- Gender (2);
- Qualification level (6);
- Age (single year age groups).

The model is a development of previous stock flow models produced by IER (focussing on NQF levels 3+) and DfES (focussing on NQF2+).

It focuses on the shares in the population by age and gender that have acquired certain levels of qualifications. The emphasis is upon the highest qualifications held.

No distinctions are made between vocational and other qualifications.

Projections of futures numbers are produced by linking projected shares to ONS based demographic projections of population numbers by age and gender.

The model also differentiates between those economically active and inactive, although the main focus is on those who are economically active.

The treatment of migration is implicit, based on the assumptions adopted by ONS for population numbers. No differentiation is made between qualification patterns between new migrants and the indigenous population.

Figure 5.2: Regional Qualifications Shares Model

2. REGIONAL QUALIFICATIONS SHARE MODEL (REGQUAL)

This model extends the analysis to cover each of the constituent countries of the UK and the English regions.

The model focuses upon the shares of the active population who are qualified to various levels. It uses a probabilistic approach to modelling these shares, based on an mlogit specification which ensures that the estimates (and projected shares) sum to 100%.

The final results are constrained to match the overall UK position in the benchmark scenario prepared for *Working Futures 2004-2014*, that emerge from the STOCKFLOW model.

It covers the following main dimensions:

- Country/region (12);
- Gender (2);
- Qualification level (6).

Figure 5.3: Occupational /Qualifications Shares Models

3. OCCUPATIONAL/QUALIFICATIONS SHARE MODELS (LFOCCS & QUALSHARE)

The next stage begins with a model which develops a more disaggregated analysis of occupational change (LFOCCS). This is because qualification patterns differ significantly between 3-digit occupational categories within each 2-digit occupation.

LFOCCS therefore develops 3 digit occupational projections within 2 digit categories. It is driven by the main occupational from *Working Futures 2004-2014.* The key dimensions are:

- 3 digit Occupation (75);
- Gender (2).

Based on these more detailed categories a mlogit analysis of qualification shares within each 3 digit occupation is conducted and used to generate projected future shares. This is referred to as (QUALSHARE). The key dimensions here are therefore:

- 3 digit Occupation (75);
- Gender (2);
- Qualification level (6).

These results are then aggregated up to SOC 2-digit level for comparison with the estimates from the stock-flow model.

Figure 5.4: Qualifications Sorting Model

4. QUALIFICATIONS SORTING MODEL (SORT)

This model is designed to reconcile the projections from the STOCKFLOW model with those from QUALSHARE. The former can be regarded as essentially a view of supply side developments (the overall numbers of people acquiring qualifications), while the latter is more concerned with what occupations they end up in.

The SORT model uses an iterative RAS procedure to reconcile the two sets of estimates, constraining the overall qualification shares from QUALSHARE to match those from STOCKFLOW, while at the same time maintaining the patterns of occupational deployment in QUALSHARE.

The constraint is imposed at the 2 digit occupational level.

The key dimensions are:

- Occupation (25);
- Gender (2);
- Qualification level (6).

SORT operates at a UK level

Figure 5.5: Qualifications Replacement Demand Module

5. QUALIFICATIONS REPLACEMENT DEMAND MODULE (QUALREPMOD)

This final module provides the mechanism whereby implications for individual sectors and regions are developed, focussing on replacement needs.

The overall results from this module are calibrated to match the main results from the benchmark projections for the UK and its constituent countries and regions which emerge from SORT and REGQUAL.

Data and parameters are provided for individual sectors and regions which enable customised projections for these categories to be developed. These include aggregate qualification and age profiles for individual sectors and regions (but not cross-classified).

While, because of data limitations, it is not possible to ensure that these results are consistent in every respect with those from the national results, they provide reasonably robust and consistent implications at the more detailed regional and sectoral level.

The key dimensions covered are:

- Occupation (25);
- Gender (2);
- Qualification level (6);
- Region(25);
- Sector (41).

Figures 5.1-5.5 provide further details of the structure and content of these various models and modules. These various elements are described in more detail in the main *Qualifications Technical Report.*

10.7 Data Sources and Related Issues

Census and LFS data
The main sources of data on qualifications of those in employment and in the labour force are the Census if Populations and the LFS. Both have been used but the main emphasis has been on LFS data which provides consistent time series.

Data have been extracted, focussing upon qualifications held across all occupational categories, for all ages and overall numbers in the workforce by age and gender (across all occupations).

Information cross-classified by occupation (at a detailed SOC 2000 3 digit level) has also been developed. This reflects the need to differentiate between qualification profiles at a more detailed level than SOC sub-major groups (2-digit).

Consistent summary data by region and by sector has also been produced, but due to limitations of the available data no attempt Has been made to develop a qualifications database covering all three main dimensions (occupation, sector and region) simultaneously.

11 Developing the Employment and Output *Database*

11.1 Background

Earlier projections produced on behalf of the Department for Education and Skills (Wilson, 2001a & b) involved the detailed examination of sectoral as well as occupational change. [23] This analysis was based on a variety of different data sources. These data sources were been used, in combination, to generate the kinds of labour market information required. The data sources included the various sectoral data produced by the Office for National Statistics (ONS), as well as a broad range of other data relating to occupational employment and skills produced by various Government Departments and other bodies.[24]

The SSDA and its partners required the provision of much more detailed projections of employment than produced hitherto. This included additional detail by industry (including other characteristics such as gender and employment status), occupation and geographical area. The previous projections produced for DfES included a spatial analysis down to individual country and regional level. The *Working Futures 2002-2012* projections were also intended to serve the interest of various other bodies. In particular, the LSC and its local arms require results at LLSC level.

There are various technical and methodological issues that constrain the amount of detail that can be provided. These methodological problems are discussed here, as well as the solutions adopted to deal with them.

To provide statistically robust estimates for all the categories specified by the SSDA and its partners would involve an enormous project, including new primary data collection to obtain the relevant occupation by industry data in statistically robust form. At present statistically precise data are not available for all the detailed sectoral categories from official sources. This is before developing breaks by occupation and geography. Moreover, there are also important issues of confidentiality as well as statistical reliability, in making such detailed data available in the public domain. These are discussed in more detail in Sections 14 and 15 below.

11. Development of greater sectoral and spatial detail

The standard sectors used in MDM have been set out in Table 2. The reason for the choice of the 41 sectoral disaggregation reflects data availability and reliability. These categories are based on data available from ONS in various official sources, especially those data relating to input-output information, which is central to MDM. They are classified according to the 2003 update of the 1992 Standard Industrial classification (SIC2003), (see Table 2).

For the purposes of the present project (*Working Futures 2004-2014*), the SSDA required an analysis on the footprints covered by the newly established SSCs. This in turn demanded a much more detailed analysis, extending the sectoral coverage to include all 2-digit categories based on the SIC2003 as shown in Table 3. The inclusion of employment in private households and extra territorial organisations expands the total number of sectors to 67.[25] These are the groupings for which the most detailed analysis was undertaken.

[23] Wilson *et al.* (2001) *Projections of Occupations and Qualifications 2000/2001*, DfES report.

[24] Section 12 summarises the sources used.

[25] However, output and employment data are not available for uranium mining and extra-territorial organisations. Effectively, therefore, there are 65 substantive industries for which there are comprehensive data.

The Development of the new Database therefore involved a number of key elements:

- Establishing a new consistent historical time series of sectoral employment and output by the countries and English regions within the UK;
- Expanding this to cover all 2-digit SIC categories instead of the 41 sectors used in RMDM;
- Using this information to generate results for SSCs;
- Expanding the geographical coverage to include all 47 LLSC areas in England;
- Development of occupational data relating to the new sectors and geographical areas.

In addition to this it was necessary to develop for *Working Futures 2002-2012* a number of new and related models and procedures, including:

- Development of forecasting models and procedures to generate consistent projections across these various dimensions (described in Sections 2 and 4);
- Development of a new replacement demand (RD) module to generate RD estimates across all the various dimensions (described in Section 11).

These have been further extended in *Working Futures 2004-2014* to include treatments of Labour Supply (Section 5) and Qualifications (Section 10).

11.3 The core Database: employment & output by 41 industries

Historical estimates of output and employment by gender and status were developed for earlier projects funded by DfES. These estimates were based on various official sources, including most recently the ABI (for employees) and the LFS (for self employment). This detailed employment data, covering all the main dimensions concerned, provided the starting point for the new ***Database***.

Employment for 41 industries: The original employment estimates were based on the 41 SIC 2003 categories used in the CE RMDM model. It covered the 12 nations and regions of the UK, gender and status. These data series have been developed over many years and are as consistent as can be achieved with all the official published sources upon which they are based.[26]

Estimates for the old Standard Regions (SSRs) were converted on to a GOR basis for those regions which are different from the SSRs. This was done using historical estimates of employment for male and female, full-time and part-time by 41 industries for local authority districts. Over the years, Cambridge Econometrics has developed employment series by type and gender for Local Authority Districts (LADs) based on data from NOMIS. These were used to convert series from SSRs to GORs. Details of definitions of the GORs and their relationship to the LLSCs are shown in Table 14.

Regional productivity by industry, and employment data for counties, were used to make estimates of GDP for the area which had to be reallocated from one SSR to another in order to define GORs. Other variables were treated in an analagous fashion, using data from CE's counties databank to do the reallocation and create historical data.

More information on output has subsequently become available for the GORs. The most recent regional accounts include output data to 1999. The model was finally respecified to include the GORs as its regional dimension.

[26] Complete consistency is not possible since the various official sources are themselves inconsistent, not least because some have been subsequently revised and updated by ONS.

11.4 Occupations (25) within industries (41)

The starting point was information taken from the Census of Population (CoP) for 1981 and 1991. This was supplemented by information from the Labour Force Survey (LFS). Industry by occupation employment estimates were produced for 1981 and 1991, for the standard regions (SSRs) and using SOC 1990 systems of classification. Details of the occupational groupings are shown in Table 12. Occupational employment estimates were taken from the CoP for both 1981 and 1991, and sectoral data from Census of Employment (CoE) (and more recently from the Annual Employment Survey (AES) and the ABI). Together these were used to generate a series of employment matrices based on 41 industries (SIC92) and the old 22 SOC 1990 Sub-Major occupational groups. These were then converted to 25 SOC 2000 sub-major groups using data from ONS to give the occupational categories shown in Table 13.

The conversion process is based on matrices for 1991, from the Census, for England and Wales and similar data for the LFS. These matrices distinguish gender. They cross classify the detailed (2 digit) occupational categories by both SOC 1990 and SOC 2000 categories. The matrices are then customised to reflect variations in detailed occupational composition, within sectors and over time, to develop a series of convertor matrices at a SOC sub-major group level, by MDM industry and by year. This approach avoids the worst implications of applying a fixed convertor.

Historical data on occupational employment for the Government Office Regions (GOR) areas were then developed by assuming the same occupational structure within industries as for the old SSRs. RAS procedures were used to ensure that these all added up consistently.

The CoP data for 1981 and 1991 were enhanced by use of the Labour Force Survey in order to provide more up to date information on on-going trends by occupation beyond 1991.

11.5 Taking into account data from the 2001 Census

The publication of data from the 2001 Census has allowed a reassessment of the conversion process described above. It is clear from this review that the conversion process does not track the changes in occupational structure with full precision. By 2001 a gap had opened up between the converted data and the Census 2001 estimates of occupational employment structure. A further series of adjustments were therefore applied in these latest results to allow for “conversion error”. This was undertaken just at an aggregate level, over all sectors.

The LFS also provides data on occupational structure. However because of its limited sample size, the use of Census data is essential in obtaining robust estimates at the level of detail required.

11.6 The detailed industrial estimates

In order to meet the requirements of the SSDA to extend the occupational analysis to a more detailed industrial level, this ***Database*** needed to be extended to cover the additional 2-digit SIC2003 categories not previously covered. Since the cornerstone of the new employment projections is RMDM, this implies the need to obtain industrial data on output as well as employment. The new employment (and output) ***Database*** has been developed specifically in order to meet the requirements of the present set of projections.

The extension of the historical industrial employment elements from the 41 industries used in RMDM to the 67 2-digit categories required by the SSDA involves disaggregating each of the 41 industries which comprise more that a single 2-digit SIC category. In principle, this is

straightforward, although it is not quite so easy in practice. ONS/DfES currently publish sectoral employment data at this level of detail (now based on the Annual Business Inquiry (ABI)). These distinguish all the SIC 1992 2-digit categories at a UK level. This includes breakdowns by gender and full-time /part-time status. However, self employment data are not available. Breaks by occupation and spatial area are also much more problematic.

Gaps in the official data were filled by assuming common patterns to those in the nearest available aggregate group. RAS procedures were used to ensure everything added up to the official published figures.

11.7 Creation of UK historical output data for the new industries

Output estimates for the additional industries were produced using methods as set out in Section 3. The first step was to construct a time series 1971-2001 of value-added in £1995m constant prices for the SSDA 67 sectors. A number of data sets, all available from the Office for National Statistics (ONS), were used to disaggregate the MDM industry data 1971-2001 to match the SSDA detailed industries:

- detailed index of production (IoP)
- GDPO index of output
- 1995 weights: i.e. proportion of industry output in total output
- supply and use tables 1992-2000 (SUTS)

Regional equivalents were generated as described in Section 4.

Table 14: Government Office Regions and LLSCs

Local LSC	Region	LSC code (full)	LSC code (4 digit)	NOMIS order
London North	GL	GL120	GL12	33
London West	GL	GL130	GL13	35
London Central	GL	GL140	GL14	31
London East	GL	GL150	GL15	32
London South	GL	GL160	GL16	34
Milton Keynes, Oxfordshire, Buckinghamshire	SE	SE260	SE26	40
Berkshire	SE	SE270	SE27	36
Hampshire and Isle of Wight	SE	SE280	SE28	38
Surrey	SE	SE290	SE29	41
Sussex	SE	SE300	SE30	37
Kent and Medway	SE	SE310	SE31	39
Norfolk	EE	EE060	EE06	29
Cambridgeshire	EE	EE070	EE07	26
Suffolk	EE	EE080	EE08	30
(Luton and) Bedfordshire	EE	EE090	EE09	25
Hertfordshire	EE	EE100	EE10	28
Essex	EE	EE110	EE11	27
Devon and Cornwall	SW	SW320	SW32	44
Somerset	SW	SW330	SW33	46
Bournemouth, Dorset & Poole	SW	SW340	SW34	43
West of England	SW	SW350	SW35	42
Wiltshire (and Swindon)	SW	SW360	SW36	47
Gloucestershire	SW	SW370	SW37	45
Shropshire	WM	WM380	WM38	22
Staffordshire	WM	WM390	WM39	23
Black Country	WM	WM400	WM40	24
Birmingham and Solihull	WM	WM410	WM41	19
Herefordshire and Worcestershire	WM	WM420	WM42	21
Coventry and Warwickshire	WM	WM430	WM43	20
Derbyshire	EM	EM010	EM01	14
Nottinghamshire	EM	EM020	EM02	18
Lincolnshire and Rutland	EM	EM030	EM03	16
Leicestershire	EM	EM040	EM04	15
Northamptonshire	EM	EM050	EM05	17
North Yorkshire	YH	YH440	YH44	11
West Yorkshire	YH	YH450	YH45	13
South Yorkshire	YH	YH460	YH46	12
Humberside	YH	YH470	YH47	10
Lancashire	NW	NW220	NW22	8
Greater Merseyside	NW	NW230	NW23	9
Greater Manchester	NW	NW240	NW24	7
Cheshire and Warrington	NW	NW250	NW25	5
Northumberland	NE	NE170	NE17	2
Tyne and Wear	NE	NE180	NE18	4
County Durham	NE	NE190	NE19	1
Tees Valley	NE	NE200	NE20	3
Cumbria	NE	NW210	NW21	6

11.8 Estimates of Output and Employment by LLSC: Expanding the spatial dimension

CE/IER have previously developed models and procedures that allow the generation of estimates for smaller geographical areas, such as those covered by LLSCs. This provides a firm foundation upon which to build the kind of database that the SSDA and its partners required. Using these methods, the country and regional results have been further disaggregated to generate information on output and employment for the 47 Local LSCs. Details are given in Section 4.

This results in the development of the full LLSC ***Database***, which includes employment data by sector, gender and type, and where the estimates have been constrained to be consistent with corresponding data in the regions and the UK.

The starting points are the ABI 2000, 2001 employment data for the LLSCs for 41 sectors. Employment time series data are generated for the 47 LLSCs by gender and status for 41 sectors. Data by gender and status are generated and scaled to corresponding regional data.

They are then extended to cover occupations, assuming common patterns of occupational structure within industries as those in the region as a whole.

This ***Database*** is the foundation for the projections for the LLSC areas. The projections are developed using a model that relates local area performance in an industry to performance in the same industry in the region and the UK over the recent past. This is based on the methodology for producing multi-local area forecasts for the Local Economy Forecasting Model (LEFM). Further details are given in Section 11.12.

11.9 Extending the occupational analysis to cover 67 sectors

Extending the *historical data* on occupations to include the 67 detailed industries is problematic. Ideally, it would involve going back to the 1991 Census (and ideally 1981 as well) and extracting data for the additional industries and local areas. As described above, the original employment estimates produced for the DfES projections do this for the 41 SAM industries. In practice, extending this data set to cover the additional industries is problematic for a number of reasons. Most importantly both SIC and SOC have changed significantly. In addition, the earlier data were only made available for a 10 per cent (hard copy) or 2 per cent (electronic) sub samples, which makes obtaining robust estimates at this level of detail difficult, if not impossible in many cases. The LFS sample size is only adequate to obtain reliable estimates at a UK level, and even here is not able to provide robust estimates for many of the additional industries required, (which almost by definition tend to be small).

In the current analysis, historical figures for the additional industries were estimated using information already to hand.[27] These historical series were then constrained to match the other estimates at more aggregate levels. Given that most of the new industries are normally small components of larger parts, this procedure generates reasonably plausible results. An RAS iterative procedure was then used to ensure that everything still adds up to the published headline totals by industry, occupation, region, etc. This RAS adjustment is not a trivial process. The software used to generate a consistent ***Database*** runs to thousands of

[27] A more comprehensive reassessment of the historical record, involving re-interrogation of old Census records could be undertaken. However, given time and resource constraints, it was decided not to attempt this in the current phase of work.

lines of complex computer code. This procedure avoids the major inconsistencies that would otherwise emerge between the published headline figures reported by ONS and the sum of the detailed parts.

Extension of the occupational model and ***Database*** to cover the additional industries ideally requires new and additional data on occupational employment for the additional industries. Given the limitations of the LFS in terms of sample size, a key input here is information from the 2001 Census of Population.

11.10 Development of new Regional Figures Consistent with the Census

The availability of English regional estimates from the Census data also offered the possibility of constraining the regional estimates to match these. As noted above, the ONS files also contained England & Wales and regional totals.

The figures from the CE/IER models were constrained to match, as far as possible, these values (in terms of percentage shares at least). A complete match was not possible because of inconsistencies between the Census estimates and the CE/IER ABI based data.

There were two main steps:

i. To develop a consistent set of Regional targets, that (as far as possible) matched the various data sets, including the ONS 2001 Census figures and CE/IER employment estimates.
ii. To apply these to the detailed data to obtain a fully consistent dataset at regional level.

Step 1

The aim of this step was to use the Census 2001 data to develop a set of constraints so that the final estimates reflected the observed occupational structure within each English Region, as revealed by the Census 2001. This required that the Census data for 2001 were processed to give a consistent array of employment:

- 12 Regions (rows) by
- 9 SOC major occupational groups (columns)

for males and females separately. The regions included the countries of Wales, Scotland and Northern Ireland. The key elements are described in Table 15.

The ***Row targets*** were the total levels of employment in each Region in 2001 by gender from the CE/IER RMDM dataset (12 numbers each for males and females) This is referred to as $\mathbf{RR_k}$ where k runs from 1 to 12.

The ***Column targets*** **($\mathbf{RC_j}$)** were the CE/IER RMDM estimates of total occupational employment by the 9 SOC major groups for the UK (j=1,9), for males and females.

The initial array elements $CEC_{k,j}$ were the Census 2001 estimates of occupational structure (proportions of total employment) within each LLSC, multiplied by the ***Row targets***. The proportions came from the D6560 and D6562.xls files and the corresponding Wales, Scotland and Northern Ireland data.

The final values of the array elements were the result of an RAS process to reconcile the original $CEC_{k,j}$ values with the ***Row*** and ***Column targets***. The $CEC_{k,j}$ values are successively scaled by the ratio of the row or column ***target*** to the row or column ***sum*** of the $CEC_{k,j}$ values.

Table 15: Generation of a Consistent set of Regional Targets

Region	Occ1	Occ2	Occ3	Occ4	Occ5	Occ6	Occ7	Occ8	Occ9	Row target
Column target	RC_1	$RC2_2$	RC_3	RC_4	RC_5	RC_6	RC_7	RC_8	RC_9	
LO	$CEC_{1,1}$	$CEC_{1,2}$	$CEC_{1,3}$	$CEC_{1,4}$	$CEC_{1,5}$	$CEC_{1,6}$	$CEC_{1,7}$	$CEC_{1,8}$	$CEC_{1,9}$	RR_1
SE	$CEC_{2,1}$	$CEC_{2,2}$	$CEC_{2,3}$	$CEC_{2,4}$	$CEC_{2,5}$	$CEC_{2,6}$	$CEC_{2,7}$	$CEC_{2,8}$	$CEC_{2,9}$	RR_2
EE	$CEC_{3,1}$	$CEC_{3,2}$	$CEC_{3,3}$	$CEC_{3,4}$	$CEC_{3,5}$	$CEC_{3,6}$	$CEC_{3,7}$	$CEC_{3,8}$	$CEC_{3,9}$	RR_3
SW										RR_4
WM										RR_5
EM				etc						RR_6
NW										RR_7
YH										RR_8
NE										RR_9
WA										RR_{10}
SC										RR_{11}
NI										RR_{12}

Step 2

Having obtained a consistent set of Regional occupational targets, these were used to constrain the more detailed occupation by gender estimates that also have industry and status dimensions.

The full data set also has a time dimension, so the question of how this needs to be rolled out both back in time and into the future also had to be addressed.

The existing occupational model already contained procedures to do this, including generating a full time series. This was done in such a manners so as not to disrupt the UK results. This entailed the development of a further and similar RAS process to those described in more detail below for the LLSC areas (see Sections 11.12-11.15). This resulted in a set of (English) Regional results that were consistent with the original UK estimates, and with the headline estimates of occupational structure (in terms of shares) by region from the 2001 Census. These targets were then used for the more detailed set of regional results (by detailed industry, gender, status and detailed occupation) before extending them to the LLSC level.

11.11 Occupations within LLSC areas

The basic assumptions adopted to generate the occupational estimates at an LLSC level are common occupational structures within each industry as at regional level.

Iterative methods (RAS procedures) are used to ensure that LLSC totals are consistent with other regional targets[28].

The main steps are therefore as follows:

- LFS and CoP data are used to determine overall occupational structure at LLSC level.
- These figures are constrained to match regional totals, using a RAS procedure (ensuring consistency by occupation, gender and status for all LLSC areas).

[28] For details of the RAS procedures, see Section 12.

- A final RAS process is undertaken to ensure consistency across all the main dimensions (region x 67 industries x gender x status x occupation).

These are now described in greater detail.

11.12 Developing the Local LSC Results: Detailed Technical Description

As noted above, at national and regional level, the following data arrays were generated:

67 arrays (1 for each of the most detailed industries) containing:

- 32 years (1981-2014);
- 25 occupations (SOC 2000, Sub-major groups);
- 6 gender status categories (FT/PT/SE).

Procedures were developed to generate LLSC versions of these. The LLSC arrays sum across LLSCs to get regions (and then sum across regions to get the UK).

The regional results (and UK ones) were produced first, using the standard CE RMDM methodology, combined with the IER's occupational model, as described above in Sections 4 and 11.3-11.9 above.

The LLSC level results were obtained using a similar procedure to that adopted in CE/IER's Local Economy Forecasting Model (LEFM). This involved a process of establishing relationships between the local data, disaggregated by industry and the regional equivalents. The data were constrained to meet various local constraints. The new method differs in a number of respects from the LEFM approach as detailed below.

The standard LEFM method involves:

1. Extracting ABI based sectoral data to produce the historical foundation for the analysis.
2. Generating local sectoral trends using regression analysis, which form the basis of the projections by sector.
3. Expanding this to cover gender and status within each sector.
4. Applying local, industry and gender status specific, occupational structures using the assumption of common occupational structures within industries using a programme called LEDAP.
5. Invoking an iterative RAS process to ensure that the local occupational structure at a SOC sub-major group level matches the structure from the 1991 Census.

Together, steps 4. and 5. generate local occupational employment structures consistent with Census of Population and other data.

In the approach adopted here, the first 3 steps were replaced by CE's new method for generating the sectoral data at an LLSC data, as described in Section 11.8 above. The CE estimates by industry and gender/status were already in a form that ensures adding up to regional totals.

Steps 4-6 were replaced by methods which are, in many respects, analogous to the LEFM / LEDAP process. These involved generating occupational employment structures by gender and status for each industry within the LLSC. As for LEFM, this was done by generating LLSC results by occupation, assuming a common structure to the regional level within each industry and gender / status category. RAS processes were used to ensure consistency and adding up to regional totals by industry and gender /status.

Unlike the LEFM / LEDAP method, this was done for all LLSC regions simultaneously.

The results from this process were applied to the CE sectoral data to get the first round estimates of employment levels by occupation.

However, it is desirable to ensure that, as far as possible, the LLSC data match independent Census 2001 estimates and that they sum to the desired regional totals. The former objective can only be achieved in part due to inconsistencies between the Census data and other sources. The latter can be strictly enforced. In order to achieve these objectives, the detailed estimates of employment levels were adjusted using a RAS procedure, across groups of LLSCs to match regional totals. This process is described in detail below.

11.13 Use of data from the Census of Population 2001

As noted above, the Census 2001 data were used to impose high level constraints at national level and also at a LLSC level.

These include aggregate LLSC results by SOC Major group, summed across all industries and status categories. These were constrained to match the overall regional figures or targets (obtained as described in Section 11.10).

Aggregate data on LLSC occupational structure were obtained from publicly available ONS Census files. These included *D6580.xls* and the separate estimates for males and females in the files *D6560.xls* and *D6562.xls*. These files contain LAD data by 9 major occupational groups. By summing over LADs, LLSC estimates were generated. The ONS files also contain England & Wales and regional totals.

The figures from the CE/IER models were constrained to match, as far as possible, these values (in terms of % shares at least). A complete match is not possible because of inconsistencies in the Census estimates and the CE/IER ABI based data.

There were two main steps:

1) **Step 1**, to develop a consistent set of LLSC targets, that (as far as possible) reconcile the various data sets, including the ONS 2001 Census figures and CE/IER employment estimates (the latter based on the various other sources used to generate the initial Regional estimates);
2) **Step 2,** to apply these to the detailed employment estimates in order to obtain a fully consistent dataset.

Step 1

The aim of this step was to use the Census 2001 data to impose a set of constraints so that the final estimates reflect the observed occupational structure within each LLSC as revealed by the Census 2001. This requires that the Census data for 2001 were first processed to give an array of employment levels:

- 47 LLSCs (rows) by
- 9 SOC major occupational groups (columns)

for males and females separately, that is consistent with the ABI based employment estimates produced at regional level by the CE/IER RMDM model. The key elements are shown in Table 16.

The ***Row targets*** were the total levels of employment in each LLSC in 2001 by gender from the CE/IER RMDM dataset (47 numbers each for males and females). This is referred to as $\mathbf{CER_k}$, where k runs from 1 to 47. For some purposes it may be easier to conceive of 9 sets of row targets, grouped into the 9 English Regions (i.e. 9 sets of **k**s, the number of elements in each set depending upon the number of LLSCs within each region).

The ***Column targets*** were the CE/IER RMDM estimates of total occupational employment by SOC major group in each region, for males and females, (where k=1,9 are the English Regions and j =1,9 the SOC 2000 occupational major groups ($\mathbf{CEC_{k,j}}$)). There were therefore 9 sets of occupational targets, one set for each region.[29]

The initial array elements $A_{i,j}$ are the Census 2001 estimates of occupational structure (proportions of total employment) within each LLSC, multiplied by the Row targets. The proportions come from the D6560 and D6562.xls files.

The final values of the array elements are the result of an RAS process to reconcile the original $A_{i,j}$ values with the row and column targets. The $A_{i,j}$ values are successively scaled by the ratio of the row or column ***target*** to the row or column ***sum*** of the $A_{i,j}$ values.

Step 2

Having obtained a consistent set of LLSC occupational targets these were used to constrain the more detailed occupation by gender estimates that also have industry and status dimensions.

The full data set also has a time dimension, so the question of how this needs to be rolled out both back in time and into the future was also addressed.

The results from the main regional occupational model provided the other set of detailed targets that the final RAS process needed to meet.

A prior stage created an amended set of regional results that met these constraints, (as set out in Section 11.10).

11.14 Generating consistent estimates for 2001

The first stage was to generate a consistent set of estimates for 2001. This was done for each gender separately.

The process described in Step 1 above generated, for each region (and for each gender), a set of **LLSC targets** of occupational employment by SOC major group. There were 9 of these for each LLSC (for each gender). The number of sets of these within each region varied, on average there were 5 sets. In total, across all the regions, there were, of course 47 such sets. As a group, *within each region*, these targets provided one wing of the RAS process.

The second wing was provided by the detailed estimates of employment from the CE/IER regional models. These formed the **Regional targets**. These comprised estimates of *detailed* occupational employment (25 SOC sub-major groups), by industry, by status and by

[29] A regional adjustment was applied prior to this to ensure the overall regional results form the Census were reflected in the results. This entailed a further and similar RAS process to that described here, to end up with a set of (English) Regional targets that were consistent with the UK estimates. This involved using data for Scotland, Wales and NI as well.

gender, *for the region as a whole*. Given that this was done separately for each gender, there were some 5025 targets (25 SOC * 67 industries* 3 status groups) for each region.

The key steps in the RAS process were then:
i) The detailed LLSC results across these various dimensions were summed (for each gender separately) across all the LLSCs within any region and the results compared to the regional targets. Ratios of the *Regional target* to this *sum* were formed and these ***5025 ratios*** were used to scale every corresponding element in the array.

ii) The full set of detailed results were then summed to get revised occupational major group totals for each LLSC (again for males and females separately). The ***9 x 5 (or so) ratios*** of the *LLSC target* to this sum were then formed and applied to each corresponding element in the aggregated array. This was done for every SOC sub-major group within a SOC major group, for every industry and for every status category.

Steps i) and ii) were repeated until the solution converged.

11.15 Results for all other years

In principle, this process needed to be rolled out to cover all the historical estimates and the forecasts, (the full database covers 1981-2014). In practice, there were no Census data to provide the constraints developed in Step 1.

In order to reflect the same kinds of adjustments, the following procedures were adopted.

Before (the RAS) and **after** (the RAS) adjustment factors were calculated for 2001, separately for each gender. There are effectively 5025 of these ratios (one for each SOC sub-major group, each industry and each status category),for each LLSC.
These ratios were then applied to the corresponding estimates for all other years.
These revised figures were then constrained to match the 5025 regional totals (distinguishing, occupational sub-major group, industry status and, of course, gender).
A further RAS process was developed to ensure that they matched the CE LLSC estimates by industry and gender based on ABI and other sources (as described in Section 11.8). These procedures imposed the constraint that they do match (when summed over all occupations). Step iii) and step iv) were then repeated and a new check carried out until the process converged.

Table 16: Generation of a Consistent set of LLSC targets

LLSC	Occ1	Occ2	Occ3	Occ4	Occ5	Occ6	Occ7	Occ8	Occ9	OccTotal
EM total	$CEC_{1,1}$	$CEC_{1,2}$	$CEC_{1,3}$	$CEC_{1,4}$	$CEC_{1,5}$	$CEC_{1,6}$	$CEC_{1,7}$	$CEC_{1,8}$	$CEC_{1,9}$	
EM010										CER_1
EM020										CER_2
EM030				$A_{i,j}$						CER_3
EM040										CER_4
EM050										CER_5
EE total	$CEC_{2,1}$	$CEC_{2,2}$	$CEC_{2,3}$	$CEC_{2,4}$	$CEC_{2,5}$	$CEC_{2,6}$	$CEC_{2,7}$	$CEC_{2,8}$	$CEC_{2,9}$	
EE060										CER_6
EE070										CER_7
EE080					$A_{i,j}$					CER_8
EE090										CER_9
EE100										CER_{10}
EE110										etc
GL total	$CEC_{3,1}$	$CEC_{3,2}$	$CEC_{3,3}$	$CEC_{3,4}$	$CEC_{3,5}$	$CEC_{3,6}$	$CEC_{3,7}$	$CEC_{3,8}$	$CEC_{3,9}$	
GL120										
GL130										
GL140					$A_{i,j}$					
GL150										
GL160										
NE total	etc									
NE170										
NE180					$A_{i,j}$					
NE190										
NE200										
NW total	etc									
NW210										
NW220										
NW230										
NW240										
NW250										
SE total										
SE260										
SE270										
SE280										
SE290										
SE300										
SE310										
SW total										
SW320										
SW330										
SW340										
SW350										
SW360										
SW370										
WM total										
WM380										
WM390										
WM400										
WM410										
WM420										
WM430										
YH total										
YH440										
YH450										
YH460										
YH470										

12 Sources and General Methods

12.1 Main Sources

The Office for National Statistics (ONS) is responsible for most of the economic and labour market statistics upon which this analysis is based. Many of the data are made available via the National Online Manpower Information System (NOMIS).

ONS is responsible for most of the key economic statistics upon which RMDM is based, including the UK National Accounts and the Input-output Tables. This includes indicators such as:
Output and related indicators;
Wages and prices;
Trade statistics;
UK Balance of Payments;
Regional Accounts.

ONS is also responsible for the Annual Business Inquiry (ABI). As well as providing information on output, this is the most important source of information on industry employment levels.

ONS also undertakes the regular Labour Force Survey (LFS) as well as the more infrequent Census of Population. These two sources provide information on key aspects of employment structure such as occupational employment, self employment and the various information on flows and age structure needed for the replacement demand estimates.

12.2 General Approach and Methods

The general approach adopted can be summarised in a few words:

Underlying the whole set of projections is the use of a detailed multi-sectoral macroeconomic model. This is described in Sections 3 and 4 above.

All published official data on employment have been used. The data within the models and data base are constrained to match the official sources.

Where there are inconsistencies between official sources, the industrial information (currently ABI based) is given precedence.

All the employment data are constrained to match headline figures published by ONS in Labour Market Trends and similar publications. This is achieved using so called RAS iterative methods as described below.

Where no official data are published, estimates are generated by assuming common patterns to the next level of aggregation up at which official estimates are available.

Occupational estimates and self employment estimates are based on information from the Census of Population and the LFS.

12.3 The RAS Iterative Process

The detailed employment data can be conceived of in terms of multi-dimensional arrays with the following dimensions:

Industries (67 2 digit SIC categories);
Geographical areas (47 English LLSC areas plus the 3 other countries within the UK);
Occupations (25 sub major groups of SOC 2000);
Gender;
Status (full-time, part-time, self employment);
Time (years from 1981-2014).

ONS publish various headline statistics for certain aggregate elements of these arrays (typically sums across one or more dimensions).

An iterative process, based on the so-called RAS procedure, is used to develop the detailed elements within the arrays in such a way that the various constraints are met.

In two dimensions, a RAS procedure involves taking a two dimensional matrix of numbers and progressively and alternatively:
forming row or column totals;
calculating a ratio of these compared with some target values (typically provided by ONS figures);
multiplying the rows or columns of the array by that ratio;
re-summing and repeating the process.

Typically this process delivers a new array which matches the desired row and column totals within a comparatively few iterations (normally 20-30).

In developing the database complex procedures have been developed which repeat this essentially simple process across all the dimensions above simultaneously, using constraints, which are, more often than not, incomplete.

12.4 Treatment of Agriculture

The Agriculture, Forestry and Fishing sector poses some particular problems. There is a paucity of data in official sources for this sector. The ABI and its predecessors have all had problems in obtaining comprehensive coverage of this sector. In the ABI 2001 (i.e. the most recent ABI data), some information is provided on Agriculture at regional level. However, at LLSC area level there is a Nomis flag for the heading 01: Agriculture, hunting, etc, which states: "that these figures are aggregates from which agriculture class 0100 (1992 SIC) has been excluded".

Hence there is a difference in data availability at regional and sub-regional level. MAFF have undertaken their own surveys, which are on a somewhat different basis (including “unpaid” family workers, for example). ONS and IER/CE are aware of these problems and have attempted to take them into account when providing overall employment estimates by adopting scaling procedures to ensure that spatial disaggregates sum to national and regional totals. However, the limitations of these estimates need to be flagged up to users.

12.5 Northern Ireland

Data for Northern Ireland are collected and published on a different basis to those for Great Britain. The present estimates make use of all published data. Gaps are filled by the same kinds of procedures adopted for producing the additional sectors and geographical areas as described in Section 11. The estimates for Northern Ireland should be regarded as indicative of general trends and not precise estimates of employment levels.

13 LLSC Level Results

13.1 Rationale for producing local level projections and their limitations

These notes are intended to accompany the detailed occupational employment projections produced for the Local arms of the Learning and Skills Council (LLSCs). They explain how the numbers have been generated and their limitations.

The changing policy environment for skills has placed renewed emphasis on the local level, resulting in a demand for ever more detailed information, focussing on local trends. The main aim of generating local projections is to provide a quantitative benchmark of labour market prospects for the local area concerned. This is based on the same macroeconomic scenario and assumptions as for the broader national projections.

It is important to emphasise that these local level projections are based solely on secondary data sources as described below. The local results are tied to the particular national and regional scenario described in the *National Report*, Wilson *et al.* (2006a). They do not incorporate any specific local knowledge or insight and are intended as a starting point for further analysis rather than a projection of what is most likely to happen. They represent one possible future, based on the assumption that employment patterns in the LLSC area continue to maintain the same relationship with the regional level as in the recent past. Sectors which have performed relatively poorly, are assumed to continue to do so and *vice versa*. This is not inevitable. In particular it does not take into account any local "surprises". These may be welcome (such as a major inward investment), or not (as in the case of a major closure). Moreover, local agencies and organisations may be able to break away from past trends. The results should be seen as providing a starting point for debate rather than the final word.

Key drivers of changing skill requirements at local level are similar to those at national level. These include:

- *technological change* - especially information and communications technology (ICT), which is affecting both the products and services produced as well as the way they are produced, resulting in increased demands for IT skills across a range of sectors and occupations;
- *competition and changing patterns of consumer demand* - which have increased the emphasis on customer handling skills;
- *structural changes* - including globalisation, sub-contracting and extension of supply chains, emphasising the need for high quality managerial skills (across a greater range than previously and at a greater depth) at various levels;
- *working practices* - such as the introduction of team- or cell-based production in engineering, and call centres in financial services, resulting in increased demand for communication and team working skills; while more generally there has been an increase in labour market flexibility; and
- *regulatory changes* - as well as increased concern about environmental issues, which have made important skill demands upon staff for some key sectors, including construction and finance; (survey evidence suggests that regulatory/legislative change is a particularly important driver of skills change in the public sector).

The results at a local level reflect all these factors although they are not dealt with explicitly in the local case.

The production of such a set of projections for a particular LLSC area should not be seen as the end of the process. Rather it is best regarded as part of an ongoing process of improving understanding about what is going on in the local area. This understanding can

then guide local policy makers and other actors (including individual workers, students and employers) to better decisions. The main benefits can be summarised as follows:

- The aims and objectives of policy intervention can be made clearer and the ability to evaluate policy can help, hopefully, to establish a virtuous circle.
- Such projections can provide a focus for discussion and co-operation and may help to breakdown old misperceptions about local markets.
- The projections should enable those involved to take more strategic actions, rather than a fire-fighting approach to problems, as the implications of current trends and outcomes for the future are explicitly explored.
- Finally, the projections can also provide guidance to individual actors (including employers and (potential) employees) enabling them to make better decisions about their own futures.

13.2 Limitations of the data

As noted above, the two *Working Futures* projects have required forecasting over half a million individual time series.[30] This is has involved generating a very detailed employment database – by far the most detailed ever produced for the UK – and in this respect, the projects have already generated considerable value added. However, it is important to recognise that the data are not without limitations. This gives rise to a number of concerns about how the data should be used and reported. The limitations arise from two elements of the procedure which has been used to produce the projections. First, the projections are based upon survey data that were not originally designed or developed to produce precise estimates at this level of disaggregation. Second, the survey data have been used to calibrate an econometric forecasting model and a set of disaggregation procedures. Forecasting is as much an art as a science and requires considerable judgement on the part of the researcher especially when the forecast horizon is as much as 10 years ahead. Any errors in the forecaster's ability to predict the future will result in inaccuracies in the projections. These will be amplified the further into the future that the projections are considered, due to the inter-linkages between the sectors and regions, and the feedback mechanisms, which permeate the model structure. The extent to which the historical base is inaccurate due to the first data limitation further exacerbates this problem.

It is important to note that the greater the sectoral and spatial disaggregation the more sensitive the results will be, as some sectors are expected to be very small and at the same time exhibiting large variations.

When considering this question a distinction needs to be made between statistical reliability and the provision of useful LMI at a detailed level. If strict rules regarding statistical robustness are applied to decide what level of sectoral and occupational disaggregation can be provided at LLSC, there is a danger of throwing the baby out with the bath water. The official surveys carried out by ONS are (with a few exceptions) not designed to provide statistically robust estimates at this level of detail. Following such rules would restrict what might be reported to very broad aggregates, which are not very helpful to those in the LLSCs and SSCs charged with monitoring detailed trends.

IER/CE have addressed this issue for a number of years in providing results based on their Local Economy Forecasting Model (LEFM) methodology. This is based on the notion of providing "benchmark" estimates and projections, using the most detailed data where they are available for the local level, in combination with broader national and regional trends where they are not. While not subject to the normal tests of statistical precision, such

[30] That is: Sector (67) * occupation (25) * LLSC (47 areas plus Scotland, Wales and Northern Ireland) * gender/status (6) = 512,550 separate time series.

estimates can provide useful and informative LMI for those operating at the local level. Other consultants have adopted similar solutions.

In providing such information it is important that the user is aware of its limitations (as well as avoiding any problems of confidentiality). However, this is arguably much more useful than suppressing the detail at an early stage. This solution requires that such detailed information is only made available to a restricted audience. It is also necessary to ensure that this audience is aware of its limitations and responsible in its use and dissemination.

Thus, while the projections of employment are based on best practice, both the historic patterns of employment and the forecast projections have inbuilt uncertainties of differing kinds. These uncertainties need to be considered when utilising the data. Forecasts of this kind should not be regarded as suitable for detailed manpower planning. Rather they should be considered to be benchmarks for consideration of likely future trends.[31] Above and beyond this general caution, it is useful to provide users with some additional guidelines to interpreting and utilising the historic and forecast data.

The next sub-section outlines the issues involved in developing such guidelines, and suggests some 'rules of thumb' for publication and for unpublished data analysis. There are two main issues to consider when developing a set of guidelines to interpreting and using the data:

- statistical precision and robustness;
- confidentiality.

The first issue is discussed in more general terms in Section 14. The second is discussed in detail in Section 15.

13.3 Problems and Issues in developing guidelines

First, it should be emphasised that any recommended guidelines can only ever be 'rules of thumb', rather than based on precise statistical analysis. Given the nature of the data, which have been constructed from a variety of different sources, it is not possible to attach precise margins of error to the historic estimates. For example, while the FT/PT status information comes from the ABI, the SE numbers are derived from the LFS. The latter is a considerably smaller database and thus has larger margins of error. Moreover, given the complexity of the forecasting model, and the subsequent RAS-based disaggregation methodologies, it is not possible to generate 'forecast errors' such as those that would be available from a single equation forecasting methodology. However, some general 'rules of thumb' can be recommended for using the data. These are based on the statistical rules adopted by ONS when publishing employment estimates.

ONS recommend using minimum cell sizes of 10,000 (grossed up), when presenting data based on the LFS. This is based on standard statistical theory and reflects the size and structure of the LFS sample. This is therefore a sensible 'rule of thumb' to adopt when *publishing* estimates which are based on such data. Given that there are 25 SOC Sub-Major group occupations to be distinguished in each sector, this suggests a minimum size for an industry of at least 250,000. The sectors chosen as the basis for reporting in the *National Report* all meet this criterion.

[31] As an example, if a proportion is forecast to change from, say, 47% to 53% over the course of the next decade, this should be interpreted as saying that the proportion will remain around one half (and possibly rise), rather than concluding that it is going to increase by precisely 6 percentage points.

The full Database provides estimates of employment at a much greater level of detail than this criterion would permit. These have been constructed by using the information that ONS/DfES *are* prepared to publish, including the raw ABI data (which are subject to frequent revision). Such estimates can provide useful information and intelligence to users about detailed employment levels and trends. However, some caution is required when using such data and there are strict limitations on what can be published by the user due to concerns about confidentiality.

The *Working Futures* employment estimates reflect the 2003 ABI and related revisions. ONS have recently published revised aggregate time series data and these have also been incorporated into the estimation procedures. The time series data currently made available by ONS for Great Britain are adequate to provide most, but not quite all, of the 67 detailed industry categories (see the discussion in Section 14 below).

At a regional level, the problems are more acute. ONS are not prepared to release data at such a detailed industrial level when cross-classified by region. Apart from construction, the categories normally separated out by ONS all form part of the service sector. Only broad aggregates are made available for the other sectors.

These problems are even more severe at a local level. For LLSC areas, a very large number of the 67 detailed industries fall far short of the 10,000 criterion (again, see the discussion in Section 14 for further details). Even at a regional level, a number of the detailed industries are problematic. In many cases, this is because there simply is no employment in that category. In others the numbers are too small to satisfy ONS's concerns about confidentiality. In particular, many of the 67 detailed industry categories would fall foul of the terms of *Statistics of Trade Act* at an LLSC level, even if the estimates were statistically robust.

The above discussion highlights that there are real problems in developing reliable data at the levels of detail that analysts and policy makers within SSDA and its partners would ideally like to have access to.[32] One response to this would be to limit the amount of detail at which the projections work is undertaken. This would be very restrictive and would severely limit the level of detail that could be made available to those with an interest in such information, both within sectors and at an LLSC level. Instead, a less restrictive approach has been adopted here. When generating the projections, full details have been maintained, while maintaining a strict control on the release of such data into the public domain to prevent misuse.

A clear distinction needs to be made between statistical reliability and the provision of useful labour market information (LMI) at a detailed level. If strict rules regarding statistical robustness are applied to decide what level of sectoral and occupational disaggregation can be provided at the LLSC level, it would not be possible to provide much detailed data at all. The official surveys carried out by ONS are (with a few exceptions) not designed to provide statistically robust estimates at this level of detail. Following such rules would restrict what might be reported to very broad aggregates, which are not very helpful to most users. However, in providing such detailed information it is important that users are aware of its limitations (as well as avoiding any problems arising over confidentiality). Nevertheless, it is arguable that this is more useful than suppressing the detail.

The reliability of both the historical and forecast data will fall with greater sectoral and spatial disaggregation. Accordingly, it has been necessary to agree precisely at what level of aggregation public access should be made available and what restrictions need to be placed

[32] Note also that this discussion refers to total employment, across all occupations. Adding an occupational dimension exacerbates the problem enormously.

upon the use of the data and the further dissemination of information based on this material. These considerations need not inhibit the presentation of the most detailed information, complete with the appropriate caveats, to groups of users within LLSCs and the SSCs, for example. However, such users need to be made aware of the limitations of these data and of the legal constraints on their use. Note that all users must be covered by a Chancellor of the Exchequer's 'Notice' (as is required for access to the ABI data via NOMIS).

In order to stay within the terms of *the Statistics of Trade Act,* limits have had to be imposed on how far to go in placing the most detailed data into the public domain. For *published* documents and information generally available on public websites, the 25 industries defined in the *National Report* set the limits at a UK level. This is broadly consistent with the limits set by ONS for the LFS, given the requirement to report on occupational detail *within* industry. At regional level a more limited number of sectors is appropriate. Any data to be published at an LLSC level would need to be even more aggregated.

In developing the rules, three possibilities were explored:

i. The first was to adopt a common set of categories across all geographies that ensure that all the data provided were both statistically robust and did not fall foul of the confidentiality constraints, regardless of the level of spatial detail. This would ensure that comparable data are available for all areas. However, it would have implied quite draconian criteria in order to ensure that the smallest areas meet the constraints, especially when breakdowns by gender, employment status and occupation are included.

ii. The second alternative was to try to develop a general set of rules regarding dis-aggregation based on individual cases. This would allow for more detail in some local areas than in others but would make comparison across areas more problematic. However, it would be incredibly time-consuming to develop such a piecemeal scheme and for this reason it was not adopted.

iii. The third possibility was to allow users to access different levels of sectoral and other detail, depending upon the geographical area covered and the size of employment in the cells concerned. Using the rules adopted by ONS for publication of LFS and other data as a guide, rules of thumb have been developed to guide users as to what is publishable and what is not.

The basic rule adopted is that individual cells to be reported should not contain fewer than 10,000 people. In most cases, the broader categories adopted in the *National* and *Regional Reports* meet this criterion (as long as the data are not cross-classified by another major dimension such as occupation). For example, the 25-fold industry breakdown used in the published reports is certainly feasible for most of the regions and countries of the UK, if occupation is not also used. However, including occupation as well poses serious risks of problems of statistical imprecision.

Thus for data to be *published*, it is recommended that a general rule of a minimum of 10,000 individuals per cell be adopted. While the ABI would technically permit a smaller minimum for the historic series on industrial employment estimates, the projections also use LFS data to supply self-employed statistics as well as breaks by occupation. There is also the issue of forecast errors in any analysis involving projections for the future. Using a single criterion provides a simpler rule than adopting different criteria according to whether historic or future projections are being analysed. However, this is a general guideline and, occasionally, it may be breached for some cross-classifications of the data.

For any *unpublished* analyses of the projections, then a more lenient criterion can be adopted. While essentially arbitrary (given that it is not possible to assign forecast errors), a sensible absolute minimum cut-off could be 1,000 individuals. Figures are rounded within the *National Report* to the nearest 1,000, and thus it would be inappropriate to consider levels or changes which are less than this. However, some degree of decision making on the part of the user still needs to be made, since, for disaggregated sectors, a *change* of 1,000 may be, proportionately, very large, albeit not robust.

For cases in between 1,000 and 10,000, it is difficult to prescribe general rules, and an element of judgement is required of the user. At an industry level, and focussing just on employees, the limits set by ONS in publishing ABI data can be used as a general guide. If ONS do not regard estimates as publishable then the equivalent figures **should not be published**. Where the focus is on self employment or upon occupations an even more stringent cut off should be applied, since these are based on LFS data.

Summary of Guidelines

PUBLISHED DATA: Ideally, a minimum of 10,000 individuals per cell

UNPUBLISHED DATA: An absolute minimum of 1,000 individuals per cell

13.4 Confidentiality

There are a number of important issues regarding the release of very detailed information on employment into the public domain and which need to be carefully considered in the context of using the data. In particular, there are legal restrictions which limit the extent to which such information can be published. Contravening these limits would fall foul of the terms of the *Statistics of Trade Act, 1947* (and its successors), which prohibit publicly collected data being disseminated in such a manner as to enable the identification of individual enterprises or individuals.

The level of detail provided, particularly for the more highly disaggregated series, would allow individual enterprises to be identified in some cases, and thus access has to be restricted.

14 Statistical robustness

14.1 Background

The discussion in Sections 11 and 12 highlighted the problems raised by trying to develop an employment ***Database*** with so many dimensions, given the current data available from official sources. The main problems relate to:

- statistical precision and robustness; and to
- confidentiality.

The first issue is addressed here, the second in the following section.

14.2 Statistical robustness

Although it has been possible to develop a very detailed employment ***Database***, covering all the various dimensions of interest to the SSDA and its partners, it is important to recognise that this has its limitations. Given the various dimensions required (sector, gender, employment status, occupation and local area), the full ***Database*** comprises around half a million time series.[33] Such detailed breakdowns can only ever be indicative, since they are based on survey estimates that were not designed to produce precise estimates at this level of detail.

The rules ONS adopt when publishing employment estimates are briefly summarised below. These can be used as guidelines in assessing the robustness and precision of the data in the ***Database***.

It is important to recognise that, without enormous resources, it is not possible to monitor and quality assure every one of these series. CE/IER have checked to ensure that the basic trends and structural features of the data are sound but it is impossible to check and validate every series, especially at local level. The detailed projections are therefore provided on a *caveat emptor* basis. The aim is to provide a useful benchmark for consideration rather than a fully thought out, local level forecast for each LLSC area.

Given the nature of the ***Database***, which has been constructed from a variety of different sources, it is not possible to attach precise margins of error to the estimates. In order to help users in deciding what weight to attach to the various estimates, some general "rules of thumb" have been developed. These are based loosely on the statistical rules adopted by ONS when publishing employment estimates.

As noted in Section 13, ONS recommend using minimum cell sizes of 10,000 (grossed up), when presenting data based on the LFS. This is relevant for the ***Database,*** since the occupation estimates and self-employed numbers are based primarily on this source. Given that there are 25 occupations to be distinguished in each sector, this suggests a minimum size for an industry of at least 250,000 if occupational data are to be published.

These rules have been used to decide on the levels of detail, which should be published and in indicating the reliability of the more detailed data.

[33] That is: Sector (67) * occupation (25) * LLSC (47 areas plus Scotland, Wales and Northern Ireland) * gender/status (6) = 512,550 separate time series.

14.3 ONS practice on release of employment data

ONS do not publish consistent time series information on employment cross-classified by region (let alone by LLSC area) at the 41 industry level of detail. Detailed information on self employment is even less reliable, being based on the Labour Force Survey (LFS), the sample size of which is inadequate to provide the kind of detail required here. Because of differences in the way data are collected for Northern Ireland, information for the whole of the UK is not available on a consistent basis.

Nevertheless, it is possible to generate ***estimates*** at this level of detail, which are informative, and of use to labour market analysts. These can be constructed by using the information ONS/DfES ***are*** prepared to publish, including the raw ABI data (which have been subject to frequent revision).[34] This involves various procedures of interpolation and adjustment to fill in gaps and to ensure consistency with published headline figures. Such procedures lie at the heart of CE/IER's Local Economy Forecasting Model (LEFM) service, which has been supplying such detailed data to TECs, LECs, LLSCs and other organisations for many years. While not strictly precise in a statistical sense, such estimates can provide useful information and intelligence to users about detailed employment trends. However, the use of such data needs to be handled with care and, as noted above, there are strict limitations on what can be published due to concerns about confidentiality. The latter are discussed in more detail in the next section.

The current employment estimates reflect the 2003 ABI and related revisions. ONS have recently published revised aggregate time series data to match all this. These are also used to constrain the ***Database.*** The time series data currently made available by ONS for Great Britain are adequate to provide most, but not quite all, of the 67 categories required by the SSDA. However, ABI and other data can be used to fill this gap. [35] Most of the additional categories are quite large and so the concerns about statistical reliability and confidentiality are less of problem than for some other SIC 2-digit categories.

At a regional level, the problems are more acute. ONS are not prepared to release data at anywhere near so detailed a sectoral level, when cross-classified by region. Apart from construction, the categories normally separated out by ONS all form part of the service sector (see Table 6). Only broad aggregates are made available for the other sectors.

These problems are much more severe at a local level. For LLSC areas the position is that a very large number of the detailed sectors are problematic. No LLSC is without problem sectors. Even at a regional and national level a number of industries are problematic. In metal ores, for example, all 3 countries within Great Britain are too small to be published. In many cases this is because there simply is no employment in that category. In others the numbers are too small to satisfy ONS's concerns about confidentiality. Many of the 67 categories would fall foul of the terms of *Statistics of Trade Act* at an LLSC level.

This discussion highlights that there are real problems in developing reliable data at the levels of detail that analysts and policy makers within SSDA and its partners would ideally like.[36] One response to this would be to limit the amount of detail at which the projections work is undertaken, so as to avoid these types of concern. This would be very restrictive and would severely limit the level of detail that could be made available to those with an interest in such information, both within sectors and at an LLSC level. Instead, a less

[34] The levels of detail which ONS typically provide for public dissemination are summarised in Section 14.

[35] As noted in Section 9, even using the full Annual Business Inquiry (ABI), there are problems in obtaining sufficient data to publish estimates for a few of these sectors at GB level.

[36] Note also that this is total employment, across all occupations. Adding an occupational dimension exacerbates the problem enormously.

restrictive line has been adopted here. When generating the projections, full details have been maintained, while maintaining a strict control on the release of such data into the public domain to prevent misuse. Details of what is available are given in Sections 11 and 13.

When considering this question a distinction needs to be made between statistical reliability and the provision of useful LMI at a detailed level. If strict rules regarding statistical robustness are applied to decide what level of sectoral and occupational disaggregation can be provided at LLSC, it would not be possible to provide much detailed data at all. The official surveys carried out by ONS are (with a few exceptions) not designed to provide statistically robust estimates at this level of detail. Following such rules would restrict what might be reported to very broad aggregates, which are not very helpful to those on the ground.

IER/CE have addressed this issue for a number of years in providing results based on their Local Economy Forecasting Model (LEFM) methodology. This is based on the notion of providing "benchmark" estimates and projections, using the most detailed data where they are available for the local level, in combination with broader national and regional trends where they are not. While not subject to the normal tests of statistical precision, such estimates can provide useful and informative LMI for those operating at the local level. Other consultants have adopted similar solutions.

In providing such information it is important that users are aware of its limitations (as well as avoiding any problems of confidentiality). Nevertheless, IER/CE would argue that this is more useful than suppressing the detail at an early stage. This solution requires that such detailed information is only made available to a restricted audience. It is therefore necessary to restrict access to the more detailed results.

Presenting detailed historical and projected data in a 'free access' public website or other media also raise other important issues apart from the confidentiality ones. The reliability of historical and projected data will inevitably fall with greater sectoral and spatial disaggregation, and will certainly be less reliable in levels terms for output data than for employment data. Accordingly it has been necessary to agree precisely at what level of aggregation public access should be made available and what restrictions need to be placed upon its use and dissemination. These considerations need not inhibit the presentation of the most detailed information, complete with the appropriate caveats, to groups of users within LLSCs and the sector working groups the SSDA is concerned to primarily inform.

14.4 Rules adopted for publication and release of detailed data

As noted in Section 15, in order to stay within the terms of the *Statistics of Trade Act,* limits have had to be imposed on how far to go in placing the most detailed data into the public domain. As far as published documents and what is generally available on public websites are concerned, the 25 sectors as they are defined in the *National Report* set the limits at a UK level. This is consistent with the limits set by ONS for the LFS, given the requirement to report on occupational detail *within* sectors. At regional level a more limited number of sectors are appropriate. The 14 sectors adopted by ONS are adopted, although this has been modified as described in Section 14 to include some detail within manufacturing. Any data to be published at an LLSC level should, in principle, be even more aggregated. In practice how far one can go will vary considerably from one case to another. The information made available on public websites is limited to those provided in the published reports and related annexes.

As far as making data available at LLSC area and for more detailed sectors is concerned, LLSC and SSC users can gain access to the fullest level of detail available. However,

access is strictly limited to those in possession of a Chancellor of the Exchequer's Notice (as is current access to similar data on NOMIS). However, such users will need to be made aware of the limitations of these data and of the legal constraints on their use. ***All users must be covered by a Chancellor of the Exchequer's "Notice".***

14.5 Rules of thumb to be used when using the data

Using the rules adopted by ONS for publication of LFS and other data as a guide, rules of thumb have been developed to guide users as to what level of detail for employment is publishable and what is not. The basic rule adopted is that individual cells should not contain fewer than 1,000 people. Indeed for most purposes a much larger cell size is needed to be reasonably confident about the estimate. As noted above a cell size of 10,000 is ideally required. Anything between 1,000 and 10,000 should be regarded as subject to a large and uncertain margin of error. The point estimates provided in the database are the best the authors can provide based on the data available.

In most cases, the broader categories adopted in the *National* and *Spatial Reports* meet this criterion (as long as the data are not cross-classified by another major dimension (e.g. occupation)). For example, the 25-fold sectoral division breakdown used in the published reports is certainly feasible for most of the regions and countries of the UK, if occupation or aspects of employment status such as self employment are ignored. However, including occupation or status as well poses serious risks of problems of statistical imprecision.

It is important to note that the greater the sectoral, occupational and spatial disaggregation the more sensitive the results will be, as some sectors are very small and at the same time exhibit large variation over time.

Changes, which are based on two levels, each of which may be subject to different errors, are even more problematic. Too much should not therefore be read into slight difference in changes between two categories.

Forecast data will also bear a further margin of uncertainty associated with forecast error. Projected numbers will therefore be subject to wider error margins than the historical estimates.

14.6 Margins of Error

The employment estimates make use of a wide variety of sources, as described in more detail in Section 11. As a consequence, it is not possible to calculate precise margins of error. From an analysis of previous projections it is clear that these margins can be quite large.

Industry employment levels are typically projected within ±10 per cent over a 5-10 year horizon. The directions of change are projected correctly in around 90 per cent of cases. The errors in terms of annual percentage growth rates are usually of the same order of magnitude as the observed changes.

Occupational employment levels are typically projected with ±7 per cent over a 5-10 year horizon. The direction of change is correctly projected in about 80 per cent of all cases. Occupational shares are usually projected within ±2 percentage points. (The typical share is around 4 percentage points).

Historical revisions to the data account for a very large part of the forecast errors. However, it is important to appreciate that the purpose of the projections is not to make precise

forecasts of employment **levels**. Rather, the aim is to provide policy analysts with useful information about the general nature of **changing employment patterns** and their implications for skill requirements.

The results provide a useful benchmark for debate and policy deliberations about underlying employment trends. However, they should not be regarded as more precise than the general statements in the text. Many years of international research have demonstrated that detailed manpower planning is not a practicable proposition. The results presented here should be regarded as indicative of general trends and orders of magnitude, given the assumptions set out below, rather than precise forecasts of what will necessarily happen.[37]

[37] See Wilson and Briscoe (2002) for further discussion.

15 Confidentiality

15.1 General Issues

There are a number of important issues regarding the release of very detailed information on employment into the public domain, which need to be carefully considered in the context of this project. It is essential to recognise that, because of confidentiality problems, there are **legal restrictions**, which limit the extent to which such information can be published. Doing so would fall foul of the terms of the ***Statistics of Trade Act, 1947*** (and its successors), which prohibit publicly collected data being disseminated in such a manner as to enable the identification of individual enterprises or individuals.

The requirements of the SSDA and its partners for very detailed employment data have resulted in the development of a very detailed Database, which has been made available to these organisations and their employees under very strict conditions.

15.2 ONS Practice on publication of data

It is informative to consider ONS's own practice in releasing data from the ABI. Table 17 sets out the time series data currently made available by ONS for Great Britain, showing how these map to the 67 categories. This information has been reordered, into the same order as Table 3. The table illustrates the data available for each of the 67 categories. In a number of cases the time series detail made available by ONS is not sufficient to produce some of the "67" categories required. These are indicated by the term "split". However, ABI and other data can be used to fill this gap.

Even using the full Annual Business Inquiry (ABI) dataset there are problems in a few cases at GB level. However, there are no problems, in principle, in extending the main dataset used for the projections to cover the 67 industry categories. Many of the additional categories are quite large and so the concerns about statistical reliability and confidentiality are not too big a problem, although the inclusion of all the 2 digit categories does involve a number of very tiny sectors. This, however, is for totals across all gender status and occupational categories.

Table 7 has already summarised the position at a regional level. This highlights the fact that ONS are not prepared to release data at anywhere near so detailed a sectoral level when cross-classified by region. Apart from the construction sector, the categories distinguished all form part of the service sector. Only broad aggregates are available for the other sectors.

At a regional level, a number of industries are problematic. These problems are much more severe at a local level. Many of the 67 categories fall foul of the *Statistics of Trade Act* at an LLSC level. The results are summarised here in the form of:

- Table 18, which shows for each of the 67 sectors, the number of spatial areas which are problematic (for the 4 gender status categories of employees);
- Table 19, which shows for 3 geographies the numbers of cases where particular sectors are problematic. [38]

As the first part of Table 18 shows, even at national level there are problems for some of the 67 industries. In metal ores, for example, all 3 countries within Great Britain are problematic. In many cases this is because there simply is no employment in that category. In others the numbers are too small to satisfy ONS's concerns about confidentiality and statistical

[38] These are based on data from the 2001 ABI.

reliability. Within England the second part of the table shows that many of the detailed sectors are problematic for the regions. In the third part of the table, the position for the LLSC areas is shown. A very large number of the detailed sectors are problematic at this level. Only sectors where there is no entry in the LLSC section of Table 18 are non-problematic.

Table 19 presents the information the opposite way around. For each geography, the number of sectors which are problematic is shown. No LLSC is without problem sectors.

The table includes results for Wales and Scotland. These results are for headline estimates of **total** employment in these industries. Once breaks by gender, status and occupation are added, the number of cases where there are confidentiality and statistical issues rises enormously.

The discussion above highlights that there are real problems in developing reliable data at the levels of detail that analysts and policy makers within SSDA and its partners would ideally like. One response to this would be to limit the amount of detail at which the projections work is undertaken so as to avoid these types of concern. This would be very restrictive and would severely limit the level of detail, which could be made available to those with an interest in such information, both within sectors and at an LLSC level.

Instead, a less restrictive line has been followed. This involves generating the projections in great detail, while maintaining a strict control on the release of the data into the public domain to prevent misuse.

Table 17: Employment by Detailed Sectors (Ind67)

Ind67	Ind67 name	FT Eqv	Male Full Time	Male Part Time	Female Full Time	Female Part Time	split
1	Agriculture	196273	133350	21499	37834	28678	
2	Forestry	9044	7031	627	993	1412	
3	Fishing	7674	6112	699	694	1036	
4	Coal mining	12412	12039	127	261	96	<
6	Uranium mining						
5	Oil and gas	30670	25402	321	4490	1234	
7	Metal ores	28714	25405	219	2667	1064	<
8	Other mining						
9	Food	386586	250409	12847	110369	38769	
10	Drink	53224	38526	992	12879	2646	<
11	Tobacco						
12	Textiles	112306	67119	2499	37742	12391	
13	Clothing	71819	36343	3456	29600	8296	
14	Leather	18015	11237	357	5874	1451	
15	Wood and wood products	73784	55362	2607	14201	5835	
16	Paper and paper products	85040	62265	2014	19653	4230	
17	Publishing and printing	324358	198990	8583	102315	37523	
18	Manufactured fuels	30618	25052	135	5075	846	
19	Pharmaceuticals	218798	152436	2877	59937	9972	<
20	Chemicals nes						
21	Rubber and plastics	207215	161621	4085	37854	11394	
22	Non-metallic mineral products	124048	101132	1123	20505	3698	
23	Basic metals	99197	87047	1488	10290	2232	
24	Metal goods	355083	291335	6289	51996	17215	
25	Mechanical engineering	322668	265053	4243	49468	12051	
26	Computers and office machinery	40530	29036	359	10552	1525	
27	Electrical engineering	140297	102800	1326	32876	7915	
28	TV and radio	91744	64930	784	24109	4625	
29	Instruments	122329	88950	3317	28933	5575	
30	Motor vehicles	202971	178044	2349	22047	3410	
31	Aerospace	100843	87518	674	12216	1544	
32	Other transport equipment	54649	48562	669	5211	1082	
33	Manufacturing nes	192554	133196	8105	45971	18668	<
34	Recycling						
35	Electricity	87662	62209	841	23191	3683	<
36	Gas supply						
37	Water supply	8787	6691	60	1772	587	
38	Construction	1101423	949227	22360	103423	75186	
39	Distribution relating to motors	491139	370145	35074	73570	59773	
40	Distribution nes	1055372	699046	47960	274006	116680	
41	Retailing nes	1912063	590312	363203	555354	1169591	
42	Hotels and catering	1187221	381559	290797	336137	648253	
43	Rail transport	50645	39572	566	10550	479	
44	Other land transport	435119	367008	32187	38836	26362	
45	Water transport	14535	10463	1022	3129	864	
46	Air transport	80746	40454	7222	30015	13332	
47	Other transport services	344438	208941	18277	109345	34026	
48	Post and courier services	272267	211645	11350	50081	9731	
49	Telecommunications	210171	148052	5564	50834	17005	
50	Banking and finance	526078	229459	21891	233803	103741	
51	Insurance	212667	103199	4662	96903	20467	
52	Financial support services	216598	113566	5910	88278	23597	
53	Real estate	320218	156115	26309	114940	72016	
54	Renting of goods	141908	88854	12564	35415	22713	
55	Computing services	450158	276777	8899	137598	62666	
56	Research and development	82095	46709	2050	30242	8237	
57	Professional services nes	1035344	553914	60188	362843	176985	
58	Other business services	1297523	609341	204007	388168	396020	
59	Public administration and defence	1259510	651358	50548	485230	195295	
60	Education	1624566	460490	160453	672273	823153	
61	Health and social work	2026169	342010	126100	1012357	1217503	
62	Waste disposal	75778	62471	2278	9970	4395	
63	Membership organisations	172917	68252	27875	57195	67065	
64	Culture and sport	517372	215044	88046	163136	190337	
65	Other services	248842	98723	46631	87239	79129	<
66	Private household						
67	Extra-territorial organisations						

Source: NOMIS, ABI data, June 2001. Detailed data from the 2003 ABI were not available at the time of writing.

Table 18: Number of geographies that are confidential in each industry

Countries (GB, England , Wales and Scotland)	Male, FT	Male, PT	Female, FT	Female , PT
1 Agriculture				
2 Forestry				
3 Fishing				
4 Coal mining				
5 Oil and gas	1	1	1	1
6 Uranium mining	4	4	4	4
7 Metal ores	3	3	3	3
8 Other mining				
9 Food				
10 Drink				
11 Tobacco	2	2	2	2
12 Textiles				
13 Clothing				
14 Leather				
15 Wood and wood products				
16 Paper and paper products				
17 Publishing and printing				
18 Manufactured fuels	1	1	1	1
19 Pharmaceuticals				
20 Chemicals nes				
21 Rubber and plastics				
22 Non-metallic mineral products				
23 Basic metals				
24 Metal goods				
25 Mechanical engineering				
26 Computers and office machinery				
27 Electrical engineering				
28 TV and radio				
29 Instruments				
30 Motor vehicles				
31 Aerospace				
32 Other transport equipment				
33 Manufacturing nes				
34 Recycling				
35 Electricity				
36 Gas supply				
37 Water supply				
38 Construction				
39 Distribution relating to motors				
40 Distribution nes				
41 Retailing nes				
42 Hotels and catering				
43 Rail transport	2	2	2	2
44 Other land transport				
45 Water transport				
46 Air transport				
47 Other transport services				
48 Post and courier services				
49 Telecommunications				
50 Banking and finance				
51 Insurance				
52 Financial support services				
53 Real estate				
54 Renting of goods				
55 Computing services				
56 Research and development				
57 Professional services nes				
58 Other business services				
59 Public administration and defence				
60 Education				
61 Health and social work				
62 Waste disposal				
63 Membership organisations				
64 Culture and sport				
65 Other services				
66 Private household	4	4	4	4
67 Extra-territorial organisations	4	4	4	4
Total				

Source: NOMIS, ABI data, June 2001. Detailed data from the 2003 ABI were not available at the time of writing.

Table 18: Number of geographies that are confidential (continued)

English Regions (GORs, (9))	Male, FT	Male, PT	Female, FT	Female , PT
1 Agriculture				
2 Forestry				
3 Fishing	1	1	1	1
4 Coal mining	6	6	6	6
5 Oil and gas	6	6	6	6
6 Uranium mining	9	9	9	9
7 Metal ores	9	9	9	9
8 Other mining				
9 Food				
10 Drink				
11 Tobacco	9	9	9	9
12 Textiles				
13 Clothing				
14 Leather	1	1	1	1
15 Wood and wood products				
16 Paper and paper products				
17 Publishing and printing				
18 Manufactured fuels	2	2	2	2
19 Pharmaceuticals	1	1	1	1
20 Chemicals nes				
21 Rubber and plastics				
22 Non-metallic mineral products				
23 Basic metals				
24 Metal goods				
25 Mechanical engineering				
26 Computers and office machinery				
27 Electrical engineering				
28 TV and radio				
29 Instruments				
30 Motor vehicles				
31 Aerospace	1	1	1	1
32 Other transport equipment				
33 Manufacturing nes				
34 Recycling				
35 Electricity				
36 Gas supply	1	1	1	1
37 Water supply				
38 Construction				
39 Distribution relating to motors				
40 Distribution nes				
41 Retailing nes				
42 Hotels and catering				
43 Rail transport	6	6	6	6
44 Other land transport				
45 Water transport				
46 Air transport				
47 Other transport services				
48 Post and courier services				
49 Telecommunications				
50 Banking and finance				
51 Insurance				
52 Financial support services				
53 Real estate				
54 Renting of goods				
55 Computing services				
56 Research and development				
57 Professional services nes				
58 Other business services				
59 Public administration and defence				
60 Education				
61 Health and social work				
62 Waste disposal				
63 Membership organisations				
64 Culture and sport				
65 Other services				
66 Private household	9	9	9	9
67 Extra-territorial organisations	9	9	9	9
Total				

Source: NOMIS, ABI data, June 2001. Detailed data from the 2003 ABI were not available at the time of writing.

Table 18: Number of geographies that are confidential (continued)

LLSCs England (47)	Male, FT	Male, PT	Female, FT	Female , PT
1 Agriculture	2	3	2	2
2 Forestry	15	17	15	15
3 Fishing	31	33	32	33
4 Coal mining	46	46	46	46
5 Oil and gas	43	43	43	43
6 Uranium mining	47	47	47	47
7 Metal ores	47	47	47	47
8 Other mining	12	13	12	12
9 Food				
10 Drink	31	31	31	31
11 Tobacco	47	47	47	47
12 Textiles	1	1	1	1
13 Clothing	3	3	3	3
14 Leather	34	34	34	34
15 Wood and wood products				
16 Paper and paper products	4	4	4	4
17 Publishing and printing				
18 Manufactured fuels	47	47	47	47
19 Pharmaceuticals	41	41	41	41
20 Chemicals nes				
21 Rubber and plastics				
22 Non-metallic mineral products				
23 Basic metals	5	5	5	5
24 Metal goods				
25 Mechanical engineering				
26 Computers and office machinery	15	16	15	15
27 Electrical engineering				
28 TV and radio	3	3	3	3
29 Instruments	2	2	2	2
30 Motor vehicles	5	5	5	5
31 Aerospace	34	34	34	34
32 Other transport equipment	10	10	10	10
33 Manufacturing nes				
34 Recycling	19	19	19	19
35 Electricity	39	39	39	39
36 Gas supply	46	46	46	46
37 Water supply	32	32	32	32
38 Construction				
39 Distribution relating to motors				
40 Distribution nes				
41 Retailing nes				
42 Hotels and catering				
43 Rail transport	40	40	40	40
44 Other land transport				
45 Water transport	31	31	31	31
46 Air transport	28	28	28	28
47 Other transport services				
48 Post and courier services				
49 Telecommunications				
50 Banking and finance				
51 Insurance	4	4	4	4
52 Financial support services				
53 Real estate				
54 Renting of goods				
55 Computing services				
56 Research and development	5	5	5	5
57 Professional services nes				
58 Other business services				
59 Public administration and defence				
60 Education				
61 Health and social work				
62 Waste disposal				
63 Membership organisations				
64 Culture and sport				
65 Other services				
66 Private household	47	47	47	47
67 Extra-territorial organisations	47	47	47	47
Total				

Source: NOMIS, ABI data, June 2001. Detailed data from the 2003 ABI were not available at the time of writing.

Table 19: Number of the 67 industries that are Confidential in each Geography

Countries (4, GB, England Wales & Scotland)	Male, FT	Male, PT	Female, FT	Female , PT
"country:Great Britain"	3	3	3	3
"country:England"	4	4	4	4
"country:Wales"	8	8	8	8
"country:Scotland"	6	6	6	6
English GORs (9)	Male, FT	Male, PT	Female, FT	Female , PT
"gor:North East"	11	11	11	11
"gor:North West"	8	8	8	8
"gor:Yorkshire and The Humber"	7	7	7	7
"gor:East Midlands"	8	8	8	8
"gor:West Midlands"	9	9	9	9
"gor:Eastern"	6	6	6	6
"gor:London"	6	6	6	6
"gor:South East"	6	6	6	6
"gor:South West"	9	9	9	9
LLSCs England (47)	Male, FT	Male, PT	Female, FT	Female , PT
"lsc:County Durham"	21	10	18	16
"lsc:Northumberland"	24	16	21	22
"lsc:Tees Valley"	24	19	23	23
"lsc:Tyne & Wear"	14	11	14	13
"lsc:Cheshire/Warrington"	14	9	14	12
"lsc:Cumbria"	21	12	20	16
"lsc:Greater Manchester"	10	5	10	9
"lsc:Lancashire"	9	6	9	7
"lsc:Merseyside/Halton"	17	11	13	14
"lsc:Humberside"	14	12	14	12
"lsc:North Yorkshire"	15	14	15	15
"lsc:South Yorkshire"	15	15	14	15
"lsc:West Yorkshire"	9	9	9	9
"lsc:Derbyshire"	13	8	11	9
"lsc:Leicestershire"	11	8	10	11
"lsc:Lincolnshire/Rutland"	13	11	12	12
"lsc:Northamptonshire"	16	11	13	12
"lsc:Nottinghamshire"	15	12	13	13
"lsc:Birmingham/Solihull"	12	8	11	10
"lsc:Coventry/Warwickshire"	14	10	13	12
"lsc:Herefordshire/Worcestershire"	10	7	10	8
"lsc:Shropshire"	13	8	11	11
"lsc:Staffordshire"	11	8	10	11
"lsc:The Black Country"	14	10	12	13
"lsc:Bedfordshire"	15	10	13	14
"lsc:Cambridgeshire"	13	10	12	11
"lsc:Essex"	8	6	7	7
"lsc:Hertfordshire"	9	8	9	9
"lsc:Norfolk"	12	12	12	12
"lsc:Suffolk"	12	10	11	10
"lsc:London Central"	7	5	7	7
"lsc:London East"	8	6	7	7
"lsc:London North"	16	12	14	13
"lsc:London South"	13	10	12	10
"lsc:London West"	14	10	13	12
"lsc:Berkshire"	16	11	15	15
"lsc:East Sussex/West Sussex/Brighton & Hove"	7	4	7	7
"lsc:Hamps/Isle of Wight/Portsm'th/S'thampton"	9	8	8	8
"lsc:Kent/Medway"	8	6	8	7
"lsc:Oxon/Bucks/Milton Keynes"	12	9	12	10
"lsc:Surrey"	11	9	10	10
"lsc:Former Avon"	10	9	10	10
"lsc:Bournemouth/Dorset/Poole"	10	7	10	8
"lsc:Devon/Cornwall"	8	6	7	6
"lsc:Gloucestershire"	16	15	12	12
"lsc:Somerset"	14	12	11	10
"lsc:Wiltshire/Swindon"	16	13	14	14

Source: NOMIS, ABI data, June 2001. Detailed data from the 2003 ABI were not available at the time of writing.

16 Comparisons with Working Futures 2002-2012

16.1 Background

Comparison of the projections with previous results and with work conducted by other organisations sounds like a straightforward task. In practice, it is quite a complex issue, with many pitfalls to trap the unwary. This section sets out briefly some of these problems and issues (with the aim of informing the reader). It then presents a overview of how the current results compare with those in Working Futures 2002-2012. A brief discussion and assessment of the issue of forecasting accuracy in such work is also provided.

Even where forecasting is carried out using hard-nosed, quantitative methods, those involved usually stress that such projections should be seen as no more precise than the general statements made in the text. It should be seen as part of an ongoing process rather than the final word and recognising the importance of incorporating more qualitative insights. Few, if nay of those involved in making labour market projections would claim that they can predict the detailed skill needs in different sectors with great quantitative precision. Rather, they suggest that they can provide the various participants in the labour market, as well as policy makers, with useful insights into how labour markets are developing in response to various external influences.

It is important to recognise therefore that accurate and precise forecasts of educational and training requirements are a chimera. The key question to ask is not whether or not such projections are **accurate**, but whether or not they are **useful**. The revealed preferences of national governments from all over the world, who support such activity with substantial funding, suggest that they are regarded as of considerable value. It is also clear that such work is seen as having a wide variety of different audiences and users, including careers guidance, as well as general labour market policy formation and planning education and training programmes. Few, if any, countries now regard such work as resulting in information that can be used to plan the scale and pattern of education and training provision with any precision. Rather it can help to inform all those involved about how economic and other forces are shaping the labour markets and the general implications for those skills that will be required.

16.2 Comparisons with Working Futures 2002-2012

This section provides a brief technical analysis of how the *Working Futures 2004-2014* (WF II) projections compare with those published in *Working Futures 2002-2012* (WF I). In comparing the present results with those from WF I a number of considerations need to be borne in mind. These include:

- Different periods covered;
- Revisions to historical data;
- New views about exogenous assumptions;
- Revised perceptions of underlying trends;
- Model and other forecasting errors.

Each of these will affect the patterns of employment projected and can contribute to differences between the two sets of projections.

The main differences can be discussed under the following headings:

- Changes to base levels;
- Macroeconomic assumptions;
- Gender status structure and changes in gender status trends;
- Sectoral structure and changes in sectoral trends;
- Occupational structure and changes in occupational trends;
- Replacement demands.

Each of these elements is now discussed in turn.

Changes to overall employment levels

The latest data from the Annual Business Inquiry and the Census of Population have resulted in quite significant changes to the official perception of the historical position. Employment levels have been revised upwards quite substantially. In WF I, the Total level of employment in the UK in 2002 was estimated as 29.336 million. The corresponding figure for WF II is 29.562 million (some ¾ of a per cent higher). The base year for the WF II forecast is 2004, by which time further increase in employment to a total level of some 30.099 million had occurred (a difference compared to the WF I base level (2002) of 2.6 per cent.

The general assumptions about macroeconomic prospects for the world and domestic economies are not too different in the WF I and WF II forecasts (see Table 21). The overall projections of employment change for the next decade are very similar. This results in a very similar projection of net change over the two forecast periods (2002-12 and 2004-14 respectively) of around 1.3 million extra jobs.

Table 20: Comparison of WF I and II, Aggregate Employment

	WF 1	WF II	Difference	%
2002	29,336	29,562	226	0.8
2004	29,366	30,099	733	2.5
2012	30,658	31,106	448	1.5
2014	n/a	31,399	n/a	n/a
2002-12	1,322	1,544	222	0.7

Source: macrotables.xls (comparisons).

Table 21: Comparison of Projections of Macroeconomic Indicators for the UK

	WF 1			WF II	
	2002-07	**2007-12**	**0**	**2004-09**	**2009-14**
GDP at market prices (% p.a.)	2.5	2.4	0	2.3	2.4
GVA at basic prices (% p.a.)	2.5	2.4	0	2.2	2.3
exl. Extra-Regio (% p.a.)	2.6	2.4	0	2.4	2.3
Manufacturing output (% p.a.)	1.7	1.8	0	1.7	1.5
Household expenditure (% p.a.)	2.7	2.5	0	2.3	2.5
Employment (millions)	30	30.8	0	30.9	31.6
Unemployment (millions)	1.3	1.2	0	1.1	1.1
RPIX Inflation (% p.a.)	2.2	2.3	0	2.2	2.3
BP/GDP (%)	-1.4	-1.1	0	-1.9	-1.6
PSNCR/GDP (%)	2	2	0	1.7	1.8

Source: Macrotables.xls, (Comparisons).
Notes: (a) GDP = Gross Domestic Product
(b) GVA = Gross Value Added
(c) RPIX = Retail price index excluding mortgage interest payments
(d) The balance of payments (BP) and the public sector net cash requirements (PSNCR) are expressed as a percentage of GDP at current prices
(e) Employment, unemployment, RPIX, BP/GDP and PSNCR/GDP refer to the last year of the period concerned.

Gender / status mix
Within these totals, the perception of both historical and future trends in gender status have changed, as a result of revised data from the ABI and elsewhere.

As a consequence the estimated share of females in employment has now been revised downwards (especially for full-time employees), while the employment shares of men have been revised upwards for part time work and self employment.

By 2012 this results in a significantly higher proportion of males in employment than was projected in WF I. By 2014 the share of male full-time employees is now projected to be over 1 percentage point higher that the corresponding estimate in WF I for 2012. Female part-time jobs are projected to see an almost opposite effect. Self employment shares generally are now projected to be slightly higher than in WF I (by around half a percentage point, especially benefiting men).

Table 22: Comparison of WF I and WF II, Gender Status Mix

	WF 1	**WF II**
Shares of total employment %	**2002**	**2004**
Males	53.0	53.5
Full-time	37.7	37.4
Part-time	6.5	6.9
Self employment	8.7	9.3
Females	47.0	46.5
Full-time	22.8	22.2
Part-time	20.9	20.7
Self employment	3.3	3.6
Shares of total employment %	**2012**	**2014**
Males	51.6	53.3
Full-time	35.9	37.2
Part-time	7.9	7.8
Self employment	7.8	8.4
Females	48.4	46.7
Full-time	22.9	22.3
Part-time	22.4	21.4
Self employment	3.2	3.0

Source: macrotables.xls (comparisons).

Sectoral change

In general, the changing patterns of employment by sector look very similar in WF I and WF II. The base level estimates suggest a slightly faster rate of historical decline for manufacturing industries offset by slightly higher employment in construction and non-marketed services.

Patterns of change over the future are also generally similar in the two sets of forecast. Manufacturing industries are projected to decline slightly less rapidly in the latest projections while business & other services are projected to grow slightly less quickly.

Table 23: Comparison of WF I and WF II, Sectoral Employment

	WF 1	**WF II**
Levels (000s)	**2002**	**2004**
Primary sector and utilities	660	609
Manufacturing	3,867	3,552
Construction	1,854	2,090
Distribution, transport etc	8,669	8,830
Business and other services	7,498	7,816
Non-marketed services	6,787	7,202
Total	29,336	30,099
Shares (%)	**2002**	**2004**
Primary sector and utilities	2.2	2.0
Manufacturing	13.2	11.8
Construction	6.3	6.9
Distribution, transport etc	29.6	29.3
Business and other services	25.6	26.0
Non-marketed services	23.1	23.9
Total	100.0	100.0
Growth (% pa)	**2002-2012**	**2004-2014**
Primary sector and utilities	-1.8	-1.7
Manufacturing	-1.8	-1.1
Construction	-0.3	-0.4
Distribution, transport etc	0.4	0.5
Business and other services	1.6	1.2
Non-marketed services	0.6	0.6
Total	0.4	0.4
Change (000s)	**2002-2012**	**2004-2014**
Primary sector and utilities	-109	-95
Manufacturing	-638	-383
Construction	-59	-92
Distribution, transport etc	393	498
Business and other services	1,282	955
Non-marketed services	453	417
Total	1,322	1,300

Source: macrotables.xls (comparisons).

Occupational Change

The latest LFS data, together with the final results from the 2001 Census of Population, have suggested a number of detailed changes to both perceptions of historical changes in occupational structure and the prospects for the future. The latest estimates suggest higher employment shares for managers & senior officials as well as for professional occupations. These are offset by lower shares for administrative, clerical & secretarial occupations.

For the forecast period somewhat slower rates of decline are now projected for skilled trades and slower growth for associate professionals and personal service occupations. These reflect both industry and occupational effects.

Table 24: Comparison of WF I and WF II, Occupational Employment

	WF I	**WF II**
Employment Levels (000s)	**2002**	**2004**
1. Managers and Senior Officials	4,349	4,609
2. Professional Occupations	3,305	3,539
3. Associate Professional and Technical Occupations	4,120	4,302
4. Administrative, Clerical and Secretarial Occupations	3,857	3,790
5. Skilled Trades Occupations	3,341	3,433
6. Personal Service Occupations	2,147	2,244
7. Sales and Customer Service Occupations	2,334	2,412
8. Machine and Transport Operatives	2,473	2,367
9. Elementary Occupations	3,409	3,403
Total	29,336	30,099
Percentage Shares	**2002**	**2004**
1. Managers and Senior Officials	14.8	15.3
2. Professional Occupations	11.3	11.8
3. Associate Professional and Technical Occupations	14.0	14.3
4. Administrative, Clerical and Secretarial Occupations	13.1	12.6
5. Skilled Trades Occupations	11.4	11.4
6. Personal Service Occupations	7.3	7.5
7. Sales and Customer Service Occupations	8.0	8.0
8. Machine and Transport Operatives	8.4	7.9
9. Elementary Occupations	11.6	11.3
Total	100.0	100.0
Net Changes	**2002-2012**	**2004-2014**
1. Managers and Senior Officials	584	617
2. Professional Occupations	703	697
3. Associate Professional and Technical Occupations	774	457
4. Administrative, Clerical and Secretarial Occupations	-423	-326
5. Skilled Trades Occupations	-541	-150
6. Personal Service Occupations	748	424
7. Sales and Customer Service Occupations	398	375
8. Machine and Transport Operatives	-249	-118
9. Elementary Occupations	-673	-675
Total	1,322	1,300

Source: macrotables.xls (comparisons).

Replacement demands

Estimates of replacement demands and total requirements are based on detailed information on age structures and flow rates taken from the Labour Force Survey. These estimates are subject to quite large margins of error and the resulting estimates of replacement needs can vary quite a lot as a consequence. The general pattern of the results in the two sets of projections is very similar although the overall scale of replacement needs is slightly lower in the latest set of results. This partly reflects the gradual unwinding of demographic effects (as the effect of the "baby boom" generation reaching retirement age begins to tail off). However, given the uncertainties with some of the data, too much should not be read into this difference. The key message remains that replacement needs are, generally speaking, quantitatively much more significant than the expansion demand (growth or decline) that is projected for each occupation.

17 Comparisons with Other Forecasts: Selected SSCs

17.1 Comparison with other forecasts

A number of other organisations produce employment projections. In particular some Sector Skills Councils (SSCs) conduct such exercises as apart of their assessment of skill needs in their sectors.

A detailed assessment of a selection of these results and how they compare with *Working Futures* has been carried out as part of the present exercise. The results of these comparisons are reported in the separate *National* and *Sectoral Reports*. The discussion here focuses upon the general approach adopted and some general issues and problems and pitfalls to be avoided.[39]

This section focuses upon the general issue of how to compare the *Working Futures 2004-2014* with such alternative projections. It provides some explanations as to how and why such differences emerge. The comparisons focus upon the main differences in data, methodology and assumptions.

It is anticipated that this work in conjunction with the projections being prepared as part of this project will offer new opportunities for obtaining feedback at both sectoral and local LSC level, which can be used to help improve the quality and reliability of the projections.

Organising such feedback in a systematic fashion across sectoral and spatial dimensions is a very time consuming and resource intensive. No major new "dialogue" events were arranged. Instead, the focus was upon developing one to one exchanges with a limited number of SSCs that had concrete alternative quantitative views to offer.

A number of SSCs have developed their own forecasting models. In selected cases these have been reviewed and assessed. This included a summary of the implications of any methodological differences and modelling assumptions, with a view to providing an explanation as to why the new *Working Futures 2004-2014* projections by SSC footprint might differ (if at all) from those commissioned by SSCs themselves.

In order to achieve this, a series of bilateral meetings with selected SSCs were arranged to discuss the matter in more **qualitative** terms. This approach also provided a means of taking on board the kinds of qualitative sectoral feedback discussed above.

The SSCs concerned were ConstructionSkills, SEMTA and e-skills UK. Meetings were held in late January/February 2005 and various information about data sources, methods and results was exchanged. In addition further comparisons were undertaken for Asset Skills as part of the process of validation of the basic *Working Futures 2004-2014* results.

The aim of the meetings with the SSCs was to discuss differences in approach, data and assumptions and to then agree a line on any differences that could be used by both parties to explain to third parties how to reconcile the different views.

Following the meetings, IER then prepared a brief report (in most cases just a couple of pages) setting out the key results of the discussions and explaining how the different approaches, data and assumptions have lead to different outcomes. The intention was that

[39] See Dickerson *et al*. (2006).

amended versions of these drafts could then be agreed which can then be used by both parties as an annex to any published results, explaining these issues to third parties.

Ideally such a comparison would require detailed access to the results (and underlying models and assumptions used) in each case and then a detailed and in-depth **technical** analysis of how this compares with the *Working Futures* results. In practice the time and resources available to devote to this element of the project was strictly limited. Rather than pursue such a technocratic solution, a **qualitative** approach was adopted based on the informal discussions held with the SSCs. The results of these discussions are summarised in the *National* and *Sectoral Reports*.[40]

To initiate the process of dialogue, comparisons were summarised using the criteria as set out in Table 25.

The main findings to emerge from these comparisons are detailed in the *National* and *Sectoral Reports*.[41] In summary these were as follows:

i. There are detailed differences in the projections resulting from differences in:
- data sources used;
- definitions and classifications adopted;
- periods covered;
- assumptions adopted.

ii The projections produced in *Working Futures* represent one possible (arguably perhaps the most likely future) but the results are not inevitable and sectors may be trying to change the paths/trajectories on which they are currently set in order to end up in some alternative (more preferred) scenario;

iii The remits of many SSCs include an occupational as well as a sectoral "footprint". There is therefore a real need for more detailed occupational as well as detailed sectoral projections.

[40] See Wilson *et al.* (2006) and Dickerson *et al*. (2006).

[41] See Wilson *et al.* (2006) and Dickerson *et al*. (2006).

Table 25: Criteria for Comparison of Projections

Criterion	*Working Futures*	Alternative SSC projections
Definition of Sector	SIC categories included	
Definition of employment	Total employment including self employment	
Occupational definitions	SOC 2000, 2 digit level (sub-major groups)	
Geographical coverage	UK, constituent countries and English regions , LLSCs	
Source of sectoral employment data	Employee estimates based on ABI data (as published by ONS in their time series estimates in *Labour Market Trends*). Self employment based on ONS estimates (as published in *Labour Market Trends*).	
Source of Occupational structural data	Census of Population and Labour Force Surveys (constrained to match sectoral totals	
Forecast Horizon	2014	
Base Year	2004	
Sectoral employment model	Econometric equation linked to output and factor prices (Briscoe and Wilson, 1991)	
Overall employment projections	2004-2014: X %, 2014 level: xxx thousands 2004-2014: Xxx,	As far as possible covering similar concepts and periods
Source of output projections	Multi-sectoral macroeconomic model (CE MDM01)	
Output growth assumptions	2004-2014: X %	
Productivity model	Implicit in employment equations (9.)	
Productivity assumptions (output per person employed)	2004-2014: X %	
Occupational model	Econometric equation mainly driven by time trends in occupational employment shares (Briscoe and Wilson, 2003)	
Key features of occupational change projected	Brief summary of main winners and losers: Occ 1, occ 2, occ 3, etc	
Replacement demand	Driven by age structure by occupation and flow rates (date from LFS and Census)	
Key features of replacement demand results	Brief summary of main winners and losers: Occ 1, occ 2, occ 3, etc	
Other aspects	Anything else of relevance	

Glossary

ABI	Annual Business Enquiry
AES	Annual Employment Survey
CE	Cambridge Econometrics
CoP	Census of Population
DfES	Department for Education and Skills
DTI	Department of Trade and Industry
ESA95	European System of (National) Accounts, 1995
GDP	Gross Domestic Product
GDPO	Gross Domestic Product (output)
GORs	Government Office Regions
GVA	Gross Value Added
IER	Institute for Employment Research
IoP	Index of Production
LEC	Local Enterprise Council
LEFM	Local Economy Forecasting Model
LFS	Labour Force Survey
LLSC	Local Learning and Skills Council
MAFF	Ministry of Agriculture Food and Fisheries
MDM	Multi-sectoral dynamic macroeconomic
NES	New Earnings Survey
nes	not elsewhere specified
nec (n.e.c.)	not elsewhere classified
NOMIS	National On-line Manpower Information System
ONS	Office for National Statistics
OPCS	Office of Population Censuses and Surveys
RAS	Iterative procedure (see Section 12)
RD	Replacement Demand
RMDM	Regional Multi-sectoral Dynamic Model
SIC	Standard Industry Coding
SOC	Standard Occupational Classification
SSCs	Sector Skills Council
SSDA	Sector Skills Development Agency
SSR	Standard Statistic Region
SUTS	Supply and Use Tables
TEC	Training and Enterprise Council
WF I	Working Futures 2002-2012
WF II	Working Futures 2004-2014

References

Barker, T. and W. Peterson (1987) (editors) *The Cambridge Multisectoral Dynamic Model of the British Economy*, Cambridge University Press, Cambridge, Great Britain.

Barker, T *et al*. (2001) 'The Regional Cambridge Multisectoral Dynamic Model of the UK Economy' , pp. 79-96 in G Clarke and M Madden (editors) *Regional Science in Business*, Springer-Verlag, Heidelberg.

Briscoe, G. and R. A. Wilson, (1991). 'Explanations of the Demand for Labour in the United Kingdom Engineering Sector'. *Applied Economics 23,* 913-26.

Briscoe, G. and R. A. Wilson, (2003). 'Modelling UK Occupational Employment'. *International Journal of Manpower.* 24, 5, 568-589.

Cambridge Econometrics, *Regional Economic Prospects* Feb 1997. Cambridge Econometrics, Cambridge

Cambridge Econometrics, *Regional Economic Prospects* May 1996. Cambridge Econometrics, Cambridge

Dickerson, A., R.A Wilson and K. Homenidou (2006). *Working Futures 2004-2014: Sectoral Report.* Sector Skills Development Agency: Wath on Dearne.

Elias P and Purcell K (2004), "The Earning of Graduates in their Early Careers", *Researching Graduate Careers Seven Years On*, ESRU and IER, September 2004.

Felstead, A, D. Gallie and F. Green. (2002), *Work Skills in Britain 1986-2001*, Department for Education and Skills, Nottingham.

Green, A, K. Homenidou and R.A.Wilson (2004) *Working Futures: New Projections of Occupational Employment by Sector and Region*, Volume 2, Regional Report. SSDA, DfES Publications: Nottingham.

Green, A., K. Homenidou, R. White, and R. A. Wilson, R. (2006). *Working Futures 2004-2014: Spatial Report.* Sector Skills Development Agency: Wath on Dearne.

Institute for Employment Research/ CMM (2001) DfES Skillsbase website: http://skillsbase.dfes.gov.uk/ (This site has now closed down).

Lindley, R.M.(1994). 'A Perspective on IER Forecasting Activities and Future Developments'. *Labour Market Forecasts by Occupation and Education: The Forecasting Activities of Three European Labour Market Research Institutes*. Ed. H. Heijke. Massachusetts: Kluwer Academic, 167-79.

Lindley, R.M.(2003). 'Projections and institutions: the state of play in Britain'. *Forecasting Labour Markets in OECD Countries*. Ed. M. Neugart. Cheltenham: Edward Elgar.

National Skills Task Force (2000) *Skills for All*. DfES Nottingham.

Polenske, K (1980) *The US Multiregional Input-Output Accounts and Model*, Lexington Books, Lexington, Mass. US.

Wilson R. A. (ed.) (2000). *Projections of Occupations and Qualifications, 1999/2000*. Department for Education and Employment/University of Warwick, Institute for Employment Research, Coventry.

Wilson, R, A. (1994). 'Modelling and Forecasting the Structure of Employment in the United Kingdom'. *Labour Market Forecasts by Occupation and Education*. Ed H. Heijke. Massachusetts: Kluwer Academic, 9-35.

Wilson, R, A. (1999). 'EMTA Quantitative Forecasting Model: Detailed specification.' Institute for Employment Research, University of Warwick: Coventry

Wilson, R. A, (2001c) *Forecasting Skill requirements at National and company Levels*, in P. Descy and M. Tessaring (eds.) (2001), *Training in Europe (2nd report on Vocational Training Research in Europe 2000: Background Report, Volume 2)* CEDEFOP Reference Series, Luxembourg, Office for Official Publications of the European Communities, pp561-609.

Wilson, R. A. (ed.) (2001a) *Projections of Occupations and Qualifications, 2000/2001*. Department for Education and Employment/University of Warwick, Institute for Employment Research, Coventry.

Wilson, R. A. (ed.) (2001b) *Projections of Occupations and Qualifications, 2000/2001: Regional Results*. Department for Education and Employment/University of Warwick, Institute for Employment Research, Coventry.

Wilson, R, and D. Bosworth, (2006). *Working Futures 2004-2014: Qualifications Report.* Sector Skills Development Agency: Wath on Dearne.

Wilson, R, and D. Bosworth, (2006b). *Working Futures 2004-2014: Qualifications Technical Report.* Sector Skills Development Agency: Wath on Dearne.

Wilson, R. A., K. Homenidou and A. Dickerson (2004a) *Working Futures: New Projections of Occupational Employment by Sector and Region, 2002-2012*., *Volume,1 National Report.* Sector Skills Development Agency/DfES Publications: Nottingham.

Wilson, R. A., K. Homenidou and A. Dickerson (2004b) *Working Futures: New Projections of Occupational Employment by Sector and Region, 2002-2012*. *Technical Report on Sources and Methods.* Sector Skills Development Agency/DfES Publications: Nottingham.

Wilson, R, K. Homenidou and A. Dickerson, (2006). *Working Futures 2004-2014: National Report.* Sector Skills Development Agency: Wath on Dearne.

Wilson R, T Hogarth and A Dickerson (2004). *Key Messages from Skills in England 2004*. LSC: Coventry

Wilson, R, A, I. Woolard and D. Lee, (2004c). *Developing a National Skills Forecasting Tool for South Africa,* South African Department of Labour: Pretoria.

Sector Skills Development Agency
This report is also available on the on the SSDA website:
www.skillsforbusiness.org.uk