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FUTURE SKILL NEEDS IN EUROPE

MEDIUM-TERM FORECAST

BACKGROUND TECHNICAL REPORT

Future skill needs in Europe: medium-term forecast

Background technical report

Luxembourg: Publications Office of the European Union, 2009

A great deal of additional information on the European Union
is available on the Internet.
It can be accessed through the Europa server (http://europa.eu).

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Europe 123, 570 01 Thessaloniki (Pylea), GREECE
PO Box 22427, 551 02 Thessaloniki, GREECE
Tel. +30 2310490111, Fax +30 2310490020
E-mail: info@cedefop.europa.eu
www.cedefop.europa.eu

Foreword

Economic crisis, climate change, globalisation, technological change and demographic developments are posing huge challenges to the whole of Europe, offering risks and threats to existing jobs, as well as many new opportunities. Acknowledging the challenge, the 2007 Council resolution on New skills for new jobs (Council of EU, 2007) stressed the need to anticipate the skill needs – and skill gaps – emerging in the European labour market. In the short term, information on emerging skills gaps is crucial, especially as several sectors already face skill shortages. The 2008 Spring European Council called for a comprehensive assessment of skill requirements in Europe up to the year 2020, a request taken up in the June 2008 Council conclusions on anticipating and matching labour market needs, with special emphasis on youth – a jobs and skills initiative. In December 2008, the European Commission launched its communication on New skills for new jobs which will be followed by several actions to match skills better with labour market needs.

Skills are a key driver for European growth, competitiveness and jobs. Information on national skill needs is no longer enough. A European labour market requires European-level information and monitoring. This is even more true in times when Europe and the whole world faces one of the largest economic crisis ever.

The Cedefop medium-term forecast of occupational skill needs in Europe, carried out in 2007, offers for the first time a comprehensive pan-European perspective, providing estimates consistently. These highlight that, while many Member States face particular problems, there are many common features. Globalisation and technological change are expected to continue to have significant impacts on sectoral employment structure and the demands for different types of skills. The continuing shift towards services and the knowledge economy, the catching up process for many countries (shifting patterns of activity and people), implications for occupations and qualifications, including a general increase in the demand for skills with implications for continued investments in skills, education and training, are highlighted. At the same time there are indications of polarisation, with significant growth in employment in some less skilled areas and implications for issues of exclusion and job quality.

The results and methodology presented in this publication represent the most comprehensive and consistent approach to skill projections ever produced for Europe. Although it could not foresee the financial/economic crisis, and even though there are some data problems and questions outstanding, many of the trends identified are robust and not sensitive to the detailed data problems nor to the detailed specifications for models used to explain changing patterns of skill demands with industries. This suggests that such projections can provide valuable and robust information to a broad range of users, from individuals making career choices through to policy-makers operating at the highest strategic level.

From 2010, Cedefop will provide projections not only of skill demand, but also of skill supply, every two years.

Aviana Bulgarelli
Cedefop Director

Acknowledgements

This report is the result of a team effort and reflects the contributions of all those working on the project, in particular:

(a) from Cedefop, Manfred Tessaring and Alena Zukersteinova for overall coordination and management of the project;

(b) from the Institute for Employment Research (IER), University of Warwick, Rob Wilson for coordinating the core team and producing the expansion demand projections together with Ilias Livanos;

(c) from Cambridge Econometrics, Ben Gardiner, Hector Pollitt and Unnada Chewpreecha for producing the sectoral employment projections;

(d) from the Research Centre for Education and the Labour Market (ROA), Maastricht University, Frank Cörvers and Ben Kriechel for producing the replacement demand projections.

Thanks are also due to expert members of Skillsnet, from individual countries across Europe, who have reviewed and commented on many of the detailed and emerging findings, and provided additional data. They have contributed enormously to the project. The list of experts is provided in Annex.

Cedefop is also grateful to Olga Strietska-Ilina for her valuable contribution and for helpful comments on the project. The comments of Torsten Dunkel from Cedefop are also sincerely acknowledged.

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Finally, thanks are due to Peter Millar of IER who undertook much of the technical analysis required to process the European labour force survey data, and linking this with the results from E3ME.

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Executive summary

Overview

This publication provides a detailed technical background and an overview of the results of the Cedefop Skillsnet project on developing a medium-term forecast of occupational skill needs in Europe, carried out in 2007. It outlines the approach that has been adopted and presents the final results. It also highlights the many data and technical problems that had to be untangled and sets out the solutions that have been adopted.

The overall aim of the project has been to develop a new system for producing detailed and consistent, quantitative projections of future skill needs across Europe. Given the difficulties faced, a certain amount of pragmatism has been required, but this set of results provides a sound foundation to take the debate about the changing pattern of demand for skills in Europe to a new level.

Background

The Lisbon agenda has emphasised the need for Europe to anticipate changing skill needs. Globalisation, technological change and demographic developments (including ageing and migration) are posing huge challenges, offering both risks and opportunities.

The need for regular forward-looking assessments has received further impetus following setting of employment targets and related policies as part of the Lisbon strategy. Such results can help to inform active labour-market policies to retrain the unemployed or reintegrate individuals who are economically inactive; this is also increasingly important given the rising levels of migration flows between countries. Labour mobility between European countries is, if anything, likely to increase further. International labour mobility can help to resolve labour-market bottlenecks and deal with surpluses. Information on future skill needs in Europe can help, therefore, to orientate and guide policy, and inform individuals about developments. Many countries are undertaking this kind of work. This project offers a pan-European perspective, providing estimates consistently for all Members States.

While it is generally accepted that, in a market economy, it is not possible to predict the future precisely, the need to make strategic plans and choices which can influence the future paths of the economy and labour market is widely accepted. Such plans need to be guided by robust labour-market information and intelligence, including a forward-looking element. This needs to be based on regular, systematic and quantitative approaches to forecasting and scenario development. Skills are a key part of the infrastructure of the economy, and the choices made by both policy-makers and individuals about investment in education and skills can help to determine the path the economy takes. These choices need to be guided by good labour-market information and intelligence.

A range of approaches to assessing future skill needs is required. These need to encompass both quantitative and qualitative methods and to serve a range of audiences such as policy-makers, stakeholders, social partners, practitioners and individuals. This project is concerned with developing quantitative models and projections. The results are aimed at all these audiences, across all Member States (plus some associated members). The present analysis covers EU-25 (before the accession of Bulgaria and Romania) plus Norway and Switzerland referred to henceforth as EU-25+.

Modular approach

The project has adopted a modular approach to anticipating Europe's future skill needs, involving four main elements. These include a multisectoral macroeconomic model, occupational and qualifications expansion demand modules and a replacement demand module. The advantage of a modular approach is that it promotes independent development and improvement of the different parts of the system. In combination, the modules provide a general framework for regular quantitative projections of changing skill needs. This initial phase of the project has involved developing the basic database and tools required to produce a comprehensive and consistent set of skill projections for all EU-25 Member States. It is based on data from Eurostat sources, adopting common methods and models. Together the database and models constitute the framework.

The framework has been designed to facilitate further development and customisation. In particular, it allows for refinement of the modelling approaches used for projecting occupational, qualification structures and replacement demand. It also allows for improvement or replacement of data

for particular countries or sectors where there are concerns about data quality and robustness. The present results began a process of dialogue with experts from other countries who have much greater knowledge about employment trends in their own countries. This framework provides an opportunity for such knowledge to be built in to future assessments efficiently and transparently.

Data sources and preferred employment estimates

A key issue addressed in the project is the best data to be used to measure employment structure in Europe in a common framework. Historically, most countries have invested considerable resources in developing data for their national accounts (NA). In many respects such estimates of employment are to be preferred as they are consistent with other key economic indicators such as output and productivity. More recently, greater emphasis has been placed on estimates of employment based on the European labour force survey (LFS). These have the considerable advantage of being broadly consistent across countries and providing a measure of employment structure by skill (occupation and qualification) that is not available from the NA-based estimates.

The numbers presented by sector, as used in the multi-sectoral macroeconomic model, are based on Eurostat NA, rather than the LFS-based estimates that some are more familiar with. There are some significant discrepancies between these two sources which remain unresolved. However, the framework developed allows for alternative data and assumptions to be incorporated with relative ease. Therefore, two sets of results have been developed to benchmark sectoral estimates, one based on NAs, the other on LFS data. The main emphasis in this report is on the former, although it also compares the two. In broad terms, the implications for changing patterns of skills are not that different between the two alternatives.

Key findings

The analysis confirms that Europe has experienced continuing shifts away from the primary sector (especially agriculture) and traditional manufacturing industries towards services and the knowledge-intensive economy in general, and that these trends are likely to continue to be a key feature over the coming

decade. This applies within individual countries and in how things are changing between European countries. Although many of the new Members States still rely to a much greater extent on agriculture and manufacturing for employment, it is clearly changing rapidly. It is partly an internal process, particular to each country, but it also reflects shifting patterns of activity and people across borders as capital and labour adjust to the political and economic changes. In some countries this is leading to changes in the opposite direction as some activities in manufacturing have been transferred eastwards and southwards within Europe. Overall, the results of this forecast suggest that these patterns of change will continue in the immediate future, and that these will be more of an evolutionary rather than revolutionary nature.

Substantial change is in prospect with over 13 million additional jobs being created between 2006 and 2015 in EU-25+. This is despite the loss of well over two million jobs in the primary sector and almost half a million in manufacturing. Distribution, transport, hotels and catering together are projected to see employment grow by 3.5 million over the next decade, while non-marketed services are expected to increase by only slightly less. Business and miscellaneous services has the best prospects, with almost nine million additional jobs being created between 2006 and 2015.

The projected sectoral changes taking place will have significant implications for occupational skills needed in the future. These will be reinforced by changes in the way work is organised and jobs are performed within sectors. The main implications are continuing growth in demand for many highly- and medium-skilled workers but also for some lower-skilled occupations. Almost 40 % of people are currently employed in higher level jobs such as management, professional work of one kind or another or technical support of those activities. These areas are all expected to experience increased demand over the next decade. In contrast, jobs requiring traditional agricultural skilled workers, several other craft and related skills and clerical skills will decline in number. There will, however, be significant expansion in the numbers of jobs for many service workers, especially in retail and distribution, and also for some elementary occupations requiring little or no formal skills.

This has been characterised as polarisation in the demand for skills. It raises concerns about job quality and mismatch, and related problems of social equality and exclusion for many of Europe's citizens. The structural and other changes taking place will, if these trends continue, create many jobs at higher levels but also large numbers at the lower end of the job spectrum, with low pay and poor terms and conditions. This will pose significant problems for

policy-makers concerned with issues of equity and social cohesion. The study emphasises that even in those areas where employment levels are expected to fall there will nevertheless be significant job openings and needs for education and training. This affects both sectors and occupations.

Despite the structural changes projected, primary and manufacturing sectors will remain viable sources of jobs and crucial components of the economy. Similarly, there are significant replacement demand by occupation (to replace those leaving for retirement or other reasons) even for those occupations where employment levels are projected to fall sharply. It is important that policy-makers, education and training providers and individual citizens are aware that many of those occupations likely to face job losses will remain viable sources of employment and make important contributions to the economy for many years to come.

The nature and skill requirements of these jobs will change and their development should be analysed. This includes the formal qualifications typically required to undertake such jobs. While there is no simple one-to-one relationship between occupation and qualification, it is possible to explore how these are changing over time. The analysis focuses on three levels (high, medium and low qualifications). The results highlight the general increase in qualification levels across most jobs. At the broadest level the projected changes are even more dramatic than for occupations. In total, the net employment increase in Europe of over 13 million jobs between 2006 and 2015 comprises increases of almost 12.5 million jobs at the highest qualification level (ISCED 5 and 6) and almost 9.5 million jobs at medium level (ISCED 3 and 4), offset by a sharp decline of 8.5 million jobs for those with no or few formal qualifications (ISCED 0 to 2). In part, these changes reflect the expected continued growth in supply of people who have acquired formal qualifications. While some have argued that there is the possibility of oversupply in some areas, there is also considerable evidence of increasing needs for, and even shortages of, formal qualifications in many areas.

Conclusions

The projections presented in this publication are the final results. Often the data used are still subject to some uncertainty; this reflects the general problems of pushing the LFS-based information to the limits in terms of the amount of detail it can reveal. As the results are reported in this publication, a completely revised set of workbooks containing the data for each country has been produced. These have been made available to country experts to enable them to comment in detail on the results. They represent the most comprehensive and consistent set of skill projections ever produced for Europe

There are still many data problems and questions outstanding. These are especially severe for the smaller countries where the sample sizes in the LFS are often inadequate to provide robust estimates. Even for many of the larger countries there are problems with the data which can probably only be addressed by detailed dialogue between country experts and the relevant statistical authorities.

Despite these reservations, many of the trends emerging from the analysis are robust and not sensitive to the detailed problems of many of the data used, nor the detailed specifications for models used to explain changing patterns of skill demand with industries. This suggests that such projections can provide valuable information to a broad range of users, from individuals making career choices through to policy-makers operating at the highest strategic level.

Such pan-European projections are not a substitute for what is being done nationally. Rather, they can complement this, offering for the first time a broad and consistent overview for the whole of Europe. While this might not be able to compete with what is being done for some countries, (where it is based on many years investment in data, systems and knowledge), it can provide a common framework within which these more detailed analyses can be compared.

CHAPTER 1

Overview and introduction

Rob A. Wilson ([1])
IER, University of Warwick

1.1. Background

1.1.1. Introduction

This publication provides a detailed technical background and summary of the results of the Cedefop Skillsnet project on developing a medium-term forecast of occupational skill needs in Europe. It outlines the approach that has been adopted and presents the final results. It also highlights the many data and technical problems that had to be untangled and sets out the solutions that have been adopted.

The overall aim of the project has been to develop a new system for producing detailed and consistent, quantitative projections of future skill needs across Europe. Given the difficulties faced, a certain amount of pragmatism has been required, but this set of results provides a sound foundation to take the debate about changing pattern of demand for skills in Europe to a new level.

The publication is divided into seven chapters. The first chapter provides an overview and introduction to the whole project, including the rationale for producing quantitative skills projections. It discusses a key issue which the project has had to address on what are the best data to use to measure changing employment structure.

Detailed data issues are discussed in Chapter 2. In particular, there is the issue of employment estimates based on national accounts (NA) and those based on the labour force survey (LFS). The chapter explores differences in concepts, definitions and numbers of employment in these two data sets.

Chapter 3 provides a detailed overview of module 1, the macroeconomic model, and the results it produces. This includes a discussion on developing alternative scenarios. A criticism often made of quantitative projections is that they focus too much on a single point forecast. One way of dealing with this

([1]) This chapter would not have been possible without the contribution of all the other team members, including Frank Cörvers, Ben Gardiner, Ben Kriechel, Hector Pollitt and Ilias Livanos.

criticism is to present a range of alternative views which can encompass the most likely outcomes.

Chapter 4 focuses on modules 2 and 3, which deal with the modelling of expansion demand. Different approaches to modelling the changing occupational and qualification patterns within sectors are discussed in detail. This considers the ideal theoretical approach to such issues, and the limitations posed by data availability and other problems.

Chapter 5 deals with the topic of replacement demand. It is argued that these are at least as important as expansion demand. However, it is also recognised that there are many problems in producing robust estimates. Again data limitations constrain what is feasible. Replacement demand is dealt with in module 4. This chapter sets out discussion of the overall approach to these issues, the problems and pitfalls faced by the research team and how these have been tackled.

Chapter 6 presents the final series of results from the project. These draw on the most recent macroeconomic scenarios from E3ME (energy-environment-economy model for Europe), in combination with other assumptions from each of the other modules. The discussion in this section also considers the sensitivity of the results to various other assumptions, including the choice of NA versus LFS sectoral employment estimates.

The last chapter sets out conclusions from the project, some outstanding issues and possible next steps of future work.

1.1.2. Rationale for producing quantitative skills projections

The Lisbon agenda has stressed the need to place more emphasis on anticipating changing skill and competence needs in Europe. Climate change, globalisation, technological change and demographic developments (including migration) are posing huge challenges. These represent risks and threats, but also opportunities. Identifying key trends and providing accurate and timely labour-market information and intelligence to those making choices and decisions is crucial to identifying possible new jobs for Europe, and jobs under threat from structural change. The most recent revision to the *Integrated employment guidelines* (Council of EU, 2005) states that anticipating future skill needs should be a top priority if Europe is to respond successfully to the challenges it faces, both externally (to compete successfully in world markets) and internally (to ensure that all its population shares the benefits of economic growth) (European Commission, 2007). The Council resolution of 15 November 2007 (Council of EU, 2007), recently adopted, has launched large-scale activity on new skills for new jobs, as well as reemphasising the need to

improve the labour-market information and intelligence available to help guide the decisions of Member State policy-makers and individual citizens.

Nobody can predict the future precisely, but everyone can plan to make the most of the opportunities they face, and to avoid the worst problems. Projections can serve as an early warning fostering strategies to prevent or alleviate future problems. Such individual strategic plans and choices will shape the future path taken by Europe as a whole. These plans and choices need to be guided by robust labour-market information and intelligence. The key question, therefore, is not whether we should try to anticipate the future, but rather how to go about it. Rather than relying on luck and individuals' own (possibly ill-informed) judgements, the philosophy underlying this project is that we should apply transparent, systematic scientific and quantitative methods consistently across Europe. This needs to be pan-European because problems are not confined within narrow national borders. The increasing mobility of labour across national boundaries, resulting from the formation of the single market and related issues such as migration, emphasise the need for a pan-European perspective.

The case for and against quantitative employment projections has been debated for many years. Table 1.1 discusses some pros and cons associated with employment and skill forecasts; it also highlights some of their limitations. However, the revealed preferences of governments and many other organisations across the world, who have invested considerable resources in such activities, suggest that they meet a real need.

Table 1.1. **Arguments for and against employment and skill needs forecasting**

Against	For
National employment planning is irrelevant because markets will respond of their own accord to ensure that the correct skills are produced.	The evidence of market failures (unemployment or skill shortages) and long time lags in training may lead to imbalances or mismatch in labour markets which could be prevented by policies including quantitative forecasts.
The fixed coefficient approach is invalid since it ignores the possibilities of substituting skills and wage adjustments.	Skill substitution processes and wage structures change slowly. Improvements in methodology allow for explicit consideration of substitution in forecasting models.
Inaccuracies in the assumptions will be compounded, making the projections of little value.	Forecasting inaccuracy applies to any economic or other projection; employment forecasts are not significantly more inaccurate than others. Besides, there is evidence that decision-

Against	For
	makers have found these useful. These forecasts are not deterministic but indicate possible developments and thus ways to shape the future. Further, the modelling of alternative scenarios/variants with different assumptions should indicate a plausible range of future developments.
Skill demand forecasts focus solely on economic considerations without reference to wider social implications.	Other disciplines have been introduced (e.g. in qualitative approaches). Interpreting results should bear in mind that economic development is only one influence among others. Quantitative and qualitative approaches are complements, not substitutes.
Past imbalances (e.g. overqualification, unemployment, shortages) are ignored and may be carried forward into the projections.	Although methodologies have been improved, this remains a crucial point. However, to consider imbalances within forecasts (if these are generally considered as useful), would imply the need to predict qualitative imbalances in the longer term. This would require assumptions which are as disputable as any others.
The approach does not allow for interaction between skill supply and demand factors.	This is a challenge to forecasters to improve methodologies. First attempts have been made to do this. One of the problems is that adaptations to future imbalances will change both skill supply and demand and require endless iterations of the calculation which may – dependent on the elasticities on both sides – lead to long-term equilibrium or exploding imbalances.
Forecasts, once made public, could change the behaviour of actors and thus invalidate themselves.	If it is a policy goal to inform the public on possible future developments (risks or opportunities), forecast results should not be kept secret. However, results should be interpreted (by the media in particular) carefully. They should be presented as possible and not as inevitable futures, dependent on the underlying assumptions used to generate them. They should be treated as just one information set among many others. If a forecast warns against undesired developments and respective actions are taken, it may be desirable for the forecast to turn out to be incorrect if undesired outcomes are avoided.
Forecast categories are more or less large aggregates and cannot be used for specific decision-making (e.g. individual choice of education and training).	Forecasts are only one information set among others for individual training and occupational decisions, illustrating general trends in labour markets and thus helping to reduce uncertainty. They cannot predict the employment prospective for an individual, but can be used as one information tool for individual guidance, such as pointing to the high risks of renouncing qualified education and training or by illustrating job opportunities in certain fields. Only in centrally planned economies can uncertainty be removed, at the expense of individual freedom, self-responsibility and social change.

Source: Cedefop (2001) with modifications by Cedefop and the present authors.

As the employment guidelines emphasise, there is an urgent need for regular and continuous anticipation, which all Member States need to take seriously. The present project is not a substitute for what needs to be done by individual States but for the first time it presents a consistent attempt to assess skill needs across the whole of Europe.

Anticipation is not a one-off exercise. It needs to be a continuous and regular process. Only if this is the case can it properly inform policy-makers and citizens about the changes they are likely to face. Economic restructuring is itself a normal and continuous process, some sectors change more rapidly than others. We cannot 'hold back the economic tides' that cause this continual change, but we can help our citizens and other decision-makers to learn to 'surf the waves' by anticipating likely future developments. Other aspects are also important. Ageing and poorly qualified workforces militate against innovation, learning, networking and anticipation, but early warning and involvement of the social partners can help to oil the wheels of change. It is not practical to pick winners, but it is possible to create an environment conducive to change and which deals with the inevitable casualties. We need to create systems that encourage flexibility and adaptability, as well as entrepreneurship and innovation, and enable industries, companies (and individuals) to reinvent themselves and to contribute to shaping the future. For example, sectors that might appear to be 'dead ducks' can often have a second lease of life by restructuring themselves and developing new angles and niches at the higher end of the value-added spectrum. Anticipation is needed to foresee the problems and to act in good time, devising strategies, technologies, etc., to cope, often right down the supply chain. This is often best handled at a sub-country or regional level. There is a need for regions to be proactive but with a strong sectoral focus. Safeguarding jobs often requires diversification. It also requires approaches to anticipation that recognise the importance of economic links.

There is no single solution to the question of how to anticipate: a multifaceted approach is required. Quantitative and qualitative approaches to anticipation are complements not substitutes or alternatives. Qualitative approaches, such as qualitative inquiry and scenario development, case studies and the like, are needed to gain more insight into underlying processes and to aspects which lie beyond numerical and statistical modelling. Examples are 'soft skills' and competences, perceptions, interpersonal interactions, mentalities, expectations, etc., which influence the behaviour of people. Quantitative methods, such as those using the types of formal models adopted here, are typically based on empirical evidence from past behaviour, using

econometric analysis and statistically significant relationships (not simply extrapolations). Such quantitative approaches can present a consistent view of one possible future that can be useful to a wide audience.

In combination, the two broad approaches can provide a comprehensive picture of future possibilities useful to different users. It is not just policy-makers who require this kind of information but also other stakeholders such as social partners, practitioners and individuals. Together, and in combination, qualitative and quantitative approaches offer the best hope of providing different audiences with the information they need to make rational and optimal choices. Skills are a key part of the economic infrastructure and the choices made by the various actors in the labour market will help to determine the path the economy takes.

Such projections should not be seen as deterministic nor prescriptive; structural changes and their implications for changing skill needs cannot be mechanistically predicted. Neither qualitative scenarios nor quantitative forecasts should be seen as precise predictions; they are more about preparation for what might come. From a policy perspective they are, themselves, 'enablers' of future opportunities. Questioning and discussing possible futures is a way of building them (make choices and shaping actions) and emphasises the need to assess and modify forecasts regularly and continuously.

With the methods deployed in this project it is possible to identify the main employment trends in Europe: where jobs may be created, as well as anticipating job losses caused by restructuring. Emphasis should not be put on where jobs are disappearing, as lobbying from sectors in decline may result in a biased view. A falling tree makes a loud crash, while there is little sound as the forest grows.

Anticipating skill needs is not a panacea. Policies relating to trade rules, finance, etc., are also crucially important to ensuring that Europe can compete effectively in the 21st century (as are intellectual capital and property rights). But anticipating changing skill needs, together with other aspects of economic and sectoral development, can help policy-makers and others to recognise where skills are the crucial factor.

Therefore, the prime aim of anticipating changing skill needs is to build capacity, improve the capability to undertake such work across Europe in a regular way, and improve understanding of the main drivers of change.

1.1.3. General approach

This section sets out a systematic approach to analysing the future skill needs of EU Member States, using common models and data sources. It establishes a general framework that can act as a starting point for further development.

The aim was to deliver the following main objectives:

(a) to develop a robust and consistent occupational database and related projection models which permitting benchmark projections by occupation, sector and qualifications across EU-25 (as of 2006, before the accession of Bulgaria, Romania) plus Norway and Switzerland ([2]). These countries are referred to as EU-25+.

(b) to develop a full set of projections using these models and data looking up to 10 years ahead and also include a range of alternative scenarios using the database and tools established.

(c) to present these results in such a way as to initiate and assist systematic dialogue with other country experts and stakeholders.

The project was carried out by Cedefop in cooperation with a research team involving the Warwick Institute for Employment Research (IER), Cambridge Econometrics and the Research Centre for Education and the Labour Market, Maastricht (ROA). Each group was responsible for particular aspects of the project. These are distinguished as separate modules and chapters of this publication.

Previous reviews (Wilson et al., 2004) suggest that best practice worldwide in quantitative skill projections involves large scale, multi-sectoral models. These provide essential understanding of how structural economic and technological changes affect the demand for skills. The typical quantitative modelling approach, therefore, involves three main elements.

The first key component is a multi-sectoral macroeconomic model of some kind, usually built around a Leontief input-output table, which considers the links between sectors. Such models are usually estimated using complex and sophisticated econometric methods. The key outputs from these models, as far as the present project is concerned, are consistent projections of employment levels by sector. In addition to providing projections of sectoral employment, such models can be used for a many other purposes, including more general macroeconomic policy analysis. This may be significant for future use of the new framework which this project has delivered.

([2]) It is hoped that the models can be extended to include the most recent accession countries in the near future.

The second key component is a module, or set of modules, which translate the employment projections from the multi-sectoral model into implications for the demand for skills. These elements vary considerably across countries. Most commonly, this aspect is much less sophisticated, mainly caused by the more limited nature of data available on skills. Usually, the focus of attention is limited to occupational employment structures within sectors. The trends in such structures are often analysed using simple techniques rather than more sophisticated econometric methods. Forecasts of expansion demand (net changes in occupational employment which can be negative) are based on an analysis of changing occupational patterns of employment within sectors.

The third key component relates to replacement demand. On the demand side of the labour market, expansion demand resulting from future changes in employment levels should be distinguished from replacement demand caused by retirement and various types of mobility (when workers leave the employed work force for whatever reason).

The project has adopted a modular approach to exploring skill needs focusing on the key component elements set out above (Figure 1.1). Four separate modules can be distinguished:

(a) module 1: a set of multi-sectoral macroeconomic forecasts, based on the preferred macroeconomic model (E3ME);
(b) module 2: an occupational expansion demand model (EDMOD), based on LFS data;
(c) module 3: a qualifications expansion demand module (QMOD), based on similar data sources;
(d) module 4: a replacement demand module (RDMOD).

Module 1 is based on the existing and well-established pan-European multi-sectoral macroeconomic model (E3ME), developed by Cambridge Econometrics and its partners around Europe. This is described in greater detail in Chapter 3, along with the underlying assumptions made about the main external influences on the economy and the labour market. The model delivers a set of consistent sectoral employment projections. In addition, two alternative scenarios are considered to show the sensitivity of the outcomes to different assumptions.

Module 2 (EDMOD) builds upon previous work in individual countries. It focuses on the factors influencing occupational structure within sectors. It delivers a comprehensive and consistent set of expansion demand estimates, based on LFS data from Eurostat.

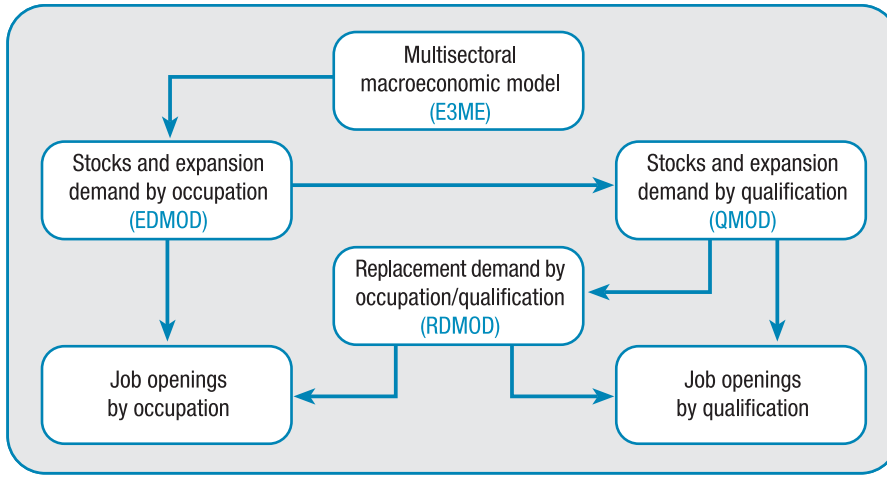
Module 3 (QMOD) focuses on the implications for formal qualifications, adopting similar procedures and data to EDMOD. The data available on

qualifications are even weaker than for occupations, with many problems of consistency across countries and over time, as well as many gaps. Problems of consistency in classification across countries are more severe here than in any other area. Modules 2 and 3 are described in detail in Chapter 4.

Module 4 (RDMOD) again on builds on previous research efforts to deliver a set of replacement demand estimates. Without estimates of replacement needs, projections of expansion demands are of little value. However, data on some aspects of replacement demand are in many respects weaker than those on occupational employment structure. Nevertheless, the analysis conducted in Chapter 5 suggests that sufficient information exists to provide at least a broad indication of the likely scale of replacement demand.

In combination, the four modules deliver a comprehensive and consistent detailed picture of job openings across Europe. Job openings are defined as the sum of expansion and replacement demand.

Figure 1.1. **Overview of the modular approach to skills forecasting (the framework)**



The advantages of a modular approach are that it facilitates independent development and improvement of individual parts of the system. In combination, the modules represent a general framework, within which it is easy to plug in alternative assumptions and parameters. The results are brought together in a set of country workbooks. These include a detailed and consistent set of historical data and a benchmark projection. Country workbooks and their accessibility are discussed in Section 1.2.3.

The aim of the present project is not to substitute for national forecasts, nor to seek to criticise or undermine them. It is to present an alternative view, set within a much broader European context that puts the national results into perspective. The longer-term aim is to work with country experts to reach consensus on historical patterns and the main underlying trends.

1.2. Data issues

1.2.1. Labour force surveys versus national accounts estimates

The labour force surveys (LFS) conducted across the union provide an invaluable source of information on industry by occupation employment. They have the advantage of being conducted much more frequently than a typical census. They also adopt much more standardised sets of questions and systems of classification. While there are still some differences across countries, this source provides a broadly consistent set of data which can be used for producing occupational employment projections within the industries identified in macroeconomic models such as E3ME.

However, as described in more detail in Chapter 2, the LFS is not without its faults. In many respects estimates of employment based on NAs are more robust and more compatible with other economic indicators.

The LFS data from Eurostat are sample data. For many countries the time series are short and the number of respondents within a particular cell is often low. This means that the estimates of occupational structure within sectors are neither precise nor robust. These problems are even more serious when it comes to making estimates of replacement demand, which asks even more from the data. Nevertheless, these are often the only data available. Besides, they have become well established in analytical discourse, with the result that some are now more familiar with these estimates than those based on the NAs.

Following detailed debate about the merits of the two sets of estimates at the technical workshop, no consensus could be reached on this question. It was therefore decided to produce two sets of estimates. The first are based on the levels of employment by sector from the NAs as in E3ME. The occupational estimates are constrained to match the sectoral totals from E3ME, while the occupational shares within sectors reflect the LFS data. An alternative set of results has been produced linked to the same benchmark scenario, but constrained to be consistent with the sectoral estimates in the published LFS data. These results, along with the outcomes from alternative macroeconomic scenarios, are discussed in Chapter 6.

1.2.2. Other data issues

Several other issues relating to data comparability and quality have emerged in the course of the project; these are discussed in more detail in Chapters 2 and 4. They include variations in estimates in different vintages of both LFS and NA data sets, and also differences between the published LFS data and those available in the microdata sets provided by Eurostat for the econometric analysis.

Many of these data series are from the same source but differ as a result of being collected, collated and published at different times. In consequence there are several different versions of each of the data sets available at any one time and considerable care is required to avoid spurious comparisons.

The main problems with the data relate to the quality of the detailed information by sector, occupation and qualification. There are particular problems of missing data, and changing systems of classification resulting in gaps or short time series of consistent estimates for analysis. Even where estimates do exist there are some concerns about precision and robustness. Work to improve the quality of these data should be a priority for future work.

1.2.3. Country workbooks

The project involved producing a series of separate country workbooks, plus a European overview, in a standard format. Each workbook includes historical data and a benchmark set of projections, including expansion and replacement demands for both occupations and qualifications. They also include facilities to enable users to customise results, including the ability to:

(a) incorporate alternative industry employment assumptions (history and projections), instead of the E3ME scenario;
(b) use alternative industry by occupation data (such as that derived from own country data), including alternative projections;
(c) adopt alternative qualification assumptions;
(d) adopt alternative replacement demand assumptions.

Initial versions of these workbooks were distributed to experts in each country in 2007 to enable them to assist in validating the data for each country. The final versions of the workbooks include a facility to allow users to experiment with alternatives, which can then be fed back to Cedefop and the core research team to develop and improve the basic forecasts.

Further details about the workbooks are available on request from the Cedefop Skillsnet coordination team (skillsnet-team@cedefop.europa.eu).

1.3. Module 1: macroeconomic and sectoral scenarios

1.3.1. E3ME outline and overview

Most countries have some national macroeconomic modelling work and often this includes multi-sectoral and multi-regional subcomponents. There have been a few attempts to develop cross-country models within Europe. Perhaps the most widely used is E3ME, developed by Cambridge Econometrics and partners around Europe. This is the model used to drive the current set of projections.

E3ME is an energy-environment-economy (E3) model of Europe. The economy element includes a detailed treatment of sectoral employment within an input-output framework. The model has been used for general macro analysis and for more focused analysis of environment policies, as well as employment forecasting. Its pan-European coverage is ideal for this project, providing a detailed industry analysis for each country/region within Europe. Further details are given in Chapter 3.

E3ME combines the features of an annual short- and medium-term sectoral model estimated by formal econometric methods with the detail and some of the methods of the computable general equilibrium models. It is essentially a dynamic simulation model estimated by econometric methods.

The main endogenous variables in E3ME are determined from functions estimated on historical data about the economy. The econometric techniques used to specify the functional form of the equations are the concepts of cointegration and error-correction.

Compared to other models targeted at achieving the same goals, the advantage of the E3ME lies in three main areas:

(a) model disaggregation: the detailed nature of the model allows it to represent complex scenarios, in particular scenarios which are differentiated according to sector and country. Similarly, the impact of any measure can be represented in a detailed way;
(b) econometric pedigree: the econometric grounding of the models gives it better capability in representing and forecasting performance in the short to medium term. It, therefore, provides information which is closer to the time horizon of many policy-makers than pure computable general equilibrium models;
(c) E3 links: an interaction (two-way feedback) between the economy, energy demand/supply and environmental emissions is an undoubted advantage

over other models which may either ignore the interaction completely or only assume a one-way causation.

In summary, the characteristics of E3ME are such that the model is:

(a) elaborated at European level rather than nationally, with national economies treated as regions of Europe;
(b) dealing with energy, the environment, population and the economy in one modelling framework;
(c) designed from the outset to address issues of central importance for employment, economic, energy and environmental policy at the European level;
(d) capable of providing short- and medium-term economic and industrial forecasts for business and government;
(e) based on a system of dynamic equations estimated on annual data and calibrated to recent outcomes and short-term forecasts;
(f) focused on the contribution of research and development, and associated technological innovation, on the dynamics of growth and change.

As with any model, E3ME has some disadvantages and limitations. While one of the main advantages of using the E3ME is its inbuilt structure of the NAs, there are also disadvantages to using a fixed structure for the analysis. In particular, there is little flexibility in the definitions of the countries and sectors modelled and, while E3ME provides a detailed sectoral breakdown of each EU-25 economy, this may miss key sectors of interest. For example, the communications industry, as defined in the model and at the NACE 2-digit level, includes both postal services and telecoms, which are largely separate and have different employment trends and skills requirements. In addition, the resources required to add Romania and Bulgaria to the model's classifications were too great to fit into the timescale of this project.

The other major disadvantage in combining detailed economic and labour-market analysis is that the two branches of research are dependent on different data sources and are based on different definitions of employment. There are often significant differences between NAs and European LFS data series, at both the macroeconomic and sectoral levels. A key consideration in the project was how best to handle these discrepancies to produce an accurate and robust set of model results.

As an econometric model, E3ME's parameters are estimated empirically, using historical time series data covering the period 1970-2004. This means that behavioural relationships in the forecast are determined by past trends. There may be cases where this is not appropriate, in particular in the new Member States where data series are shorter (1993-2004) and cover a period

of transition. To compensate partially for this, E3ME uses a system of shrinkage estimation for its long-term parameters. This assumes that there is long-term convergence between the new Members States and the previous EU-15.

1.3.2. Alternative scenarios

E3ME has also been set up to explore alternative scenarios. A key focus of the final phase of the project was on developing a range of alternative macroeconomic and related scenarios. This includes a broad assessment of the sensitivity of outcomes to some key external drivers, thus providing a tool to answer various policy-oriented questions about the role of skills in Europe's strategic development.

The benchmark projections are seen as part of a coherent European perspective rather than being based on national projections and inputs. The use of the macroeconomic model sets the macroeconomic context for the overall skill projections. E3ME provides consistent predictions of sectoral employment growth, considering factors such as GDP growth, as well as the underlying changes in the components of aggregate demand, demographic changes, etc. These scenarios are described in more detail in Chapter 3.

1.4. Modules 2 and 3: expansion demand by occupation and qualifications

1.4.1. Overview of modules 2 and 3

Modules 2 and 3 are based on data on occupational employment structure by industry plus information on qualifications held from the European LFS. This avoids the problems of incomparable systems of classification if country specific data were used. The data used are all drawn from LFS information harmonised by Eurostat.

Occupational employment patterns are only one way of measuring skills. From the point of view of training, and especially formal educational planning, the types of qualifications typically required are also important. Some (but by no means all) countries include a qualification dimension in their quantitative projections. A review of the data available suggests that it is possible to create employment matrices by occupation cross-classified by qualification from the LFS. However, there are problems in comparability across countries in how qualifications are coded within the LFS.

Even with only weak data for qualifications it is possible to begin to explore implications for qualifications (levels of education), although to ensure broad comparability this is limited to just three bread levels:

Low qualification	at most lower secondary (ISCED 0-2)
Medium qualification	upper secondary (ISCED 3-4)
High qualification	tertiary (ISCED 5-6)

Ideally, in the longer term this approach would also be extended to include a much more comprehensive and explicit analysis of the supply side. There are some significant data limitations in many countries. For the present, therefore, such development lies outside the remit of this project.

Another key issue is separating out supply from demand issues. The present exercise focuses on changing patterns of those in employment without any reference to supply side developments.

1.4.2. Modelling employment by occupation and qualification

Previous research on expansion demand and occupational structure is limited, especially at a detailed level. There is even less work on modelling qualifications from a demand perspective. There is a large gap between the ideal theoretical model and the typical specifications used in most national skills projections.

The main reason for this is probably data limitations. Where detailed data have been available, researchers have exploited them. However, the paucity of information often resulted in simple approaches based on time series methods with single variable (the occupational share) rather than multivariate, behavioural approaches. Judgement is often the key element rather than any formal model (see the approach adopted by the Bureau of Labor Statistics in the US).

The ideal approach based on economic theories of what determines demand for skill would relate occupational and qualification structure to a range of economic and other determinants, including:

(a) technology;
(b) cyclical indicators;
(c) price (wage) indicators;
(d) other economic factors such as trade performance, etc.

In practice, many such models revert to simple extrapolative procedures (using linear or non-linear methods) with time as the only independent variable acting as a proxy for technological change and other factors.

These issues are discussed in more detail in Chapter 4. A range of more and less sophisticated explanatory models have been explored covering both occupation and qualification dimensions. The focus is on employment patterns (shares) within sectors. Chapter 4 describes both the data issues with which the project has had to grapple, as well as further refinement of the models used to explain changing employment structure by occupation and qualification.

The most robust results are obtained for some of the simplest models, involving some form of trend rather than more sophisticated models with behavioural content. Given the problems with the current data this is probably not too surprising. As the data are extended and improved it may be possible to add in more economic content to this part of the modelling.

1.5. Module 4: replacement demand

1.5.1. General approach

In addition to analysing changes in overall occupational employment levels, replacement needs arising from retirements, net migration, movement into other occupations and in-service mortality should be considered. This is referred to as replacement demand and represents the final key component in the approach. Expansion demand and replacement demand together comprise the job openings for newcomers to the labour market.

Because of the limited data on such flows, estimating replacement needs consistently across Europe is far from straightforward. Chapter 5 explains the approach adopted in detail.

Estimating replacement demand is sensitive to both the methods and the data sources used (Fox and Comerford, 2006). In general terms, however, there is agreement about what it is about. Replacement needs focus on job openings arising because people leave the workforce, for whatever reason. Most previous work has tended to focus on what might be called permanent or semi-permanent withdrawals from the employed workforce. These include:

(a) mortality;
(b) retirement (and other reasons for leaving the workforce, including family issues);
(c) emigration;
(d) interoccupational mobility.

Information on age and gender is usually required because many of the flows, especially retirements and mortality, are age and gender specific. Age structures also vary significantly by occupation. Differences in age structure across occupations can clearly influence exits, with more older people retiring, but more younger people changing occupations. Age structure also affects mortality.

From the LFS, it is possible to analyse the demographic composition of each occupation. This makes it possible to estimate specific rates of retirement and mortality for each occupational class. LFS data can also be used to estimate rates of outflow. However, there are problems in obtaining robust data since samples are often small, and sampling errors large, even for broad age categories.

The replacement demand model (RDMOD) in the project is based on similar data sources to the occupational model. It adopts a modified cohort components approach as set out in greater detail in Chapter 5. The estimates are driven partly by the occupational and qualification employment levels projected from modules 2 and 3, combined with information on the probability of flowing out from employment caused by retirements, mortality and migration derived from the cohort component model.

Replacement demand for a particular category (e.g. an occupation) depends essentially on:

(a) the size of the category;
(b) the rate of outflow (which can be separated out to distinguish the various elements as described above).

Replacement demand is the product of (a) and (b).

Geographical mobility/migration is an important aspect of potential outflows in an EU context, with migration flows across national boundaries becoming an increasingly significant issue. However, obtaining robust estimates of these flows is not straightforward, since the available data are rarely adequate. In much previous work researchers have simply suggested that, in particular circumstances, such outflows might be significant, even though they may not have been able to measure them robustly. This is explored in much more detail in the project, although data limitations make this task difficult.

CHAPTER 2

National accounts versus labour force survey

Ilias Livanos and Rob A. Wilson
IER, University of Warwick

2.1. Introduction

This chapter is concerned with obtaining the best estimates of employment structure by sector and occupation, and with explaining the differences between different data series used to estimate this.

The main sources of employment data that this project uses are:

(a) national accounts- (NA) based data, as used in the macroeconomic model E3ME ([3]);

(b) LFS data from Eurostat.

E3ME produces forecasts of sectoral employment, using data from the individual country NA. These data are mainly drawn from the OCED STAN database (structural analysis database), and in some cases from Eurostat's sectoral data breakdown ([4]). The data on occupational employment come from the labour force survey (LFS), as collected by Eurostat; again, different versions of these data are available.

The estimates of employment from the main data source described above do not always match, and often the differences are significant. Previous research (Ypma and van Ark, 2006; Eurostat, 2006; 2007a) has examined the different methods used and data available from NA and LFS. Some of this work has been misleading. For example, both Ypma and van Ark (2006) and Eurostat (2006) suggest that the UK NAs estimates of employment are based

([3]) E3ME uses data from various sources. The most important include OECD and Eurostat. When Eurostat data are not available or need to be improved, other internationally available sources such as the International Monetary Fund (IMF) are consulted. Also, national statistical agencies and other data sources are used to update the remaining missing series and gaps in the data used.

([4]) For STAN database see: www.oecd.org/sti/stan/
For the Eurostat sectoral data breakdown see: http://epp.eurostat.ec.europa.eu/portal/page?_pageid=1996,45323734&_dad=portal&_schema=PORTAL&screen=welcomeref&open=/&product=EU_MAIN_TREE&depth=1

solely on LFS. This is incorrect. The Office for National Statistics (ONS, 2006) confirms that estimates from both administrative records and the LFS are used, with the former being crucial for the detailed sectoral estimates.

An example of the differences between employment data as estimated by LFS and business surveys, which are often the main source of NA estimates, is provided for the UK by Ganson (2002). This compares estimates of employment as calculated by the LFS and the annual business inquiry (ABI) based workforce series (WF). Ganson (2002) explains that there are various conceptual and coverage differences between these data sets. These differences also arise in other countries, although the precise details vary from case to case.

The purpose of this chapter is to explore these differences further. The chapter lists the differences between the two main sources: NA-based estimates and LFS-based estimates. The aim is to explore the causes of these differences to appreciate the potential of the data, and how these can be best used for the purposes of Cedefop's Skillsnet project. The comparisons suggest that even though the total levels of employment in each country may not differ greatly, the variations are much more significant at detailed sectoral level; this has implications for estimates of employment by occupation. Other potential differences to be explored are:

(a) differences between LFS micro and aggregate data;
(b) differences between NA data as estimated by E3ME and other sources (i.e. OECD and the different data sets of Eurostat).

Section 2.2 explores these differences in more detail, including conceptual and definitional differences between LFS and NA estimates as well as differences in coverage. Section 2.3 then presents a summary of the two estimates. Section 2.4 concludes.

2.2. Examining the main differences

2.2.1. Methods and data collection

The LFS covers the whole of the resident population, i.e. all persons whose usual place of residence is in the territory of the EU Member States. However, the results are compiled for the population of private households only. This comprises all persons living in the households surveyed during the reference week, and those persons absent from the household for short periods due to studies, holidays, illness, business trips, etc. It does not cover individuals who:

(a) usually live in another household;
(b) live in collective households (such as armed forces);
(c) have emigrated.

The results are based on asking a member of the household about the employment status of all other members. Because the LFS is based on a small sample it will include sampling errors, which can be significant for detail industry and occupational categories.

NAs data on employment are compiled using a range of different sources. The most important are:
(a) employment registers;
(b) administrative records;
(c) censuses;
(d) data derived from income tax records;
(e) the LFS;
(f) various other surveys (farm surveys, enterprise surveys, etc.).

The above sources (including the LFS) might have a minor or major role in producing employment estimates in any particular country. Many of countries rely on employers and official records. Generally NA estimates at sectoral level are more reliable than LFS-based estimates, but it is difficult to put a precise measure on margins of error.

2.2.2. **Concepts and definitions**

The concepts and definitions of employment used in both the LFS (Eurostat, 2003) and the NAs (Council of EU, 1996) are agreed internationally and are, in principle, common among all countries. Nevertheless, some disparities may still exist, which in turn can reduce precise comparability across the Member States.

2.2.2.1. *Employment in the LFS*

'A person is considered as having an employment if he or she did any work for pay or profit during the reference week. "Work" means any work for pay or profit during the reference week, even for as little as one hour. Pay includes cash payments or "payment in kind" (payment in goods or services rather than money), whether payment was received in the week the work was done or not. Also counted as working is anyone who receives wages for on-the-job training which involves the production of goods or services [...]. Self-employed persons with a business, farm or professional practice are also considered to be working' according to the *European labour force survey: methods and definitions* (Eurostat, 2003).

2.2.2.2. *Employment in NA*

'Employment covers all persons – both employees and self-employed – engaged in some productive activity that falls within the production boundary of the system […] Employees are defined as all persons who, by agreement, work for another resident institutional unit and receive remuneration […]. Self-employed persons are defined as persons who are the sole owners, or joint owners, of the unincorporated enterprises in which they work' according to the *European systems of accounts, ESA95* (Council of EU, 1996).

2.2.2.3. *Head count versus job count*

The LFS and the NA used a different unit of measurement until 1995. In the LFS, employment was measured as a head count, while in the system of national accounts of 1993 (SNA93), employment was measured by jobs. This difference can create significant discrepancy between the estimated levels of employment. In the UK, for example, over 2 million people have more than one job. In the European system of accounts (ESA95) employment is now measured as a head count. However, several countries do not adhere to this rule. For example Greece still only produces counts of jobs. The UK also uses jobs for NA purposes. In many respects jobs is a more meaningful measure. Individuals with more than one job will contribute to GDP in both their main job and any others and this contribution will be ignored if a pure head count measure is used.

2.2.2.4. *Concepts usually not measured in NA*

There is a range of dimensions that may not be measured in the administrative records and business surveys which are usually the major source of the NA estimates. These dimensions include unpaid members of family business, self-employment, unobserved economy, etc. However, most countries use other sources to make adjustments, and include these dimensions in NA estimates.

2.2.3. **National versus domestic concept**

One important factor behind some of the differences between NA and LFS estimates is geographical coverage, and, in particular, the difference between the national and the domestic concept. The concept of the national labour force captures persons who reside in each country. The concept of the domestic labour force captures persons working in resident production units, irrespective of the place of residence. The LFS focuses mainly on the concept of national employment while NA usually uses the domestic one. In particular,

NA employment covers those engaged in production activity that falls within the production boundary of the system. This means that the nationals working abroad (armed forces, scientific personnel working at national bases outside the country, staff of diplomatic missions abroad), as well as non-resident frontier and seasonal workers working in the economic territory, local employees of general government bodies abroad, and crew of boats, etc., situated outside the economic territory, are counted in the employment figures. In the LFS, a person is considered as employed if he/she did any work for pay or profit during the reference week, irrespective of whether it falls within the production boundary of the system. The residence factor can be responsible for a significant portion of the differences between typical NA and LFS estimates, especially in small countries such as Luxembourg. Nevertheless, even though the concept of NA 'domestic' employment, as described above, is suggested by the ESA95 definitions of employment, some countries (such as Lithuania) adopt the national concept rather than the domestic one.

2.2.4. Groups not included in the LFS

In the NA, students who have a formal commitment, whereby they contribute some of their own labour as input to enterprise production in return for education services, are counted as in employment. In the LFS these are usually not counted as employed. Other groups of individuals not captured as employed in the LFS include conscripts and persons in extended parental leave. Given the small numbers involved, the above differences would contribute to only a small portion of the difference between the LFS and NA levels of employment.

NA do not exclude individuals because of their age. LFS excludes individuals aged below 15 or above 75.

2.2.5. Sectoral and occupational classification

A large portion of the difference between NA and LFS employment, for specific sectors and occupations, can arise because of classification and response differences. In the LFS, the respondent is asked about the occupation and sector of employment for each member of the household, while in the NA it is the employer who is asked similar questions about their main areas of economic activity. This can create significant differences in the levels of sectoral and occupational employment as individual respondents might classify household members differently from employers. To illustrate, in the LFS someone working in a catering department at a university could be classified by the respondent as working in a restaurants rather than in the

education sector, although their employer is the university. NA estimates would classify the same individual based on the records of the employer and allocate them to the education sector. There is also the risk that the LFS researchers might make mistakes in coding people's sector and occupation. NA employment is generally based on employer records which are likely to be more reliable.

2.2.6. Employees of temporary employment agencies

In the LFS someone employed by a temporary employment agency, but actually working in a hotel, when asked by the LFS researcher about his sector of activity, might suggest that he/she works in a hotel. In NA the same individual will be registered as an employee of the temporary employment agency (part of other business services) and not in the industry of the enterprise for which they actually work, in this case hotels and catering. This could cause considerable differences in the levels of sectoral employment.

2.3. Different aggregate employment levels

2.3.1. Differences caused by concept used

Table 2.1 presents data from Eurostat on NA employment for all EU-27 Member States, as calculated using both the national and the domestic concepts, showing the percentage differences. The difference between the two is not large (0.10 for EU-27) except for Luxembourg, where it is significant (55 %) in 2005.

Tables 2.2 and 2.3 compare total employment for each Member State as estimated by LFS and NA methods. Table 2.2 shows NA employment using the national concept and Table 2.3 the domestic concept. NA employment using the national concept is generally closer to LFS estimates. The use of the domestic concept in the NA causes especially large differences in the levels of employment for the Czech Republic, Luxembourg, Portugal, Slovakia and the UK. For the other countries the differences are small. However, even though the national concept is closer to LFS estimates of employment, the NA national concept has less consistency with output data (production, value added, etc.), for which purpose the domestic concept is preferable. This is used in E3ME.

Table 2.1. **NA estimates national concept versus domestic concept**

	2000			2005		
	National	Domestic	Difference (%)	National	Domestic	Difference (%)
EU-27	207 081	207 622	-0.3	214 410	214 550	-0.1
EU-25	195 472	196 013	-0.3	202 669	202 910	-0.1
EU-15	165 894	166 402	-0.3	173 051	173 299	-0.1
BE	4 142	4 091	1.2	4 264	4 214	1.2
BG	2 980	2 980	0.0	3 262	3 286	-0.7
CZ	4 825	4 940	-2.4	4 857	5 009	-3.1
DK	2 764	2 764	0.0	2 753	2 761	-0.3
DE	39 038	39 144	-0.3	38 726	38 823	-0.3
EE	575	572	0.5	610	604	1.0
IE	1 696	1 696	0.0	1 956	1 956	0.0
EL	n/a	3 789	n/a	4 148	4 033	2.8
ES	16 399	16 412	-0.1	19 194	19 212	-0.1
FR	24 332	24 332	0.0	25 028	25 028	0.0
IT	22 498	22 930	-1.9	24 413	24 281	0.5
CY	317	315	0.6	369	366	0.8
LV	944	944	0.0	1 024	1 024	0.0
LT	1 403	1 403	0.0	1 479	1 461	1.2
LU	185	264	-42.7	198	307	-55.1
HU	3 844	3 844	0.0	3 879	3 879	0.0
MT	146	146	0.0	153	153	0.0
NL	8 114	8 115	0.0	8 191	8 208	-0.2
AU	n/a	n/a	n/a	n/a	n/a	n/a
PL	14 526	14 526	0.0	14 116	14 116	0.0
PT	5 021	4 924	1.9	5 161	5 016	2.8
RO	8 629	8 629	0.0	8 480	8 354	1.5
SI	895	895	0.0	916	916	0.0
SK	2 102	2 025	3.7	2 216	2 084	6.0
FI	2 302	2 297	0.2	2 401	2 397	0.2
SE	4 254	4 264	-0.2	4 323	4 328	-0.1
UK	27 317	27 473	-0.6	28 328	28 730	-1.4

n/a = not available

Source: Eurostat online databases.

Table 2.2. **LFS (national) and NA (national) differences in employment across EU-27**

	2000			2005		
	National	Domestic	Difference (%)	National	Domestic	Difference (%)
EU-27	202 359	207 081	-2.3	209 573	214 410	-2.3
EU-25	188 911	195 472	-3.5	197 476	202 669	-2.6
EU-15	159 514	165 894	-4.0	167 919	173 051	-3.1
BE	4 092	4 142	-1.2	4 235	4 264	-0.7
BG	2 794	2 980	-6.7	2 981	3 262	-9.4
CZ	4 681	4 825	-3.1	4 764	4 857	-2.0
DK	2 713	2 764	-1.9	2 752	2 753	0.0
DE	36 466	39 038	-7.1	36 352	38 726	-6.5
EE	572	575	-0.5	607	610	-0.5
IE	1 692	1 696	-0.2	1 952	1 956	-0.2
EL	4 088	n/a	n/a	4 368	4 148	5.0
ES	15 505	16 399	-5.8	18 973	19 194	-1.2
FR	23 331	24 332	-4.3	24 535	25 028	-2.0
IT	21 079	22 498	-6.7	22 562	24 413	-8.2
CY	295	317	-7.5	348	369	-6.0
LV	943	944	-0.1	1 033	1 024	0.9
LT	1 404	1 403	0.1	1 473	1 479	-0.4
LU	171	185	-8.2	193	198	-2.6
HU	3 829	3 844	-0.4	3 901	3 879	0.6
MT	143	146	-2.1	148	153	-3.4
NL	7 870	8 114	-3.1	8 110	8 191	-1.0
AU	3 710	n/a	n/a	3 824	n/a	n/a
PL	14 525	14 526	0.0	14 115	14 116	0.0
PT	5 020	5 021	0.0	5 122	5 161	-0.8
RO	10 652	8 629	19.0	9 114	8 480	7.0
SI	900	895	0.6	949	916	3.5
SK	2 101	2 102	0.0	2 215	2 216	0.0
FI	2 336	2 302	1.5	2 400	2 401	0.0
SE	4 240	4 254	-0.3	4 346	4 323	0.5
UK	27 184	27 317	-0.5	28 187	28 328	-0.5

n/a = not available

Source: Eurostat online databases.

Table 2.3. **LFS (national) and NA (domestic) differences in employment across EU-27 (domestic)**

	2000			2005		
	National	Domestic	Difference (%)	National	Domestic	Difference (%)
EU-27	202 359	207 622	-2.6	209 573	214 550	-2.3
EU-25	188 911	196 013	-3.7	197 476	202 910	-2.7
EU-15	159 514	166 402	-4.3	167 919	173 299	-3.2
BE	4 092	4 091	0.0	4 235	4 214	0.5
BG	2 794	2 980	-6.6	2 981	3 286	-10.2
CZ.	4 681	4 940	-5.5	4 764	5 009	-5.1
DK	2 713	2 764	-1.8	2 752	2 761	-0.3
DE	36 466	39 144	-7.3	36 352	38 823	-6.8
EE	572	572	0.0	607	604	0.4
IE	1 692	1 696	-0.2	1 952	1 956	-0.2
EL	4 088	3789	7.3	4 368	4 033	7.6
ES	15 505	16 412	-5.8	18 973	19 212	-1.2
FR	23 331	24 332	-4.2	24 535	25 028	-2.0
IT	21 079	22 930	-8.7	22 562	24 281	-7.6
CY	295	315	-6.7	348	366	-5.1
LV	943	944	-0.1	1 033	1 024	0.8
LT	1 404	1 403	0.0	1 473	1 461	0.8
LU	171	264	-54.3	193	307	-59.0
HU	3 829	3 844	-0.3	3 901	3 879	0.5
MT	143	146	-2.1	148	153	-3.3
NL	7 870	8 115	-3.1	8 110	8 208	-1.2
AU	3 710	n/a		3 824	n/a	
PL	14 525	14 526	-0.0	14 115	14 116	-0.0
PT	5 020	4 924	1.9	5 122	5 016	2.0
RO	10 652	8 629	18.9	9 114	8 354	8.3
SI	900	895	0.5	949	916	3.4
SK	2 101	2 025	3.6	2 215	2 084	5.9
FI	2 336	2 297	1.6	2 400	2 397	0.1
SE	4 240	4 264	-0.5	4 346	4 328	0.4
UK	27 184	27 473	-1.0	28 187	28 730	-1.9

n/a = not available

Source: Eurostat online databases.

2.3.2. E3ME versus Eurostat estimates

Table 2.4 presents a comparison of NA employment numbers for 2005, as used in the E3ME, with those published by Eurostat's auxiliary indicators. E3ME data for 2005 come mainly from Eurostat's sectoral data breakdowns (this is a different database from Eurostat's auxiliary indicators). An exception is Cyprus, as Eurostat does not provide data and, therefore, the estimates of employment are drawn from the Directorate-General for Economic and Financial Affairs AMECO database (06a version). In principle, since the sources of these data are the same, the numbers ought to be identical but this is not always the case. The differences are small for most countries, the largest observed for Spain, Cyprus, Poland and the UK. These differences are mainly caused by inconsistencies within Eurostat's different braches and between Eurostat and national agencies. This issue is being explored further to identify the nature of the differences more precisely.

Table 2.4. **2005 E3ME and Eurostat estimates of NA employment**

	Eurostat	E3ME	Difference (%)		Eurostat	E3ME	Difference (%)
BE	4 214	4 188.5	0.6	**LU**	307	307	-0.1
BG	3 286	n/a		**HU**	3 879	3 900	-0.5
CZ	5 009	4 913	1.9	**MT**	153	153	0.0
DK	2 761	2 760	0.0	**NL**	8 208	8 221	-0.2
DE	38 823	38 378	1.1	**AU**	n/a	4 089	
EE	604			**PL**	14 116	14 746	-4.5
IE	1 956	1 954	0.1	**PT**	5 016	4 995	0.4
EL	4 033	4 047	-0.3	**RO**	8 354	n/a	
ES	19 212	16 837	12.4	**SI**	916	900	1.8
FR	25 028	25 070	-0.2	**SK**	2 084	2 093	-0.4
IT	24 281	24 536	-1.1	**FI**	2 397	2 397	0.0
CY	366	336	8.3	**SE**	4 328	4 287	0.9
LV	1 024	1024	0.0	**UK**	28 730	30 205	-5.1
LT	1 461	1 429	2.2				

n/a = not available

Source: E3ME, Eurostat online databases.

2.3.3. NA-LFS differences for sectors

Table 2.5 presents the differences between NA-based estimates (as used in E3ME ([5])) and Eurostat LFS estimates (as published by Eurostat ([6])) for six broad sectors of economic activity for Member States. The E3ME results are based on the data presented originally in Wilson (2006) and are the same as those supplied to individual country experts prior to the May workshop. The LFS data are those published by Eurostat as of autumn 2006.

Table 2.5. **Differences between LFS and NA employment for six broad sectors of economic activity for each EU-25 Member State**

		1995			2000			2005		
		NA	Diff.	ELFS-NA Diff. (%)	NA	ELFS-NA Diff.	ELFS-NA Diff. (%)	NA	ELFS-NA Diff.	ELFS-NA Diff. (%)
AU	Primary sector and utilities	659	-342	-107	590	-327	-125	548	-313	-133
	Manufacturing	704	106	13	683	75	10	647	51	7
	Construction	296	26	8	287	21	7	273	1	0
	Distribution and transport	1 046	-45	-4	1 102	-57	-5	1 139	-63	-6
	Business and other services	496	9	2	605	-36	-6	669	-7	-1
	Non-marketed services	727	-8	-1	784	-43	-6	817	-5	-1
	Total	3 928	-253	-7	4 050	-367	-10	4 094	-336	-9
BE	Primary sector and utilities	144	5	3	131	-14	-12	122	5	4
	Manufacturing	674	89	12	652	121	16	620	96	13
	Construction	228	33	13	235	18	7	234	39	14
	Distribution and transport	988	-3	0	998	36	4	1 034	3	0
	Business and other services	772	-231	-43	941	-248	-36	1 017	-299	-42
	Non-marketed services	1 033	61	6	1 131	119	10	1 191	150	11
	Total	3 839	-46	-1	4 088	32	1	4 218	-5	0
CZ	Primary sector and utilities	488	n/a	n/a	362	31	8	272	46	15
	Manufacturing	1 366	n/a	n/a	1 300	-20	-2	1 387	-99	-8
	Construction	521	n/a	n/a	420	17	4	372	91	20
	Distribution and transport	1 305	n/a	n/a	1 233	-99	-9	1 280	-127	-11
	Business and other services	656	n/a	n/a	689	-155	-29	768	-196	-34
	Non-marketed services	488	n/a	n/a	362	31	8	272	46	15
	Total	1 366	n/a	n/a	1 300	-20	-2	1 387	-99	-8

([5]) The data for 2005 refer to forecasted values of employment rather than the actual NA numbers. Forthcoming work will update these tables with the actual numbers.

([6]) For details see http://forum.europa.eu.int/irc/dsis/employment/info/data/eu_lfs/index.htm

		1995			2000			2005		
		NA	Diff.	ELFS-NA Diff. (%)	NA	ELFS-NA Diff.	ELFS-NA Diff. (%)	NA	ELFS-NA Diff.	ELFS-NA Diff. (%)
DK	Primary sector and utilities	139	-4	-3	122	-9	-8	114	-5	-5
	Manufacturing	474	46	9	454	36	7	424	19	4
	Construction	145	18	11	169	13	7	167	30	15
	Distribution and transport	644	-23	-4	696	-65	-10	713	-78	-12
	Business and other services	404	-20	-5	479	-1	0	501	-5	-1
	Non-marketed services	762	12	2	815	-2	0	845	10	1
	Total	2 568	28	1	2 736	-28	-1	2 764	-29	-1
DE	Primary sector and utilities	1 677	67	4	1 388	22	2	1 257	27	2
	Manufacturing	8 439	491	5	8 098	532	6	7 584	364	5
	Construction	3 227	117	3	2 761	337	11	2 279	145	6
	Distribution and transport	9 309	-1 033	-12	9 848	-1 478	-18	9 876	-1 371	-16
	Business and other services	6 551	-1 099	-20	8 138	-1 824	-29	8 640	-1 379	-19
	Non-marketed services	8 179	-143	-2	8 515	-13	0	8 997	-220	-3
	Total	37 382	-1 600	-4	38 748	-2 424	-7	38 632	-2 434	-7
EE	Primary sector and utilities	89	n/a	n/a	62	-2	-4	48	4	7
	Manufacturing	157	n/a	n/a	129	2	1	115	31	21
	Construction	34	n/a	n/a	39	5	12	35	10	22
	Distribution and transport	160	n/a	n/a	155	-7	-5	155	5	3
	Business and other services	38	n/a	n/a	47	33	41	59	24	29
	Non-marketed services	156	n/a	n/a	139	-34	-33	155	-30	-24
	Total	634	n/a	n/a	572	-3	-1	566	43	7
IE	Primary sector and utilities	167	3	2	148	3	2	137	-1	-1
	Manufacturing	249	-14	-6	300	-8	-3	272	-0	0
	Construction	96	-0	0	171	-5	-3	206	37	15
	Distribution and transport	307	-6	-2	455	-11	-2	508	-12	-2
	Business and other services	200	- 0	0	307	-2	-1	344	29	8
	Non-marketed services	270	-13	-5	315	- 1	0	408	1	0
	Total	1 289	-31	-2	1 696	-25	-1	1 875	54	3
EL	Primary sector and utilities	808	30	4	739	32	4	648	-48	-8
	Manufacturing	625	-48	-8	603	-31	-5	565	-4	-1
	Construction	252	-0	0	280	16	5	302	66	18
	Distribution and transport	1 041	55	5	1 103	126	10	1 191	162	12
	Business and other services	439	-36	-9	508	-17	-4	588	36	6

		1995			2000			2005		
		NA	Diff.	ELFS-NA Diff. (%)	NA	ELFS-NA Diff.	ELFS-NA Diff. (%)	NA	ELFS-NA Diff.	ELFS-NA Diff. (%)
	Non-marketed services	655	-0	0	702	37	5	741	135	15
	Total	3 820	0	0	3 935	163	4	4 035	347	8
ES	Primary sector and utilities	1 198	86	7	1 130	68	6	1 031	116	10
	Manufacturing	2 454	-39	-2	2 881	13	0	2 897	206	7
	Construction	1 237	-39	-3	1 631	70	4	1 843	496	21
	Distribution and transport	3 703	-85	-2	4 327	128	3	4 633	646	12
	Business and other services	2 260	-425	-23	2 758	-199	-8	3 203	403	11
	Non-marketed services	2 718	-574	-27	3 017	-383	-15	3 138	283	8
	Total	13 570	-1 075	-9	15 744	-304	-2	16 745	2 150	11
FR	Primary sector and utilities	1 303	24	2	1 226	-34	-3	1 148	12	1
	Manufacturing	3 877	251	6	3 812	524	12	3 602	373	9
	Construction	1 433	81	5	1 430	73	5	1 532	68	4
	Distribution and transport	5 154	-70	-1	5 622	-273	-5	6 021	-335	-6
	Business and other services	4 721	-819	-21	5 800	-1 361	-31	6 290	-1 437	-30
	Non-marketed services	6 199	-259	-4	6 421	-125	-2	6 588	371	5
	Total	22 687	-792	-4	24 311	-1 197	-5	25 181	-949	-4
IT	Primary sector and utilities	1 539	42	3	1 311	17	1	1 229	-99	-9
	Manufacturing	5 142	-214	-4	5 164	-339	-7	5 178	-381	-8
	Construction	1 458	72	5	1 504	92	6	1 716	228	12
	Distribution and transport	5 380	-492	-10	5 792	-496	-9	6 135	-356	-6
	Business and other services	4 162	-1 472	-55	5 025	-1 766	-54	5 931	-1 489	-34
	Non-marketed services	4 316	44	1	4 337	290	6	4 441	117	3
	Total	21 997	-2 019	-10	23 133	-2 203	-11	24 630	-1 979	-9
CY	Primary sector and utilities	n/a	n/a	n/a	30	-10		28	-9	-48
	Manufacturing	n/a	n/a	n/a	36	2	4	29	12	29
	Construction	n/a	n/a	n/a	25	4	15	30	11	27
	Distribution and transport	n/a	n/a	n/a	108	-9	-9	116	-10	-9
	Business and other services	n/a	n/a	n/a	30	25	46	35	42	55
	Non-marketed services	n/a	n/a	n/a	71	-17	-32	88	-25	-40
	Total	n/a	n/a	n/a	299	-5	-9	326	22	6
LV	Primary sector and utilities	214	n/a	n/a	179	-17	-10	184	-31	-20
	Manufacturing	193	n/a	n/a	168	6	4	145	6	4
	Construction	56	n/a	n/a	65	-9	-15	74	15	17

		1995			2000			2005		
		NA	Diff.	ELFS-NA Diff. (%)	NA	ELFS-NA Diff.	ELFS-NA Diff. (%)	NA	ELFS-NA Diff.	ELFS-NA Diff. (%)
	Distribution and transport	262	n/a	n/a	285	-42	-17	316	-37	-13
	Business and other services	64	n/a	n/a	73	27	27	91	38	29
	Non-marketed services	256	n/a	n/a	268	-62	-30	296	-69	-31
	Total	1 046	n/a	n/a	1 038	-96	-10	1 106	-78	-8
LT	Primary sector and utilities	437	n/a	n/a	355	-42	-13	296	-47	-19
	Manufacturing	303	n/a	n/a	280	-22	-8	292	-38	-15
	Construction	115	n/a	n/a	96	-15	-18	101	23	19
	Distribution and transport	326	n/a	n/a	361	-41	-13	362	0	0
	Business and other services	70	n/a	n/a	73	38	34	75	72	49
	Non-marketed services	394	n/a	n/a	420	-86	-26	425	-89	-26
	Total	1 644	n/a	n/a	1 586	-167	-12	1 551	-78	-5
LU	Primary sector and utilities	6	1	15	6	-1	-11	5	n/a	n/a
	Manufacturing	33	-11	-49	33	-12	-58	33	n/a	n/a
	Construction	24	-7	-42	26	-10	-67	29	n/a	n/a
	Distribution and transport	60	-19	-45	72	-28	-62	82	n/a	n/a
	Business and other services	57	-20	-53	86	-38	-80	109	n/a	n/a
	Non-marketed services	35	0	1	41	5	10	49	n/a	n/a
	Total	216	-55	-34	265	-84	-47	307	n/a	n/a
HU	Primary sector and utilities	426	n/a	n/a	356	-12	-3	280	-15	-5
	Manufacturing	850	n/a	n/a	937	-15	-2	899	-31	-4
	Construction	217	n/a	n/a	267	-1	-1	305	9	3
	Distribution and transport	896	n/a	n/a	991	3	0	1 065	-35	-3
	Business and other services	405	n/a	n/a	456	1	0	562	-20	-4
	Non-marketed services	829	n/a	n/a	850	-25	-3	905	-34	-4
	Total	3 623	n/a	n/a	3 856	-50	-1	4 017	-125	-3
MT	Primary sector and utilities	7	n/a	n/a	5	1	23	4	1	22
	Manufacturing	30	n/a	n/a	26	7	20	23	7	22
	Construction	6	n/a	n/a	7	4	36	7	5	44
	Distribution and transport	36	n/a	n/a	37	6	13	37	6	15
	Business and other services	24	n/a	n/a	25	-8	-43	24	-3	-15
	Non-marketed services	32	n/a	n/a	35	-2	-7	44	-8	-21
	Total	135	n/a	n/a	135	8	5	140	9	6

		1995			2000			2005		
		NA	Diff.	ELFS-NA Diff. (%)	NA	ELFS-NA Diff.	ELFS-NA Diff. (%)	NA	ELFS-NA Diff.	ELFS-NA Diff. (%)
NL	Primary sector and utilities	342	-31	-10	327	-41	-14	306	3	1
	Manufacturing	1 067	15	1	1 085	10	1	1 015	46	4
	Construction	437	-42	-11	506	-56	-12	500	-24	-5
	Distribution and transport	1 852	-107	-6	2 129	-192	-10	2 151	-196	-10
	Business and other services	1 752	-596	-52	2 213	-681	-44	2 170	-612	-39
	Non-marketed services	1 697	190	10	1 864	199	10	2 041	327	14
	Total	7 147	-572	-9	8 124	-760	-10	8 184	-455	-6
PL	Primary sector and utilities	4 503	n/a	n/a	4 433	-1 162	-36	4 120	-1 266	-44
	Manufacturing	3 104	n/a	n/a	2 733	137	5	2 565	321	11
	Construction	841	n/a	n/a	869	210	19	818	-28	-4
	Distribution and transport	2 897	n/a	n/a	3 129	53	2	3 208	-139	-5
	Business and other services	1 145	n/a	n/a	1 484	-77	-5	1 663	-114	-7
	Non-marketed services	2 248	n/a	n/a	2 370	339	12	2 320	475	17
	Total	14 738	n/a	n/a	15 018	-500	-3	14 694	-751	-5
PT	Primary sector and utilities	579	-18	-3	549	124	18	497	151	23
	Manufacturing	979	26	3	965	119	11	893	80	8
	Construction	390	-27	-7	519	72	12	473	77	14
	Distribution and transport	1 018	34	3	1 137	34	3	1 210	64	5
	Business and other services	662	-69	-12	793	-174	-28	891	-188	-27
	Non-marketed services	861	-18	-2	968	-103	-12	1 026	-41	-4
	Total	4 488	-72	-2	4 931	71	1	4 989	143	3
SL	Primary sector and utilities	153	n/a	n/a	124	-21	-21	105	-6	-6
	Manufacturing	284	n/a	n/a	256	13	5	248	30	11
	Construction	57	n/a	n/a	67	-19	-40	71	-12	-20
	Distribution and transport	192	n/a	n/a	192	20	10	198	7	3
	Business and other services	99	n/a	n/a	114	-14	-15	129	-6	-5
	Non-marketed services	127	n/a	n/a	142	15	9	157	21	12
	Total	912	n/a	n/a	895	-7	-1	908	34	4
SK	Primary sector and utilities	254	n/a	n/a	173	43	20	143	23	14
	Manufacturing	596	n/a	n/a	535	3	1	511	79	13
	Construction	160	n/a	n/a	141	26	15	151	54	27
	Distribution and transport	495	n/a	n/a	540	-46	-9	642	-148	-30
	Business and other services	254	n/a	n/a	281	-82	-41	287	-14	-5

		1995			2000			2005		
		NA	Diff.	ELFS-NA Diff. (%)	NA	ELFS-NA Diff.	ELFS-NA Diff. (%)	NA	ELFS-NA Diff.	ELFS-NA Diff. (%)
	Non-marketed services	475	n/a	n/a	463	6	1	475	-11	-2
	Total	2 234	n/a	n/a	2 133	-51	-2	2 208	-17	-1
FI	Primary sector and utilities	188	-1	-1	161	12	7	136	7	5
	Manufacturing	414	-2	0	460	21	4	422	22	5
	Construction	118	-5	-5	154	-1	-1	153	6	4
	Distribution and transport	463	-35	-8	532	2	0	551	3	1
	Business and other services	297	20	6	368	49	12	421	51	11
	Non-marketed services	575	-18	-3	629	-24	-4	681	-34	-5
	Total	2 055	-41	-2	2 304	58	2	2 365	54	2
SE	Primary sector and utilities	171	7	4	155	5	3	139	-9	-7
	Manufacturing	215	22	9	223	-1	0	250	7	3
	Construction	914	-34	-4	964	-65	-7	988	-57	-6
	Distribution and transport	701	-20	-3	823	-28	-4	930	-7	-1
	Business and other services	1 355	-40	-3	1 355	-50	-4	1 348	85	6
	Non-marketed services	4 101	-51	-1	4 265	-142	-3	4 373	-37	-1
	Total									
UK	Primary sector and utilities	802	66	8	725	-17	-2	623	36	5
	Manufacturing	4 406	513	10	4 248	345	8	3 571	145	4
	Construction	1 813	26	1	1 884	34	2	2 075	124	6
	Distribution and transport	7 941	-1 050	-15	8 487	-1 349	-19	8 827	-1 434	-19
	Business and other services	8 923	-3 790	-74	10 261	-4 428	-76	10 742	-4 681	-77
	Non-marketed services	3 767	2 452	39	3 821	3 007	44	4 090	3 884	49
	Total	27 652	-1 784	-7	29 426	-2 408	-9	29 928	-1 925	-7

n/a = not available

NB: E3ME estimate for 2005 is a projected number rather than an actual.

Source: Cambridge Econometrics (E3ME) for NA data, and the Eurostat online database for LFS data.

The years examined are 1995, 2000 and 2005. The differences vary between countries from -9 % in Italy to 11 % in Spain (for 2005). The differences between the two data sets across all sectors are often large: more than 3 % for Estonia, Greece, Spain, Malta and Slovenia, for which LFS estimates are higher than the NA ones, and also for Belgium, the Czech Republic, Denmark, Hungary, Portugal, Slovakia and Sweden for which the LFS estimates are lower than the NA ones. For the rest of the countries, the differences are below 3 %.

Usually the differences do not vary greatly over time, generally retaining the same sign.

On the broad sectors of economic activity the differences are even greater across countries. For 2005 we observe:

(a) primary sector and utilities: the differences vary across countries. In particular, for 2005, they vary from -133 % for Austria to 23 % for Portugal. However, no particular patterns can be observed;
(b) manufacturing: in general LFS estimates are much higher (more than 3 %) than NA for most of the countries. The differences between the two sources vary from -15 % for Lithuania to 29 % for Cyprus;
(c) construction: in most countries LFS estimates are much higher (more than 3 %) than NA. The differences vary from -20 % for Slovenia to 44 % for Malta;
(d) distribution: in general, NA estimates are higher (3 %) than LFS. However, the differences vary from -19 % for the UK to 12 % for Greece;
(e) business: in general LFS the estimates are much higher (more than 3 %) than NA. However, the differences vary from -77 % for the UK to 55 % for Cyprus;
(f) non-marketed services: the differences vary across countries, no particular patterns can be observed. However, the differences vary from -40 % for Cyprus to 49 % for the UK.

The above observations are broadly stable over time.

The levels and proportions of total employment for more detailed sectors of economic activity for each Member State are also examined. In general, the differences between NA and LFS regarding the share of each sector in total employment do not seem to vary greatly. Nevertheless, for some groups the differences are large across most countries: distribution, electricity, computing services, and professional services. Other categories with large differences for some countries include construction, education, health and social security, and agriculture.

2.4. Conclusions

This chapter has outlined some discrepancies between the various available estimates of employment. In particular, it focuses on the major differences between NA and LFS estimates and reasons for the discrepancies between the estimated levels of employment in the two. The main causes of the differences are found to be methods of collection, concepts and definition and coverage.

The LFS has some advantages, summarised by Eurostat (2007a):

(a) it is a large sample, household survey with periodicity and level of detail;
(b) it is continuous (it captures seasonal employment variations);
(c) it has information on persons, jobs and hours of work;
(d) it captures informal employment and self-employment;
(e) it is harmonised across the EU;
(f) it adopts common definitions and concepts.

Nevertheless, several reasons make NA estimates preferable to LFS:

(a) employment in NA estimates is consistent with other economic variables such as output, wages, etc.;
(b) the domestic concept of employment used in NA allows employment and GDP to be examined together, as employment is a count of resident production units irrespective of the place of residence of the employed individual;
(c) employment in NA estimates covers all individuals, the LFS excludes several categories;
(d) while LFS data on total employment are accurate and comparable across countries, they become progressively less robust and reliable as they disaggregate by sector. NA estimates are much more appropriate for analysis at a sectoral level. This is a dimension that a sample survey cannot capture with great accuracy, and the estimated numbers of people in employment by sector in the LFS often fall below the reliability limits set by Eurostat;
(e) the LFS is a survey and, therefore, subject to sampling errors, errors in coding, etc. In the NA estimates employment is based on registers, administrative records and other sources which are more reliable. They cover all individuals within the economic boundary of a system.

This project is primarily concerned with changes in employment by occupation rather than sector. The key question is, therefore, whether or not these discrepancies make any difference when it comes to producing projections.

Following detailed debate about the merits of the two sets of estimates at the technical workshop no consensus was reached. It was, therefore, decided to produce two sets of estimates: one based on employment by sector from the NAs as in E3ME (the occupational estimates are constrained to match the sectoral totals from E3ME, while the occupational shares within sectors reflect the LFS data); and an alternative linked to the same benchmark scenario, but constrained to be consistent with the sectoral estimates in the published LFS data. These results, along with the outcomes from alternative macroeconomic scenarios, are discussed in Chapter 6.

CHAPTER 3

Macroeconomic and multisectoral scenarios

Ben Gardiner, Hector Pollitt and Unnada Chewpreecha
Cambridge Econometrics

3.1. Introduction

This chapter presents the methods used to create projections of labour demand by economic sector, using Cambridge Econometrics' energy-environment-economy model of Europe (E3ME). Section 3.2 describes the E3ME in more detail and Section 3.3 outlines the method used to form the baseline projections. Finally, Section 3.4 presents a summary of the baseline projections and the main results of the scenario analysis, giving upper and lower boundaries to the central forecast.

For further more technical details about the E3ME, the reader is referred to the main model website ([7]) and the full online manual ([8]). Users are requested to report any errors to the authors.

The aim was to develop a full set of projections of employment demand, by occupation, sector and qualification. These projections were formed using different modelling frameworks. The role of E3ME was to provide the projections for employment by economic sector, and to provide the links between developments in the wider economy and impacts on employment demand.

The projections for employment demand are then used for projections of employment by occupation and qualification and, from this, replacement demand by occupation and by qualification are formed.

([7]) Available from Internet: http://www.e3me.com [cited 9.3.2009].
([8]) Available from Internet: http://www.camecon-e3memanual.com/cgi-bin/EPW_CGI [cited 9.3.2009].

3.2. The E3ME

3.2.1. General introduction to the E3ME

The E3ME is intended to meet an expressed need of researchers and policy-makers for a framework for analysing the long-term implications of energy-environment-economy (E3) policies, especially those concerning R&D and environmental taxation and regulation. The model is also capable of addressing the short-term and medium-term economic effects as well as, more broadly, the long-term effects of such policies, such as those from the supply side of the labour market.

The E3ME has been built by an international European team under a succession of contracts in the Joule/Thermie and European Commission research programmes. The projects Completion and extension of E3ME ([9]) and Applications of E3ME' ([10]), were completed in 1999. The 2001 contract, Sectoral economic analysis and forecasts ([11]) generated an update of the E3ME industry output, products and investment classifications to bring the model into compliance with the European system of accounts, ESA95. This led to a significant disaggregation of the service sector. The 2003 contract, Tipmac ([12]), led to full development of the E3ME transport module to include detailed country models for several modes of passenger and freight transport; Seamate (2003/04) ([13]) resulted in the improvement of the E3ME technology indices. The COMETR ([14]) (2005-07) and Matisse ([15]) (2005-08) projects allowed expansion of E3ME to cover 27 regions (EU-25+). E3ME is the latest in a succession of models developed for energy-economy and, later, E3 interactions in Europe, starting with Explor built in the 1970s, then Hermes in the 1980s. Each model has required substantial resources from international teams and each model has learned from earlier problems and developed new techniques.

E3ME combines the features of an annual short- and medium-term sectoral model, estimated by formal econometric methods, with the detail and some of the methods of the computable general equilibrium models that provide analysis of the movement of the long-term outcomes for key economic

([9]) European Commission contract No JOS3-CT95-0011
([10]) European Commission contract No JOS3-CT97-0019
([11]) European Commission contract No B2000/A7050/001
([12]) European Commission contract NoGRD1/2000/25347-SI2.316061
([13]) European Commission contract No IST-2000-31104
([14]) European Commission contract No 501993 (SCS8)
([15]) European Commission contract No 004059 (GOCE)

indicators in response to policy changes. It can be used for dynamic policy simulation and for forecasting and projecting over the medium and long terms. As such, it is a valuable tool for economic policy analysis in Europe. E3ME has the following advantages over many competing models:

(a) the detailed nature of the model allows representation of complex scenarios, especially those differentiated according to sector and to country. Similarly, forecasts and the impact of policy measures can be represented in detail; for example, employment projections are split into 42 industrial sectors;

(b) the econometric grounding of the model makes it better able to represent and forecast performance in the short to medium term, providing information that is closer to the time horizon of many policy-makers than pure computable general equilibrium models;

(c) an interaction (two-way feedback) between the economy, energy demand/supply and environmental emissions is an undoubted advantage over other models, which may either ignore the interaction completely or only assume one-way causation. These links played only a minor role in this project but are important in the model, for example in evaluating the impacts of higher international energy prices in the scenarios (Section 3.4.2);

(d) like its predecessors, E3ME is an estimated model and its parameters are the results of econometric analysis based on historical time series data. Version 4.2 (E3ME42) is based on international data sources such as Eurostat and the OECD (Stan). See Section 3.2.5 for more details about the available data sources, references and the order of preference;

(e) E3ME is a detailed model of 42 product/industrial sectors, compatible with ESA95 accounting classifications, and with disaggregation of the energy and service sectors. E3ME42 includes 16 service sectors, reflecting the importance of services across Europe. A full list of the sectors and their NACE 2-digit codes can be found in Table 3.1.

Table 3.1. **E3ME industry classification**

	Full industry heading	2-letter ID	NACE REV 1.1
1	Agriculture, etc.	AG	01,02,05
2	Coal	CO	10
3	Oil and gas, etc.	OG	11,12
4	Other mining	MI	13,14
5	Food, drink and tobacco	FD	15,16

	Full industry heading	2-letter ID	NACE REV 1.1
6	Textiles, clothing and leather	TC	17,18,19
7	Wood and paper	WP	20,21
8	Printing and publishing	PP	22
9	Manufactured fuels	MF	23
10	Pharmaceuticals	PH	24.4
11	Chemicals nes	CH	24(ex24.4)
12	Rubber and plastics	RP	25
13	Non-metallic mineral products	NM	26
14	Basic metals	BM	27
15	Metal goods	MG	28
16	Mechanical engineering	MA	29
17	Electronics	IT	30,32
18	Electrical engineering and instruments	EI	31,33
19	Motor vehicles	MV	34
20	Other transport equipment	TE	35
21	Manufacturing nes	OM	36,37
22	Electricity	EL	40.1
23	Gas supply	GS	40.2,40.3
24	Water supply	WA	41
25	Construction	CN	45
26	Distribution	DT	50,51
27	Retailing	RT	52
28	Hotels and catering	HC	55
29	Land transport, etc.	LT	60,63
30	Water transport	WT	61
31	Air transport	AT	62
32	Communications	CM	64
33	Banking and finance	BF	65,67
34	Insurance	IN	66
35	Computing services	CS	72
36	Professional services	PS	70,71,73,74.1-74.4
37	Other business services	OB	74.5-74.8
38	Public administration and defence	PA	75
39	Education	ED	80
40	Health and social work	HS	85
41	Miscellaneous services	OS	90 to 93,95,99
42	Unallocated	UN	

3.2.2. Theoretical background to E3ME

Economic activity undertaken by persons, households, firms and other groups has effects on other groups after a time lag. These effects persist into future generations, although many soon become so small as to be negligible. But there are many actors, and the effects, both beneficial and damaging, accumulate in economic and physical stocks. The effects are transmitted through the economy and the price and money system (via the markets for labour and commodities), and through the global transport and information networks. The markets transmit effects in three main ways: through the level of activity creating demand for inputs of materials, fuels and labour; through wages and prices affecting incomes; and through incomes leading in turn to further demands for goods and services. These interdependencies suggest that an economic model should be comprehensive, and include many links between different parts of the economic system.

The economic system has the following characteristics: economies and diseconomies of scale in both production and consumption (meaning the same amount of input will not always create the same amount of output); markets with different degrees of competition, ranging from perfectly competitive markets, with many small competing firms, to monopolies; governments and other organisations that do not maximise profits; and rapid and uneven changes in technology and consumer preferences. Labour markets in particular may be characterised by long-term unemployment. A model capable of representing these features must, therefore, be flexible, capable of embodying various behaviours and of simulating a dynamic system ([16]). This approach can be contrasted with that adopted by general equilibrium models: they typically assume constant returns to scale; perfectly competitive markets; maximising social welfare through private consumption; no involuntary unemployment; and exogenous technical progress following a constant time trend (see Barker, 1998, for a more detailed discussion).

3.2.3. E3ME as a regional econometric input-output ([17]) model

Figure 3.1 below shows how the economic module is solved as an integrated EU regional model. Most of the economic variables shown in the chart are at a 42-industry level. The whole system is solved simultaneously for all industries and all 27 regions, although single-region solutions are also possible.

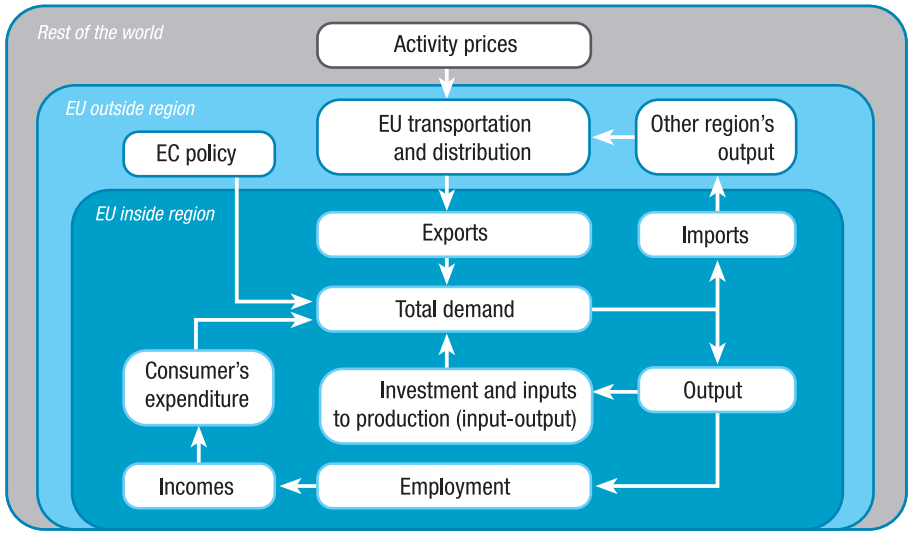
([16]) A dynamic model is one where behaviour in one time period has a direct effect on behaviour in the next time period and in subsequent time periods.

([17]) An input-output table is a matrix that shows the value of goods purchased by each sector from all other sectors, showing links within the economy.

The figure shows interactions at three spatial levels: the outermost area is the rest of the world; the next level is the EU outside the country in question; and finally, the inside level contains the relationships within the country.

The figure also shows the three loops or circuits of economic interdependence, which are described in some detail below. These are the income loop, the export loop and the output-investment loop.

Figure 3.1. **E3ME as a regional econometric input-output model**



In the income loop, industrial output generates employment and incomes, which leads to further consumer expenditure, adding to total demand. Changes in output are used to determine changes in employment, along with changes in real wage costs, interest rates and energy costs. With wage rates explained by price levels and conditions in the labour market, the wage and salary payments by industry can be calculated from the industrial employment levels. These are some of the largest payments to the personal sector, but not the only ones. There are also payments of interest (e.g. from bank accounts) and share dividends, transfers from government in the form of state pensions, unemployment benefits and other social security benefits. Payments made by the personal sector include mortgage interest payments and personal income taxes. Personal disposable income is calculated from these accounts, and deflated by the consumer price index to give real personal disposable income.

Totals of consumer spending by region are derived from consumption functions estimated from time-series. These equations relate consumption to regional personal disposable income, a measure of wealth for the personal sector, inflation and interest rates. Sets of equations have been estimated from time-series data relating the spending per capita to the national spending using the CBS ([18]) version of the consumption allocation system.

The export loop runs from the EU transport and distribution network to the region's exports, then to total demand. The region's imports feed into other EU region exports and output and finally to these other regions' demand from the EU pool and back to the exports of the region in question.

An important part of the modelling concerns international trade. The basic assumption is that, for most commodities, there is a European 'pool' into which each region supplies part of its production and from which each region satisfies part of its demand. This might be compared to national electricity supplies and demands: each power plant supplies to the national grid and each user draws power from the grid and it is not possible or necessary to link a particular supply to a particular demand.

The demand for a region's exports of a commodity is related to three factors:

(a) domestic demand for the commodity in all the other EU regions, weighted by their economic distance from the region in question;
(b) activity in the main external EU export markets, as measured by GDP or industrial production;
(c) relative prices, including the effects of exchange rate changes.

Economic distance is measured by a special distance variable. For a given region, this variable is scaled to be one for the home region and values less than one for external regions. The economic distance to other regions is inversely proportional to trade between the regions. In E3ME regional imports are determined for the demand and relative prices by commodity and region. In addition, measures of innovation (including spending on R&D) have been introduced into the trade equations to pick up an important long-term dynamic effect on economic development.

The output-investment loop includes industrial demand for goods and services and runs from total demand to output and then to investment and back to total demand. For each region, total demand for the gross output of goods and services is formed from industrial demand, consumer expenditure, government consumption, investment (fixed domestic capital formation and

([18]) *Centraal Bureau voor de Statistiek* (CBS, Bracke and Meyermans, 1997) allocation of consumption, where consumption of any one good is a function of its price, the average real consumption and the price of each of the other (n-1) commodities.

stockbuilding) and exports. These totals are divided between imports and output depending on relative prices and levels of activity. Industrial demand represents the inputs of goods and services from other industries required for current production; this is calculated using input-output coefficients. The coefficients are calculated as inputs of commodities from whatever source, including imports, per unit of gross industrial output.

Forecast changes in output are important determinants of investment in the model. Investment in new equipment and new buildings is one of the ways in which companies adjust to the new challenges introduced by energy and environmental policies. Thus, the quality of the data and the way data are modelled are of great importance to the performance of the whole model. Regional investment by the investing industry is determined in the model as choices over time depending on capacity output and investment prices. When investment by user industry is determined, it is converted, using coefficients derived from input-output tables, into demands on the industries producing the investment goods and services, mainly engineering and construction. These demands then constitute one of the components of total demand.

Gross fixed investment, enhanced by R&D expenditure in constant prices, is accumulated to provide a measure of the technological capital stock (i.e. the state of technology at any given time). This avoids problems with the usual definition of the capital stock and lack of data on economic scrapping. The accumulation measure is designed to get round the worst of these problems. Investment is central to determining long-term growth and the long-term behaviour of the trade and employment equations.

3.2.4. E3ME treatment of the labour market

E3ME includes a detailed treatment of the labour market with estimated equations for employment, average wages, hours worked and labour-market participation. Unemployment is calculated as the difference between employment and the active labour force and is a key explanatory variable in the equations for wages and household consumption. Unlike many computable general equilibrium models, E3ME does not assume full employment, even in the long term ([19]).

Employment is modelled for each industry and region as a function of industry output, wages, hours worked, technological progress, and energy prices. Industry output is assumed to have a positive effect on employment,

([19]) For more details about the exact specifications of E3ME equations see Part 3, Chapter 1 of the model online manual.

while the effect of higher wages and longer working hours is assumed to be negative. The effects of technical progress are ambiguous, as investment may create or replace labour; this will vary between sectors.

Employment is modelled as a headcount, including male and female employment in all age groups. The NA data do not disaggregate by gender or age group and, although these data are available from other sources such as the labour force survey (LFS), the required time series data (especially relating to gender-specific incomes) are not of high quality enough to use in the model.

Hours worked is a simple equation, where average hours worked by industry and region is a function of 'normal hours-worked' (employees' expected hours based on hours worked in other industries and regions) and technological progress. It is assumed the effects of technical progress gradually reduce average hours worked over time as processes become more efficient. The resulting estimate of hours worked is an explanatory variable in the employment equation.

Hours worked is defined as an average across all workers in an industry, incorporating the effects of higher levels of part-time employment in certain regions and industries.

In E3ME, wages are determined by a complex union bargaining system that includes both worker productivity effects and prices, and wage rates in the wider economy. Other important factors include unemployment, tax rates and cyclical economic effects. Generally it is assumed that higher prices and productivity will push up wage rates, but rising unemployment will reduce wages. A single average wage is estimated for each region and sector.

Estimates of average wages are a key input to both employment and the price equations in E3ME. If output does not increase, rising wages will increase overall unit costs and industry prices. These prices may get passed on to other industries (through the input-output relationships), building up inflationary pressure.

Labour-market participation is estimated as a rate between 0 and 1 for male, female and total working-age population. At present there is no disaggregation by age groups. Labour-market participation is a function of output, wages, unemployment and benefit rates. Participation is assumed to be higher when output and wages are growing, but falls when unemployment is high, or benefits create a disincentive to work. In addition, there is a measure of economic structure and the relative size of the service sector of the economy; this has been found to be important in determining female participation rates.

Participation rates determine the stock of employment available, by multiplying by working-age population, which is exogenous. This is an

important factor in determining unemployment, which in turn feeds into wages and back to labour-market participation.

3.2.5. Main data sources

The following section gives a summary of data sources used in the E3ME. The data need to be consistent across countries and in the same units. For monetary data the euro is used. The data are updated as and when new data become available. For each set of the model variables there are four possible groups of data sources with the following ranking:

Eurostat ([20]) and the OECD (STAN ([21])) are always the preferred choice, which establishes a comparable basis across Member States. Even where Eurostat data are incomplete or of poor quality, the Eurostat definitions are adopted and the data improved via other sources. This allows inclusion of improved Eurostat data on an annual basis;

data from AMECO ([22]) are used to make the Eurostat total consistent with an accepted macroeconomic total, and also to provide limited sectoral information;

when Eurostat data are not available or need to be improved, international sources, such as the International Monetary Fund (IMF), are consulted and are also important for data covering the world areas outside the E3ME regions;

once these international data sources have been exhausted, national statistical agencies and other sources are used to update the remaining missing series and gaps in the data.

Data from official sources are always preferred and used in the most comprehensive possible way. There are also several sets of variables in E3ME that are calculated, and special variables that use different sources.

Due to the way trade is modelled within E3ME, via a European pool rather than as a series of bilateral relationships, an aggregated version is used in equation estimating. The importance of one country's trade to another country's economic activity is determined using OECD bilateral trade data. This information is also used to construct trends for filling gaps in data for trade in services.

([20]) http://epp.eurostat.ec.europa.eu/portal/page?_pageid=0,1136173,0_45570698&_dad=portal&_schema=PORTAL

([21]) http://www.oecd.org/document/15/0,2340,en_2649_34445_40696318_1_1_1_1,00.html

([22]) AMECO is the annual macroeconomic database of the European Commission's Directorate General for Economic and Financial Affairs. http://ec.europa.eu/economy_finance/db_indicators/db_indicators8646_en.htm

3.2.6. Technical progress

E3ME includes measures of endogenous technological progress. These are defined by sector and country as functions of accumulated investment, enhanced by R&D spending. In EU-15 the distinction is made between ICT and non-ICT investment to capture the effects of the new economy. The technical progress indicators feature as explanatory variables in nine of E3ME estimated equations, including the employment equation.

The basic equation structure is shown in Equation 3.1, with the change in technical progress at time *t* ($d_t(\tau_1)$) specified as a function of the previous year's change ($d_{t-1}(\tau_1)$), Tau1, Tau2, investment (GI) and R&D spending (RD).

$$d_t(\tau_1) + \tau_1 d_1 - 1(\tau_1) + (1-\tau_1) \log (GI_t + \tau_2 RD_t) \quad (3.1)$$

The values of Tau1 (0.3) and Tau2 (5 in the EU-15 and 28 in the EU-10) have been carefully determined by empirical analysis using existing data sets, including the E3ME database. Tau2 is lower in EU-15 Member States because it is compared against ICT investment rather than total gross investment.

3.2.7. Parameter estimation

The econometric model has a complete specification of the long-term solution in the form of an estimated equation which has long-term restrictions imposed on its parameters. Economic theory, for example the recent theories of endogenous growth, informs the specification of the long-term equations and hence properties of the model; dynamic equations which embody these long-term properties are estimated by econometric methods to allow the model to provide forecasts. The method uses developments in time-series econometrics, in which dynamic relationships are specified in terms of error correction models (ECM) that allow dynamic convergence to a long-term outcome. The specific functional form of the equations is based on the econometric techniques of cointegration and error-correction, as promoted by Engle and Granger (1987) and Hendry et al. (1984).

E3ME model parameters are estimated on a set of annual time series data covering 1970-2004 (1993-2004 in EU-10). An individual equation is estimated for each country and sector (panel data methods are not used). The exception to this is the long-term specification of the EU-10, where suitable time-series data are not available to estimate model parameters. These parameters are estimated using a shrinkage technique, which effectively sets the long-term parameters to average EU-15 values in each sector. This assumes that, in the long term, behavioural relationships in EU-10 will become similar to those in EU-15.

3.2.8. Employment data

E3ME is based on NA data and this also applies for employment data, allowing a direct comparison between sectoral economic performance and industrial employment. However, there are sometimes substantial differences between NA employment data and LFS data sets used for similar labour-market analysis. The discrepancies are mainly caused by differences in definition, notably counting those with more than one part-time job (sometimes counted as number of jobs in NAs but just once in the LFS data) and cross-border commuting (jobs are counted by workplace in the NA but place of residence in LFS) ([23]). The largest difference by far is in Luxembourg, where cross-border commuting (into Luxembourg) is common.

3.3. Producing baseline projections

3.3.1. Baseline economic forecast

E3ME baseline solution is calibrated to match the figures presented in the European Environment Agency's report, *State and outlook 2005* (EEA, 2005), which draws on the detailed projections of energy use described in the Directorate-General for Energy and Transport *Trends to 2030* (European Commission, 2003). The design of the baseline is such that it is consistent with previous European Commission publications; it is accepted as a moderate and plausible prediction of future activity in the economic and energy systems. This provides the economic context for the baseline employment projections.

These Commission reports provide a consistent set of projections of activity in the economic and energy systems and are therefore well-suited to the integrated approach used in the E3ME.

The growth rates from the following variables are used to form E3ME baseline forecast:

(a) European and global GDP growth;
(b) economic growth by broad sector and in the main fuel-using sectors;
(c) population;
(d) household incomes;
(e) various energy and environment indicators.

Each variable is defined at Member State level, except for global GDP growth which is defined by world region.

([23]) See more in Section 3.3.

The baseline economic forecast does not include an explicit view on employment. Employment projections are formed by the model equations.

The raw data presented in the report and accompanying data files were processed using Cambridge Econometrics' custom software based on the Ox ([24]) programming system. The first stage was to convert the data from 10-year snapshots into annual time series; this is done using simple linear interpolation techniques.

The second stage created the detailed sectoral data required by the E3ME model. The raw data provide measures of economic activity at aggregate level, and for the most energy-intensive sectors, but do not cover the service sectors, for example. Projections of activity in these sectors are estimated using E3ME historical database, the more aggregate totals presented in the European Environment Agency report (EEA, 2005) and a previous E3ME forecast (CE, 2005).

Perhaps the most complex stage involved estimating time series for other economic variables. The structure of E3ME is consistent with that of the NA system, as defined by ESA95. This includes specific treatment of the individual components of aggregate demand (household consumption, international trade) and the labour market, each defined at detailed sectoral level (Table 3.2). Projections for each of these variables were formed as consistently as possible with the aggregate GDP growth rates presented in the raw data and any sectoral information available.

The baseline forecast, as presented in the raw data, has since been updated to consider the following:

(a) E3ME historical database in EU-25 has been updated so its historical time series cover 1970-2004 in the EU-15 and 1993-2004 in EU-10. Data for 2005 are included where possible, although as these are partly estimated data they are not used for equation estimating. The baseline forecast has been scaled to take this into account, although the growth rates after the final year of historical data remain unchanged;

(b) recent developments in global energy prices mean energy demand is likely to be different from the forecast presented in the European Environment Agency's report (EEA, 2005). Therefore, E3ME baseline forecast uses more recent IEA (2006) projections of global energy prices. The effects are calculated using the estimated parameters of the model. It is, however, an important feature of the forecast as oil prices feed into employment demand directly;

([24]) See http://www.doornik.com/products.html#Ox

(c) inclusion of the EU emission trading scheme: the EEA's publication does not make allowance for the emission trading scheme, so this was also added to the baseline projections. However, the treatment of the emission trading scheme in the baseline solution is stylised. Allowance prices are treated as exogenous and set to rise broadly in line with inflation, reaching just under EUR 25 per tonne of CO_2 by 2020. Allocations of allowances are determined by the national allocation plans for Phase I and Phase II with the allocations remaining unchanged after 2012 in subsequent phases of the emission trading scheme.

Table 3.2. **Baseline economic results**

	Unit	2007-15	2015-20
GDP	% p.a., 2000-based euros	2.4	2.3
Household consumption	% p.a., 2000-based euros	2.1	2.3
Government spending	% p.a., 2000-based euros	3.0	3.2
Investment	% p.a., 2000-based euros	2.5	2.2
Total export	% p.a., 2000-based euros	2.6	2.1
Total import	% p.a., 2000-based euros	2.6	2.5

NB: Figures presented are average annual growth rates for the EU-25+
Sources: E3ME, Cambridge Econometrics.

3.3.2. Baseline employment projections

The baseline economic forecast provides the inputs for the employment projections. A forecast for employment consistent with these economic results is created by obtaining a partial solution of the E3ME with all the equations of the model except employment fixed. It means the model is forced to reproduce the baseline economic forecast while estimating a consistent set of employment projections.

Employment is estimated for each of E3ME 42 economic sectors, in EU-25 plus Norway and Switzerland (EU-25+), for each year up to 2020.

This approach overrides the dynamic feedbacks within E3ME. For example, an increase in employment would usually cause wage rise but, in this case, wages have been fixed to match the baseline economic forecast. It is a trade-off for using a fixed economic forecast, and a model of employment demand rather than supply or labour market in general. For example, one possible result is that employment would grow fast enough to exceed working age population (usually E3ME structure would prevent this by increasing wage rates).

The inputs to the employment equations, as defined in Section 3.2.4, are:
(a) output (gross output, defined as P1 in the NA);
(b) average real labour costs;
(c) average hours worked per week;
(d) technological progress (Section 3.2.6);
(e) oil prices (global).

Each variable, except the global oil price, is disaggregated by country and by sector.

It is not possible to use empirically estimated parameters to form projections for all of the E3ME 42 economic sectors. The sectors that may not be estimated fall into two broad groups:
(a) sectors where employment is not typically determined by economic variables, mainly government sectors;
(b) sectors where economic and labour-market indicators are too unstable to estimate a robust set of parameters; mainly the energy sectors with low levels of employment.

The sectors where employment is treated as exogenous are:
(a) coal;
(b) oil and gas;
(c) electricity supply;
(d) gas supply;
(e) water supply;
(f) public administration and defence;
(g) education;
(h) health.

In these sectors, employment growth is assumed. The role of the country experts has been important in this process.

3.3.3. The role of country experts

The country experts played an important role in forming the final set of baseline employment projections. They were invited to comment on projections for output and wages and several other macroeconomic indicators, as well as employment levels.

The initial projections were provided in spreadsheet format to one or more experts in each country (EU-25+). Responses varied in terms of detail and coverage, but suggestions for most of the countries were incorporated. When major changes were made or historical data updated (i.e. equation parameters estimated again), a second set of projections was sent out.

The main role of the country experts was to include factors which would not

be picked up in E3ME equations. These were typically developments that had happened since the most recent data were published (usually 2005-06) or 'forward-looking' factors that, by definition, E3ME empirical approach could not cover. One of the key aims of the supplementary questionnaire was to determine if there were to be any major developments in taxation policy or major changes to any particular industry in the short term.

Table 3.3. **Scenario B: optimistic**

Drivers	Characteristics	
	Primary model variables to change	Likely secondary effects
Economic growth and competitiveness	Global GDP growth, relative trade prices between Europe and rest of world, energy prices.	Exports, innovation, trade prices, GDP, employment.
Social welfare and government	Tax and benefit rates, government spending.	Incomes, trade prices, exports, GDP, employment.
Technological change	R&D spending.	Investment, innovation, exports, GDP, employment.
Globalisation and mobility	Reductions in both export and import prices. Increase in labour-market participation. NB: also has consequences for skills modelling.	If skill shortages are a problem, wages, employment and domestic production will be affected. Trade volumes will increase; exporters will benefit from a larger market and consumers will benefit from cheaper imports.
Demography	Population (especially working age population).	All labour-market variables, competitiveness, final demand for goods and services (depends on the structure of age groups).

3.3.4. Defining the scenarios

The aim of the scenario analysis was to provide a range for employment values, giving an upper and lower bound for employment in each sector and showing how sensitive the baseline projections are to global conditions and government policy. The quantitative definitions used in the scenarios are arbitrary in nature and show a broad picture rather than an exact set of values. These were meant to represent an optimistic and a pessimistic view of global conditions.

Description
In this scenario Europe and its economies benefit from higher growth in exports and overall world GDP, partly as a result of lower world energy prices. This results from a combination of greater innovation (see technical change), strong price competitiveness (see social welfare and government) and a global marketplace boosted by lower fuel costs. Despite a strengthening trade balance, there is no appreciation in the euro which matches exchange rates in the baseline.
Higher world GDP growth and employment mean that European governments are receiving higher tax revenues and spending less money on benefits. This in turn means they can reduce taxes or social security, boosting competitiveness of exports. Alternatively, governments may wish to spend some of this windfall on improved public services, boosting aggregate demand.
An increase in innovation and technological progress is a key feature of this scenario, leading to increases in competitiveness. Technical progress is assumed to increase as a result of higher R&D spending (i.e. innovation) and induced investment in new buildings, machinery and production processes. The largest increase in innovation is in rapidly developing ICT sectors, which have knock-on effects to all other sectors. Technical progress may have a positive or negative direct effect on employment, but resulting competitiveness gains should result in overall increases in output and employment.
This scenario assumes the WTO makes further progress in reducing global trade barriers. It is also assumed domestic European labour markets are able to attract skilled labour from abroad (mainly from outside Europe) meaning no significant labour shortages may restrict growth. This boosts overall labour-market participation rates across Europe.
Enhanced wealth and growth become attractive to labour and immigration of working age people increases across the EU compared to the baseline. This means population growth rates increase overall (or decline by less) with the largest effect on working age populations, which are also boosted by an increase in the retirement age. New entrants to the labour force are assumed to be suitably equipped to work within it. This helps to reduce dependency ratios and reduce the effects of an ageing population.

The final scenario definitions were decided after discussions between the project team and Cedefop. Three scenarios were finally produced: baseline scenario (A), optimistic scenario (B), and pessimistic scenario (C).

Definitions of optimistic and pessimistic scenarios are presented on the following pages.

The scenario inputs were entered into the E3ME using appropriate variables. Although the identified trends are broadly positive in the optimistic scenario and negative in the pessimistic one, some of the sectoral impacts may have the reverse effects. For example, more trade barriers in the pessimistic scenario may have a beneficial effect for an industry that does not export goods and is under pressure in its domestic market.

The final scenario changes were chosen to reflect the states outlined above, without making the scenarios overly complex (Table 3.5).

Table 3.4. **Scenario C: pessimistic**

Drivers	Characteristics	
	Primary model variables to change	Likely secondary effects
Economic growth and competitiveness	Global GDP growth, relative trade prices between Europe and rest of world, energy prices, interest rates, exchange rates.	Exports, innovation, trade prices, GDP, employment.
Social welfare and government	Tax and benefit rates, government spending, average hours worked.	Incomes, trade prices, exports, GDP, employment.
Technological change	R&D spending.	Investment, innovation, exports, GDP, employment.
Globalisation and mobility	Increase in both export and import prices. Decrease in labour-market participation (population discussed below).	Trade volumes will decrease; exporters will struggle to compete and consumers will face more expensive imports.
Demography	Population (especially the older population above normal retirement age).	All labour market variables, competitiveness, final demand for goods and services (depends on the structure of age groups).

Table 3.5. **Model variables changed in the positive and negative scenarios, 2007-20**

	Optimistic scenario	Pessimistic scenario
Direct tax	-2 percentage point	+2 percentage point
R&D spending	+10 %	-10 %
Government spending	+5 %	-5 %
Public sector employment	+2 %	-5 %
(exogenous in E3ME)	(assume efficiency gains)	(assume no efficiency gains)
World growth rate	+5 percentage point	-5 percentage point
Oil price	-5 %	+5 %
Price of export	-10 % (trade barriers lowered)	+10 % (more trade barriers)
Price of import	-10 % (trade barriers lowered)	+10 % (more trade barriers)
Interest rate	0	+1 percentage point
Global euro exchange rates	0	+10 % (euro appreciates)

Description
Higher world energy prices and a loss of confidence in the world economy have a negative impact on global growth rates, reducing demand for Europe's exports. This results in inflationary pressure and higher nominal interest rates, causing a persistent appreciation in the value of the euro (and other European currencies). At the same time, higher tax rates and a continued lack of innovation, all cause a substantial loss of earnings among Europe's exporters.
Falling tax receipts and higher benefit payments force national governments to raise taxes just to maintain current spending levels. This has further knock-on effects to international competitiveness. As a result of union demands, workers spend less time at work, which creates employment opportunities initially but damages competitiveness.
There is a failure to invest in R&D and production development in key sectors. Innovation in developed economies (such as the US) and competing developing economies (such as China) is not matched in Europe. This helps, contributing to a sharp fall in relative productivity.
Concerns about domestic economies lead to a backlash against globalisation and the WTO is unable to prevent new trade barriers being set up to protect vulnerable industries. This is reciprocated in Europe and worldwide. Exporters are unable to compete in international markets and consumers are unable to buy cheap imports. At the same time, concerns over domestic labour markets lead to national governments taking measures to reduce innovation, meaning fewer people of working age enter the labour force. Overall labour-market participation rates fall as a result.
Life expectancy continues to increase but union pressures manage to prevent national governments from increasing the retirement age. This is not compensated by immigration of people working age from outside Europe. Thus, the effects of the ageing population are felt hardest and State benefits have to increase to cover pension costs.

3.4. Summary of results

3.4.1. Baseline projections

The detailed results for employment may be found in the country workbooks and are summarised in this section. Table 3.6 shows annual average growth rates for baseline employment for each of EU-25+.

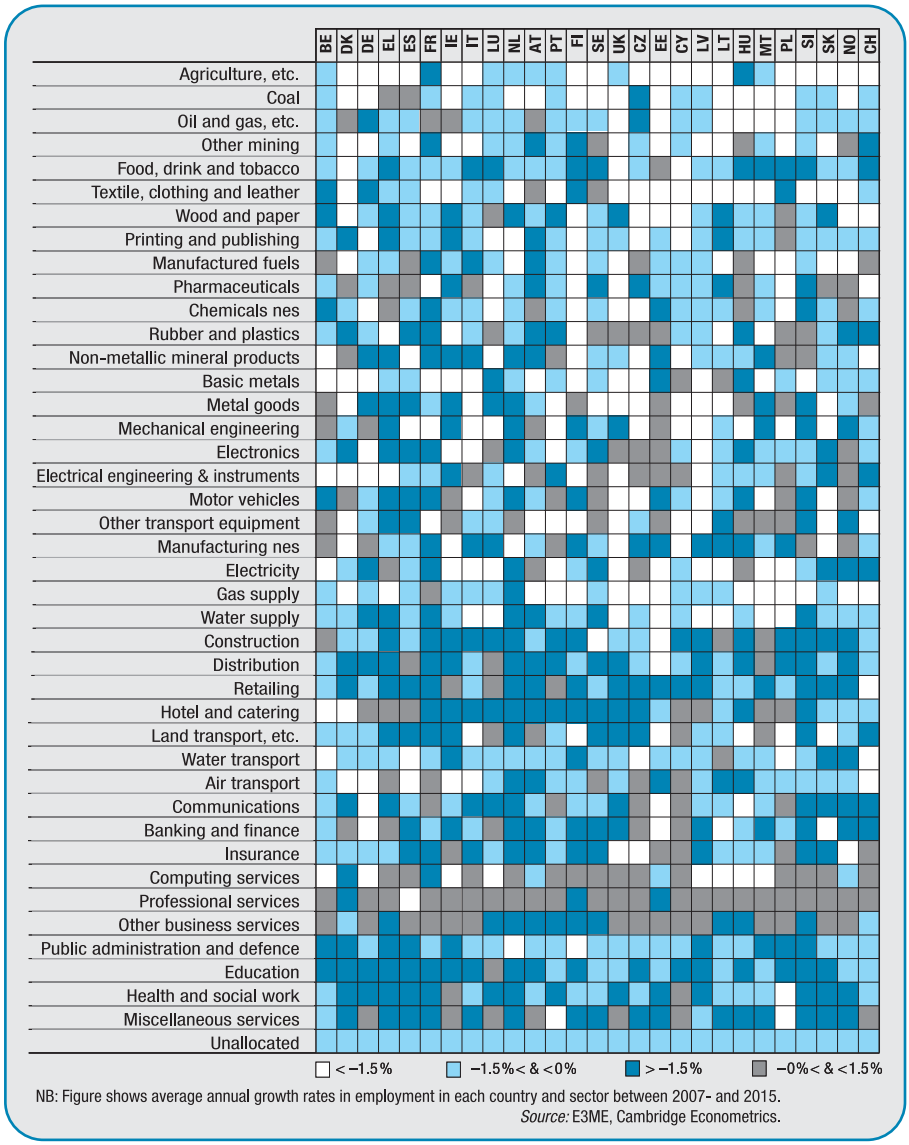
Table 3.6. **Baseline employment (average annual growth rate, % p.a.)**

	1995-2001	2001-07	2007-15	2015-20		1995-2001	2001-07	2007-15	2015-20
BE	1.3	0.4	1.0	0.5	**HU**	1.1	-0.1	0.4	0.2
CZ	-0.6	0.5	0.4	0.5	**MT**	0.8	0.8	0.9	0.7
DK	1.1	0.3	0.2	0.4	**NL**	2.5	0.1	0.8	0.6
DE	0.7	-0.4	0.7	0.3	**AU**	0.6	0.0	0.8	0.5
EE	-1.6	1.5	-0.4	0.4	**PL**	0.1	-0.3	0.5	0.7
IT	5.2	2.4	1.3	1.0	**PT**	1.9	0.2	0.7	0.4
EL	0.4	1.4	0.8	0.5	**SI**	-0.2	0.2	0.8	0.2
ES	3.8	2.3	0.7	0.5	**SK**	-0.6	0.4	0.1	-0.6
FR	1.5	0.4	0.7	0.7	**FI**	2.2	0.3	0.0	0.3
IT	1.1	0.7	0.5	0.5	**SE**	1.0	-0.1	0.2	0.2
CY	1.4	2.6	1.6	1.9	**UK**	1.2	0.6	0.9	1.1
LV	-0.1	1.4	0.0	0.1	**NO**	1.5	0.6	0.6	0.6
LT	-3.1	1.6	-0.2	0.1	**CH**	0.8	0.7	0.5	0.7
LU	4.4	2.1	1.4	1.2					

Source: E3ME, Cambridge Econometrics.

Figure 3.2 shows average annual growth rates in baseline employment for the E3ME 42 sectors in each of EU-25+. There is a clear trend that employment in market services (especially in professional and other business services) is expected to grow faster than other sectors. Overall growth is expected to be fastest in service sectors, with hotels and catering and miscellaneous (media and consumer) services growing quickly.

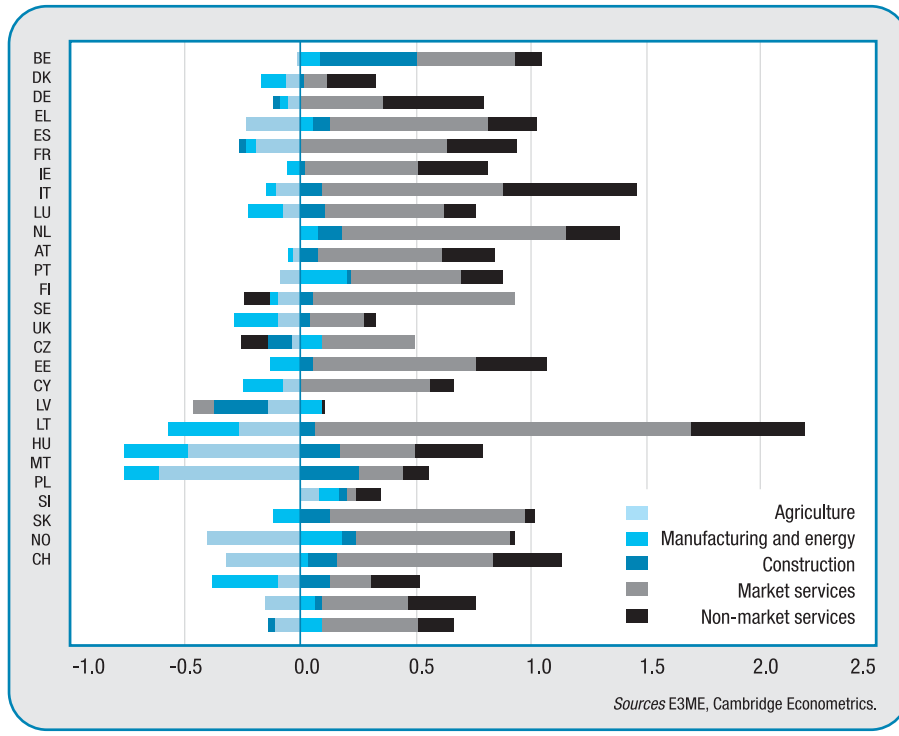
Figure 3.2. **Baseline employment: average annual growth rate between 2007 and 2015**



NB: Figure shows average annual growth rates in employment in each country and sector between 2007- and 2015.
Source: E3ME, Cambridge Econometrics.

The slowest growth in employment is in the energy sectors and, in particular, in agriculture, where in most countries negative historical trends continue throughout the forecast (Figure 3.3).

Figure 3.3. **Baseline employment: average annual growth rate between 2007 and 2015 by main sector**



Sources E3ME, Cambridge Econometrics.

However, as Figures 3.2 and 3.3 show, the patterns in employment growth can vary between countries considerably.

3.4.2. Scenario results

Table 3.7 summarises annual average growth rates for total employment in the baseline and in the two scenarios. The Czech Republic, Spain, Slovakia, Sweden and Switzerland reacted most to the scenarios while Estonia, Greece, Italy, Luxembourg and Norway have the smallest reactions. With few exceptions, the countries that gained more employment in the optimistic scenario are also the countries that lost more employment in the pessimistic scenario. Employment reactions to the scenarios are much larger during 2015-20 compared with reactions during 2007-15. This is because changes to the E3ME variables in each scenario are accumulated from 2007 to 2020 (see Table 3.5 for list of variables changed in the positive and the negative scenarios).

Table 3.7. **Employment comparison between scenarios**

	2007-15 (% p.a.)			2015-20 (% p.a.)		
	Pessimistic	Baseline	Optimistic	Pessimistic	Baseline	Optimistic
BE	0.7	1.0	1.3	-0.1	0.5	1.0
CZ	0.0	0.4	0.7	0.0	0.5	1.2
DK	-0.2	0.2	0.4	0	0.4	1.0
DE	0.3	0.7	1.0	-0.3	0.3	1.0
EE	-0.6	-0.4	-0.2	0.2	0.4	0.7
IE	1.0	1.3	1.6	0.6	1.0	1.3
EL	0.6	0.8	0.9	0.3	0.5	0.8
ES	0.4	0.7	1.1	0.0	0.5	1.2
FR	0.5	0.7	0.9	0.4	0.7	1.1
IT	0.3	0.5	0.7	0.0	0.5	0.9
CY	1.4	1.6	1.8	1.5	1.9	2.2
LV	-0.3	0.0	0.3	-0.2	0.1	0.4
LT	-0.5	-0.2	0.1	-0.5	0.1	0.6
LU	1.4	1.4	1.5	0.4	1.2	1.6
HU	0.0	0.4	0.6	-0.3	0.2	0.7
MT	0.7	0.9	1.1	0.3	0.7	1.1
NL	0.5	0.8	1.1	0.1	0.6	1.1
AT	0.5	0.8	1.0	0.1	0.5	0.9
PL	0.3	0.5	0.7	0.3	0.7	1.1
PT	0.4	0.7	0.9	0.1	0.4	0.7
SI	0.6	0.8	1.0	-0.2	0.2	0.6
SK	-0.3	0.1	0.6	-1.1	-0.6	0.0
FI	-0.3	0.0	0.3	-0.3	0.3	0.8
SE	-0.1	0.2	0.6	-0.4	0.2	0.9
UK	0.6	0.9	1.2	0.7	1.1	1.4
NO	0.4	0.6	0.7	0.4	0.6	0.8
CH	0.1	0.5	0.9	-0.1	0.7	1.8

NB: Figures show annual average growth rates.
Sources: E3ME, Cambridge Econometrics.

Employment impacts are less predictable in the scenarios because of the complex relationship between different model variables. For example, in the optimistic scenario, R&D spending increases by 10 % between 2007 and

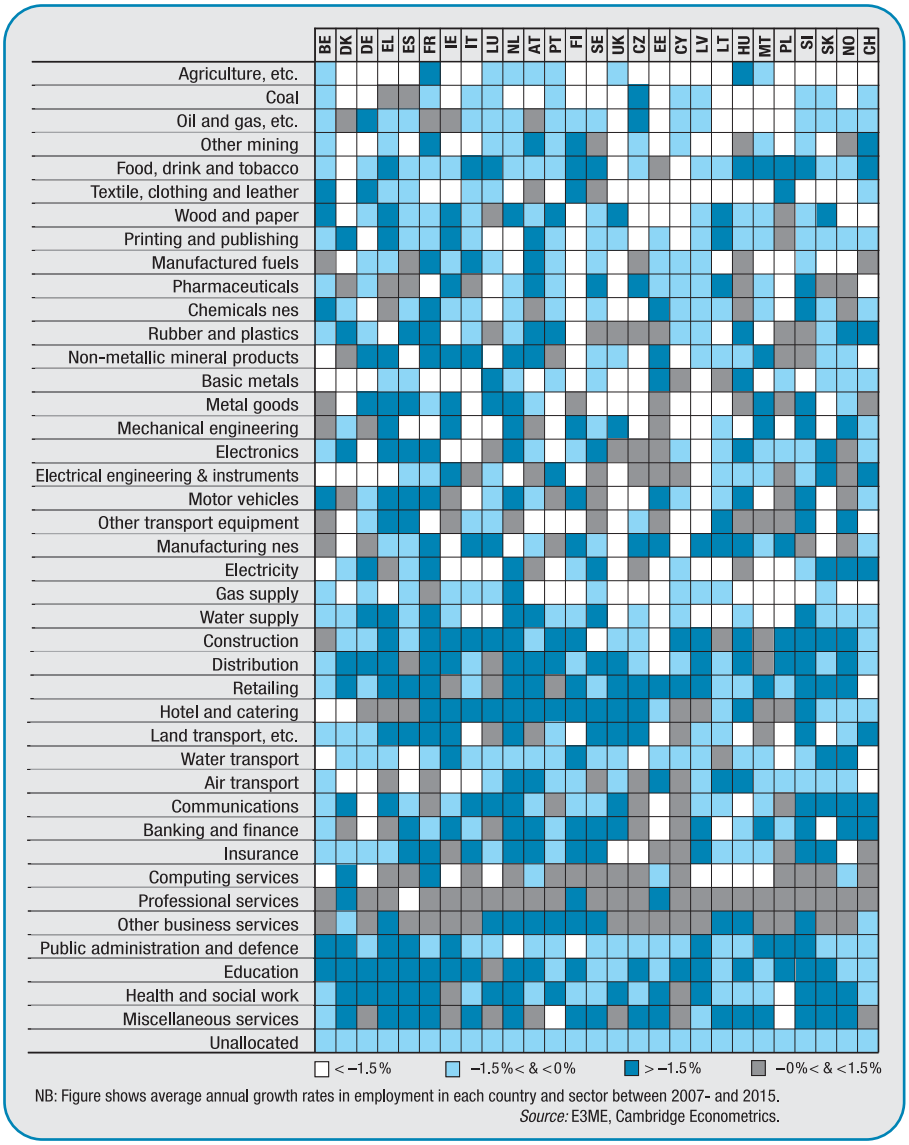
2020. This can lead to either a positive or negative impact to overall employment depending on structure of the economy and the extent of extra R&D spending that leads to labour-saving technologies. Another good example is the reduction in import and export prices by 10 % between 2007 and 2020, as a result of globalisation and reduction in trade barriers in the optimistic scenario. It is not always clear whether this will cause employment to increase. The impacts will depend on the price elasticity of imports and exports, the relative sizes of exports and imports, and the extent to which changes in economic output translate to changes in employment.

Despite this, there are clear patterns of employment losses in the pessimistic scenario and employment gains in the optimistic scenario when comparing them to the baseline forecast. Figures 3.4 and 3.5 show average annual employment growth rates in the pessimistic and optimistic scenarios respectively for E3ME 42 sectors in each of EU-25+ countries. Figures 3.4 and 3.5 are directly comparable between themselves and to Figure 3.2 (the baseline).

In the optimistic scenario, employment increases faster in industries related to consumption, such as retailing, distribution and construction. Generally, services sector employment grows faster in the optimistic scenario than in the baseline. However, this trend is less obvious in Figure 3.5 because service sector employment in the baseline is forecast to grow by more than 1.5 % per year.

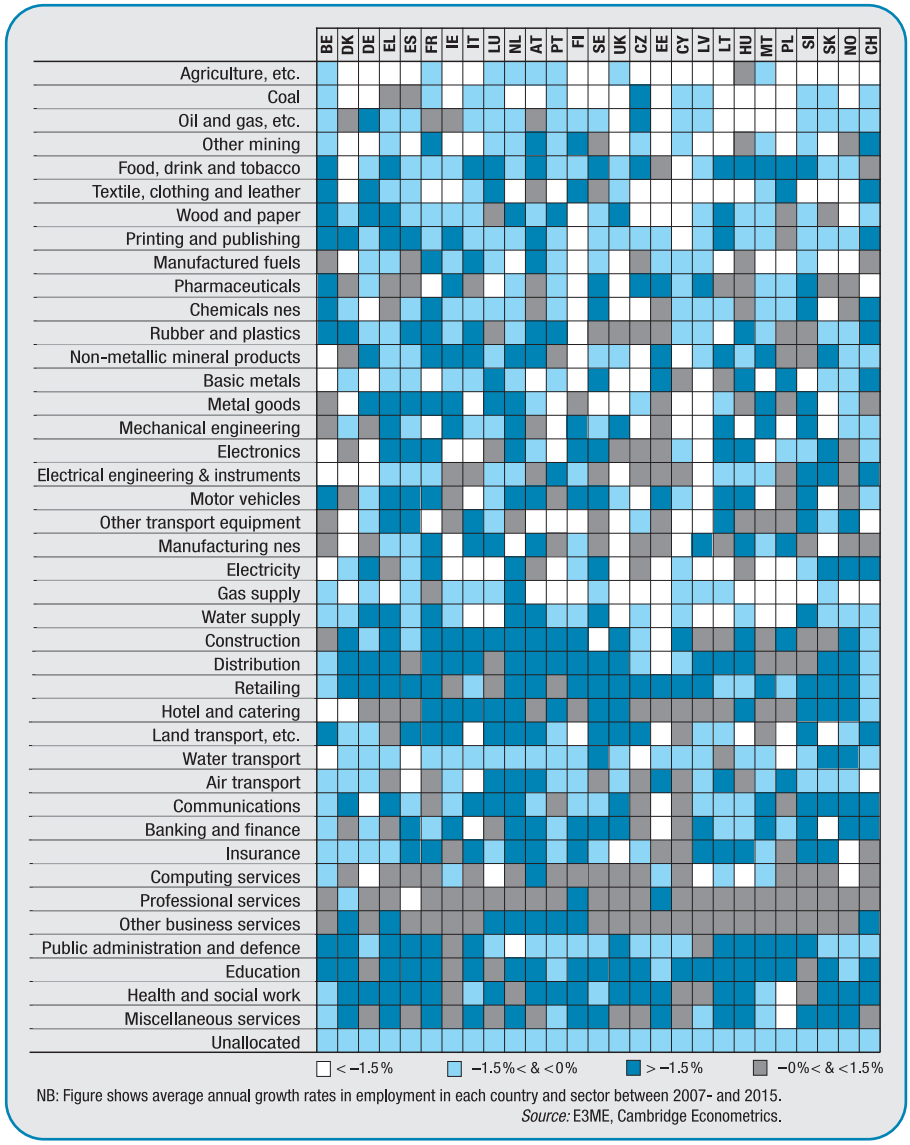
In the pessimistic scenario, employment generally grows at lower rate (or declines at a faster rate) than in the baseline. There are exceptions where employment grows faster in the pessimistic scenario than in the baseline (also vice versa in the optimistic scenario) and these are often the case in manufacturing sectors. Part of the explanation is that, in the pessimistic scenario, there are more trade barriers (prices of both exports and imports increase by 10 %) which turn out to be beneficial to some national manufacturing sectors that would otherwise struggle to compete in a more competitive global market. This explanation also applies when trade barriers decrease in the optimistic scenario; some sectors fail to compete in a more competitive environment and, therefore, reducing trade barriers causes adverse effects on employment. However, this explanation is only one of many plausible explanations from altering various model variables in each scenario and these variables have complex relationships between themselves and other variables that can directly or indirectly affect employment.

Figure 3.4. **Pessimistic scenario employment: average annual growth rate between 2007 and 2015**



NB: Figure shows average annual growth rates in employment in each country and sector between 2007- and 2015.
Source: E3ME, Cambridge Econometrics.

Figure 3.5. **Optimistic scenario employment: average annual growth rate between 2007 and 2015**



NB: Figure shows average annual growth rates in employment in each country and sector between 2007- and 2015.

Source: E3ME, Cambridge Econometrics.

CHAPTER 4

Expansion demand and changes in occupational and qualifications structure

Ilias Livanos and Rob A. Wilson
IER, University of Warwick

4.1. Introduction

The purpose of this chapter is to describe the procedures followed to estimate the occupational shares used in the forecasting exercise and discuss the results acquired from this process. It illustrates the various techniques and datasets explored in the project rather than presenting final results. During different stages of the project various vintages of data and alternative methods were used, which have provided different results. The results presented in this chapter, are for illustrative purposes only and may differ from those included in the final results (Cedefop, 2008). It reviews recent literature on occupational modelling and the specifications and data used by previous research, to examine how the data available can facilitate developing a best pan-European practice approach. In addition to presenting various simple extrapolation approaches, the chapter explores a new method for estimating occupational shares using a multinomial logistic regression, rather than the simple extrapolation of past trends. This same method is also used to analyse qualification shares within occupations.

Section 4.2 reviews some of the most recently applied methods and approaches to modelling occupational employment. Section 4.3 discusses data availability and sets outs an ideal theoretical model specification to explain the changing patterns of occupational shares by sector. Section 4.4 presents empirical models to be explored for the present occupational modelling and qualifications exercise. Section 4.5 discusses the main implications of the data problems. Section 4.6 discusses the results obtained from a more ambitious modelling approach; the multinomial logistic regression approach. Section 4.7 compares results from alternative methods for projecting shares. Section 4.8 concludes.

4.2. Modelling occupational structure in forecasting

4.2.1. Most common methods

Most occupational forecasts are based on either fixed share coefficients or simple trend-extrapolated coefficients. These are the most common methods used for conducting forecasts by occupation in most Member States. For example, in Cyprus (Cedefop, Oxinos et al., 2007) forecasts by occupation are obtained by applying past occupational shares to future sectoral employment data. In Ireland (Cedefop, Hughes and Fox, 2007) the occupational structure of employment is projected by considering past trends and expectations relating to the evolution of skills and occupations. Occupational share coefficients for each sector are calculated for the data period. Linear and semi-log trend line regressions of geometric growth rates, where appropriate, are used to project the shares for the sectors for the target forecast year.

Similar methods are used in many other countries. For example, in Australia, the occupational share effects are treated as a technical change and forecast by extrapolating historical trends in the occupational mix in each industry (Meagher et al., 2000; Meagher, 1997).

In the US, the occupational projections of the Bureau of Labor Statistics are published in the *Monthly labor review* (e.g. Hecher, 2005). Based on recent correspondence, their overall approach (BLS, 1997) has not changed since the late 1990s. The *BLS handbook of methods* (BLS, 1997) sets out a series of steps used to determine the shifts in occupational shares or coefficients. First they review historical data to identify trends, then they identify the factors underlying these trends through analytical studies of specific industries and occupations, technological change, and other economic data. Finally, judgements are made as to how the patterns will change. The Bureau of Labor Statistics suggests various factors that can affect the use of workers in an occupation in particular industries. Among them are some changes:

(a) in technology, business practices;
(b) the mix of goods and services produced;
(c) the size of business establishments.

The Bureau of Labor Statistics staff analyse each occupation in the matrix to identify the factors that are likely to cause an increase or decrease in the use of the occupation within a particular industry in the future. The analyses incorporate judgments about new trends that may influence occupational use, such as the Internet and electronic commerce.

Various efforts have been made to develop more systematic, quantitative approaches, using econometric methods, but with mixed success. In some cases these have tried to adopt behavioural models in which the demand for skills is related to economic and other indicators; some of these are described below. Usually, however, a simpler approach based on time series methods, in which the shares of those employed in different occupations or skills categories is simply related to past trends in those variables, has been used, coupled with a large dose of judgement.

4.2.2. Best practice approaches to modelling occupational structure

There is considerable evidence (Machin and van Reeven, 1998; Autor et al. 2002; Acemogly, 2002; Machin; 2001; Murray and Steedman, 1998) of a marked shift in demand away from unskilled and towards skilled occupations in recent years (for a review see Briscoe and Wilson; 2003). The main causes of this change have been suggested as:

(a) international trade;
(b) skill-biased technological change.

Even though the shift towards high-skilled occupations is evident, few studies have examined the causes of changing occupational structures in detail within economic sectors, mainly due to data constraints. The kind of analysis referenced above has been based on sophisticated econometric techniques but generally only examines broad occupational categories. It is, therefore, of only limited value when there is interest in the occupational detail for its own sake.

Gregory et al. (2001) examined the changing demand for skills in the UK, and how it is influenced by technology, trade and domestic demand, using a Leontief input-output model. Their approach identifies the output and factor required across the economy to produce the final output for each destination (that is domestic consumption, exports, etc.) and from each sector. It gives a central role to intersectoral links covering the entire economy and it captures the transmission of changes in final output through economy-wide outputs, employment, and skill-use along supply chains. This includes capturing the trends towards contracting out parts of the production process to specialist suppliers, and the impact that it has on the use of skills. They used UK data for the years 1979 and 1990. Sectoral output and input use information is derived from the UK input tables from the Broad system of ordering 1983 and the Central Statistical Office 1995. Gregory et al. (2001) also examine employment change at a broad level (one-digit occupational level, and distinguishing three skill levels: high, intermediate, and low).

The specification used is as follows:

$$\begin{aligned}\Delta ND = {} & Nr(f\Delta\hat{}F) \\ & + n(R(\Delta\hat{}E) + R(Df\hat{}F)\hat{}X + R(DhA)\hat{}X + R(\Delta kJ)\hat{}X) \\ & + \Delta n\hat{}X + n(R(h\Delta A)\hat{}X + R(k\Delta J)\hat{}X)\end{aligned} \tag{4.1}$$

where ΔND denotes change in employment skill group in each industry. X denotes the vector of sectoral gross outputs and n= [$n_{kj} = N_{kj} / X_j$ is the skill by sector matrix of skill use coefficients denoting the number of workers of skill type *k* required to produce one unit of gross output of sector *j*. A and J are the inter industry matrices and capital goods purchases per unit of gross sectoral output. F denotes domestic final consumption, E exports and f is the home shares in final consumption. The matrices *h* and *k* are the home shares in the demand for intermediates and new capital goods respectively. $R=(I-h\cdot A-k\cdot J)^{-1}$. ˆ denotes a vector converted into a diagonal matrix and $\Delta NS = [\Delta N_{kj}]$ denotes the matrix of changes in employment of skill groups *k* associated with changes in final output in sector *j*.

Their main findings are that, in the UK, technological change had a major influence on the relative demand for skills, leading to an increase in employment for the highly skilled, while reducing employment in intermediate and particularly low-skilled jobs. Another major cause of the rise in skilled employment was found to be changing patterns of consumption. Finally, trade added a minor additional element to the explanation of net job loss and skill shifts, with a bias against the unskilled. While their approach does not offer any particular insights as far as econometric modelling is concerned, it does emphasise the crucial importance of changes in skill structures within a multi-sectoral model that incorporates insights from input-output analysis.

Briscoe and Wilson (2003) used annual data from successive UK labour force surveys (LFS) to model occupational trends over the period 1981-99. They developed time series models for some nine occupational groups across 17 industrial sectors. The variables they used included; output, wages, unemployment, export and import shares, which were combined with different technology (trend) and interactive dummy terms to identify the most significant determinants of the changing demand for occupational skills.

Briscoe and Wilson (2003) estimated various models. These are briefly summarised in this section. Equation 4.2 separates out the 153 individual occupational shares by industry (Sijt) and regresses each such share against a set of economic determinants, using the method of ordinary least squares regression.

$$S_{ijt} = F\,(Time, Out_t, Wage_t, UE_t, Exp_t, Imp_t) \quad (4.2)$$

In equation 4.3 data relating to each occupation are pooled across industries and time to produce nine share variables, one of each of the *j* occupations, each comprising some 323 data observations (17 industries x 19 years).

$$SJ_t = F\,(Time, Out_t, Wage_t, UE_t, Exp_t, Imp_t, Ind_{it}, I_i, T_t) \quad (4.3)$$

In equation 4.4 the industry dummies interact with each of the economic variables to allow the coefficients to vary for each industry i.

$$SJ_t = F\,(Time_t, OI_t, WJ_t, UE_{it}, Exp_{it}, Imp_{it}, Ind_{it}, I_i, T_t) \quad (4.4)$$

Equation 4.5 presents the most complete model, in which coefficients are estimated for all i and *j* simultaneously.

$$S = F\,(Time, Out, Wage, Exp, Imp, UE, Out_{ij}, Wage_{ij}, Exp_{ij}, Imp_{ij}, UE_{ij}, O_j I_i, O_j I_i T)\ (all\ i,\ \&\ J) \quad (4.5)$$

Table 4.1. **List of variables used**

SHARE (S)	Share of employment in occupation *j* within industry
SHARE (SJ)	Share of employment in occupation *j* within all industries (i =1,17)
SHARE (Sij)	Share of employment in occupation *j* within each individual industry I
TIME (t)	Time trend
OUT	Output, constant price index, by industry
WAGE	Relative earnings by occupation
EXP	Export volume share
IMP	Import volume penetration
UE	Claimant average unemployment rate for UK
OCCj	A simple 0/1 dummy to indicate the occupation
INDi	Another 0/1 dummy to indicate the industry
OjT	The occupational dummy, interacted with the time trend
IiT	The industry dummy, interacted with the time trend;
OjIi	OCCj interacted with INDi
OjIiT	OjIi interacted with TIME time trend
OI	OUT interacted with INDi 17
WJ	WAGE interacted with OCCj
EXPi	EXP interacted with INDi

Bishop and Carter (1991) and Bishop (1997) analysed the trends of occupational employment for 13 broad occupational groups in the US. They argue that the change in occupational employment shares follows a logistic growth path. They assume that the logistic function has a ceiling of 20 % ([25]). The specification used is as follows:

$$log\ [S_{jt} / (.20 - S_{jt})] = a0 + a1(U_t - 2005) + a2(U_t - .055) \quad (4.6)$$
$$+ a3\,(Xt - X2500)\,t = 1972 \ldots 1989$$

The log of the ratio of the 'j'th occupation's share of employment in year *t* to .2 minus that same occupational share, [Sjt/(.2-Sjt)], is assumed to depend on time (Tt), the unemployment rate (Ut), and one or more structural variables, (Xt), intended to capture the influence of the economic changes that occurred in the 1980s. The independent variables were defined relative to their projected value in the year 2005.

For the three smallest occupations, farm workers, protective service workers, and private household workers, Xt is a trend shift variable for the years after 1980. For the other 10 occupations the X variables were the ratio of the merchandise trade deficit to GNP, (TRADEFt), and the ratio of personal computers used in business to civilian employment, (PCUSEt).

Cörvers and Dupuy (2006) developed a model to explain the occupational structure of sectors of industry in the Netherlands. They estimated the structural parameters of a model as set out in equation 4.7 for the period between 1988 and 2003 using system dynamics OLS techniques to account for the employment dynamics dependence across occupations and sectors of industry. They distinguish between 13 sectors of industry and 43 occupational groups. The specification used is the following:

$$l_{ost} = a_{os} + a_t + \Delta \underline{x}'_{st}(\underline{b}_o + \underline{b}_o) + \quad (4.7)$$
$$\left[\underline{x}'_{st} - \underline{c}_o - \underline{\sum_p \Delta \underline{x}'_{pt}\,\underline{d}_p}\right](\underline{\gamma}_o + \underline{\mu}_o) + \varepsilon_{ost}$$
$$= \underbrace{a_{os} + \underline{c}_o(\underline{\gamma}_o + \underline{\mu}_o)}_{} + a_t + \underbrace{\underline{x}'_{st}(\underline{\gamma}_o + \underline{\mu}_o)}_{}$$
$$+ \underbrace{\Delta \underline{x}'_{st}(\underline{b}_o + \underline{b}_o) - \underline{\Delta \underline{x}'_{st}\,d_o}(\underline{\gamma}_o + \underline{\mu}_o)}_{} - \underbrace{(\underline{\gamma}_o + \underline{\mu}_o)\underline{\sum_{p\neq 0} \Delta \underline{x}'_{pt}\,\underline{d}_p}}_{} + \varepsilon_{ost}$$

([25]) Changes in occupational employment shares were assumed to follow a logistic growth path. The logistic function was assumed to have a ceiling of 20 %. The ceiling was set at the rather low 20 % level because this fit the data slightly better than a ceiling set at 25 % and because it would build in a slowdown in the rate of growth for three large, fast-growing occupations - managers, professionals, and sales workers.

where l_{ost} is the log employment of occupation o in sector *s*, a_{os} is an occupation ×sector fixed effect, $c_s\gamma_s$ is a sector fixed effect and at a year fixed effect. The occupation specific vector of parameters b_o indicates the effect of a 1 % increase in the respective explanatory variables between *t* – 1 and *t* on the level of employment in occupation o, similarly, the sector specific vector of parameters b_s indicates the effect of a 1 % increase in the respective explanatory variables of sector s between *t* – 1 and *t* on the level of employment in sector s. $\Delta x0_{st}d_s$ (γ_s+ μ_o) indicates the effect of a 1 % increase in the respective explanatory variables of sector p between *t*–1 and *t* on the level of employment in occupation o in sector s.

Cörvers and Dupuy (2006) argue that employment series by occupation and sector have both a long term relationship with levels of value added, capital and R&D, reflecting the production technology specific to each sector, and a short-term relationship with changes in value added, capital and R&D. They suggest that intrasectoral dynamics indicate that changes in the explanatory variables in a sector affect occupational employment in that sector, whereas the intersectoral dynamics indicate that changes in the explanatory variables in a sector affect occupational employment in other sectors.

They found that both the long-and short-term relationships explain a significant part of employment by occupation and sector of industry. Employment by occupation and sector is significantly affected not only by the intrasectoral dynamics but also by the intersectoral dynamics. In addition, high-skill occupations have a negative and significant elasticity with respect to value-added but large and positive elasticity with respect to R&D. Output expansion in a sector led to a reduction in employment in high-skilled occupations within that sector. However, this effect can be partly or fully compensated by the complementarity of high-skilled workers with new technology as indicated by the positive elasticities of employment in high-skilled occupations with respect to R&D. Intermediate-skill occupations have a positive and significant elasticity with respect to capital.

Given a long enough term of consistent data, it is possible to estimate reasonably sophisticated behavioural models which can explain the development of the skill structure of employment. In practice, most studies (with some notable exceptions such as Cörvers and Dupuy; 2006) have been unable to do this at any great level of occupational detail.

4.3. Data available and the ideal specification

Based on the literature review in Section 4.2 an ideal specification for modelling occupational employment might be a behavioural model such as equation 4.8:

$$S_{ijt} = f(Year, Technology_{ijt}, Trade_{ijt}, Wage_{ijt}, Output_{ijt}, Unemployment, X) \quad (4.8)$$

where S denotes the share of employment by occupation (j) within industry (i) and occupation (j), and X denotes a vector of other employment characteristics such as, country of residence and gender.

This represents the long-term relationship between the demand for skills and various key drivers. In practice we can anticipate that there will be various lags and adjustments which require exploration of the dynamics of this relationship.

Finding suitable data to test such a model is difficult, even nationally. The data considered for the present occupational modelling exercise come mainly from two sources.

First, the project used aggregate data from the EU-LFS, as published by Eurostat. These data cover the 27 countries for the period 1993-2005, and contain information on employment by country, gender, industry (41), occupation (27), and qualification (three levels). These data measure the changing pattern of skill demand ([26]) and are harmonised to a common classification.

To investigate the importance of various economic indicators on the occupational structure, economic indicators by sector from E3ME ([27]) were included in the data set. These were included to find links between changing economic drivers and the pattern of employment by skills. The E3ME data set includes many possible indicators by industry such as gross value added (GVA), hours worked, average earnings, gross output, imports, and exports, as well as technological indicators such as R&D expenditure and investment in ICT. In combination, the Eurostat and E3ME data allow, in principle, estimation of a detailed specification such the one outlined in equation 4.8 above, including the impact of the business cycle and of exposure to

([26]) Although the observed employment levels are the consequence of both demand and supply factors, the latter may be especially important with regard to the qualification dimension.

([27]) Available from Internet: http://www.e3me.com [cited 9.3.2009].

international trade. However, various technical and data problems restricted the ability to allow simultaneous analysis of all industries, which would capture the impact of E3ME indicators. Nor did they allow the inclusion of a full set of additional variables such as industry dummies, and industry dummies interacted with time.

The second main data set used is the LFS microdata set on individuals, covering 1983-2005 ([28]). They also provide a great deal of information: general characteristics (age, gender, nationality, etc.); individual labour-market activity over the reference week (employed/unemployed, etc.); their first job (occupation, sector, employment status, hours of work, etc.); flexible working patterns (evening work, overnight, etc.); second job; previous employment (if unemployed); methods of looking for a job; and education (for a full description of the variables included in the LFS see Eurostat, 2003). However, much of this detailed information is of more interest from a supply side rather than a demand perspective.

The lack of a sufficiently detailed sectoral dimension, the absence of data on wages, and the sparse nature of the industry by occupation employment data in the data set meant that this data set was much less useful than had been hoped ([29]).

Several other issues need to be highlighted about the microdata set and the published Eurostat data. For many countries there is only a short consistent data series. In many instances there are breaks and gaps in the data. There is often also considerable volatility. This reflects statistical noise as well as some changes in methods and systems of classification rather than real change.

There are more specific problems for the data on qualifications. For instance, for a small number of countries (such as Germany and the UK) there is no data on the levels of qualifications for 1998. More important, there are question marks against the comparability of some of the data across countries (the treatment of medium-level qualifications in the UK for example). The above problems with the data do not create a precise picture about the

([28]) Analysis of this chapter focuses on the period 1998-2005, however at the time the final results were produced a more up-to-date EU LFS dataset was available covering the period 1998-2006.

([29]) LFS microdata contain sectoral information only at one-digit level (16 sectors), due to the anonymisation procedures of Eurostat. This is a major drawback as it restricts the analysis below the desired level of disaggregation which refers to 41 industries. The microdata set also did not include information on wages. For these reasons, this data set was not suited to the analysis, which was focused on examining developments at the most detailed level possible by sector and occupation.

historical levels of employment, limiting what can be achieved in modelling and affecting the projections. These issues are discussed in greater detail in the following sections.

4.4. Empirical specifications

Given the problems with the data, and while the ideal specification might look like equation 4.8, several simpler specifications have also been considered. These include a range of models of the general form shown in equation 4.9:

$$S_{ijt} = F\,(Time) \tag{4.9}$$

Two main methods of analysis were adopted. The first is based on analysis of the employment shares in the published LFS data, and adopting specifications as in equation 4.9. These include several variations including linear, semi-log and logistic forms. Such equations can be regarded as simplified versions of equation 4.8, where time is used as a proxy for technological change.

Several variants are possible. These range from simple extrapolation between fixed points, to various methods based on 'line fitting'. The latter includes fitting:

(a) a linear trend,

$$S = a + b\,*Time \tag{4.10}$$

(b) a log linear trend

$$Ln(S) = a + b\,*Time \tag{4.11}$$

(c) or a logistic equation

$$Ln\left[S/(1-S)\right] = a + b\,*Time \tag{4.12}$$

The second method of analysing changes in employment structure involved a probability model, estimated on individual or pseudo-individual data. The propensity to be employed in a particular occupation is modelled using a multinomial logistic regression framework, based on pooled cross-sectional data from the Eurostat/LFS data ([30]).

A multinomial logistic regression model can be used to estimate the probability of an individual working in occupation (OCC) *j* at time *t*. The general model is specified as follows:

$$Pr(OCC = j / T = t) = \frac{exp(\Omega^{(j)}X)}{1 + \sum_{i=1}^{N} exp(\Omega^{(i)}X)} \quad (4.13)$$

and for an arbitrarily chosen base category:

$$Pr(OCC = N / T = t) = \frac{1}{1 + \sum_{i=1}^{N} exp(\Omega^{(i)}X)} \quad (4.14)$$

The equations state that the probability of the representative individual working in occupation *j* at time *t* can be expressed as a function of explanatory variables, normalised by the sum of probabilities for all categories. There are N occupations and the sum of probabilities is constrained to add up to one (shares of employment across occupations sum to 100 %).

Similarly, the above model can be used to estimate the probability of an individual working in occupation (OCC) *j* at time *t* holding a qualification n.

In the model X relates to a vector of regressors which are included in the model as explanatory variables for occupational or qualification structure. Potentially these might include:

(a) wage of occupation *j*;
(b) unemployment rate of occupation *j*;
(c) sectoral value added (this may be estimated as sectoral VA/VA trend);
(d) export volume share (exports as a percentage of domestic value added);
(e) import volume share (exports as a percentage of domestic value added;
(f) sector of employment (41 industry level);
(g) sector of employment *x* time;
(h) country of residence;
(i) country of residence *x* time;
(j) individual characteristics: gender, age;
(k) time period of observation, *t* (LFS quarter and year).

([30]) For the purposes of the analysis both micro-LFS and a pseudo-individual data set (based on published LFS) were used. However, for reasons outlined in Chapter 2, in the final results the microdata set was rejected. The pseudo-individual data set based on the published Eurostat numbers was used for the mlogit analysis reported here. This was created by generating large numbers of pseudo-individual cases with the same properties (occupational and qualification shares) as the published estimates.

The time trend variable proxies the impact of technology and other factors on changing occupational structure. Time was interacted with country and industry to allow for these effects to be country and sector specific. The regression coefficients are estimated so that the predicted model achieves 'best fit' to the observed data. This is done using the maximum likelihood method. In the model, Ω is the matrix of regression coefficients which is used to predict the distribution of employment by occupation at each point in time, *t*. Categorical variables (SIC, country, age, gender, etc.) are included in the model as an exhaustive set of dummy variables.

The primary aim of estimating such a model is to provide a behavioural explanation of changing patterns of employment structure. If a robust specification can be estimated, the model can be used to forecast shares of employment forward over time and also to indicate sensitivity to a range of economic influences. Using the coefficients of the model, predicted shares of employment by occupation can be obtained.

Both the individual data sets are large, comprising huge numbers of observations for each country ([31]), causing serious estimation technical problems. The initial intention was to estimate general models covering all countries simultaneously. Despite various efforts to get around these problems, this was not technically feasible given current hardware and software available ([32]). Much simpler specifications had to be adopted, focusing on estimation for just one country at a time.

The final analysis was conducted for each industry separately rather than pooling all industries together. Mlogit analyses were conducted to estimate the shares of qualifications of each occupation within every industry of each country. The main advantage of the mlogit method is that the sum of probabilities is constrained by the model to add up to one (i.e. shares of employment across occupations/qualifications sum to 100 %), whereas the other methods (e.g. linear, simple extrapolation) estimate the share of each occupational/qualification group separately and then are constrained to add up to unity. Therefore, the mlogit approach ensures a consistent picture across occupations (all probabilities summing to 100 %) without having to impose an external constraint.

Despite considerable effort to develop more general models, the most robust results were obtained using simple country data sets, distinguishing

([31]) To achieve a reasonable degree of precision, the number of cases created for the pseudo-individual data set had to be even larger than the microdata set.

([32]) Estimation was undertaken using the STATA package.

occupation and qualification for each sector, based on the published LFS shares and using models that included just time as the only independent variable.

For the final set of results an algorithm was developed to select the preferred models to be used for projecting occupational and qualification shares within each sector. This choice depends on the data available and how well the model fits and predicts the shares. The default model is a logistic specification, based on the published LFS shares, with time as the only independent variable, fitted on published LFS data for the period 1993-2006.

Where data are unavailable, inappropriate, missing or inconsistently classified, the estimation period is truncated accordingly. The algorithm also checks to see if the projected changes are plausible, censoring out shares that lie outside the range zero to unity and also where the projected change is exceptionally rapid (which usually arises as a results of idiosyncrasies in the data). Where there are problems of this kind the algorithm explores alternative specifications (log liner, liner and fixed shares) until an acceptable outcome is achieved. This applies to both shares of occupations within each sector and shares of qualifications within occupations. Further details are given in Section 4.9.

4.5. Data problems implications

This section illustrates some of the problems caused by the limitations of the LFS data, focusing on occupational shares (these are the published Eurostat data rather than the microdata set). The following five figures are for selected countries for all industries and services. The results for individual sectors, especially the smaller ones, show much greater volatility and even more gaps and discontinuities; this is seen in Figures 4.6, 4.7 and 4.8, some of which also show the implications for the projections. The same is truer of the data disaggregated by qualification.

Figure 4.1 is for the UK and represents what appears to be an ideal case, with no major problems. However, closer inspection reveals some difficulties, including marked discontinuity in 2000/01 linked to a change in official classification.

Figure 4.2 is for the Czech Republic and illustrates that, for many countries, data are available only for recent years. In some cases there are also missing years at the end (Luxembourg and Switzerland are currently missing 2006).

Figure 4.3 is for France. This shows major discontinuity in 1994/95. For this

reason the data for this country, and others in a similar position, have only been used for years after the obvious statistical break. Ideally the data series for such countries should be replaced by a more consistent one covering all years. Table 4.2 summarises the situation country by country.

Figure 4.4 is for Ireland. This shows a similar break but rather later (1998/99). The data set used has again been truncated, but this leaves a much shorter period to establish meaningful trends.

Figure 4.5 is for Italy. This illustrates a problem common to several other countries, including Austria and Poland, with a much more recent discontinuity. This leaves too few observations to truncate the data set from before the break. In such cases the discontinuity has been ignored, but this may cause some odd results when trends are extrapolated forward, by whatever means. This may require some adjustment in the final results used in the main projections.

Figure 4.6, shows some of the possible implications of the discontinuities for France noted above. The results for corporate managers indicate an unlikely explosion in the number of corporate managers. This is a reflection of a change in classification rather than reality. It disappears if the period used for modelling the trend starts in 1995 rather than 1993, which is what is actually done for the main results.

Figure 4.7 illustrates that, although at aggregate level, across all industries, the UK may appear to demonstrate some reasonably stable trends, at more detailed level this may be far from the truth. The diagram shows the results for coal industries, which now employ few people in the UK. As a consequence the LFS estimates are erratic and provide little guidance on likely future trends.

Figure 4.8 illustrates another common problem, in this case for Ireland, in retailing. Sample sizes in the LFS are much larger here but this does not avoid rather erratic changes over time. This can result in strange projections using extrapolative methods of all kinds. Note the rapid growth projected for managers of small enterprises and the collapse of employment in models, salespersons and demonstrators. Also, the fact that there are no data for 1998 constitutes an additional problem, constraining the analysis to be conducted for the period after the gap.

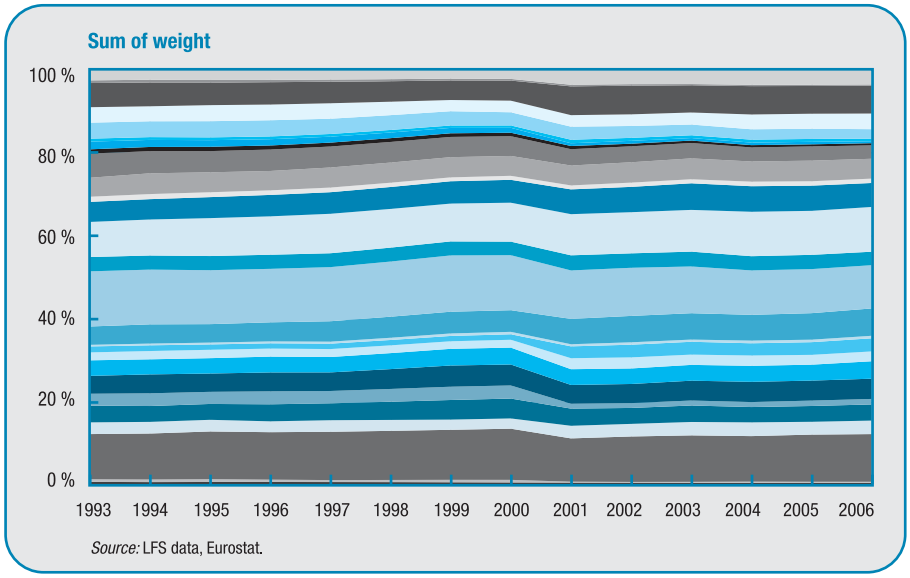
Unfortunately this kind of problem is typical rather than exceptional. Some are related to discontinuities in the basic Eurostat LFS data. Others are more a function of the lack of precision and robustness of these data (with many cells being empty or containing estimates with large margins of error). Despite considerable effort, it has not proved possible to develop models or rules to avoid these kinds of problems. There is no single model or method that avoids

all such difficulties. A purely technocratic solution is not possible and considerable judgement is needed to choose the best method and projection. This suggests that there is a need for further detailed scrutiny of the results and the use of judgement as advocated by the Bureau of Labor Statistics in the US rather than simply relying on mechanistic modelling.

Table 4.2. **Breaks and discontinuities in the LFS data**

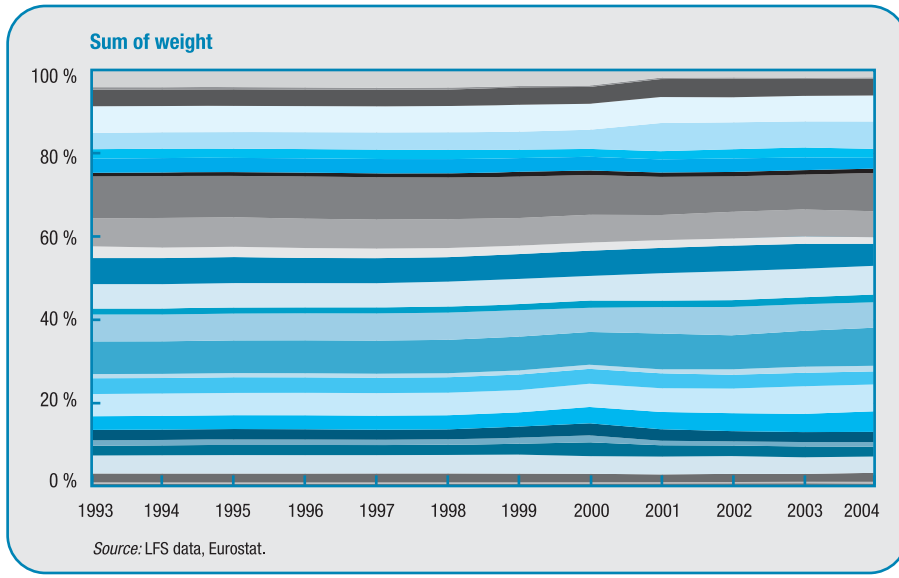
DK	Ok
DE	Discontinuity in 2001 (due to reunification)
EE	Truncated 1997
EL	Ok
ES	Ok
FR	Discontinuity 1994/95
IE	Discontinuity 1997-99
IT	Discontinuity 2003/04
CY	Truncated 1999
LV	Truncated 1998
LT	Truncated 1998
LU	Truncated 2006
HU	Truncated 1997
MT	Truncated 2000
NL	Truncated 1996
AT	Truncated 1995 discontinuity 2003/04
PL	Truncated 1997 discontinuity 2004/05
PT	Discontinuity 1997/98
SI	Truncated 1996
SK	Truncated 1998
FI	Truncated 1997 discontinuity 2001/02
SE	Truncated 1997
UK	Discontinuity 2000/01
CH	Truncated 1996 and 2006 discontinuities up to 2001
NO	Truncated 1996

Figure 4.1. **Occupational share, all industries, 1993-2006, UK**



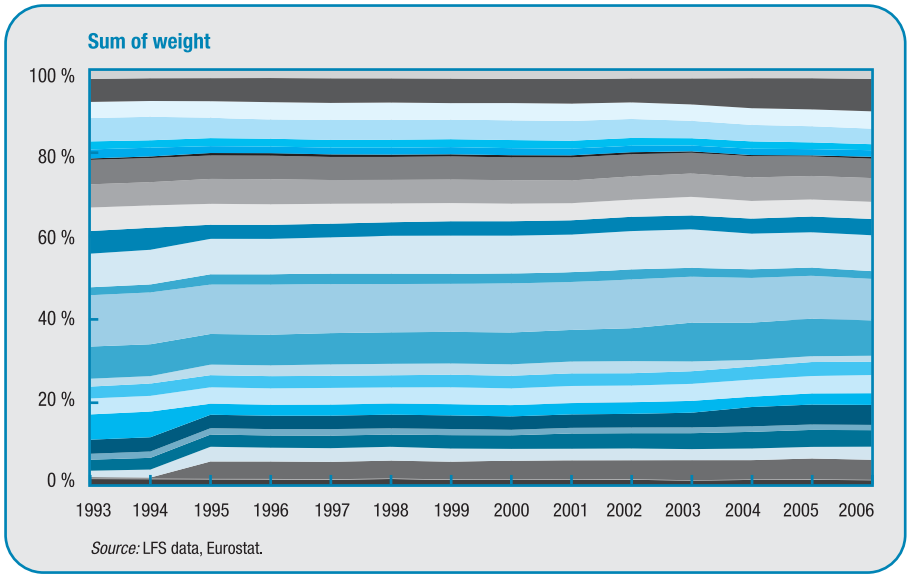
Source: LFS data, Eurostat.

Figure 4.2. **Occupational share, all industries, 1997-2004, Czech Republic**



Source: LFS data, Eurostat.

Figure 4.3. **Occupational share, all industries, 1997-2006, France**



Source: LFS data, Eurostat.

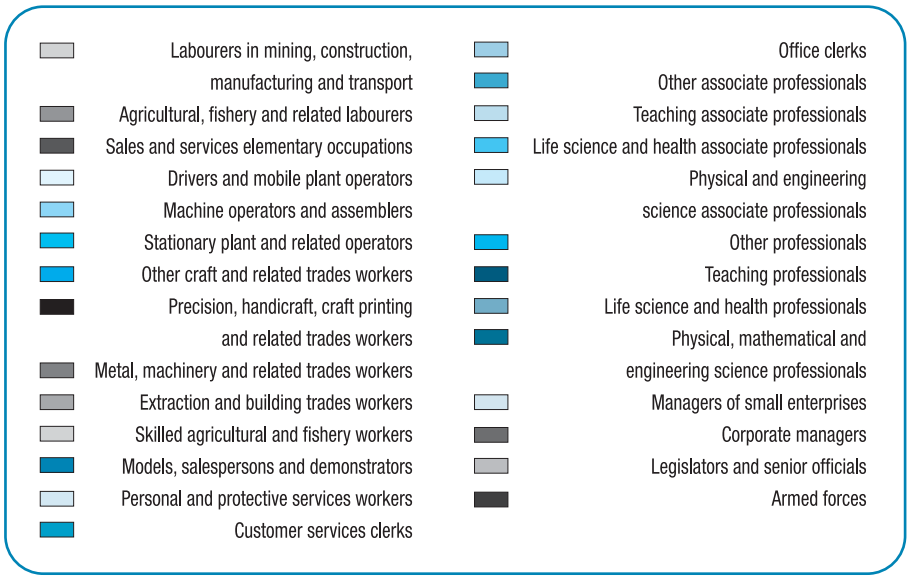
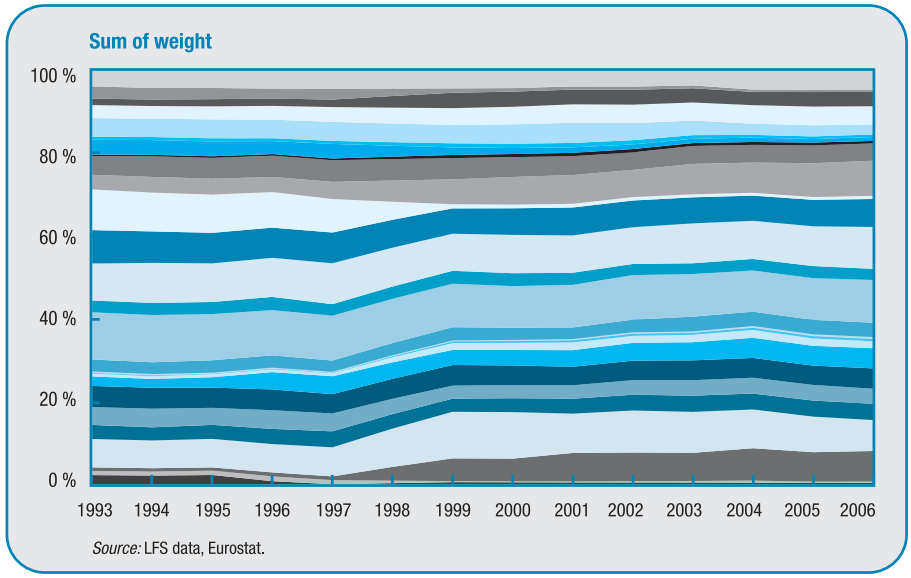
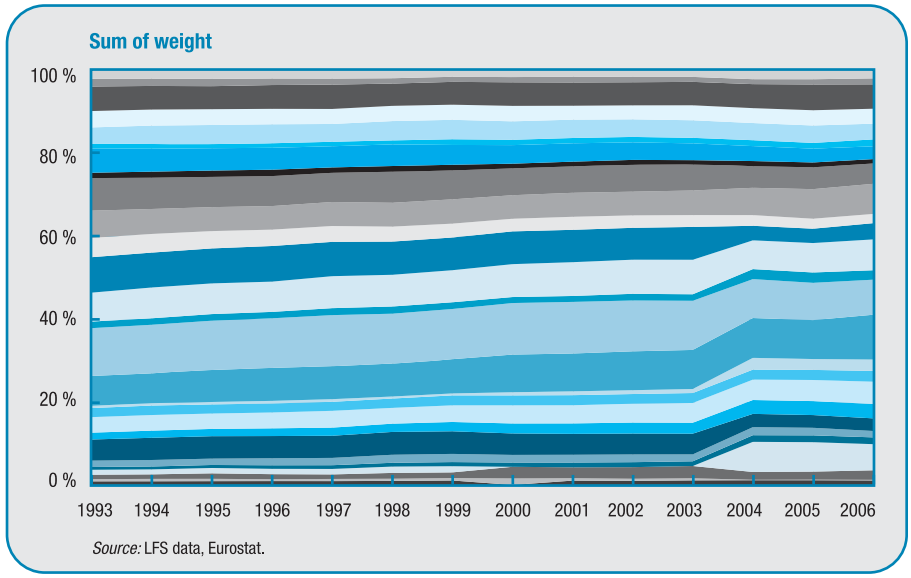


Figure 4.4. **Occupational share, all industries, 1993-2006, Ireland**



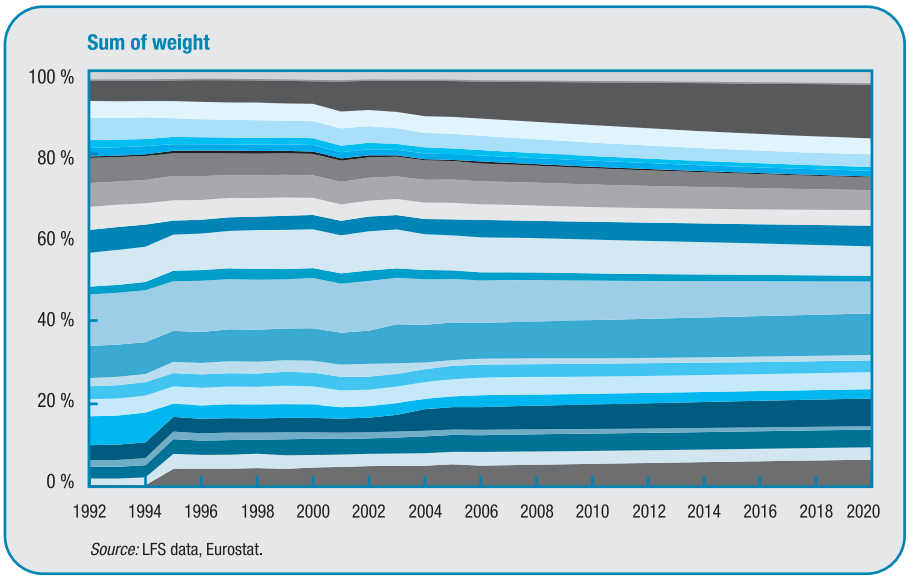
Source: LFS data, Eurostat.

Figure 4.5. **Occupational share, all industries, 1993-2006, Italy**



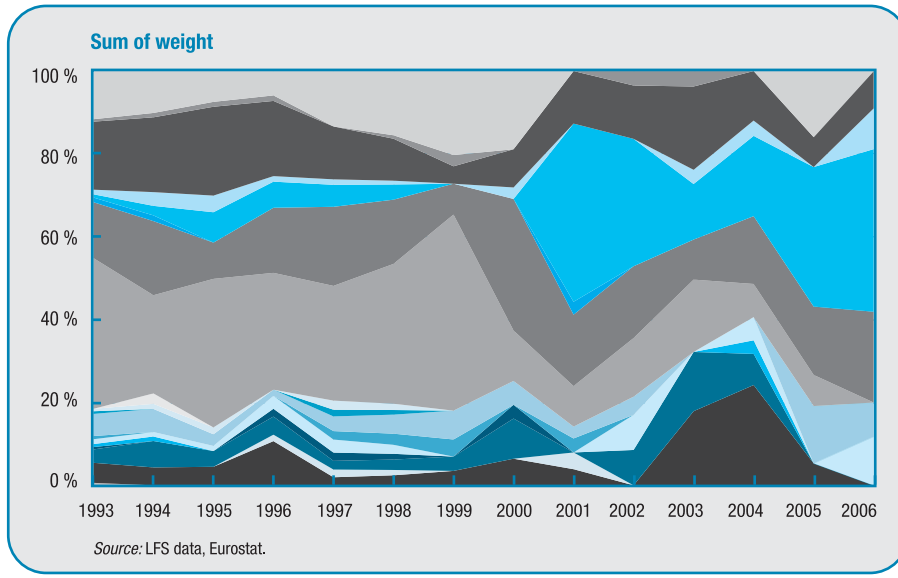
Source: LFS data, Eurostat.

Figure 4.6. **Occupational share, past trends and projections for all industries, 1992-2020, France**



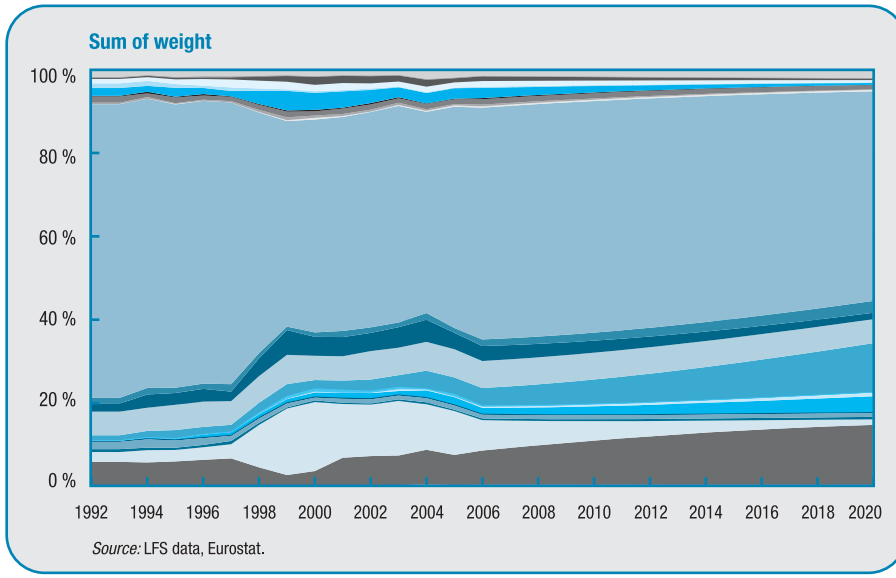
Source: LFS data, Eurostat.

Figure 4.7. **Occupational share, coal industries, 1993-2006, UK**

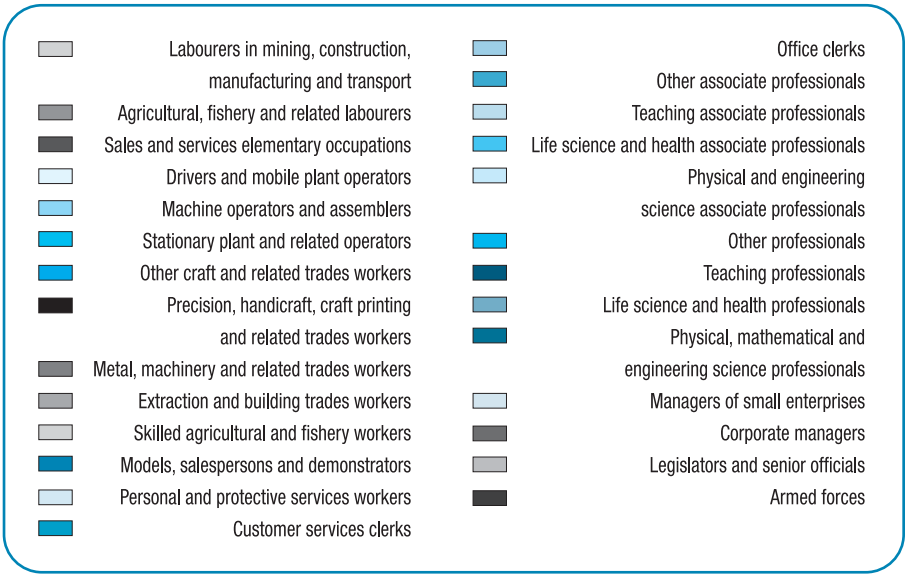


Source: LFS data, Eurostat.

Figure 4.8. **Occupational share, past trends and projections for retailing, 1992-2020, Ireland**



Source: LFS data, Eurostat.



4.6. Mlogit results for occupations and qualifications

4.6.1. Examples of results by selected industries

This section focuses on the results obtained by applying the multinomial logistic regression technique. The estimated mlogit models presented here have time as the only regressor. Attempts to estimate more general models that entail behavioural content failed to establish any consistent and robust results. However, this does not mean that such models may not be relevant but we have not been able to identify them in the time available. The final models were estimated for each of the 41 sectors and each of the EU-25+ countries.

The mlogit models estimated were robust, and most of the coefficients were statistically significant. Over 90 % of all analysis coefficients were statistically significant at the 95 % level. The robustness of the estimated models should, therefore, provide a reasonably sound foundation for obtaining the predictions for the shares of occupations and qualifications. However, the short length of the time series involved and other difficulties with the data cause problems in some cases.

Tables 4.3 to 4.6 illustrate the econometric output regarding the occupational shares for two industries: printing and publishing, and banking and finance, for Greece and the UK respectively. The tables report the coefficients, the Z-ratios and the P-values. An important feature of the multinomial logit model is that it estimates *k-1* models, where *k* is the number of categories distinguished in the dependent variable. In this case there are 27-1=26 occupations. In Table 4.3 precision, handicraft, craft printing and related trades workers are the base outcome. Therefore, the estimated coefficients of the model for any other occupational group are relative to precision, handicraft, craft printing and related trades workers ([33]).

Since the parameter estimates are relative to the reference group, the standard interpretation of the multinomial logit is that for a unit change in the predictor variable, the logit of outcome *m* relative to the referent group is expected to change by its respective parameter estimate. For example, the multinomial logit for legislators and senior officials for industry printing and publishing suggests that for one unit of change in time, the probability of being in the occupational group of legislators and senior officials is expected to change by 0.010 relative to precision, handicraft, craft printing and related trades workers (reference category).

An important general consideration when interpreting the results of the econometric analysis is the short period of historical data used to forecast the period ahead. A longer period of historical data would probably lead to more robust results. However, in some cases the LFS sample is small (Cyprus), making detailed industry and occupation estimates imprecise, and thus difficult to reach robust conclusions about the trends in occupational shares at great level of detail.

([33]) This is chosen automatically by the STATA package and, therefore, differs from industry to industry in the tables.

Table 4.3. **Multinomial logistic regression output, printing and publishing, Greece**

Banking and finance	Coefficient	Z-ratio	P-value
Legislators and senior officials	0.010	0.99	0.32
Corporate managers	-0.028	-24.94	0.00
Managers of small enterprises	0.028	92.91	0.00
Physical, mathematical and engineering science professionals	0.014	6.25	0.00
Life science and health professionals	-0.051	-5.61	0.00
Teaching professionals	-0.033	-3.72	0.00
Other professionals	0.005	11.85	0.00
Physical and engineering science associate professionals	0.047	69.36	0.00
Life science and health associate professionals	-0.033	-3.72	0.00
Teaching associate professionals	0.010	0.99	0.32
Other associate professionals	0.047	73.31	0.00
Office clerks	-0.003	-6.07	0.00
Customer services clerks	0.071	42.18	0.00
Personal and protective services workers	-0.113	-18.94	0.00
Models, salespersons and demonstrators	0.065	43.11	0.00
Skilled agricultural and fishery workers	-0.021	-2.19	0.029
Extraction and building trades workers	-0.135	-28.4	0.00
Metal, machinery and related trades workers	-0.087	-29.07	0.00
Other craft and related trades workers	-0.073	-13.92	0.00
Stationary plant and related operators	-0.093	-9.8	0.00
Machine operators and assemblers	-0.032	-37.02	0.00
Drivers and mobile plant operators	0.024	22.11	0.00
Sales and services elementary occupations	-0.053	-29.92	0.00
Agricultural, fishery and related labourers	0.010	0.99	0.32
Labourers in mining, construction, manufacturing and transport	-0.040	-22.15	0.00

NB: occupation = precision, handicraft, craft printing and related trades workers is the base outcome.

Table 4.4. **Multinomial logistic regression output, banking and finance, Greece**

Banking and finance	Coefficient	Z-ratio	P-value
Legislators and senior officials	-0.001	-0.26	0.79
Corporate managers	0.006	14.48	0.00
Managers of small enterprises	0.036	34.49	0.00
Physical, mathematical and engineering science professionals	0.028	36.08	0.00
Life science and health professionals	-0.113	-43.44	0.00
Teaching professionals	-0.041	-6.17	0.00
Other professionals	0.007	19.7	0.00
Physical and engineering science associate professionals	-0.02	-20.82	0.00
Life science and health associate professionals	0.122	46.95	0.00
Teaching associate professionals	-0.001	-0.26	0.79
Other associate professionals	0.036	84.87	0.00
Office clerks	-0.026	-83.26	0.00
Customer services clerks	-0.014	-11.26	0.00
Personal and protective services workers	-0.00	-0.26	0.79
Models, salespersons and demonstrators	-0.07	-12.08	0.00
Skilled agricultural and fishery workers	-0.190	-38.43	0.00
Extraction and building trades workers	-0.122	-45.29	0.00
Metal, machinery and related trades workers	-0.046	-7.83	0.00
Other craft and related trades workers	-0.001	-0.26	0.79
Stationary plant and related operators	-0.00	-0.26	0.793
Machine operators and assemblers	-0.041	-5.92	0.00
Drivers and mobile plant operators	0.015	8.33	0.00
Sales and services elementary occupations	-0.012	-22.7	0.00
Agricultural, fishery and related labourers	-0.091	-14.15	0.00
Labourers in mining, construction, manufacturing and transport	-0.11	-20.86	0.00

NB: occupation = customer services clerks is the base outcome.

Table 4.5. **Multinomial logistic regression output, printing and publishing, UK**

Banking and finance	Coefficient	Z-ratio	P-value
Legislators and senior officials	-0.035	-14.7	0.00
Managers of small enterprises	0.039	123.23	0.00
Physical, mathematical and engineering science professionals	0.018	47.5	0.00
Life science and health professionals	-0.087	-31.4	0.00
Teaching professionals	0.017	16.65	0.00
Other professionals	0.032	175.3	0.00
Physical and engineering science associate professionals	0.017	48.59	0.00
Life science and health associate professionals	-0.014	-5.93	0.00
Teaching associate professionals	0.092	55.61	0.00
Other associate professionals	0.020	103.1	0.00
Office clerks	-0.010	-56.38	0.00
Customer services clerks	0.026	64.55	0.00
Personal and protective services workers	-0.120	-68.77	0.00
Models, salespersons and demonstrators	-0.053	-51.48	0.00
Skilled agricultural and fishery workers	-0.032	-12.4	0.029
Extraction and building trades workers	-0.071	-61.24	0.00
Metal, machinery and related trades workers	-0.039	-71.69	0.00
Other craft and related trades workers	-0.000	-0.89	0.375
Stationary plant and related operators	-0.142	-63.92	0.00
Machine operators and assemblers	0.060	106.7	0.00
Drivers and mobile plant operators	-0.166	-435.8	0.00
Sales and services elementary occupations	-0.020	-44.78	0.00
Agricultural, fishery and related labourers	0.021	83.1	0.32
Labourers in mining, construction, manufacturing and transport	0.063	240.82	0.00

NB: occupation = coporate managers is the base outcome.

Table 4.6. **Multinomial logistic regression output, banking and finance, UK**

Banking and finance	Coefficient	Z-ratio	P-value
Legislators and senior officials	-0.07	-51.14	0.00
Corporate managers	0.07	234.79	0.00
Managers of small enterprises	-0.02	-122.03	0.00
Physical, mathematical and engineering science professionals	-0.07	-43.75	0.00
Life science and health professionals	-0.08	-125.58	0.00
Teaching professionals	0.00	11.31	0.00
Other professionals	0.07	250.98	0.00
Physical and engineering science associate professionals	-0.04	-23.04	0.00
Life science and health associate professionals	0.09	170.45	0.00
Teaching associate professionals	0.01	68.25	0.00
Other associate professionals	-0.03	-292.73	0.00
Office clerks	-0.02	-238.27	0.00
Customer services clerks	-0.10	-156.78	0.00
Personal and protective services workers	0.02	33.45	0.00
Models, salespersons and demonstrators	-0.03	-18.5	0.00
Skilled agricultural and fishery workers	-0.07	-75.75	0.00
Extraction and building trades workers	-0.03	-51.85	0.00
Metal, machinery and related trades workers	-0.10	-67.54	0.00
Other craft and related trades workers	-0.02	-11.26	0.79
Stationary plant and related operators	-0.04	-22.72	0.793
Machine operators and assemblers	-0.01	-18.21	0.00
Drivers and mobile plant operators	0.05	58.98	0.00
Sales and services elementary occupations	0.02	88.98	0.00
Agricultural, fishery and related labourers	-0.01	-4.38	0.00
Labourers in mining, construction, manufacturing and transport	0.08	106.66	0.00

NB: occupation = corporate managers is the base outcome.

The results of the multinomial logistic regression analysis are then used to estimate national predictions for future occupational shares (two-digit level), as well as shares of qualifications for each occupation, within the 41 industries.

4.6.2. **Overview of results for occupations** ([34])

Figures 4.9-4.12 present some indicative occupational shares, for the top 10 occupational groups (occupations with the largest share in employment), across all 41 industries, for four countries: Greece, Latvia, Poland and the UK. Figures 4.9-4.12 show in fact 10 coloured areas, however, the area on top (no colour) shows the residual category (the share of all remaining occupations), which covers all the remaining share up to 100 %. However, the figures for presentational purposes do not present an area up to 100 %. The period covered is 1993-2015 and the shares presented are the outcome of the mlogit econometric analysis. The shares of the historic period 1993-2005 are the predicted shares from the multinomial regression technique. These shares are close to the actual historical shares as estimated and published by Eurostat, since most are strongly trended. However, the fitted values show a smoother historical pattern than actual values.

Some similarities exist across the different countries.

The 10 most important occupational groups in the UK, by order of importance, are:

(a) corporate managers;
(b) office clerks;
(c) metal, machinery and related trades workers;
(d) physical, mathematical and engineering science professionals;
(e) machine operators and assemblers;
(f) other associate professionals;
(g) personal and protective services workers;
(h) drivers and mobile plant operators;
(i) physical and engineering science associate professionals;
(j) physical and engineering science associate professionals.

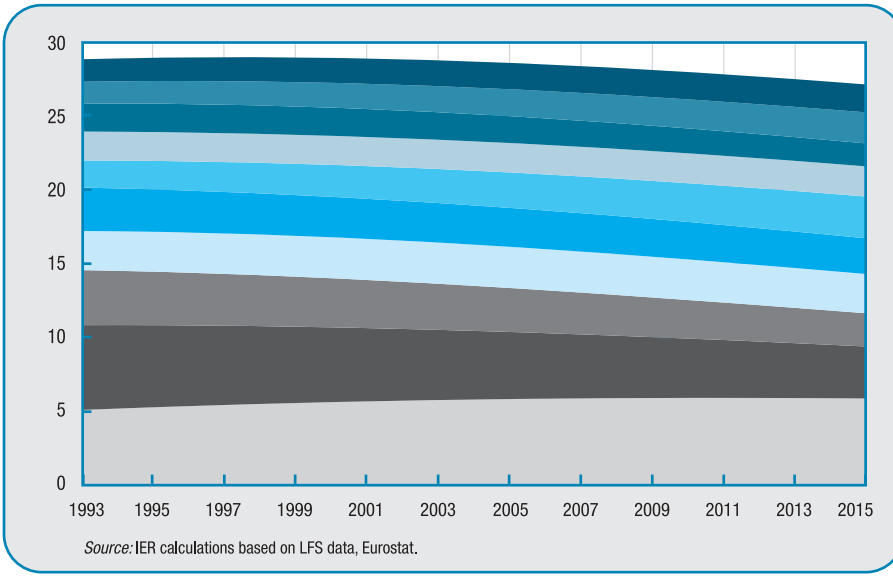
([34]) In the multinomial logistic analysis armed forces have been omitted. Hence, this analysis is not directly consistent with the other methods which include this group.

For the case of Greece, the 10 most important occupations are:

(a) office clerks;
(b) metal, machinery and related trades workers;
(c) extraction and building trades workers;
(d) drivers and mobile plant operators;
(e) physical and engineering science associate professionals;
(f) machine operators and assemblers;
(g) other associate professionals;
(h) managers of small enterprises
(i) physical, mathematical and engineering science professionals;
(j) personal and protective services workers.

The results suggest a decline in low-skilled occupations and, in particular, for office clerks and metal, machinery and related trades workers. This decline might account for the impact of technological change that has replaced many workers by software packages and more complex machines. However, the share of occupations requiring high level of education is projected to increase. In particular, other associate professionals and physical and engineering science associate professionals are forecast to increase share of total employment.

Figure 4.9. **Indicative occupational share for top 10 occupations, all industries, 1993-2015, UK**



Source: IER calculations based on LFS data, Eurostat.

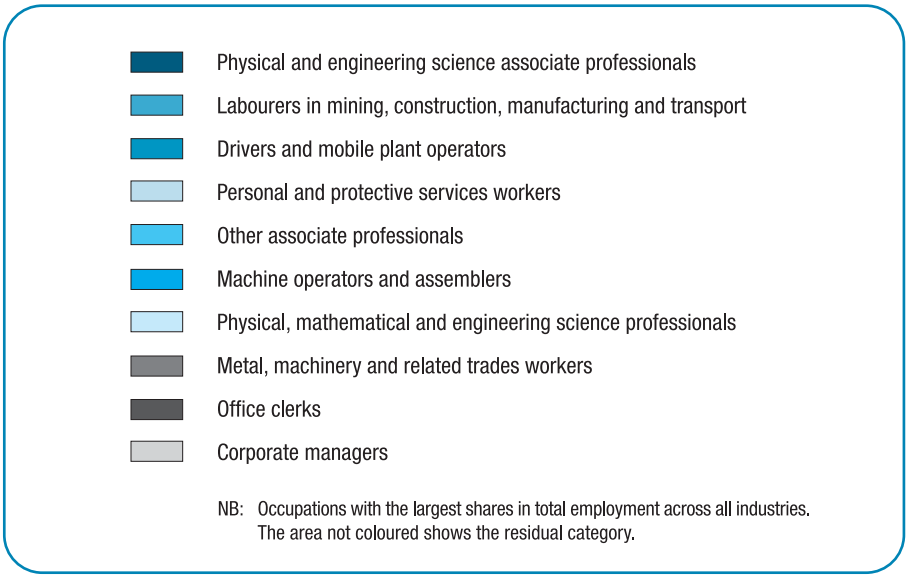


Figure 4.10. **Indicative occupational share for top 10 occupations, all industries, 1993-2015, Greece**

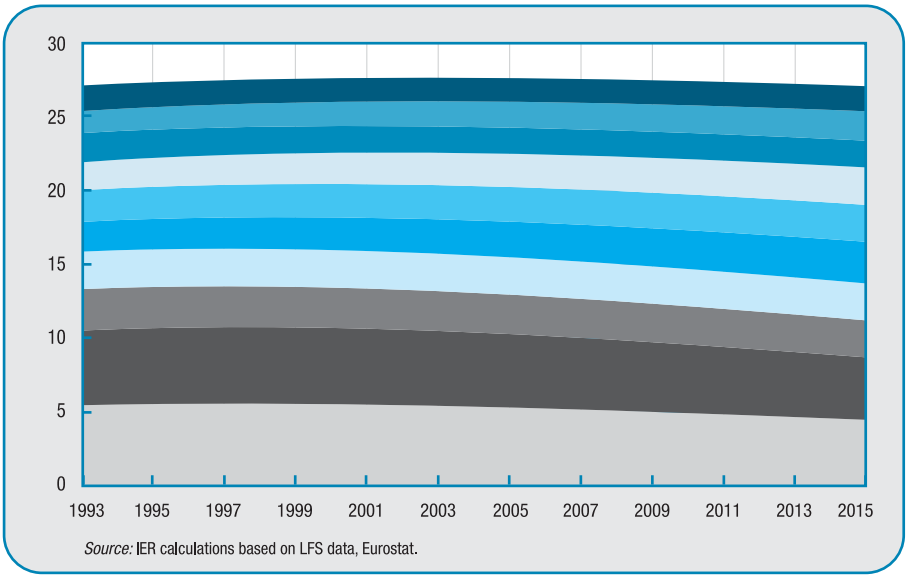
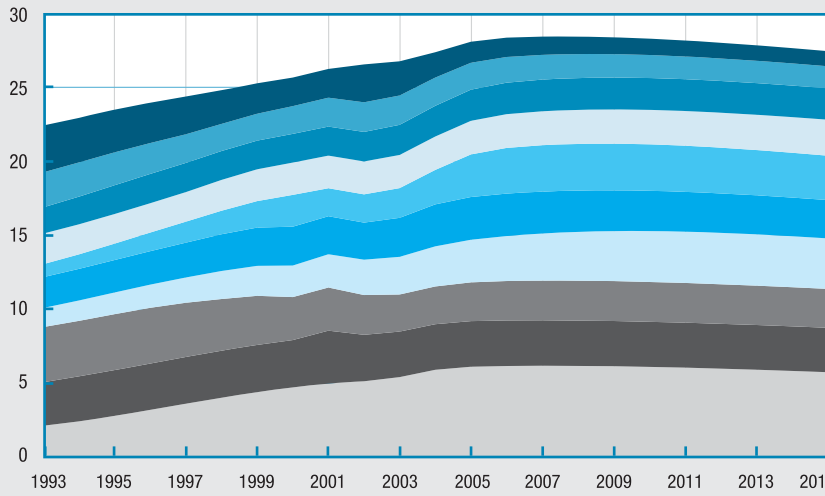


Figure 4.11. **Indicative occupational share for top 10 occupations, all industries, 1993-2015, Latvia**

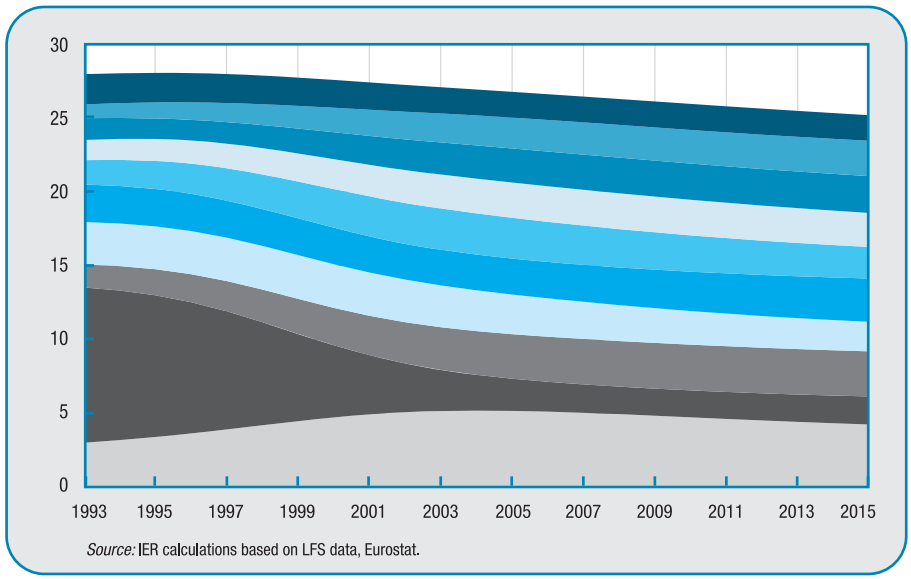


Source: IER calculations based on LFS data, Eurostat.

- Physical and engineering science associate professionals
- Labourers in mining, construction, manufacturing and transport
- Drivers and mobile plant operators
- Personal and protective services workers
- Other associate professionals
- Machine operators and assemblers
- Physical, mathematical and engineering science professionals
- Metal, machinery and related trades workers
- Office clerks
- Corporate managers

NB: Occupations with the largest shares in total employment across all industries. The area not coloured shows the residual category.

Figure 4.12. **Indicative occupational share for top 10 occupations, all industries, 1993-2015, Poland**



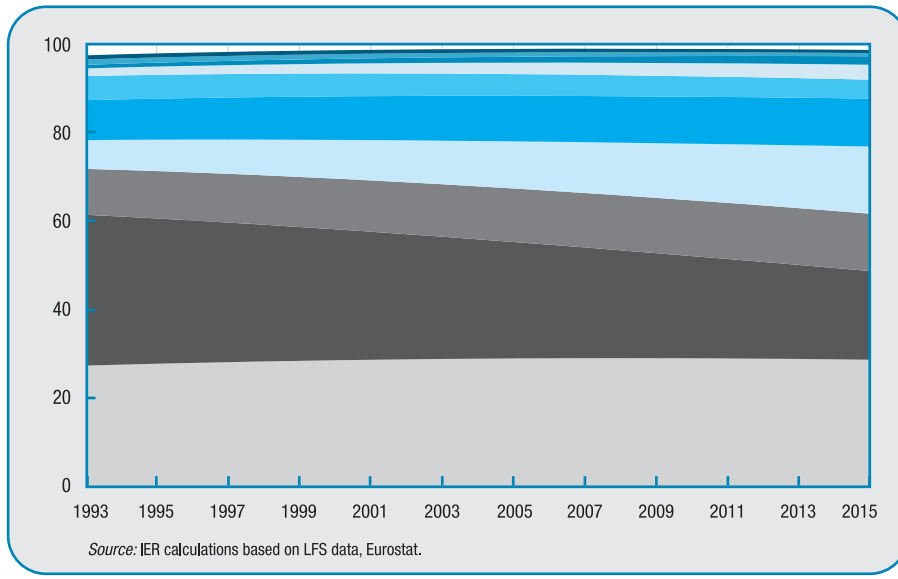
Source: IER calculations based on LFS data, Eurostat.

The importance of the different occupations and the trends observed for different occupational groups varies across industries. Figures 4.13-4.17 show the occupational shares for five industries in Greece: banking and finance, retailing, education, construction, and distribution. These figures illustrate the 10 occupational groups which have the largest share in employment for each particular industry (as a share of total sectoral employment). As in Figures 4.9-4.12 the uncoloured area illustrates the residual category.

The occupational shares within industries also vary across countries. Figures 4.18-4.21 present the shares for the communications industry for Italy, Latvia, and Poland. Some differences exist, such as the office clerks group whose share within the communications industry is forecast to decline for Italy and the UK, but increase for Latvia and Poland. The projected decline is high for the UK, which may be indicative of technological change impact on occupational groups, such as clerks, where workers are often replaced by technology.

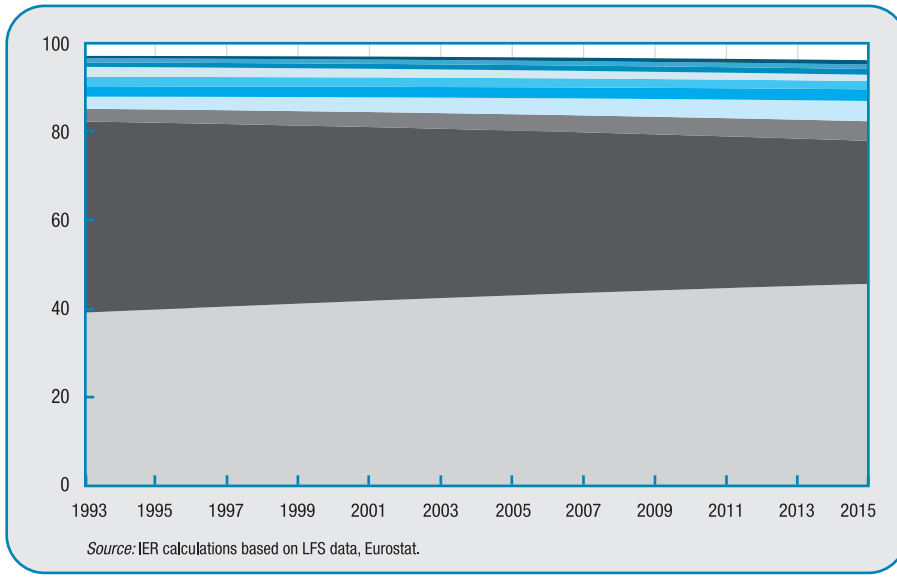
The importance of each occupational group also varies across countries. For example, while corporate managers are an important group for the communication industry in Latvia, Poland and the UK, in Italy its share is much lower. This may reflect some remaining differences with the way jobs are classified across countries, despite attempts to harmonise the system of classification.

Figure 4.13. **Indicative occupational share for top 10 occupations, banking and finance, 1993-2015, Greece**



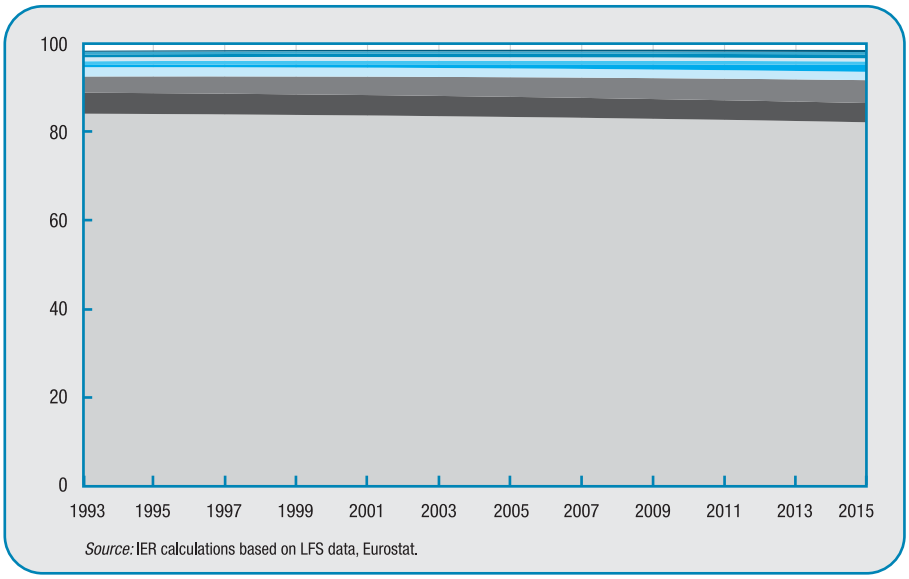
Source: IER calculations based on LFS data, Eurostat.

Figure 4.14. **Indicative occupational share for top 10 occupations, retailing, 1993-2015, Greece**



Source: IER calculations based on LFS data, Eurostat.

Figure 4.15. **Indicative occupational share for top 10 occupations, education, 1993-2015, Greece**

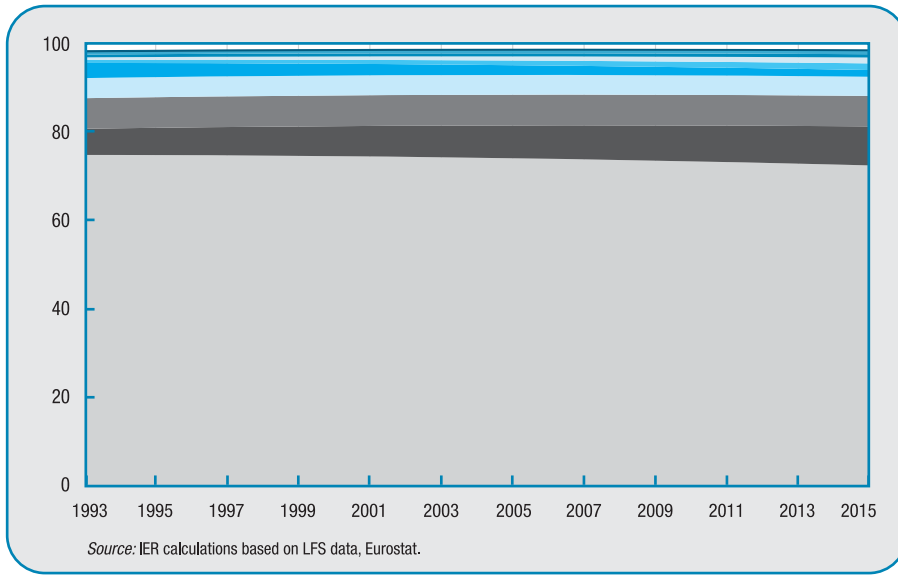


Source: IER calculations based on LFS data, Eurostat.

Physical and engineering science associate professionals
Labourers in mining, construction, manufacturing and transport
Drivers and mobile plant operators
Personal and protective services workers
Other associate professionals
Machine operators and assemblers
Physical, mathematical and engineering science professionals
Metal, machinery and related trades workers
Office clerks
Corporate managers

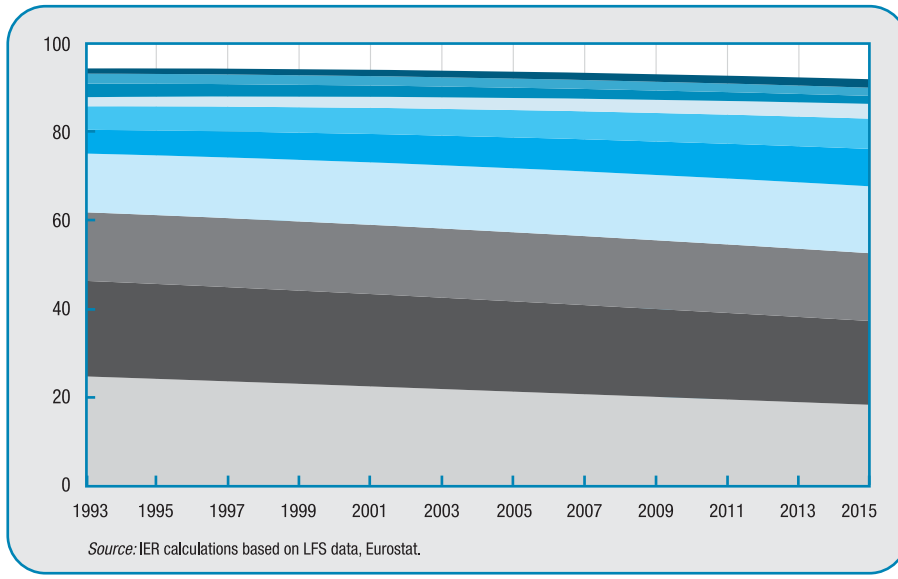
NB: Occupations with the largest shares in total employment across all industries. The area not coloured shows the residual category.

Figure 4.16. **Indicative occupational share for top 10 occupations, construction, 1993-2015, Greece**



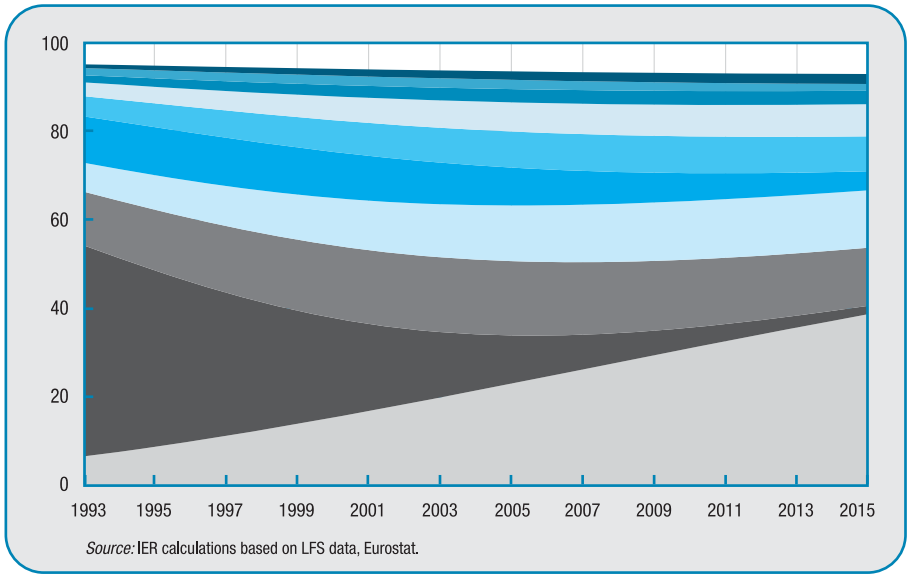
Source: IER calculations based on LFS data, Eurostat.

Figure 4.17. **Indicative occupational share for top 10 occupations, distribution, 1993-2015, Greece**



Source: IER calculations based on LFS data, Eurostat.

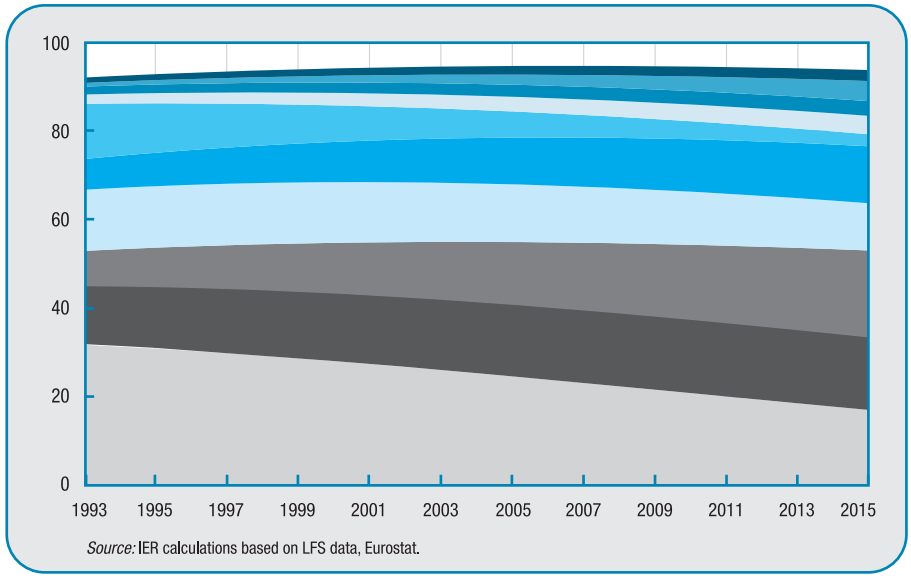
Figure 4.18. **Indicative occupational share for top 10 occupations, communications, 1993-2015, UK**



Source: IER calculations based on LFS data, Eurostat.

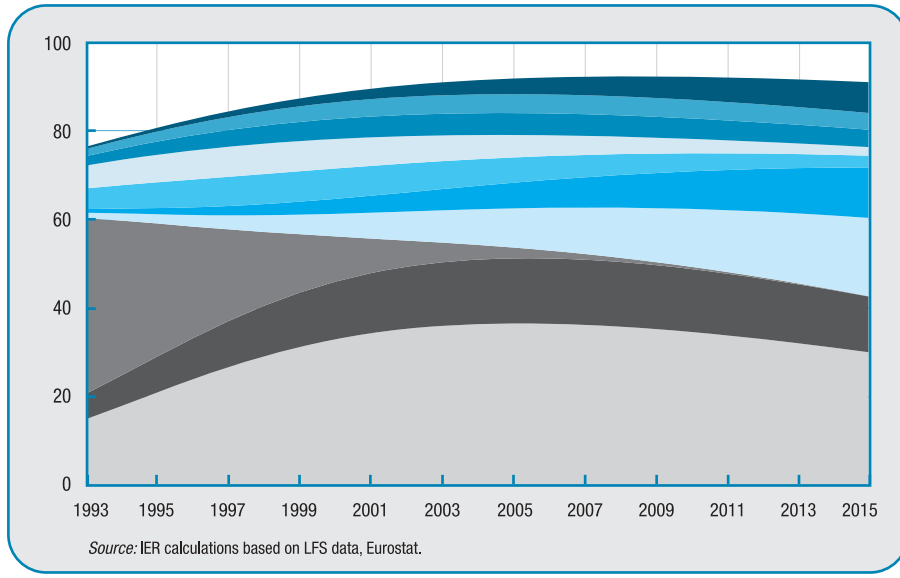
NB: Occupations with the largest shares in total employment across all industries. The area not coloured shows the residual category.

Figure 4.19. **Indicative occupational share for top 10 occupations, communications, 1993-2015, Italy**



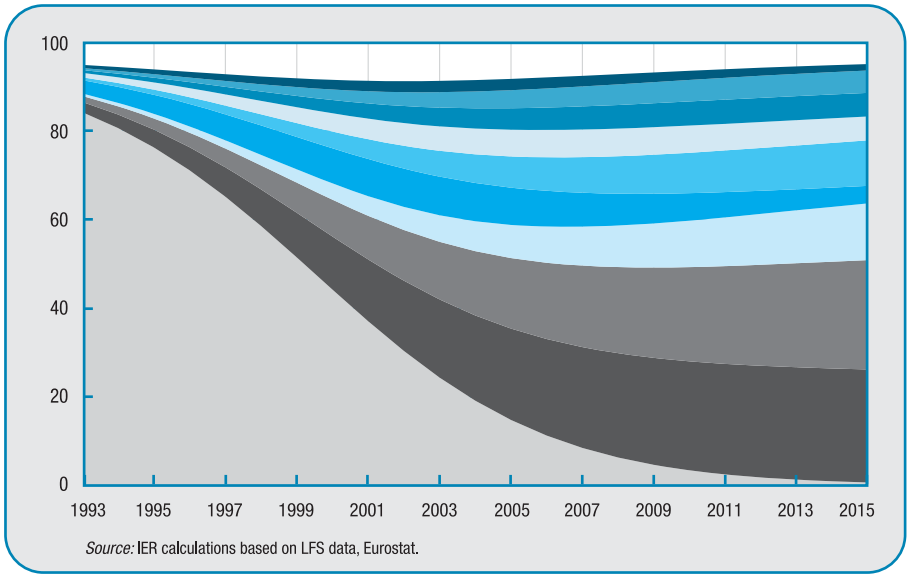
Source: IER calculations based on LFS data, Eurostat.

Figure 4.20. **Indicative occupational share for top 10 occupations, communications, 1993-2015, Latvia**



Source: IER calculations based on LFS data, Eurostat.

Figure 4.21. **Indicative occupational share for top 10 occupations, communications, 1993-2015, Poland**



Source: IER calculations based on LFS data, Eurostat.

- Physical and engineering science associate professionals
- Labourers in mining, construction, manufacturing and transport
- Drivers and mobile plant operators
- Personal and protective services workers
- Other associate professionals
- Machine operators and assemblers
- Physical, mathematical and engineering science professionals
- Metal, machinery and related trades workers
- Office clerks
- Corporate managers

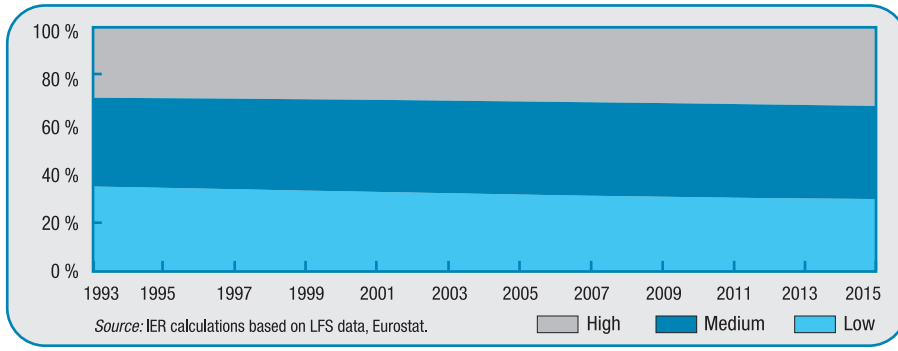
NB: Occupations with the largest shares in total employment across all industries. The area not coloured shows the residual category.

4.6.3. Qualifications results

Similar models were estimated for obtaining qualification shares within occupations, across industries and countries. This section again presents the results based on the mlogit technique, using a similar approach to occupations. Three categories of qualifications are distinguished in the dependent variable (which is regressed on time). The three levels of education based on the international standard classification of education (ISCED) are: high (ISCED 5-6), medium (ISCED 3-4) and low (ISCED 0-2). Despite moves towards harmonisation, some inconsistencies remain in the classification across countries, and thus direct comparisons between countries need to be considered with care.

Figure 4.22 presents the estimated trends for qualifications for Greece across all occupations and industries. The proportion of individuals with low level of qualification is declining and is projected to continue. At the same time, the proportion of those in employment with medium levels of qualification (largest share) is increasing. Similarly, those with high level of qualification increase. These trends are also projected to continue.

Figure 4.22. **Qualification share, all industries and occupations, 1993-2015, Greece**



Figures 4.23, 4.24 and 4.25 present trends in qualification patterns for Ireland, Cyprus, and the UK: the picture painted is similar across countries, with jobs with low education in decline while those with medium or high qualification increase. However, in Cyprus the proportions seem to be stable over time, although overall those with high qualifications are higher than the EU-27 average.

Figure 4.23. **Qualification share, all industries and occupations, 1993-2015, Ireland**

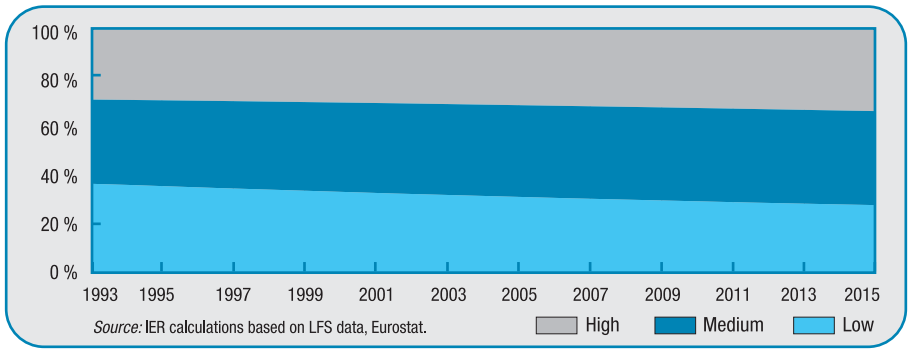


Figure 4.24. **Qualification share, all industries and occupations, 1993-2015, Cyprus**

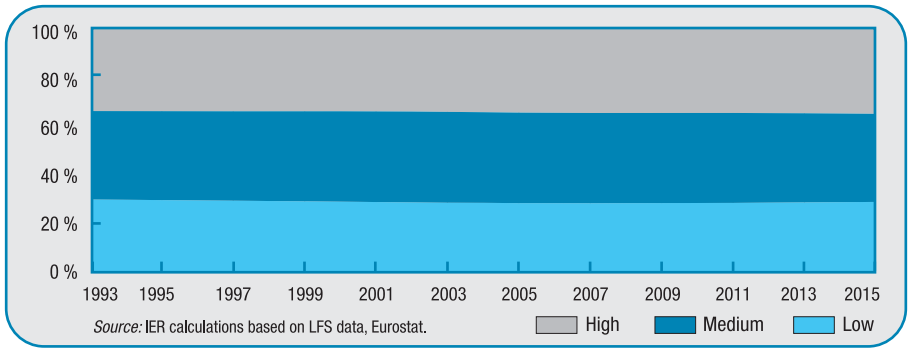
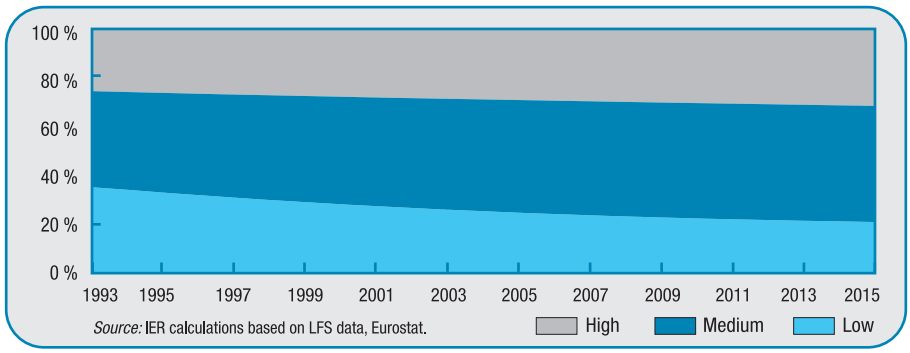


Figure 4.25. **Qualification share, all industries and occupations, 1993-2015, UK**



The qualifications vary significantly across the different occupational groups. Figures 4.26 to 4.30 examine the case of Greece for corporate managers, physical, mathematical and engineering science professionals, physical and engineering science associate professionals, office clerks, and sales and services elementary occupations respectively, for all industries. The proportion of highly qualified workers is greater for highly skilled occupations, such as corporate managers, physical, mathematical and engineering science professionals. Within low-skilled groups such as office clerks, sales and services elementary occupations, medium and low levels of qualification are dominant.

Figure 4.26. **Qualification share, corporate managers, all industries, 1993-2015, Greece**

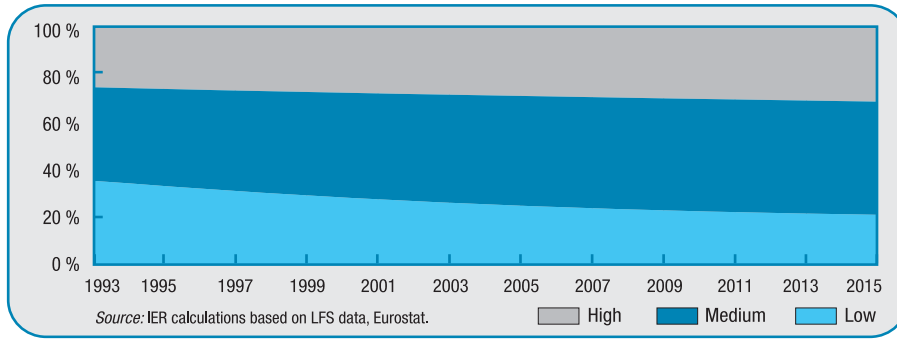


Figure 4.27. **Qualification share, physical, mathematical and engineering sciences professionals, all industries, 1993-2015, Greece**

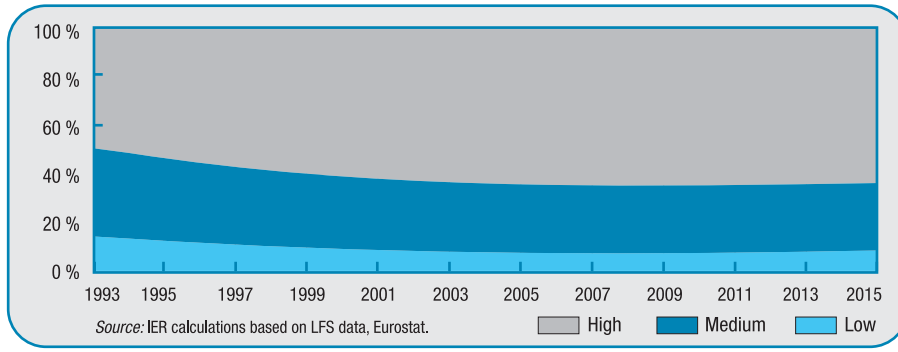


Figure 4.28. **Qualification share, physical and engineering sciences associate professionals, all industries, 1993-2015, Greece**

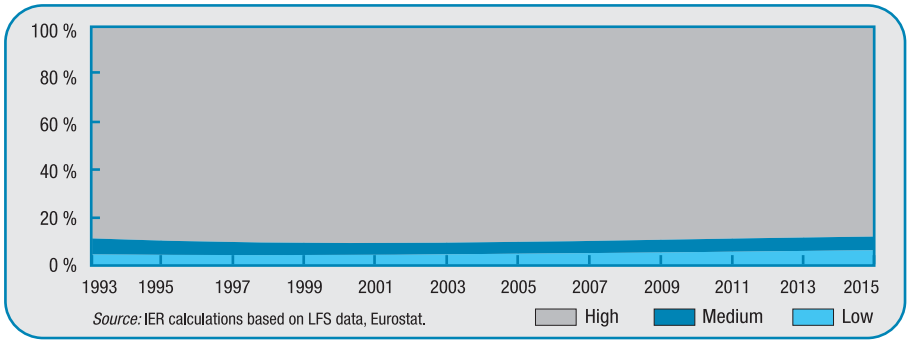


Figure 4.29. **Qualification share, office clerks, all industries, 1993-2015, Greece**

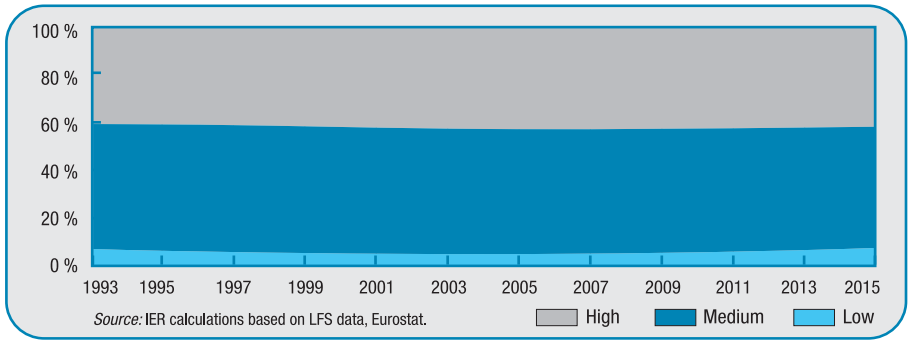
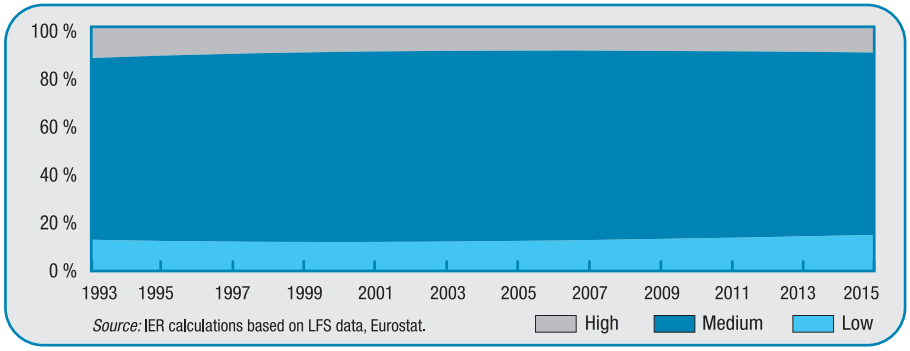


Figure 4.30. **Qualification share, sales and services elementary occupations, all industries, 1993-2015, Greece**



4.7. Comparing methods for projecting shares

This section considers the sensitivity of the final projections to alternative methods of forecasting occupational shares as described in Section 4.5. The main focus is on how the results of the multinomial method compare with the results of the logistic function or with the simple extrapolation ones. In particular, this section examines the case of Greece for illustrative purposes.

For example, Figures 4.31 and 4.32 present the occupational shares for the construction industry based on the mlogit and the logistic function respectively. The results from the two methods are broadly similar. Over the period 1993-2005 (Figure 4.31) the mlogit results offer a smoother picture of occupational shares because the figures reported consist of the fitted values of occupational shares, rather than the actual values of Figure 4.32. Nevertheless, the fitted and the actual values are broadly similar.

Figures 4.33 and 4.34 present similar results for the retailing industry. Again the results of the two methods are broadly similar. Nevertheless, the size of the differences between the two methods used to acquire the occupational and qualifications shares might vary across countries and industries. However, both methods paint a similar picture about what the future might look like. Finally, Figures 4.35 and 4.36 present similar results for the distribution industry. Again, the two approaches adopted produced similar results for trends.

Table 4.7 presents results of the predicted levels of occupational employment for all industries in Greece. The forecast occupational levels are not identical but are similar. For example, for trades workers employment for 2015 is forecast to be 1 050 824 based on the logistic function, and 1 088 328 based on the mlogit. Similarly, for service workers for 2015 the forecast levels are 719 500 based on the logistic function and 705 500 based on the mlogit.

However, there are significant variations across the occupational groups and years, especially at most detailed level, and in some instances the differences are quite large. For instance, the difference for associate professionals is substantial for 2015: 459 000 and 366 000 in the two methods respectively.

Table 4.8 presents further results for Greece, based on the simple extrapolation technique (linear extrapolation of the shares between two extreme end points in the historical data). Again, the results show many differences across occupational groups and years.

Table 4.9 presents the forecast occupational shares at two-digit level based on three of the methods used for obtaining occupational shares, namely the logistic, the mlogit, and simple extrapolation. Figure 4.37 presents the shares

acquired by the different methods at two-digit occupational level; while some differences exist, all methods yield broadly similar results. Figures 4.38 to 4.45 present similar shares for each of the 27 occupations in total employment. In most cases they are similar although there are exceptions such as other associate professionals, where the logistic stands out. This method can sometimes generate rather odd results, although checks have been built into the workbooks to avoid the more extreme cases and replace these by alternatives.

If comparisons are made focusing on changes over time, some of the differences get much larger. Figure 4.46 presents the projected occupational change between 2006 and 2015, for one-digit occupations, based on the mlogit and the logistic regression technique. The two different techniques suggest different patterns, (i.e. managers, professionals and elementary occupations).

Figure 4.31. **Occupational structure, constructions, mlogit, 1993-2015, Greece**

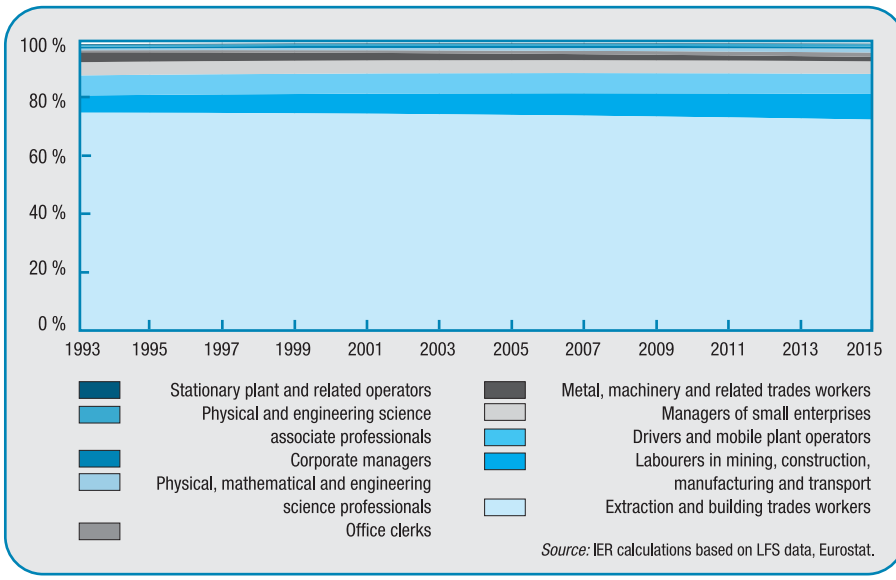


Figure 4.32. **Occupational structure, constructions, logistic function, 1993-2015, Greece**

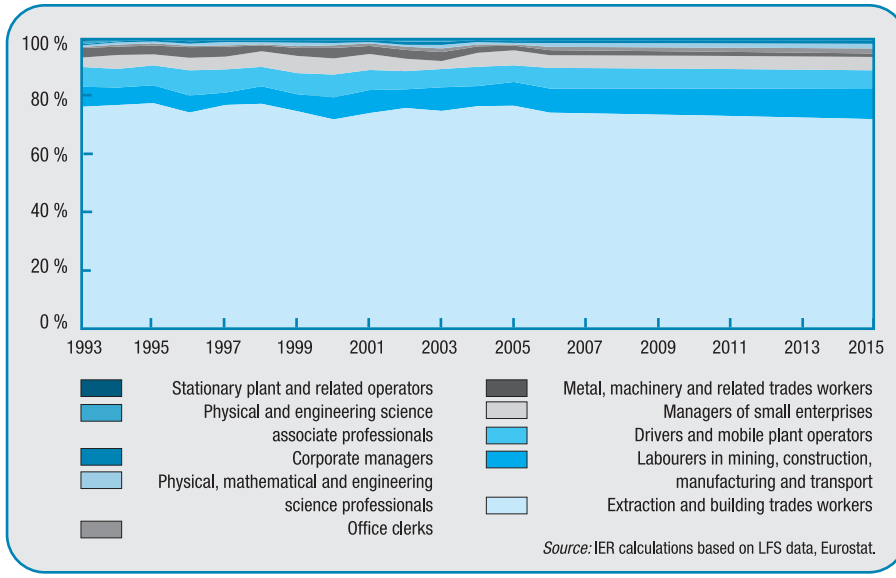


Figure 4.33. **Occupational structure, constructions, retailing, 1993-2015, Greece**

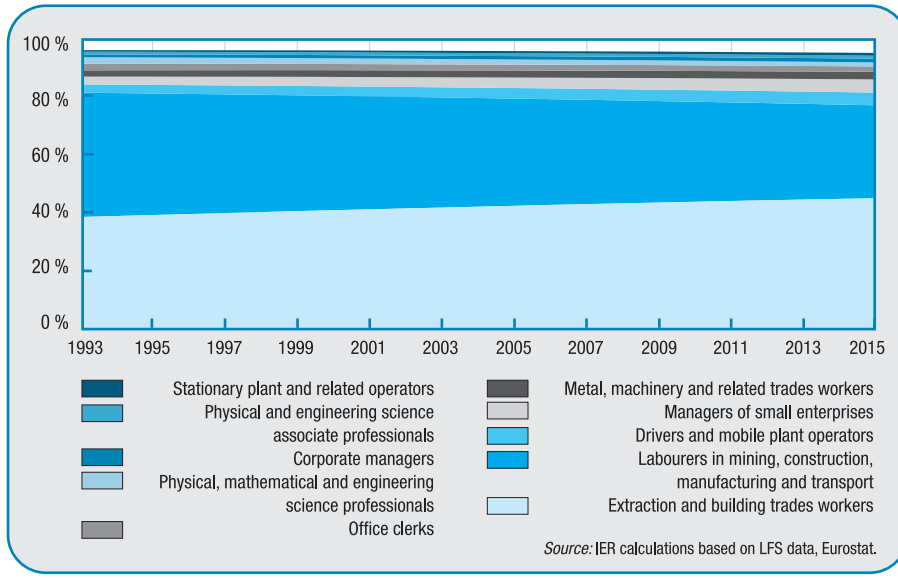


Figure 4.34. **Occupational structure, constructions, retailing logistic function, 1993-2015, Greece**

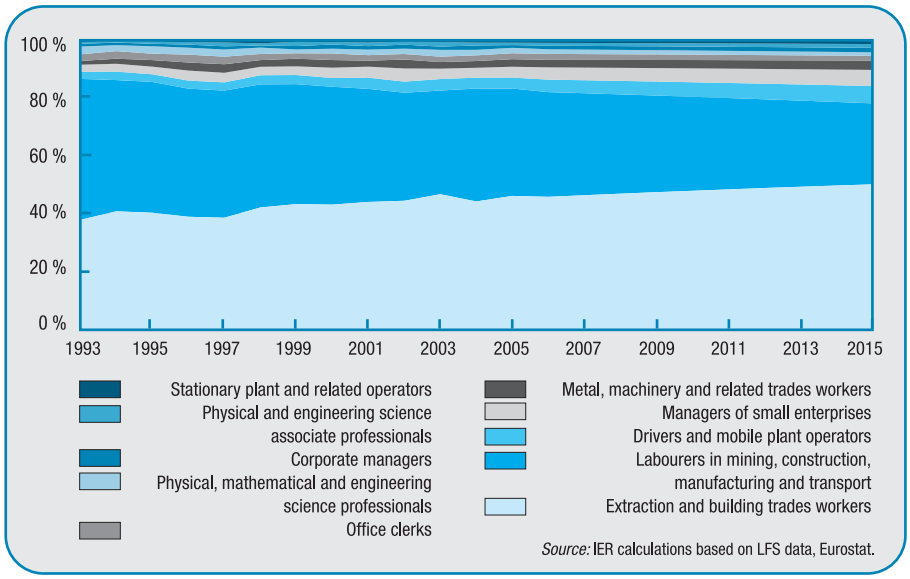


Figure 4.35. **Occupational structure, constructions, distribution, mlogit, 1993-2015, Greece**

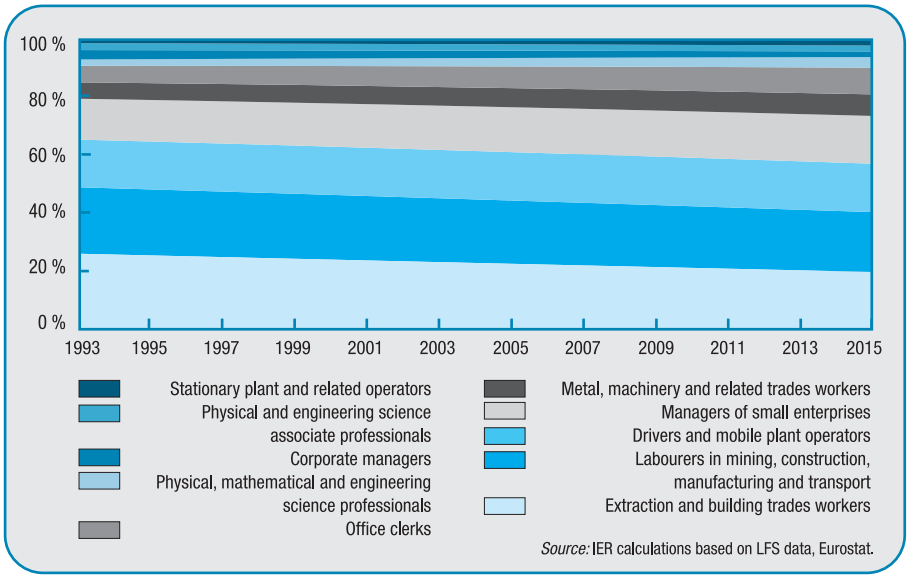
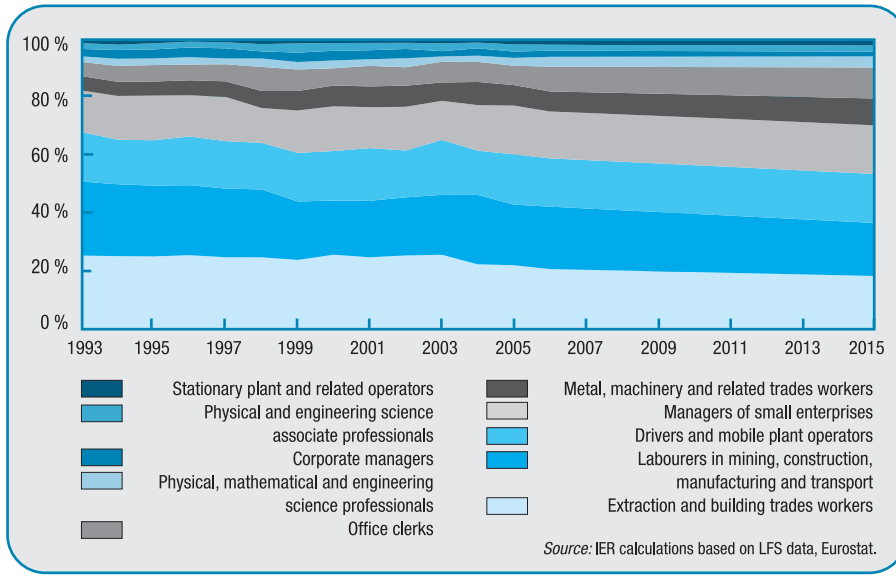


Figure 4.36. **Occupational structure, constructions, distribution, logistic, 1993-2015, Greece**



Source: IER calculations based on LFS data, Eurostat.

Table 4.7. **Occupational structure, all industries, logistic and mlogit, 2006, 2010, 2015, Greece**

Occupations	2006		2010		2015	
	Logistic	Mlogit	Logistic	Mlogit	Logistic	Mlogit
Armed forces	43 237	0	45 470	0	46 641	0
Legislators and senior officials	1 616	2 762	1 068	2 883	1 024	3 032
Corporate managers	62 280	60 509	71 648	67 670	82 354	74 291
Managers of small enterprises	366 214	367 276	345 219	390 875	332 595	403 910
Managers	430 111	430 547	417 935	461 428	415 973	481 233
Physical, mathematical and eng. professionals	47 686	74 095	51 905	69 970	64 399	66 594
Life science and health professionals	81 831	82 374	74 820	86 321	60 125	90 111
Teaching professionals	230 088	232 707	243 488	240 974	252 283	250 412
Other professionals	114 994	147 715	146 902	138 958	139 588	125 546
Professionals	474 600	536 890	517 115	536 224	516 395	532 664
Physical and engineering science associates	85 963	84 256	88 844	90 054	93 769	93 057
Life science and health associate professionals	64 340	59 586	64 916	67 052	56 057	76 995
Teaching associate professionals	11 214	11 163	11 540	12 414	12 461	14 281
Other associate professionals	151 719	159 318	229 419	171 714	297 096	182 113
Associate professionals	313 236	314 323	394 719	341 234	459 383	366 446
Office clerks	333 197	374 926	362 796	375 146	345 863	364 806
Customer services clerks	121 442	112 191	123 572	129 896	138 332	148 558
Clerks	454 638	487 117	486 369	505 042	484 195	513 363
Personal and protective services workers	338 459	326 227	367 080	377 417	386 919	427 043
Models, salespersons and demonstrators	255 071	247 652	283 499	267 850	317 601	292 408
Service workers	593 530	573 879	650 579	645 267	704 520	719 451
Skilled agricultural and fishery workers	528 680	530 876	489 015	486 517	438 312	437 035
Extraction and building trades workers	318 153	321 393	332 450	338 877	329 779	341 451
Metal, machinery and related trades workers	154 130	170 494	173 462	167 352	160 639	159 094
Precision, handicraft; craft, etc.	27 523	28 678	22 999	28 123	19 855	26 082
Other craft and related trades workers	134 262	139 914	118 902	132 888	102 239	124 665
Trades workers	1 162 749	1 191 356	1 136 829	1 153 757	1 050 824	1 088 328
Stationary plant and related operators	21 583	22 447	37 471	23 449	96 366	24 677
Machine operators and assemblers	92 950	88 923	104 137	94 790	110 873	98 431
Drivers and mobile plant operators	236 476	235 719	247 026	246 274	262 550	261 663
Machinery and plant operators	351 009	347 088	388 633	364 513	469 788	384 771
Sales and services elementary occupations	283 875	227 839	260 340	281 008	289 722	342 733
Agricultural, fishery and related labourers	18 917	17 087	19 077	17 902	22 327	19 204
Labourers in mining, etc.	76 898	76 674	68 534	79 226	69 130	80 707
Elementary occupations	379 690	321 600	347 951	378 135	381 179	442 644
Grand total	**4 202 800**	**4 202 801**	**4 385 600**	**4 385 600**	**4 528 900**	**4 528 900**

Table 4.8. **Occupational structure, all industries, simple extrapolation, 2006, 2010, 2015, Greece**

	2006	2010	2015
Armed forces	43 237	43 729	44 056
Legislators and senior officials	1 616	1 623	1 623
Corporate managers	62 280	73 439	85 138
Managers of small enterprises	366 214	380 663	382 240
Physical, mathematical and engineering science	47 686	55 931	63 895
Life science and health professionals	81 831	84 445	86 709
Teaching professionals	230 088	237 626	247 801
Other professionals	114 994	105 448	107 548
Physical and engineering science associate professionals	85 963	94 865	101 903
Life science and health associate professionals	64 340	74 588	87 530
Teaching associate professionals	11 214	13 179	15 704
Other associate professionals	151 719	174 377	199 716
Office clerks	333 197	325 388	314 378
Customer services clerks	121 442	141 356	162 069
Personal and protective services workers	338 459	382 953	413 293
Models, salespersons and demonstrators	255 071	280 354	311 860
Skilled agricultural and fishery workers	528 680	484 054	434 289
Extraction and building trades workers	318 153	334 257	336 437
Metal, machinery and related trades workers	154 130	149 082	139 781
Precision, handicraft, craft workers, etc.	27 523	26 543	24 004
Other craft and related trades workers	134 262	120 086	103 704
Stationary plant and related operators	21 583	21 887	22 272
Machine operators and assemblers	92 950	102 652	111 378
Drivers and mobile plant operators	236 476	248 166	266 172
Sales and services elementary occupations	283 875	329 548	364 060
Agricultural, fishery and related labourers	18 917	20 158	21 300
Labourers in mining, construction, etc.	76 898	79 202	80 040
Grand total	**4 202 800**	**4 385 600**	**4 528 900**

Table 4.9. **Occupational share, all industries, 2015, Greece**

Occupations	Logistic	MIogit	Simple extrapolation
Armed forces	0.01	0.00	0.01
Legislators and senior officials	0.00	0.00	0.00
Corporate managers	0.02	0.02	0.02
Managers of small enterprises	0.07	0.09	0.08
Managers	0.09	0.11	0.11
Physical, mathematical and eng. professionals	0.01	0.01	0.01
Life science and health professionals	0.01	0.02	0.02
Teaching professionals	0.06	0.06	0.05
Other professionals	0.03	0.03	0.02
Professionals	0.11	0.12	0.11
Physical and engineering science associate professionals	0.02	0.02	0.02
Life science and health associate professionals	0.01	0.02	0.02
Teaching associate professionals	0.00	0.00	0.00
Other associate professionals	0.07	0.04	0.04
Associate professionals	0.10	0.08	0.09
Office clerks	0.08	0.08	0.07
Customer services clerks	0.03	0.03	0.04
Clerks	0.11	0.11	0.11
Personal and protective services workers	0.09	0.09	0.09
Models, salespersons and demonstrators	0.07	0.06	0.07
Service workers	0.16	0.16	0.16
Skilled agricultural and fishery workers	0.10	0.10	0.10
Extraction and building trades workers	0.07	0.08	0.07
Metal, machinery and related trades workers	0.04	0.04	0.03
Precision; handicraft; craft, etc.	0.00	0.01	0.01
Other craft and related trades workers	0.02	0.03	0.02
Trades workers	0.13	0.14	0.13
Stationary plant and related operators	0.02	0.01	0.00
Machine operators and assemblers	0.02	0.02	0.02
Drivers and mobile plant operators	0.06	0.06	0.06
Machinery and plant operators	0.10	0.08	0.09
Sales and services elementary occupations	0.06	0.08	0.08
Agricultural, fishery and related labourers	0.00	0.00	0.00
Labourers in mining, etc.	0.02	0.02	0.02
Elementary occupations	0.08	0.10	0.10
Grand total	**1.00**	**1.00**	**1.00**

Figure 4.37. **Projected occupational share using different methods, 2015, Greece**

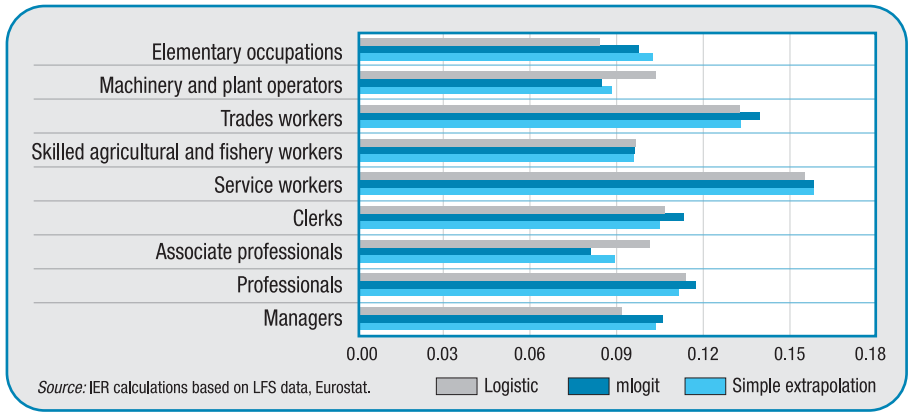


Figure 4.38. **Projected occupational share using different methods, managers, 2015, Greece**

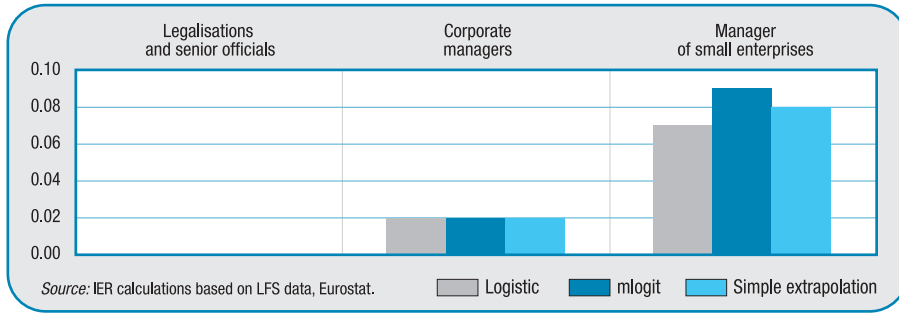


Figure 4.39. **Projected occupational share using different methods, professionals, 2015, Greece**

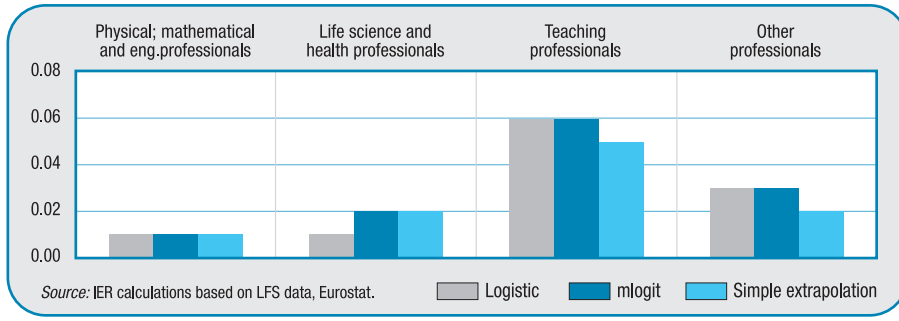


Figure 4.40. **Projected occupational share using different methods, associates professionals, 2015, Greece**

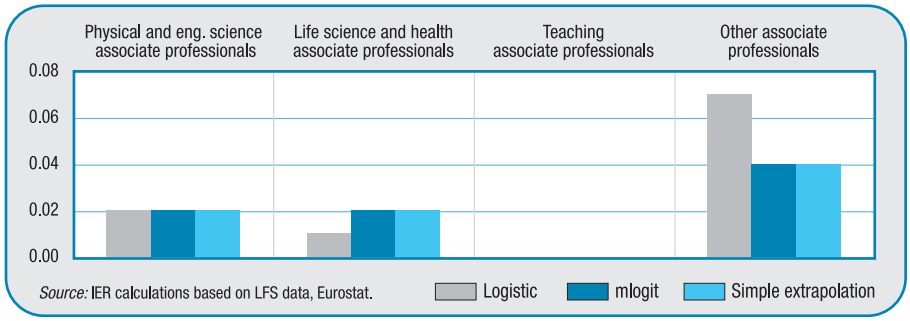


Figure 4.41. **Projected occupational share using different methods, clerks, 2015, Greece**

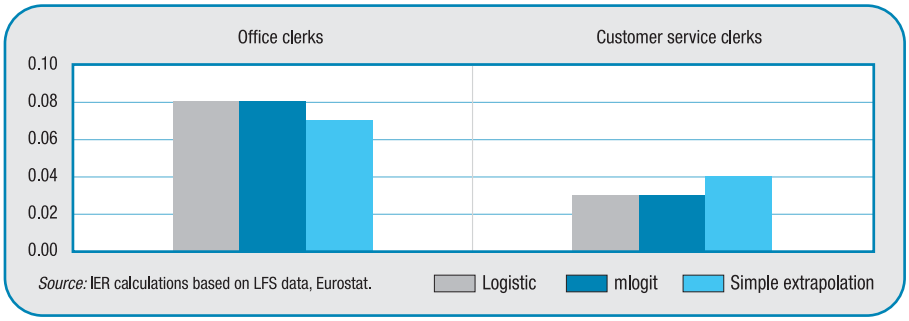


Figure 4.42. **Projected occupational share using different methods, service workers, 2015, Greece**

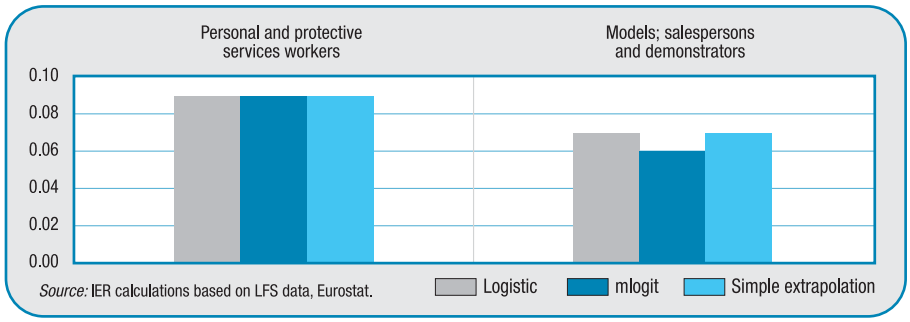


Figure 4.43. **Projected occupational share using different methods, trade workers, 2015, Greece**

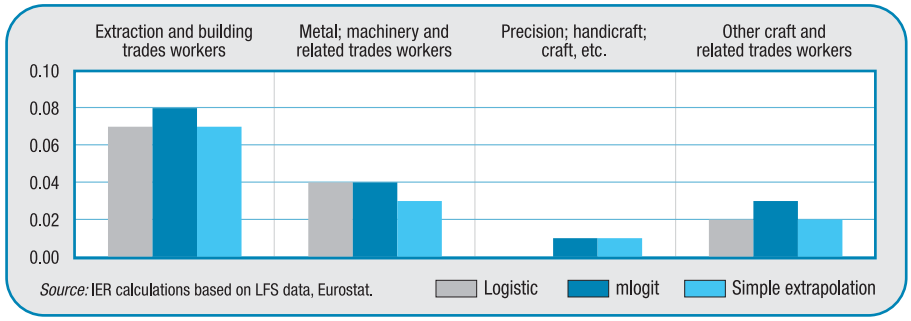


Figure 4.44. **Projected occupational share using different methods, machinery and plant operators, 2015, Greece**

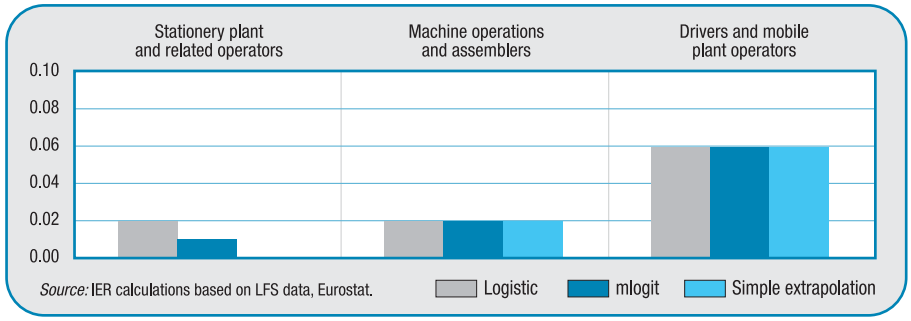


Figure 4.45. **Projected occupational share using different methods, elementary occupations, 2015, Greece**

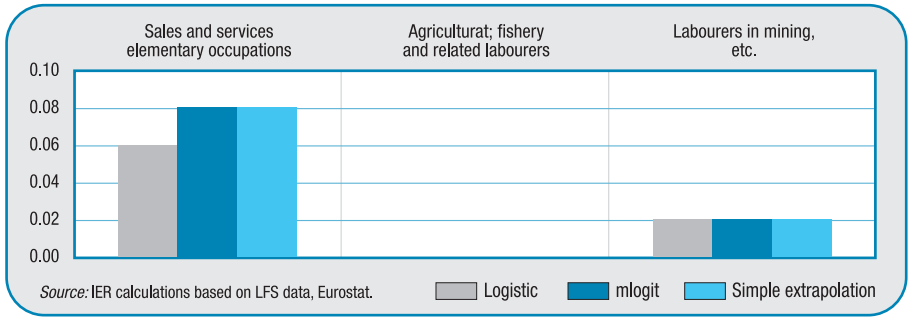
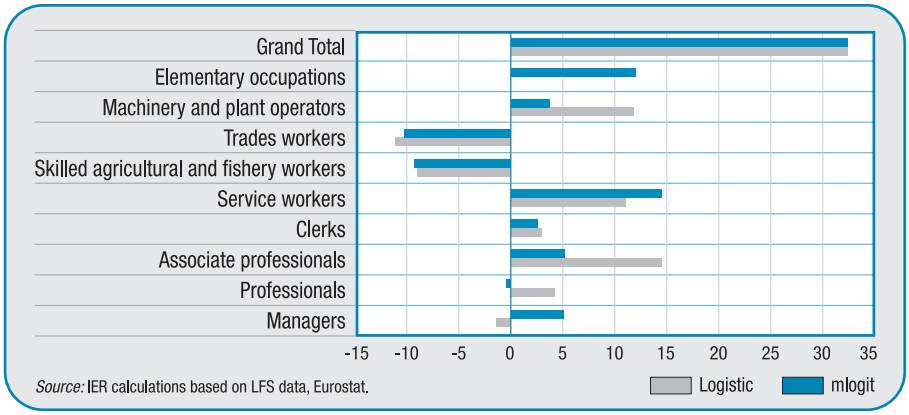


Figure 4.46. **Occupational change 2006-15, mlogit versus logistic, Greece ('000)**



Source: IER calculations based on LFS data, Eurostat.

4.8. Concluding remarks

Data available for a pan-European analysis of changing employment structure by occupation and qualification have improved significantly over the past few years, with harmonised statistics from the LFS. However, there is still some way to go before these data become robust and harmonised enough to develop sophisticated economic models. Short time series and lack of consistency combine to make anything other than simple methods of modelling impractical at the kind of detailed level attempted here.

Using simple methods and some judgement, it is possible to develop some reasonably robust results, but there are still many problems to resolve with the data for individual countries which need further input from country experts and the relevant statistical authorities.

Broadly, the main trends in occupational and qualification patterns are reasonably clear. Delving down into greater detail, the quality of the data often obscures any patterns: much of this is probably statistical 'noise' which tends to cancel out as data are aggregated. This is of less comfort if one is interested in the detail, both in terms of understanding structural changes in economy (the industry dimension) and changes in the way work is carried out (the occupational dimension and the demand for skills). Although there may be scope for improving the sophistication of the modelling work if industries and occupations were aggregated together, this would be at the expense of this desired emphasis on detail.

Until the quality and length of the time series available have both been increased, the potential benefits of more sophisticated modelling work are probably limited. The main emphasis should be on improving the quality of the industry by occupation and qualification employment estimates that underlie this work. There is probably considerable potential to do this on a country by country basis. While this would move away from the advantage of using a common data set, the benefits in terms of increased precision and statistical robustness would be considerable.

4.9. Algorithm for choice of specification

The projection of the occupation and the qualification shares is based on the years selected on the 'Manager' sheet.

There are four options on how the projection is done:

(a) regression: logistic;
(b) regression: linear;
(c) linear: first and last three years (simple extrapolation);
(d) linear: first and last years only (simple extrapolation).

'Regression: logistic' is the default.

The first LFS year available for each country is 1993 except:

02. CZ	1997	15. HU	1996	22. CH	1996
05. EE	1997	16. MT	2000	23. SI	1996
11. CY	1999	18. NO	1995	24. SK	1998
12. LV	1998	19. AT	1995	25. FI	1995
13. LT	1998	20. PL	1997	26. SE	1995

The last LFS year available for each country is 2006 except:

14. LU	2005	22. CH	2005	

The projection is done using the first and last LFS years except in these cases:

Country	Start year	End year	
DE	1995		
FR	1995		
IE	1999		
IT		2003	2003 Occupations discontinuity
CH	2001		
SE	2002		
the UK	2001	2005	2001 SOC discontinuity 2005 Qualification problem

Regression: logistic option selected
Regression: logistic is used:
- if the highest year-to-year growth rate in the years from the last projection year to the last year, 2020, is positive and less than +15 %;
- if the highest year-to-year growth rate in the years from the last projection year to the last year, 2020, is negative and more than -15 % or the 'regression: linear' result is negative;

Regression: linear option selected
Regression: linear is used:
- if the growth rate in is between -20 % and +20 %;
  otherwise
- the average LFS share of the extrapolation years.

Discontinuity
Whatever extrapolation method is used there will be a discontinuity between the last available LFS share and the first forecast share. This is greater if the last LFS year was not included in the extrapolation because of a change in the occupation classification in the last few years, for example in Italy.

If the option is selected on EuLfsData.xls workbook, sheet 'manager', the forecast is scaled to match the last LFS year.

A ratio of the share in the last LFS year and the forecast for that year is used to scale all the forecast years, i.e. multiplicative.

Italy
In Italy the LFS share for occupation '13 managers of small enterprises' in all industries was zero from 2000 to 2003. This caused the forecast to be more negative than appropriate. A fix was applied that the share in 1999 was used for the missing years.

Gap in LFS data
In four countries (Germany, Ireland, Luxembourg and the UK) there was no qualification in 1998. A fix was applied to the LFS data at an early stage, the level was set to the average of 1997 and 1999.

CHAPTER 5

Replacement demand module

Ben Kriechel and Frank Cörvers
ROA, Maastricht University

5.1. Introduction

This chapter gives an overview of the methodology used in the replacement demand module (Section 5.2) presenting the data gaps and limitations relevant for the modelling (Section 5.3). It explains the cohort component method (Section 5.4), addresses some critical points and practical challenges (Section 5.5), and presents and discusses results on replacement demand by country (Section 5.6).

5.2. General approach

In addition to analysing changes in overall occupational employment levels, replacement demand arising from retirements, net migration, movement into other occupations and in-service mortality should be considered. This is referred to as replacement demand.

Replacement demand focuses on job openings arising because people leave the workforce, for whatever reason. Most previous work has tended to focus on what might be called 'permanent or semi-permanent' withdrawals from the employed workforce. These include:

(a) mortality;
(b) retirement (and other reasons for leaving the workforce, including family formation);
(c) emigration;
(d) interoccupational mobility.

Information on the age and gender structure is usually required to estimate such demands because many of the flows, especially retirements and mortality, are age and gender specific. Age structures also vary significantly by occupation. Differences in age structure across occupations will clearly influence exits, with more older people retiring, but more younger people changing occupations. Age structure also affects mortality.

From the LFS, it is possible to analyse the demographic composition of each occupation. This makes it possible to estimate specific rates of retirement and mortality for each occupational class. LFS data can also be used for making estimates of outflow. However, there are problems in obtaining robust data since samples are often small and sampling errors large, even for broad age categories.

Replacement demand for a particular category (e.g. an occupation) depend essentially on:

(a) the size of the category;
(b) the rate of outflow (which can be separated out to distinguish the various elements as described above).

Replacement demand is simply the product of (a) and (b). Replacement demand calculated with the cohort-component method, namely observed through year-to-year changes, is always net replacement demand. Here, the replacement demand percentages are based on such net flows, rather than gross flows.

Geographical mobility/migration is an important aspect of potential outflows in an EU context, with migration flows across national boundaries becoming an increasingly significant issue. However, obtaining robust estimates of these flows is not straightforward, since the available data are rarely adequate. In much previous work researchers have simply suggested that in particular circumstances such outflows might be significant, even though they may not have been able to measure them robustly. This will be discussed in Section 5.5.3 on migration.

5.3. Data

Three data sources are needed for the forecast. First, information on the number of workers within occupations, the age structure of the working population as a whole and within an occupation, and the flows in and out of occupations across time are used. All of these are taken from the LFS from Eurostat. Second, information on the population dynamics within a country is needed. The population forecasts are taken from Eurostat (for the Member States), or from national statistics offices (for others). Third, the participation rate and expected changes are taken from the E3ME, which in turn rely on input from the country experts.

5.3.1. Labour force survey

Estimating replacement demand relies heavily on the microdata of the LFS (Eurostat, 2005). Given the set-up and the goal of the project, the replacement demand methodology should be consistent across all countries, i.e. using the same data available to most of the countries.

The microdata of the LFS, available in March 2007, contained data up until 2004, and did not include Malta, the UK and Switzerland. An update of the data contained full data on the UK, and extended the data period to 2005 for the other countries. Missing microdata for Malta and Switzerland means that only simplified replacement demand was calculated for these two countries.

The LFS provides counts of workers within the two-digit ISCO occupational indicator by a two-digit educational ISCED indicator. The data from 1998 available for two-digit ISCED were translated into the three levels: low, intermediate, high. Low includes all ISCED levels up until 29, intermediate ranges from 30 to 49, and high are all degrees indicated by 50 to 69. These counts are used by the five-year age cohort, and separately for gender.

Whenever possible, the indicator Mainstat (main status of all people aged 15 and more) was used to indicate that a person is indeed actively participating in the labour force. However, in several instances this labour-market participation variable was unavailable.

5.3.2. Population forecasts

The population forecasts used to provide estimates of the population size and composition are from Eurostat. They provide a consistent estimate of the population changes for all Member States. They should include all changes in the population due to birth, deaths and migration.

For Norway forecasts from the national statistics office are used to fill in the missing forecasts from Eurostat. In all cases the base or middle scenario of population development is chosen.

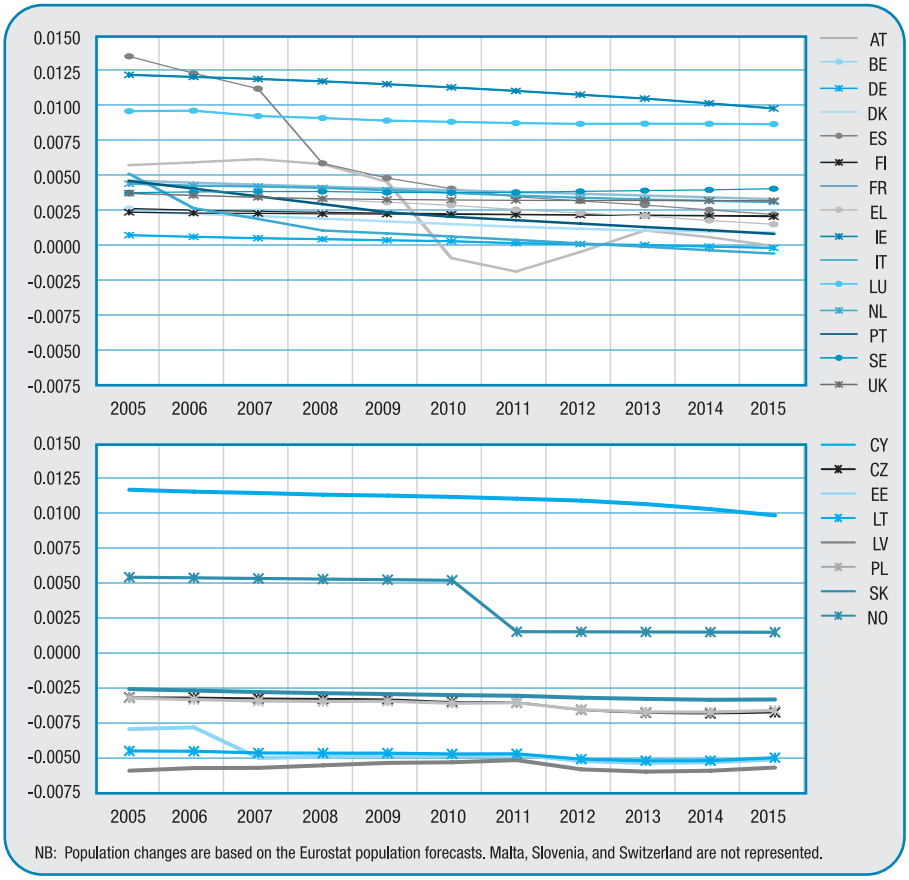
In principle, forecasts include migration to and from a country. However, given that the population forecasts seem to be conservative in the expected flows, especially out of new Member States of which, economically speaking, a bigger outflow of workers is expected, separate data on net migration flows were also included. This separate figure can be used in addition to the general replacement demand, and users are able to change the net migration in country workbooks.

Figure 5.1 gives the population as a total across all age and gender groups. Several countries have positive population growth, which is partially driven by immigration (such as Spain and Austria in the upper panel during the first years).

The lower panel of Figure 5.1 shows that all accession countries in Central and Eastern Europe are expected to have a slight population decrease across all groups. This is due to a low birth rate, but also to the expected net migration. This element is included in the modelling and the estimation of replacement demand where the population size on age-gender cohort is adjusted for these predictions over time.

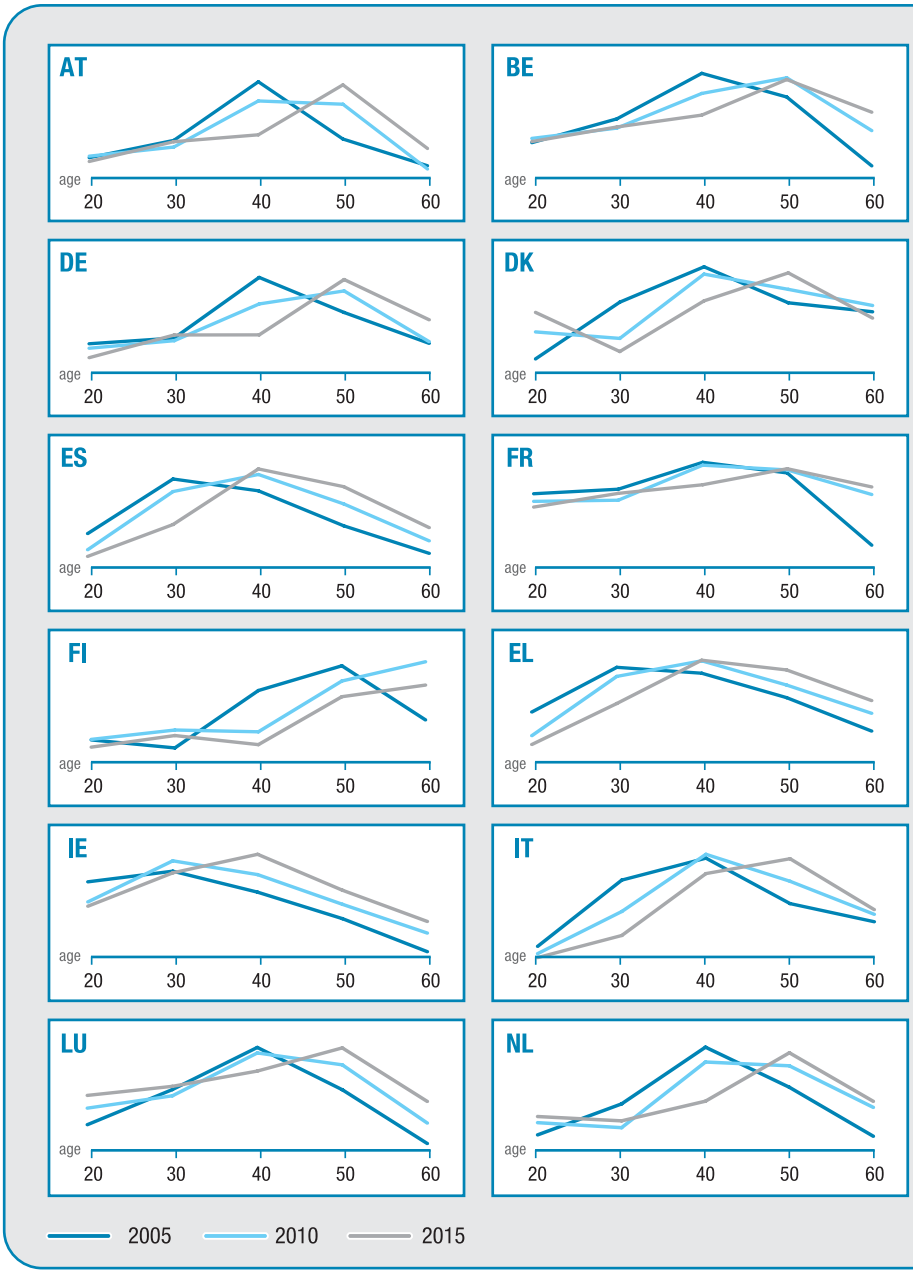
More important for this aspect is the change in age distribution of the population. In many countries, a shift towards the older age cohorts can be observed (Figure 5.2).

Figure 5.1. **Annual predicted changes in the population 2005-15**

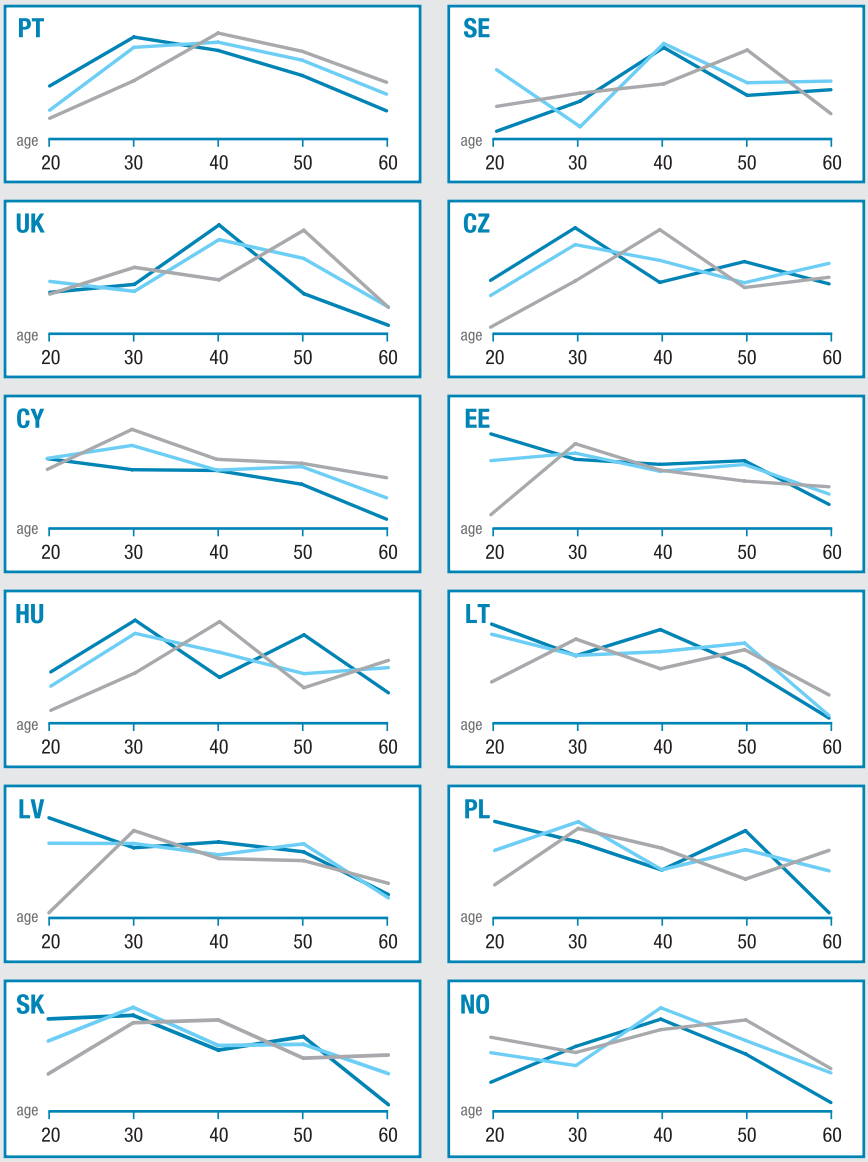


NB: Population changes are based on the Eurostat population forecasts.
Malta, Slovenia, and Switzerland are not represented.

Figure 5.2. **Population forecast by age group for 2005, 2010, 2015**



NB: Based on Eurostat population forecasts. Malta, Slovenia and Switzerland are not represented.



NB: Based on Eurostat population forecasts. Malta, Slovenia and Switzerland are not represented.

Most countries illustrate the shift of the post World War II generation moving towards retirement age. These are the driving forces of the replacement demand and it is not surprising to find high replacement demand in those countries. Immigration can keep this process at bay for some time (Spain or the UK). Some of the new Member States show different patterns in demographic forecasts. The influence of migration can be seen especially in countries such as Lithuania, Hungary or Poland.

5.3.3. Participation

Participation by age groups is important for replacement demand. In most studies participation of the male and female population aged 15 to 64 is considered. Although there are plans to extend the normal working age beyond the currently normal age of retirement (65), these changes will only gradually affect participation, as the average retirement age is in all countries several years before the institutionalised age.

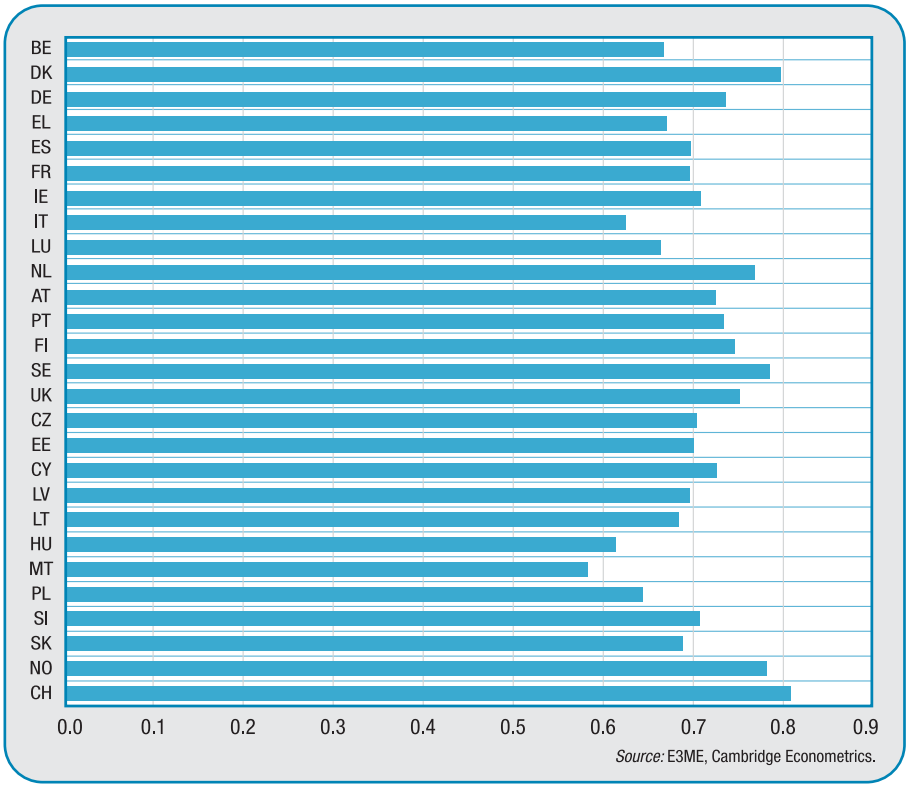
Changes in participation rates directly affect replacement demand, reducing replacement demand with increasing participation. This is especially relevant among the age groups that are at the core of the non-occupation replacement demand: middle-aged women and the age category above 50 of both sexes, who are not participating due to early retirement.

As participation in age groups changes, their net outflow can be significantly affected. For example, a predicted 10 % outflow of 35 to 45 year old workers in a specific occupation, could be (partially) compensated by an increase in the participation rate of that age group.

The increased participation of women across all age groups, and the higher participation of older workers as postulated in the Lisbon agenda, can be expected to have some influence on these groups.

Figure 5.3 provides the participation rates for the final year of the available data, showing significant differences across the countries. These differences can have several causes. First, participation rates differ among age groups; older worker tend to participate less than younger and medium-aged workers. Thus, countries with higher levels of older workers tend to have lower participation rates. Second, participation rates of women tend to differ more across countries than the participation rates of men, hence, these differences are also reflected in the country totals.

Figure 5.3. **Participation rates across countries**



Source: E3ME, Cambridge Econometrics.

Table 5.1. **Data availability**

Country	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
1 **AT**	–	–	–	–	–	–	–	–	–	–
2 **BE**	Q2	Q2	Q2	Q2	Q2	Q2	Q2	Q2	Q2	Q2
3 **CY**	–	–	–	–	–	–	–	–	–	–
4 **CZ**	–	–	–	–	–	–	–	–	–	–
5 **DK**	Q2	Q2	Q2	Q2	Q2	Q2	Q2	Q2	Q2	Q2
6 **ES**	–	Q2	Q2	Q2	Q2	Q2	Q2	Q2	Q2	Q2
7 **EE**	–	–	–	–	–	–	–	–	–	–
8 **FI**	–	–	–	–	–	–	–	–	–	–
9 **FR**	Q1	Q1	Q1	Q1	Q1	Q1	Q1	Q1	Q1	Q1
10 **DE**	–	–	–	–	–	–	–	–	–	–
11 **EL**	Q2	Q2	Q2	Q2	Q2	Q2	Q2	Q2	Q2	Q2
12 **HU**	–	–	–	–	–	–	–	–	–	–
13 **IE**	Q2	Q2	Q2	Q2	Q2	Q2	Q2	Q2	Q2	Q2
14 **IT**	Q2	Q2	Q2	Q2	Q2	Q2	Q2	Q2	Q2	Q2
15 **LV**	–	–	–	–	–	–	–	–	–	–
16 **LT**	–	–	–	–	–	–	–	–	–	–
17 **LU**	Q2	Q2	Q2	Q2	Q2	Q2	Q2	Q2	Q2	Q2
18 **NL**	Q2	–	Q2	Q2	Q2	Q2	Q2	Q2	Q2	Q2
19 **NO**	–	–	–	–	–	–	–	–	–	–
20 **PL**	–	–	–	–	–	–	–	–	–	–
21 **PT**		Q2	Q2	Q2	Q2	Q2	Q2	Q2	Q2	Q2
22 **SK**	–	–	–	–	–	–	–	–	–	–
23 **SW**	–	–	–	–	–	–	–	–	–	–
24 **SI**	–	–	–	–	–	–	–	–	–	–
25 **UK**	–	Y	Y	Y	Y	Y	Y	Y	Y	Y
26 **MT**	–	–	–	–	–	–	–	–	–	–
27 **CH**	–	–	–	–	–	–	–	–	–	–

NB: Q1, Q2, Q3, Q4= quarter of observation available; all= all four quarters observed,
Y= yearly data; – = no observation in that year.
Source: Availability of data in Eurostat microdata: LFS.

1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Q1	Q1	Q1	Q1	all	all	all	all	all	all	all
Q2	Q2	Q2	Q2	all	all	all	all	all	all	all
–	–	–	–	Q2	Q2	Q2	Q2	Q2	Q3	Q3
–	–	Q2	all	all	all	all	all	all	all	all
Q2	Q2	Q2	Q2	all	all	all	all	all	all	all
Q2	Q2	Q2	all	all	all	all	all	all	all	all
–	–	Q2		all	all	all	all	all	all	all
Q2	Q2	Q2	all	all	all	all	all	all	all	all
Q1	Q1	Q1	Q1	Q1	Q1	Q1	Q1	all	all	all
–	–	–	–	–	–	–	Q2	Q2	Q2	Q2
Q2	Q2	Q2	all	all	all	all	all	all	all	all
–	Q2	Q2	all	all	all	all	all	all	all	all
Q2	Q2	Q2	Q2	all	all	all	all	all	all	all
Q2	Q2	Q2	all	all	all	all	all	all	all	all
–	–	–	Q2,Q4	Q2,Q4	Q2,Q4	Q2,Q4	all	all	all	all
–	–	–	Q2,Q4	Q2,Q4	Q2,Q4	Q2,Q4	all	all	all	all
Q2	Q2	Q2	Q2	Q2	Q2	Q2	Q2	Q1,Q2	Q1,Q2	Q1,Q2
Q2	Q2	Q2	Q2	Q2	all	all	all	all	all	all
Q2	Q2	Q2	Q2	Q2	all	all	all	all	all	all
–	–	Q2	Q2	all	all	all	all	all	all	all
Q2	Q2	Q2	all	all	all	all	all	all	all	all
–	–	–	all	all	all	all	all	all	all	all
Q2	Q2	Q2	Q2	Q2	Q2	all	all	all	all	all
–	–	Q2	Q2	all	all	all	all	all	all	all
Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–

5.4. Methodology

The methodology follows the approach by ROA in its national forecasts (Cörvers et al., 2002; 2006), adapted for data availability. It is a model based on an adapted cohort-component model that allows use of the LFS for most Member States, while disaggregating:

(a) education into several ISCED categories for replacement demand of education;
(b) occupation into several ISCO categories for the replacement demand of occupation.

The estimates are partly driven by the occupational and qualification employment levels projected from Modules 2 and 3 of the project, in combination with information on the probability of flow out from employment due to retirements, mortality, migration and occupational mobility derived form the cohort component model.

5.4.1. Replacement demand components

There are three necessary inputs into the model:

(a) a forecast of demographic development within a country;
(b) a forecast of (changes in) participation, preferably by gender and age groups;
(c) an estimate of the outflow by occupation (education) category, gender and age group.

Components (a) and (b) are usually considered external to the model. The estimates rely on the baseline model of the Europop2004 forecast which is the most recent demographic forecast by Eurostat. Changes in participation use the same participation rate by country and gender as it is used in the E3ME of Cambridge Econometrics. This ensures consistency across the entire set of forecasts.

5.4.2. Estimated and projected flows

This section discusses the basic steps using occupation, subindex o, as the relevant subcategory. However, the methodology can be read analogously if education is used instead. During the project, given the high level of aggregation on the education variable, education is not estimated separately. Instead replacement demand by education is deduced from occupational replacement demand. By using occupational replacement demand and imposing the most recent distribution of education by occupation, it is possible to present the most likely replacement demand using the current

demand for education levels within an occupational class.

Figure 5.4 is a schematic input-output table of a labour force population in a country (see also Willems and de Grip, 1993). The first rectangle gives the movements within the labour market. The second, bigger, rectangle shows movements out of the labour market, while the third rectangle also considers changes in the population. Adding rows (for time *t*) or columns (for time *t-n*) of these flows gives the total population within an occupation.

Figure 5.4. **Schematic of replacement demand**

t / *t-n*	Occupation	Occupation 1	Unemployed *l*	Outside the labour force	Outflow population	Total
Occupation 1	A	B	C	D		$W_{1,t-n}$
Occupation *l*	E					$W_{l,t-n}$
Unemployed	F					
Outside the labour force	G					
Inflow population						
Total	$W_{1,t}$	$W_{l,t}$				

Source: Willems and de Grip (1993).

Several flows are indicated in the table with capital letters. A denotes the workers that work in occupation 1 at time *t-n* and continue to do so in period *t*. B denotes the workers that move from occupation 1 to occupation *l* in the observed time period; E denotes the opposite movement from *l* to 1. Thus, B and E denote the job-to-job mobility. C and D denote movement out of the labour market from holders of occupation 1. Corresponding inflows into occupation 1 are F and G in the schema.

Replacement demand is dependent on the expansion demand forecast, as the replacement demand is derived from the relative size of the different cells. If there is positive expansion demand, i.e. growing occupations, replacement demand is equal to the number of workers leaving that occupation over the relevant time period. Vacancies have to be filled before a rise in employment within the occupation can be achieved. Figure 5.4 would consider the sum of B, C, D as the relevant replacement demand.

If the occupation is declining, only the (remaining) inflow into the occupation will constitute the replacement demand. In terms of Figure 5.4 this implies the sum of flows E, F, G.

Modelling replacement demand requires several steps. First per occupation, and separately for each gender, the flows of an occupation are calculated over time. This is based on the cohort components methods, as cohort change rates are calculated based on the number of persons in the same age cohort at two different points in time.

$$F_o = \frac{W_{o,age,t} - W_{o,age-1,t-1}}{W_{o,age-1,t-1}} \tag{5.1}$$

Equation 5.1 gives the (net) flow of the worker in an age group. These equations are calculated for all occupational groups separately. *W* denotes the number of people working in a specific occupation *o*, of the specified age group *age* at time period *t* and *t–1*, respectively. To simplify the exposition, a gender index in this exposition is ignored; it is, however, included in the estimation itself. Negative flow percentages are net outflows for the age-gender cohort, while positive numbers are net inflows.

Within this project, the cohort-component method had to be slightly adapted, as not all countries have sufficiently long data-sets to compare to full age cohorts ([35]). To compensate, year to year changes were compared as proxy for the entire period. These changes were then rescaled to resemble the full period.

Second, the amount to which the vacancies have been filled relative to the outflow of workers, and sum up all changes of an occupation over age and gender classes, were determined. This denotes the total replacement demand, in this context historic, or structural replacement demand.

Third, a regression model is estimated, explaining the net inflow or outflow ratios by occupation specific and age specific effects. Deviations from the total gross flow of the entire labour force population are examined to ensure that the sum of flows corresponds:

$$\dot{F}_o = \dot{F} + \sum_{age} \beta_{ox} D_x \tag{5.2}$$

Where is the percentage flow (across all occupations, for particular gender, age and time), while is the occupation specific percentage. The coefficient β is the outflow coefficient estimated, while *D* is a dummy variable identifying the relevant occupation for the estimation.

([35]) Within this project the size of the cohort after the duration of 10 years was examined – which is the cohort size.

The outflow coefficient is then combined with changes in participation rates and applied to the population of workers within an age cohort. An increase in participation rates implies less replacement demand. As workers participate more, or mostly longer in terms of age, historical outflow coefficients are lower than future ones. For those countries that have provided changing participation rates, corrections were made before calculating replacement demand.

Finally, a projection is made based on the estimated coefficient combined with participation rate changes onto the age-sex structure of the occupation as it is predicted by demographic and participation forecasts. To model the demographic composition of an occupation and its dynamic changes, uniform changes of one age cohort in the next cohort over the total projected time-horizon are projected.

5.5. Challenges

Several challenges had to be addressed in the replacement demand module. Some have been mentioned in earlier sections, but it is useful to review them all together here.

5.5.1. Methodological challenges

Methodological challenges around the cohort-component approach commonly used in replacement demand are essentially twofold. One is that the methodology uses pseudo-panels to estimate net-flows, making assumptions of comparability across different cross-sections. The second shortcoming is that replacement demand is inherently dependent on the degree of aggregation.

The concern of the cohort-component was voiced by Fox and Comerford (2006), who focused on the shortcoming due to the measurement of net-flows. Especially in countries with high degrees of migration, or other disturbances to common flows on the labour market, the critique is certainly relevant and correct: the cohort-component method falls short in measuring the exact flows of people from occupation to other occupations or (temporarily) out of the labour market. Further, it is not well equipped to deal with issues that would need gross flows, nor it is able to establish directly changes in demand (such as in terms of educational upgrading) for the workers leaving their workplace. The reason for leaving is also not addressed in the cohort component method as there are actually two different samples of a cross-section compared, relying on the fact that the sample drawn should be a reliable indicator of the current situation on the labour market.

A good solution would be to use LFS based on panels, thus following the same worker for some time. In this case one can actually observe the change of occupation (or education), moves in or out of the labour market, and most likely also their reason. This would allow an estimate of the gross flows, and possibly building policy models, that take the reasons for job changes or job leaving into account. However, to estimate such replacement demand models, reliable panels of the labour force of comparable magnitude (in sample size) to the current LFS would be needed. Given that these panels do not exist, at least not for most European countries, the only possibility is to rely on the cohort component method, measuring net flows, with all its shortcomings.

Second, replacement demand is inherently dependent on the degree of aggregation chosen for the occupation class or education class. The more disaggregate, the more job-to-job movements are theoretically observed, i.e. the higher will be replacement demand. This can be understood if one considers one single occupation class: there will be no job-to-job movements, hence there will be no replacement demand created. If one distinguishes, however, several occupations, net flows to or from an occupation class will influence replacement demand.

5.5.2. Data challenges

Data challenges are several: the length of the historic data available for the European countries differs greatly. Longer time-series, in principle, increase the stability of estimates. However, a second challenge that usually occurs with longer time series is the structural breaks in the data, both in definition or identification, and also in the methodology of collecting or coding of the data. Finally, and always an important data issue in replacement demand estimation, is the reliability of the estimate. The estimates are based on sub-sets of occupational classes, which are divided into several age-gender cohorts. The cell size of the remaining actual sample can, in some countries and for smaller occupations, be rather low. This reduces the reliability of the estimate, such that in some cases a more aggregate measure is estimated to replace the disaggregated, but unreliable, estimate for such small cell sizes. There is a need to substitute with more aggregate outcomes, especially within smaller European countries.

Another approach to dealing with small cell size, but also short or qualitatively poor data-series, is to pool the estimate across all countries. The implied assumption is that occupation specific in- and outflows by age and gender are similar across countries. To be precise, countries can still differ in the timing of their (early) retirement age, but the deviation from this average age by occupation is assumed to be similar.

Within the LFS several aspects of the microdata have been altered to prohibit identifying respondents. To aggregate age into five year age-groups is relevant for replacement demand. This inhibits the efficient use of the cohort component method, even though the cohort-component method uses five year age groups to calculate changes of cohorts across time. It is thus not possible to compare directly two subsequent cohorts of the same age group. Rather, it is necessary to make use of year-to-year differences of the same age cohort to proxy the yearly flows.

5.5.3. Migration

Finally, the question of migration remains. While the demographic forecast should include all migration issues for a country, occupations can be affected differently by migration, both inward and outward. Often countries allow migration to a country for certain occupations with large vacancy rates, while they bar entrance for other immigrants. Besides, the growth in the open market and the gradual opening of the labour market will lead to different flows in different countries. The team contacted several researchers that have specialised databases on migration flows to compensate for such occupation (and education) differentiated migration. However, migration is not explicitly included but indicates the share of total replacement demand (per occupation or aggregates of occupations) caused by migration; retirement and other sources of replacement demand (as far as possible) are also provided. Therefore, a common methodology for all European countries is kept, so that the country results reflect as much as possible differences in outflow per occupation instead of ad hoc adjustments of the methodology.

Several studies addressed the issue of migration from the new Member States to EU-15. However, most studies concentrate estimates of future migration on the inflows into EU-15, while replacement demand is more interested in the net outflows from countries. Pytlikova (2007) summarises the outcome of several studies.

Migration, especially within the EU can have an important influence on occupational skill forecasting. One of the key elements of the EU is the freedom of movement which allows its citizens to work and live wherever their skill is most needed.

In the past, migration across Member States to live and work in another country of the EU was rather limited. Barriers to the free movement such as language, incompatibility of social security systems, and practical issues were sufficiently large while differences in skill shortages and pay were small enough not to warrant large scale movement out of some countries into others.

With the extension of the EU to central and eastern European countries, there are reasons to believe that the differences in pay across countries could be sufficient to overcome institutional and language barriers that remain within the EU. While many old Member States have limited inflow from the new Member States, there is significant emigration (Table 5.2).

Table 5.2. **Net migration by country 2000-05**

Net migration	% of total population	Net migration	% of total population	Net migration	% of total population
BE	1.55	**CY**	6.29	**SI**	0.80
CZ	0.21	**LV**	-0.61	**SK**	-0.30
DK	0.81	**LT**	-1.21	**FI**	0.50
DE	1.07	**LU**	2.80	**SE**	1.54
EE	0.00	**HU**	0.64	**UK**	1.39
EL	1.58	**MT**	4.50	**BG**	-2.74
ES	6.31	**NL**	0.85	**RO**	-2.68
FR	0.96	**AT**	2.39	**IS**	1.00
IE	4.46	**PL**	-1.23	**NO**	1.48
IT	2.77	**PT**	2.79	**CH**	2.58

Source: *Eurostat Yearbook 2006-07* (Eurostat, 2006b, Chapter 1).

Latvia, Lithuania, Poland, Slovakia, Bulgaria and Romania have in recent years seen significant outflow from their country. Over a five year period Eurostat reports outflows that range between 0.3 and 2.7 % of the total population.

While this is only 1/20th to 1/5th of the total replacement demand, it shows that many workers have already left their home country. In fact there are reasons to believe that official statistics underestimate the number of migrants from these countries, mainly due to the administrative underreporting from the migrants themselves.

The replacement demand module tries to estimate outflow figures including the migration flows. However given the recent increase in emigration in some countries and the underreporting of it, there are reasons to believe that for emigration countries the replacement demand underestimates the total replacement need due to migration.

The main groups of work-migrants are the higher educated and younger workers, sometimes within specific occupations, for whom migration is especially attractive. The five mentioned countries' outflow migration percentages, based on the total outflows from last five years as reported by Eurostat, are included within the country workbooks. These can be added to replacement demand.

However, the receiving countries will, with more inflow from migrants, have lower need for replacement demand, part of which is within the estimation of the net-outflow coefficients. Again, these coefficients are based on the LFS and the population forecasts, so their reliability and the stability depends on how much the past years are a good measure of future development. Given that this is more an issue of labour supply than demand, no additional factor for replacement demand is added in the country workbooks for the receiving countries.

5.6. Results

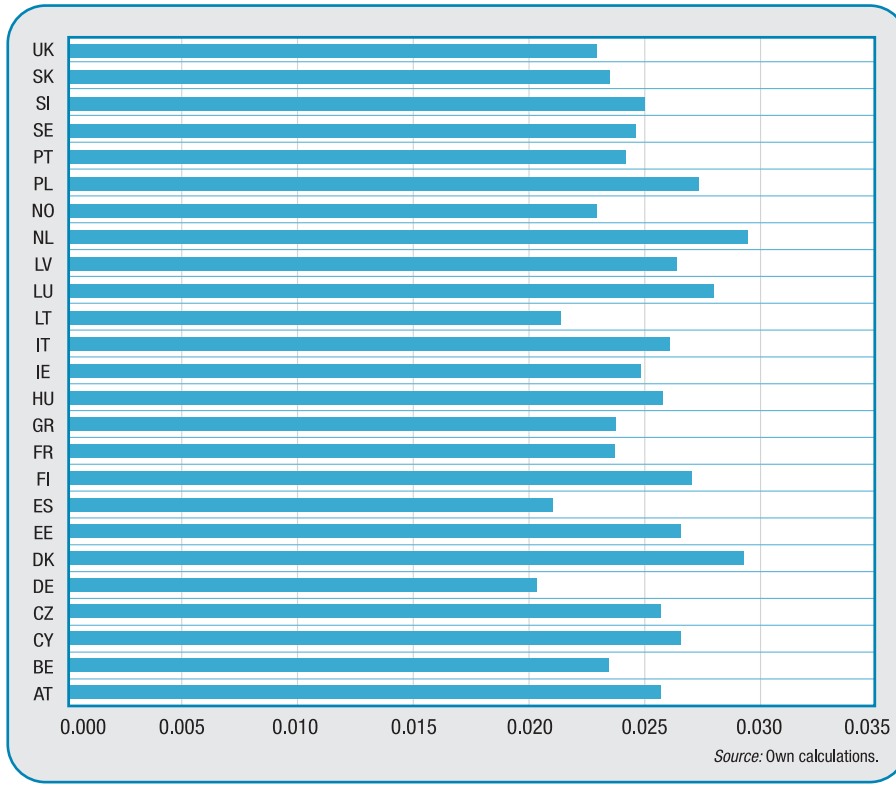
Detailed replacement demand rates by occupation (ISCO 2-digits) and education levels (low, intermediate, high) are given in the separate country workbooks. There, replacement demand is split into demand due to retirement, other replacement demand, and a separate figure for net emigration. Together these data form total replacement demand. The first two are estimated using the above mentioned model. Migration is added *ex ante* as described above.

Figure 5.5 depicts the total (annual) replacement demand, which is normally between 2 and 3 % per annum. Several countries are above 2.5 % per annum, notably the Netherlands, Denmark and Luxembourg.

For some countries the team had to rely on joint estimation of the flow coefficient to stabilise the results. This allows countries with data problems, short data series, or other reasons why the figures are unsatisfactory, to have reasonable replacement demand estimates. Joint estimation has been used for Germany, Lithuania, Hungary, and the Netherlands.

Though Spain seems well in the range of the average replacement demand countries, some data problems mean that only part of the LFS data set for Spain could be used. The more recent LFS figures for Spain were often not usable through missing data observations, making replacement demand more unstable than for other countries in this context.

Figure 5.5. **Total annual net replacement demand by country**



Source: Own calculations.

5.6.1. Occupations

Occupations are identified by ISCO two-digit level. However, not all countries use two-digit levels consistently for the historical time period and, in several cases, some occupations groups are not or rarely used. For example ISCO 92 'agricultural, fishery and related labourers' is small or missing in Belgium, Denmark, France, Finland and Sweden, probably because the national coding includes them in the highly skilled labourers in agriculture and fishery (ISCO 61). Many occupations are also not interpreted in the same ways across Europe, resulting in various occupational groups being much larger or smaller across countries.

Some higher or lower than the average results confirm the initial notion of what is driving replacement demand. For example, in most countries the occupation group 'legislators and senior officials' is used to include predominantly experienced workers, as they are in the older age groups.

Younger age cohorts are either entirely missing, or sparse. The resulting replacement demand is, therefore, higher than the national total. In some countries the annual replacement demand even exceeds 5 %. Cyprus and Sweden have only older age cohorts within this occupation.

5.6.2. **Country workbook**

The country workbook gives the detailed results by occupation (ISCO two-digit). Replacement demand is divided into three components: demand due to retirement, for other reasons, and due to net emigration. Further, the replacement demand by education levels (ISCED low, intermediate and high) are given for each country.

Replacement demand due to retirement is based on the size age group that will enter the assumed retirement age of 65 within the period of the forecast. This result is driven by the age structure of the older age cohorts.

Replacement demand for other reasons is the remainder of the estimated replacement demand net of the retirement group. It comprises occupational mobility, early retirement, and movements out of the labour force for other reasons. This result is driven by all elements of replacement demand, population, participation, and the gender-age specific outflow coefficient.

Replacement demand due to net emigration is an additional component for those countries that have experienced net outflow of their population over the last five years. It is a proxy of the actual flows to be expected, but no precise forecasts or even historical figures could be found to improve on this proxy (see the Section 5.5.3 on migration for more details).

5.7. Concluding remarks

There are several caveats in the use of the replacement demand forecasts. The first and most important is data quality and consistency. The team had to use several time-series from several countries; it was found that across time and countries there is no full agreement on translating national occupations into the ISCO two-digit standard. There are several changes in the data across time that make some data unusable and some predictions less precise. Over time this will probably be eliminated given that all statistical offices make an effort to harmonise and cooperate on these standards.

Further, the micro-level LFS data lacked detailed age-information which would have improved the cohort-component method, especially for series shorter than the size of a single age cohort. This was overcome by estimating

and adjusting year-to-year changes from neighbouring age cohorts. However, more detailed data would improve this approximation.

The length of the historical data is not always enough to warrant 10 year extrapolation, as it was done for the current project. Technically, it is feasible to extrapolate based on a few years only but the longer the series, the more precise is the estimation procedure.

Participation rates in this project were only rudimentary. Most countries included unchanged participation rates, while two current trends would suggest this is a simplification: the greying of the population would lead to a reduction of the overall participation rates as higher age groups tend to participate less, while the policy to discourage early retirement and to increase the participation of women would, given the same age structure within the population, lead to higher total participation rates.

Migration remains an important issue for skill forecasting for two reasons: it is a means of solving skill shortages as immigrants increase the supply of workers (this part is not modelled within the current framework as it deals with demand); and emigration leaves us with estimating the replacement demand for people leaving a country. Little quantitative information is known; estimated figures are not consistent across the different methodologies used to collect them. Also, they usually do not include the important information on the occupation structure of emigrants, nor in which occupations they are working in the receiving country.

In general, replacement demand based on LFS is plagued by small cell size. Occupations are subdivided into age-gender groups, which decreases the number of observations substantially and increases the disturbance of the results through sampling variation. As this is inherent to the methodology of comparing repeated cross-sections, only different methodologies (e.g. using a panel structure), or bigger data-sets (e.g. administrative data including occupations), can solve these problems.

National estimates of replacement demand should be welcome as additions to this project, especially if they use more detailed, nationally available data to overcome some of the shortcomings of the European LFS data. In addition, national estimates could try to use improved methodology that uses their specific national data source to its fullest. For example, if a panel structure is available, not only can net replacement demand can be estimated, but also gross flows can be studied and the net replacement rate could be estimated more precisely.

CHAPTER 6

Forecast results

Rob A. Wilson ([36])

6.1. Background

This chapter presents estimates and projections of pan-European occupational employment. These are based on the macroeconomic scenarios produced by Cambridge Econometrics. Almost 100 000 basic time series projections of employment by industry and occupation and qualification cover EU-25.

Some of the numbers by sector presented are based on Eurostat NA information (as used in the multi-sectoral macroeconomic model), rather than the LFS-based estimates that some are more familiar with. There are some significant discrepancies between these two sources which remain unresolved (see more in Chapter 2).

Section 6.2 presents the final results. Section 6.3 is in three main parts. Section 6.2.1 provides an illustration of the kinds of results available for individual countries, taking Greece as an example. Section 6.2.2 presents an overview for Europe as a whole, covering all Member States. Section 6.2.3 presents a selection of the more detailed results, covering and comparing all the countries.

Section 6.3 considers the sensitivity of the results to some key assumptions. In particular it explores what difference the alternative macro scenarios make to the changing pattern of demand for skills and what difference it makes if sectoral data are constrained to match the LFS totals.

6.2. Benchmark macro and sectoral employment scenario

6.2.1. Typical national results

This section illustrates the kinds of results available, using Greece as an example, selected because one of the project team members is a Greek national, familiar with the main trends and, therefore, better placed to assess

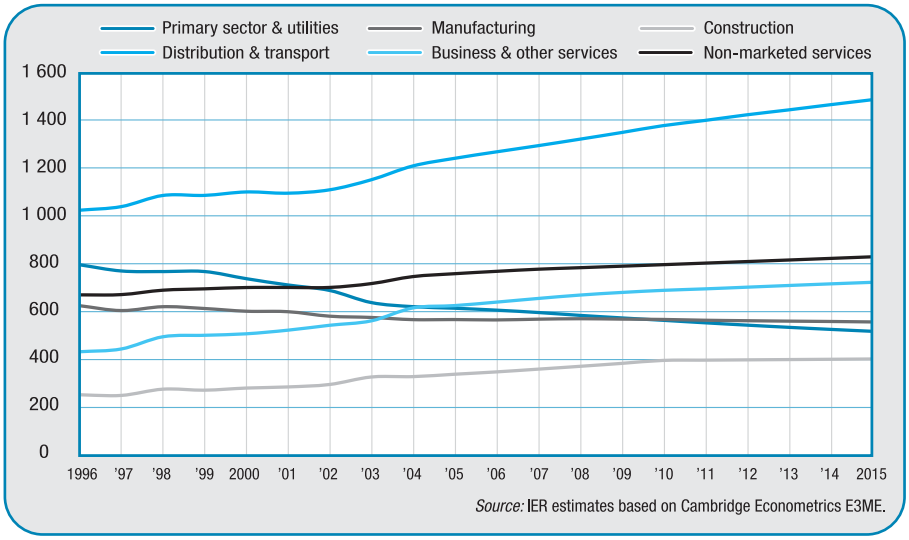
([36]) In cooperation with Frank Cörvers , Ben Gardiner, Ben Kriechel, Hector Pollitt and Ilias Livanos.

the results critically than is the case for the results for some other countries. The results shown are also available for each of the other countries.

6.2.1.1. *Prospects by sector*

Figure 6.1 illustrates trends by broad sector. Similar information is available for a more detailed 16 industry breakdown in Table 6.1. Table 6.2 presents an analysis of changes over time. The most detailed breakdown available provides similar results for 41 detailed industries. The results are based on a benchmark scenario developed by Cambridge Econometrics as described in Gardiner et al. (2007).

Figure 6.1. **Employment trends by broad sector, Greece**



Source: IER estimates based on Cambridge Econometrics E3ME.

Table 6.1. **Employment trends by broad sector, Greece**

	1996	2001	2006	2010	2015
Level ('000)					
Primary sector and utilities	797	713	607	564	518
Manufacturing	626	600	566	568	558
Construction	252	285	348	396	402
Distribution and transport	1 027	1 098	1 272	1 382	1 490
Business and other services	432	523	641	690	724
Non-marketed services	671	702	770	798	831
All industries	*3 805*	*3 921*	*4 203*	*4 398*	*4 522*
Share (%)					
Primary sector and utilities	21.0	18.2	14.4	12.8	11.5
Manufacturing	16.4	15.3	13.5	12.9	12.3
Construction	6.6	7.3	8.3	9.0	8.9
Distribution and transport	27.0	28.0	30.3	31.4	32.9
Business and other services	11.4	13.3	15.2	15.7	16.0
Non-marketed services	17.6	17.9	18.3	18.1	18.4
All industries	*100.0*	*100.0*	*100.0*	*100.0*	*100.0*
	1996-2001	**2001-06**	**2006-10**	**2010-15**	**2006-15**
Growth (% per annum)					
Primary sector and utilities	-2.2	-3.2	-1.8	-1.7	-1.7
Manufacturing	-0.8	-1.2	0.1	-0.4	-0.2
Construction	2.5	4.1	3.3	0.3	1.6
Distribution and transport	1.4	3.0	2.1	1.5	1.8
Business and other services	3.9	4.1	1.9	1.0	1.4
Non-marketed services	0.9	1.9	0.9	0.8	0.8
All industries	*0.6*	*1.4*	*1.1*	*0.6*	*0.8*
Change ('000)					
Primary sector and utilities	-85	-106	-43	-46	-89
Manufacturing	-25	-35	2	-10	-8
Construction	33	63	48	6	54
Distribution and transport	72	173	110	109	218
Business and other services	90	118	50	34	83
Non-marketed services	31	68	28	33	61
All industries	*116*	*282*	*195*	*125*	*320*

Source: IER estimates based on Cambridge Econometrics E3ME.

Table 6.2. **Employment trends by industry, Greece**

	1996	2001	2006	2010	2015
Level ('000)					
Agriculture, etc.	737	658	549	505	456
Mining and quarrying	17	16	21	22	23
Food, drink and tobacco	131	129	117	114	110
Engineering	45	46	43	47	46
Rest of manufacturing	450	425	405	407	401
Electricity, gas and water	43	39	37	38	40
Construction	252	285	348	396	402
Distribution	540	583	671	704	743
Hotels and catering	224	247	307	370	416
Transport and telecommunications	262	267	293	307	331
Banking and insurance	76	95	101	112	117
Other business services	178	241	298	322	340
Public admin and defence	276	275	295	302	310
Education	224	251	277	289	304
Health and social work	170	177	198	207	217
Miscellaneous services	178	187	242	257	267
All industries	*3 805*	*3 921*	*4 203*	*4 398*	*4 522*
Share (%)					
Agriculture, etc.	19.4	16.8	13.1	11.5	10.1
Mining and quarrying	0.5	0.4	0.5	0.5	0.5
Food, drink and tobacco	3.4	3.3	2.8	2.6	2.4
Engineering	1.2	1.2	1.0	1.1	1.0
Rest of manufacturing	11.8	10.8	9.6	9.2	8.9
Electricity, gas and water	1.1	1.0	0.9	0.9	0.9
Construction	6.6	7.3	8.3	9.0	8.9
Distribution	14.2	14.9	16.0	16.0	16.4
Hotels and catering	5.9	6.3	7.3	8.4	9.2
Transport and telecommunications	6.9	6.8	7.0	7.0	7.3
Banking and insurance	2.0	2.4	2.4	2.5	2.6
Other business services	4.7	6.1	7.1	7.3	7.5
Public admin and defence	7.3	7.0	7.0	6.9	6.9
Education	5.9	6.4	6.6	6.6	6.7
Health and social work	4.5	4.5	4.7	4.7	4.8
Miscellaneous services	4.7	4.8	5.8	5.8	5.9
All industries	*100.0*	*100.0*	*100.0*	*100.0*	*100.0*

Source: IER estimates based on Cambridge Econometrics E3ME.

Table 6.3. **Employment trends by industry, changes, Greece**

	1996-2001	2001-06	2006-10	2010-15	2006-15
Growth (% per annum)					
Agriculture, etc.	-2.3	-3.5	-2.1	-2.0	-2.1
Mining and quarrying	-1.7	5.9	0.4	1.1	0.8
Food, drink and tobacco	-0.3	-1.8	-0.7	-0.7	-0.7
Engineering	0.7	-1.4	2.2	-0.4	0.7
Rest of manufacturing	-1.1	-1.0	0.1	-0.3	-0.1
Electricity, gas and water	-1.9	-1.4	0.9	1.0	1.0
Construction	2.5	4.1	3.3	0.3	1.6
Distribution	1.5	2.9	1.2	1.1	1.1
Hotels and catering	2.0	4.4	4.8	2.4	3.4
Transport and telecommunications	0.4	1.9	1.1	1.5	1.4
Banking and insurance	4.5	1.1	2.7	0.9	1.7
Other business services	6.2	4.4	1.9	1.1	1.5
Public admin and defence	-0.1	1.5	0.6	0.5	0.5
Education	2.3	2.0	1.1	1.0	1.0
Health and social work	0.7	2.3	1.1	1.0	1.0
Miscellaneous services	1.0	5.3	1.5	0.8	1.1
All industries	*0.6*	*1.4*	*1.1*	*0.6*	*0.8*
Change ('000)					
Agriculture, etc.	-79	-108	-44	-49	-93
Mining and quarrying	-1	5	0	1	2
Food, drink and tobacco	-2	-11	-3	-4	-7
Engineering	2	-3	4	-1	3
Rest of manufacturing	-25	-20	1	-6	-4
Electricity, gas and water	-4	-3	1	2	3
Construction	33	63	48	6	54
Distribution	43	88	33	38	71
Hotels and catering	23	59	63	46	109
Transport and telecommunications	6	26	14	24	38
Banking and insurance	19	5	11	5	16
Other business services	62	57	24	18	42
Public admin and defence	-2	21	7	8	15
Education	27	26	12	15	27
Health and social work	6	21	9	11	19
Miscellaneous services	9	55	15	10	25
All industries	*116*	*282*	*195*	*125*	*320*

Source: IER estimates based on Cambridge Econometrics E3ME.

6.2.1.2. *Prospects by occupation and qualification*

Figure 6.2 illustrates similar trends by broad occupation (nine groups). Analogous information is available for a more detailed 27 category breakdown as shown in Table 6.2.3a and b. Tables 6.4 and 6.5 present an analysis of changes over time.

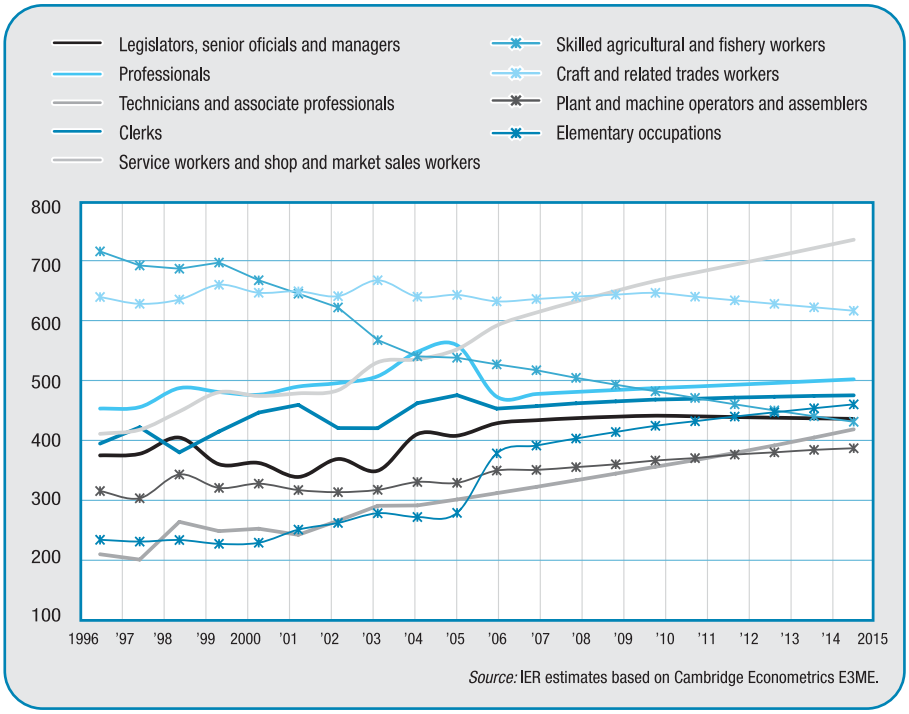
For each country, the results are based on the preferred model of changes in occupational employment structure (shares) within each sector. Figure 6.2 illustrates some of the volatility of the occupational data even at this level of aggregation. The main problems at this level appear to be discontinuities in classification (see the sharp breaks in 2006 for elementary occupations and some others in the Greek case. These are typical, although the years the discontinuities arise differ from country to country.

The data in the country workbooks have been handled and presented in such a manner that the user can recalculate the projected shares using alternative assumption, including, changing the years and the number of years over which the analysis takes place, as well as adopting non-linear extrapolative techniques. It is also possible to incorporate alternative estimates of shares based on econometric or other methods if these are regarded as superior.

The occupational shares are constrained to lie between 0 and 1, and the sum of shares across occupations (within an industry) is scaled to 100 %.

This analysis has been extended to include qualification, although concerns about data quality currently limit this to just three broad levels. Table 6.8 and Figure 6.3 illustrate the main trends. In most countries there are strong positive trends towards the need for higher qualifications and reductions in the number of those in employment with low or no formal qualifications. These patterns are clearly illustrated in the figure for Greece. The 2006 discontinuity is again plain to see.

Figure 6.2. **Employment trends by broad occupation, Greece**



Source: IER estimates based on Cambridge Econometrics E3ME.

Table 6.4. **Employment trends (levels) by occupation, broad group, Greece ('000)**

Level	1996	2001	2006	2010	2015
Armed forces	43	36	43	45	46
Legislators and senior officials	1	1	2	2	1
Corporate managers	51	45	62	71	80
Managers of small enterprises	324	294	366	370	356
Physical, mathematical and engineering science professionals	67	76	48	55	62
Life science and health professionals	69	64	82	82	81
Teaching professionals	194	216	230	239	249
Other professionals	124	136	115	113	111
Physical and engineering science associate professionals	64	60	86	91	95
Life science and health associate professionals	41	49	64	73	85
Teaching associate professionals	6	9	11	13	16
Other associate professionals	100	125	152	180	224
Office clerks	315	369	333	331	321
Customer services clerks	81	92	121	139	156
Personal and protective services workers	236	264	338	389	430
Models, salespersons and demonstrators	176	216	255	279	307
Skilled agricultural and fishery workers	718	647	529	484	433
Extraction and building trades workers	243	272	318	348	343
Metal, machinery and related trades workers	181	182	154	154	150
Precision, handicraft, craft printing and related trades workers	30	25	28	25	22
Other craft and related trades workers	187	172	134	120	104
Stationary plant and related operators	22	19	22	21	21
Machine operators and assemblers	89	76	93	99	105
Drivers and mobile plant operators	206	224	236	247	262
Sales and services elementary occupations	150	167	284	325	357
Agricultural, fishery and related labourers	17	9	19	21	25
Labourers in mining, construction, manufacturing and transport	69	76	77	79	79
All occupations	*3 805*	*3 921*	*4 203*	*4 398*	*4 522*

Source: IER estimates based on Cambridge Econometrics E3ME.

Table 6.5. **Employment trends (shares) by occupation, broad group, Greece (%)**

Share	1996	2001	2006	2010	2015
Armed forces	1.1	0.9	1.0	1.0	1.0
Legislators and senior officials	0.0	0.0	0.0	0.0	0.0
Corporate managers	1.3	1.1	1.5	1.6	1.8
Managers of small enterprises	8.5	7.5	8.7	8.4	7.9
Physical, mathematical and engineering science professionals	1.8	1.9	1.1	1.2	1.4
Life science and health professionals	1.8	1.6	1.9	1.9	1.8
Teaching professionals	5.1	5.5	5.5	5.4	5.5
Other professionals	3.3	3.5	2.7	2.6	2.5
Physical and engineering science associate professionals	1.7	1.5	2.0	2.1	2.1
Life science and health associate professionals	1.1	1.2	1.5	1.7	1.9
Teaching associate professionals	0.2	0.2	0.3	0.3	0.4
Other associate professionals	2.6	3.2	3.6	4.1	5.0
Office clerks	8.3	9.4	7.9	7.5	7.1
Customer services clerks	2.1	2.4	2.9	3.2	3.5
Personal and protective services workers	6.2	6.7	8.1	8.9	9.5
Models, salespersons and demonstrators	4.6	5.5	6.1	6.3	6.8
Skilled agricultural and fishery workers	18.9	16.5	12.6	11.0	9.6
Extraction and building trades workers	6.4	6.9	7.6	7.9	7.6
Metal, machinery and related trades workers	4.8	4.6	3.7	3.5	3.3
Precision, handicraft, craft printing and related trades workers	0.8	0.6	0.7	0.6	0.5
Other craft and related trades workers	4.9	4.4	3.2	2.7	2.3
Stationary plant and related operators	0.6	0.5	0.5	0.5	0.5
Machine operators and assemblers	2.3	1.9	2.2	2.3	2.3
Drivers and mobile plant operators	5.4	5.7	5.6	5.6	5.8
Sales and services elementary occupations	3.9	4.3	6.8	7.4	7.9
Agricultural, fishery and related labourers	0.4	0.2	0.5	0.5	0.6
Labourers in mining, construction, manufacturing and transport	1.8	1.9	1.8	1.8	1.8
All occupations	*100.0*	*100.0*	*100.0*	*100.0*	*100.0*

Source: IER estimates based on Cambridge Econometrics E3ME.

Table 6.6. **Employment growth by occupation, broad group, Greece (% per annum)**

Growth	1996-2001	2001-06	2006-10	2010-15	2006-15
Armed forces	-3.5	3.6	0.8	0.6	0.7
Legislators and senior officials	-0.7	9.3	-0.8	-1.0	-0.9
Corporate managers	-2.5	6.7	3.5	2.4	2.9
Managers of small enterprises	-1.9	4.5	0.3	-0.8	-0.3
Physical, mathematical and engineering science professionals	2.5	-8.8	3.5	2.6	3.0
Life science and health professionals	-1.5	4.9	0.0	-0.2	-0.1
Teaching professionals	2.1	1.3	1.0	0.8	0.9
Other professionals	1.8	-3.3	-0.4	-0.3	-0.3
Physical and engineering science associate professionals	-1.2	7.3	1.4	0.9	1.1
Life science and health associate professionals	3.5	5.7	3.3	2.9	3.1
Teaching associate professionals	8.6	4.5	4.0	4.2	4.1
Other associate professionals	4.6	3.9	4.4	4.5	4.4
Office clerks	3.2	-2.0	-0.2	-0.6	-0.4
Customer services clerks	2.6	5.6	3.4	2.4	2.8
Personal and protective services workers	2.2	5.1	3.6	2.0	2.7
Models, salespersons and demonstrators	4.2	3.3	2.3	1.9	2.1
Skilled agricultural and fishery workers	-2.1	-4.0	-2.2	-2.2	-2.2
Extraction and building trades workers	2.3	3.2	2.3	-0.3	0.8
Metal, machinery and related trades workers	0.0	-3.2	0.0	-0.5	-0.3
Precision, handicraft, craft printing and related trades workers	-3.4	1.9	-2.1	-2.9	-2.5
Other craft and related trades workers	-1.6	-4.9	-2.7	-2.9	-2.8
Stationary plant and related operators	-2.8	2.9	-0.3	-0.3	-0.3
Machine operators and assemblers	-3.0	4.1	1.6	1.3	1.4
Drivers and mobile plant operators	1.6	1.1	1.1	1.1	1.1
Sales and services elementary occupations	2.2	11.2	3.5	1.9	2.6
Agricultural, fishery and related labourers	-11.8	16.4	3.2	3.2	3.2
Labourers in mining, construction, manufacturing and transport	2.1	0.2	0.8	0.0	0.4
All occupations	*0.6*	*1.4*	*1.1*	*0.6*	*0.8*

Source: IER estimates based on Cambridge Econometrics E3ME.

Table 6.7. **Employment change by occupation, broad group, Greece ('000)**

Change	1996-2001	2001-06	2006-10	2010-15	2006-15
Armed forces	-7	7	1	1	3
Legislators and senior officials	0	1	0	0	0
Corporate managers	-6	17	9	9	18
Managers of small enterprises	-30	72	4	-14	-11
Physical, mathematical and engineering science professionals	9	-28	7	8	15
Life science and health professionals	-5	17	0	-1	-1
Teaching professionals	21	15	9	10	19
Other professionals	12	-21	-2	-2	-4
Physical and engineering science associate professionals	-4	25	5	4	9
Life science and health associate professionals	8	16	9	11	20
Teaching associate professionals	3	2	2	3	5
Other associate professionals	25	26	29	44	73
Office clerks	54	-35	-2	-10	-12
Customer services clerks	11	29	17	17	35
Personal and protective services workers	28	75	51	41	91
Models, salespersons and demonstrators	40	39	24	28	52
Skilled agricultural and fishery workers	-71	-118	-45	-51	-96
Extraction and building trades workers	29	46	30	-6	25
Metal, machinery and related trades workers	0	-28	0	-4	-4
Precision, handicraft, craft printing and related trades workers	-5	2	-2	-3	-6
Other craft and related trades workers	-15	-38	-14	-17	-30
Stationary plant and related operators	-3	3	0	0	-1
Machine operators and assemblers	-13	17	6	6	13
Drivers and mobile plant operators	17	13	11	14	25
Sales and services elementary occupations	17	117	41	32	73
Agricultural, fishery and related labourers	-8	10	3	4	6
Labourers in mining, construction, manufacturing and transport	7	1	2	0	2
All occupations	*116*	*282*	*195*	*125*	*320*

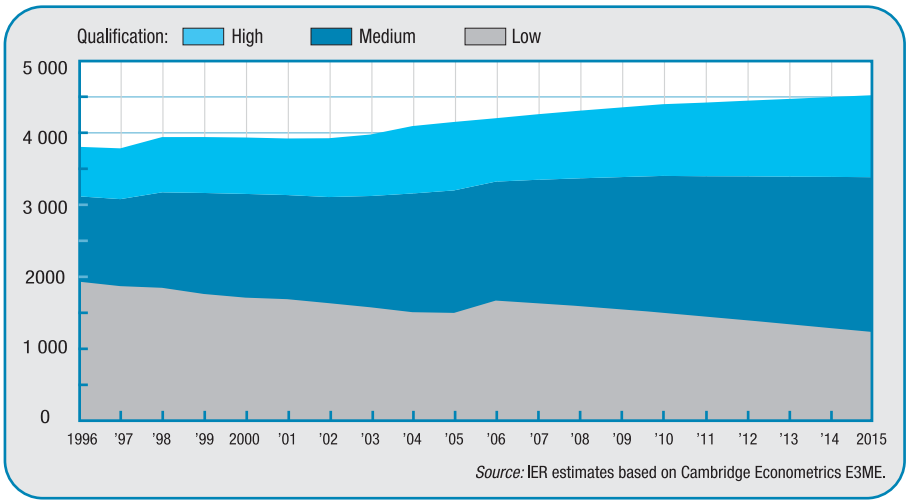
Source: IER estimates based on Cambridge Econometrics E3ME.

Table 6.8. **Employment by qualification/level of education, Greece**

	1996	2001	2006	2010	2015
Level ('000)					
Low qualification	1 930	1 686	1 666	1 501	1 231
Medium qualification	1 186	1 448	1 655	1 900	2 151
High qualification	689	787	882	997	1 140
All qualifications	*3 805*	*3 921*	*4 203*	*4 398*	*4 522*
Share (%)					
Low qualification	50.7	43.0	39.7	34.1	27.2
Medium qualification	31.2	36.9	39.4	43.2	47.6
High qualification	18.1	20.1	21.0	22.7	25.2
All qualifications	*100.0*	*100.0*	*100.0*	*100.0*	*100.0*
	1996-2001	**2001-06**	**2006-10**	**2010-15**	**2006-15**
Growth (% per annum)					
Low qualification	-2.7	-0.2	-2.6	-3.9	-3.3
Medium qualification	4.1	2.7	3.5	2.5	3.0
High qualification	2.7	2.3	3.1	2.7	2.9
All qualifications	*0.6*	*1.4*	*1.1*	*0.6*	*0.8*
Change ('000)					
Low qualification	-244	-19	-166	-269	-435
Medium qualification	262	206	245	252	497
High qualification	98	95	116	142	258
All qualifications	*116*	*282*	*195*	*125*	*320*

Source: IER estimates based on Cambridge Econometrics E3ME.

Figure 6.3. **Employment trends by qualification/level of education, Greece ('000)**



Source: IER estimates based on Cambridge Econometrics E3ME.

6.2.1.3. *Replacement demand*

Table 6.9 presents estimates of replacement demand and total requirements (job openings) for broad occupational groups, based on the cohort component approach described in Chapter 5. More detailed results are also available by the 27 occupational categories and by qualification/level of education. These results emphasise the crucial importance of considering replacement needs and are generally much larger than expansion demand.

Table 6.9. **Replacement demand by occupation, broad group, Greece**

	1996	2001	2006
Level ('000)			
Armed forces	43	36	43
Legislators, senior officials and managers	376	340	430
Professionals	455	492	475
Technicians and associate professionals	211	244	313
Clerks	396	461	455
Service workers and shop and market sales workers	412	480	594
Skilled agricultural and fishery workers	718	647	529
Craft and related trades workers	641	651	634
Plant and machine operators and assemblers	317	318	351
Elementary occupations	235	252	380
All occupations	*3 805*	*3 921*	*4 203*
Share (%)			
Armed forces	1.1	0.9	1.0
Legislators, senior officials and managers	9.9	8.7	10.2
Professionals	12.0	12.5	11.3
Technicians and associate professionals	5.5	6.2	7.5
Clerks	10.4	11.8	10.8
Service workers and shop and market sales workers	10.8	12.2	14.1
Skilled agricultural and fishery workers	18.9	16.5	12.6
Craft and related trades workers	16.9	16.6	15.1
Plant and machine operators and assemblers	8.3	8.1	8.4
Elementary occupations	6.2	6.4	9.0
All occupations	*100.0*	*100.0*	*100.0*
Growth (% per annum)	**1996-2001**	**2001-06**	**2006-10**
Armed forces	-3.5	3.6	0.8
Legislators, senior officials and managers	-2.0	4.8	0.7
Professionals	1.6	-0.7	0.7
Technicians and associate professionals	2.9	5.2	3.4
Clerks	3.1	-0.3	0.8
Service workers and shop and market sales workers	3.1	4.3	3.0
Skilled agricultural and fishery workers	-2.1	-4.0	-2.2
Craft and related trades workers	0.3	-0.5	0.6
Plant and machine operators and assemblers	0.1	2.0	1.2
Elementary occupations	1.4	8.5	2.9
All occupations	*0.6*	*1.4*	*1.1*

Source: IER/ROA estimates based on Cambridge Econometrics E3ME.

2010	2015	Net change 2006-15	Replacement demand	Total requirement
45	46	3	11	13
443	437	7	77	84
489	504	29	74	104
357	420	107	65	171
470	477	22	108	130
668	737	144	192	335
484	433	-96	155	59
648	618	-16	171	156
368	388	37	76	113
426	462	82	73	155
4 398	*4 522*	*320*	*1 001*	*1 320*
1.0	1.0	6.3	24.3	30.6
10.1	9.7	1.7	17.9	19.6
11.1	11.1	6.1	15.7	21.8
8.1	9.3	34.1	20.6	54.7
10.7	10.5	4.9	23.8	28.7
15.2	16.3	24.2	32.3	56.5
11.0	9.6	-18.2	29.3	11.1
14.7	13.7	-2.5	27.0	24.5
8.4	8.6	10.6	21.5	32.2
9.7	10.2	21.6	19.2	40.8
100.0	*100.0*	*7.6*	*23.8*	*31.4*
2010-15	**2006-15**			
0.6	0.7	0.7	2.4	3.0
-0.2	0.2	0.2	1.8	2.0
0.6	0.7	0.7	1.6	2.2
3.3	3.3	3.3	2.1	5.0
0.3	0.5	0.5	2.4	2.8
2.0	2.4	2.4	3.2	5.1
-2.2	-2.2	-2.2	2.9	1.2
-0.9	-0.3	-0.3	2.7	2.5
1.1	1.1	1.1	2.2	3.1
1.6	2.2	2.2	2.0	3.9
0.6	*0.8*	*0.8*	*2.4*	*3.1*

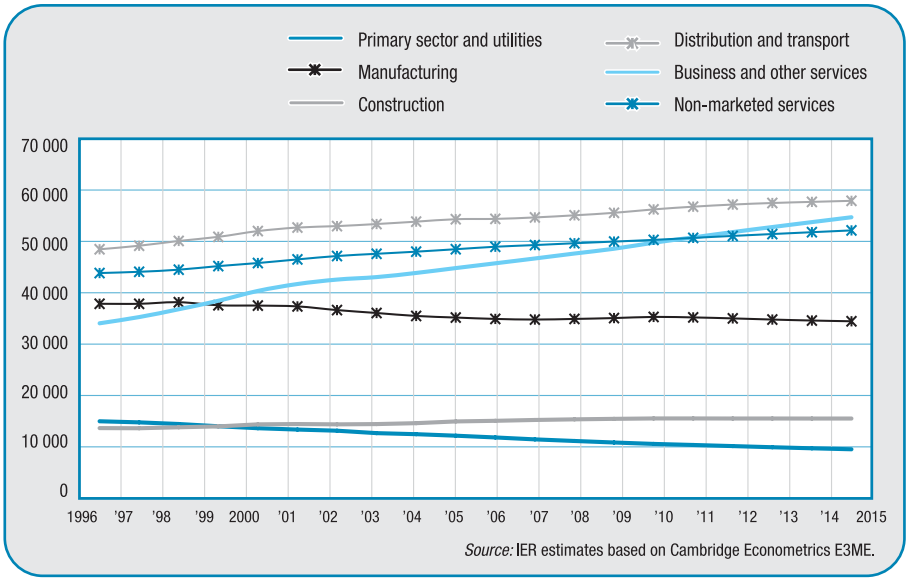
6.2.2. **Pan-European results**

This section presents a summary of the results summed across EU-25+. They follow a similar format to those for individual countries.

6.2.2.1. *Prospects by sector*

Figure 6.4 illustrates trends by broad sector for EU-25+. As with individual countries, similar information is available for a 16 industry breakdown and for 41 detailed industries. General trends are not dissimilar to those of Greece, although the significance of the different sectors obviously varies quite significantly across countries.

Figure 6.4. **Employment trends by broad sector, EU-25+ ('000)**



Source: IER estimates based on Cambridge Econometrics E3ME.

Table 6.10. **Employment trends by broad sector, EU-25+**

	1996	2001	2006	2010	2015
Level ('000)					
Primary sector and utilities	15 052	13 446	11 917	10 667	9 629
Manufacturing	37 802	37 297	34 871	35 256	34 414
Construction	13 729	14 514	15 141	15 598	15 583
Distribution and transport	48 356	52 566	54 242	56 078	57 740
Business and other services	34 022	41 627	45 638	49 626	54 559
Non-marketed services	43 753	46 394	48 846	50 175	52 011
All industries	*192 714*	*205 844*	*210 656*	*217 399*	*223 936*
Share (%)					
Primary sector and utilities	7.8	6.5	5.7	4.9	4.3
Manufacturing	19.6	18.1	16.6	16.2	15.4
Construction	7.1	7.1	7.2	7.2	7.0
Distribution and transport	25.1	25.5	25.7	25.8	25.8
Business and other services	17.7	20.2	21.7	22.8	24.4
Non-marketed services	22.7	22.5	23.2	23.1	23.2
All industries	*100.0*	*100.0*	*100.0*	*100.0*	*100.0*
	1996-2001	**2001-06**	**2006-10**	**2010-15**	**2006-15**
Growth (% per annum)					
Primary sector and utilities	-2.2	-2.4	-2.7	-2.0	-2.3
Manufacturing	-0.3	-1.3	0.3	-0.5	-0.1
Construction	1.1	0.8	0.7	0.0	0.3
Distribution and transport	1.7	0.6	0.8	0.6	0.7
Business and other services	4.1	1.9	2.1	1.9	2.0
Non-marketed services	1.2	1.0	0.7	0.7	0.7
All industries	*1.3*	*0.5*	*0.8*	*0.6*	*0.7*
Change ('000)					
Primary sector and utilities	-1 606	-1 529	-1 251	-1 038	-2 289
Manufacturing	-505	-2 426	385	-842	-457
Construction	785	627	457	-15	442
Distribution and transport	4 210	1 676	1 836	1 662	3 498
Business and other services	7 606	4 011	3 988	4 933	8 921
Non-marketed services	2 642	2 452	1 329	1 837	3 165
All industries	*13 131*	*4 811*	*6 743*	*6 537*	*13 280*

NB: In some tables and figures in the workbooks, estimates for years before 1993 exclude data for certain countries. In total these account for some 30 million jobs.

Source: IER estimates based on Cambridge Econometrics E3ME.

Table 6.11. **Employment trends by industry, EU-25+**

	1996	2001	2006	2010	2015
Level ('000)					
Agriculture, etc.	12 230	11 096	9 753	8 690	7 764
Mining and quarrying	1 005	724	651	572	500
Food, drink and tobacco	5 012	4 987	4 781	4 743	4 632
Engineering	7 943	8 096	7 502	7 660	7 542
Rest of manufacturing	24 847	24 214	22 588	22 852	22 241
Electricity, gas and water	1 817	1 626	1 514	1 404	1 364
Construction	13 729	14 514	15 141	15 598	15 583
Distribution	28 945	31 127	32 153	33 042	34 031
Hotels and catering	7 891	9 158	9 932	10 801	11 547
Transport and telecommunications	11 520	12 280	12 157	12 235	12 162
Banking and insurance	5 743	6 028	6 014	6 040	6 032
Other business services	17 424	23 308	26 140	29 196	33 079
Public admin and defence	13 837	14 157	14 258	14 336	14 432
Education	12 896	13 693	14 507	14 927	15 574
Health and social work	17 020	18 545	20 081	20 911	22 005
Miscellaneous services	10 855	12 292	13 485	14 390	15 448
All industries	*192 714*	*205 844*	*210 656*	*217 399*	*223 936*
Share (%)					
Agriculture, etc.	6.3	5.4	4.6	4.0	3.5
Mining and quarrying	0.5	0.4	0.3	0.3	0.2
Food, drink and tobacco	2.6	2.4	2.3	2.2	2.1
Engineering	4.1	3.9	3.6	3.5	3.4
Rest of manufacturing	12.9	11.8	10.7	10.5	9.9
Electricity, gas and water	0.9	0.8	0.7	0.6	0.6
Construction	7.1	7.1	7.2	7.2	7.0
Distribution	15.0	15.1	15.3	15.2	15.2
Hotels and catering	4.1	4.4	4.7	5.0	5.2
Transport and telecommunications	6.0	6.0	5.8	5.6	5.4
Banking and insurance	3.0	2.9	2.9	2.8	2.7
Other business services	9.0	11.3	12.4	13.4	14.8
Public admin and defence	7.2	6.9	6.8	6.6	6.4
Education	6.7	6.7	6.9	6.9	7.0
Health and social work	8.8	9.0	9.5	9.6	9.8
Miscellaneous services	5.6	6.0	6.4	6.6	6.9
All industries	*100.0*	*100.0*	*100.0*	*100.0*	*100.0*

NB: In some tables and figures in the workbooks, estimates for years before 1993 exclude data for certain countries. In total these account for some 30 million jobs.

Source: IER estimates based on Cambridge Econometrics E3ME.

Table 6.12. **Employment trends by industry, changes, EU-25+**

	1996	2001	2006	2010	2015
Level ('000)					
Agriculture, etc.	-1.9	-2.5	-2.8	-2.2	-2.5
Mining and quarrying	-6.3	-2.1	-3.2	-2.7	-2.9
Food, drink and tobacco	-0.1	-0.8	-0.2	-0.5	-0.4
Engineering	0.4	-1.5	0.5	-0.3	0.1
Rest of manufacturing	-0.5	-1.4	0.3	-0.5	-0.2
Electricity, gas and water	-2.2	-1.4	-1.9	-0.6	-1.2
Construction	1.1	0.8	0.7	0.0	0.3
Distribution	1.5	0.7	0.7	0.6	0.6
Hotels and catering	3.0	1.6	2.1	1.3	1.7
Transport and telecommunications	1.3	-0.2	0.2	-0.1	0.0
Banking and insurance	1.0	0.0	0.1	0.0	0.0
Other business services	6.0	2.3	2.8	2.5	2.7
Public admin and defence	0.5	0.1	0.1	0.1	0.1
Education	1.2	1.2	0.7	0.9	0.8
Health and social work	1.7	1.6	1.0	1.0	1.0
Miscellaneous services	2.5	1.9	1.6	1.4	1.5
All industries	*1.3*	*0.5*	*0.8*	*0.6*	*0.7*
Change ('000)					
Agriculture, etc.	-1 134	-1 344	-1 062	-926	-1 989
Mining and quarrying	-281	-73	-78	-72	-150
Food, drink and tobacco	-25	-206	-38	-112	-149
Engineering	153	-595	159	-119	40
Rest of manufacturing	-633	-1 625	264	-611	-348
Electricity, gas and water	-192	-112	-110	-40	-150
Construction	785	627	457	-15	442
Distribution	2 182	1 025	889	989	1 878
Hotels and catering	1 268	773	869	746	1 615
Transport and telecommunications	760	-123	78	-73	4
Banking and insurance	286	-15	26	-8	18
Other business services	5 884	2 832	3 056	3 883	6 939
Public admin and defence	320	101	78	96	174
Education	797	814	420	647	1 067
Health and social work	1 524	1 536	831	1 094	1 924
Miscellaneous services	1 437	1 193	905	1 058	1 963
All industries	*13 131*	*4 811*	*6 743*	*6 537*	*13 280*

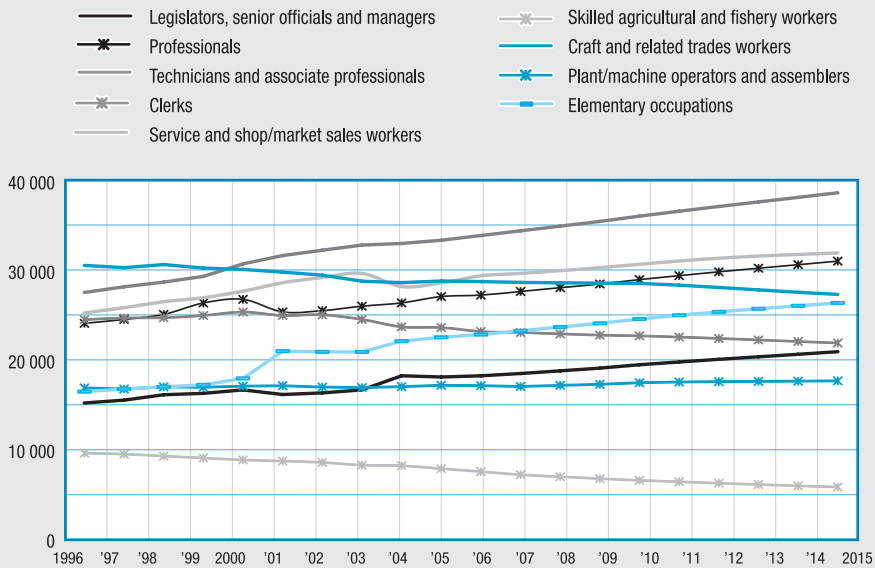
NB: Here and in subsequent tables and figures, estimates for years before 1993 exclude data for certain countries. In total these account for some 30 million jobs.

Source: IER estimates based on Cambridge Econometrics E3ME.

6.2.2.2. *Prospects by occupation*

Figure 6.5 illustrates similar trends by broad occupation (nine groups). Similar information is available for a more detailed 27 category breakdown as shown in Tables 13 and 14. Tables 15 and 16 present an analysis of changes over time. Again, while there are some similarities with trends in Greece, there are many differences. The basic data exhibit some discontinuities even at this level, especially around 2000/01 when some countries apparently changed systems of classification. The methods, used to project occupational shares within sectors over such an extended period, can also result in some quite extreme results in a few cases.

Figure 6.5. **Employment trends by broad occupation, EU-25+ ('000)**



Source: IER estimates based on Cambridge Econometrics E3ME.

Table 6.13. **Employment trends (levels) by occupation, broad group, EU-25+ ('000)**

Level	1996	2001	2006	2010	2015
Armed forces	1245	1197	1215	1197	1165
Legislators and senior officials	484	603	495	531	596
Corporate managers	8349	9294	9920	11032	12346
Managers of small enterprises	6561	6436	7990	8071	8135
Physical, mathematical and engineering science professionals	5518	5995	6401	6944	7452
Life science and health professionals	3698	3345	3551	3602	3658
Teaching professionals	7862	8057	8464	8595	8736
Other professionals	7143	8086	8933	9927	11265
Physical and engineering science associate professionals	6911	7666	7715	7927	8129
Life science and health associate professionals	4807	5559	5618	5671	5800
Teaching associate professionals	2126	2408	2606	2874	3315
Other associate professionals	13799	16100	18013	19626	21446
Office clerks	20840	20891	18795	18075	16944
Customer services clerks	3792	4198	4522	4758	5100
Personal and protective services workers	15408	17497	18848	20154	21361
Models, salespersons and demonstrators	9977	11221	10642	10611	10656
Skilled agricultural and fishery workers	9829	8960	7789	6817	6082
Extraction and building trades workers	11205	11657	12597	12851	12718
Metal, machinery and related trades workers	11976	11646	10466	10264	9555
Precision, handicraft, craft printing and related trades workers	1865	1614	1444	1298	1171
Other craft and related trades workers	5595	4975	4338	4237	3977
Stationary plant and related operators	2034	2081	2103	2060	2079
Machine operators and assemblers	6622	6961	6498	6588	6596
Drivers and mobile plant operators	8414	8262	8713	8991	9175
Sales and services elementary occupations	10408	14092	15568	17095	18630
Agricultural, fishery and related labourers	1269	1197	1249	1163	1116
Labourers in mining, construction, manufacturing and transport	4978	5848	6163	6440	6735
All occupations	*192713*	*205844*	*210656*	*217399*	*223936*

NB: In some tables and figures in the workbooks, estimates for years before 1993 exclude data for certain countries. In total these account for some 30 million jobs.

Source: IER estimates based on Cambridge Econometrics E3ME.

Table 6.14. **Employment trends (shares) by occupation, broad group, EU-25+ (%)**

Share	1996	2001	2006	2010	2015
Armed forces	0.6	0.6	0.6	0.6	0.5
Legislators and senior officials	0.3	0.3	0.2	0.2	0.3
Corporate managers	4.3	4.5	4.7	5.1	5.5
Managers of small enterprises	3.4	3.1	3.8	3.7	3.6
Physical, mathematical and engineering science professionals	2.9	2.9	3.0	3.2	3.3
Life science and health professionals	1.9	1.6	1.7	1.7	1.6
Teaching professionals	4.1	3.9	4.0	4.0	3.9
Other professionals	3.7	3.9	4.2	4.6	5.0
Physical and engineering science associate professionals	3.6	3.7	3.7	3.6	3.6
Life science and health associate professionals	2.5	2.7	2.7	2.6	2.6
Teaching associate professionals	1.1	1.2	1.2	1.3	1.5
Other associate professionals	7.2	7.8	8.6	9.0	9.6
Office clerks	10.8	10.1	8.9	8.3	7.6
Customer services clerks	2.0	2.0	2.1	2.2	2.3
Personal and protective services workers	8.0	8.5	8.9	9.3	9.5
Models, salespersons and demonstrators	5.2	5.5	5.1	4.9	4.8
Skilled agricultural and fishery workers	5.1	4.4	3.7	3.1	2.7
Extraction and building trades workers	5.8	5.7	6.0	5.9	5.7
Metal, machinery and related trades workers	6.2	5.7	5.0	4.7	4.3
Precision, handicraft, craft printing and related trades workers	1.0	0.8	0.7	0.6	0.5
Other craft and related trades workers	2.9	2.4	2.1	1.9	1.8
Stationary plant and related operators	1.1	1.0	1.0	0.9	0.9
Machine operators and assemblers	3.4	3.4	3.1	3.0	2.9
Drivers and mobile plant operators	4.4	4.0	4.1	4.1	4.1
Sales and services elementary occupations	5.4	6.8	7.4	7.9	8.3
Agricultural, fishery and related labourers	0.7	0.6	0.6	0.5	0.5
Labourers in mining, construction, manufacturing and transport	2.6	2.8	2.9	3.0	3.0
All occupations	*100.0*	*100.0*	*100.0*	*100.0*	*100.0*

NB: In some tables and figures in the workbooks, estimates for years before 1993 exclude data for certain countries. In total these account for some 30 million jobs.

Source: IER estimates based on Cambridge Econometrics E3ME.

Table 6.15. **Employment trends (growth) by occupation, broad group, EU-25+ (% per annum)**

Growth	1996-2001	2001-06	2006-10	2010-15	2006-15
Armed forces	-0.8	0.3	-0.4	-0.5	-0.5
Legislators and senior officials	4.5	-3.9	1.7	2.3	2.1
Corporate managers	2.2	1.3	2.7	2.3	2.5
Managers of small enterprises	-0.4	4.4	0.3	0.2	0.2
Physical, mathematical and engineering science professionals	1.7	1.3	2.1	1.4	1.7
Life science and health professionals	-2.0	1.2	0.4	0.3	0.3
Teaching professionals	0.5	1.0	0.4	0.3	0.4
Other professionals	2.5	2.0	2.7	2.6	2.6
Physical and engineering science associate professionals	2.1	0.1	0.7	0.5	0.6
Life science and health associate professionals	2.9	0.2	0.2	0.4	0.4
Teaching associate professionals	2.5	1.6	2.5	2.9	2.7
Other associate professionals	3.1	2.3	2.2	1.8	2.0
Office clerks	0.0	-2.1	-1.0	-1.3	-1.1
Customer services clerks	2.1	1.5	1.3	1.4	1.3
Personal and protective services workers	2.6	1.5	1.7	1.2	1.4
Models, salespersons and demonstrators	2.4	-1.1	-0.1	0.1	0.0
Skilled agricultural and fishery workers	-1.8	-2.8	-3.3	-2.3	-2.7
Extraction and building trades workers	0.8	1.6	0.5	-0.2	0.1
Metal, machinery and related trades workers	-0.6	-2.1	-0.5	-1.4	-1.0
Precision, handicraft, craft printing and related trades workers	-2.8	-2.2	-2.6	-2.0	-2.3
Other craft and related trades workers	-2.3	-2.7	-0.6	-1.3	-1.0
Stationary plant and related operators	0.5	0.2	-0.5	0.2	-0.1
Machine operators and assemblers	1.0	-1.4	0.3	0.0	0.2
Drivers and mobile plant operators	-0.4	1.1	0.8	0.4	0.6
Sales and services elementary occupations	6.2	2.0	2.4	1.7	2.0
Agricultural, fishery and related labourers	-1.2	0.9	-1.8	-0.8	-1.3
Labourers in mining, construction, manufacturing and transport	3.3	1.1	1.1	0.9	1.0
All occupations	*1.3*	*0.5*	*0.8*	*0.6*	*0.7*

NB: In some tables and figures in the workbooks, estimates for years before 1993 exclude data for certain countries. In total these account for some 30 million jobs.

Source: IER estimates based on Cambridge Econometrics E3ME.

Table 6.16. **Employment trends (change) by occupation, broad group, EU-25+ ('000)**

Change	1996-2001	2001-06	2006-10	2010-15	2006-15
Armed forces	-48	18	-18	-32	-51
Legislators and senior officials	119	-108	35	65	101
Corporate managers	945	626	1112	1314	2426
Managers of small enterprises	-125	1554	81	64	145
Physical, mathematical and engineering science professionals	478	406	543	509	1052
Life science and health professionals	-354	206	51	56	107
Teaching professionals	195	408	130	141	271
Other professionals	943	847	994	1338	2332
Physical and engineering science associate professionals	755	48	212	202	414
Life science and health associate professionals	751	60	53	129	182
Teaching associate professionals	282	198	268	441	709
Other associate professionals	2301	1913	1613	1820	3434
Office clerks	51	-2096	-719	-1131	-1851
Customer services clerks	405	324	235	342	578
Personal and protective services workers	2089	1351	1307	1207	2514
Models, salespersons and demonstrators	1244	-579	-31	45	14
Skilled agricultural and fishery workers	-869	-1171	-972	-735	-1707
Extraction and building trades workers	452	940	254	-133	121
Metal, machinery and related trades workers	-330	-1181	-202	-710	-911
Precision, handicraft, craft printing and related trades workers	-251	-171	-146	-127	-273
Other craft and related trades workers	-620	-637	-101	-260	-361
Stationary plant and related operators	47	22	-43	19	-24
Machine operators and assemblers	339	-462	89	8	98
Drivers and mobile plant operators	-152	451	278	184	461
Sales and services elementary occupations	3684	1476	1527	1535	3062
Agricultural, fishery and related labourers	-72	53	-86	-48	-134
Labourers in mining, construction, manufacturing and transport	870	314	278	295	572
All occupations	*13131*	*4811*	*6743*	*6537*	*13280*

NB: In some tables and figures in the workbooks, estimates for years before 1993 exclude data for certain countries. In total these account for some 30 million jobs.

Source: IER estimates based on Cambridge Econometrics E3ME.

6.2.2.3. *Replacement demand*

As was the case in Greece, these are based on the cohort component approach described in Chapter 5. The estimates reflect particular occupational structures within each country, as revealed by the LFS data. The rates of outflow used to estimate replacement needs are not customised to reflect detailed sectoral differences.

Aggregate replacement needs by qualification have also been calculated. These do not differ by occupation and, therefore, have not been used in the workbooks.

Outflow rates depend on the age structure of the particular group of workers, and other specific factors such as mortality. Important among the latter are factors relating to migration flows between countries; these have become of much greater significance in recent years. While the general framework developed here allows for these differences to be considered, its application in this publication is based on a simpler set of assumptions, so the present set of results should be regarded as illustrative. The assumptions in the workbooks allow the various components of replacement needs to be modified by the user.

Table 6.17. **Replacement demand by occupation, broad group, EU-25+**

	1996	2001	2006
Level ('000)			
Armed forces	1 245	1 197	1 215
Legislators, senior officials and managers	15 394	16 333	18 405
Professionals	24 220	25 482	27 349
Technicians and associate professionals	27 643	31 733	33 952
Clerks	24 632	25 088	23 317
Service workers and shop and market sales workers	25 385	28 717	29 490
Skilled agricultural and fishery workers	9 829	8 960	7 789
Craft and related trades workers	30 641	29 893	28 845
Plant and machine operators and assemblers	17 069	17 304	17 314
Elementary occupations	16 655	21 137	22 980
All occupations	*192 713*	*205 844*	*210 656*
Share (%)			
Armed forces	0.6	0.6	0.6
Legislators, senior officials and managers	8.0	7.9	8.7
Professionals	12.6	12.4	13.0
Technicians and associate professionals	14.3	15.4	16.1
Clerks	12.8	12.2	11.1
Service workers and shop and market sales workers	13.2	14.0	14.0
Skilled agricultural and fishery workers	5.1	4.4	3.7
Craft and related trades workers	15.9	14.5	13.7
Plant and machine operators and assemblers	8.9	8.4	8.2
Elementary occupations	8.6	10.3	10.9
All occupations	*100.0*	*100.0*	*100.0*
Growth (% per annum)	**1996-2001**	**2001-06**	**2006-10**
Armed forces	-0.8	0.3	-0.4
Legislators, senior officials and managers	1.2	2.4	1.6
Professionals	1.0	1.4	1.5
Technicians and associate professionals	2.8	1.4	1.5
Clerks	0.4	-1.5	-0.5
Service workers and shop and market sales workers	2.5	0.5	1.1
Skilled agricultural and fishery workers	-1.8	-2.8	-3.3
Craft and related trades workers	-0.5	-0.7	-0.2
Plant and machine operators and assemblers	0.3	0.0	0.5
Elementary occupations	4.9	1.7	1.8
All occupations	*1.3*	*0.5*	*0.8*

NB: In some tables and figures in the workbooks, estimates for years before 1993 exclude data for certain countries. In total these account for some 30 million jobs

2010	2015	Net change 2006-15	Replacement demand	Total requirement
1 197	1 165	-51	294	244
19 633	21 076	2 671	4 362	7034
29 067	31 111	3 762	5 747	9509
36 099	38 691	4 739	6 857	11596
22 833	22 044	-1 273	5 772	4498
30 765	32 017	2 528	8 039	10567
6 817	6 082	-1 707	2 201	494
28 650	27 420	-1 425	7 493	6067
17 639	17 850	536	4 048	4584
24 699	26 480	3 501	6 188	9689
217 399	*223 936*	*13 280*	*51 001*	*64281*
0.6	0.5	-4.2	24.2	20.1
9.0	9.4	14.5	23.7	38.2
13.4	13.9	13.8	21.0	34.8
16.6	17.3	14.0	20.2	34.2
10.5	9.8	-5.5	24.8	19.3
14.2	14.3	8.6	27.3	35.8
3.1	2.7	-21.9	28.3	6.3
13.2	12.2	-4.9	26.0	21.0
8.1	8.0	3.1	23.4	26.5
11.4	11.8	15.2	26.9	42.2
100.0	*100.0*	*6.3*	*24.2*	*30.5*
2010-15	**2006-15**			
-0.5	-0.5	-0.5	2.4	2.1
1.4	1.5	1.5	2.4	3.7
1.4	1.4	1.4	2.1	3.4
1.4	1.5	1.5	2.1	3.3
-0.7	-0.6	-0.6	2.5	2.0
0.8	0.9	0.9	2.7	3.5
-2.3	-2.7	-2.7	2.8	0.7
-0.9	-0.6	-0.6	2.6	2.1
0.2	0.3	0.3	2.4	2.6
1.4	1.6	1.6	2.7	4.0
0.6	*0.7*	*0.7*	*2.4*	*3.0*

Source: IER estimates based on Cambridge Econometrics E3ME.

6.2.3. Detailed pan-European results by country

This section presents a range of comparisons across all 27 European countries covered in the present analysis and also EU-25+. More detailed information is available using the 27 occupations and 41 industries distinguished in the full database (country workbooks).

6.2.3.1. *Prospects by sector*

Table 6.18 provides an overall summary of the employment estimates and projections by country. The table illustrates the relative sizes of the 27 countries in terms of total employment, as well as overall trends in each case.

Tables 6.19-6.24 enable comparisons across countries at more detailed sectoral level, here focusing on six broad sectors. Even at this broad level, significant variations across countries reflect their existing sectoral specialisation and stages of economic development. Despite this, some common themes emerge in terms of changes over time at this broad level, notably the declining shares of primary and manufacturing sectors and the growth in services.

Table 6.18. **Changes in employment by country**

All industries	Level ('000)				Share of EU-25+ total (%)				Change 2006-10			Change 2010-15		
	1996	2006	2010	2015	1996	2006	2010	2015	'000	%	% p.a.	'000	%	% p.a.
BE	3 881	4 256	4 420	4 556	2.0	2.0	2.0	2.0	163	3.8	0.9	137	3.1	0.6
CZ	5 195	5 076	5 148	5 247	2.7	2.4	2.4	2.3	72	1.4	0.4	99	1.9	0.4
DK	2 584	2 776	2 824	2 828	1.3	1.3	1.3	1.3	48	1.7	0.4	4	0.1	0.0
DE	37 270	38 095	39 014	40 068	19.3	18.1	17.9	17.9	918	2.4	0.6	1054	2.7	0.5
EE	609	634	614	610	0.3	0.3	0.3	0.3	-20	-3.2	-0.8	-4	-0.6	-0.1
EL	3 805	4 203	4 398	4 522	2.0	2.0	2.0	2.0	195	4.6	1.1	125	2.8	0.6
ES	13 744	19 181	19 892	20 453	7.1	9.1	9.2	9.1	711	3.7	0.9	561	2.8	0.6
FR	22 780	25 135	25 993	26 913	11.8	11.9	12.0	12.0	858	3.4	0.8	920	3.5	0.7
IE	1 330	1 982	2 095	2 229	0.7	0.9	1.0	1.0	113	5.7	1.4	134	6.4	1.2
IT	21 968	24 369	25 198	25 996	11.4	11.6	11.6	11.6	829	3.4	0.8	799	3.2	0.6
CY	300	375	408	458	0.2	0.2	0.2	0.2	34	9.0	2.2	50	12.2	2.3
LV	944	1 034	1 057	1 053	0.5	0.5	0.5	0.5	22	2.1	0.5	-4	-0.4	-0.1
LT	1 496	1 482	1 522	1 543	0.8	0.7	0.7	0.7	40	2.7	0.7	21	1.4	0.3
LU	220	311	328	351	0.1	0.1	0.2	0.2	17	5.5	1.3	23	7.0	1.4
HU	3 605	3 925	3 985	4 099	1.9	1.9	1.8	1.8	60	1.5	0.4	115	2.9	0.6
MT	142	150	157	164	0.1	0.1	0.1	0.1	7	4.4	1.1	8	4.9	1.0
NL	7 307	8 265	8 596	8 867	3.8	3.9	4.0	4.0	331	4.0	1.0	271	3.1	0.6
AT	3 904	4 102	4 218	4 389	2.0	1.9	1.9	2.0	116	2.8	0.7	171	4.1	0.8
PL	13 745	13 356	13 758	14 032	7.1	6.3	6.3	6.3	402	3.0	0.7	274	2.0	0.4
PT	4 555	5 025	5 132	5 345	2.4	2.4	2.4	2.4	106	2.1	0.5	213	4.2	0.8
SI	894	904	943	977	0.5	0.4	0.4	0.4	39	4.3	1.1	34	3.6	0.7
SK	2 156	2 086	2 116	2 104	1.1	1.0	1.0	0.9	30	1.4	0.4	-12	-0.6	-0.1
FI	2 084	2 385	2 391	2 408	1.1	1.1	1.1	1.1	5	0.2	0.1	18	0.7	0.1
SE	4 066	4 311	4 364	4 407	2.1	2.0	2.0	2.0	53	1.2	0.3	43	1.0	0.2
UK	28 021	30 584	31 835	33 212	14.5	14.5	14.6	14.8	1 251	4.1	1.0	1 377	4.3	0.9
NO	2 152	2 399	2 478	2 552	1.1	1.1	1.1	1.1	80	3.3	0.8	74	3.0	0.6
CH	3 957	4 252	4 517	4 551	2.1	2.0	2.1	2.0	265	6.2	1.5	34	0.8	0.2
EU-25+	192 714	210 656	217 399	223 936	100.0	100.0	100.0	100.0	6 743	3.2	0.8	6 537	3.0	0.6
EU-25	186 604	204 005	210 403	216 832	96.8	96.8	96.8	96.8	6 399	3.1	0.8	6 429	3.1	0.6

NB: In some tables and figures in the workbooks, estimates for years before 1993 exclude data for certain countries. In total these account for some 30 million jobs.

Source: IER estimates based on Cambridge Econometrics E3ME.

Table 6.19. **Changes in employment by country, primary sector and utilities**

	Level ('000)				Share of EU-25+ total (%)				Change 2006-10			Change 2010-15		
	1996	2006	2010	2015	1996	2006	2010	2015	'000	%	% p.a.	'000	%	% p.a.
BE	137	110	100	89	0.9	0.9	0.9	0.9	-10	-8.8	-2.3	-11	-10.7	-2.2
CZ	495	303	293	281	3.3	2.5	2.7	2.9	-11	-3.6	-0.9	-11	-3.8	-0.8
DK	133	114	102	95	0.9	1.0	1.0	1.0	-13	-11.2	-2.9	-7	-6.7	-1.4
DE	1 541	1 197	1 063	953	10.2	10.0	10.0	9.9	-134	-11.2	-2.9	-110	-10.4	-2.2
EE	75	47	43	36	0.5	0.4	0.4	0.4	-4	-9.1	-2.4	-7	-16.1	-3.4
EL	798	607	564	518	5.3	5.1	5.3	5.4	-43	-7.0	-1.8	-46	-8.2	-1.7
ES	1 211	1 104	916	734	8.0	9.3	8.6	7.6	-189	-17.1	-4.6	-182	-19.9	-4.3
FR	1 247	1 082	1 041	1 076	8.3	9.1	9.8	11.2	-40	-3.7	-0.9	34	3.3	0.6
IE	158	133	119	110	1.1	1.1	1.1	1.1	-14	-10.7	-2.8	-9	-7.9	-1.6
IT	1 458	1 046	963	801	9.7	8.8	9.0	8.3	-83	-7.9	-2.0	-162	-16.8	-3.6
CY	23	18	18	18	0.2	0.2	0.2	0.2	0	0.0	0.0	0	0.0	0.0
LV	182	139	122	99	1.2	1.2	1.1	1.0	-17	-12.1	-3.2	-23	-18.8	-4.1
LT	346	215	165	123	2.3	1.8	1.5	1.3	-50	-23.3	-6.4	-42	-25.4	-5.7
LU	6	6	6	5	0.0	0.0	0.1	0.1	0	-1.8	-0.4	0	-7.1	-1.5
HU	424	274	256	239	2.8	2.3	2.4	2.5	-18	-6.5	-1.7	-17	-6.6	-1.4
MT	7	6	5	5	0.0	0.0	0.1	0.1	0	-5.3	-1.3	0	-3.7	-0.8
NL	343	301	290	277	2.3	2.5	2.7	2.9	-11	-3.6	-0.9	-13	-4.4	-0.9
AT	637	534	515	487	4.2	4.5	4.8	5.1	-19	-3.5	-0.9	-28	-5.5	-1.1
PL	3 380	2 752	2 263	2 018	22.5	23.1	21.2	21.0	-490	-17.8	-4.8	-245	-10.8	-2.3
PT	587	534	510	483	3.9	4.5	4.8	5.0	-24	-4.4	-1.1	-27	-5.4	-1.1
SI	143	106	90	74	0.9	0.9	0.8	0.8	-16	-15.4	-4.1	-15	-17.1	-3.7
SK	234	125	113	102	1.6	1.1	1.1	1.1	-12	-9.6	-2.5	-11	-9.6	-2.0
FI	179	134	121	110	1.2	1.1	1.1	1.1	-13	-9.8	-2.5	-10	-8.5	-1.8
SE	164	143	136	129	1.1	1.2	1.3	1.3	-6	-4.6	-1.2	-7	-5.4	-1.1
UK	784	590	598	548	5.2	4.9	5.6	5.7	8	1.3	0.3	-50	-8.4	-1.7
NO	145	122	106	89	1.0	1.0	1.0	0.9	-17	-13.5	-3.6	-17	-16.0	-3.4
CH	215	176	151	130	1.4	1.5	1.4	1.3	-26	-14.6	-3.9	-21	-13.7	-2.9
EU-25+	15 052	11 917	10 667	9 629	100.0	100.0	100.0	100.0	-1251	-10.5	-2.7	-1038	-9.7	-2.0
EU-25	14 692	11 619	10 411	9 410	97.6	97.5	97.6	97.7	-1208	-10.4	-2.7	-1000	-9.6	-2.0

NB: In some tables and figures in the workbooks, estimates for years before 1993 exclude data for certain countries. In total these account for some 30 million jobs.

Source: IER estimates based on Cambridge Econometrics E3ME.

Table 6.20. **Changes in employment by country, manufacturing**

Manufacturing	Level ('000)				Share of EU-25+ total (%)				Change 2006-10			Change 2010-15		
	1996	2006	2010	2015	1996	2006	2010	2015	'000	%	% p.a.	'000	%	% p.a.
BE	669	596	568	538	1.8	1.7	1.6	1.6	-28	-4.7	-1.2	-30	-5.3	-1.1
CZ	1 458	1 356	1 394	1 445	3.9	3.9	4.0	4.2	38	2.8	0.7	51	3.7	0.7
DK	456	409	387	381	1.2	1.2	1.1	1.1	-22	-5.4	-1.4	-6	-1.6	-0.3
DE	8 212	7 400	7 637	7 285	21.7	21.2	21.7	21.2	237	3.2	0.8	-352	-4.6	-0.9
EE	148	135	141	144	0.4	0.4	0.4	0.4	6	4.3	1.1	4	2.6	0.5
EL	626	566	568	558	1.7	1.6	1.6	1.6	2	0.4	0.1	-10	-1.8	-0.4
ES	2 513	3 071	3 051	2 990	6.6	8.8	8.7	8.7	-20	-0.6	-0.2	-61	-2.0	-0.4
FR	3 678	3 392	3 314	3 230	9.7	9.7	9.4	9.4	-78	-2.3	-0.6	-85	-2.5	-0.5
IE	256	270	263	262	0.7	0.8	0.7	0.8	-7	-2.8	-0.7	-1	-0.3	-0.1
IT	5 005	4 971	4 985	4 933	13.2	14.3	14.1	14.3	14	0.3	0.1	-52	-1.1	-0.2
CY	42	37	38	39	0.1	0.1	0.1	0.1	1	3.2	0.8	1	1.6	0.3
LV	179	164	164	148	0.5	0.5	0.5	0.4	0	-0.1	0.0	-16	-9.9	-2.1
LT	278	256	248	234	0.7	0.7	0.7	0.7	-8	-3.2	-0.8	-15	-5.9	-1.2
LU	31	32	33	33	0.1	0.1	0.1	0.1	1	3.5	0.9	0	1.2	0.2
HU	851	869	838	805	2.3	2.5	2.4	2.3	-32	-3.6	-0.9	-32	-3.9	-0.8
MT	33	29	29	28	0.1	0.1	0.1	0.1	0	-0.3	-0.1	0	-0.4	-0.1
NL	1 051	969	1 000	950	2.8	2.8	2.8	2.8	31	3.2	0.8	-50	-5.0	-1.0
AT	685	644	626	612	1.8	1.8	1.8	1.8	-18	-2.7	-0.7	-15	-2.3	-0.5
PL	3 096	2 637	3 065	3 091	8.2	7.6	8.7	9.0	429	16.3	3.8	25	0.8	0.2
PT	989	879	845	854	2.6	2.5	2.4	2.5	-33	-3.8	-1.0	9	1.0	0.2
SI	269	242	244	246	0.7	0.7	0.7	0.7	3	1.0	0.3	2	0.9	0.2
SK	590	498	499	447	1.6	1.4	1.4	1.3	1	0.2	0.1	-52	-10.4	-2.2
FI	417	417	402	394	1.1	1.2	1.1	1.1	-16	-3.7	-0.9	-8	-2.0	-0.4
SE	742	702	708	727	2.0	2.0	2.0	2.1	6	0.9	0.2	19	2.7	0.5
UK	4 480	3 391	3 223	3 060	11.9	9.7	9.1	8.9	-168	-4.9	-1.3	-163	-5.1	-1.0
NO	304	280	284	285	0.8	0.8	0.8	0.8	4	1.4	0.3	1	0.5	0.1
CH	742	661	702	698	2.0	1.9	2.0	2.0	42	6.3	1.5	-5	-0.7	-0.1
EU-25+	37 802	34 871	35 256	34 414	100.0	100.0	100.0	100.0	385	1.1	0.3	-842	-2.4	-0.5
EU-25	36 755	33 931	34 270	33 431	97.2	97.3	97.2	97.1	339	1.0	0.2	-838	-2.4	-0.5

NB: In some tables and figures in the workbooks, estimates for years before 1993 exclude data for certain countries. In total these account for some 30 million jobs.

Source: IER estimates based on Cambridge Econometrics E3ME.

Table 6.21. **Changes in employment by country, construction**

Construct-ion	Level ('000)				Share of EU-25+ total (%)				Change 2006-10			Change 2010-15		
	1996	2006	2010	2015	1996	2006	2010	2015	'000	%	% p.a.	'000	%	% p.a.
BE	233	247	258	263	1.7	1.6	1.7	1.7	11	4.5	1.1	5	1.8	0.4
CZ	508	432	415	395	3.7	2.9	2.7	2.5	-17	-3.9	-1.0	-20	-4.9	-1.0
DK	148	174	181	177	1.1	1.1	1.2	1.1	7	4.0	1.0	-5	-2.5	-0.5
DE	3 126	2 139	2 087	2 024	22.8	14.1	13.4	13.0	-52	-2.4	-0.6	-64	-3.0	-0.6
EE	35	58	47	43	0.3	0.4	0.3	0.3	-11	-19.7	-5.3	-3	-7.3	-1.5
EL	252	348	396	402	1.8	2.3	2.5	2.6	48	13.9	3.3	6	1.5	0.3
ES	1 243	2 383	2 487	2 392	9.1	15.7	15.9	15.3	104	4.4	1.1	-95	-3.8	-0.8
FR	1 426	1 601	1 661	1 657	10.4	10.6	10.6	10.6	60	3.7	0.9	-4	-0.2	0.0
IE	101	251	259	268	0.7	1.7	1.7	1.7	9	3.4	0.8	9	3.3	0.6
IT	1 469	1 831	1 801	1 765	10.7	12.1	11.5	11.3	-29	-1.6	-0.4	-36	-2.0	-0.4
CY	28	37	41	48	0.2	0.2	0.3	0.3	5	12.5	3.0	7	16.0	3.0
LV	51	90	98	105	0.4	0.6	0.6	0.7	8	8.8	2.1	7	7.2	1.4
LT	99	146	195	205	0.7	1.0	1.2	1.3	49	33.3	7.4	10	5.1	1.0
LU	24	30	31	33	0.2	0.2	0.2	0.2	1	4.7	1.2	2	6.1	1.2
HU	218	319	355	408	1.6	2.1	2.3	2.6	37	11.6	2.8	52	14.7	2.8
MT	6	8	9	10	0.0	0.1	0.1	0.1	1	14.1	3.4	1	9.0	1.7
NL	445	499	524	557	3.2	3.3	3.4	3.6	25	4.9	1.2	33	6.2	1.2
AT	297	267	265	263	2.2	1.8	1.7	1.7	-2	-0.7	-0.2	-2	-0.9	-0.2
PL	843	678	812	802	6.1	4.5	5.2	5.1	134	19.8	4.6	-11	-1.3	-0.3
PT	398	462	472	484	2.9	3.1	3.0	3.1	9	2.0	0.5	12	2.5	0.5
SI	58	66	74	82	0.4	0.4	0.5	0.5	8	12.1	2.9	8	10.4	2.0
SK	158	138	154	161	1.2	0.9	1.0	1.0	16	11.4	2.7	7	4.6	0.9
FI	123	166	170	175	0.9	1.1	1.1	1.1	4	2.2	0.6	5	2.9	0.6
SE	209	248	211	202	1.5	1.6	1.4	1.3	-38	-15.1	-4.0	-9	-4.3	-0.9
UK	1 797	2 073	2 136	2 216	13.1	13.7	13.7	14.2	62	3.0	0.7	81	3.8	0.7
NO	120	145	148	152	0.9	1.0	0.9	1.0	3	2.0	0.5	4	2.4	0.5
CH	314	306	313	300	2.3	2.0	2.0	1.9	7	2.3	0.6	-13	-4.0	-0.8
EU-25+	13 729	15 141	15 598	15 583	100.0	100.0	100.0	100.0	457	3.0	0.7	-15	-0.1	0.0
EU-25	13 295	14 690	15 137	15 131	96.8	97.0	97.0	97.1	447	3.0	0.8	-6	0.0	0.0

NB: In some tables and figures in the workbooks, estimates for years before 1993 exclude data for certain countries. In total these account for some 30 million jobs.

Source: IER estimates based on Cambridge Econometrics E3ME.

Table 6.22. **Changes in employment by country, distribution and transport**

Distribut-ion and transport	Level ('000)				Share of EU-25+ total (%)				Change 2006-10			Change 2010-15		
	1996	2006	2010	2015	1996	2006	2010	2015	'000	%	% p.a.	'000	%	% p.a.
BE	982	1 050	1 094	1 107	2.0	1.9	1.9	1.9	43	4.1	1.0	13	1.2	0.2
CZ	1 259	1 287	1 324	1 364	2.6	2.4	2.4	2.4	37	2.8	0.7	40	3.0	0.6
DK	661	719	729	724	1.4	1.3	1.3	1.3	10	1.4	0.3	-4	-0.6	-0.1
DE	9 326	9 482	9 645	9 758	19.3	17.5	17.2	16.9	162	1.7	0.4	113	1.2	0.2
EE	160	170	160	155	0.3	0.3	0.3	0.3	-10	-6.2	-1.6	-4	-2.7	-0.5
EL	1 027	1 272	1 382	1 490	2.1	2.3	2.5	2.6	110	8.7	2.1	109	7.9	1.5
ES	3 747	5 333	5 775	6 194	7.7	9.8	10.3	10.7	442	8.3	2.0	419	7.3	1.4
FR	5 169	5 933	6 131	6 322	10.7	10.9	10.9	10.9	198	3.3	0.8	191	3.1	0.6
IE	322	518	545	579	0.7	1.0	1.0	1.0	27	5.2	1.3	34	6.3	1.2
IT	5 346	5 937	6 013	6 102	11.1	10.9	10.7	10.6	77	1.3	0.3	89	1.5	0.3
CY	104	133	144	156	0.2	0.2	0.3	0.3	10	7.6	1.8	13	8.9	1.7
LV	217	287	295	298	0.4	0.5	0.5	0.5	9	3.0	0.8	3	1.0	0.2
LT	325	387	424	466	0.7	0.7	0.8	0.8	37	9.4	2.3	43	10.1	1.9
LU	62	83	88	96	0.1	0.2	0.2	0.2	5	5.8	1.4	8	8.5	1.6
HU	922	1 029	1 053	1 070	1.9	1.9	1.9	1.9	24	2.3	0.6	17	1.6	0.3
MT	38	41	45	49	0.1	0.1	0.1	0.1	3	7.7	1.9	5	10.3	2.0
NL	1 873	2 168	2 237	2 308	3.9	4.0	4.0	4.0	69	3.2	0.8	71	3.2	0.6
AT	1 047	1 135	1 159	1 191	2.2	2.1	2.1	2.1	24	2.1	0.5	32	2.7	0.5
PL	2 954	2 997	3 116	3 229	6.1	5.5	5.6	5.6	119	4.0	1.0	113	3.6	0.7
PT	1 014	1 275	1 393	1 506	2.1	2.4	2.5	2.6	118	9.3	2.2	113	8.1	1.6
SI	194	200	216	226	0.4	0.4	0.4	0.4	16	7.8	1.9	10	4.5	0.9
SK	494	584	564	557	1.0	1.1	1.0	1.0	-21	-3.6	-0.9	-6	-1.1	-0.2
FI	476	557	559	563	1.0	1.0	1.0	1.0	2	0.3	0.1	4	0.7	0.1
SE	902	958	976	995	1.9	1.8	1.7	1.7	18	1.9	0.5	18	1.9	0.4
UK	8 014	8 931	9 243	9 457	16.6	16.5	16.5	16.4	313	3.5	0.9	213	2.3	0.5
NO	568	617	633	656	1.2	1.1	1.1	1.1	16	2.6	0.6	23	3.6	0.7
CH	1 153	1 158	1 139	1 123	2.4	2.1	2.0	1.9	-20	-1.7	-0.4	-16	-1.4	-0.3
EU-25+	48 356	54 242	56 078	57 740	100.0	100.0	100.0	100.0	1836	3.4	0.8	1662	3.0	0.6
EU-25	46 635	52 466	54 306	55 961	96.4	96.7	96.8	96.9	1840	3.5	0.9	1655	3.0	0.6

NB: In some tables and figures in the workbooks, estimates for years before 1993 exclude data for certain countries. In total these account for some 30 million jobs.

Source: IER estimates based on Cambridge Econometrics E3ME.

Table 6.23. **Changes in employment by country, business and other services**

Business and other services	Level ('000)				Share of EU-25+ total (%)				Change 2006-10			Change 2010-15		
	1996	2006	2010	2015	1996	2006	2010	2015	'000	%	% p.a.	'000	%	% p.a.
BE	808	1 021	1 111	1 213	2.4	2.2	2.2	2.2	90	8.8	2.1	102	9.2	1.8
CZ	646	831	867	914	1.9	1.8	1.7	1.7	35	4.2	1.0	47	5.4	1.1
DK	414	525	561	563	1.2	1.1	1.1	1.0	37	7.0	1.7	2	0.3	0.1
DE	6 748	9 005	9 452	10 367	19.8	19.7	19.0	19.0	447	5.0	1.2	915	9.7	1.9
EE	65	89	91	99	0.2	0.2	0.2	0.2	2	2.5	0.6	7	8.1	1.6
EL	432	641	690	724	1.3	1.4	1.4	1.3	50	7.7	1.9	34	4.9	1.0
ES	2 290	3 761	4 011	4 330	6.7	8.2	8.1	7.9	250	6.7	1.6	320	8.0	1.5
FR	4 587	5 920	6 413	6 900	13.5	13.0	12.9	12.6	492	8.3	2.0	488	7.6	1.5
IE	209	392	452	510	0.6	0.9	0.9	0.9	60	15.4	3.6	58	12.9	2.5
IT	4 329	6 042	6 726	7 474	12.7	13.2	13.6	13.7	684	11.3	2.7	748	11.1	2.1
CY	50	78	95	118	0.1	0.2	0.2	0.2	16	20.7	4.8	23	24.4	4.5
LV	101	139	150	158	0.3	0.3	0.3	0.3	11	8.1	2.0	8	5.3	1.0
LT	120	159	173	189	0.4	0.3	0.3	0.3	14	8.6	2.1	16	9.4	1.8
LU	60	108	117	128	0.2	0.2	0.2	0.2	8	7.8	1.9	12	9.9	1.9
HU	382	546	591	664	1.1	1.2	1.2	1.2	45	8.3	2.0	73	12.3	2.4
MT	24	29	32	34	0.1	0.1	0.1	0.1	2	7.5	1.8	2	7.3	1.4
NL	1 889	2 267	2 444	2 607	5.6	5.0	4.9	4.8	178	7.8	1.9	163	6.7	1.3
AT	507	691	783	917	1.5	1.5	1.6	1.7	92	13.3	3.2	134	17.1	3.2
PL	1 195	1 693	1 866	2 212	3.5	3.7	3.8	4.1	173	10.2	2.5	346	18.5	3.5
PT	692	835	875	987	2.0	1.8	1.8	1.8	40	4.8	1.2	112	12.8	2.4
SI	101	130	151	166	0.3	0.3	0.3	0.3	21	16.3	3.8	15	9.9	1.9
SK	233	287	325	354	0.7	0.6	0.7	0.6	38	13.2	3.1	29	8.8	1.7
FI	303	426	451	482	0.9	0.9	0.9	0.9	25	5.9	1.4	31	6.9	1.3
SE	718	885	979	1 043	2.1	1.9	2.0	1.9	94	10.6	2.6	64	6.6	1.3
UK	6 060	7 722	8 519	9 601	17.8	16.9	17.2	17.6	797	10.3	2.5	1082	12.7	2.4
NO	291	409	451	491	0.9	0.9	0.9	0.9	42	10.4	2.5	39	8.7	1.7
CH	768	1 009	1 252	1 316	2.3	2.2	2.5	2.4	243	24.1	5.6	64	5.1	1.0
EU-25+	34 022	45 638	49 626	54 559	100.0	100.0	100.0	100.0	3988	8.7	2.1	4933	9.9	1.9
EU-25	32 962	44 220	47 922	52 753	96.9	96.9	96.6	96.7	3702	8.4	2.0	4831	10.1	1.9

NB: In some tables and figures in the workbooks, estimates for years before 1993 exclude data for certain countries. In total these account for some 30 million jobs.

Source: IER estimates based on Cambridge Econometrics E3ME.

Table 6.24. **Changes in employment by country, non-marketed services**

Non-marketed services	Level ('000)				Share of EU-25+ total (%)				Change 2006-10			Change 2010-15		
	1996	2006	2010	2015	1996	2006	2010	2015	'000	%	% p.a.	'000	%	% p.a.
BE	1 053	1 232	1 289	1 347	2.4	2.5	2.6	2.6	57	4.6	1.1	58	4.5	0.9
CZ	828	866	856	848	1.9	1.8	1.7	1.6	-10	-1.1	-0.3	-8	-0.9	-0.2
DK	772	836	865	889	1.8	1.7	1.7	1.7	29	3.5	0.9	24	2.8	0.6
DE	8 317	8 871	9 129	9 682	19.0	18.2	18.2	18.6	258	2.9	0.7	553	6.1	1.2
EE	125	135	133	133	0.3	0.3	0.3	0.3	-2	-1.6	-0.4	0	-0.2	0.0
EL	671	770	798	831	1.5	1.6	1.6	1.6	28	3.6	0.9	33	4.1	0.8
ES	2 740	3 530	3 653	3 814	6.3	7.2	7.3	7.3	123	3.5	0.9	161	4.4	0.9
FR	6 673	7 207	7 433	7 729	15.3	14.8	14.8	14.9	226	3.1	0.8	296	4.0	0.8
IE	284	418	457	500	0.6	0.9	0.9	1.0	39	9.3	2.3	43	9.5	1.8
IT	4 361	4 543	4 709	4 921	10.0	9.3	9.4	9.5	167	3.7	0.9	212	4.5	0.9
CY	54	71	73	79	0.1	0.1	0.1	0.2	2	2.3	0.6	7	9.5	1.8
LV	214	216	227	245	0.5	0.4	0.5	0.5	11	5.3	1.3	17	7.5	1.5
LT	328	319	318	327	0.7	0.7	0.6	0.6	-1	-0.2	0.0	9	2.8	0.6
LU	36	52	54	56	0.1	0.1	0.1	0.1	1	2.7	0.7	2	3.5	0.7
HU	809	889	892	914	1.8	1.8	1.8	1.8	3	0.4	0.1	22	2.4	0.5
MT	34	37	38	38	0.1	0.1	0.1	0.1	0	1.3	0.3	0	0.8	0.2
NL	1 706	2 061	2 102	2 168	3.9	4.2	4.2	4.2	40	2.0	0.5	66	3.1	0.6
AT	731	832	870	921	1.7	1.7	1.7	1.8	38	4.6	1.1	51	5.8	1.1
PL	2 277	2 599	2 636	2 681	5.2	5.3	5.3	5.2	37	1.4	0.4	45	1.7	0.3
PT	875	1 042	1 037	1 032	2.0	2.1	2.1	2.0	-5	-0.4	-0.1	-5	-0.5	-0.1
SI	130	160	168	183	0.3	0.3	0.3	0.4	8	5.1	1.3	14	8.6	1.7
SK	445	453	462	483	1.0	0.9	0.9	0.9	8	1.8	0.5	22	4.7	0.9
FI	586	685	688	684	1.3	1.4	1.4	1.3	4	0.5	0.1	-4	-0.6	-0.1
SE	1 331	1 375	1 354	1 311	3.0	2.8	2.7	2.5	-22	-1.6	-0.4	-43	-3.2	-0.6
UK	6 886	7 878	8 117	8 331	15.7	16.1	16.2	16.0	239	3.0	0.7	215	2.6	0.5
NO	724	826	857	881	1.7	1.7	1.7	1.7	31	3.7	0.9	24	2.8	0.6
CH	765	943	961	985	1.7	1.9	1.9	1.9	19	2.0	0.5	24	2.5	0.5
EU-25+	43 753	48 846	50 175	52 011	100.0	100.0	100.0	100.0	1329	2.7	0.7	1837	3.7	0.7
EU-25	42 265	47 078	48 357	50 145	96.6	96.4	96.4	96.4	1279	2.7	0.7	1789	3.7	0.7

NB: In some tables and figures in the workbooks, estimates for years before 1993 exclude data for certain countries. In total these account for some 30 million jobs.

Source: IER estimates based on Cambridge Econometrics E3ME.

6.2.3.2. *Prospects by occupation*

Tables 6.25 to 6.28 illustrate how occupational employment structures vary across Europe, as well as showing how changes over time compare. In the sectors, there are many common themes but also many differences, especially at more detailed levels.

These results are crucially dependent on:

(a) the original LFS data;

(b) the method used for projections.

Chapter 4 discusses these points in some detail. It is clear that there is considerable room for improvement in the basic data.

Table 6.25. **Occupational employment by country 2006 ('000)**

OMG	0	1	2	3	4	5	6	7	8	9	All
BE	30	489	884	498	645	451	90	412	349	408	4 256
CZ	16	339	559	1 119	352	631	79	891	785	305	5 076
DK	16	220	420	578	269	437	70	297	172	298	2 776
DE	193	2 162	5 025	7 963	4 687	5 124	671	5 639	2 602	4 031	38 095
EE	4	80	98	79	28	77	12	103	96	57	634
EL	43	430	475	313	455	594	529	634	351	380	4 203
ES	101	1 322	2 038	2 018	1 689	3 069	553	3 198	1 811	3 382	19 181
FR	279	2 082	3 382	4 341	3 020	3 122	946	2 926	2 220	2 816	25 135
IE	6	320	308	126	260	318	15	286	174	168	1 982
IT	237	2 153	1 925	4 845	2 549	3 027	488	4 169	2 183	2 793	24 369
CY	4	12	42	44	57	66	10	50	25	64	375
LV	0	137	117	143	50	113	66	170	108	130	1 034
LT	6	135	254	129	58	167	136	289	145	164	1 482
LU	1	24	51	45	47	29	4	39	22	48	311
HU	17	298	525	535	359	566	116	708	478	323	3 925
MT	1	13	18	25	18	21	2	17	16	20	150
NL	33	848	1 391	1 396	1 061	1 186	122	787	470	971	8 265
AT	10	275	375	760	468	520	453	502	252	489	4 102
PL	61	889	2 094	1 530	1 010	1 287	2 125	2 129	1 228	1 003	13 356
PT	34	400	484	492	521	708	470	929	385	603	5 025
SI	4	63	145	152	73	90	69	108	137	62	904
SK	11	131	245	404	138	314	22	345	298	177	2 086
FI	12	233	391	393	158	397	104	297	192	206	2 385
SE	9	211	735	859	408	821	99	427	463	279	4 311
UK	71	4 703	4 377	3 762	4 194	5 168	313	2 603	1 960	3 433	30 584
NO	11	152	262	567	183	585	68	253	179	141	2 399
CH	4	280	727	836	560	604	156	641	214	230	4 252
EU-25+	1 215	1 8405	27 349	33 952	23 317	29 490	7 789	28 845	17 314	22 980	210 656
EU-25	1 200	1 7973	26 360	32 549	22 574	28 301	7 565	27 952	16 921	22 608	204 005

NB: In some tables and figures in the workbooks, estimates for years before 1993 exclude data for certain countries. In total these account for some 30 million jobs.

Source: IER estimates based on Cambridge Econometrics E3ME.

OMG = Occupation major group

- **0** armed forces
- **1** legislators, senior officials and managers
- **2** professionals
- **3** technicians and associate professionals
- **4** clerk
- **5** service workers and shop and market sales workers
- **6** skilled agricultural and fishery workers
- **7** craft and related trades workers
- **8** plant and machine operators and assemblers
- **9** elementary occupations

Table 6.26. **Projected employment by country and occupation ('000)**

OMG	0	1	2	3	4	5	6	7	8	9	All
BE	-10	66	48	128	1	26	-11	-59	93	19	300
CZ	1	-3	22	193	-7	2	-13	-136	171	-58	171
DK	0	20	88	86	-55	-24	-14	-26	-25	0	52
DE	8	-83	518	325	-576	856	-144	135	-36	967	1972
EE	1	-8	-1	-8	-1	15	-7	-25	3	7	-24
EL	3	7	29	107	22	144	-96	-16	37	82	320
ES	27	10	230	915	-160	538	-302	-233	-83	329	1272
FR	-37	333	317	455	-317	138	0	-181	-57	1127	1778
IE	-3	62	71	48	7	50	-5	11	-6	12	247
IT	-5	571	358	1262	239	250	-232	-773	-228	185	1628
CY	-1	3	13	16	17	-3	-3	4	2	35	84
LV	0	38	14	7	6	9	-30	-9	-17	-2	18
LT	10	-25	74	10	-19	26	-64	27	0	23	61
LU	0	2	15	10	0	7	-1	-7	2	11	40
HU	-13	92	66	-11	28	36	-15	-104	54	42	175
MT	1	4	-3	4	-2	4	0	2	-3	6	14
NL	-11	-100	117	96	136	139	-28	-38	-22	312	602
AT	0	26	64	186	-7	20	-32	-52	-51	133	287
PL	1	183	586	137	97	-212	-624	361	88	59	676
PT	-9	45	197	4	34	15	-21	-78	69	63	319
SI	0	19	58	40	-18	-5	-25	10	-13	8	73
SK	5	10	26	31	-31	45	-2	-43	-6	-17	18
FI	-2	120	23	45	-62	33	-30	-31	-28	-44	23
SE	-5	20	30	38	-45	69	4	-51	5	31	96
UK	-6	1235	516	420	-484	238	61	-98	564	181	2629
NO	-4	-40	62	114	-34	101	-34	3	-5	-11	153
CH	0	62	222	80	-41	7	-39	-19	27	-1	299
EU-25+	-51	2 671	3 762	4 739	-1 273	2 528	-1 707	-1 425	536	3 501	13 280
EU-25	-47	2 649	3 477	4 545	-1 198	2 419	-1 634	-1 410	514	3 512	12 828

NB: In some tables and figures in the workbooks, estimates for years before 1993 exclude data for certain countries. In total these account for some 30 million jobs.

Source: IER estimates based on Cambridge Econometrics E3ME.

OMG = Occupation major group

0 armed forces
1 legislators, senior officials and managers
2 professionals
3 technicians and associate professionals
4 clerk
5 service workers and shop and market sales workers
6 skilled agricultural and fishery workers
7 craft and related trades workers
8 plant and machine operators and assemblers
9 elementary occupations

Table 6.27. **Projected employment growth by country and occupation (%)**

OMG	0	1	2	3	4	5	6	7	8	9	All
BE	-33.5	13.5	5.4	25.7	0.1	5.8	-12.6	-14.4	26.5	4.6	7.0
CZ	3.9	-1.0	3.9	17.3	-2.0	0.3	-17.0	-15.2	21.7	-19.1	3.4
DK	-0.5	9.2	21.0	14.9	-20.5	-5.4	-20.6	-8.7	-14.3	0.1	1.9
DE	4.3	-3.8	10.3	4.1	-12.3	16.7	-21.4	2.4	-1.4	24.0	5.2
EE	24.2	-10.4	-1.1	-10.5	-3.7	19.8	-59.7	-24.4	3.6	12.9	-3.8
EL	6.3	1.7	6.1	34.1	4.9	24.2	-18.2	-2.5	10.6	21.6	7.6
ES	26.4	0.8	11.3	45.3	-9.5	17.5	-54.6	-7.3	-4.6	9.7	6.6
FR	-13.3	16.0	9.4	10.5	-10.5	4.4	0.0	-6.2	-2.6	40.0	7.1
IE	-44.4	19.2	23.1	37.9	2.7	15.7	-33.4	3.7	-3.7	7.4	12.4
IT	-2.2	26.5	18.6	26.1	9.4	8.3	-47.5	-18.5	-10.4	6.6	6.7
CY	-19.6	28.6	32.1	36.2	29.2	-4.1	-25.1	7.8	6.8	53.8	22.3
LV	0.0	27.7	12.1	5.2	12.4	8.4	-45.7	-5.3	-15.5	-1.2	1.7
LT	165.6	-18.9	29.3	8.0	-32.9	15.6	-47.3	9.2	-0.1	13.9	4.1
LU	-31.4	7.4	30.0	21.3	0.0	24.8	-12.5	-17.3	9.3	23.2	12.8
HU	-80.4	30.9	12.5	-2.0	7.7	6.4	-13.3	-14.7	11.3	13.1	4.4
MT	110.7	30.4	-16.2	17.7	-10.6	21.6	3.1	11.1	-17.3	28.9	9.5
NL	-34.7	-11.8	8.4	6.9	12.8	11.8	-22.9	-4.8	-4.6	32.1	7.3
AT	4.0	9.6	16.9	24.4	-1.5	3.9	-7.1	-10.4	-20.1	27.2	7.0
PL	1.5	20.6	28.0	8.9	9.6	-16.5	-29.3	17.0	7.2	5.8	5.1
PT	-28.1	11.3	40.8	0.8	6.6	2.1	-4.5	-8.4	18.0	10.5	6.4
SI	-7.0	29.8	39.7	26.1	-25.0	-5.8	-35.5	9.6	-9.6	13.2	8.1
SK	45.6	7.6	10.6	7.6	-22.3	14.5	-8.3	-12.4	-2.1	-9.8	0.9
FI	-15.1	51.5	5.9	11.4	-39.5	8.2	-29.2	-10.4	-14.8	-21.3	1.0
SE	-58.7	9.6	4.0	4.5	-11.1	8.4	4.3	-12.0	1.0	11.1	2.2
UK	-8.5	26.3	11.8	11.2	-11.5	4.6	19.5	-3.8	28.8	5.3	8.6
NO	-32.7	-26.3	23.7	20.2	-18.4	17.3	-50.6	1.3	-3.0	-7.7	6.4
CH	-4.1	22.2	30.6	9.6	-7.4	1.2	-24.8	-2.9	12.4	-0.2	7.0
EU-25+	-4.2	14.5	13.8	14.0	-5.5	8.6	-21.9	-4.9	3.1	15.2	6.3
EU-25	-3.9	14.7	13.2	14.0	-5.3	8.5	-21.6	-5.0	3.0	15.5	6.3

NB: In some tables and figures in the workbooks, estimates for years before 1993 exclude data for certain countries. In total these account for some 30 million jobs.

Source: IER estimates based on Cambridge Econometrics E3ME.

OMG = Occupation major group

- **0** armed forces
- **1** legislators, senior officials and managers
- **2** professionals
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- **5** service workers and shop and market sales workers
- **6** skilled agricultural and fishery workers
- **7** craft and related trades workers
- **8** plant and machine operators and assemblers
- **9** elementary occupations

Table 6.28. **Projected employment growth (annual %)**

OMG	0	1	2	3	4	5	6	7	8	9	All
BE	-4.4	1.4	0.6	2.6	0.0	0.6	-1.5	-1.7	2.6	0.5	0.8
CZ	0.4	-0.1	0.4	1.8	-0.2	0.0	-2.1	-1.8	2.2	-2.3	0.4
DK	-0.1	1.0	2.1	1.6	-2.5	-0.6	-2.5	-1.0	-1.7	0.0	0.2
DE	0.5	-0.4	1.1	0.4	-1.4	1.7	-2.6	0.3	-0.2	2.4	0.6
EE	2.4	-1.2	-0.1	-1.2	-0.4	2.0	-9.6	-3.1	0.4	1.4	-0.4
EL	0.7	0.2	0.7	3.3	0.5	2.4	-2.2	-0.3	1.1	2.2	0.8
ES	2.6	0.1	1.2	4.2	-1.1	1.8	-8.4	-0.8	-0.5	1.0	0.7
FR	-1.6	1.7	1.0	1.1	-1.2	0.5	0.0	-0.7	-0.3	3.8	0.8
IE	-6.3	2.0	2.3	3.6	0.3	1.6	-4.4	0.4	-0.4	0.8	1.3
IT	-0.2	2.6	1.9	2.6	1.0	0.9	-6.9	-2.3	-1.2	0.7	0.7
CY	-2.4	2.8	3.1	3.5	2.9	-0.5	-3.2	0.8	0.7	4.9	2.3
LV	0.0	2.8	1.3	0.6	1.3	0.9	-6.6	-0.6	-1.9	-0.1	0.2
LT	11.5	-2.3	2.9	0.9	-4.3	1.6	-6.9	1.0	0.0	1.5	0.5
LU	-4.1	0.8	3.0	2.2	0.0	2.5	-1.5	-2.1	1.0	2.3	1.3
HU	-16.6	3.0	1.3	-0.2	0.8	0.7	-1.6	-1.7	1.2	1.4	0.5
MT	8.6	3.0	-1.9	1.8	-1.2	2.2	0.3	1.2	-2.1	2.9	1.0
NL	-4.6	-1.4	0.9	0.7	1.3	1.2	-2.8	-0.5	-0.5	3.1	0.8
AT	0.4	1.0	1.8	2.5	-0.2	0.4	-0.8	-1.2	-2.5	2.7	0.8
PL	0.2	2.1	2.8	1.0	1.0	-2.0	-3.8	1.8	0.8	0.6	0.6
PT	-3.6	1.2	3.9	0.1	0.7	0.2	-0.5	-1.0	1.9	1.1	0.7
SI	-0.8	2.9	3.8	2.6	-3.1	-0.7	-4.8	1.0	-1.1	1.4	0.9
SK	4.3	0.8	1.1	0.8	-2.8	1.5	-1.0	-1.5	-0.2	-1.1	0.1
FI	-1.8	4.7	0.6	1.2	-5.4	0.9	-3.8	-1.2	-1.8	-2.6	0.1
SE	-9.3	1.0	0.4	0.5	-1.3	0.9	0.5	-1.4	0.1	1.2	0.2
UK	-1.0	2.6	1.2	1.2	-1.4	0.5	2.0	-0.4	2.8	0.6	0.9
NO	-4.3	-3.3	2.4	2.1	-2.2	1.8	-7.5	0.1	-0.3	-0.9	0.7
CH	-0.5	2.3	3.0	1.0	-0.8	0.1	-3.1	-0.3	1.3	0.0	0.8
EU-25+	-0.5	1.5	1.4	1.5	-0.6	0.9	-2.7	-0.6	0.3	1.6	0.7
EU-25	-0.4	1.5	1.4	1.5	-0.6	0.9	-2.7	-0.6	0.3	1.6	0.7

NB: In some tables and figures in the workbooks, estimates for years before 1993 exclude data for certain countries. In total these account for some 30 million jobs.

Source: IER estimates based on Cambridge Econometrics E3ME.

OMG = Occupation major group

- **0** armed forces
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- **6** skilled agricultural and fishery workers
- **7** craft and related trades workers
- **8** plant and machine operators and assemblers
- **9** elementary occupations

6.2.3.3. *Replacement demand*

Table 6.29 illustrates how expansion demand and replacement demand vary across countries, emphasising the importance of the latter.

Table 6.30 provides a summary of the total number of job openings across Europe. These are the sum of expression demand plus replacement demand. The results again highlight the crucial importance of considering replacement needs as well as expansion demand. They also provide a general guide to orders of magnitude.

Table 6.29. **Replacement demand by country and occupation ('000)**

OMG	0	1	2	3	4	5	6	7	8	9	All
BE	7	87	170	97	144	130	22	129	86	106	980
CZ	4	66	119	239	80	199	26	267	211	85	1 296
DK	5	60	110	128	98	164	23	100	47	113	849
DE	63	543	1 093	1 434	837	965	163	1 058	520	966	7 641
EE	1	18	26	24	8	22	4	25	25	16	169
EL	11	77	74	65	108	192	155	171	76	73	1 001
ES	23	244	226	252	397	781	133	667	339	887	3 950
FR	61	434	659	895	722	881	261	746	517	717	5 893
IE	2	69	64	23	89	86	3	74	39	39	488
IT	63	857	378	966	620	802	117	1 304	560	680	6 347
CY	1	3	11	9	18	21	5	12	7	15	101
LV	0	27	25	37	11	32	20	55	24	40	271
LT	2	21	46	21	9	39	33	67	32	47	316
LU	0	6	11	11	18	10	2	13	6	13	89
HU	5	76	127	152	114	158	29	145	122	90	1 015
MT	0	6	8	11	8	9	1	7	7	8	65
NL	6	228	427	354	384	493	36	212	93	426	2 659
AT	4	60	74	145	146	164	108	180	61	105	1 047
PL	3	265	484	350	285	388	629	693	310	286	3 691
PT	9	86	76	87	111	181	173	244	77	140	1 184
SI	1	13	27	32	18	32	16	29	39	16	223
SK	0	25	51	91	37	78	5	85	67	46	486
FI	3	76	86	94	45	107	36	83	57	63	650
SE	2	54	153	174	115	230	29	104	117	92	1 069
UK	13	798	820	671	1 028	1 419	82	667	469	964	6 932
NO	3	29	51	92	49	165	17	47	39	43	535
CH	2	135	351	404	271	292	75	309	103	111	2 054
EU-25+	294	4 362	5 747	6 857	5 772	8 039	2 201	7 493	4 048	6 188	51 001
EU-25	289	4 198	5 345	6 360	5 452	7 582	2 109	7 136	3 906	6 034	48 411

NB: In some tables and figures in the workbooks, estimates for years before 1993 exclude data for certain countries. In total these account for some 30 million jobs.

Source: IER estimates based on Cambridge Econometrics E3ME.

OMG = Occupation major group

0 armed forces
1 legislators, senior officials and managers
2 professionals
3 technicians and associate professionals
4 clerk
5 service workers and shop and market sales workers
6 skilled agricultural and fishery workers
7 craft and related trades workers
8 plant and machine operators and assemblers
9 elementary occupations

Table 6.30. **Total job openings by country and occupation ('000)**

OMG	0	1	2	3	4	5	6	7	8	9	All
BE	-3	153	219	225	145	156	11	70	179	125	1 280
CZ	4	63	141	432	73	201	13	131	381	27	1 466
DK	5	80	198	214	43	141	8	75	23	114	900
DE	71	461	1 611	1 759	260	1 821	20	1 193	485	1933	9 613
EE	2	9	25	16	7	37	-3	0	28	23	144
EL	13	84	104	171	130	335	59	156	113	155	1 320
ES	50	254	456	1 166	237	1 319	-168	434	256	1216	5 221
FR	24	767	976	1 350	405	1 019	261	565	460	1844	7 671
IE	-1	131	135	71	96	136	-2	84	33	52	735
IT	58	1 428	736	2 229	859	1 052	-115	531	332	865	7 975
CY	0	6	24	25	35	18	3	16	9	50	185
LV	0	65	39	44	17	42	-10	46	7	39	289
LT	12	-5	120	31	-10	65	-31	93	31	70	377
LU	0	7	27	21	18	17	1	6	8	24	129
HU	-9	168	192	141	141	194	14	41	176	132	1 190
MT	2	10	5	15	6	13	1	9	4	14	80
NL	-5	128	544	450	519	633	8	174	71	738	3 260
AT	4	86	138	331	139	184	76	128	10	238	1 334
PL	4	448	1 070	487	381	176	5	1 054	398	344	4 368
PT	-1	131	273	91	146	196	152	166	146	203	1 503
SI	1	31	85	71	0	27	-9	39	26	24	296
SK	6	35	77	121	6	123	3	43	61	28	504
FI	1	196	109	139	-17	140	6	52	29	19	673
SE	-4	74	183	212	70	299	33	53	121	123	1 165
UK	7	2 034	1 337	1 092	544	1 657	143	569	1 033	1145	9 561
NO	0	-11	113	207	16	266	-17	50	34	32	689
CH	2	198	573	484	229	299	37	291	130	111	2 354
EU-25+	244	7 034	9 509	11 596	4 498	10 567	494	6 067	4 584	9689	64 281
EU-25	242	6 847	8 822	10 905	4 254	10 002	475	5 727	4 420	9 547	61 239

NB: In some tables and figures in the workbooks, estimates for years before 1993 exclude data for certain countries. In total these account for some 30 million jobs.

Source: IER estimates based on Cambridge Econometrics E3ME.

OMG = Occupation major group

- **0** armed forces
- **1** legislators, senior officials and managers
- **2** professionals
- **3** technicians and associate professionals
- **4** clerk
- **5** service workers and shop and market sales workers
- **6** skilled agricultural and fishery workers
- **7** craft and related trades workers
- **8** plant and machine operators and assemblers
- **9** elementary occupations

6.3. Alternative pan-European macro scenarios

6.3.1. Background

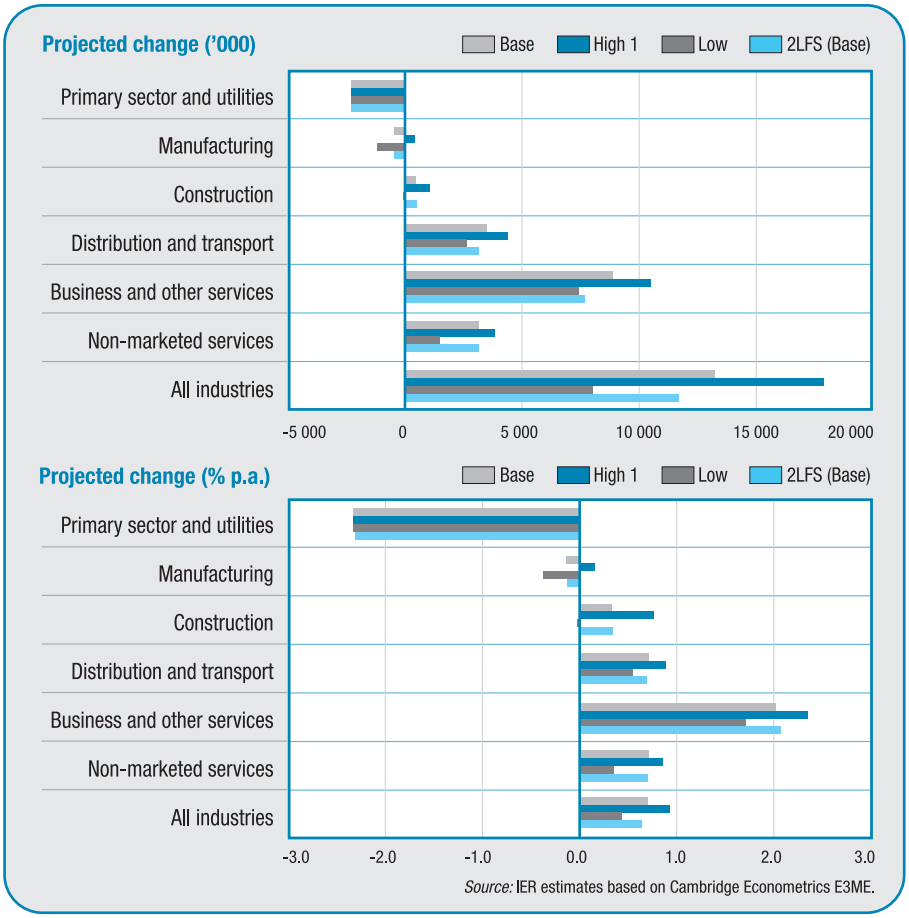
This section presents an analysis of the sensitivity of the results to the alternative macroeconomic scenarios developed by Cambridge Econometrics, as well as exploring the impact of using LFS-based employment estimates for the projections rather than national accounts- (NA) based ones. The latter adopt the same growth rates by sector as in the NAs-based results, but constrained to match LFS estimates of the sectoral totals in the base year.

6.3.1.1. *Sensitivity by sector*

Figure 6.6 and Table 6.31 compare across the scenarios by broad sector for EU-25+. Similar information could be generated for a more detailed 16 industry and 41 industry breakdowns but this is not attempted here for reasons of time and space. Similarly, more detailed comparisons are possible for each country. The results are based on the three scenarios developed by Cambridge Econometrics (base 0, high 1 and low 2). The other case is the base 0 scenario, but with sectoral totals now constrained to match the published LFS totals. This is referred to as LFS (base). Detailed discussion of the three macro scenarios is in Chapter 3.

Focusing on the three macro scenarios, at this broad level there is little difference in the results for the primary sector and utilities which are projected to decline significantly in all cases. Manufacturing shows a shift from employment decline in the more pessimistic scenario to some employment growth in the optimistic high scenario. For the other broad sectors, the pattern is one of projected job growth, and within this the high scenario is projected to generate substantially more jobs and the low one rather fewer. Comparing the LFS base with the NAs variant in base 0, the differences are not huge and the patterns across sectors are broadly similar.

Figure 6.6. **Employment trends by broad sector, different scenarios, EU-25+**



Source: IER estimates based on Cambridge Econometrics E3ME.

Table 6.31. **Employment trends by industry, different scenarios, EU-25+**

Sectors	NA-based level in 2006	Change 2006-15 scenario:		
		Base 0	High 1	Low 2
Levels and net change ('000)				
Primary sector and utilities	11 917	-2 289	-2 287	-2 288
Manufacturing	34 871	-457	431	-1 198
Construction	15 141	442	1 052	-53
Distribution and transport	54 242	3 498	4 410	2 660
Business and other services	45 638	8 921	10 521	7 439
Non-marketed services	48 846	3 165	3 835	1 494
All industries	*210 656*	*13 280*	*17 961*	*8 054*
Growth (% per annum)				
Primary sector and utilities		-2.3	-2.3	-2.3
Manufacturing		-0.1	0.1	-0.4
Construction		0.3	0.7	0.0
Distribution and transport		0.7	0.9	0.5
Business and other services		2.0	2.3	1.7
Non-marketed services		0.7	0.8	0.3
All industries		*0.7*	*0.9*	*0.4*

Source: IER estimates based on Cambridge Econometrics E3ME.

6.3.1.2. *Sensitivity by occupation*

Figure 6.7 illustrates similar trends in the alternative scenarios by broad occupation (nine groups). Analogous information is available for a more detailed 27 category breakdown.

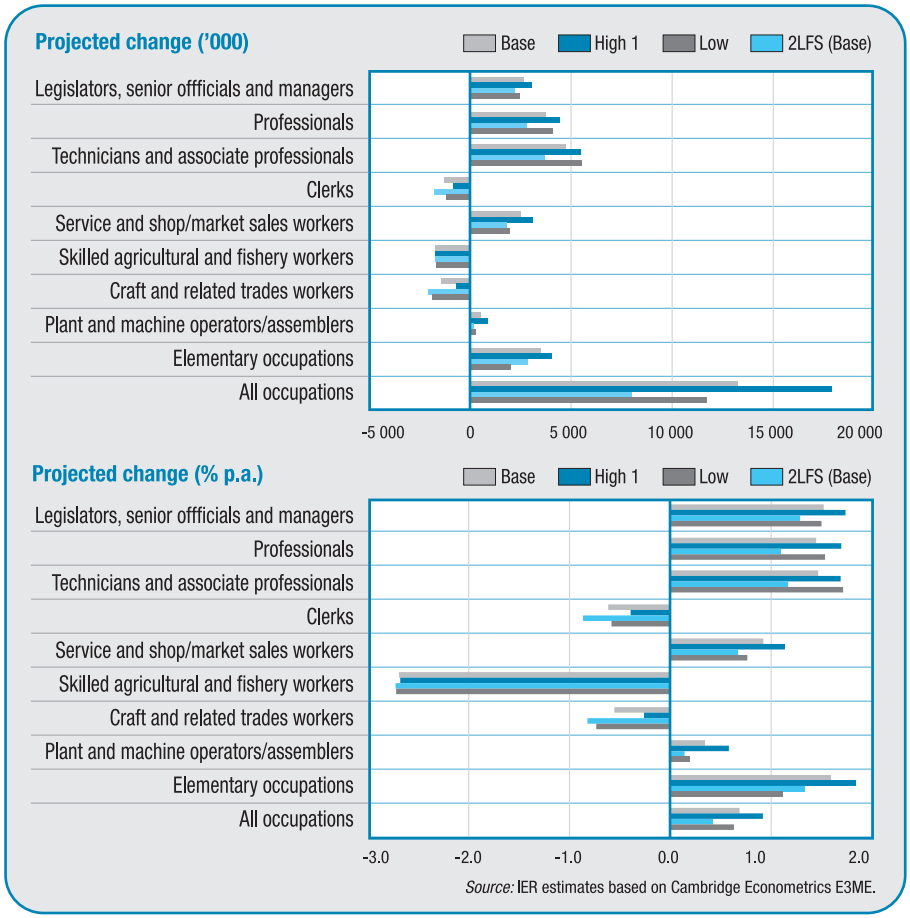
No attempt has been made to differentiate the projected occupational shares (which drive the expansion demand estimates) by scenario: the same shares within sectors are used in all four cases. These might be expected to show some variation in the different scenarios, with perhaps faster growth for some higher level occupations in the high scenario, for example. These issues will be explored further in future work.

Focusing on the three macro scenarios, at this broad level all occupations benefit from the more optimistic scenario and suffer from the more pessimistic one. Elementary occupations show particular sensitivity, but in percentage terms there is not that much variation for most occupations.

Comparing the LFS base with the NAs variant in base 0, there are some notable differences: these reflect the different base year sector weights in the two variants. Elementary occupations are projected to grow less rapidly in the LFS variant. This is partially offset by slightly more optimistic prospects for some other occupations such as technicians, etc. However, the differences in shares and patterns of change are not huge.

In total, the LFS-based scenario has 1.5 million fewer jobs by 2015 than the base 0 scenario. This is largely a reflection of the difference in the base year levels.

Figure 6.7. **Employment trends by broad occupation, different scenarios, EU-25+**



Source: IER estimates based on Cambridge Econometrics E3ME.

Table 6.32. **Employment trends by broad occupation, different scenarios, EU-25+**

Sectors	NA-based level in 2006	Change 2006-15 scenario:		
		Base 0	High 1	Low 2
Levels and net change ('000)				
Elementary occupations	22 980	3 730	4 322	3 129
Plant and machine operators and assemblers	17 314	612	995	288
Craft and related trades workers	28 845	-1 192	-454	-1 851
Skilled agricultural and fishery workers	7 789	-1 647	-1 633	-1 661
Service workers and shop and market sales workers	29 490	3 056	3 671	2 351
Clerks	23 317	-997	-553	-1 493
Technicians and associate professionals	33 952	5 012	5 783	3 997
Professionals	27 349	3 840	4 534	2 890
Legislators, senior officials and managers	18 405	918	1 332	491
All industries	*210 656*	*13 280*	*17 961*	*8 054*
Total change (%)				
Elementary occupations		5.3	7.2	2.7
Plant and machine operators and assemblers		14.0	16.6	10.6
Craft and related trades workers		14.8	17.0	11.8
Skilled agricultural and fishery workers		-4.3	-2.4	-6.4
Service workers and shop and market sales workers		10.4	12.4	8.0
Clerks		-21.2	-21.0	-21.3
Technicians and associate professionals		-4.1	-1.6	-6.4
Professionals		3.5	5.7	1.7
Legislators, senior officials and managers		16.2	18.8	13.6
All industries		*6.3*	*8.5*	*3.8*
Growth (% per annum)				
Elementary occupations		0.5	0.8	0.3
Plant and machine operators and assemblers		1.5	1.7	1.1
Craft and related trades workers		1.5	1.8	1.2
Skilled agricultural and fishery workers		-0.5	-0.3	-0.7
Service workers and shop and market sales workers		1.1	1.3	0.9
Clerks		-2.6	-2.6	-2.6
Technicians and associate professionals		-0.5	-0.2	-0.7
Professionals		0.4	0.6	0.2
Legislators, senior officials and managers		1.7	1.9	1.4
All industries		*0.7*	*0.9*	*0.4*

Source: IER estimates based on Cambridge Econometrics E3ME.

6.3.1.3. *Sensitivity of replacement demand*

Replacement calculations for expansion demand have not been varied between the macro scenarios, although there might be a case for introducing differences. Since replacement needs are based on opening stock values, this means there is no variation between the three macro scenarios.

The main macroeconomic indicator that might affect replacement demand (ignoring policy changes for a moment) is that affecting participation. Fluctuations in participation due to business cycles are not modelled in the replacement demand estimates but structural differences in participation might be expected to have some impact. Policy changes affecting retirement behaviour (i.e. extending mandatory retirement ages to say 67 instead of 65), or factors that might result in increases in female participation in the labour market (free child care during the day-time, tax changes making dual-income households more attractive, etc.) could also affect replacement demand. However, those effects are usually not large (and adjustment processes are often slow).

Focusing on the three macro scenarios, the differences in replacement needs and total requirements are shown in Table 6.33 and Figure 6.8. For replacement needs, as noted above, there is no difference between the three macroeconomic scenarios, but the LFS base variant shows around two million fewer replacement needs because of the smaller base year starting level. Differences between occupations are negligible.

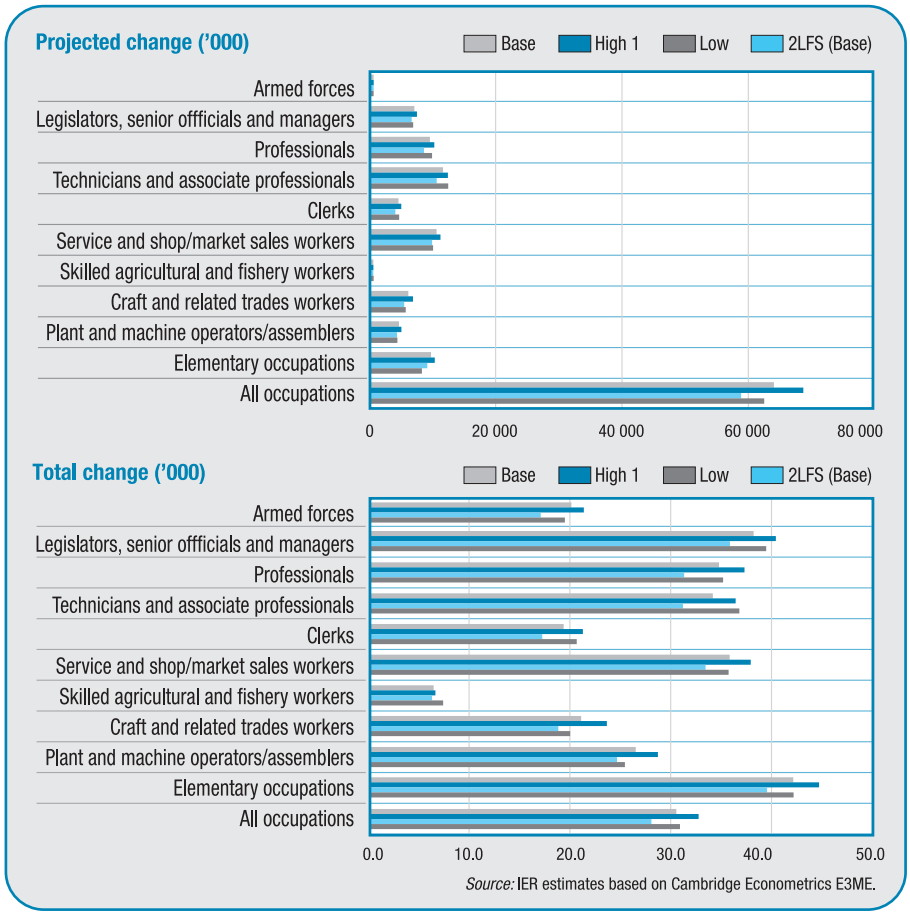
Total requirement shows some variation because of the difference in expansion demand. However, the main message coming across is of the broad similarity of the results across the scenarios rather than of any differences.

Table 6.33. **Replacement demand by broad occupation based on LFS, EU-25+**

Occupations	Level in 2006	Change 2006-15		
		'000	%	% p.a.
Legislators, senior officials and managers	17 326	4 362	25.2	2.5
Professionals	27 994	5 747	20.5	2.1
Technicians and associate professionals	33 752	6 857	20.3	2.1
Clerks	22 388	5 772	25.8	2.6
Service workers and shop and market sales workers	28 025	8 039	28.7	2.8
Skilled agricultural and fishery workers	7 507	2 201	29.3	2.9
Craft and related trades workers	28 362	7 493	26.4	2.6
Plant and machine operators and assemblers	17 056	4 048	23.7	2.4
Elementary occupations	19 509	6 188	31.7	3.1
All occupations	*203 163*	*51 001*	*25.1*	*2.5*

NB: There are no differences between the base 0, high 1 and low 2 scenarios for replacement demand.
Source: IER/ROA estimates based on Cambridge Econometrics E3ME.

Figure 6.8. **Total requirements by broad occupation, different scenarios, EU-25+**



Source: IER estimates based on Cambridge Econometrics E3ME.

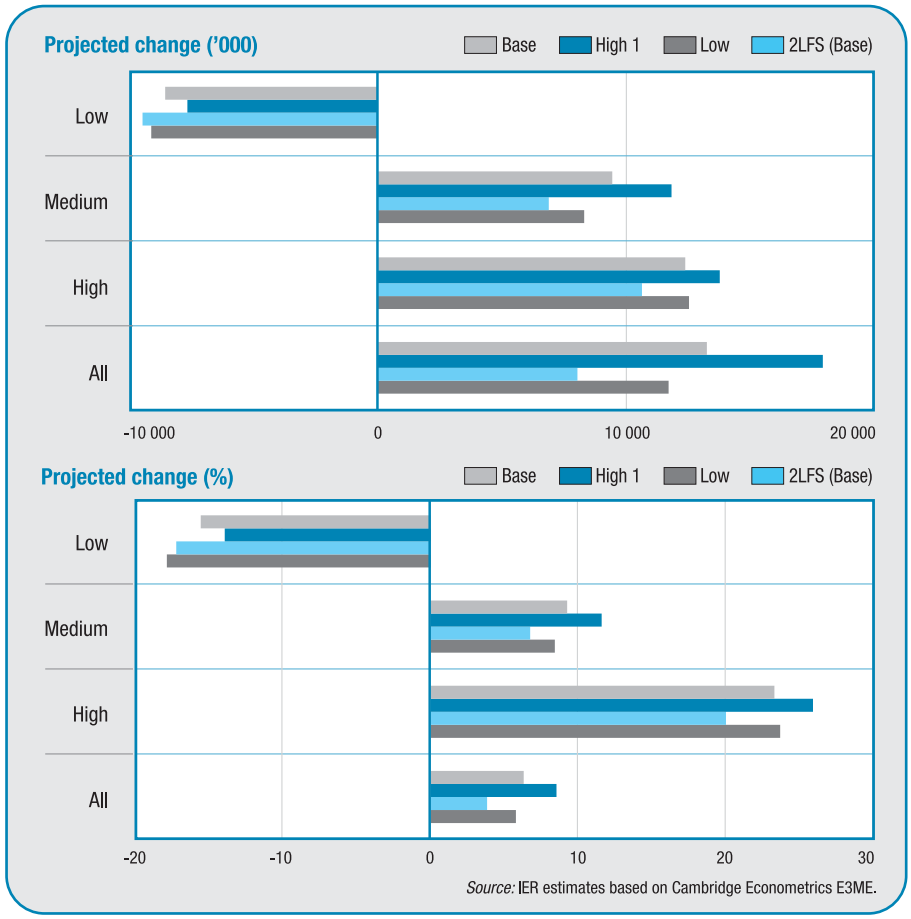
6.3.2. Sensitivity by qualifications

This section presents a summary of the results for qualifications across the alternative scenarios. Again, the expansion and replacement demand elements have not been varied across the scenarios; any differences reflect the sectoral variations assumed.

While there are some obvious differences between the three scenarios, with all qualification levels benefiting from the more optimistic scenarios, the differences are not huge, either for expansion demand or for total requirements. In broad terms these results seem robust across alternative scenarios.

The LFS base scenario suggests smaller overall increase in employment but the results for higher qualifications are almost identical to the NA base 0 scenario. It is the medium qualification group that loses out most although the low qualification category also experiences almost a million fewer job losses in the LFS variant.

Figure 6.9. **Expansion demand by qualification, different scenarios, EU-25+**



Source: IER estimates based on Cambridge Econometrics E3ME.

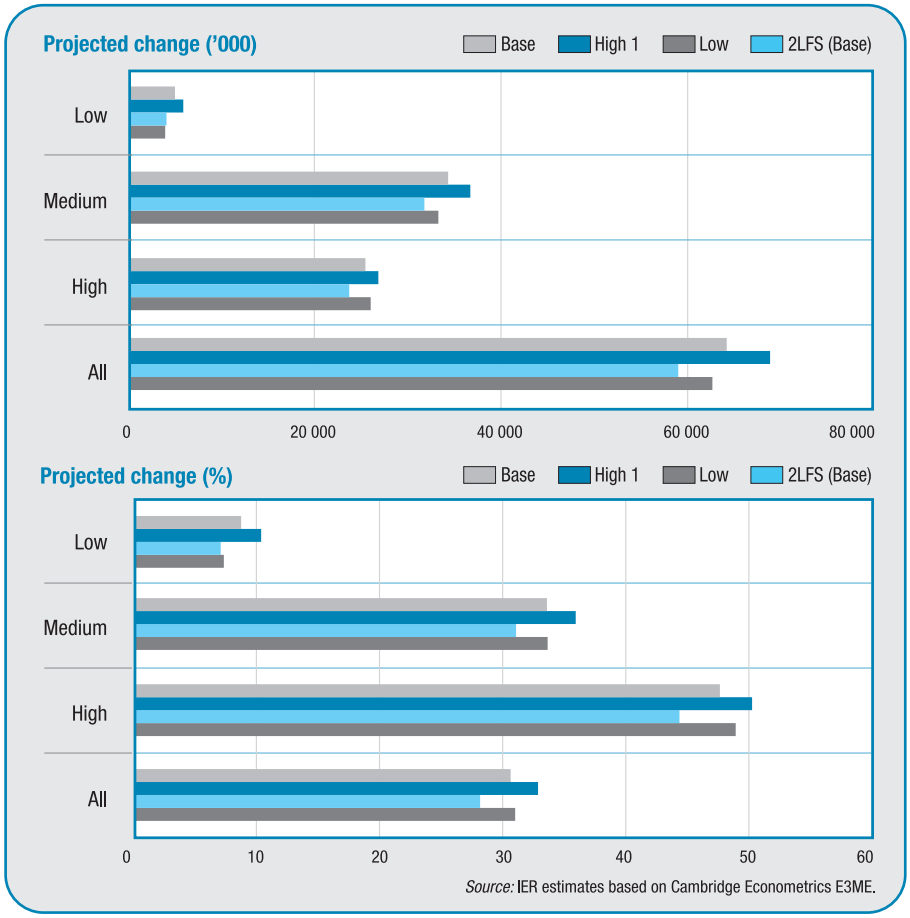
Table 6.34. **Expansion demand by qualification, different scenarios, EU-25+**

Sectors	NA-based level in 2006	Change 2006-15 scenario: Base 0	High 1	Low 2
Levels and net change ('000)				
Low qualification	55 104	-8 588	-7 692	-9 503
Medium qualification	102 291	9 461	11 853	6 898
High qualification	53 261	12 408	13 801	10 660
All qualifications	*210 656*	*13 280*	*17 961*	*8 054*
Change (%)				
Low qualification		-15.6	-14.0	-17.2
Medium qualification		9.2	11.6	6.7
High qualification		23.3	25.9	20.0
All qualifications		*6.3*	*8.5*	*3.8*

NB: In some tables and figures in the workbooks, estimates for years before 1993 exclude data for certain countries. In total these account for some 30 million jobs.

Source: IER/ROA estimates based on Cambridge Econometrics E3ME.

Figure 6.10. **Total requirements by qualification, different scenarios, EU-25+**



Source: IER estimates based on Cambridge Econometrics E3ME.

Table 6.35. **Total requirements by qualification, scenarios, EU-25+**

Sectors	NA-based level in 2006	Change 2006-15 scenario: Base 0	High 1	Low 2
Levels and net change ('000)				
Low qualification	55 104	4 753	5 649	3 838
Medium qualification	102 291	34 226	36 618	31 663
High qualification	53 261	25 302	26 695	23 554
All qualifications	*210 656*	64 281	68 962	59 055
Change (%)				
Low qualification		8.6	10.3	7.0
Medium qualification		33.5	35.8	31.0
High qualification		47.5	50.1	44.2
All qualifications		*30.5*	*32.7*	*28.0*

NB: In some tables and figures in the workbooks, estimates for years before 1993 exclude data for certain countries. In total these account for some 30 million jobs.

Source: IER/ROA estimates based on Cambridge Econometrics E3ME.

CHAPTER 7

Conclusions and the way forward

Alena Zukersteinova
Cedefop

Rob A. Wilson
IER, University of Warwick

7.1. Summary

This publication presents a set of consistent and comprehensive employment projections across EU-25+. The results are based on the use of E3ME as a starting point for assessing sectoral prospects across Europe and were combined with data from the European LFS. Various alternative sets of employment projections by occupation and qualification were produced. These also include implications for replacement demand.

This project was concerned with developing a sound historical and projections database, including developing the basic data and related software needed to produce projections of the demand for skill in a replicable fashion. A key objective was to develop a framework within which alternative possibilities can be considered. While there may still be some concerns about the quality of some of the data for individual countries or for particular sectors or occupations, this framework enables other, better data to be incorporated easily to improve the quality of the analysis and the projections.

The project involved the production of a set of benchmark projections as a foundation for continuing dialogue on such issues across Europe. These consider different possible macroeconomic scenarios as well as the impact of using LFS as opposed to NA-based employment estimates.

The project focuses on refining data and models used for expansion and replacement demand, although this proved to be a difficult task. The analysis was based on both the LFS microdata (individual level) and the published data from Eurostat. This analysis forms the basis for the econometric models developed for Modules 2, 3 and 4.

The last phase of the project also involved developing three alternative macro scenarios with a range of possible economic situations Europe may

face over the next 5 to 10 years. All this was brought together in final versions of the country workbooks, as well as more conventional reports. The detailed results in the workbooks were made available in a manner to facilitate continuing dialogue with country experts to improve the quality and robustness of the basic data and results, by taking note of local knowledge.

The project has initiated dialogue with both country experts and the relevant statistical authorities. As this process continues the quality and reliability of the relevant data and estimates will gradually be improved. While these results have their limitations, they provide a useful starting point for thinking about likely future developments in employment structure across the continent.

7.2. Key findings

Europe has experienced considerable structural change over recent decades, both economic and political. This has resulted in continuing shifts away from primary industries (especially agriculture) and from traditional manufacturing industries towards services and the knowledge-intensive economy. The results of the medium-term forecasts of occupational skill needs in Europe suggest that these trends are likely to remain a key feature over the coming decade, both within countries and in how the division of labour is changing between countries.

The recent enlargement of the EU to 27 members resulted in increasing diversity of sectoral employment patterns. Many of the newer Member States still rely considerably on agriculture and manufacturing for employment, more than was the case among older members. However, this is changing rapidly, with a catching-up process for many countries and significant restructuring away from these areas into services. This is partly an internal process, particular to each country, but it also reflects shifting patterns of activities and people across borders, as capital and labour adjust to the new political and economic situation. The results suggest that this process of change will continue in the near future, and will be more evolutionary rather that revolutionary.

Substantial change is in prospect. In total, Europe (EU-25+) is expected to have more than 13 million additional jobs (net change) by 2015, despite the loss of well over two million in the primary sector and half a million in manufacturing industries. The distribution and transport sector, including hotels and catering, is projected to have over three million more jobs over the next decade, while employment in non-marketed services, including health and education, is projected to grow by only slightly less. The best prospects for

employment lie in business and miscellaneous services with almost nine million additional jobs being created between 2006 and 2015.

The alternative scenarios elaborated, one with a positive and one with a more negative outlook, suggest an increase in overall employment ranging between 7.5 million and 17.5 million jobs. The broad patterns by sector are not too sensitive to these alternatives, though manufacturing might be the most sensitive sector with forecast losses of 1.3 million jobs in the pessimistic scenario, and a projected modest growth in the optimistic one.

The primary and manufacturing sectors will remain important areas of employment, although skill requirements will also change here. The primary sector will still employ around 10 million people by 2015 and manufacturing 35 million. These sectors will remain viable sources of jobs, and crucial components of the economy.

These trends are likely to be reinforced by changes in the way work is organised and jobs are done as a result of technological change and other factors. The implications for occupational employment are for continuing growth in demand for many highly- and medium-skilled workers but also for some lower-skilled categories. In 2006 just under 80 million of the 210 million people employed in Europe had higher-level jobs such as management, professional work of one kind or another or technical support of those activities. These areas are all expected to experience increased demand over the next decade. This, however, includes also elementary occupations.

Even in those areas where declining employment levels are expected there will be significant numbers of job openings and needs for education and training. This is reflected in estimates of replacement demand by occupation. While the projections suggest job losses for several occupational categories, in all cases these losses are more than offset by the estimated need to replace those leaving because of retirement or other reasons. Of course, the nature of these jobs will change and their development should be analysed

The results highlight increased requirements in terms of qualification levels (high, medium and low) across most jobs. At the broadest level the forecast changes are even more dramatic than for occupations. Total employment in Europe is projected to grow by around 13 million jobs between 2006 and 2015. This comprises increases of almost 11 million jobs at the highest qualification level (roughly ISCED 5 and 6) and a further almost 12 million jobs at medium level (ISCED 3 and 4) while there is a decline of over nine million jobs for those with no or few formal qualifications (ISCED 1 and 2).

Part of these changes reflects the expected continued growth in supply of people with formal qualifications. While some have argued that there is the

possibility of oversupply in some areas, there is also considerable evidence of the changing nature of job requirements increasing the need for formal qualifications in many areas.

The results show that the trend of increasing skill requirements is unbroken, with high job gains for highly- and medium-skilled workers – including those with vocational qualifications – and substantial job losses for the lower-skilled. However, the results differ by countries, sectors and occupations – thus requiring further research and analysis that should also indicate points of reference for education and training policies to prevent undesired developments, such as possible skill mismatches.

7.3. Policy implications

Based on these findings, the overall demand for skills is likely to continue to rise. If Europe is to maintain its competitive position, policy needs to ensure that the workforce can adapt to these requirements. Europe needs a strategy to satisfy the demands of the service-oriented knowledge-intensive economy. Labour-market policy will face enormous challenges to cope with structural changes and occupational mobility needs. Continuing training and lifelong learning will have to contribute to enabling skills to constantly to continuous structural change in labour markets. It is against this background that lifelong learning strategies and policies to reconcile flexibility and security become a new dimension.

The young generation entering the labour market in the next decade cannot fulfil all the skill needs required by the labour market. This has implications for education and training, with lifelong learning paramount. This requires a consistent and ambitious strategy: to reduce the flow of early school leavers and drop-outs; set up a comprehensive skills plan for adults/adult learning; and increase the supply of people trained in science and technology.

While education and training are important for improving qualification, they cannot fully solve problems of over- and under-education. There is a need for policy-making to initiate measures in time to prevent, or at least alleviate, risks of skills mismatch and job polarisation. Bottlenecks in high skill segments of the labour market may exert upward pressure on wages for these workers. At the same time, there may be a surplus of unskilled workers, which can worsen their bargaining power and, thus, their wage and working conditions. These trends can be reinforced by globalisation and signal the need to explore in more detail working conditions, skill and competence requirements, and

profiles of these precarious job segments (i.e. elementary occupations).

It is also important to recognise that training and evaluation measures alone cannot solve the problem of a major workforce shortage in Europe. Migration may be a partial answer. Given the demography and the shrinking workforce across the EU and trends in workforce demand, intra-European mobility will not suffice. Alleviating labour-market tightness in one Member State, at the expense of another, will not improve European economic performance overall. However, pessimistic demographic trends are a global challenge, not only European. Attracting workers from non-EU Member States, as well as intra-European mobility, should go hand-in-hand with measures to ensure social cohesion and equal treatment.

Adequately valuing skills of those in employment, in particular of those with lower-level formal qualifications, older workers and people with migrant backgrounds or those returning to the labour market is important to avoid wasting skills. Validating and accrediting people's knowledge, skills and competences could help customise training and make it more cost-effective. Also guidance and counselling play an important role in validating and developing personal training plans. The common European tools, principles and mechanisms developed in the Education and training 2010 work programme, need to be integral to such packages. They have an important role in the interplay between education, employment and social policies. Policy-makers need to appreciate how information on skill needs, labour-market intelligence and these tools can reinforce one another.

Focusing on learning outcomes, rather than on formal qualification levels is one potential answer to the challenges faced. Having national and related European (international) qualification levels which describe the knowledge, skills and competences people have acquired, can help employers and citizens look for, or retain, jobs to match supply and demand better. European and national qualification frameworks may help improve the ways in which information on skill needs and supply is interpreted and translated.

Labour-market and other social policy measures need to develop more flexible solutions for those who need to change their jobs. Alongside flexicurity, Europe needs to come up with proposals of how to maximise the employment potential of its workforce. Bringing more women into the labour market and longer working lives become crucial and unavoidable measures for Europe's sustainable future.

How to balance work with personal and family lives? Reconciling the work-life balance in flexicurity at policy level (social policy agenda) and corporate level (corporate social responsibility) is a challenge for the coming years.

7.4. Outstanding data problems and scope for refinement

Detailed examination of results for each country reveals several outstanding problems and questions. These are especially severe for some of the smaller countries where the sample sizes in the LFS are inadequate to provide robust estimates. Even for many of the larger countries there are problems with the data which can probably only be addressed by further detailed dialogue between country experts and the relevant statistical authorities. However, the framework developed allows for alternative data and assumptions to be incorporated with relative ease. Therefore, given cooperation with the countries concerned, such issues can, in principle easily be resolved.

There is considerable scope for improving the basic methods used to make the projections of changing occupational and qualification structure, as well as the estimates of replacement demand. The limitations of the data and other technical problems have limited the sophistication of some of the modelling work, but the potential for refinement offered by the framework is clear. The modular structures adopted and the presentation of the material in separate country workbooks enables such developments to take place nationally and at pan-European level.

7.5. Continuing dialogue and country expert input

The present set of projections has been put together with the voluntary involvement of many country experts. It is clear from the issues raised that such involvement is crucial to ensuring credibility of the national results and for improving both estimates and methods.

As with all quantitative projections, a considerable amount of judgement is needed to develop robust and credible results. This must involve national and European experts and stakeholders who can bring their unique knowledge and expertise relating to data, trends and political strategies on employment and socioeconomic development for their own countries to bear. The feedback obtained so far suggests that with such input it will be possible to develop a much more robust database. All experts and stakeholders are invited to join in this mission.

7.6. The way forward

The results of the forecasts reiterate the need for more detail on working conditions, skill and competence requirements and profiles of both precarious and knowledge-intensive job segments. They equally emphasise the need for policy-making to initiate measures in time to prevent, or at least alleviate, risks of skill mismatches (shortages and surpluses). The projected occupational change has implications for industrial, education and training, guidance and counselling, active and passive labour-market measures, migration, mobility and social policies in Member States. This calls for improved governance and the cooperation of all actors, including the social partners.

The forecast brings important insights and added value to the limited knowledge about the likely future development of European labour markets. However, it also raises several questions and uncertainties about specific developments in demand for occupations and qualifications. Is demand changing in nature? Do elementary occupations still correspond to their initial definition ([37])? How does supply change affect demand and what could be the economic consequences of this interaction? Which specific skills and competences are needed in the future? These and other questions can only be answered if Europe invests in further research and analysis on early identification of skill needs. Quantitative and qualitative methods of forecasting and research on the interaction between supply and demand seem crucial to understanding job polarisation and skill mismatch.

Responding to this need, acknowledged also by recent policy developments, Cedefop is strengthening its research in this area by improving and updating forecasts, continuing dialogue and other complementary activities.

In 2008, Cedefop carried out a complementary forecast of future skill supply and a detailed analysis of possible mismatches between supply and demand (skill shortages and gaps, oversupply and overqualification). Results are expected in early 2009.

As this initial forecasting exercise proved to be successful, Cedefop will continue with regular updates of forecasts (every two years) and further methodological and data improvement, working closely with country experts.

Given that information on future skill and competence needs in Europe is essential for effective national and European level, such information cannot be obtained by pure quantitative forecasting methods alone. They need to be

([37]) According to the ISCO-88 definition, elementary occupations consist of simple and routine tasks and normally require skills at the first ISCO skill level (ILO).

enriched by other sources of information, such as enterprise-level surveys and studies. Therefore, in parallel to quantitative measurement of skills demand, Cedefop explores the feasibility and efficiency of measuring developments and changes in the demand for skills, skills gaps and shortages, and recruitment difficulties at the workplace using employers' surveys.

In addition, Cedefop will continue to organise sectoral workshops to identify new and emerging skill needs in specific innovative sectors and will investigate how labour-market developments shape skill requirements, how participation in education and training impact on the supply of skills, and to what extent European labour markets suffer from skill mismatch problems.

ANNEX

List of contributing country experts

Country	Name	Organisation
Austria	LASSNIGG, Lorenz	Institute for Advanced Studies
	STEINER, Peter	Institute for Advanced Studies
	VOGTENHUBER, Stefan	Institute for Advanced Studies
	HUEMER, Ulrike	WIFO
	MAHRINGER, Helmut	WIFO
Belgium	SCHATTEMAN, Paul	Ministry of Education and Training
	HENDRICKX, Koen	Federal Planning Bureau
Bulgaria	KUNEV, Ruslan	NCVT within the BCCI
	BRATOEVA, Liliya	NCVT
Croatia	NESTIC, Danijel	Institute of Economics
	CRNKOVIĆ-POZAIĆ, Sanja	CEPOR
Cyprus	MOUROUZIDES, Yiannis	Human Resource Development Authority
	OXINOS, George	Human Resource Development Authority
Czech Republic	HAVLIČKOVÁ, Věra	National Training Fund, National Observatory of Employment and Training
	MICHALIČKA, Ludvik	Research Institute for Labour and Social Affairs
	LAPÁČEK, Michal	National Training Fund, National Observatory of Employment and Training
	LEPIČ, Martin	Education Policy Centre, Charles University in Prague
	KOUCKÝ, Jan	Education Policy Centre, Charles University in Prague
Estonia	LAMBING, Mario	Ministry of Economic Affairs and Communication
	MERIKULL, Jaanika	University of Tartu
Finland	TIAINEN, Pekka	Ministry of Labour
France	SAUVAGEOT, Claude	DEPP – Ministry of Education
	ESTRADE, Marc-Antoine	Centre d'analyse stratégique
	OMALEK, Laure	Ministère de l'Emploi – DARES
Germany	SCHNEIDER, Marc	Institute for the Study of Labour (IZA)
	VOGLER-LUDWIG, Kurt	Economix
Greece	CHLETSOS, Michalis	University of Ioannina, Dept of economics
	KAMINIOTI, Olympia	Employment Observatory
Hungary	HÁRS, Agnes	Kopint-Tarki
Ireland	FOX, Roger	FAS
	LUNN, Pete	Economical and Social Research Institute

Country	Name	Organisation
Italy	DELL'ARINGA, Carlo	Universita Cattolica
	TORCHIO, Nicoletta	IRS – Istituto per la Ricerca Sociale
	COLOMBO, Emilio	University of Milano-Bicocca
Latvia	JAKOBSONS, Andrejs	Riga Business School
Lithuania	SVENTICKAITE, Kristina	Institute of Labour and Social Research
	DUMČIUS, Rimantas	Public Policy and Management Institute
	KVEDARAS, Virmantas	Vilnius University, Dept of Econometric Analysis
Luxembourg	CLEMENT, Franz	CEPS/INSTEAD
	BLOND-HANTEN, Carole	CEPS/INSTEAD
Malta	CAMILLERI, Edwin	Employment and Training Corporation, Labour Market Information Section
Netherlands	CÖRVERS, Frank	ROA, Maastricht University
	KRIECHEL, Ben	ROA, Maastricht University
	HEIJKE, Hans	ROA, Maastricht University
Norway	STØLEN, Nils Martin	Statistics Norway
Poland	GAJDOS, Artur	University of Lodz
	SUCHECKI, Bogdan	University of Lodz
Portugal	RODRIGUES, Maria João	University of Lisbon
	VALENTE, Ana	Higher Institute of Social Sciences and Business studies
Romania	GHINARARU, Catalin	National Scientific Research Institute for Labour and Social Protection
Slovakia	VANTUCH, Juraj	Slovak National Observatory of Vocational Education and Training (SNO)
	KVETAN, Vladimir	Slovak Academy of Sciences
	PALENIK, Michal	Employment Institute
Slovenia	PAVLIN, Samo	University of Ljubljana, Faculty of Social Sciences
	KRAMBERGER, Anton	University of Ljubljana, Faculty of Social Sciences
Spain	HOMS, Oriol	Fundació CIREM
	VILLAGÓMEZ, Elizabeth	Fundació CIREM
Sweden	PÄRLEMO, Linda	National Labour Market Board
Switzerland	SCHWERI, Juerg	Swiss Federal Institute of Vocational Education and Training
	MULATERO, Fulvio	Swiss Federal Institute for VET
United Kingdom	LINDLEY, Robert	Institute for Employment Research, University of Warwick
	WILSON, Rob	Institute for Employment Research, University of Warwick
	LIVANOS, Ilias	Institute for Employment Research, University of Warwick
	GARDINER, Ben	Cambridge Econometrics
	POLLITT, Hector	Cambridge Econometrics

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List of abbreviations

E3ME	energy-environment-economy model for Europe (Multi-sectoral macroeconomic model)
EDMOD	model to produce occupational projections
ESA95	European system of accounts 1995
EU-25	European Union as of 2006, i.e. before the accession of Bulgaria, Romania
EU-25+	EU-25 plus Norway and Switzerland
IER	Institute for Employment Research
LFS	labour force survey
NA	national account
QMOD	model to produce qualification projections
RDMOD	model to produce projections of replacement demand
ROA	Research Centre for Education and the Labour Market, University of Maastricht
STAN	Structural analysis database

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The overall aim is to develop a comprehensive system for producing detailed and consistent quantitative projections of future skill needs across Europe. This approach and the set of results provide a sound foundation to take the debate on the changing pattern of demand for skills forward.

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CEDEFOP | European Centre for the Development of Vocational Training

Europe 123, 570 01 Thessaloniki (Pylea), GREECE
Postal address: PO Box 22427, 551 02 Thessaloniki, GREECE
Tel. +30 2310490111, Fax +30 2310490020
E-mail: info@cedefop.europa.eu
www.cedefop.europa.eu

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