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European Centre for the Development of Vocational Training

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FUTURE SKILL SUPPLY IN EUROPE

MEDIUM-TERM FORECAST UP TO 2020

SYNTHESIS REPORT

CEDEFOP

Future skill supply in Europe

Medium-term forecast up to 2020: synthesis report

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Foreword

Economic crisis, climate and structural change, and demographic developments, including ageing and migration, are posing huge challenges for economies and labour markets in Europe and across the world. Driving economic recovery through skills enhancement is crucial because skills are, and will be, needed to respond to the new economic structures that will emerge and to fill the new jobs that will be created.

The recently launched 'new skills for new jobs' initiative ([1]) recognises that better labour-market information and improved capability to anticipate changing skill needs is required. Anticipation in times of crisis is difficult and there is a clear need to combine different tools, methods and approaches. Forecasting skill needs can provide an insight into possible medium- to longer-term trends beyond the current crisis.

Although carried out before the crisis, Cedefop's forecast of skill needs published in 2008 provides some indication of which qualifications and occupations Europe will need in the longer-term. There is strong evidence that, until 2020, more and different jobs will be created. Further, an increasing number of positions will have to be filled as workers leave the labour market. Most jobs in 2020 will be for those with high- and medium-level qualifications (around 32 % and 50 % respectively). In 1996, 31 % of jobs needed low-level or no qualifications. By 2020, this proportion is expected to fall to around 18 %.

This publication presents a first and indicative medium-term forecast of skill supply in Europe until 2020. It provides complementary information on how many people with different qualifications will be available in future labour markets, developing macro-economic projections and alternative scenarios for each Member State, plus aggregate European results.

The results suggest substantial further increases in the supply of people with both high- and medium-level qualifications across Europe. In contrast, the proportion of people with low-level qualifications is projected to decline. These general trends are observed in almost all countries and are in line with the Lisbon agenda, which aims to raise the proportion of people holding higher-level qualifications. One concern for policy-makers is whether the

([1]) http://ec.europa.eu/social/main.jsp?catId=568&langId=en

historical trends identified will continue undisturbed by the recent economic crisis, or whether people will make different choices related to their desired level of education.

The results set out general trends, though more details are desirable to assist both policy-makers and individual labour-market participants. This, however, requires considerable improvement in underlying data, which are not sufficient in many cases, in particular when analysing flows of people into and within the labour market. Nevertheless, I believe that this publication will not only provide useful information to actors and stakeholders but will also further stimulate improvement in European databases and infrastructures for identifying future skill supply and demand.

Aviana Bulgarelli
Director of Cedefop

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- Rob Wilson for leading and coordinating the working team and modelling supply by qualification together with Ilias Livanos, both from the Institute for Employment Research (IER), University of Warwick;
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- Frank Cörvers, Arnaud Dupuy and Judit Vall Castello from the Research Centre for Education and the Labour Market (ROA), University of Maastricht, for the analysis of flows and discussion on potential labour-market imbalances.

Many thanks are also due to expert members of Skillsnet, from countries across Europe, who have reviewed and commented upon many of the detailed and emerging findings, and validated and provided additional data. They have contributed considerably to the project. The publication has benefited greatly from their comments and suggestions, although it has not always been possible to incorporate all of them due to data limitations. The list of experts is provided in Annex F. Cedefop is also grateful to Olga Strietska-Ilina for her valuable contribution and for helpful comments on the project. Valuable comments from Peter Szovics and Torsten Dunkel are also appreciated.

Finally, thanks are due to Peter Millar of IER who undertook much of the technical analysis required to process the European labour force survey (EU LFS) data and link them with the results from E3ME. Luke Bosworth, Andrew Holden and Amanda Kerry from IER also provided computing, clerical and secretarial support. Thanks are also due to Roula Panagiotou and Lenke Laura Molnár for their assistance in preparing the publication for print.

Preface

In the global economic crisis it is more important than ever to provide future-oriented labour-market information. It is essential to know which jobs are at risk, where new jobs will emerge and which skill will be needed. Education and training policies need to consider time periods which go far beyond short-term business cycles.

Cedefop's work on the early identification of skill needs, which started in 2001/02, is seen as very important by many stakeholders. They asked Cedefop to extend and coordinate future actions in this field. In 2004, Cedefop established its 'Skillsnet', an international network of experts working on the early identification of skill needs. Its main aim is to make European activities in this field more transparent and to provide a platform for dialogue and information exchange. In doing so, Cedefop follows two strands of research: early identification of new and emerging skills, and anticipation of skill needs and supply.

Early identification of new and emerging skill needs concerns research and analysis of occupations and skills which do not exist yet or are emerging at national, regional, local and sectoral level. There is a considerable knowledge gap in identifying skill and competence needs in European enterprises and key sectors. Cedefop is filling this gap by analysing skill needs in selected key sectors (e.g. green jobs). Moreover, Cedefop is currently assessing the feasibility of an employer survey to identify skill, competence and training needs in European enterprises.

Forecasting labour-market skill needs – in the short, medium or longer term – involves estimating the expected future number of jobs available in an economy and their particular skill or qualification requirements. Often, skill demand forecasts are complemented by forecasts of the supply of workers with particular skills. The comparison of demand and supply can indicate potential imbalances or skill mismatches on future labour markets.

Such forecasts are carried out in several countries at national and/or regional level. They are mostly based on macroeconomic and demographic projections. Often several variants or scenarios are calculated, which – based on alternative assumptions – provide a range of the number of future jobs with their particular skill requirements and the number of people with particular skills available in the labour market.

However, there are many caveats in skills forecasting and anticipation. It is believed to be too focused on economics and to neglect the political and behavioural aspects of those involved as well as qualitative or social aspects. Forecasts that provide aggregate results might be too general for concrete policies or educational programmes; the longer the forecasting period and the more detailed the categories, the less accurate and robust the results. These caveats have to be taken seriously. Therefore, every forecast has to indicate clearly its assumptions and limitations to prevent misinterpretation. Although forecasts are of particular value for economic, employment and education/training policies, they should not be seen as precise predictions but as one source of information for informed decision making. They provide early warning of what might come in the future.

National forecasts are mostly not comparable between countries as they use different approaches, methods and data/classifications; they cannot be aggregated at European level. Therefore, following suggestions by stakeholders, Cedefop organised an initial expert workshop in Cyprus in October 2005 to explore a potential core system of European skills forecasting. All participants agreed on the feasibility and urgency of a European skills forecasting exercise and asked Cedefop to proceed on this issue and coordinate further steps.

In 2008, Cedefop published the first pan-European forecast of skill needs, which provides consistent and comprehensive medium-term projections of employment and skill needs across Europe (EU-25 plus Norway and Switzerland) until 2015 and 2020. The starting point is a multi-sectoral macroeconomic projection of employment prospects across Europe. The sectoral employment trends are further broken down by occupations and formal qualifications. In addition, alternative sets of employment projections by occupations and qualifications have been produced. These scenarios cover a range of possible economic situations and their implications for employment and skill needs. The forecast provides information about net employment change (expansion demand) and also takes into account the replacement of workers leaving the workforce for various reasons (replacement demand). Expansion and replacement demand, taken together, allow assessment of future job openings (total requirements) on the labour market.

This publication presents the results of the first skill supply forecast in Europe until 2020, complementing the forecast of skills demand. It builds on an augmented multi-sectoral macroeconomic model, extended to include a set of overall labour supply projections by age and gender. The labour supply projection focuses on changing patterns in the overall supply of people in the

population and in the labour force according to the highest qualification attained. It provides results for Europe as a whole (EU-25 (without Malta) plus Norway) and for individual countries. The forecast confirms that the general upward trends in the qualification levels of the population coincide with national projections. The forecasts for individual Member States provided in this exercise are useful as a point of reference and comparison with national forecasts. They are an additional source of information – especially in cases where national forecasting systems do not yet exist. However, forecasts for individual Member States are sometimes problematic owing to objective data limitations which could not be overcome within the current project.

The present publication is the result of intensive work by the research team (IER, ROA, CE) and Cedefop's Skillsnet network, including individual country experts who provided additional information and validated the national data. However, the challenging task of developing a European forecasting system will take a long time to accomplish. Although we are at the end of one particular project phase, we are still at the beginning of the much longer and very demanding process of establishing a comprehensive system of regular forecasts of skill demand and supply for Europe.

Table of contents

Annexes

List of tables and figures

Tables

Figures

Boxes

Executive summary

Overview and objectives

This publication provides an overview of the results of the Cedefop pilot project on developing a medium-term forecast of skill supply in Europe. It summarises the approach that has been adopted and presents the key findings. It also highlights the many data and technical problems with which the research team has had to grapple and sets out the solutions that have been adopted, including some ideas for further work ([2]).

The overall aim has been to develop a system for producing regular, detailed and consistent quantitative projections of future skill supply across the whole of Europe, and to present the first results. Given the difficulties faced, a certain amount of pragmatism has been required, but this set of results provides an important contribution to the debate about the changing pattern of skills supply in Europe. In theory, such projections should allow a comparison with likely future demands ([3]). In practice, such comparisons are fraught with difficulty, mainly due to the different data vintages of the initial projections. However, the report explores how such a comparison might be achieved in future work. The present results benefited greatly from the various comments and suggestions of individual country experts made during the project.

The reasons for forecasting the demand for and supply of skills in Europe in a regular, consistent and systematic way are now well established. The Lisbon agenda and the 'new skills for new jobs' initiative, followed by a number of related policy documents, have given high priority to anticipation of changing skill needs. This project aims at extending previous work on the demand side to cover the supply of skills. The present publication covers the EU without Bulgaria, Malta and Romania, but includes Norway (hereinafter 'EU-25*'). Bulgaria, Malta and Romania are not included for various reasons discussed in more detail below.

([2]) Cedefop is currently working on updating forecasts of both skill supply and skill demand in Europe with financial support from the 'Progress programme' managed by the European Commission, Directorate-General for Employment, Social Affairs and Equal Opportunities. This subsequent research activity on regularly forecasting skill supply and demand in Europe started in 2008.

([3]) In particular, with the set of demand-side projections published by Cedefop in 2008 (Cedefop, 2008a).

The use of common models and assumptions, however, does always allow incorporation of 'local' knowledge about detailed policy and other factors that may affect skills supply. The results presented in this publication, therefore, need to be placed in context and supplemented by other qualitative information before any policy recommendations are made.

Key findings

The results suggest substantial further increases in the supply of both high- and medium-level qualifications across Europe. The rates of increase are generally higher for women than for men, which means that women will have higher-level (formal) qualifications than men in the future. In contrast, the proportion of people with low-level qualifications is projected to decline across Europe. This decline is projected to be sharper for women than for men. These general trends are observed in almost all countries. They are in line with the Lisbon agenda, which aims at increasing the proportion of people holding higher-level educational qualifications.

The proportion of people with high-level qualifications has risen steadily in recent years in most countries. This is reflected in the aggregate numbers for both the population and the labour force. The baseline scenario projects that between 2007 and 2020 the population of Europe (EU-25*) aged 15+ holding high-level qualifications (ISCED 5 and 6) will increase by almost 32 million. Similarly, the number of people in the labour force (in other words, economically active people aged 15+) with high-level qualifications, is projected to increase by more than 20 million.

The number of people with medium-level qualification is also expected to rise, although not as sharply as for the high-level qualification. Between 2007 and 2020 the population of Europe (EU-25*) aged 15+ holding medium-level qualification will increase by almost 18 million and the labour force will increase by more than 3 million. However, the qualification structure of the labour force in 2020 shows that almost half of the labour force will hold medium-level qualifications.

In contrast, the proportions and number of those with low-level or no qualifications have been steadily falling. Between 2007 and 2020 the population of Europe (EU-25*) aged 15+ with low-level or no qualifications will fall by more than 28 million and the labour force will contract by more than 18 million.

The results for those aged 25-64 (taking into account only the age cohorts that are likely to have completed most of their studies) confirm the general trends identified earlier. The results also show that the European benchmark

for 2010, namely that Member States should ensure 80 % or more of 25-64 years old in the EU having at least upper secondary education, will be reached by 2020 (almost 82 %).

When age groups are examined in more detail, notable variations can be observed. Young people, aged 15-24, are projected to experience only moderate increases in high-level qualifications, while the levels of those with medium- and low-level qualifications are expected to decline. This can be attributed in part to the general decline in the total numbers in these age groups and to the fact that young people are still in the process of acquiring qualifications (hence the slow growth in the number of those with high-level qualifications).

For older age groups (25+) the increase in the numbers with high-level qualifications is much sharper, especially for women. The age group 30-39 is projected to experience some of the biggest increases in high-level qualifications.

The number of people holding medium-level qualifications as their highest level is projected to decline for all groups aged up to 39, but to increase for groups aged 40+. This is an indication of cohort effects as people age and the fact that younger people are nowadays generally better qualified than older people.

The qualification structure of those aged 65 and over also changes substantially with time as the younger cohorts with medium- and high-level qualifications move into this group. For example, the number of low-skilled people in this age group is projected to fall to around 49 % in 2020, compared to 67 % in 2000, and in the labour force (economically active) it is projected to fall to 41 % from 63 % during the same period. The number of people with a medium-level qualification as their highest level is projected to increase the most.

Alternative scenarios – one pessimistic, the other more optimistic – project that changes in labour-force qualifications will move in the same general directions. The pessimistic scenario projects a decline in the labour force for all qualification levels, while both the baseline and the positive scenario project an increase.

The optimistic scenario includes the assumption that there will be no significant labour shortages in European labour markets that might restrict growth, that labour-market participation rates across Europe will improve and that Europe will be able to attract skilled labour from abroad.

In contrast, the pessimistic scenario assumes a deteriorating economic situation, with government measures to reduce innovation and fewer people entering the labour market.

All scenarios project that there will be increases for medium- and high-level qualifications, with the number of people with high-level qualifications projected to increase most. All scenarios project a decline in the total number of people with low-level qualifications.

Although the overall results suggest a relatively positive picture, one concern for policy-makers is whether the historical trends identified will continue undisturbed by the recent economic crisis. It is possible that the crisis may disrupt the steady improvement in qualification profiles observed over recent decades. Initial indications are that the immediate impact of the crisis may be increasing educational participation and qualification acquisition as individuals delay entry into a depressed labour market; they may also expect better opportunities with higher-level qualifications after the recovery. In the longer term, potential financial constraints may discourage investment in human capital. Policy-makers may need to take proactive steps to ensure that the projected improvements are realised and that investment, both in initial education and in continuing training and adult education, will continue.

These results indicate the general trends. To be more useful to both policy-makers and individual labour-market participants, more research is needed and more detail is desirable. Progress is mainly dependent on improvements in the underlying data, especially the information provided by national statistical authorities to Eurostat. More effort needs to be made in Europe to ensure that data are consistent, both over time and across countries.

Methodology

The project developed the basic database and tools required to produce a comprehensive and consistent set of skill supply projections for all countries in the EU.

Building on the previous skill-demand forecast (Cedefop, 2008a), this project extends the modular approach adopted there to the anticipation of Europe's future skills. The advantages of a modular approach are that it aids independent development and improvement of the different parts of the system. In combination, the modules provide a general conceptual framework for producing regular quantitative projections of changing skill needs and skills supply. In the present project three new modules have been added to the four main modules of the skill-demand forecast (Cedefop, 2008a):

(a) Module 1* – E3ME*: an augmented/extended version of the existing E3ME pan-European macroeconomic model, which incorporates a new

demographic and labour-supply module. This provides historical analysis and projections of overall labour supply by age and gender;

(b) Module 5 – StockMOD: an analysis of labour force survey (LFS) microdata from Eurostat to predict the probabilities of the population and the labour force achieving different levels of qualification (focusing on overall number of people with the three broad levels of qualification, defined by the highest-level of qualification held);

(c) Module 6 – FlowMOD: an analysis of aggregate flow data published by Eurostat/OECD (on enrolment and graduation) to produce a complementary analysis of participation and qualification rates by broad age groups.

The approach adopts common methods and models for all countries. Together the demand and supply databases and the models and modules constitute the overall conceptual framework for analysis of future developments in skills demand and supply.

The conceptual framework has been designed to facilitate further development and customisation. The present results are intended to continue the dialogue with experts from other countries, who are likely to have much greater knowledge about trends in their own countries. This conceptual framework provides an opportunity for this knowledge to be efficiently and transparently incorporated in future assessments.

The project is based on official data sources for the whole of Europe. In particular it draws on Eurostat demographics data, national accounts (NA), the LFS and additional data on flows of those acquiring and attaining qualifications.

The projections presented in this publication are the results of this pilot project. In many cases the data used are still subject to some uncertainty, reflecting the general problems of pushing the LFS and other data to the limits in terms of the amount of detail they can reveal. By presenting such results for further expert scrutiny, a dialogue that has already been launched at Cedefop Skillsnet expert workshops, and other events can be used to improve the results in Cedefop's subsequent project on developing regular forecasts of skill supply and demand in Europe. In addition to the results reported in this publication, a completely revised set of Excel workbooks has been produced containing the data for each country. They represent the most comprehensive and consistent sets of skill supply projections ever produced for Europe.

Conclusions

There are still many data problems and questions unresolved. The sample sizes in the LFS are often inadequate for providing robust more detailed estimates. Even for many of the larger countries there are problems with the data, which can probably only be resolved through painstaking dialogue between individual country experts and the relevant statistical authorities. Efforts to address these concerns will be made in the continuing research project recently initiated by Cedefop and supported by the European Commission.

Despite these reservations about the quality of the existing data, many of the trends which emerge from the analysis are quite robust and are unaffected by the detailed problems of many of the data used and by the detailed specifications for the models used to explain changing patterns of skill supply. This suggests that such projections can provide valuable information to a broad range of users.

A very important matter from a policy perspective is the possibility of skill imbalances in the labour market. Such information can, in conjunction with corresponding demand estimates, throw light on possible future developments in European labour markets, highlighting potential education mismatches and helping to inform decisions on investment in skills, especially formal qualifications, made by individuals, organisations and policy-makers.

Comparing current demand and supply projections is problematic for both practical and theoretical reasons. For instance, this forecast relied on different vintages of the EU LFS data and different population projections than the previous demand forecast. For many countries estimates have been significantly revised. Other circumstances, including the general economic and labour-market situation, have also changed significantly since the previous projections were made. Unless the two sets of results are based on common data and are carried out simultaneously, they cannot be directly compared. This report discusses these issues, as well as various other conceptual and methodological issues regarding imbalances, which provide useful insights for future work.

Such pan-European projections are not intended to be a substitute for what is already being done nationally but rather to complement it, providing, for the first time, a broad and consistent overview for the whole of Europe. This may not be able to compete with the forecasting work of individual countries, which draws on many years investment in data, systems and knowledge, but it does provide a common conceptual framework within which these more detailed analyses can be compared.

CHAPTER 1

Introduction

1.1. Objectives

This report sets out a systematic approach to analysing the future skill supply of EU Member States, using common models and data sources. It builds on an existing general conceptual framework that was established to consider the demand for skills (Cedefop, 2008a). The results presented here are intended as a starting point for further development.

The main aims of this project are to develop procedures and to process the available data to deliver the first medium-term forecast of skill supply in Europe. The work builds on the firm foundations already laid by the team ([4]), including previous work carried out by Cedefop ([5]) and research specific to their individual countries. The project had the following main objectives:

(a) to develop a robust and consistent database and projection models to enable the production of benchmark skill-supply projections for all Member States;

(b) to use the database and models to develop a full set of skill-supply projections, up to the year 2020, including a range of alternative scenarios;

(c) to compare those projections with the skill-demand projections produced previously in the companion project 'medium-term forecast of occupational skill needs in Europe (Cedefop, 2008a);

(d) to present these results in such a way as to initiate and foster systematic dialogue with experts in other countries.

The present document is a key step in disseminating the projections to a wider audience.

Extensive reviews of existing approaches to supply-side modelling, forecasts and projections were undertaken at the start of the project. Previous research suggests that there are a number of ways to model and project the labour supply and the skills supply (as measured by qualifications attained).

([4]) The team was led by the IER at the University of Warwick in the UK. It also included CE and the ROA based at Maastricht University in the Netherlands.

([5]) Project on medium–term forecast of occupational skill needs in Europe (Cedefop, 2008a).

The present analysis builds on these previous studies, including Cedefop's recent work on the implications of demographic changes for vocational education (Cedefop, 2008b) and work done in individual Member States. The models adopted are generally much less sophisticated than those used in some individual Members States owing to the limitations of the available pan-European data. In particular, it is not possible at present to develop fully-fledged stock-flow models.

1.2. Approach and methods: modular approach and general conceptual framework

The project adopts a modular approach, building on that developed in the earlier demand-side project and also extends the related conceptual framework, focusing on the supply side.

To explore skill demands, four separate modules can be used from the modular approach developed in the earlier project to focus on occupations and qualifications:

(a) Module 1: a set of multi-sectoral macroeconomic forecasts, based on the E3ME macroeconomic model;
(b) Module 2: an occupational model, focused on explaining expansion demand within sectors, which adopts common classifications and data sources (EDMOD);
(c) Module 3: a qualifications module (QMOD), based on similar data sources (mainly LFS), but focusing on the implications for qualification employment patterns within occupations (demand) rather than the supply side;
(d) Module 4: a replacement demand module, based on similar data sources, recognising the crucial importance of considering not just changing occupational employment levels but also the need to replace those leaving the workforce because of retirement, migration and mortality (RDMOD).

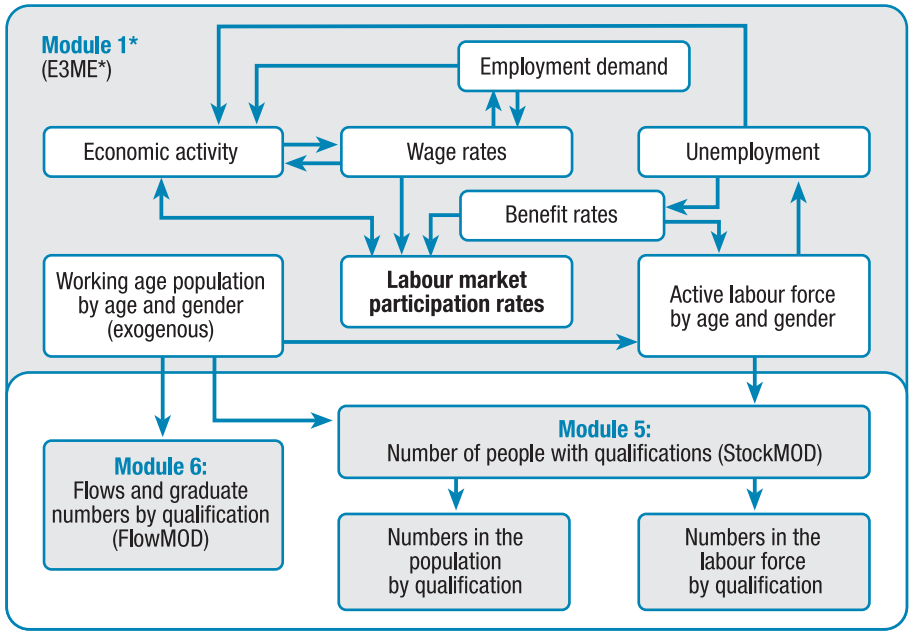
The supply-side work adds the following:

(a) Module 1*: E3ME* macroeconomic model (as Module 1, but including new elements such as an aggregate labour supply model now embedded within it);
(b) Module 5: qualifications model (number of people by qualifications held, StockMOD);
(c) Module 6: qualification model (flows of people acquiring and attaining qualifications, FlowMOD).

Figure 1 provides an overview of the main features of the three new modules. The modular approach aids independent development and improvement of parts of the system. In combination, the six main modules constitute the current conceptual framework (details in Annex C), within which it is relatively easy to insert 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 were designed to be compatible with the demand-side workbooks already developed in the previous project (more details about country workbooks in Section 2.1).

Initial versions of these workbooks were distributed to experts in each country in 2008 to enable them to assist in validating the data for each country. The final versions of the workbooks allow users to experiment with alternatives, which can then be fed back to the core research team to develop and improve the basic forecasts ([6]).

Figure 1. **Modelling the supply of skills (framework)**



([6]) Experts interested in obtaining access to the workbooks are welcome to contact the Cedefop skills analysis team (skillsnet-team@cedefop.europa.eu).

The aim of the present supply forecast project is not to replace national forecasts, nor to seek to criticise or undermine them; it is rather to present an alternative view, set within a much broader European context that puts the individual country results into perspective. The aim is to work with country experts to try to reach consensus on historical patterns and the main underlying trends.

To carry out a consistent and regular set of quantitative supply projections requires a robust database, containing comparable data for all countries, and an estimation by suitable models using econometric methods, which can be used to predict future developments. It includes:

(a) development of consistent demographic and labour-supply data by age and gender, and analysis of the data to develop models and projections as part of E3ME;
(b) analysis of Eurostat and LFS microdata on qualifications held, by population, labour force and employed workforce, using multi-logit and other methods to establish the probabilities of individuals in each country attaining the different levels of qualification;
(c) collation and analysis of aggregate data on educational participation and graduation, flows through the educational system, and transitions from education to the labour market, making plausible assumptions if data are missing and including integration with the other elements of the database ((a) and (b) above);
(d) further synthesis and analysis, including involvement of individual country experts to bring in country-specific expertise and insights.

All this has been done from a medium-term perspective (up to the year 2020), breaking skills levels down by ISCED (Annex B) to as detailed a level as the data will sustain. The analysis has been conducted for each of the EU-27 (without Bulgaria, Malta and Romania) plus Norway ([7]). Different variants have been explored, to illustrate the sensitivity of the results to alternative assumptions, where possible.

Many of the historical data are only available up to 2005 or 2006. Some historical data, especially those used in E3ME, extend to 2007 and occasionally 2008. For practical purposes, 2007 has been used as the historical benchmark, from which the formal projections stretch into the future.

More detailed information about the methodology is available in the Annexes C and D.

([7]) Analysis of Switzerland was also planned but has not been undertaken because data for Switzerland have not been made available by Eurostat in the same format as for other countries. Eurostat does plan to include all EU-27+ countries in future versions of the harmonised LFS data set.

1.3. Structure of the publication

A key issue the project addresses is what are the best data and methods to be used to measure changing skill supplies. These and other data-related issues are discussed briefly in Section 2.1.

Section 2.2 provides a brief overview of Module 1*, integration of a detailed model of the overall supply of labour by age and gender in the macroeconomic model, and the results the module produces. The development of alternative scenarios are also discussed. A criticism often made of quantitative projections is that they focus too much on a single-point forecast. One way of dealing with this criticism is to present a range of alternative views or scenarios which can encompass the most likely outcomes. Pollitt and Chewpreecha (2008) explore all these issues in greater depth.

Section 2.3 focuses on Module 5. This deals with modelling the probability of the population and labour force attaining certain qualification levels. Different approaches to modelling skills supply are summarised, drawing on the more detailed discussion in Livanos and Wilson (2008). This considers the ideal theoretical approach to such issues, as well as the limitations posed by data availability and other problems.

Section 2.4 presents an overview of an alternative approach focusing on flows; this represents Module 6. A discussion of the overall approach to these issues, the problems and pitfalls faced by the research team and how these have been tackled is set out in more detail in Cörvers et al. (2008).

Chapter 3 brings all this together, and presents a summary of the results from the project, which draw on the macroeconomic scenarios from E3ME combined 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.

Chapter 4 considers the implications of possible mismatches and imbalances in the demand for and supply of skills. The discussion here is largely conceptual and methodological since there are a number of practical difficulties which prevent a direct comparison between the supply projections presented here and the previous set of demand projections (Cedefop, 2008a).

The final chapter draws some conclusions from the project, including policy implications, and identifies outstanding issues for research and a possible way forward.

CHAPTER 2

Data issues and methodology

2.1. Data issues

2.1.1. Review of data sources

Existing data sources were reviewed to assess the quality of the data and its fitness for purpose within each module. This was coherent with the overall aim of developing a supply-side database suitable for supporting regular quantitative supply-side projections that are consistent between countries and with the existing demand-side projections.

A number of key data sources were identified and reviewed. These included:

(a) Eurostat data on demographics and labour supply by age and gender (this provides benchmark estimates of overall supply);

(b) Eurostat/LFS data on detailed patterns of the qualifications held by the population, including economically active and employed people (this includes the education and training section of the Eurostat harmonised database on population and social conditions);

(c) the Unesco-OECD-Eurostat (UOE) data collection on education statistics (student participation and graduation rates). These data are collected from the joint Unesco Institute of Statistics (UIS)/OECD/Eurostat questionnaires on education statistics which constitute the core of the database on education. Each of the 27 countries considered provided data from administrative records using commonly agreed definitions;

(d) individual country data, accessed through dialogue with individual country experts.

2.1.2. Measuring and modelling overall skills supply (stocks)

The LFS, conducted in a consistent fashion across the EU and collated by Eurostat, provides an invaluable source of information on the skills supply. It has the advantage of being conducted much more frequently than a typical census. It also adopts much more standardised sets of questions and classification systems.

While there are still some differences between countries, this source provides a broadly consistent set of data that can be used for producing skill-supply projections, mainly focusing on the overall number of those in the

population or the labour force who have acquired certain qualifications (stocks). The data set focuses on the highest qualifications (levels of education) held. ISCED 0-6 is the basis used for classifying the qualification levels attained (see Annex B for details).

As described in more detail in Livanos and Wilson (2008) and Wilson (2008), the EU LFS data set is not without faults and limitations. The LFS data are sample data. For many countries the time series are short and the number of respondents within a particular cell is often very low. There are also problems relating to the lack of consistency in definitions of qualifications across countries and over time. This means that the estimates are, in some cases, neither very precise nor robust.

2.1.3. Other data issues

There are a number of other data-comparability and quality issues that have emerged during the project. They relate in particular to the comparison of supply and demand estimates. Direct comparisons are problematic because the current projections and the previous demand projections use different demographic projections and different vintages of the LFS and other data sources, such as national accounts ([8]). These difficulties are discussed in more detail in Chapter 4.

2.1.4. Flow data

The data on stocks have been complemented by information on flows from the joint UOE database. This includes information on educational participation and attainment by age group, including graduation rates by level and field of education. The data come from questionnaires on education statistics, which constitute the core of the database on education for a range of developed countries, including the EU. Each of the 27 Member States considered provided data from administrative records on the basis of commonly agreed definitions. As noted by Córvers et al., 2008, there are problems of consistency with the stock-based estimates, although the two data sets appear to tell a broadly similar story (for more details see Córvers et al., 2008).

2.1.5. The country workbooks

As with the demand-side project, the supply-side work has involved producing a series of separate country workbooks, plus a European overview, in a

([8]) For a detailed discussion of the differences between the LFS and national accounts data see Livanos and Wilson (2007a) and Ypma and van Ark (2006).

standard format. Each workbook includes both historical data and a benchmark set of skill-supply projections.

Livanos and Wilson (2008) describe the main features of the workbooks which contain detailed supply data for each country. They also contain data prepared by individual country experts. The workbooks include facilities to enable users to customise results, including the ability to:

(a) incorporate alternative data;
(b) adopt alternative assumptions;
(c) consider alternative scenarios (there are separate workbooks for each of the three scenarios developed using E3ME).

Features embedded in the workbooks allow the user to access the underlying data, link and combine the two main data sets and generate alternative scenarios. The qualification proportions can be projected using various techniques (results based on multi-logit analysis using individual data, or time series analysis using aggregate data). These proportions can then be used to split the population and labour-force projections from E3ME* to generate the numbers in the population and labour force by broad qualification level ([9]). Note that activity rates for different qualification categories are not modelled explicitly but emerge from separate population and labour-force analyses.

2.2. Module 1*: overall labour supply scenarios (E3ME*)

2.2.1. E3ME* outline and overview

Most countries have done some macroeconomic modelling work at national level and many include multi-sectoral and multi-regional sub-components. There have been a few attempts to develop cross-country models within Europe. Perhaps the most widely used is E3ME, developed by Cambridge Econometrics in collaboration with others. 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.

([9]) In the workbooks, the user can, for example, select the method of extrapolation for the qualification proportions and then click on the extrapolate button, choose a file to import or install two given files, relating to levels of population and the labour force or qualification proportions. Experts interested in obtaining access to the workbooks are welcome to contact the Cedefop skills analysis team (skillsnet-team@cedefop.europa.eu).

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 ([10]). It provides a detailed industry analysis for each country/region within Europe ([11]). Further details are given in Gardiner et al. (2007) and in Annex D.

Before the present project E3ME only had a fairly crude treatment of labour supply. This distinguished gender but not age. This gap has now been filled by new modelling work as described in detail in Pollitt and Chewpreecha (2008). E3ME has been augmented to include a detailed treatment of labour supply by age and gender. E3ME* enables the production of a set of benchmark projections of labour supply that can be seen as part of a coherent European perspective, rather than being based on projections and inputs from individual countries. The use of the macroeconomic model sets the macroeconomic context for the overall skill projections. This also enables the development of alternative supply-side scenarios as described in more detail in Sections 2.2.3 and 3.2 below. The main drivers of labour supply are demographic; real wage output levels, unemployment rates, social benefits, and the structure of the economy (manufacturing versus services).

E3ME* also provides (in principle) consistent predictions of the demand side, including sectoral employment growth, taking into account factors such as GDP growth, as well as the underlying changes in the components of aggregate demand, demographic changes, etc. Such demand-side perspectives are described in more detail in Gardiner et al. (2007). However, these represent a different benchmark scenario to that underlying the present results. They also use earlier vintages of data for many key indicators, so direct comparisons are problematic. In future work on both demand and supply projections will be developed simultaneously from a consistent macroeconomic scenario ([12]).

([10]) Europe is defined here as the 27 Member States (EU-27) plus Norway and Switzerland. In some of the other modules Bulgaria, Malta, Romania and Switzerland are excluded because of problems in obtaining consistent data on qualification patterns. All the results in this section also exclude those four countries.

([11]) 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 (CGE) 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.

([12]) Cedefop expects to finalise and present the updated forecasts in early 2010.

2.2.2. Labour supply by age and gender

Pollitt and Chewpreecha (2008) explain in more detail how the new labour-supply analysis fits into the broader E3ME model, and how the previous treatment has been extended to cover both age and gender. This builds on earlier work for the UK by Briscoe and Wilson (1992). They explore a range of possible theoretical drivers of labour-market participation rates, before subjecting these to empirical testing using best-practice time-series methodologies. A number of factors are found to be important in explaining changing patterns of labour-market participation, including hours worked, the qualification mix, and unemployment. The results are generally statistically robust and in line with prior theoretical expectations.

The equations estimated are then used to make projections of the labour force by combining the predicted participation rates with projections of population by age and gender based on Eurostat (2008 vintage) (more details in Box 1).

Table 1 shows activity rates by age for the sum of all EU Member States excluding Bulgaria, Malta and Romania but including Norway ([13]). They show typical profiles in different age groups. There are low participation rates for the very young and very old. The former reflects young people's investment in education, while the latter shows the impact of retirement as older people withdraw from the labour market.

The separate results for men and women indicate different patterns of activity, with the activity rate for men being, in general, considerably higher than for women. Table 2 shows activity rates by gender and age for the sum of EU-25* countries, respectively.

Most countries show slight positive trends in overall labour-market participation over time, but the patterns vary between different age groups and between men and women. Although, historically, activity rates for women have tended to be lower, they have been increasing fast. Continuing variation between men and women illustrates the different family commitments of men and women. Participation rates for women have been rising in almost all age groups. The exceptions are the younger age groups which have been investing more in education and consequently (still) exhibit low participation rates.

([13]) EU Member States excluding Bulgaria, Malta and Romania but including Norway are referred to as EU-25* throughout the report. The full model, to be finalised in 2010, will eventually cover all 27 EU Member States, plus Norway and Switzerland.

Activity rates for men have fallen over the last 20-30 years in many age groups. For younger people this reflects a similar pattern of continued investment in education. For older people (at least until recently) it reflected trends towards earlier retirement. However, over recent years there has been an upward trend in the overall activity rate, although there are several countries where activity rates for men aged 30+ show a slight downward trend. Some of the highest increases in activity rates are for people aged 50+. This reflects the general trend towards longer working lives and perhaps concerns about pensions and the consequent need to work longer. Countries where the overall trend across all age groups and for both men and women has shown a slight decline include Denmark, Finland, France, Italy, Luxembourg, Norway, Poland, Slovakia and Spain. This trend may be reversed if concerns about pensions and the tendency to retire later continue.

Table 1. **Activity rates by age, EU-25***

Males and females Percentage (%)

	2000	2005	2007	2013	2020
15-19	25.5	24.9	24.9	23.6	23.3
20-24	65.8	65.2	65.0	65.0	65.0
25-29	82.3	82.9	83.3	84.2	85.0
30-39	85.3	86.1	86.7	87.5	88.2
40-49	84.0	85.6	86.3	87.1	87.8
50-54	74.6	78.1	79.5	80.2	80.6
55-59	55.1	59.8	60.7	61.9	64.0
60-64	23.5	28.6	30.2	30.6	32.7
65+	3.7	4.0	4.1	4.3	4.7
15+	56.3	57.2	57.5	57.0	55.8

Source: E3ME*.

Note: EU-25 without Malta but including Norway.

Table 2. **Activity rates by age and gender, EU-25***

Females

Percentage (%)

	2000	2005	2007	2013	2020
15-19	23.2	22.6	22.8	22.3	22.1
20-24	60.7	60.3	59.9	59.7	59.7
25-29	74.6	76.1	77.1	78.9	80.2
30-39	75.3	77.5	78.3	79.2	80.0
40-49	75.0	78.2	79.2	80.5	81.9
50-54	63.3	69.3	71.3	72.0	72.4
55-59	42.8	49.6	51.0	53.0	56.0
60-64	15.5	20.3	22.2	22.4	23.9
65+	2.3	2.4	2.5	2.6	2.7
15+	47.4	49.2	49.8	49.6	48.6

Males

Percentage (%)

	2000	2005	2007	2013	2020
15-19	27.6	27.0	26.8	24.9	24.4
20-24	70.7	69.9	70.0	70.2	70.1
25-29	89.8	89.4	89.3	89.4	89.6
30-39	95.0	94.6	94.9	95.5	96.2
40-49	93.1	93.1	93.4	93.7	93.7
50-54	86.0	87.3	87.9	88.5	88.8
55-59	67.8	70.5	70.8	71.3	72.2
60-64	32.3	37.5	38.8	39.4	42.2
65+	5.9	6.2	6.3	6.7	7.3
15+	65.9	65.7	65.7	64.8	63.4

Source: E3ME*.

Note: EU-25 without Malta but including Norway.

2.2.3. Development of alternative scenarios

E3ME has also been set up to explore alternative scenarios for the labour supply. Two main scenarios are explored in addition to the central benchmark (baseline scenario). These present more and less optimistic outcomes, based on a range of different assumptions about the prospects for economic growth and competitiveness, social welfare and government policies, technological change, globalisation and mobility.

The outcomes are more or less symmetric around the central view, with overall labour supply varying by plus or minus 5 %. More detailed analysis reveals many variations between countries, and sensitivity to different types of assumption. The alternative scenarios and their assumptions are described in more detail in Section 3.2.

2.3. Module 5: probability of attaining qualifications (StockMOD)

2.3.1. Overview

Although there has been much academic work on educational choice and related issues, it has focused only rarely on models suitable for developing skill-supply projections. Some work in individual Member States has made progress in this direction, but the progress has usually been due to access to specific data that is not generally available at a pan-European level.

Best practice involves full analysis of both stocks and flows. Stocks in one period are related to stocks in an earlier period, plus inflows and less any outflows. The flows can be linked to demographic developments, migration and to a range of behavioural drivers, including economic and social factors. Livanos and Wilson (2008) briefly review this research before presenting a much simpler approach, which focuses solely on changes in the average qualification patterns within stocks and so takes account of the limitations of the data available at a pan-European level.

The methodology is based on analysis of changes in data patterns in each country separately for the stocks of people in the population and in the labour force, defined by the highest qualification held. These data are taken from the EU LFS. This avoids the problems of incomparable systems of classification in country-specific data. The data used are all drawn from information harmonised by Eurostat.

Nevertheless, it is also clear from the analysis that there are still problems in comparing countries due to the way qualifications are coded in the LFS.

There are also difficulties in comparing the data for some countries over time owing to undocumented discontinuities due to changes in the classification or definitions used.

However, the results suggest that, even though the historical data on the highest qualifications attained are not perfect, it is possible to begin to explore the implications for the future supply of qualifications in the population and the labour force. Many of the trends appear to be robust and common to all countries. However, there are some significant data limitations for some countries that make further research necessary, as indicated below.

Ideally, in the longer term, this approach could also be extended to include a much more sophisticated analysis of the supply side that could include a sharper focus on the factors which influence flows and more details about the types of qualification held. These possibilities are being explored in a subsequent Cedefop project to develop regular forecasts of the skill supply and demand in Europe.

Another key aspect is distinguishing supply issues from demand issues. The present exercise focuses on changing supply patterns, with no reference to demand-side developments. In practice, the changes observed are likely to have been the result of a combination of both demand and supply influences. Future work will need to pay greater attention to distinguishing supply and demand influences and determining the interaction between them.

Another related issue is the possibility of measuring imbalances and mismatches between supply and demand. The previous project (Cedefop, 2008a) developed demand projections for different levels of qualification. In principle, these can be compared with the supply-side projections presented here. In practice, such comparisons are problematic for conceptual and practical reasons. Chapter 4 discusses some of the methodological and conceptual issues surrounding the measurement of imbalances and mismatches. Chapter 4 also outlines some of the practical difficulties involved in making such comparisons on the basis of the present results. It concludes that there are currently too many inconsistencies between the initial demand and new supply projections to make direct comparisons meaningful, but further work would make such analysis feasible.

2.3.2. Issues in developing stock-flow models

In principle, it is possible to develop quite sophisticated analyses of the number of people qualified at a higher level by using information on the flows of people through the education system and the labour market. The overall supply of people with higher-level formal qualifications (ISCED 5 and 6) is relatively

straightforward to conceptualise and model. However, there are considerable conceptual and practical difficulties in extending this:

(a) to include lower-level qualifications (e.g. ISCED 1-2);
(b) to conceptualise the idea of supply to cover specific dimensions such as occupation, sector and geographical area.

One of the problems faced (as noted by Cörvers et al., 2008) is that education systems in most countries are not completely hierarchical. These issues are discussed in turn.

The first problem to be addressed in extending stock-flow models to cover the full range of qualifications is the much more limited information available on flows for lower-level qualifications (especially ISCED 1-2). Ideally, stock-flow modelling requires a comprehensive set of demographic accounts showing how individuals progress through the education system and the labour market over time. In practice such detailed accounts do not exist, although there is a considerable amount of information on certain flows, which has been exploited in Module 6.

Statistical agencies collect and publish a considerable amount of information on the higher education system in particular. In principle, this can be used to develop estimates of the main flows involved and so develop stock-flow models of this process. In practice, this information is often inconsistent and far from comprehensive. It is also not consistent between countries.

For lower-level qualifications, while there is an enormous amount of detailed information available on the acquisition of qualifications, there is much less information on previously held qualifications. This makes it difficult, if not impossible, to develop stock-flow models analogous to those constructed for higher levels, as in Wilson and Bosworth (2006) for the UK.

As people acquire qualifications equivalent to ISCED 4, 5 and 6, it is almost inevitable that the proportions of people with ISCED 1-3 as their highest qualification will fall. This can mean that, despite increases in the number of people acquiring ISCED 1-3, the number of people with ISCED 1-3 as their highest qualification may actually decline in absolute and relative terms.

2.3.3. Issues in modelling supply by qualification

Livanos and Wilson (2008) review the previous theoretical and empirical approaches to modelling and forecasting the supply of people with different levels of qualifications. Where detailed data were available, researchers have exploited them. More often than not, however, the paucity of information available has resulted in very simple approaches, applying time series methods, frequently based on a single variable (time), rather than

multivariate, behavioural approaches.

The ideal approach would probably be based on a linked stock-flow model, with future stocks being related to past ones by an accounting relationship, with separate analysis of all relevant inflows and outflows, including flows of people into and out of education and outflows for various reasons (including mortality, migration and flows into and out of economic activity).

Given suitable data, such flows can be explained using behavioural models, such as the human capital approach. This argues that education can be regarded as an investment and that the decisions of people to participate in education and to acquire qualifications are influenced by the returns on such investment. Based on such theories, the supply of skills (as measured by qualifications) can be related to career choices that are influenced by a range of economic and other determinants, including:

(a) pay (returns on investment in qualification);
(b) employment opportunities when searching for a job;
(c) social security and tax system;
(d) personal and household characteristics;
(e) other economic and social factors.

Previous pan-European empirical research on these issues is quite limited, especially at a detailed level. In practice, pan-European data to construct such models are not generally currently available. There is quite a large gap between the ideal theoretical model and the typical specifications used in most national-level skills-supply projections.

There are pan-European stock data available from the LFS and more limited flow data as described in the Section 2.4. In both cases, the period covered by the available time series data is also very short. In practice, such data only allow for fairly very simple extrapolative procedures (using linear or non-linear methods). Effectively, time is the only independent variable, acting as a proxy for other factors.

The following section presents an approach with a focus on selected flows. However, these data are not suitable for developing a fully-fledged stock-flow model. The next section simply analyses changing qualification patterns within overall stocks, highlights the net result of all the unmeasured changes in inflows and outflows. Until much better data are available on flows (consistent with the stock estimates), this is all that will be feasible at a pan-European level ([14]).

([14]) These issues and possible further refinement of the models used to explain the changing skill supply are discussed in more detail in Livanos and Wilson (2008).

2.3.4. Modelling the supply of skills

To assess changing patterns of skill supply within each country, a simple model has been constructed to develop projections of the supply of people by qualification. This model looks at patterns in the qualifications currently held, as reported in the LFS. Those patterns are then applied to independent projections of the population aged 15+ and the labour force, both broken down by age and gender, taken from Module 1* (E3ME*).

The LFS is a sample survey which collects information about current educational attainment (individuals list qualifications currently held by level and type). This information is used to ascertain the current stock of qualifications, with the emphasis on the highest qualification held by age group, gender and country. The models used effectively identify separate time trends for each qualification level, which are then used to generate projections of qualification attainment over the forecast period. The data on qualification proportions are then mapped onto labour-force projections from the E3ME model to project the number of people holding qualifications by age group and gender.

The propensity to hold a given level of qualification is measured either using aggregate data (based on information from the LFS as supplied by Eurostat) or for individuals (using a pooled cross-sectional data set drawn from the EU LFS microdata set). The trends are estimated using a multi-logit model (estimated on the individual data) or some form of trend extrapolation (based on aggregate data). The latter is the default method used in the detailed country workbooks and is the basis for the results presented here. Variables are introduced into the model specifically to capture 'spatial effects' (including country-specific intercept and time trends for each qualification level, age group and gender). This modelling strategy makes maximum use of the limited sample size in the LFS. The analysis focuses on individual qualification achievement levels (dependent variable) against a set of explanatory variables. Demographics are controlled for by including age-band categories across which qualifications achievement may be expected to vary.

Note that the focus is not primarily on explaining attainment per se; instead it is on using the estimated historical trends by qualification level to project future attainment, while controlling for other influences. This is done, either by using econometric analysis of individual data from the LFS microdata set, or using more simplistic trend-fitting methods applied to aggregate data. In both cases, the time trend variables drive the projections, and the inclusion of the age-gender categories allows independent projections by age and gender.

The regression analysis of individual data uses a multinomial logit specification. The propensity for individuals to obtain a given level of qualification:

$$Q_{ijk} = \alpha_{jk} + \beta_{jkt} + \gamma A_{ijk} + \phi G_{ijk}$$

where, *i* denotes the *i*th individual, *j* refers to the *j*th country and *k* is the *k*th age group. *Q* takes values of 0 or 1 depending on whether the individual holds a particular qualification or not. There are three qualification categories, high medium and low, (one category is left out as the base group). *A* denotes a set of age band dummies, taking values of 1 if the individual falls into a particular age group. *G* is a gender dummy, taking values of 1 for women and 0 for men. Finally, a set of time trend variables *t* are included, capturing changes in achievement levels over time which differ by country and gender and for each age band ([15]). The model is estimated using the multi-logit procedure in the STATA software package, which constrains the proportion of individuals holding each qualification level to sum to unity. Some typical results of the multinomial logit regression are shown in Livanos and Wilson (2008).

The most robust and plausible results are obtained from some of the simpler models using the aggregate data. Those models generally involve some form of simple time trend rather than more sophisticated econometric models of individual data, building in more 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 and other behavioural content to this part of the modelling.

2.4. Module 6: flows (FlowMOD)

2.4.1. The importance of flows

In addition to analysing changes in the overall stocks of people acquiring qualifications, it is important to consider flows. Ideally, this would comprise a comprehensive examination of all the key inflows and outflows including:

(a) both inflows into the stock of the population with different levels of formal qualifications, including various intermediate flows as individuals make their way through education;
(b) outflows, for whatever reason (including outward migration, retirement and mortality).

([15]) That is to say, time trends multiplied by dummy variables which take a value of 1 for those living in a particular region or in a particular age group.

Effectively, this would comprise a full set of demographic accounts, linking the number of people in various socioeconomic 'states', from one period to the next, in a comprehensive, detailed and systematic fashion. In practice, especially at a pan-European level, obtaining all the data necessary to develop such a set of demographic accounts is problematic. Even for individual countries the available data are generally far from perfect, although in some cases data are available to undertake more sophisticated analysis (for example in Germany, the Netherlands and the UK), which is why the approach is discussed in this section even though no results are presented.

2.4.2. A practical approach to analysis of flows

The report by Cörvers et al., 2008 focuses on developing a methodology to derive projections of some of the flows that can be identified in a systematic and consistent fashion across Europe. This analysis concentrates on young people entering the labour market by educational level, based on aggregate data from UOE. This data set includes information on the population, by age group, following certain courses of study and the number of graduates by level and field of education.

Cörvers et al., 2008, document the limitations of these data for the purposes of the project, before setting out a general methodology for exploiting these data to provide additional insights into trends and developments in the supply of skills across Europe. They highlight two main data limitations:

(a) missing values;
(b) lack of information on the outflows from the education system.

Solutions are proposed to address the data limitations, and preliminary models and projections are developed, including a comparison with the overall numbers emerging from Module 5 (which is based purely on an analysis of changing patterns within the stocks).

Cörvers et al., 2008, develop a model based on the so-called participation rate method (Cedefop, 2008b, among others). Participation rates are defined as the number of students, broken down by age bracket, gender and ISCED level, divided by the population in the same age bracket. The participation rate is calculated for all years between 1998 and 2005 for which data are available, for each of the 29 countries in the dataset.

Cörvers et al., 2008, derive projections of the rates of students and graduates by broad educational levels (ISCED 0-2+3C short, ISCED 3-4 and ISCED 5-6). Projections of the number of students and number of graduates

are then obtained by linking these participation and graduation rates to Eurostat projections of the population.

Two scenarios have been produced to analyse flows. The first assumes constant student participation and graduation rates by age, gender and education level. The second incorporates a continuation of recently observed participation or enrolments trends, although graduation rates for those enrolled are assumed to be constant. For the former, the evolution of the number of students and graduates results from population growth within age groups and gender. For the latter, increased enrolment rates are taken into account.

The results vary between countries. In the first scenario, even though participation rates by age and gender are assumed to be constant, the aggregate (across all ages) participation rates change between 2006 and 2020. This reflects differences in population growth rates between age groups and between men and women. Where allowance is made for trends in enrolment rates, the rates are amplified. For some countries, the results are not too different, implying relatively weak trends in enrolment rates (e.g. Ireland, Luxembourg, Malta, the Netherlands, Austria, Portugal, Sweden and the United Kingdom). Other countries have experienced more significant increases in enrolment over the last decade; these trends will eventually level off, as rates cannot exceed 100 %. Assuming that the trend will not weaken, the forecasts can be regarded as an upper limit.

Because the population aged 15 to 34 is expected to shrink between 2006 and 2020 in most countries, the number of graduates will fall unless enrolment rates increase. The number of graduates is projected to decrease at all levels and for almost all countries between 2006 and 2020 in the first scenario. However, taking into account recent positive trends in enrolment rates, the numbers at ISCED 5 and 6 are forecast to increase in nearly all countries.

In principle, the stock method and the flow method applied on a consistent dataset should be comparable. The change in the stock of people by education in the working-age population is, by definition, equal to the inflow minus the outflow. The inflow comes from new graduates or immigrants. The outflow is due to morbidity or net outward migration, the latter constituting the bulk of the outflow in most cases. Different qualification rates between older and younger people result in a large cohort effect on average qualification levels in the stock.

Differences between the change in the forecast stock and the inflow forecast in the flow method could arise for a variety of reasons, including variations in migrant qualification patterns. The main problem however is lack

of consistency between the datasets being used, and in particular the fact that the flow method uses data which suffer from double counting ([16]). This means that the forecasts from the flow method will generally be biased upwards compared to the stock-based estimates.

While there are some difficulties with the flow data, the results obtained appear to be generally plausible. They are also broadly consistent with those based solely on analysing changing patterns in stocks (Module 5), although it is difficult to make direct comparisons, as Cörvers et al., 2008, point out. The authors have general concerns about their results. Although the flow results correlate with the stock results quite closely in some cases, there are concerns about the consistency of the forecasts for some countries. The data problems are especially severe for particular countries, which makes it difficult to produce robust general forecasts. The focus in the remainder of this report is, therefore, on the stock-based estimates.

([16]) For example, graduates from Bachelors and subsequent Masters programmes are, in official statistics, counted twice as graduates of ISCED 5.

CHAPTER 3

Prospects for changing skill supply in Europe

This chapter presents estimates and projections of the skill supply at a pan-European level. They are driven by the new macroeconomic scenarios produced by Cambridge Econometrics and use the stock-based results on the number of people acquiring formal qualifications from Module 5.

The dialogue with individual country experts concerning the supply-side results that were first produced in June 2008 has continued; all these results have been considered by members of Cedefop's Skillsnet network and feedback obtained from many countries. While it has not always been possible to adopt all the suggestions made, the final results have benefited greatly from this input ([17]).

These results are presented in even greater detail in supply country workbooks, which are available from Cedefop to members of its Skillsnet network (more details in Section 2.1). This has been a pilot project and, at this stage, the results should be regarded as indicative of the kind of information that it is possible to generate from this general approach rather than precise predictions.

Section 3.1 presents the results on the supply of skills, focusing on the stock-based estimates of the number of qualified people. They are driven by the E3ME results on the overall labour supply and are based on Eurostat demographic data rather than purely LFS estimates. The macro (baseline) scenario is revised and updated in the light of the scenario that is used for the demand-side projections reported in the earlier project (Cedefop, 2008a). Section 3.1.1 presents an overview for Europe as a whole, focusing on people aged 15+. Section 3.1.2 also presents pan-European results but focuses on different age groups. Section 3.1.3 presents a selection of the more detailed results, covering and comparing all the individual countries. Section 3.2 then goes on to consider the sensitivity of the results to some key assumptions. In

([17]) The results have been extensively revised compared to those presented at Cedefop Skillsnet expert workshop in Cambridge in December 2008. In particular the LFS data on qualification patterns are now based on weighted estimates and therefore match the published data from Eurostat. Some of the detailed country results have also been revised following particular comments.

particular, it explores what difference the alternative macro scenarios make to the changing skill supply. Section 3.3 moves on to a summary of the discussion about various issues that were raised by country experts during the project.

For some purposes it is more informative to focus on the age groups 25 and older in education-related statistics. In many studies the working-age population by qualification is defined as 25-64 year-olds, because cohorts aged up to 25 have (mostly) not yet completed the acquisition of formal qualifications. In some of the analysis below the patterns for that broad age group are examined in more detail. In others the population (15+) is examined.

In general, the results are based on the assumption that the broad historical trends in average qualification patterns observed over the past 5 to10 years will continue, and that these recent patterns (for each country, gender and age group) provide a useful guide to how the future might evolve. Those results are combined with the demographic and labour-force numbers from Module 1* (E3ME*) to generate the projected numbers in each category ([18]). Based on these assumptions, there will be increases in both the proportions and the number of people with medium- and high-level qualifications, both in the population and the labour force. In contrast, the number of people with low-level qualifications are expected to decline in absolute and proportional terms.

3.1. Benchmark (baseline) scenario

3.1.1. Pan-European prospects for those aged 15+

This section presents a summary of the results for all EU Member States excluding Bulgaria, Malta and Romania, but including Norway. This group is referred to throughout as EU-25*. In principle, the results could cover all the current 27 Member States, plus Norway and Switzerland. However, it has not been possible to include Malta and Switzerland at this stage as these two countries are not included in the EU LFS microdata. They are currently recorded with zero values in many of the tables. There were also problems in obtaining consistent data for Bulgaria and Romania, so those countries are also excluded from most of the analysis. Figure 2 illustrates population trends

([18]) The EU LFS microdata have been weighted when calculating the proportions to match the aggregate data as published by Eurostat.

for the EU-25*. Similar information is available for the labour force (Figure 3 and in more detail in Tables 3 and 4).

In general, the proportion of people with high-level qualifications has risen steadily in recent years in most countries and this is reflected in the aggregate numbers in both the population and the labour force. In contrast, the proportions and number of those holding low-level (or no) qualifications have been steadily falling.

The underlying historical trends are very clear in most countries and are projected to continue, resulting in a steady increase in the number of those with medium- and higher-levels of education rising throughout Europe. It is projected that between the benchmark year 2007 and the target year 2020 the population of Europe aged 15+ (EU-25*) with high-level qualifications will increase by almost 32 million. The numbers with no or low-level qualifications will fall by rather more.

Similarly, the number of people in the labour force with high-level qualifications is projected to increase by more than 20 million, while the number with low-level qualifications will fall by an even larger amount.

These general trends are common to both men and women. Women have seen the most significant rates of improvement in qualification levels attained in recent years and these patterns are projected to continue. The rates of increase in the number of women with high-level qualifications are significantly higher than the rates for men for both the population and the labour force. For example, between 2007 and 2020 the number of men in the population with a high level of education is projected to increase by over 14 million compared with an increase of over 17 million for women. In terms of percentage change, the number of men with higher-level qualifications will increase by 38 % in the population of working age while the corresponding figure for women is 46 %.

In contrast, the number of those with low-levels of formal qualifications in both the population and the labour force are projected to decline dramatically (by 28 and 18 million respectively). The decline will be around 29 % for the labour force and around 19 % for the population of working age. The number of women in the population with a low level of education will decline more rapidly than the number of men with the same level (-22 % and -15 % respectively).

These changes are even more pronounced for the labour force as a whole. While at first sight they may appear extreme, they largely reflect cohort effects. As well-qualified young people enter the workforce, and older less well formally qualified workers leave as they retire, the average qualification levels increase very significantly.

Table 3. **Population trends (those aged 15+) by gender and broad qualification levels, EU-25***

	Levels (000s)				
Males	**2000**	**2007**	**2013**	**2020**	**000s**
Low qualification	70 825	67 190	62 594	56 872	-3 635
Medium qualification	78 788	85 011	89 183	92 097	6 223
High qualification	31 630	38 263	45 002	52 643	6 633
All qualifications	181 243	190 464	196 779	201 612	9 221
Females	**2000**	**2007**	**2013**	**2020**	**000s**
Low qualification	91 706	82 961	74 168	64 828	-8 745
Medium qualification	74 382	82 385	88 552	93 268	8 004
High qualification	29 004	37 903	46 272	55 171	8 898
All qualifications	195 092	203 249	208 991	213 267	8 157
Males & females	**2000**	**2007**	**2013**	**2020**	**000s**
Low qualification	162 531	150 150	136 761	121 700	-12 381
Medium qualification	153 170	167 396	177 735	185 365	14 227
High qualification	60 635	76 166	91 274	107 814	15 531
All qualifications	376 336	393 713	405 770	414 879	17 378

Source: IER estimates from qualifications model based on CE forecasts for the supply (from the E3ME model).
Note: In qualification-related studies, the age groups for the working-age population are usually defined as those aged 25-64 because younger cohorts (aged up to 24) have not yet completed their studies. This partly explains the difference between 150 000 low-qualified people in 2007 in this table compared to the LFS figure of 78 000 (which also includes Bulgaria and Romania). For this reason it may be preferable in some circumstances to focus just on those aged 25 – 60/65. Figures 4 to 13 provide more detailed analysis by age group. Even more detail by age is available in the workbooks and in Annex A.

Change 2000-07		Change 2007-13			Change 2007-20		
%	% p.a.	000s	%	% p.a.	000s	%	% p.a.
-5.1	-0.7	-4 596	-6.8	-1.2	-10 318	-15.4	-1.3
7.9	1.1	4 172	4.9	0.8	7 086	8.3	0.6
21.0	2.8	6 739	17.6	2.7	14 380	37.6	2.5
5.1	0.7	6 315	3.3	0.5	11 148	5.9	0.4
%	% p.a.	000s	%	% p.a.	000s	%	% p.a.
-9.5	-1.4	-8 793	-10.6	-1.9	-18 132	-21.9	-1.9
10.8	1.5	6 166	7.5	1.2	10 882	13.2	1.0
30.7	3.9	8 369	22.1	3.4	17 268	45.6	2.9
4.2	0.6	5 742	2.8	0.5	10 018	4.9	0.4
%	% p.a.	000s	%	% p.a.	000s	%	% p.a.
-7.6	-1.1	-13 389	-8.9	-1.5	-28 450	-18.9	-1.6
9.3	1.3	10 339	6.2	1.0	17 968	10.7	0.8
25.6	3.3	15 107	19.8	3.1	31 648	41.6	2.7
4.6	0.6	12 057	3.1	0.5	21 166	5.4	0.4

Table 4. **Labour-force trends (those aged 15+) by gender and broad qualification levels, EU-25***

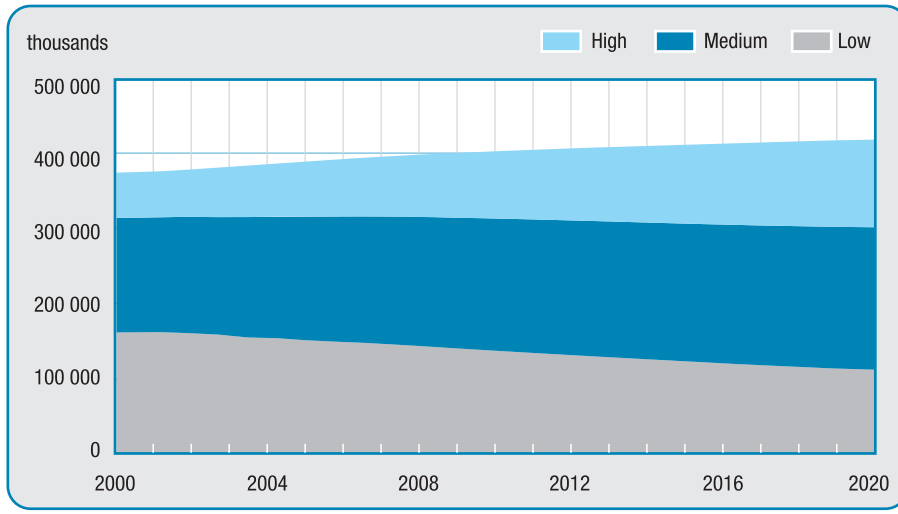
	Levels (000s)				
Males	**2000**	**2007**	**2013**	**2020**	**000s**
Low qualification	38 050	35 289	31 578	26 933	-2 761
Medium qualification	57 548	61 024	62 575	62 567	3 476
High qualification	23 932	28 852	33 442	38 247	4 920
All qualifications	119 530	125 165	127 595	127 747	5 635
Females	**2000**	**2007**	**2013**	**2020**	**000s**
Low qualification	30 977	28 113	23 305	18 197	-2 864
Medium qualification	43 234	48 062	49 701	49 677	4 828
High qualification	18 256	25 128	30 624	35 825	6 872
All qualifications	92 467	101 303	103 630	103 698	8 836
Males & females	**2000**	**2007**	**2013**	**2020**	**000s**
Low qualification	69 027	63 402	54 883	45 130	-5 625
Medium qualification	100 782	109 086	112 277	112 244	8 304
High qualification	42 188	53 980	64 065	74 072	11 792
All qualifications	211 997	226 468	231 224	231 446	14 471

Source: IER estimates, based on the CE E3ME model.

Note: In qualification-related studies, the age groups for the working age population/labour force are usually defined as those aged 25-64 because younger cohorts (aged up to 24) have not yet completed their studies. For this reason it may be preferable in some circumstances to focus just on those aged 25- 60/65. Figures 4 to 13 provide more detailed analysis by age group. Even more detail by age is available in the workbooks and in Annex A.

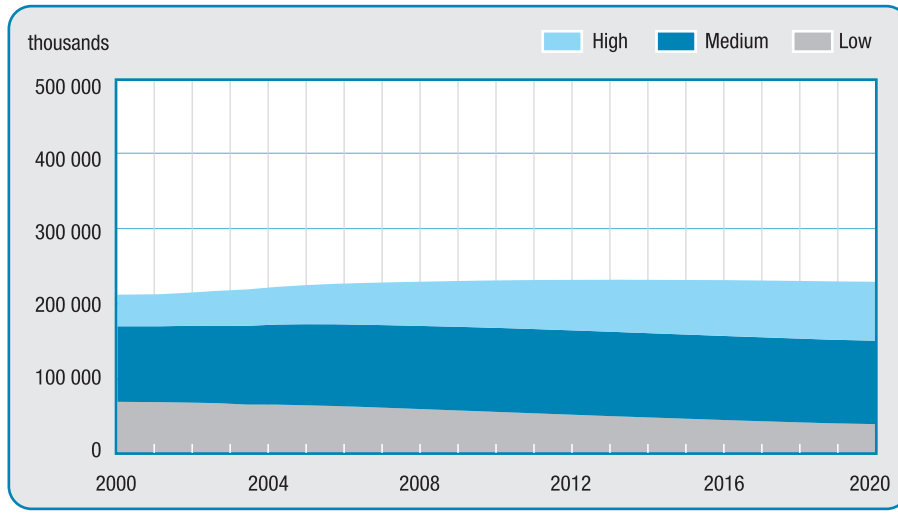
Change 2000-07		Change 2007-13			Change 2007-20		
%	% p.a.	000s	%	% p.a.	000s	%	% p.a.
-7.3	-1.1	-3 711	-10.5	-1.8	-8 356	-23.7	-2.1
6.0	0.8	1 551	2.5	0.4	1 543	2.5	0.2
20.6	2.7	4 589	15.9	2.5	9 395	32.6	2.2
4.7	0.7	2 430	1.9	0.3	2 582	2.1	0.2
%	% p.a.	000s	%	% p.a.	000s	%	% p.a.
-9.2	-1.4	-4 808	-17.1	-3.1	-9 916	-35.3	-3.3
11.2	1.5	1 639	3.4	0.6	1 615	3.4	0.3
37.6	4.7	5 495	21.9	3.4	10 696	42.6	2.8
9.6	1.3	2 327	2.3	0.4	2 395	2.4	0.2
%	% p.a.	000s	%	% p.a.	000s	%	% p.a.
-8.1	-1.2	-8 519	-13.4	-2.4	-18 272	-28.8	-2.6
8.2	1.1	3 191	2.9	0.5	3 158	2.9	0.2
28.0	3.6	10 085	18.7	2.9	20 092	37.2	2.5
6.8	0.9	4 756	2.1	0.3	4 978	2.2	0.2

Figure 2. **Supply trends, population (15+), EU-25***



Source: IER estimates from StockMOD.

Figure 3. **Supply trends, labour force (15+), EU-25***



Source: IER estimates from StockMOD.

Notes: Figure 3 deliberately uses the same scale as Figure 2.
Historical data for Italy have been adjusted to smooth out a major discontinuity in 2004.

3.1.2. Pan-European prospects for different age groups

Figures 4 to 13 illustrate the changing patterns for the different age groups. They show the number of people (separately for men and women) in the total population and the labour force, broken down by age group. These figures all focus on the number of people for the years 2007 and 2020, according to the highest level of qualification held. Detailed tables are presented in Annex A.

The number of people in the population with only low-level qualifications fell for all age groups between 2000 and 2007 (with the exception of men aged 65+). Over the same period the number of people with high-level qualifications increased rapidly for all age groups except the youngest. Those aged 15-19 are generally only just starting on the process of acquiring higher-level qualifications; for those aged 20-24, this process is continuing in many cases. Other age groups show a significant improvement over time, reflecting the fact that each generation or cohort tends to be better qualified than its predecessor. The 30-39 age group shows the largest decline in people with low-level qualifications and the sharpest increase in people with high-level qualifications over the same period.

These patterns are projected to continue, reflecting the improvement in the highest-level qualifications held for most age groups and gender and with the demographic changes in prospect. For instance, over the period 2000-20 the 30-39 age group is projected to experience a decline of more than 10 million people with just low-level qualifications; at the same time, the number of people holding high-level qualifications is projected to increase by more than 11 million.

These patterns are reflected in the results for the labour force. Between 2000 and 2007 there were big reductions in the number of people in the age group 30-50 with low-level or no qualifications, and big increases in the number with high-level qualifications. These trends are expected to continue up to 2020. They reflect increases in the qualifications being acquired by those in the workforce but, more importantly, the fact that each age cohort tends to be better qualified than its predecessor. At some point this progression will meet its natural limit, but the positive cohort effects are likely to continue for the period covered by these projections.

Figures 8 and 11 show net projected changes in the number of people in the population and the labour force over the period 2007-20, highlighting those with different levels of qualification (including those with medium-level qualifications), again broken down by age and gender. The top left panels focus on the changes for all 25 to 64 year-olds, highlighting the age cohorts that are likely to have completed most of their studies. These results confirm

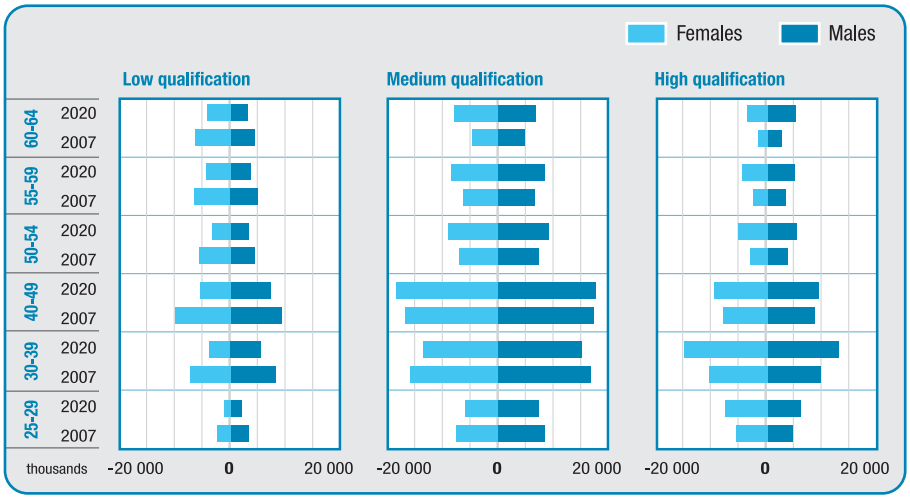
the general trends identified earlier, suggesting that for Europe as a whole there is likely to be a significant increase in the number of people (both in the population and in the labour force) holding high-level qualifications. A more moderate increase is projected for those holding medium-level qualifications and a marked decline for those with low-level qualifications.

When age groups are examined in more detail, notable variations can be observed. Young people, aged 15-24, are projected to experience only moderate increases in high-level qualifications, while the number of those holding medium-level and low-level qualifications are expected to decline. This can be attributed to the general decline in the total number of people in these age groups, and to the fact that young people are still in the process of acquiring qualifications (hence the slow growth in the number of those with high-level qualifications).

However, for older age groups (25+) the increase in the number of people with high-level qualifications is much more marked, especially for women. The age group 30-39 is projected to experience some of the largest increases at high level. The number of people with medium-level qualifications as their highest qualification is projected to decline for all of the groups aged 15-39, but to increase for the groups aged 40+. This reflects cohort effects as people age and the fact that younger people are generally better qualified than older people. A much higher proportion of young people is likely to have acquired higher qualifications, whereas older people are generally less well qualified.

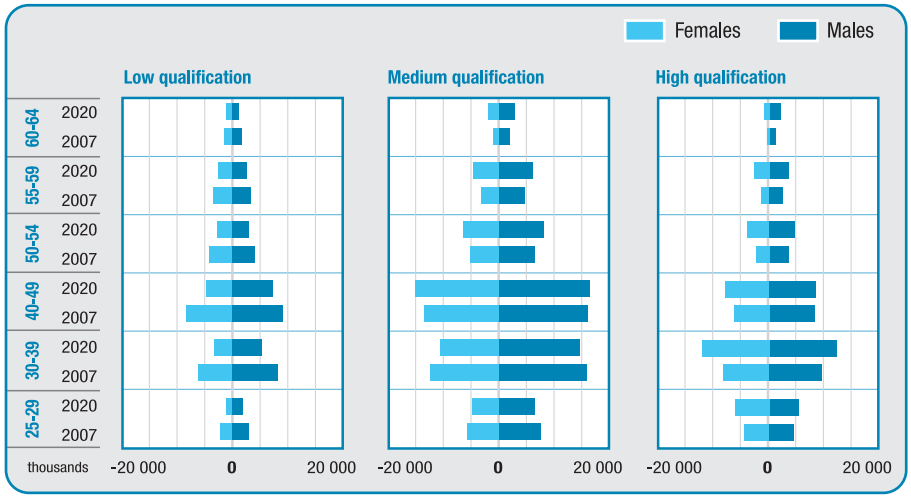
People aged 65 and more have a very low participation rate in the labour market, although this is projected to increase by 0.5 % by 2020. This reflects the recent trend towards earlier retirement, which may be reversed as a result of concerns about pensions and economic conditions, and the trend towards longer working lives and policies that promote that trend. It is projected that there will be 20 million more people in this age group in 2020 than there were in 2007, but the labour force in this group will increase by less than 1.5 million. The qualification structure of the age group changes substantially over time (Figures 12 and 13) as the younger cohorts with medium- and high-level qualifications move into this group.

Figure 4. **Population by age, gender and qualifications, in thousands 2007 and 2020, EU-25***



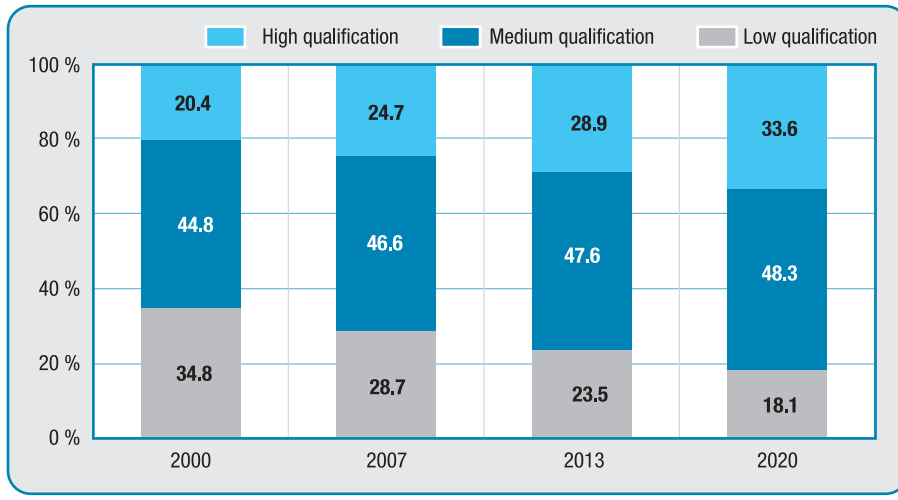
Source: IER estimates from StockMOD.

Figure 5. **Labour force by age, gender and qualifications, in thousands, 2007 and 2020, EU-25***



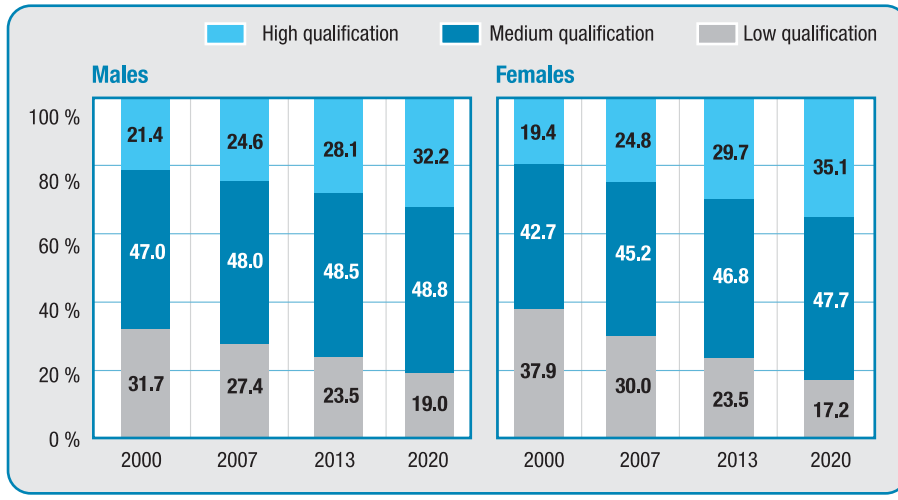
Source: IER estimates from StockMOD.

Figure 6. **Changing qualifications structure of the working age population (25-64), in %, EU-25***



Source: IER estimates from StockMOD.

Figure 7. **Changing qualifications structure of the working age population (25-64), by gender, in %, EU-25***

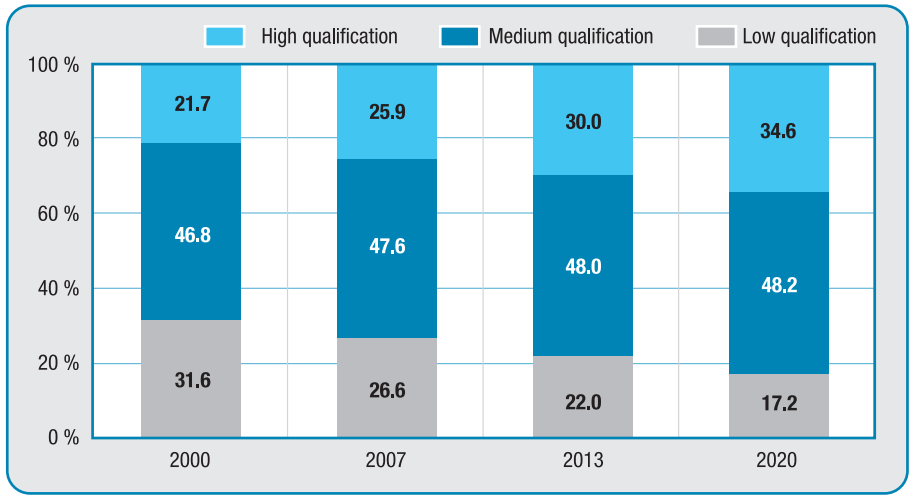


Source: IER estimates from StockMOD.

Figure 8. **Population by gender, age and qualifications, change in thousands, EU-25***

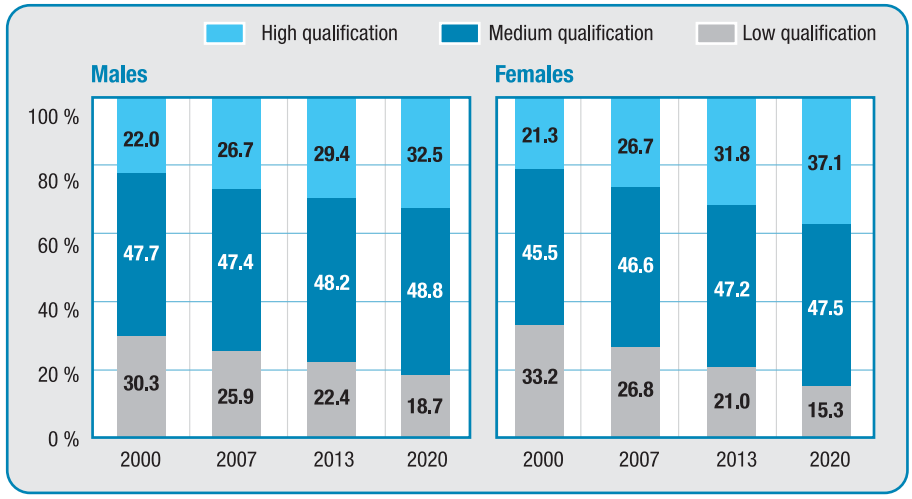
Source: IER estimates from StockMOD.

Figure 9. **Changing qualifications structure of the labour force (25-64), in %, EU-25***



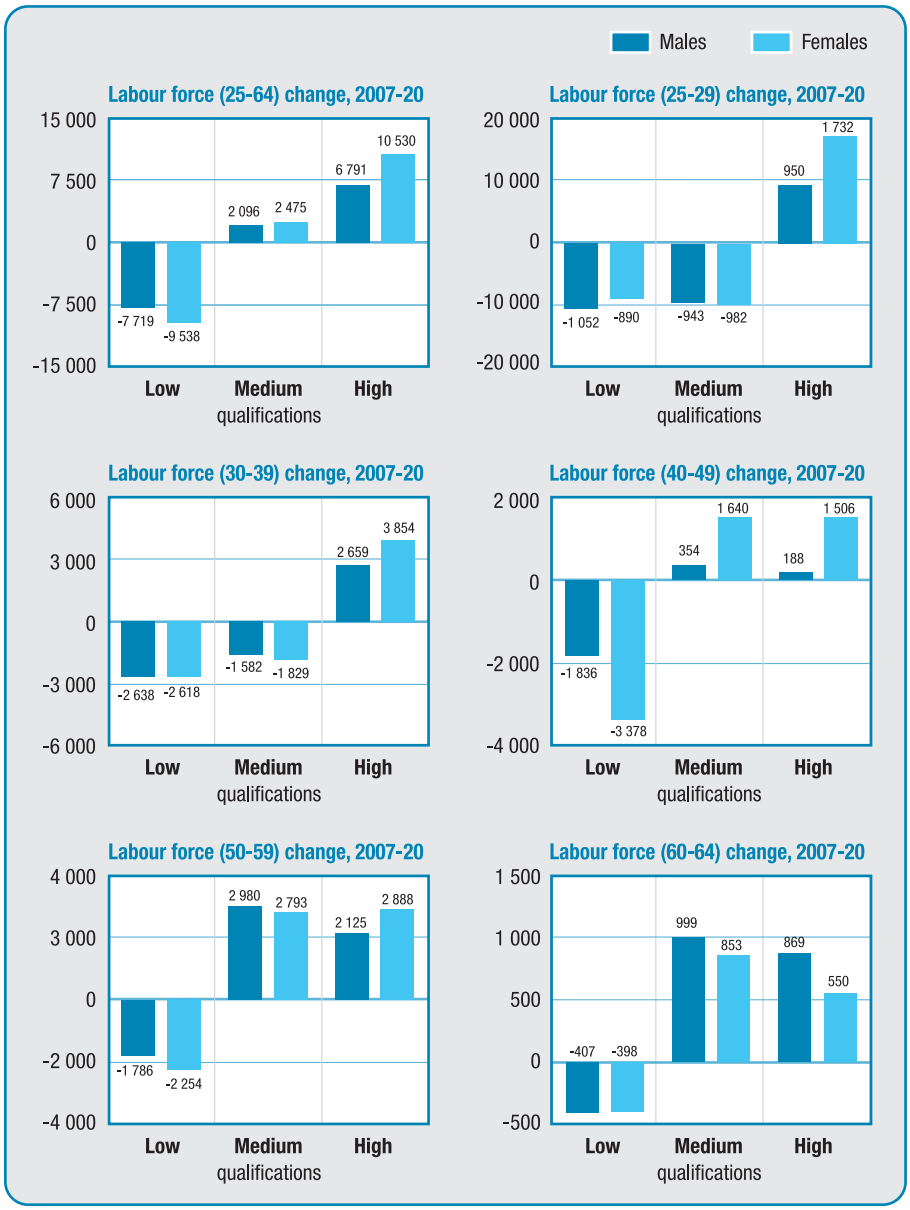
Source: IER estimates from StockMOD.

Figure 10. **Changing qualifications structure of the labour force (25-64) by gender, in %, EU-25***



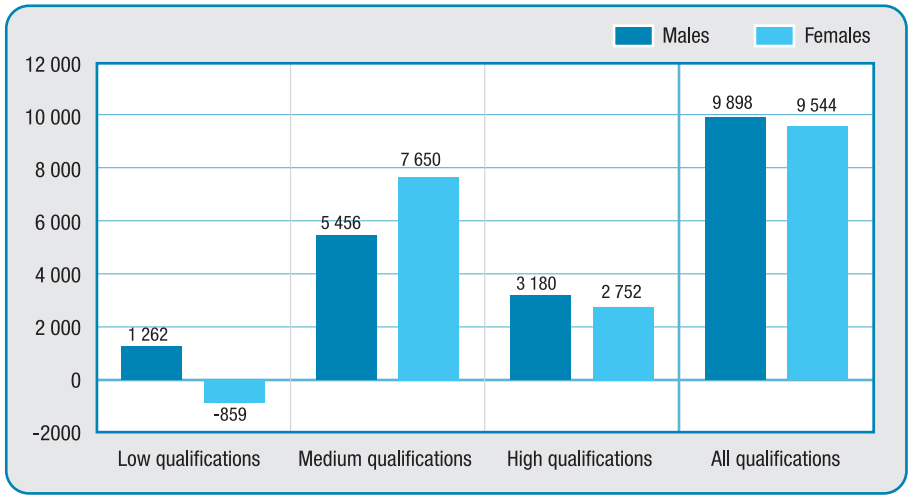
Source: IER estimates from StockMOD.

Figure 11. **Labour force by gender, age and qualifications, change in thousands, EU-25***



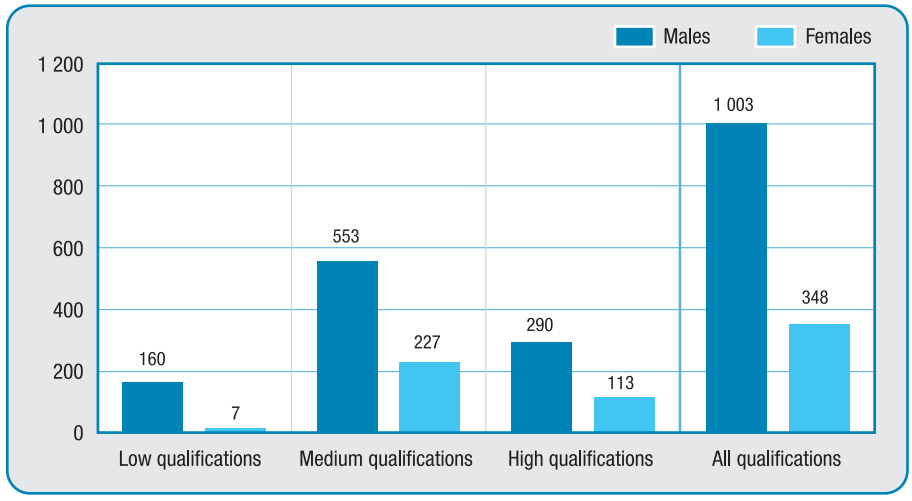
Source: IER estimates from StockMOD.

Figure 12. **Population (65+) by gender and qualifications, change in thousands, 2007-20, EU-25***



Source: IER estimates from StockMOD.

Figure 13. **Labour force (65+) by gender and qualifications, change in thousands, 2007-20, EU-25***



Source: IER estimates from StockMOD.

Annex A presents more detailed results for EU-25* broken down by qualification levels, gender and age.

3.1.3. Individual country results

This section presents comparative results for all European countries covered in the present analysis (EU-25, without Malta, plus Norway). The totals refer to the EU-25* group ([19]).

3.1.3.1. *Population*

Table 5 provides projections of the population aged 15+ by country ([20]), illustrating the relative sizes of the 27 countries in terms of total population, as well as overall trends in each case. The historical data and projections are based on official Eurostat figures (2008 vintage) (see Pollitt and Chewpreecha (2008) and Box 1 for further details).

Tables 6 to 8 enable comparisons to be made between countries at the more detailed qualification-category level. It is clear that, even at this broad level, there are significant variations, though many common themes emerge in terms of changes over time.

In almost all countries, the proportion of people in the population aged 15+ with low-level qualifications fell between 2000 and 2007 (Table 6). However, there are a few countries with much higher proportion in this category. In Portugal, for example, even in 2007, over 75 % of the population were low-qualified, in contrast to the Czech Republic and Norway, where the corresponding figure is just 20 %. This raises questions about the comparability of such estimates, although they are the best estimates currently available. The new Cedefop project will make further efforts to improve the consistency and quality of these data. In a few cases, such as Germany and Ireland, the projections suggest only a modest fall in future proportions of those with low-level qualifications, and in Denmark it actually increases slightly in the short term.

Table 8 gives the number of people with higher-level qualifications. With the exception of Finland and Lithuania, all countries show significant increases in the proportion of the population aged 15+ holding such qualifications, and

([19]) The earlier demand estimates did not include Bulgaria and Romania as they were not in the EU at the start of that project. The supply analysis has not been able to include Malta and Switzerland fully because they were not included in the EU LFS microdata supplied by Eurostat. All these countries are included in the E3ME data for population and labour force. They will all be included in future development work on skill demand and supply.

([20]) Data for all age groups by country, gender and qualifications is available in the country workbooks.

Table 5. **Population of working age (15+), EU-25***

	(000s)				Share of	
All qualifications	**2000**	**2007**	**2013**	**2020**	**2000**	**2007**
Belgium	8 435	8 779	9 128	9 426	2.2	2.2
Czech Republic	8 570	8 797	8 954	8 995	2.3	2.2
Denmark	4 350	4 427	4 586	4 714	1.2	1.1
Germany	69 263	70 857	71 295	71 208	18.4	18.0
Estonia	1 121	1 139	1 118	1 090	0.3	0.3
Greece	9 209	9 566	9 774	9 895	2.4	2.4
Spain	34 074	37 984	40 902	43 185	9.1	9.6
France	47 733	50 137	51 843	53 674	12.7	12.7
Ireland	2 949	3 431	3 860	4 265	0.8	0.9
Italy	48 759	50 736	52 150	53 204	13.0	12.9
Cyprus	533	639	716	788	0.1	0.2
Latvia	1 954	1 963	1 902	1 822	0.5	0.5
Lithuania	2 802	2 853	2 825	2 744	0.7	0.7
Luxembourg	352	388	422	458	0.1	0.1
Hungary	8 493	8 540	8 514	8 429	2.3	2.2
Netherlands	12 918	13 380	13 810	14 247	3.4	3.4
Norway	3 584	3 775	4 020	4 246	1.0	1.0
Austria	6 630	6 992	7 269	7 474	1.8	1.8
Poland	31 088	32 063	32 493	32 353	8.3	8.1
Portugal	8 539	8 954	9 210	9 503	2.3	2.3
Slovenia	1 667	1 727	1 762	1 766	0.4	0.4
Slovakia	4 330	4 521	4 615	4 639	1.2	1.1
Finland	4 228	4 367	4 509	4 586	1.1	1.1
Sweden	7 221	7 556	7 895	8 135	1.9	1.9
United Kingdom	47 536	50 141	52 197	54 036	12.6	12.7
EU-25*	**376 336**	**393 713**	**405 770**	**414 879**	**100.0**	**100.0**

Source: IER estimates from StockMOD.

Note: People aged 15 and over; for 2000 Germany uses 2002 qualification figures, the first LFS data available; Lithuania has a blip in LFS in the 200 high/medium proportions.

EU-25* total (%)		Change 2007-13			Change 2013-20		
2013	2020	000s	%	%p.a.	000s	%	%p.a.
2.2	2.3	350	4.0	0.7	298	3.3	0.5
2.2	2.2	157	1.8	0.3	42	0.5	0.1
1.1	1.1	159	3.6	0.6	128	2.8	0.4
17.6	17.2	438	0.6	0.1	-87	-0.1	0.0
0.3	0.3	-21	-1.9	-0.3	-29	-2.5	-0.4
2.4	2.4	208	2.2	0.4	121	1.2	0.2
10.1	10.4	2 918	7.7	1.2	2 282	5.6	0.8
12.8	12.9	1 706	3.4	0.6	1 831	3.5	0.5
1.0	1.0	429	12.5	2.0	405	10.5	1.4
12.9	12.8	1 414	2.8	0.5	1 054	2.0	0.3
0.2	0.2	78	12.1	1.9	71	10.0	1.4
0.5	0.4	-61	-3.1	-0.5	-80	-4.2	-0.6
0.7	0.7	-28	-1.0	-0.2	-82	-2.9	-0.4
0.1	0.1	34	8.6	1.4	36	8.5	1.2
2.1	2.0	-26	-0.3	-0.1	-86	-1.0	-0.1
3.4	3.4	430	3.2	0.5	437	3.2	0.4
1.0	1.0	245	6.5	1.1	225	5.6	0.8
1.8	1.8	277	4.0	0.6	206	2.8	0.4
8.0	7.8	430	1.3	0.2	-140	-0.4	-0.1
2.3	2.3	256	2.9	0.5	293	3.2	0.4
0.4	0.4	36	2.1	0.3	4	0.2	0.0
1.1	1.1	94	2.1	0.3	24	0.5	0.1
1.1	1.1	142	3.3	0.5	77	1.7	0.2
1.9	2.0	339	4.5	0.7	240	3.0	0.4
12.9	13.0	2 055	4.1	0.7	1 839	3.5	0.5
100.0	**100.0**	**12 057**	**3.1**	**0.5**	**9 109**	**2.2**	**0.3**

Table 6. **Population of working age (15+) by low qualification level, EU-25***

	(000s)				Share of	
Low qualification	**2000**	**2007**	**2013**	**2020**	**2000**	**2007**
Belgium	4 218	3 813	3 402	2 907	50.0	43.4
Czech Republic	2 078	1 675	1 344	1 103	24.2	19.0
Denmark	1 422	1 342	1 401	1 387	32.7	30.3
Germany	18 801	19 423	18 955	18 693	27.1	27.4
Estonia	325	269	197	165	29.0	23.6
Greece	5 093	4 738	4 271	3 667	55.3	49.5
Spain	22 437	21 805	19 716	16 248	65.8	57.4
France	22 768	21 426	19 895	18 135	47.7	42.7
Ireland	1 444	1 367	1 332	1 310	49.0	39.8
Italy	30 139	29 398	29 269	28 592	61.8	57.9
Cyprus	254	257	254	230	47.7	40.3
Latvia	606	566	471	425	31.0	28.8
Lithuania	901	812	650	536	32.2	28.5
Luxembourg	153	164	164	155	43.5	42.2
Hungary	3 547	3 001	2 699	2 482	41.8	35.1
Netherlands	5 426	4 809	4 225	3 587	42.0	35.9
Norway	835	777	711	610	23.3	20.6
Austria	2 215	2 036	1 848	1 607	33.4	29.1
Poland	10 507	8 232	6 163	4 287	33.8	25.7
Portugal	7 017	6 722	6 224	5 494	82.2	75.1
Slovenia	568	468	379	301	34.0	27.1
Slovakia	1 251	1 077	876	688	28.9	23.8
Finland	1 445	1 473	1 477	1 538	34.2	33.7
Sweden	2 387	1 975	1 620	1 289	33.1	26.1
United Kingdom	16 696	12 526	9 218	6 264	35.1	25.0
EU-25*	**162 531**	**150 150**	**136 761**	**121 700**	**43.2**	**38.1**

Source: IER estimates from StockMOD.

Note: People aged 15 and over; for 2000 Germany uses 2002 qualification figures, the first LFS data available; Lithuania has a blip in LFS in the 200 high/medium proportions.

national total (%)		Change 2007-13			Change 2013-20		
2013	2020	000s	%	%p.a.	000s	%	%p.a.
37.3	30.8	-412	-10.8	-1.9	-494	-14.5	-2.2
15.0	12.3	-331	-19.8	-3.6	-240	-17.9	-2.8
30.6	29.4	60	4.4	0.7	-14	-1.0	-0.1
26.6	26.3	-468	-2.4	-0.4	-262	-1.4	-0.2
17.7	15.1	-72	-26.6	-5.0	-33	-16.5	-2.5
43.7	37.1	-468	-9.9	-1.7	-604	-14.1	-2.2
48.2	37.6	-2 088	-9.6	-1.7	-3 468	-17.6	-2.7
38.4	33.8	-1 531	-7.1	-1.2	-1 761	-8.8	-1.3
34.5	30.7	-34	-2.5	-0.4	-22	-1.7	-0.2
56.1	53.7	-130	-0.4	-0.1	-676	-2.3	-0.3
35.4	29.2	-4	-1.4	-0.2	-23	-9.3	-1.4
24.8	23.3	-95	-16.7	-3.0	-46	-9.8	-1.5
23.0	19.5	-162	-20.0	-3.6	-114	-17.5	-2.7
38.8	33.9	0	-0.1	0.0	-9	-5.4	-0.8
31.7	29.4	-302	-10.1	-1.8	-217	-8.0	-1.2
30.6	25.2	-583	-12.1	-2.1	-638	-15.1	-2.3
17.7	14.4	-66	-8.5	-1.5	-101	-14.2	-2.2
25.4	21.5	-188	-9.2	-1.6	-241	-13.0	-2.0
19.0	13.3	-2 069	-25.1	-4.7	-1 877	-30.4	-5.1
67.6	57.8	-498	-7.4	-1.3	-730	-11.7	-1.8
21.5	17.0	-89	-19.1	-3.5	-78	-20.6	-3.2
19.0	14.8	-201	-18.7	-3.4	-189	-21.5	-3.4
32.8	33.5	4	0.3	0.0	61	4.1	0.6
20.5	15.8	-355	-18.0	-3.3	-331	-20.4	-3.2
17.7	11.6	-3 308	-26.4	-5.0	-2 954	-32.0	-5.4
33.7	**29.3**	**-13 389**	**-8.9**	**-1.5**	**-15 061**	**-11.0**	**-1.7**

Table 7. **Population of working age (15+) by medium qualification level, EU-25***

	(000s)				Share of	
Medium qualific.	**2000**	**2007**	**2013**	**2020**	**2000**	**2007**
Belgium	2 488	2 835	3 212	3 561	29.5	32.3
Czech Republic	5 721	6 144	6 440	6 488	66.7	69.8
Denmark	2 071	1 867	1 676	1 470	47.6	42.2
Germany	38 134	37 365	36 011	33 247	55.1	52.7
Estonia	549	560	556	526	48.9	49.1
Greece	3 007	3 256	3 522	3 757	32.7	34.0
Spain	5 701	7 583	10 005	13 342	16.7	20.0
France	16 756	18 528	20 188	22 150	35.1	37.0
Ireland	1 000	1 172	1 268	1 336	33.9	34.2
Italy	15 099	16 397	17 146	17 813	31.0	32.3
Cyprus	177	226	261	303	33.2	35.4
Latvia	1 074	1 044	1 007	925	55.0	53.2
Lithuania	1 022	1 433	1 408	1 305	36.5	50.2
Luxembourg	147	148	152	156	41.7	38.1
Hungary	4 012	4 287	4 291	4 104	47.2	50.2
Netherlands	5 028	5 153	5 140	4 979	38.9	38.5
Norway	1 850	2 016	2 221	2 401	51.6	53.4
Austria	3 652	3 952	4 150	4 241	55.1	56.5
Poland	17 979	19 138	19 373	18 949	57.8	59.7
Portugal	962	1 280	1 592	1 998	11.3	14.3
Slovenia	899	955	972	937	53.9	55.3
Slovakia	2 749	2 917	3 002	2 970	63.5	64.5
Finland	1 670	1 753	1 827	1 814	39.5	40.1
Sweden	3 114	3 720	4 198	4 465	43.1	49.2
United Kingdom	18 309	23 666	28 116	32 127	38.5	47.2
EU-25*	**153 170**	**167 396**	**177 735**	**185 365**	**40.7**	**42.5**

Source: IER estimates from StockMOD.

Notes: Persons aged 15 and over; for 2000 Germany uses 2002 qualification figures, the first LFS data available; Lithuania has a blip in LFS in the 2000 high/medium proportion.

national total (%)		Change 2007-13			Change 2013-20		
2013	2020	000s	%	%p.a.	000s	%	%p.a.
35.2	37.8	377	13.3	2.1	348	10.8	1.5
71.9	72.1	296	4.8	0.8	49	0.8	0.1
36.5	31.2	-191	-10.2	-1.8	-205	-12.3	-1.8
50.5	46.7	-1 354	-3.6	-0.6	-2 764	-7.7	-1.1
49.7	48.3	-4	-0.7	-0.1	-30	-5.3	-0.8
36.0	38.0	266	8.2	1.3	236	6.7	0.9
24.5	30.9	2 422	31.9	4.7	3 336	33.3	4.2
38.9	41.3	1 660	9.0	1.4	1 962	9.7	1.3
32.8	31.3	95	8.1	1.3	68	5.4	0.8
32.9	33.5	749	4.6	0.7	666	3.9	0.5
36.5	38.4	35	15.7	2.5	41	15.8	2.1
52.9	50.8	-37	-3.6	-0.6	-82	-8.1	-1.2
49.8	47.5	-24	-1.7	-0.3	-104	-7.4	-1.1
36.1	34.1	4	2.7	0.4	4	2.5	0.3
50.4	48.7	4	0.1	0.0	-187	-4.4	-0.6
37.2	35.0	-13	-0.3	0.0	-161	-3.1	-0.5
55.3	56.6	205	10.2	1.6	180	8.1	1.1
57.1	56.7	198	5.0	0.8	90	2.2	0.3
59.6	58.6	235	1.2	0.2	-424	-2.2	-0.3
17.3	21.0	311	24.3	3.7	406	25.5	3.3
55.2	53.1	17	1.8	0.3	-35	-3.6	-0.5
65.1	64.0	85	2.9	0.5	-32	-1.1	-0.2
40.5	39.6	73	4.2	0.7	-12	-0.7	-0.1
53.2	54.9	478	12.8	2.0	267	6.4	0.9
53.9	59.5	4 450	18.8	2.9	4 011	14.3	1.9
43.8	**44.7**	**10 339**	**6.2**	**1.0**	**7 629**	**4.3**	**0.6**

Table 8. **Population of working age (15+) by high-level qualification level, EU-25***

	(000s)				Share of	
High qualification	**2000**	**2007**	**2013**	**2020**	**2000**	**2007**
Belgium	1 729	2 130	2 514	2 958	20.5	24.3
Czech Republic	772	978	1 171	1 404	9.0	11.1
Denmark	857	1 219	1 509	1 856	19.7	27.5
Germany	12 327	14 069	16 329	19 268	17.8	19.9
Estonia	248	311	365	398	22.1	27.3
Greece	1 109	1 572	1 982	2 470	12.0	16.4
Spain	5 936	8 596	11 180	13 595	17.4	22.6
France	8 209	10 183	11 760	13 389	17.2	20.3
Ireland	505	892	1 260	1 619	17.1	26.0
Italy	3 520	4 941	5 735	6 799	7.2	9.7
Cyprus	102	156	202	255	19.1	24.4
Latvia	274	353	424	472	14.0	18.0
Lithuania	879	609	767	903	31.4	21.3
Luxembourg	52	76	106	147	14.8	19.6
Hungary	934	1 253	1 524	1 843	11.0	14.7
Netherlands	2 463	3 418	4 445	5 680	19.1	25.5
Norway	900	982	1 087	1 234	25.1	26.0
Austria	763	1 003	1 270	1 627	11.5	14.3
Poland	2 602	4 693	6 956	9 117	8.4	14.6
Portugal	560	952	1 394	2 011	6.6	10.6
Slovenia	201	304	411	528	12.1	17.6
Slovakia	329	526	736	981	7.6	11.6
Finland	1 114	1 141	1 205	1 234	26.3	26.1
Sweden	1 719	1 861	2 078	2 381	23.8	24.6
United Kingdom	12 532	13 950	14 863	15 645	26.4	27.8
EU-25*	**60 635**	**76 166**	**91 274**	**107 814**	**16.1**	**19.3**

Source: IER estimates from StockMOD.

Notes: Persons aged 15 and over; for 2000 Germany uses 2002 qualification figures, the first LFS data available; Lithuania has a blip in LFS in the 2000 high/medium proportion.

national total (%)		Change 2007-13			Change 2013-20		
2013	2020	000s	%	%p.a.	000s	%	%p.a.
27.5	31.4	384	18.0	2.8	444	17.6	2.3
13.1	15.6	192	19.6	3.0	233	19.9	2.6
32.9	39.4	290	23.8	3.6	347	23.0	3.0
22.9	27.1	2 260	16.1	2.5	2 939	18.0	2.4
32.6	36.6	54	17.4	2.7	34	9.3	1.3
20.3	25.0	410	26.1	3.9	489	24.7	3.2
27.3	31.5	2 584	30.1	4.5	2 414	21.6	2.8
22.7	24.9	1 576	15.5	2.4	1 629	13.9	1.9
32.6	38.0	368	41.3	5.9	359	28.5	3.6
11.0	12.8	795	16.1	2.5	1 064	18.6	2.5
28.1	32.4	46	29.4	4.4	53	26.5	3.4
22.3	25.9	71	20.1	3.1	48	11.4	1.5
27.2	32.9	159	26.1	3.9	136	17.7	2.4
25.1	32.1	30	39.0	5.6	41	38.6	4.8
17.9	21.9	272	21.7	3.3	319	20.9	2.7
32.2	39.9	1 026	30.0	4.5	1 235	27.8	3.6
27.0	29.1	106	10.8	1.7	147	13.5	1.8
17.5	21.8	267	26.6	4.0	356	28.1	3.6
21.4	28.2	2 264	48.2	6.8	2 161	31.1	3.9
15.1	21.2	442	46.4	6.6	617	44.3	5.4
23.3	29.9	108	35.5	5.2	117	28.4	3.6
15.9	21.2	210	39.9	5.7	245	33.3	4.2
26.7	26.9	65	5.7	0.9	28	2.3	0.3
26.3	29.3	217	11.7	1.9	304	14.6	2.0
28.5	29.0	913	6.5	1.1	782	5.3	0.7
22.5	**26.0**	**15 107**	**19.8**	**3.1**	**16 541**	**18.1**	**2.4**

in virtually all countries the absolute number rises significantly ([21]). Portugal is the country with the lowest proportion in 2000, but by 2007 it had caught up with Italy to reach a figure of just over 10 %. The highest proportions in 2007 were generally just over 25 %, to be found mainly in Scandinavian and northern European countries. Most countries are projected to see some further improvement as these trends continue up to 2020, but in most cases a plateau at around 30 % of the total is reached; there are a few exceptions, most notably Denmark and the Netherlands, which almost reach the 40 % mark.

For most countries the proportion of people with medium-level qualifications increased modestly over the period 2000 to 2007. This is projected to continue. Notable exceptions are Denmark, Germany, Latvia and Lithuania, where a fall is projected. The results for the medium-level qualification category partly reflect the focus on the highest qualification level held. The number in this category increases as people acquire medium-level qualifications but declines if (and when) they then go on to obtain higher-level qualifications. The same applies to those in the low-level category who go on to acquire medium-level qualifications.

3.1.3.2. *Labour force*

Table 9 provides projections of those in the labour force. The table illustrates the relative sizes of the countries in terms of labour force and overall trends in each case. The historical data and projections are based on official Eurostat population figures (2008 vintage) combined with the analysis of labour-market activity rates described in Pollitt and Chewpreecha (2008). Consequently, they do not precisely match LFS-based estimates of the labour force for each country.

Tables 10-12 enable comparisons to be made between countries at the broad qualification level. Even here, there are some significant variations, though many common themes emerge in terms of changes over time at this level.

In all countries there was a fall in the proportion of people in the labour force with low-level qualifications between 2000 and 2007 (Table 10). In many cases the declines were quite significant; notable exceptions were Denmark and Germany. These patterns are forecast to continue, with further significant reductions in the proportion of the workforce with low-level or no qualifications. By 2020, this group will account for around 20 % in most countries and well

([21]) The results in Lithuania reflect a significant discontinuity in the LFS historical data.

below that in a few others, although Italy and Portugal will still be well represented in these categories.

Table 12 shows the numbers and proportions of people with high-level qualifications. With one or two exceptions (notably Lithuania) where there is a major problem with the consistency of the underlying LFS data, there have been significant improvements in this area in most countries. In many cases proportions increased by 5 percentage points or more between 2000 and 2007. There were significant increases in the proportion of the labour force holding high-level qualifications over the projection period in nearly all countries, the main exceptions being countries where the proportion was already quite high. In all countries the absolute numbers are projected to rise. The Czech Republic, Italy, Portugal and Slovakia are the countries with the lowest proportions in 2000, but all undergo significant increase. The highest proportions in 2007 were generally just around 30 %, found mainly Scandinavian and northern European countries. In a number of cases these proportions are expected to rise, with Denmark, Ireland and the Netherlands projected to show the highest proportions if such trends continue. With the exception of these three countries, the trend in most others seems to be towards a proportion of between 30 % and 40 %.

For many countries there has been a modest increase in the proportion of those in the labour force qualified at medium level, and this is projected to continue. However the picture here is complicated by the focus on the highest qualification held, since many people go on to acquire high-level qualifications and therefore 'drop out' of this category. There are some notable differences between countries in the overall percentages, with the Czech Republic and Slovakia placing much greater emphasis on this level. There are questions about how comparable some of the data are across countries. In a few cases, notably Germany and Poland, there have been quite sharp proportionate falls that are projected to continue.

Table 9. **Labour force (15+), EU-25***

	(000s)				Share of	
All qualifications	**2000**	**2007**	**2013**	**2020**	**2000**	**2007**
Belgium	4 411	4 644	4 817	4 931	2.1	2.1
Czech Republic	5 147	5 203	5 252	5 184	2.4	2.3
Denmark	2 864	2 922	2 960	2 999	1.4	1.3
Germany	40 365	42 057	42 264	41 317	19.0	18.6
Estonia	655	699	726	710	0.3	0.3
Greece	4 867	5 167	5 282	5 262	2.3	2.3
Spain	17 886	22 051	23 743	24 176	8.4	9.7
France	26 374	28 297	28 558	28 467	12.4	12.5
Ireland	1 737	2 172	2 440	2 654	0.8	1.0
Italy	23 314	24 815	25 008	24 672	11.0	11.0
Cyprus	316	404	469	529	0.1	0.2
Latvia	1 097	1 167	1 173	1 123	0.5	0.5
Lithuania	1 688	1 616	1 639	1 609	0.8	0.7
Luxembourg	186	218	228	242	0.1	0.1
Hungary	4 159	4 300	4 234	4 220	2.0	1.9
Netherlands	8 133	8 754	8 747	8 777	3.8	3.9
Norway	2 406	2 539	2 682	2 802	1.1	1.1
Austria	3 874	4 211	4 357	4 388	1.8	1.9
Poland	17 505	17 233	17 016	16 616	8.3	7.6
Portugal	5 189	5 600	5 757	5 913	2.4	2.5
Slovenia	958	1 010	984	946	0.5	0.4
Slovakia	2 586	2 645	2 620	2 556	1.2	1.2
Finland	2 674	2 675	2 607	2 551	1.3	1.2
Sweden	4 362	4 808	4 968	5 158	2.1	2.1
United Kingdom	29 243	31 262	32 698	33 646	13.8	13.8
EU-25*	**211 997**	**226 468**	**231 224**	**231 446**	**100.0**	**100.0**

Source: IER estimates from StockMOD.

Notes: Economically active, aged 15 and over; for 2000 Germany uses 2002 qualification proportions, the first LFS data available.

EU-25* total (%)		Change 2007-13			Change 2013-20		
2013	2020	000s	%	%p.a.	000s	%	%p.a.
2.1	2.1	173	3.7	0.6	115	2.4	0.3
2.3	2.2	48	0.9	0.2	-68	-1.3	-0.2
1.3	1.3	38	1.3	0.2	39	1.3	0.2
18.3	17.9	207	0.5	0.1	-947	-2.2	-0.3
0.3	0.3	27	3.9	0.6	-17	-2.3	-0.3
2.3	2.3	115	2.2	0.4	-20	-0.4	-0.1
10.3	10.4	1 692	7.7	1.2	433	1.8	0.3
12.4	12.3	261	0.9	0.2	-90	-0.3	0.0
1.1	1.1	268	12.4	2.0	214	8.8	1.2
10.8	10.7	193	0.8	0.1	-336	-1.3	-0.2
0.2	0.2	65	16.2	2.5	60	12.9	1.7
0.5	0.5	6	0.5	0.1	-50	-4.3	-0.6
0.7	0.7	23	1.4	0.2	-30	-1.8	-0.3
0.1	0.1	10	4.5	0.7	14	6.1	0.8
1.8	1.8	-66	-1.5	-0.3	-14	-0.3	0.0
3.8	3.8	-7	-0.1	0.0	30	0.3	0.0
1.2	1.2	143	5.6	0.9	121	4.5	0.6
1.9	1.9	146	3.5	0.6	32	0.7	0.1
7.4	7.2	-218	-1.3	-0.2	-400	-2.4	-0.3
2.5	2.6	157	2.8	0.5	156	2.7	0.4
0.4	0.4	-27	-2.7	-0.4	-38	-3.9	-0.6
1.1	1.1	-26	-1.0	-0.2	-63	-2.4	-0.3
1.1	1.1	-68	-2.5	-0.4	-57	-2.2	-0.3
2.1	2.2	160	3.3	0.5	190	3.8	0.5
14.1	14.5	1 436	4.6	0.8	948	2.9	0.4
100.0	**100.0**	**4 756**	**2.1**	**0.3**	**221**	**0.1**	**0.0**

Table 10. **Labour force (15+) by low qualification level, EU-25***

	(000s)				Share of	
Low qualification	**2000**	**2007**	**2013**	**2020**	**2000**	**2007**
Belgium	1 625	1 374	1 121	833	36.8	29.6
Czech Republic	682	475	347	255	13.3	9.1
Denmark	715	685	679	626	25.0	23.4
Germany	7 767	8 258	8 332	8 284	19.2	19.6
Estonia	106	102	94	87	16.1	14.6
Greece	2 109	1 896	1 589	1 210	43.3	36.7
Spain	10 052	10 329	8 621	6 124	56.2	46.8
France	9 092	8 506	7 282	5 931	34.5	30.1
Ireland	701	677	606	522	40.4	31.2
Italy	11 849	11 222	10 408	9 164	50.8	45.2
Cyprus	113	113	111	102	35.7	28.0
Latvia	193	221	224	225	17.6	18.9
Lithuania	264	200	198	223	15.6	12.4
Luxembourg	66	70	66	61	35.3	32.1
Hungary	1 053	838	668	548	25.3	19.5
Netherlands	2 855	2 578	2 064	1 592	35.1	29.4
Norway	407	381	346	297	16.9	15.0
Austria	916	877	787	664	23.6	20.8
Poland	3 268	2 142	1 365	815	18.7	12.4
Portugal	4 075	3 905	3 500	2 942	78.5	69.7
Slovenia	221	174	124	87	23.1	17.2
Slovakia	357	278	218	171	13.8	10.5
Finland	721	557	429	320	27.0	20.8
Sweden	1 026	868	680	535	23.5	18.1
United Kingdom	8 794	6 676	5 023	3 511	30.1	21.4
EU-25*	**69 027**	**63 402**	**54 883**	**45 130**	**32.6**	**28.0**

Source: IER estimates from StockMOD.

Notes: Economically active, aged 15 and over; for 2000 Germany uses 2002 qualification proportions, the first LFS data available.

national total (%)		Change 2007-13			Change 2013-20		
2013	2020	000s	%	%p.a.	000s	%	%p.a.
23.3	16.9	-253	-18.4	-3.3	-288	-25.7	-4.2
6.6	4.9	-128	-27.0	-5.1	-92	-26.6	-4.3
22.9	20.9	-6	-0.8	-0.1	-53	-7.8	-1.1
19.7	20.0	74	0.9	0.1	-48	-0.6	-0.1
12.9	12.3	-8	-8.0	-1.4	-6	-6.5	-1.0
30.1	23.0	-307	-16.2	-2.9	-378	-23.8	-3.8
36.3	25.3	-1 708	-16.5	-3.0	-2 497	-29.0	-4.8
25.5	20.8	-1 224	-14.4	-2.6	-1 352	-18.6	-2.9
24.8	19.7	-71	-10.5	-1.8	-84	-13.9	-2.1
41.6	37.1	-814	-7.3	-1.2	-1 243	-11.9	-1.8
23.6	19.3	-2	-1.9	-0.3	-9	-7.8	-1.1
19.1	20.0	4	1.6	0.3	0	0.1	0.0
12.1	13.9	-2	-1.1	-0.2	25	12.5	1.7
28.9	25.1	-4	-5.8	-1.0	-5	-8.0	-1.2
15.8	13.0	-170	-20.3	-3.7	-120	-18.0	-2.8
23.6	18.1	-514	-19.9	-3.6	-471	-22.8	-3.6
12.9	10.6	-35	-9.1	-1.6	-50	-14.4	-2.2
18.1	15.1	-91	-10.3	-1.8	-122	-15.5	-2.4
8.0	4.9	-776	-36.2	-7.2	-550	-40.3	-7.1
60.8	49.8	-405	-10.4	-1.8	-558	-15.9	-2.5
12.6	9.2	-50	-28.6	-5.5	-37	-29.9	-5.0
8.3	6.7	-60	-21.4	-3.9	-47	-21.7	-3.4
16.5	12.5	-128	-22.9	-4.2	-109	-25.4	-4.1
13.7	10.4	-189	-21.7	-4.0	-145	-21.3	-3.4
15.4	10.4	-1 653	-24.8	-4.6	-1 511	-30.1	-5.0
23.7	**19.5**	**-8 519**	**-13.4**	**-2.4**	**-9 753**	**-17.8**	**-2.8**

Table 11. **Labour force (15+) by medium qualification level, EU-25***

	(000s)				Share of	
Medium qualific.	**2000**	**2007**	**2013**	**2020**	**2000**	**2007**
Belgium	1 563	1 794	2 011	2 197	35.4	38.6
Czech Republic	3 915	4 044	4 106	3 982	76.1	77.7
Denmark	1 501	1 313	1 133	952	52.4	44.9
Germany	24 096	24 069	22 956	20 598	59.7	57.2
Estonia	380	382	381	355	58.0	54.6
Greece	1 957	2 136	2 305	2 398	40.2	41.3
Spain	3 607	5 288	6 831	8 415	20.2	24.0
France	11 337	12 267	12 614	12 697	43.0	43.3
Ireland	675	827	890	926	38.9	38.1
Italy	9 322	10 420	10 910	11 192	40.0	42.0
Cyprus	124	166	195	223	39.1	41.2
Latvia	720	712	672	597	65.6	61.0
Lithuania	762	976	893	763	45.1	60.4
Luxembourg	85	93	90	88	45.4	42.9
Hungary	2 567	2 712	2 676	2 604	61.7	63.1
Netherlands	3 514	3 693	3 551	3 298	43.2	42.2
Norway	1 305	1 416	1 538	1 633	54.3	55.8
Austria	2 422	2 635	2 711	2 667	62.5	62.6
Poland	12 473	11 946	11 040	9 917	71.3	69.3
Portugal	690	954	1 182	1 467	13.3	17.0
Slovenia	597	624	587	531	62.3	61.7
Slovakia	1 984	1 997	1 910	1 755	76.7	75.5
Finland	1 171	1 280	1 318	1 338	43.8	47.9
Sweden	2 099	2 612	2 898	3 079	48.1	54.3
United Kingdom	11 916	14 731	16 879	18 572	40.7	47.1
EU-25*	**100 782**	**109 086**	**112 277**	**112 244**	**47.5**	**48.2**

Source: IER estimates from StockMOD.

Notes: Economically active, aged 15 and over; for 2000 Germany uses 2002 qualification proportions, the first LFS data available.

national total (%)		Change 2007-13			Change 2013-20		
2013	2020	000s	%	%p.a.	000s	%	%p.a.
41.7	44.6	217	12.1	1.9	186	9.3	1.3
78.2	76.8	61	1.5	0.3	-123	-3.0	-0.4
38.3	31.8	-181	-13.8	-2.4	-180	-15.9	-2.4
54.3	49.9	-1 113	-4.6	-0.8	-2 358	-10.3	-1.5
52.5	50.0	-1	-0.1	0.0	-27	-7.0	-1.0
43.6	45.6	168	7.9	1.3	93	4.0	0.6
28.8	34.8	1 543	29.2	4.4	1 585	23.2	3.0
44.2	44.6	347	2.8	0.5	84	0.7	0.1
36.5	34.9	64	7.7	1.2	36	4.1	0.6
43.6	45.4	491	4.7	0.8	282	2.6	0.4
41.6	42.0	29	17.4	2.7	27	14.0	1.9
57.3	53.1	-39	-5.5	-0.9	-75	-11.2	-1.7
54.5	47.4	-83	-8.5	-1.5	-130	-14.6	-2.2
39.7	36.4	-3	-3.2	-0.5	-2	-2.7	-0.4
63.2	61.7	-36	-1.3	-0.2	-72	-2.7	-0.4
40.6	37.6	-141	-3.8	-0.6	-253	-7.1	-1.1
57.4	58.3	122	8.6	1.4	94	6.1	0.9
62.2	60.8	76	2.9	0.5	-44	-1.6	-0.2
64.9	59.7	-906	-7.6	-1.3	-1 123	-10.2	-1.5
20.5	24.8	229	24.0	3.6	285	24.1	3.1
59.7	56.1	-36	-5.8	-1.0	-56	-9.6	-1.4
72.9	68.7	-87	-4.4	-0.7	-155	-8.1	-1.2
50.5	52.5	37	2.9	0.5	20	1.5	0.2
58.3	59.7	286	10.9	1.7	181	6.2	0.9
51.6	55.2	2 148	14.6	2.3	1 693	10.0	1.4
48.6	**48.5**	**3 191**	**2.9**	**0.5**	**-33**	**0.0**	**0.0**

Table 12. **Labour force (15+) by high qualification level, EU-25***

	(000s)				Share of	
High qualification	**2000**	**2007**	**2013**	**2020**	**2000**	**2007**
Belgium	1 223	1 476	1 684	1 901	27.7	31.8
Czech Republic	550	684	799	947	10.7	13.1
Denmark	647	924	1 148	1 420	22.6	31.6
Germany	8 502	9 731	10 976	12 435	21.1	23.1
Estonia	169	215	251	267	25.9	30.8
Greece	802	1 135	1 388	1 654	16.5	22.0
Spain	4 227	6 434	8 292	9 637	23.6	29.2
France	5 945	7 524	8 662	9 839	22.5	26.6
Ireland	361	668	944	1 205	20.8	30.7
Italy	2 144	3 174	3 690	4 316	9.2	12.8
Cyprus	80	124	163	205	25.2	30.8
Latvia	184	235	277	302	16.8	20.1
Lithuania	662	440	548	624	39.2	27.2
Luxembourg	36	55	71	93	19.3	25.0
Hungary	539	750	890	1 068	13.0	17.4
Netherlands	1 764	2 484	3 132	3 886	21.7	28.4
Norway	694	742	797	873	28.8	29.2
Austria	536	698	859	1 057	13.8	16.6
Poland	1 763	3 146	4 611	5 884	10.1	18.3
Portugal	424	741	1 074	1 503	8.2	13.2
Slovenia	140	213	272	328	14.6	21.0
Slovakia	244	370	492	631	9.4	14.0
Finland	783	838	860	893	29.3	31.3
Sweden	1 237	1 327	1 390	1 544	28.4	27.6
United Kingdom	8 533	9 855	10 796	11 563	29.2	31.5
EU-25*	**42 188**	**53 980**	**64 065**	**74 072**	**19.9**	**23.8**

Source: IER estimates from StockMOD.

Notes: Economically active, aged 15 and over; for 2000 Germany uses 2002 qualification proportions, the first LFS data available.

national total (%)		Change 2007-13			Change 2013-20		
2013	2020	000s	%	%p.a.	000s	%	%p.a.
35.0	38.6	209	14.2	2.2	217	12.9	1.7
15.2	18.3	115	16.8	2.6	148	18.6	2.5
38.8	47.4	224	24.3	3.7	272	23.7	3.1
26.0	30.1	1 245	12.8	2.0	1 459	13.3	1.8
34.6	37.7	36	16.6	2.6	16	6.4	0.9
26.3	31.4	253	22.3	3.4	266	19.1	2.5
34.9	39.9	1 857	28.9	4.3	1 345	16.2	2.2
30.3	34.6	1 138	15.1	2.4	1 178	13.6	1.8
38.7	45.4	276	41.3	5.9	262	27.7	3.6
14.8	17.5	516	16.3	2.5	626	17.0	2.3
34.7	38.6	39	31.0	4.6	42	25.6	3.3
23.6	26.9	42	17.8	2.8	25	9.0	1.2
33.4	38.8	108	24.6	3.7	75	13.8	1.9
31.4	38.5	17	31.0	4.6	22	30.1	3.8
21.0	25.3	141	18.7	2.9	178	20.0	2.6
35.8	44.3	648	26.1	3.9	754	24.1	3.1
29.7	31.1	55	7.4	1.2	76	9.5	1.3
19.7	24.1	161	23.0	3.5	198	23.0	3.0
27.1	35.4	1 465	46.6	6.6	1 273	27.6	3.5
18.7	25.4	334	45.0	6.4	429	39.9	4.9
27.7	34.6	59	27.9	4.2	56	20.5	2.7
18.8	24.7	121	32.8	4.8	139	28.3	3.6
33.0	35.0	22	2.7	0.4	32	3.7	0.5
28.0	29.9	63	4.7	0.8	154	11.1	1.5
33.0	34.4	941	9.5	1.5	767	7.1	1.0
27.7	**32.0**	**10 085**	**18.7**	**2.9**	**10 007**	**15.6**	**2.1**

3.2. Alternative macro scenarios

3.2.1. Background

This section describes some key features of the alternative scenarios used in this project, and discusses the sensitivity of the results to the different scenarios. Further details can be found in Pollitt and Chewpreecha (2008). The main drivers considered in developing the alternative scenarios are:

(a) factors external to Europe,
(b) general government policy,
(c) demographics and the labour market,
(d) technological progress.

Some of the more detailed factors in these broad categories affect labour supply directly, for example changes in population, benefit rates and restrictions on working hours. In others, such as technological progress indicators, the effects will be indirect through changes in output, wage rates and levels of unemployment ([22]).

Table 13. **Model variables changed in the scenarios**

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

Source: Pollitt and Chewpreecha (2008).

Two additional scenarios, one positive and one negative, were created to provide upper and lower boundaries for the projections. Unlike the central (baseline) forecast, the alternative scenarios used a fully endogenous version of the E3ME model, so that all the feedback effects could be captured through the structure of the national accounts and the model's estimated equations. The aim of the scenario analysis is to provide a likely range for labour supply values, giving an upper and lower boundary for labour supply in each group and showing how sensitive the baseline projections are to global conditions and government policy.

3.2.1.1. *Optimistic scenario*

In this scenario, Europe and its constituent economies benefit from higher growth rates in exports and overall world GDP, partly as a result of lower world energy prices. This results from a combination of greater innovation, strong price competitiveness and a global marketplace boosted by lower fuel costs.

Higher world GDP growth and employment rates mean that European governments receive higher tax revenues and spend less on benefits. This in turn means they can reduce taxes, boosting export competitiveness; alternatively governments may wish to spend some of this windfall on improved public services, boosting aggregate demand.

Innovation and technological progress is a key feature of this scenario, as an increase leads to an increase in competitiveness. The largest increase in innovation activity is in rapidly developing ICT (information and communication technologies) sectors, which have knock-on effects on all other sectors. Technical progress may have a positive or negative direct effect on employment, but resulting competitiveness gains should bring overall increases in output and employment.

The optimistic scenario assumes that the WTO (World Trade Organisation) makes further progress in reducing global trade barriers. It also assumes that domestic European labour markets are able to attract skilled labour from abroad (mainly from outside Europe) meaning that there are no significant labour shortages that might restrict growth, boosting overall labour-market participation rates across Europe.

(22) The particular variables in the E3ME model that are changed to produce the scenarios include: direct tax rates; benefit rates (includes pensions); R&D spending; government spending; public sector employment (which is exogenous in E3ME); world growth rates; the oil price; the price of exports; the price of imports; interest rates and global exchange rates.

3.2.1.2. *Pessimistic scenario*

The pessimistic scenario suggests that 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 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 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 on international competitiveness. As a result of union demands, workers spend less time at work, which creates employment opportunities initially but damages competitiveness.

In this scenario, there is a failure to invest in R&D (research and development) and production development in key sectors. Innovation, both in developed economies such as the US and competing developing economies such as China, is not matched in Europe. This contributes 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 falls as a result.

3.2.1.3. *Possible influence of the financial/economic crisis*

These projections, including the underlying macroeconomic scenarios, were developed before the serious nature of the credit crunch and its subsequent impact on the real economy became clear. The more pessimistic scenario shows how the overall effect of a less optimistic macroeconomic situation might impact on labour supply but it was not developed explicitly to model the crisis. The model includes a link between labour-market activity rates and unemployment (as well as wage rates).

The number of those unemployed and discouraged workers both increase in the pessimistic scenario. Labour supply excludes discouraged workers, so more discouraged workers means a lower labour supply ([23]).

The pessimistic scenario is based on a broad set of circumstances which, when put together, result in contraction in labour supply (compared to the

baseline projections). The scale of the changes used as inputs to the model is fairly moderate, each designed to represent a small shock. The outcome should be interpreted as an indication of which demographic groups (by age, gender and country) are most likely to be affected (at the margin) by changes in economic activity.

It would not be correct to interpret this scenario as an indication of the specific impacts of the recent financial crisis and the subsequent recession in Europe. Much of the slowdown has been caused, directly or indirectly, by a single factor, the credit crunch (and related behaviour in the banking sector and housing markets), rather than the broad range of inputs used in the scenario. To model the financial crisis accurately, a set of specific model inputs would be required, for example a reduction in lending by banks or adjustments to savings ratios. The present analysis was carried out in early September 2008, prior to the collapse of Lehman brothers. Even now there remains much uncertainty over the scale of the likely impacts.

Overall labour supply in E3ME* is a function of general economic activity levels, average wage rates, unemployment, benefit rates, services ratio (employment in services relative to the total), educational attainment, and average hours worked. Based on this analysis the financial crisis can be expected to affect labour supply via impacts on:

(a) economic output: a negative impact, so potentially reducing labour-market participation via a discouraged worker effect (e.g. as new labour-market entrants or those returning find it less easy to secure a job);
(b) unemployment: large increases will reduce participation (e.g. as older workers retire early);
(c) the other key drivers identified seem unlikely to have much direct impact, especially in the short term:
    (i) average wages: in real terms these will probably not affect labour-market participation much, as there are some reductions in nominal wage rates, but inflation may be turning negative;
    (ii) benefit rates: no real change;
    (iii) services ratio: unchanged as employment levels in both manufacturing and services seem likely to be affected in the same direction;

([23]) It would be possible to develop new scenarios, focusing on all those people who are inclined to work, independently of whether they are currently unemployed or discouraged. One indicator of the scope of the potential labour force could be to apply employment rates based on full-employment, where everyone who wishes to work is employed, and contrast this with a situation of unemployment. Alternatively, activity rates could be set at 100 % for all those of working age (in which case the labour force would equal the population in that age gender category). These possibilities can be explored in scenarios developed in the subsequent project.

(iv) educational attainment: this is unlikely to change, or might increase only slightly in the short term;
(v) hours worked: this has a negative impact on participation rates in the model, and it might have a significant impact in the future if there are substantial reductions in average weekly hours (as in France in recent years).

The E3ME* model does not pick up any impact of choices about education participation. There is some evidence that individuals are choosing to continue with education given the uncertainties in the job market, so qualification rates could be positively affected in the short term. However, the fact that in many countries such choices will incur direct costs may dissuade many from this course if the general economic situation continues to deteriorate.

The initial negative effects of unemployment on participation may have been exaggerated as high-paid bankers and related workers would not have qualified for benefits, so might be persuaded to drop out of the labour market temporarily. But now that the downturn has become much more general, affecting all types of workers across all sectors, this probably is no longer true. There may also be migratory effects from the crisis that will not be picked up by the E3ME model. In many countries boom conditions have encouraged substantial cross-border movements. It is not clear to what extent these may be reversed as economic conditions deteriorate.

3.2.2. Comparison with other projections

The results here are based on Eurostat's 2008 population projections. In all cases the base scenario has been adopted. Eurostat also provide alternatives and, in some cases, individual country experts have indicated a preference for one of these. However, to maintain consistency the team has adopted the Eurostat base scenario as the foundation for each of the alternative macro scenarios presented here. In future work such variations could be explored in more detail. As long as there was no major change in dependency ratios, altering the underlying population projections would mainly have a scalar and linear impact on the overall labour-force projections developed within E3ME, although these will vary by country, age and gender category.

In *The 2009 ageing report*, the European Commission, DG ECFIN (2008) published a comprehensive set of labour-force projections. The basic methodology used was similar to this study in that participation rates were estimated for population groups defined by age and gender (although the single-year age groups used are more detailed than the five-year bands used in E3ME). These were then multiplied by exogenous population projections

to measure labour force. The data sources used were also similar, with LFS data used for participation rates and Eurostat projections used for population.

The studies differ in the methodologies used to project participation rates. The ECFIN report is based on detailed analysis of entry and exit from the labour force and focuses on education and retirement decisions in the top and bottom age ranges. In contrast, the E3ME approach allows individuals to enter, leave and return to the labour market in response to changes in employment status or economic prospects.

In summary, the E3ME approach is probably best suited for modelling participation rates in the 25-50 age ranges, but future model projections could make use of the more detailed data on the factors affecting retirement decisions, presented in the ECFIN report. The conclusions from the two studies are remarkably similar. In both cases, labour supply is projected to remain fairly constant, but with increases in the number of women workers and of older workers.

3.2.3. Sensitivity of overall labour supply in alternative scenarios

The magnitudes of changes in labour supply from the baseline are almost identical in the pessimistic and the optimistic scenarios: the difference is the direction of changes. The results for all countries show labour supply reduced in the pessimistic scenario and increased substantially in the optimistic scenario.

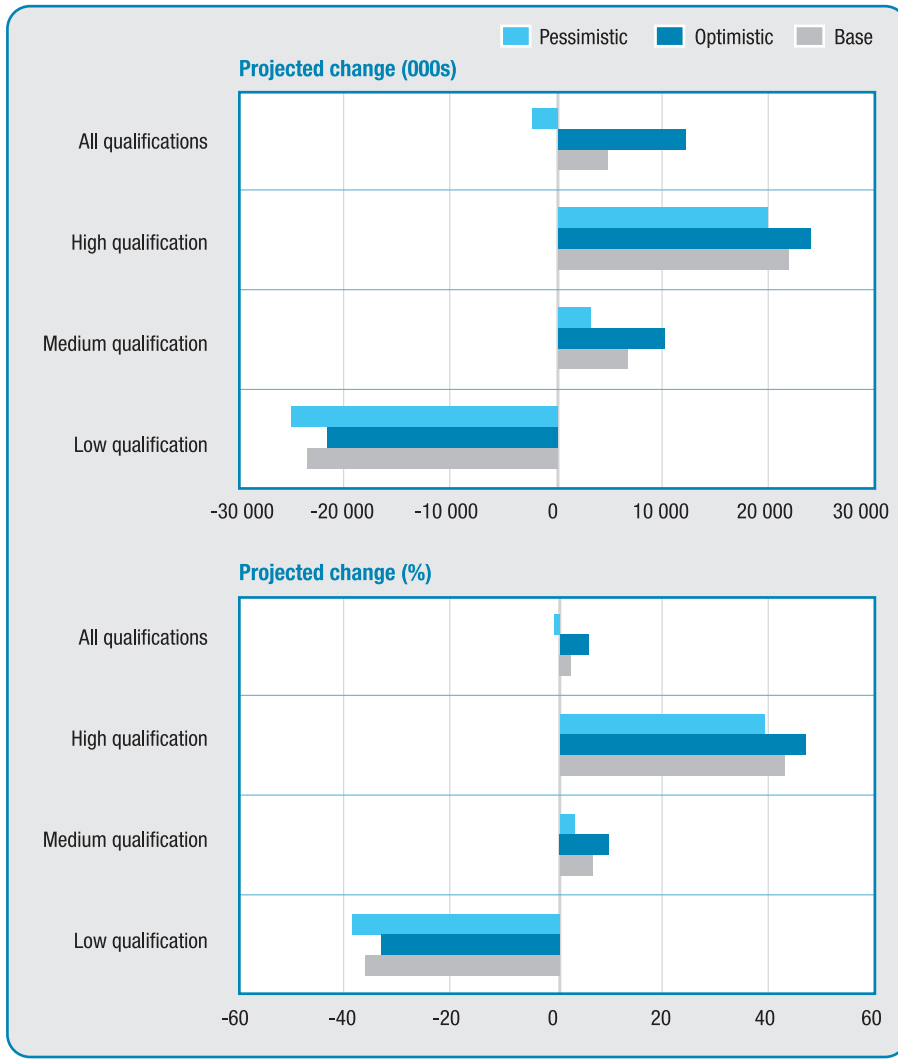
Total labour supply is reduced by around 4.6 % in the pessimistic and increased by 5.1 % in the optimistic scenario. Countries that are most sensitive to the pessimistic scenario include Belgium, Denmark, Italy and Switzerland. In Italy, for example, women aged 55-59 and men aged 60-64 are most affected by the pessimistic scenario.

In the optimistic scenario, countries which show the biggest increase compared with the base include Belgium, Greece, Portugal and Slovenia. Most of the increases in labour supply in these countries are among the older labour groups where, relative to other groups, their retirement decisions are more heavily influenced by economic conditions, wage rates, and benefit rates. Cyprus, Malta, the Netherlands and Romania have the least positive impacts on their labour supply in this scenario.

The results by labour groups for the EU-25* show that older age men (60-64 and 65+) and young age group (men aged 15-19 and women aged 15-19) are the most sensitive in both the pessimistic and optimistic scenarios. As participation rates in these groups are relatively low in the baseline forecast, it is reasonable to expect that conditions, such as benefit rates, in the

scenarios are likely to have a greater influence on these groups' decision to join/leave the labour force than in those groups where participation rates are already high (e.g. men 25-29, men 30-39, men 40-49 and women 40-49).

Figure 14. **Supply projections, labour force (15+), compared across scenarios, change in thousands and %, 2007-20, EU-25***



Source: IER estimates based on CE E3ME model.

3.2.4. Qualifications supply in alternative scenarios

Figure 14 presents the supply of qualifications across the alternative scenarios. The top block presents projected changes across scenarios and the block at the bottom presents percentage changes.

All scenarios project that labour-force changes across qualifications will move in the same general directions. The low scenario projects a decline in the labour force across all qualifications, while both the base and the high scenario project an increase. All scenarios project that there will be increases for medium- and high-level qualifications, with numbers with high-level qualifications projected to experience the largest increases. Similarly, all scenarios project a decline in the total number of low-level qualifications.

While there are some obvious differences between the three scenarios, with all qualification levels benefiting from the more optimistic scenarios, the differences in the patterns of change by broad qualifications levels are not huge.

Table 14. **Supply projections, labour force (15+), compared across scenarios, EU-25***

	NA based level in 2007	Change 2007-20 scenario		
		Base	Optimistic	Pessimistic
Levels and net change (000s)				
Low qualification	63 402	-18 272	-16 386	-20 098
Medium qualification	109 086	3 158	6 676	-191
High qualification	53 980	20 092	22 145	18 057
All qualifications	226 468	4 977	12 435	-2 233
Changes (%)				
Low qualification		-28.8	-25.8	-31.8
Medium qualification		2.9	6.1	-0.2
High qualification		37.2	41.0	33.5
All qualifications		2.2	5.5	-1.0

Source: IER estimates based on CE E3ME model.

3.3. Feedback from country experts

This final subsection provides a summary discussion of various issues raised by the experts during the Cedefop Skillsnet workshops and subsequently. It outlines the main actions taken in response to these comments and suggestions. Such input has been a crucial element in developing pan-European projections, providing detailed country insights as well more general expert input. Although all the comments and suggestions have been considered, and many have resulted in detailed changes being incorporated in the revised version of the report and the workbooks, it has not been possible to take all of them fully into account, as explained below.

In a number of cases (e.g. comments from the Czech Republic, Estonia, Cyprus and Slovenia) specific comments were made regarding the validity of the individual country figures, focusing on both the historical and the future data presented here. The main concerns were that:

- in some cases the historical data presented, both in the report and in the workbooks, did not match either with the data from the national statistical agencies available to individual country experts nor the data published by Eurostat;
- some future data show unrealistic trends for some specific groups.

There are several limitations as to what can be done in response to such comments, given the general approach of the project, which aims to adopt a common dataset and methodology, rather than using data from individual countries. Many of the comments raised by the experts have been taken into account in this final set of results. For instance, in some cases an alternative period of historical data was used in developing the trends to achieve greater consistency ([24]). The historical data have also been revised to match more closely to the aggregate data published by Eurostat, by using weighted shares.

Another set of comments related to the implied participation rates from the projections, defined as the ratio of the numbers in the labour force expressed as a proportion of the number in the corresponding working age population category. Some concerns were expressed regarding the validity of these rates. To assess the participation rates implied by the projections, these have been calculated explicitly and are now included in the workbooks, with detailed results by age and gender.

([24]) For example in Denmark, Germany, Italy, Cyprus and Lithuania.

Various checks were conducted and, in most cases, the rates look plausible. Labour-market participation is generally slightly higher for those with higher-level qualifications, especially for older age groups. Investing in education may require people to work longer to reap the full benefits of that investment but it may also make it easier for people to sustain active involvement in the formal economy. Most countries show positive trends over time, for most age groups for all three qualification levels, although there are many exceptions.

A further question raised is whether various cohort effects are reflected successfully in the projections. For example, the progressive nature of qualification acquisition would suggest that growth in the population for low-level qualifications should be less than growth for the population as a whole; successive pseudo cohorts should show steady progression as individuals cannot become unqualified or less well qualified. However, such effects are not explicitly dealt with in the model, which focuses on trends in stocks. Such effects are not always reflected in the projections (e.g. in Belgium). This issue will be followed up in greater detail in future work, when cohort effects will be considered in more detail and more explicitly.

Many other more detailed comments were received that need to be acknowledged. Where possible these have been taken into account and revision to the results incorporated into the workbooks. However, in many instances it is not possible to follow up the suggestions made by individual country experts as they imply moving away from using common data sets and common methods for all countries. It is undoubtedly possible to improve individual country results by customising them to use individual country data, but the purpose of the present exercise is to use common datasets and models, which cannot always take into account the particularities of each country.

Regarding the method utilised to estimate supply projections, a consensus was developed in discussions about the limitations of a purely stock-based approach compared to a more comprehensive stock-flow model. The advantages of some other alternative methods are also apparent for individual countries where data are available. Nevertheless, due to data and resource constraints, elaboration of a pan-European full stock-flow model or such other variations is not currently possible. However, future research and data enhancement, might lead to the development of more sophisticated models.

A series of other issues were discussed, which are not related to the data or the methodology. These include:

(a) differences in, and changes to, official retirement ages in each country;
(b) the effects of the economic crisis; and its subsequent impact on the economy and the labour market;

(c) variations in individual country policies regarding participation in education and how this may affect future developments.

It was recognised that variations in the official retirement age across countries can affect the totals in the labour force. E3ME uses data that include this variation. However, the forecasts implicitly assume that the retirement age stays the same in each country as it was in the last year of historical data used. The highest age group 65+ provides some labour supply, but generally at very low rates of participation. This varies slightly from country to country. The same change in official rates may also have different effects in different countries.

There was consensus that the crisis will affect future developments, which are not taken into account explicitly in the projections. It was agreed that this should be dealt with in future work rather than trying to use the more pessimistic/negative scenario developed as part of the present project as a proxy for the recession input. For further discussion on this point see Section 3.2.

Country specific policies on participation in education should ideally be taken into consideration to contextualise the data when presenting the final country results. It has not been possible to undertake a detailed review across all countries for the present analysis, and it should be recognised that use of a homogeneous model when analysing heterogeneous educational systems has various limitations.

CHAPTER 4

Imbalances: conceptual and methodological issues

4.1. Distinguishing demand and supply

The results presented above make clear that there have been major changes on the supply side, partly in response to government policies to increase participation in higher education. This has resulted in a big increase in the numbers emerging onto the labour market with formal qualifications and this is projected here to continue. The proportion of young people with formal qualifications is much higher than for older people. There is, therefore, a strong cohort effect. This has been reinforced to some extent by also increasing qualification rates for older people (an upskilling effect).

The observed historical patterns of employment by qualification result from a combination of supply and demand factors. Separating them is not straightforward. Recent trends have seen a sharp rise in the formal qualifications held by those in employment in most countries. There is some evidence that this reflects demand changes, with many jobs requiring more formal higher-level qualifications than used to be the case. There are also indications that the returns on obtaining such qualifications have remained high (for a review, see Wilson et al., 2005).

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

4.2. Conceptualising supply into occupations or sectors

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

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

ROA's experience of confronting labour supply by education with labour demand by occupation (sector) in the Netherlands suggests that this can be done using a detailed allocation matrix of education/qualification by occupation (sector). This matrix indicates in each year the number of workers with various qualifications working in different occupations (sectors). Using such a matrix, a supply forecast by qualification can be translated into a supply forecast by occupation (sector) which, in turn, can be set against demand forecast by occupation. The distance between supply and demand at the occupational level can give an indication of the adjustment required to achieve equilibrium. This type of matrix has been available in the Netherlands for a long period, and has been used by ROA in its forecasting activity. The currently available data at a pan-European level are inadequate to provide this for all countries. This limits the scope for confronting demand and supply.

However, it is possible to develop a simple algorithm to reconcile demand and supply results in aggregate, given the data available for all countries. Such an algorithm is described in Annex E. Once comparable estimates of supply and demand are available it will be possible to use this algorithm to provide indications of supply/demand pressures in different occupations. It compares

the patterns of qualifications revealed by the original unconstrained demand projections and a set constrained to match supply. The outcome for individual occupations or sectors (in each country) will show how any surpluses or shortages affect the qualification mix. If supply is growing faster than demand for particular levels of qualifications then the constrained qualification mix will be 'richer' (i.e. more highly qualified) than the unconstrained one: the converse is also true. For example, if there is excess supply of those with high-level qualifications, some will experience an increase in proportions of those employed holding such qualifications, even though this may not be necessary from a demand perspective. Some of these people might be over- or under-qualified for the job they are doing. Comparison of the constrained and unconstrained results can then provide a useful indicator of supply demand pressures for different occupational and sectoral groups. Where supply is growing faster than demand for a particular qualification category, the proportions qualified in the constrained results will exceed those in the unconstrained results, and the converse.

The concept of supply of qualifications at a spatial level is more manageable than for occupations or sectors. It is relatively straightforward to develop quantitative estimates and projections of population and the labour force for each country. In principle, this can be extended to cover formal qualifications held. However, available pan-European data are generally less robust than at national level. Further, the issues of commuting and migration flows become significant. While it is possible, in principle, to envisage the development of customised qualification supply models for each individual country, this would require considerable resources and a time frame well beyond that available in the present project. A common approach is adopted here. The present modelling, therefore, is limited to a much more simplified level than the more detailed and sophisticated stock-flow analysis applied in individual Member States such as the UK national level; Wilson and Bosworth (2006), reflecting the data constraints faced at a pan-European level.

4.3. Other imbalance/mismatch conceptual issues

There are several other conceptual issues that arise when matching labour demand and supply, which mean that naive comparisons can be misleading. These can be illustrated with stylised examples demonstrating what might happen when occupational demand and educational supply are mismatched, and illustrating the kinds of adjustments that can take place.

Assume that the economy starts from a position of balance between demand for and supply of skills (equilibrium). Some percentage of the population is unemployed or not willing to search for work at the prevailing wage. If there is a simple situation in which occupational demand for one occupation is forecast to rise by the same amount as the demand for another occupation is forecast to decline, this implies that total labour demand does not change. However, if educational requirements within occupations are fixed (fixed coefficients, or fixed proportions of total employment in each occupation), then there will be a short-fall of workers with one level of qualification and excess supply in the other. The labour market is now in disequilibrium and various market forces will tend to cause adjustments to address these imbalances.

The example focuses on quantities (employment, etc.), but wages may adapt to the new situation. There may be some upward pressure on wages for the educational level in shortage, and (initially) some downward pressure for the one with excess supply. As a result, production processes may also change and employers may feel incentives to change capital intensities, the technologies in use, and/or their organisational structures. These describe possible responses from an infinite number that might occur as market pressures work to match labour demand and supply.

Another example could assume that occupational demand for one particular occupation cannot be met by reallocating people from one educational category to that occupation, and so more workers with the closest level of qualification are employed in that occupation. As a result, the input ratios of both levels of qualification in this occupation change in favour of the 'closest' educational category: the increased demand for educational level needed for this occupation causes the demand for the closest educational level also to rise. This demand can be regarded as a form of 'substitution demand' (Cörvers and Heijke, 2004). In the example above, with fixed coefficients, excess supply for the 'closest' educational category was predicted. Due to substitution demand the wage of the 'closest' educational category may decline less than initially predicted or could even rise. Rising demand for people with such qualifications may cause the population in that category currently not employed to fall, in response to better job opportunities and any increase in the wages of this qualification category. Moreover, since labour demand for both educational categories has risen (and there is upward pressure on wages for these categories), it may become less attractive for other employers to employ such workers in another occupation.

The process of matching demand and supply of skills is complex.

4.4. Measuring imbalances in practice

Measuring imbalances by simply confronting independently produced supply and demand risks several pitfalls. There are various reasons why large discrepancies might arise which have nothing to do with mismatches between supply and demand. Such differences may be very misleading as indicators of shortage or surplus.

Supply and demand projections are both subject to error; the margins of uncertainty around such point estimates are difficult to measure with any precision. Supply and demand are both large numbers relative to any difference between them. Imbalances are small numbers produced by the difference between these large numbers. This makes the error margins associated with any such gaps much larger than for the original estimates. For example, while demand and supply may be predicted reasonably precisely, with confidence intervals of say plus or minus 5 %, the error band associated with the difference between them could be plus or minus 100 % (or more) ([25]).

A second reason why simple confrontation of supply and demand projections may be misleading is that different datasets may have been used for the two sets of projections. For example, the demographic data that E3ME uses for supply projections comes from Eurostat's population estimates, rather than being taken directly from the LFS microdata set (although StockMOD uses data on the supply of qualifications extracted directly form the micro LFS data). The demand-side projections also use LFS data. This may be either from the Eurostat published aggregate data or from the LFS microdata set. Unless the comparisons are made using consistent data they will be misleading.

There are also significant differences arising from different vintages of data used. The latest supply-side projections have used a newer version of the EU LFS data (2008), as well as various other revised and updated data relating to E3ME and the general economic and labour-market situation. The use of different underlying economic scenarios in the demand and supply sets of projections prevents simple direct comparison of demand and supply estimates.

([25]) The precise relationship will depend on the detailed statistical properties of the two estimates. These are very complex and the production of simple statistical margins of error is not possible. Such issues will be addressed more explicitly in future work.

A final reason for discrepancies between supply and demand measures relates to differences in historical estimates of the labour force, employment and unemployment used within E3ME. The main underlying reason for these differences is the different sources used for each model variable. Employment (proxy for demand) is measured according to the Eurostat NA data set, which provides a link to economic activity. However, estimates of the labour force (proxy for labour supply) are not available from the NA data and therefore are based on the EU LFS. This is made consistent with the Eurostat population projections by calculating LFS participation rates and applying them to Eurostat population figures. Unemployment data come from the DG ECFIN AMECO database, which uses a definition similar, but not identical, to the LFS.

Many of the differences between the series are related to the differences between LFS and NA definitions for employment: counting people rather than jobs, cross-border commuting, and correcting for sample errors. Different factors are significant in different countries. These were described in detail in Cedefop, 2008a.

The E3ME model's internal structure deals with these discrepancies by automatically calculating a 'residual' value that corrects for the differences between the data sets. This is defined as:

Residual = employed + unemployed – labour force

The residual is defined for each country in each year of the model solution. In forecasting it is held constant as a proportion of labour supply (so any discrepancies are maintained throughout the forecast). This allows the model to determine endogenously labour supply, employment and unemployment using the data available. In the scenarios, the residual value is assumed to be the same, independent of the model inputs, so the differences in results reflect only the scenario inputs.

Discrepancies between labour supply and demand can arise between vintages of projections because of:

(a) differences in baseline data,

(b) other changes outside the modelling framework.

The baseline E3ME forecast used in the two sets of projections for the demand and supply pilot projects were similar, but not identical. In particular the latter included two additional years of historical data and a revised Eurostat forecast for population growth (Box 1).

Box 1. **Eurostat population projections**

To guarantee the most recent data, two different sets of Eurostat population projections have been used for the two sets of Cedefop's forecasts (demand and supply): Europop2004 and Europop2008 respectively. Both population projections are based on assumptions for fertility, mortality and migration. However, the framework in which the assumptions were made differs:

Europop2004 is a trend scenario, based on past trends and analysis of driving forces from the past as well as expert opinion, and it does not take into account any future measures that might influence demographic trends;

Europop2008 assumptions have been developed in a conceptual framework of convergence of demographic values as a result of decreasing socio-economic and cultural differences between the Member States of the European Union, Norway and Switzerland.

These two population projections complement, and do not cancel out, each other. The main difference between the two scenarios (trend scenario and convergence scenario) is the assumption they are based on. The trend scenario, from 2004, assumes that the components of change (fertility, mortality and migration) will continue to work in the future the same way, keeping their tendency. Following this tendency will lead towards certain estimation of the population. In contrast, the convergence scenario 2008 is based on the assumption that the differences between the demographic drivers in the Member States of the European Union will narrow and this way a convergence of demographic values is expected, the convergence year being 2150. Following this scenario might lead to different results concerning the population.

Source: Eurostat, 2009a, 2009b.

Other changes outside the modelling framework refer to how the model's internal structure may be by-passed by entering alternatives to the forecast it is calculating. This has been used to enter the changes requested by the individual national experts in the Skillsnet group, which differed between the two sets of projections. In both cases, E3ME internally adjusts to the changes by adjusting the residual values over time so that the model's output reflects all the outcomes it is expecting to produce.

Some country examples illustrate these E3ME issues. Luxembourg stands out as an obvious example where there is a large discrepancy in the historical

data between the demand and supply measures. This is due to cross-border commuting, a difference between LFS and NA data. The next largest difference is in Greece, where the two sets of figures differ in their units between (employment) jobs and (labour force) persons, e.g. due to multiple job holders.

In the forecast years, the differences between the projections of labour demand and supply are often due to revisions in the population forecasts (vintages of data used). For example, United Kingdom employment demand forecast was set to match a national forecast that was based on different population assumptions. The employment demand forecast for the Czech Republic was also based on different population assumptions from the ones used for the more recent supply projections.

The current methodology in E3ME is based on producing the best possible forecast for labour demand in the first 'demand' project, and then producing the best possible forecast for labour supply in the second project. This involved fixing all model outputs except the ones on which the projects were focused (employment and unemployment for estimating labour demand, and participation rates, unemployment and wage rates for estimating labour supply). The approach in the two projects has been to produce a forecast that is consistent with baseline economic forecasts published by the European Commission (but these were not the same for the two projects). E3ME has two-way linkages between the economy and the labour market so developments in the labour market affect levels of economic activity. Therefore the outputs from the economic equations in the model were fixed to ensure consistency with the EC published forecasts. The result is that both the labour supply and demand forecasts were consistent with the EC economic forecast. The downside to this was that the model's own internal mechanisms to ensure balance between demand and supply were overridden. The next step in the development will be to integrate the demand and supply forecasts so that they are consistent with each other and thus enable analysis of possible imbalances.

Ideally, this requires more detailed understanding of how the NA employment data sets are compiled in each of the EU Member States. If this could be quantified there is scope for improving the treatment of these discrepancies in the E3ME modelling, both for forecasting and scenario analysis. For example, factors that affect total employment may also affect cross-border commuting, and the 16-25 population level will influence the number of students.

To produce a combined forecast of labour supply and demand simultaneously, all E3ME outputs should be fixed except for labour supply, employment demand, wage rates and unemployment. Any overall imbalances between demand and supply should then be represented by either increasing wage rates (demand exceeding supply) and/or high levels of unemployment (supply exceeding demand). Assumptions about the levels of cross-border commuting, etc. can be entered explicitly as exogenous.

All of these concerns are likely to affect the quality and robustness of the estimated imbalances between demand for and supply of qualification levels. During the Cedefop Skillsnet workshop in Cambridge in December 2008 there was considerable discussion about these issues and the interpretation of any comparisons between the current results and the previous demand projections. On balance it was agreed that any simplistic comparison of implied imbalances and mismatches should be treated with caution at this stage. In particular, since there are several important methodological, conceptual and data issues which affect the outcomes, any publication of such results should be deferred until, as far as possible, 'like' could be compared with 'like'. It was suggested, therefore, that such results should not be disseminated into the wider public domain at this stage, since they might give conflicting messages regarding the future skill imbalances. Thus this report does not include any detailed analysis and results on estimating labour-market imbalances.

Nevertheless, the estimation of skill imbalance remains a central policy concern, and this should be treated as a priority for further research, which will eventually lead to more robust results. The next phase of work will generate consistent projections of demand and supply which will enable such direct comparisons, and this issue will be subject to further detailed analysis. A separate report discussing these various issues regarding labour-market imbalances will follow in the next stage of work.

CHAPTER 5

Conclusions

5.1. Overview

This publication presents an overview of a set of consistent and comprehensive skill supply projections across Europe. There have been difficulties in obtaining consistent and detailed data for all countries. Estimates for Bulgaria and Romania, and for Malta and Switzerland, will be added in the next phase of work, although this may involve using substitute data from sources other than the preferred ones used for all other countries.

Skills are measured here using formal qualifications, distinguishing three broad levels; low, medium, and high (details in Annex B). While this has its limitations, and more detailed analysis is desirable, the present results illustrate the general feasibility of developing consistent supply and demand projections. Further work is needed to improve the basic underlying data to achieve additional detail, but this appears to be feasible.

The results presented are based on the use of E3ME as a starting point for assessing overall prospects for labour supply across Europe. The information from E3ME has been used in combination with data from the EU LFS, and Eurostat demographic estimates and projections, to generate overall labour supply projections. These have then been translated into the supply of skills. The analysis has been based on both the LFS microdata (individual level) and published data from Eurostat and other sources (such as the UOE data collection on education flow statistics).

Together, the two Cedefop projects have involved the production of sets of benchmark projections of both skill demand and supply that can be the foundation for continuing dialogue about such issues across Europe. The present supply-focused project has been concerned with the development of a sound historical and projections database, including developing the basic data and related software needed to produce projections of the supply of skills in a replicable fashion, and in a manner that can be compared with the demand-side projections produced in the previous Cedefop project (Cedefop, 2008a). A key objective of the two projects has been to develop a general conceptual framework, within which alternative possibilities can be considered. While there may still be concerns about the quality of some of the data for

individual countries, or for particular aspects of supply or demand, this conceptual framework enables other, better data to be easily incorporated to improve the quality of the analysis and the projections.

All the results have also been brought together in country workbooks. The detailed results in the excel workbooks have been made available to assist dialogue with country experts to improve the quality and robustness of the basic data and results, by taking note of local knowledge. These workbooks are consistent with those produced earlier in the demand-side project.

The project has involved a process of dialogue with both individual country experts and the relevant statistical authorities. As this process continues it is hoped that the quality and reliability of the relevant data and estimates will gradually be further improved. While the present results have their limitations, they provide a useful starting point for thinking about likely future developments in skill supply and demand across the EU.

5.2. Key findings

Despite the difficulties with many of the data, a number of clear and robust trends emerge, common across almost all countries. There has been a strong tendency for the overall numbers and proportions within the total population of those with formal qualifications to rise in recent years. In particular, the proportions of those with higher-level qualifications have risen significantly and those with low-level or no formal qualifications have fallen steadily. This applies even more strongly to patterns within the economically active labour force. Those with medium-level qualification have exhibited a more mixed pattern, partly reflecting the focus on highest qualification held (which means that many people move on from this middle category to acquire higher qualifications).

It is generally expected that these historical trends will continue. If future developments continue the patterns of the recent past, there will be substantial increases in both the proportions and the number of people with medium- and high-level qualifications, both in the population and the labour force. In contrast, the number of people with low-level qualifications can be expected to experience a significant decline in absolute numbers and a falling share. This is all in line with the ambitious targets set out in the Lisbon agenda.

Over the period 2007-20 the numbers in the population aged 15+ with high-level qualifications could rise by 32 million. This is equivalent to a rate of increase of almost 42 %. The numbers with low-level (or no qualifications) can

be expected to fall by a larger figure too (a rate of decline of about 19 %). There are similar but sharper trends for the economically active labour force. The number of people with low levels of education is projected to fall by 29 %. This is an indication of the general trend towards a highly-educated labour force, as younger cohorts are increasingly better qualified than older ones. As well qualified young people enter the workforce, and older less well (formally) qualified workers leave, the average qualifications levels increase significantly.

The precise trends vary between countries, with some (such as the Netherlands) likely to get much closer to attaining the targets set out in the Lisbon agenda than others. This reflects very different starting points, as well as different historical trajectories. In a number of countries there is some evidence of a plateau being reached, with rates of improvement appearing to level off for the highest levels of qualification. In others there is more room for improvement, with a number of countries still expected to have very significant proportions in the low category, even by 2020. The results here should only be regarded as broad brush and indicative and not specific targets or criticisms of current performance. Although these are the best pan-European estimates currently available, questions remain about the comparability of such estimates.

These trends are common to men and women. Women have shown the most significant rates of improvement in formal qualification levels in recent years, and these patterns are projected to continue, with rates of increase significantly higher than men for both the population and the labour force. The number of men in the population aged 15+ with higher-level qualifications will increase by 38 % between 2007 and 2020, while the corresponding figure for women is 46 %.

It is important to consider different possible macroeconomic scenarios. The project has developed two alternative macro scenarios which present a range of economic situations Europe may face over the next 5 to 10 years and beyond. At present this does not include an assessment of the consequences of the current world-wide economic crisis, but the results presented here demonstrate the ability of the general present conceptual framework to deal with such external shocks, given further work. The scenarios developed so far suggest that the overall improvements in terms of average qualification levels are likely to be a common feature, whichever scenario evolves.

Although these results suggest a relatively optimistic picture, it should be recognised that the historical trends on which the projections are based may be disrupted by the unprecedented shock to the economy due to recent events in financial and related markets. These results were developed before the full

extent of that shock become clear. This may disrupt the previous steady improvement in qualification profiles observed over recent decades. Initial indications are that the immediate impact of the crisis may be to increase educational participation and qualification acquisition as individuals delay entry into a depressed labour market. In the longer term, as financial constraints start to bite in the real economy, this may discourage investment in human capital, especially in less affluent sections of the community, which have been the main source of recent growth. Policy-makers may, therefore, need to take proactive steps to ensure that these projected improvements are realised.

5.3. Data problems and scope for refinement

Detailed examination of the results for individual countries reveals a number of outstanding problems and questions. These are especially serious for some countries where the sample sizes in the LFS are inadequate to provide robust estimates, or more often where major changes in definition or classification appear to have been ignored. LFS could also provide better quality data on the education fields to be used for skill supply forecasts. These problems with the data can probably be addressed only by further detailed dialogue between country experts and the statistical authorities concerned.

A key priority should be to develop improved LFS data series, with additional detail on qualifications held and programme orientation (vocational or general); the conceptual framework developed allows for alternative data and assumptions to be incorporated with relative ease. Therefore, given cooperation with the countries concerned, in principle such issues can be easily resolved and better data slotted in once they are available. There is also considerable scope for improving the basic methods used to carry out projections of supply (both stocks and flows) and demand (changing occupational and qualification structure, and estimates of replacement demands).

Problems with the data and other technical difficulties have limited the sophistication of some of the modelling work so far, but the potential for refinement and improvement offered by the conceptual framework is clear. The modular structures adopted and the presentation of the material in separate country workbooks enables such developments to take place at pan-European and country level.

5.4. Continuing dialogue and country experts' input

The present set of projections has been compiled with the voluntary involvement of many country experts. This project has benefited greatly from their detailed comments and suggestions. Their commitment, input and expert knowledge have been of great importance and have helped to increase the quality of the projections. It is clear from the issues raised in connection with these preliminary results that such involvement is crucial for ensuring the credibility of the results for individual countries 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 individuals who can bring their unique knowledge and expertise to bear on data and trends for their own countries. The feedback obtained so far suggests that, with such input, it will be possible to develop a much more robust database.

5.5. Comparing demand and supply

The project has also begun to explore how the new supply-side analysis can interface with the previous demand-side forecast. Development of consistent country supply workbooks aids such comparisons, but care should be taken to avoid simplistic comparisons of supply and demand estimates. The project has explored some of the issues involved in allocating skill supply by occupations (and also, implicitly, sectors), while taking into account occupational/sectoral change and mobility processes. This raises questions about what it means conceptually to talk about supply of labour to a particular occupation or sector. In many cases there is no clear boundary, and sectors and occupations can (to some degree at least) source their labour demand regardless of qualification or field of study.

For many combinations of occupation and education there is no one-to-one relationship. Depending on the degree of labour market regulation, organisations can employ people with very different education backgrounds for the vacancies they have. This implies that there is usually a wide range of different education backgrounds relevant to a job opening in a particular occupational class. This makes comparison of supply and demand estimates difficult. Nevertheless, a start has been made on developing procedures and ideas for using the available data as much as possible to match supply and demand in the labour market. Some new ideas for presenting and quantifying

indications of future mismatches for some aggregate occupational classes are presented in this publication. These will be further refined in the continuing project.

As the E3ME model is the provider of labour-supply forecasts and the demand projections, there is, in principle, an automatic link with the demand-side project. Once the demand and supply projections are undertaken simultaneously, this will ensure consistent treatment of the demand for and supply of labour. This ensures:

(a) consistent model ideology;
(b) use of the same basic data sets;
(c) a consistent set of coefficients/elasticities;
(d) a common set of assumptions.

5.6. Ideas for further research

This project suggests some key priorities for future research in skills-supply modelling and forecasting. Some ideas have already been sketched out above, including the desirability of moving towards a full stock-flow modelling approach.

Some areas can be identified where adoption of best practice methodologies in individual countries could be extended to other countries to begin to develop a more sophisticated pan-European perspective. For example, extension (adding more countries) of the Reflex project methodology for higher education graduates could result in better estimates of the transition from education to the labour market. A similar project could also be started for secondary education, in particular to compare flows within the educational system between countries. Such approaches are being explored in a subsequent Cedefop project.

As in the earlier demand-side project, there is a tension between wanting to improve the approach for some individual countries (by further exploiting particular data sets and previous research) and preserving a consistent approach across all countries, using common data sets. Further discussion with country experts could help to identify where particular approaches might prove most productive. The second prong of Cedefop's long-term strategy is to encourage further harmonisation of both data and methods across countries. This could bear fruit in this particular area, although the difficulties of harmonising classifications and definitions, let alone data and methods of analysis, should not be underestimated.

A related possibility is to modify the results within the current conceptual framework to be more consistent with the views of country experts. The use of common models and assumptions does not exploit 'local' knowledge about detailed policy and other factors that may be affecting the supply of skills, including labour-market activity rates. This will be explored further in the future new project where additional resources have has been made available for checking and customising country results.

One area for development would be to pay more attention to implied cohort effects and implied activity rates for detailed age groups and gender. The current stock model does not deal with these issues explicitly but generates results implicitly. The analyses for individual age gender categories have been undertaken independently, without detailed attention being paid to the implications for the progression of cohorts over time. For example, there are currently no constraints on the qualification patterns for 55 to 59 year-olds in 2020 compared to the results for 50 to 54 year-olds five years earlier, yet in reality these are linked by the flows of people in and out, including mortality, withdrawal from the labour market, migration and new acquisition of qualifications. Without a full set of demographic accounts or longitudinal data to measure all these flows, a comprehensive stock-flow model is not practicable. However, some improvements could probably be made to avoid making implausible assumptions implicitly.

Another area for potential refinement relates to detailed labour-market activity rates by age and gender for those with different levels of qualification. The current approach models the qualification structure of the population and the labour force separately and independently, based on changing patterns over time within each age, gender and group. Activity rates are then obtained by dividing the labour force estimate of numbers in each qualification group by the corresponding population estimate. This can lead to implausible outcomes in some cases, both in terms of actual rates and developments over time. An alternative approach would be to model activity rates for age and gender qualification categories separately. This would make it easier to focus on ensuring that activity rates follow a more plausible path over time. If activity rates are modelled explicitly it would not be necessary to model both numbers qualified in the population and the labour force, since any two of these implies the third.

Having established the basic database, the possibility of undertaking different types of estimation is also opened up. For example, a panel estimation of the cross-country, aggregate time series is now also a practical possibility. Further work to develop appropriate explanatory variables is the

main obstacle to developing such an approach. Nevertheless, this approach should be explored in future work.

The problems of mismatch and the concept and interpretation of skill imbalances in general terms, when comparing demand and supply forecasts, is another key area of concern. The problems faced by employers and others in trying to match qualifications and occupations, the various mechanisms (aspects of market clearing) and the different possibilities for dealing with these imbalances, require further research. This has been given new urgency by the labour-market disturbances likely to result from the deepening worldwide recession. The recession is likely to introduce a more serious element of lack of aggregate demand, which may well swamp any detailed skills imbalances and mismatches. Work on this topic will form part of future work.

5.7. Building a comprehensive system to anticipate skill needs

Anticipation is, by nature, difficult and it is argued that a holistic approach is required combining different tools, methods and approaches (both quantitative and qualitative). The priorities for future Cedefop work on skill needs includes several parts of such a comprehensive approach: developing regular forecasts of skill supply and demand in Europe, analysing skill mismatch, exploring use of employers' surveys as a tool for skill needs analysis, and identifying skill needs in selected key sectors of the economy (e.g. the green economy).

Cedefop is continuing its forecasting activities and is currently working on a new research project with the aim of developing a system for regular forecasts of skill supply and demand. This will build on the existing conceptual framework developed for the initial skills-demand forecast and the skills-supply forecast presented in this publication. Cedefop will work on improving the methodology and will explore all the ideas in this publication for further development. The updated forecasts will again take into account various economic aspects and scenarios, including the recent economic crisis. The forecasts, which will be published (with the financial support of the European Commission, DG EMPL) every two years starting in 2010, will serve as a main input for the Commission's forthcoming regular assessment of skills in Europe related to the 'new skills for new jobs' initiative. Once the two forecasts are done simultaneously, it will also allow assessment of potential future labour-market imbalances, as discussed in this publication.

In this context, Cedefop has recently started complementary and groundbreaking research that aims to provide a comprehensive assessment and analysis of skill mismatch in Europe. Work on skill mismatch aims to strengthen the comprehensive approach to future skill needs by assessing and examining skill mismatch at different levels and pointing out the implications of individual skill imbalances for organisations and the economy.

A number of different studies are being carried out in the coming years, giving a comprehensive overview of skill mismatch both in quantitative and qualitative terms and outlining what types of skill mismatch can be distinguished, what the implications are, and why skill mismatch should be a concern for policy-makers. They will provide an accessible overview of skill mismatch issues in Europe and at the same time indicate the gaps in the current understanding of skill mismatch.

Skill mismatch for ageing workers, which is closely connected to the current debates on the impacts of demographic change and active ageing, will be examined. Taking into account most recent insights, emphasis will be placed on over- and under-skilling, aiming at preventing conceptual and empirical problems often encountered in analyses of over- and under-education. In addition, Cedefop will examine the consequences of skill mismatch in terms of various labour-market outcome indicators, such as earnings, job satisfaction, employability and unemployment risk.

To broaden and validate the knowledge base, it is necessary to complement the quantitative forecasts with other information. Cedefop currently explores the feasibility of identifying European skill and competence needs using enterprise/employer surveys as a complementary and more qualitative source of information.

There is currently a lack of European data and relevant information on skills from the employer's viewpoint. There are many surveys for identifying skill and training needs in the EU Member States, but they are not comparable across Europe. They differ significantly in their objectives, content, regularity and methodology.

Even though the methods and objectives of employers' surveys in individual countries differ, country experts expressed their willingness to discuss and find ways of making their survey methodologies and results comparable.

The following three options for future work were identified: modification of existing employers' surveys at European level by including questions on skill needs (e.g. continuing vocational training survey); adjustment of national surveys in (selected) Member States to achieve comparability of results (i.e. including specific module, etc.); and the launch of a new European employers'

survey specifically aimed at identifying skill needs (new Community instrument). Cedefop is currently carrying out a feasibility study to assess the above-mentioned options. The study will consider the costs and benefits of all options. Based on the findings, the development and piloting of a new survey instrument will start in 2010 (with the financial support of the European Commission, DG EMPL).

Cedefop is also continuing to identify new and emerging skill needs in selected sectors. A joint project with the International Labour Organisation aims at conducting applied policy research into skill needs for greener economies with respect to new and changing occupational profiles, greening existing occupations, and identifying skills and occupations that become obsolete. The research is based on a number of country studies with the primary focus on examples of good practice in supplementing national policies for greening economies by the identification of skills needs and efficient skills-response strategies. Altogether between 10 and 15 country studies, covering EU and non-EU countries, will be conducted using the same research methodology. The results are expected in 2010.

All this work will contribute to the 'new skills for new jobs' agenda, which aims, among other things, to improve the capacity to anticipate and match labour market and skill needs in the EU and gather comparable results at EU level. All experts and stakeholders are invited contribute their knowledge and experience.

ANNEX A

Detailed results by qualification

Table 15. **Population by age and gender, all qualifications, EU-25***

All qualifications	(000s)				
Males	**2000**	**2007**	**2013**	**2020**	**000s**
15+	181 243	190 464	196 779	201 612	9 221
15-19	14 876	14 517	13 210	12 909	-359
20-24	15 353	15 259	15 109	13 614	-94
25-29	16 541	16 138	16 021	15 387	-404
30-39	35 386	34 539	33 621	33 364	-848
40-49	32 129	35 046	35 811	34 023	2 917
50-54	14 458	15 522	16 800	17 647	1 064
55-59	12 293	14 659	15 235	16 859	2 366
60-64	11 509	11 870	13 976	14 997	361
65+	28 698	32 915	36 997	42 813	4 217
25-64	122 316	127 773	131 464	132 276	5 457
Females	**2000**	**2007**	**2013**	**2020**	**000s**
15+	195 092	203 249	208 991	213 268	8 157
15-19	14 217	13 785	12 573	12 316	-432
20-24	14 882	14 752	14 573	13 150	-130
25-29	16 169	15 686	15 537	14 909	-483
30-39	34 762	33 752	32 679	32 289	-1 009
40-49	32 238	34 915	35 448	33 506	2 677
50-54	14 692	15 921	17 103	17 723	1 229
55-59	12 791	15 269	15 920	17 379	2 478
60-64	12 571	12 716	15 004	16 001	145
65+	42 771	46 452	50 155	55 996	3 682
25-64	123 223	128 260	131 690	131 806	0
Total	**2000**	**2007**	**2013**	**2020**	**000s**
15+	376 336	393 713	405 770	414 879	17 378
15-19	29 093	28 302	25 782	25 225	-791
20-24	30 235	30 011	29 682	26 763	-224
25-29	32 710	31 824	31 558	30 296	-886
30-39	70 148	68 291	66 300	65 653	-1 857
40-49	64 367	69 961	71 259	67 529	5 594
50-54	29 150	31 443	33 902	35 370	2 293
55-59	25 084	29 928	31 154	34 238	4 844
60-64	24 080	24 586	28 980	30 998	506
65+	71 468	79 367	87 152	98 809	7 899
25-64	245 540	256 033	263 154	264 083	10 494

Source: IER estimates based on StockMOD.

level, age and gender for EU-25*

Change 2000-07		Change 2007-13			Change 2007-20		
%	% p.a.	000s	%	% p.a.	000s	%	% p.a.
5.09	0.001	6 315	3.32	0.001	11 148	5.85	0.001
-2.41	0.000	-1 307	-9.01	-0.001	-1 608	-11.08	-0.001
-0.61	0.000	-151	-0.99	0.000	-1 646	-10.79	-0.001
-2.44	0.000	-116	-0.72	0.000	-751	-4.65	0.000
-2.40	0.000	-917	-2.66	0.000	-1 175	-3.40	0.000
9.08	0.001	765	2.18	0.000	-1 023	-2.92	0.000
7.36	0.001	1 278	8.23	0.001	2 125	13.69	0.001
19.25	0.002	575	3.93	0.001	2 199	15.00	0.001
3.13	0.000	2 106	17.74	0.003	3 128	26.35	0.002
14.69	0.001	4 082	12.40	0.002	9 898	30.07	0.002
4.46	0.000	3 691	2.89	0.000	4 503	3.52	0.000
%	% p.a.	000s	%	% p.a.	000s	%	% p.a.
4.18	0.000	5 742	2.83	0.000	10 018	4.93	0.000
-3.04	0.000	-1 212	-8.79	-0.001	-1 469	-10.65	-0.001
-0.87	0.000	-179	-1.21	0.000	-1 602	-10.86	-0.001
-2.98	0.000	-149	-0.95	0.000	-778	-4.96	0.000
-2.90	0.000	-1 074	-3.18	-0.001	-1 463	-4.34	0.000
8.30	0.001	533	1.53	0.000	-1 409	-4.04	0.000
8.37	0.001	1 182	7.42	0.001	1 802	11.32	0.001
19.37	0.002	651	4.26	0.001	2 110	13.82	0.001
1.15	0.000	2 288	17.99	0.003	3 284	25.83	0.002
8.61	0.001	3 703	7.97	0.001	9 544	20.54	0.002
0.00	0.000	0	0.00	0.000	0	0.00	0.000
%	% p.a.	000s	%	% p.a.	000s	%	% p.a.
4.62	0.000	12 057	3.06	0.000	21 166	5.38	0.000
-2.72	0.000	-2 519	-8.90	-0.001	-3 077	-10.87	-0.001
-0.74	0.000	-329	-1.10	0.000	-3 248	-10.82	-0.001
-2.71	0.000	-266	-0.83	0.000	-1 529	-4.80	0.000
-2.65	0.000	-1 991	-2.92	0.000	-2 639	-3.86	0.000
8.69	0.001	1 298	1.85	0.000	-2 432	-3.48	0.000
7.87	0.001	2 460	7.82	0.001	3 927	12.49	0.001
19.31	0.002	1 226	4.10	0.001	4 310	14.40	0.001
2.10	0.000	4 394	17.87	0.003	6 412	26.08	0.002
11.05	0.001	7 785	9.81	0.001	19 442	24.50	0.002
4.27	0.000	7 121	2.78	0.000	8 049	3.14	0.000

Table 16. **Population by age and gender, low qualification level, EU-25***

Low qualification	(000s)				
Males	**2000**	**2007**	**2013**	**2020**	**000s**
15+	70 825	67 190	62 594	56 872	-3 635
15-19	11 800	11 623	10 544	10 216	-176
20-24	4 004	3 818	3 760	3 452	-186
25-29	4 010	3 292	2 673	2 107	-718
30-39	9 703	8 292	6 904	5 452	-1 411
40-49	9 655	9 418	8 848	7 400	-237
50-54	5 176	4 534	4 078	3 344	-642
55-59	4 923	4 907	4 182	3 733	-16
60-64	5 283	4 525	4 149	3 128	-758
65+	16 270	16 779	17 457	18 041	508
25-64	38 751	34 970	30 833	25 163	-3 782
Females	**2000**	**2007**	**2013**	**2020**	**000s**
15+	91 706	82 961	74 168	64 828	-8 745
15-19	10 686	10 473	9 552	9 324	-213
20-24	2 944	2 666	2 569	2 321	-277
25-29	3 633	2 443	1 746	1 242	-1 189
30-39	10 004	7 342	5 388	3 794	-2 661
40-49	11 762	10 088	8 101	5 501	-1 674
50-54	6 856	5 687	4 686	3 405	-1 170
55-59	6 812	6 537	5 357	4 436	-274
60-64	7 659	6 362	5 733	4 301	-1 297
65+	31 351	31 362	31 036	30 503	11
25-64	46 725	38 459	31 010	22 681	-8 266
Total	**2000**	**2007**	**2013**	**2020**	**000s**
15+	162 531	150 150	136 761	121 700	-12 381
15-19	22 486	22 096	20 096	19 540	-390
20-24	6 948	6 485	6 328	5 773	-463
25-29	7 643	5 736	4 418	3 349	-1 907
30-39	19 707	15 635	12 292	9 246	-4 072
40-49	21 417	19 506	16 948	12 901	-1 911
50-54	12 033	10 221	8 764	6 749	-1 812
55-59	11 735	11 445	9 540	8 169	-290
60-64	12 942	10 887	9 881	7 429	-2 055
65+	47 621	48 141	48 493	48 543	519
25-64	85 477	73 429	61 843	47 843	-12 048

Source: IER estimates based on StockMOD.

Change 2000-07		Change 2007-13			Change 2007-20		
%	% p.a.	000s	%	% p.a.	000s	%	% p.a.
-5.13	-0.001	-4 596	-6.84	-0.001	-10 318	-15.36	-0.001
-1.50	0.000	-1 079	-9.28	-0.002	-1 407	-12.10	-0.001
-4.64	-0.001	-59	-1.53	0.000	-366	-9.59	-0.001
-17.90	-0.002	-620	-18.82	-0.003	-1 186	-36.01	-0.004
-14.54	-0.002	-1 388	-16.74	-0.003	-2 841	-34.26	-0.004
-2.45	0.000	-571	-6.06	-0.001	-2 018	-21.43	-0.002
-12.40	-0.001	-457	-10.07	-0.002	-1 191	-26.26	-0.003
-0.33	0.000	-725	-14.77	-0.003	-1 175	-23.94	-0.002
-14.35	-0.002	-376	-8.31	-0.001	-1 396	-30.86	-0.003
3.12	0.000	678	4.04	0.001	1 262	7.52	0.001
-9.76	-0.001	-4 136	-11.83	-0.002	-9 807	-28.04	-0.003
%	% p.a.	000s	%	% p.a.	000s	%	% p.a.
-9.54	-0.001	-8 793	-10.60	-0.002	-18 132	-21.86	-0.002
-1.99	0.000	-921	-8.79	-0.001	-1 149	-10.97	-0.001
-9.42	-0.001	-98	-3.66	-0.001	-345	-12.95	-0.001
-32.74	-0.004	-697	-28.55	-0.005	-1 201	-49.16	-0.006
-26.61	-0.003	-1 955	-26.62	-0.005	-3 548	-48.32	-0.006
-14.23	-0.002	-1 987	-19.70	-0.003	-4 586	-45.46	-0.005
-17.06	-0.002	-1 001	-17.60	-0.003	-2 282	-40.12	-0.005
-4.03	0.000	-1 180	-18.05	-0.003	-2 101	-32.14	-0.003
-16.93	-0.002	-629	-9.89	-0.002	-2 061	-32.39	-0.004
0.04	0.000	-325	-1.04	0.000	-859	-2.74	0.000
-17.69	-0.002	-7 449	-19.37	-0.003	-15 779	-41.03	-0.005
%	% p.a.	000s	%	% p.a.	000s	%	% p.a.
-7.62	-0.001	-13 389	-8.92	-0.001	-28 450	-18.95	-0.002
-1.73	0.000	-2 000	-9.05	-0.002	-2 556	-11.57	-0.001
-6.66	-0.001	-156	-2.41	0.000	-712	-10.97	-0.001
-24.96	-0.003	-1 317	-22.97	-0.004	-2 387	-41.61	-0.005
-20.66	-0.003	-3 343	-21.38	-0.004	-6 389	-40.86	-0.005
-8.92	-0.001	-2 558	-13.11	-0.002	-6 605	-33.86	-0.004
-15.06	-0.002	-1 457	-14.26	-0.002	-3 472	-33.97	-0.004
-2.48	0.000	-1 905	-16.65	-0.003	-3 276	-28.62	-0.003
-15.88	-0.002	-1 005	-9.23	-0.002	-3 457	-31.76	-0.003
1.09	0.000	352	0.73	0.000	403	0.84	0.000
-14.09	-0.002	-11 586	-15.78	-0.003	-25 586	-34.84	-0.004

Table 17. **Population by age and gender, medium qualification level, EU-25***

Medium qualification	(000s)				
Males	**2000**	**2007**	**2013**	**2020**	**000s**
15+	78 788	85 011	89 183	92 097	6 223
15-19	3 042	2 816	2 574	2 568	-226
20-24	9 804	9 842	9 695	8 489	38
25-29	8 841	8 435	8 076	7 363	-405
30-39	17 477	16 762	15 903	15 180	-714
40-49	15 496	17 240	17 897	17 604	1 744
50-54	6 254	7 430	8 332	9 115	1 176
55-59	4 992	6 568	7 324	8 372	1 576
60-64	4 385	4 884	6 171	6 916	499
65+	8 499	11 034	13 212	16 490	2 535
25-64	57 443	61 319	63 702	64 550	3 876
Females	**2000**	**2007**	**2013**	**2020**	**000s**
15+	74 382	82 385	88 552	93 268	8 004
15-19	3 473	3 251	2 971	2 944	-222
20-24	9 804	9 672	9 426	8 256	-132
25-29	8 138	7 507	6 815	5 950	-631
30-39	16 801	15 858	14 577	13 381	-943
40-49	14 229	16 780	18 216	18 356	2 551
50-54	5 459	7 023	8 136	8 942	1 564
55-59	4 305	6 158	7 240	8 329	1 853
60-64	3 693	4 627	6 605	7 950	934
65+	8 478	11 510	14 567	19 160	3 031
25-64	52 626	57 953	61 589	62 907	5 327
Total	**2000**	**2007**	**2013**	**2020**	**000s**
15+	153 170	167 396	177 735	185 365	14 227
15-19	6 516	6 068	5 544	5 512	-448
20-24	19 608	19 513	19 121	16 745	-94
25-29	16 979	15 942	14 891	13 313	-1 037
30-39	34 278	32 620	30 479	28 561	-1 657
40-49	29 724	34 020	36 113	35 959	4 296
50-54	11 713	14 453	16 468	18 058	2 740
55-59	9 297	12 726	14 563	16 701	3 429
60-64	8 078	9 511	12 776	14 866	1 433
65+	16 977	22 543	27 779	35 650	5 566
25-64	110 069	119 272	125 290	127 458	9 203

Source: IER estimates based on StockMOD.

Change 2000-07		Change 2007-13			Change 2007-20		
%	% p.a.	000s	%	% p.a.	000s	%	% p.a.
7.90	0.001	4 172	4.91	0.001	7 086	8.33	0.001
-7.43	-0.001	-243	-8.61	-0.001	-249	-8.83	-0.001
0.39	0.000	-146	-1.49	0.000	-1 353	-13.74	-0.001
-4.58	-0.001	-359	-4.26	-0.001	-1 073	-12.72	-0.001
-4.09	0.000	-860	-5.13	-0.001	-1 582	-9.44	-0.001
11.26	0.001	657	3.81	0.001	363	2.11	0.000
18.80	0.002	902	12.14	0.002	1 686	22.69	0.002
31.58	0.003	756	11.51	0.002	1 804	27.48	0.002
11.38	0.001	1 287	26.34	0.004	2 032	41.60	0.003
29.83	0.003	2 179	19.75	0.003	5 456	49.45	0.004
6.75	0.001	2 382	3.89	0.001	3 231	5.27	0.000
%	% p.a.	000s	%	% p.a.	000s	%	% p.a.
10.76	0.001	6 166	7.48	0.001	10 882	13.21	0.001
-6.39	-0.001	-281	-8.64	-0.001	-307	-9.44	-0.001
-1.35	0.000	-246	-2.55	0.000	-1 416	-14.64	-0.001
-7.76	-0.001	-692	-9.22	-0.002	-1 557	-20.74	-0.002
-5.61	-0.001	-1 281	-8.08	-0.001	-2 477	-15.62	-0.002
17.93	0.002	1 436	8.56	0.001	1 576	9.39	0.001
28.64	0.003	1 113	15.84	0.002	1 919	27.32	0.002
43.03	0.004	1 082	17.57	0.003	2 171	35.25	0.003
25.28	0.002	1 979	42.76	0.006	3 323	71.83	0.005
35.75	0.003	3 058	26.57	0.004	7 650	66.47	0.005
10.12	0.001	3 636	6.27	0.001	4 955	8.55	0.001
%	% p.a.	000s	%	% p.a.	000s	%	% p.a.
9.29	0.001	10 339	6.18	0.001	17 968	10.73	0.001
-6.87	-0.001	-523	-8.63	-0.001	-556	-9.16	-0.001
-0.48	0.000	-393	-2.01	0.000	-2 768	-14.19	-0.001
-6.11	-0.001	-1 051	-6.59	-0.001	-2 629	-16.49	-0.002
-4.84	-0.001	-2 141	-6.56	-0.001	-4 059	-12.44	-0.001
14.45	0.001	2 093	6.15	0.001	1 939	5.70	0.000
23.39	0.002	2 015	13.94	0.002	3 605	24.94	0.002
36.88	0.003	1 837	14.44	0.002	3 975	31.24	0.002
17.73	0.002	3 265	34.33	0.005	5 355	56.31	0.004
32.79	0.003	5 236	23.23	0.003	13 107	58.14	0.004
8.36	0.001	6 018	5.05	0.001	8 185	6.86	0.001

Table 18. **Population by age and gender, high qualification level, EU-25***

High qualification	(000s)				
Males	**2000**	**2007**	**2013**	**2020**	**000s**
15+	31 630	38 263	45 002	52 643	6 633
15-19	34	78	92	125	44
20-24	1 546	1 600	1 654	1 673	54
25-29	3 690	4 410	5 272	5 917	720
30-39	8 207	9 484	10 815	12 732	1 277
40-49	6 978	8 387	9 066	9 020	1 409
50-54	3 027	3 557	4 390	5 188	530
55-59	2 378	3 184	3 729	4 754	806
60-64	1 841	2 461	3 657	4 953	620
65+	3 929	5 102	6 328	8 282	1 174
25-64	26 122	31 484	36 928	42 563	5 362
Females	**2000**	**2007**	**2013**	**2020**	**000s**
15+	29 004	37 903	46 272	55 171	8 898
15-19	57	60	50	47	3
20-24	2 134	2 414	2 579	2 572	280
25-29	4 398	5 736	6 977	7 717	1 338
30-39	7 956	10 552	12 714	15 114	2 596
40-49	6 247	8 047	9 131	9 649	1 800
50-54	2 376	3 211	4 281	5 376	835
55-59	1 674	2 574	3 323	4 614	899
60-64	1 219	1 728	2 666	3 749	508
65+	2 941	3 581	4 551	6 333	639
25-64	23 872	31 848	39 092	46 218	7 977
Total	**2000**	**2007**	**2013**	**2020**	**000s**
15+	60 635	76 166	91 274	107 814	15 531
15-19	92	138	142	172	46
20-24	3 680	4 013	4 233	4 245	334
25-29	8 088	10 146	12 249	13 634	2 058
30-39	16 163	20 036	23 529	27 845	3 873
40-49	13 226	16 435	18 197	18 669	3 209
50-54	5 404	6 769	8 671	10 563	1 365
55-59	4 052	5 758	7 052	9 368	1 706
60-64	3 061	4 189	6 323	8 703	1 128
65+	6 870	8 683	10 879	14 615	1 813
25-64	49 993	63 332	76 020	88 782	13 338

Source: IER estimates based on StockMOD.

Change 2000-07		Change 2007-13			Change 2007-20		
%	% p.a.	000s	%	% p.a.	000s	%	% p.a.
20.97	0.002	6 739	17.61	0.003	14 380	37.58	0.003
128.01	0.009	14	18.22	0.003	47	61.00	0.004
3.48	0.000	54	3.39	0.001	73	4.56	0.000
19.50	0.002	863	19.56	0.003	1 508	34.19	0.003
15.56	0.002	1 331	14.03	0.002	3 248	34.24	0.003
20.19	0.002	679	8.09	0.001	632	7.54	0.001
17.51	0.002	833	23.40	0.003	1 630	45.83	0.003
33.91	0.003	545	17.10	0.003	1 570	49.29	0.004
33.65	0.003	1 196	48.58	0.006	2 492	101.27	0.006
29.87	0.003	1 226	24.02	0.003	3 180	62.32	0.004
20.53	0.002	5 445	17.29	0.003	11 080	35.19	0.003
%	% p.a.	000s	%	% p.a.	000s	%	% p.a.
30.68	0.003	8 369	22.08	0.003	17 268	45.56	0.003
4.71	0.000	-10	-17.22	-0.003	-13	-21.53	-0.002
13.11	0.001	165	6.84	0.001	159	6.58	0.001
30.43	0.003	1 240	21.62	0.003	1 980	34.52	0.003
32.62	0.003	2 162	20.49	0.003	4 562	43.23	0.003
28.81	0.003	1 084	13.47	0.002	1 602	19.90	0.002
35.14	0.003	1 070	33.31	0.005	2 164	67.40	0.005
53.72	0.005	749	29.11	0.004	2 040	79.28	0.005
41.71	0.004	939	54.33	0.007	2 022	117.03	0.007
21.74	0.002	971	27.10	0.004	2 752	76.86	0.005
33.41	0.003	7 243	22.74	0.003	14 370	45.12	0.003
%	% p.a.	000s	%	% p.a.	000s	%	% p.a.
25.61	0.002	15 107	19.83	0.003	31 648	41.55	0.003
50.56	0.004	4	2.74	0.000	34	24.94	0.002
9.07	0.001	219	5.47	0.001	232	5.78	0.001
25.44	0.002	2 103	20.72	0.003	3 488	34.37	0.003
23.96	0.002	3 493	17.43	0.003	7 809	38.98	0.003
24.26	0.002	1 762	10.72	0.002	2 234	13.59	0.001
25.26	0.002	1 902	28.10	0.004	3 795	56.06	0.004
42.10	0.004	1 294	22.47	0.003	3 610	62.70	0.004
36.86	0.003	2 134	50.95	0.007	4 514	107.77	0.007
26.39	0.003	2 196	25.29	0.004	5 932	68.32	0.005
26.68	0.003	12 688	20.03	0.003	25 450	40.18	0.003

Table 19. **Labour force by age and gender, all qualifications, EU-25***

All qualifications	(000s)				
Males	**2000**	**2007**	**2013**	**2020**	**000s**
15+	119 530	125 165	127 595	127 747	5 635
15-19	4 105	3 886	3 285	3 153	-219
20-24	10 860	10 681	10 605	9 537	-179
25-29	14 858	14 407	14 324	13 786	-451
30-39	33 631	32 768	32 125	32 091	-863
40-49	29 906	32 721	33 549	31 877	2 815
50-54	12 430	13 637	14 874	15 671	1 207
55-59	8 337	10 374	10 866	12 174	2 037
60-64	3 713	4 608	5 506	6 322	895
65+	1 690	2 083	2 462	3 136	393
25-64	102 875	108 515	111 243	111 922	5 640
Females	**2000**	**2007**	**2013**	**2020**	**000s**
15+	92 467	101 303	103 630	103 698	8 836
15-19	3 301	3 148	2 805	2 718	-153
20-24	9 038	8 838	8 703	7 849	-199
25-29	12 070	12 099	12 261	11 959	29
30-39	26 178	26 424	25 889	25 831	246
40-49	24 187	27 657	28 550	27 425	3 470
50-54	9 303	11 347	12 312	12 831	2 044
55-59	5 479	7 786	8 432	9 728	2 306
60-64	1 945	2 823	3 362	3 829	878
65+	966	1 182	1 316	1 529	215
25-64	79 163	88 135	90 806	91 602	0
Total	**2000**	**2007**	**2013**	**2020**	**000s**
15+	211 997	226 468	231 224	231 446	14 471
15-19	7 406	7 034	6 090	5 871	-372
20-24	19 898	19 520	19 307	17 385	-378
25-29	26 928	26 506	26 585	25 745	-422
30-39	59 809	59 192	58 014	57 922	-617
40-49	54 093	60 378	62 099	59 301	6 284
50-54	21 733	24 984	27 185	28 502	3 251
55-59	13 816	18 159	19 298	21 902	4 343
60-64	5 659	7 432	8 867	10 151	1 773
65+	2 656	3 265	3 778	4 665	609
25-64	182 038	196 650	202 049	203 524	14 612

Source: IER estimates based on StockMOD.

Change 2000-07		Change 2007-13			Change 2007-20		
%	% p.a.	000s	%	% p.a.	000s	%	% p.a.
4.71	0.001	2 430	1.94	0.001	2 582	2.06	0.001
-5.34	-0.001	-601	-15.47	-0.007	-733	-18.86	-0.008
-1.64	0.000	-77	-0.72	0.000	-1 145	-10.72	-0.004
-3.03	-0.001	-83	-0.58	0.000	-621	-4.31	-0.002
-2.57	0.000	-643	-1.96	-0.001	-677	-2.07	-0.001
9.41	0.002	828	2.53	0.001	-844	-2.58	-0.001
9.71	0.002	1 237	9.07	0.004	2 035	14.92	0.005
24.43	0.004	492	4.74	0.002	1 801	17.36	0.006
24.10	0.004	897	19.47	0.007	1 714	37.19	0.012
23.27	0.004	379	18.20	0.007	1 053	50.54	0.016
5.48	0.001	2 728	2.51	0.001	3 407	3.14	0.001
%	% p.a.	000s	%	% p.a.	000s	%	% p.a.
9.56	0.002	2 327	2.30	0.001	2 395	2.36	0.001
-4.63	-0.001	-343	-10.88	-0.005	-430	-13.64	-0.006
-2.20	0.000	-136	-1.53	-0.001	-990	-11.20	-0.005
0.24	0.000	163	1.35	0.001	-140	-1.15	0.000
0.94	0.000	-535	-2.03	-0.001	-593	-2.24	-0.001
14.34	0.002	893	3.23	0.001	-232	-0.84	0.000
21.97	0.004	965	8.50	0.003	1 484	13.08	0.005
42.09	0.006	647	8.31	0.003	1 942	24.94	0.009
45.12	0.007	538	19.07	0.007	1 005	35.61	0.012
22.28	0.004	134	11.37	0.004	348	29.42	0.010
0.00	0.000	0	0.00	0.000	0	0.00	0.000
%	% p.a.	000s	%	% p.a.	000s	%	% p.a.
6.83	0.001	4 756	2.10	0.001	4 978	2.20	0.001
-5.02	-0.001	-944	-13.42	-0.006	-1 162	-16.53	-0.007
-1.90	0.000	-212	-1.09	0.000	-2 135	-10.94	-0.004
-1.57	0.000	80	0.30	0.000	-761	-2.87	-0.001
-1.03	0.000	-1 178	-1.99	-0.001	-1 269	-2.14	-0.001
11.62	0.002	1 721	2.85	0.001	-1 076	-1.78	-0.001
14.96	0.002	2 201	8.81	0.003	3 519	14.08	0.005
31.44	0.005	1 139	6.27	0.003	3 743	20.61	0.007
31.33	0.005	1 436	19.32	0.007	2 719	36.59	0.012
22.91	0.004	514	15.73	0.006	1 400	42.89	0.014
8.03	0.001	5 399	2.75	0.001	6 874	3.50	0.001

Table 20. **Labour force by age and gender, low qualification level, EU-25***

Low qualification	(000s)				
Males	**2000**	**2007**	**2013**	**2020**	**000s**
15+	38 050	35 289	31 578	26 933	-2 761
15-19	3 087	2 940	2 525	2 419	-147
20-24	2 801	2 694	2 642	2 418	-107
25-29	3 566	2 929	2 384	1 877	-636
30-39	9 222	7 853	6 571	5 215	-1 369
40-49	9 038	8 823	8 327	6 987	-215
50-54	4 437	4 001	3 620	2 977	-436
55-59	3 212	3 348	2 871	2 586	136
60-64	1 729	1 682	1 575	1 275	-47
65+	959	1 019	1 065	1 180	60
25-64	31 203	28 636	25 347	20 917	-2 567
Females	**2000**	**2007**	**2013**	**2020**	**000s**
15+	30 977	28 113	23 305	18 197	-2 864
15-19	2 238	2 155	1 960	1 958	-83
20-24	1 777	1 626	1 577	1 438	-151
25-29	2 695	1 883	1 375	993	-812
30-39	7 328	5 674	4 251	3 056	-1 654
40-49	8 379	7 715	6 304	4 337	-664
50-54	4 009	3 893	3 268	2 455	-117
55-59	2 670	3 125	2 682	2 309	454
60-64	1 173	1 302	1 154	904	129
65+	706	739	732	747	33
25-64	26 256	23 592	19 035	14 054	-2 664
Total	**2000**	**2007**	**2013**	**2020**	**000s**
15+	69 027	63 402	54 883	45 130	-5 625
15-19	5 325	5 095	4 484	4 376	-230
20-24	4 578	4 320	4 219	3 857	-258
25-29	6 261	4 812	3 758	2 871	-1 449
30-39	16 550	13 527	10 823	8 272	-3 023
40-49	17 417	16 538	14 631	11 324	-879
50-54	8 446	7 894	6 888	5 431	-553
55-59	5 882	6 473	5 553	4 894	591
60-64	2 903	2 984	2 729	2 179	81
65+	1 665	1 759	1 797	1 926	94
25-64	57 459	52 228	44 383	34 971	-5 231

Source: IER estimates based on StockMOD.

Change 2000-07		Change 2007-13			Change 2007-20		
%	% p.a.	000s	%	% p.a.	000s	%	% p.a.
-7.26	-0.001	-3 711	-10.52	-0.005	-8 356	-23.68	-0.010
-4.75	-0.001	-416	-14.13	-0.006	-522	-17.74	-0.008
-3.83	-0.001	-52	-1.93	-0.001	-275	-10.22	-0.004
-17.85	-0.003	-545	-18.62	-0.008	-1 052	-35.91	-0.017
-14.84	-0.003	-1 282	-16.32	-0.007	-2 638	-33.59	-0.016
-2.38	0.000	-496	-5.63	-0.002	-1 836	-20.81	-0.009
-9.83	-0.002	-381	-9.52	-0.004	-1 024	-25.60	-0.011
4.24	0.001	-477	-14.26	-0.006	-762	-22.76	-0.010
-2.74	0.000	-107	-6.36	-0.003	-407	-24.21	-0.011
6.29	0.001	45	4.43	0.002	160	15.72	0.006
-8.23	-0.002	-3 289	-11.48	-0.005	-7 719	-26.96	-0.012
%	% p.a.	000s	%	% p.a.	000s	%	% p.a.
-9.25	-0.002	-4 808	-17.10	-0.008	-9 916	-35.27	-0.017
-3.71	-0.001	-195	-9.07	-0.004	-197	-9.16	-0.004
-8.47	-0.002	-49	-3.02	-0.001	-188	-11.55	-0.005
-30.14	-0.006	-508	-26.99	-0.013	-890	-47.26	-0.025
-22.57	-0.005	-1 423	-25.08	-0.012	-2 618	-46.14	-0.024
-7.92	-0.001	-1 411	-18.29	-0.008	-3 378	-43.79	-0.022
-2.91	-0.001	-625	-16.04	-0.007	-1 438	-36.94	-0.018
17.01	0.003	-442	-14.15	-0.006	-816	-26.12	-0.012
10.97	0.002	-148	-11.34	-0.005	-398	-30.59	-0.014
4.70	0.001	-7	-0.92	0.000	7	1.01	0.000
-10.15	-0.002	-4 557	-19.31	-0.009	-9 538	-40.43	-0.020
%	% p.a.	000s	%	% p.a.	000s	%	% p.a.
-8.15	-0.002	-8 519	-13.44	-0.006	-18 272	-28.82	-0.013
-4.31	-0.001	-611	-11.99	-0.005	-719	-14.11	-0.006
-5.63	-0.001	-101	-2.34	-0.001	-463	-10.72	-0.004
-23.14	-0.005	-1 054	-21.89	-0.010	-1 941	-40.35	-0.020
-18.27	-0.004	-2 705	-19.99	-0.009	-5 255	-38.85	-0.019
-5.05	-0.001	-1 907	-11.53	-0.005	-5 214	-31.53	-0.015
-6.54	-0.001	-1 005	-12.74	-0.006	-2 462	-31.19	-0.014
10.04	0.002	-920	-14.21	-0.006	-1 578	-24.38	-0.011
2.80	0.000	-255	-8.53	-0.004	-806	-26.99	-0.012
5.62	0.001	38	2.18	0.001	168	9.54	0.004
-9.10	-0.002	-7 845	-15.02	-0.007	-17 257	-33.04	-0.016

Table 21. **Labour force by age and gender, medium qualification level, EU-25***

Medium qualification	(000s)				
Males	**2000**	**2007**	**2013**	**2020**	**000s**
15+	57 548	61 024	62 756	62 567	3 476
15-19	1 007	920	713	695	-87
20-24	6 955	6 832	6 572	5 951	-123
25-29	7 932	7 494	7 078	6 551	-438
30-39	16 608	15 913	15 051	14 618	-695
40-49	14 360	16 049	16 602	16 403	1 689
50-54	5 360	6 487	7 684	8 068	1 127
55-59	3 445	4 673	5 492	6 072	1 228
60-64	1 379	1 927	2 527	2 925	548
65+	504	730	1 038	1 283	227
25-64	49 083	52 542	54 433	54 637	3 459
Females	**2000**	**2007**	**2013**	**2020**	**000s**
15+	43 234	48 062	49 701	49 677	4 828
15-19	1 042	976	833	750	-67
20-24	5 954	5 714	5 542	4 853	-240
25-29	6 002	5 714	5 314	4 732	-288
30-39	12 800	12 430	11 485	10 601	-370
40-49	11 014	13 497	14 815	15 137	2 483
50-54	3 687	5 094	5 898	6 436	1 407
55-59	1 995	3 228	3 847	4 679	1 233
60-64	556	1 080	1 532	1 934	525
65+	185	329	435	556	144
25-64	36 053	41 043	42 891	43 519	4 990
Total	**2000**	**2007**	**2013**	**2020**	**000s**
15+	100 782	109 086	112 277	112 244	8 304
15-19	2 049	1 896	1 565	1 445	-153
20-24	12 908	12 546	12 331	10 804	-362
25-29	13 933	13 208	12 486	11 283	-726
30-39	29 408	28 343	26 696	25 220	-1 066
40-49	25 373	29 546	31 507	31 539	4 172
50-54	9 047	11 581	13 245	14 503	2 534
55-59	5 440	7 901	9 091	10 751	2 461
60-64	1 934	3 007	3 971	4 859	1 073
65+	689	1 059	1 383	1 839	371
25-64	85 136	93 585	96 997	98 156	8 449

Source: IER estimates based on StockMOD.

Change 2000-07		Change 2007-13			Change 2007-20		
%	% p.a.	000s	%	% p.a.	000s	%	% p.a.
6.04	0.001	1 732	2.84	0.001	1 543	2.53	0.001
-8.60	-0.002	-207	-22.54	-0.011	-225	-24.45	-0.011
-1.76	0.000	-260	-3.81	-0.002	-880	-12.89	-0.005
-5.52	-0.001	-416	-5.55	-0.002	-943	-12.58	-0.005
-4.19	-0.001	-862	-5.42	-0.002	-1 294	-8.13	-0.003
11.76	0.002	553	3.44	0.001	354	2.21	0.001
21.03	0.003	1 197	18.45	0.007	1 580	24.36	0.008
35.65	0.005	819	17.54	0.007	1 399	29.95	0.010
39.74	0.006	600	31.16	0.011	999	51.85	0.016
44.99	0.007	308	42.22	0.014	553	75.70	0.022
7.05	0.001	1 892	3.60	0.001	2 096	3.99	0.002
%	% p.a.	000s	%	% p.a.	000s	%	% p.a.
11.17	0.002	1 639	3.41	0.001	1 615	3.36	0.001
-6.41	-0.001	-143	-14.66	-0.007	-226	-23.17	-0.010
-4.02	-0.001	-172	-3.01	-0.001	-862	-15.08	-0.006
-4.79	-0.001	-400	-7.01	-0.003	-982	-17.18	-0.007
-2.89	-0.001	-945	-7.60	-0.003	-1 829	-14.71	-0.006
22.55	0.004	1 318	9.76	0.004	1 640	12.15	0.004
38.17	0.006	804	15.78	0.006	1 342	26.34	0.009
61.81	0.009	620	19.19	0.007	1 451	44.95	0.014
94.46	0.012	452	41.82	0.014	853	78.98	0.023
77.77	0.010	106	32.21	0.011	227	68.96	0.020
13.84	0.002	1 848	4.50	0.002	2 475	6.03	0.002
%	% p.a.	000s	%	% p.a.	000s	%	% p.a.
8.24	0.001	3 191	2.92	0.001	3 158	2.89	0.001
-7.49	-0.001	-330	-17.43	-0.008	-451	-23.79	-0.011
-2.81	-0.001	-215	-1.71	-0.001	-1 742	-13.89	-0.006
-5.21	-0.001	-721	-5.46	-0.002	-1 924	-14.57	-0.006
-3.62	-0.001	-1 646	-5.81	-0.002	-3 123	-11.02	-0.005
16.44	0.003	1 961	6.64	0.003	1 994	6.75	0.003
28.01	0.004	1 663	14.36	0.006	2 922	25.23	0.009
45.24	0.007	1 191	15.07	0.006	2 850	36.08	0.012
55.46	0.008	964	32.06	0.011	1 852	61.60	0.019
53.80	0.008	324	30.55	0.011	780	73.60	0.021
9.92	0.002	3 412	3.65	0.001	4 571	4.88	0.002

Table 22. **Labour force by age and gender, high qualification level, EU-25***

High qualification	(000s)				
Males	**2000**	**2007**	**2013**	**2020**	**000s**
15+	23 932	31 143	34 927	38 247	7 211
15-19	11	25	30	39	14
20-24	1 105	1 159	1 165	1 167	54
25-29	3 361	4 408	5 009	5 358	1 047
30-39	7 801	9 598	10 899	12 257	1 797
40-49	6 508	8 299	8 520	8 487	1 790
50-54	2 633	3 503	4 205	4 627	870
55-59	1 680	2 516	2 959	3 516	836
60-64	605	1 253	1 635	2 122	648
65+	227	383	504	673	156
25-64	22 589	29 576	33 227	36 368	6 987
Females	**2000**	**2007**	**2013**	**2020**	**000s**
15+	18 256	25 128	30 624	35 825	6 872
15-19	20	17	13	11	-3
20-24	1 307	1 498	1 583	1 557	191
25-29	3 373	4 502	5 573	6 234	1 129
30-39	6 049	8 320	10 152	12 173	2 271
40-49	4 794	6 445	7 431	7 951	1 650
50-54	1 607	2 360	3 145	3 941	753
55-59	814	1 433	1 903	2 740	619
60-64	216	441	675	991	224
65+	75	113	148	226	38
25-64	16 854	23 500	28 879	34 030	6 646
Total	**2000**	**2007**	**2013**	**2020**	**000s**
15+	42 188	53 980	64 065	74 072	11 792
15-19	32	43	41	50	11
20-24	2 412	2 654	2 757	2 725	242
25-29	6 734	8 486	10 341	11 591	1 753
30-39	13 850	17 322	20 495	24 431	3 471
40-49	11 303	14 293	15 961	16 438	2 991
50-54	4 240	5 509	7 052	8 568	1 269
55-59	2 494	3 786	4 654	6 256	1 292
60-64	822	1 440	2 167	3 113	619
65+	302	447	598	900	145
25-64	39 443	50 837	60 669	70 397	11 394

Source: IER estimates based on StockMOD.

Change 2000-07		Change 2007-13			Change 2007-20		
%	% p.a.	000s	%	% p.a.	000s	%	% p.a.
30.13	0.005	3 783	12.15	0.005	7 104	22.81	0.008
119.93	0.014	5	18.92	0.007	14	54.74	0.017
4.88	0.001	7	0.59	0.000	9	0.75	0.000
31.15	0.005	601	13.63	0.005	950	21.55	0.008
23.03	0.004	1 301	13.56	0.005	2 659	27.71	0.009
27.51	0.004	221	2.66	0.001	188	2.27	0.001
33.03	0.005	703	20.06	0.008	1 124	32.10	0.011
49.73	0.007	443	17.59	0.007	1 000	39.76	0.013
107.06	0.013	382	30.44	0.011	869	69.31	0.020
68.69	0.009	121	31.65	0.011	290	75.71	0.022
30.93	0.005	3 651	12.34	0.005	6 791	22.96	0.008
%	% p.a.	000s	%	% p.a.	000s	%	% p.a.
37.64	0.006	5 495	21.87	0.008	10 696	42.57	0.014
-14.26	-0.003	-4	-23.83	-0.011	-6	-35.14	-0.017
14.60	0.002	85	5.69	0.002	60	3.98	0.002
33.47	0.005	1 071	23.80	0.009	1 732	38.47	0.013
37.54	0.006	1 833	22.03	0.008	3 854	46.32	0.015
34.42	0.005	986	15.31	0.006	1 506	23.37	0.008
46.86	0.007	785	33.26	0.012	1 580	66.97	0.020
76.08	0.010	470	32.76	0.012	1 307	91.21	0.025
103.64	0.013	234	53.17	0.018	550	124.89	0.031
50.74	0.007	35	31.07	0.011	113	99.90	0.027
39.44	0.006	5 379	22.89	0.008	10 530	44.81	0.014
%	% p.a.	000s	%	% p.a.	000s	%	% p.a.
27.95	0.004	10 085	18.68	0.007	20 092	37.22	0.012
35.06	0.005	-2	-5.05	-0.002	8	17.65	0.006
10.04	0.002	103	3.89	0.002	71	2.67	0.001
26.03	0.004	1 854	21.85	0.008	3 105	36.59	0.012
25.06	0.004	3 173	18.32	0.007	7 109	41.04	0.013
26.46	0.004	1 667	11.66	0.005	2 145	15.00	0.005
29.93	0.005	1 543	28.02	0.010	3 059	55.52	0.017
51.79	0.007	868	22.92	0.008	2 470	65.25	0.019
75.30	0.010	726	50.42	0.017	1 673	116.12	0.030
47.81	0.007	152	33.93	0.012	453	101.36	0.027
28.89	0.005	9 832	19.34	0.007	19 560	38.48	0.013

ANNEX B

Levels of qualification

Level of qualification

Low	At most lower secondary (ISCED 0-2, 3c short)
Medium	Upper secondary (ISCED 3-4, excluding 3c short)
High	Tertiary (ISCED 5-6)

Classification ISCED 1997 (from 1998 data onwards)

ISCED **0**	Pre-primary education	
ISCED **1**	Primary education or first stage of basic education	
ISCED **2**	Lower secondary education or second stage of basic education	
ISCED **3**	(Upper) secondary education	
	ISCED **3A**	Programmes designed to provide direct access to ISCED 5A
	ISCED **3B**	Programmes designed to provide direct access to ISCED 5B
	ISCED **3C**	Programmes not designed to lead to ISCED **5A** or **5B**
ISCED **4**	Post-secondary non tertiary education	
ISCED **5**	First stage of tertiary education (not leading directly to an advanced research qualification)	
ISCED **6**	Second stage of tertiary education (leading to an advanced research qualification)	

Note: More details are available in the documentation by EULFS: Levels of education and training ISCED 1997 (http://circa.europa.eu/irc/dsis/employment/info/data/eu_lfs/lfs_main/ Related_ documents/ ISCED_EN.htm).

ANNEX C

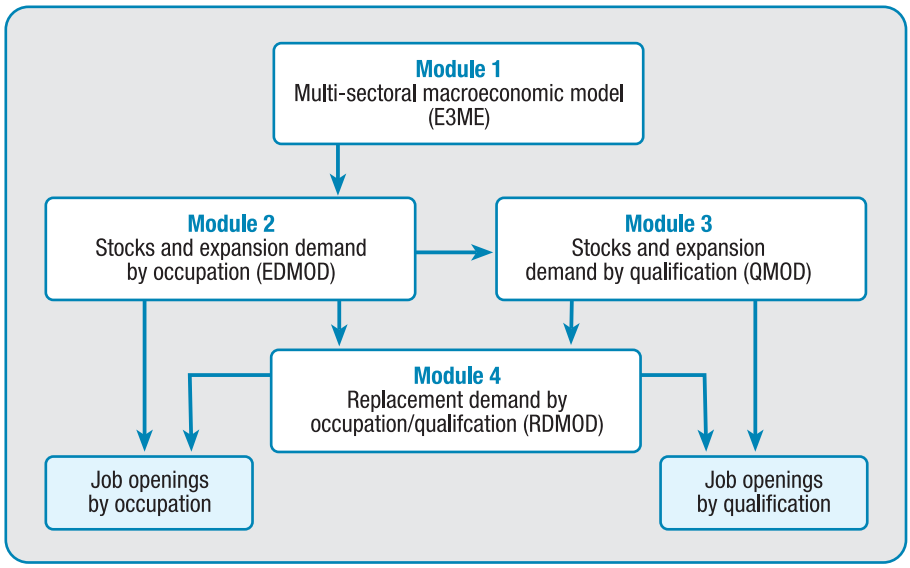
Conceptual framework

The demand side

The current conceptual framework comprises four key elements on the demand side, as shown in Figure 15:

- Module 1: a set of multi-sectoral macroeconomic forecasts, based around the E3ME macroeconomic model;
- Module 2: an occupational model, focused on explaining expansion demand within sectors, adopting common classifications and data sources (EDMOD);
- Module 3: a qualifications module (QMOD), based on similar data sources, focusing on the implications for qualification intensities within occupations (demand) rather than the supply side;
- Module 4: a replacement demand module, based on similar data sources, recognising the crucial importance of considering not just changing occupational employment levels but also the need to replace those leaving the workforce because of retirement, migration and mortality (RDMOD).

Figure 15. **Overview of the modular approach to skills-demand forecasting (framework)**



Each module has associated with it a database (D) and models (M), some of which already exist. Together with the corresponding skill-supply elements described in Figure 16, the modules constitute the conceptual framework.

Module 1: multi-sectoral macroeconomic model (E3ME)

Module 1 is based around the existing pan-European multi-sectoral macroeconomic model (E3ME) developed by Cambridge Econometrics in collaboration with others. This delivers a set of consistent sectoral projections, which is transparent in terms of the assumptions made about the main external influences on the various countries (including technological change and the impact of global competition). Full details are given in Annex D.

Module 2: occupational expansion demand model (EDMOD)

Most national occupational projections rely on population census data. This is because they normally provide the largest sample of data on occupational employment cross-classified by industry and occupation (industry by occupation employment matrices). Such data cannot be used in a pan-European comparative exercise because of lack of synchronisation and consistency between countries.

The LFS conducted in all countries as part of their obligations to the European Union provide an alternative source of such industry-by-occupation employment matrices. They have the advantage of being conducted on a much more frequent basis than a census. They also adopt much more standardised sets of questions and systems of classification. While there are still some differences between 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.

Such data have been used to produce results in the previous Cedefop projects. The forecasting model (EDMOD) based on these data works out the implications of the projected sectoral employment levels developed from Module 1 for occupational employment using quite basic models (fixed coefficients, or simple extrapolations). The current approach also includes results based on development of more sophisticated econometric models. This includes the use of multi-logit probability models.

Module 3: qualification expansion demand model (QMOD)

Occupational employment patterns are only one way of measuring skills. For training, and especially formal educational planning, the types of qualifications

typically required are also important. Even with only weak data for qualifications, it has been possible to develop an extension to the EDMOD module which allows inferences to be made about implications for qualifications. This builds on approaches already developed by IER and ROA at national level. This is referred to as QMOD.

Module 4: replacement demand model (RDMOD)

In addition to changes in overall occupational employment levels, it is important to consider replacement demand arising from retirements, net migration, movement into other occupations and in-service mortality. Estimating replacement demand is not straightforward and is quite sensitive to the data sources used.

There is general agreement about what it is about: 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);
(c) emigration;
(d) inter-occupational mobility.

Information on the age and gender structure is required because many of the flows, especially retirements and mortality, are age- and gender-specific. Age structures also vary significantly by occupation. The influence of differences in age structure across occupations exists, 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 estimating rates of outflow. The replacement demand model (RDMOD) has been developed based on similar data sources to the occupational model. It is driven partly by the occupational and qualification employment levels projected from Modules 2 and 3, in combination with models and information on the probability of outflow from employment due to retirements, mortality and migration. Again, these models build on those already developed by IER and ROA at national level.

Replacement demands for a particular category (e.g. an occupation) are the product of: the size of the category and the rate of outflow (which can in principle be separated out to distinguish the various elements as described

above). Replacement demands are simply the product of these two. The main database and EDMOD produce the former for every country, sector, occupation and gender category. RDMOD produce the latter.

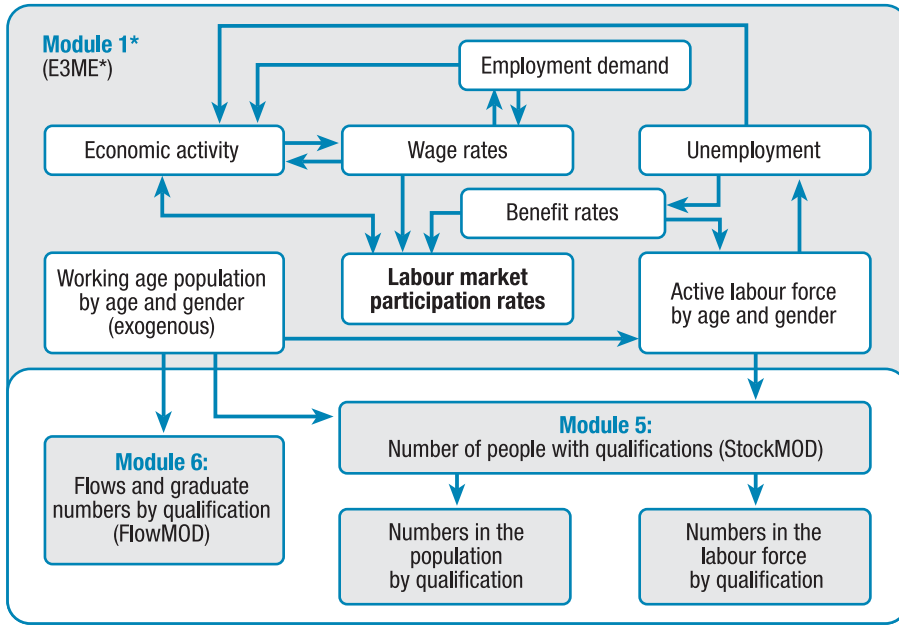
The supply side

The demand side is complemented by a similar modular approach on the supply side. In this case there are three modules, although one of these is E3ME, which it has in common with the demand side. The three modules are:

- Module 1*: an extension of the macroeconomic model (as Module 1 above) to include the aggregate labour supply model (E3ME*);
- Module 5: a qualifications model focusing on stocks of people by educational attainment (StockMOD);
- Module 6: a qualifications model focusing on flows and graduate numbers by educational attainment (FlowMOD).

Figure 16 sets out how these modules are linked and how they map onto the demand side.

Figure 16. **Overview of the modular approach to skills-supply forecasting (framework)**



Module 1*: overall labour supply by age and gender (E3ME*)

The links between overall labour supply and activity in the wider economy are provided by the E3ME model. E3ME is a macro-econometric model used for forecasting and policy analysis across Europe. The model includes a relatively detailed treatment of the labour market, including econometric equations for employment demand, hours worked and wages (all by 42 economic sectors) and labour-market participation rates. The specification of these equations means that the model is well-suited to short- and medium-term forecasting. Model parameters for each of these equations are estimated empirically using data sets covering the period from 1970 for the Member States (from 1993 for the new members) plus Norway and Switzerland.

This project focuses on the supply of labour, which E3ME addresses by extending and augmenting its labour-market participation rate equations. This models labour supply as a function of economic activity, real wage rates, unemployment, benefit rates and other variables. Econometric techniques are used to explore the impact of key drivers of changes in labour-market participation rates. Model parameters are estimated for labour-market participation in each country. The analysis has been extended in this project so that participation rates are modelled separately for different age groups and for gender. This is of key importance for modelling educational participation and attainment since these are known to be age-specific. The models developed recognise that the factors that determine labour-market participation may be different for workers of different age (e.g. those approaching retirement age compared to participation rates among younger people still completing their education). Projections of participation rates are made using these models. These are then combined with official Eurostat population projections.

The analysis is based on the most recent data sets provided by Eurostat (population data) and the EU LFS. Many of the available historical data refer to the period up to 2006, although some extend to 2007 and beyond. The most recent Eurostat projections of population (Europop2008) are used. Together these provide the data required to complete a comprehensive set of labour-market participation rates across all countries stretching to 2017 and beyond. The year 2007 is used as the baseline for the projections. This is an estimate based on the limited data available at the time the analysis was completed. The years after 2007 are projections.

The flow chart shows how the labour market sits within E3ME. The expanded conceptual framework is then used to create a detailed set of baseline projections for labour supply, disaggregated by country, age group

and gender, and covering a 10 to 15 year time horizon. It provides the main link between overall economic activity and labour-market supply. This then forms a key input for the analysis of the supply of qualifications and skills in Module 6.

For further details about the treatment of general labour supply within the E3ME model, see Pollitt and Chewpreecha (2008).

Module 5: qualifications stock model (StockMOD)

A number of methods for modelling the supply of qualifications have been developed in recent years. The most sophisticated involve quite complex stock-flow models, with strong behavioural elements (Wilson and Bosworth, 2006). Such models are very demanding on data requirements, including detailed and consistent data on stock and flows, as well as information on the factors that drive behavioural choices.

The methods developed here are less ambitious They range from very simple models based on fitting trends to aggregate qualification patterns amongst the population and/or labour force, to rather more sophisticated approaches based on econometric analysis of microdata on individuals, using LFS data. All focus on overall stocks rather than flows.

The more sophisticated econometric approach involves estimation of models which focus on the propensity of a representative individual to obtain a given level of highest qualification. This is based on an analysis of a combination of a time series and a cross-sectional data on individuals from the LFS microdata set. The modelling of qualifications structure and trend is done using a multinomial logistic regression model. The model incorporates age group and gender differences in educational attainment, differentiating trends by age group and gender. In principle the model also incorporates region-/country-specific effects on underlying structure and trend, i.e. based on differences between countries.

The multinomial logistic regression model is used to estimate the probability of an individual attaining qualification level *j* (as dependent variable) at time *t*. The probability of the representative individual attaining level *j* at time *t* can be expressed as a function of vector of explanatory variables, normalised by the sum of probabilities for all qualification categories. There are *j* levels of qualifications (as measured using ISCED, see Annex B). The sum of probabilities is constrained to add up to one. The vector of regressors which are included in the model as explanatory variables can include the full range of personal and other indicators available in the LFS microdata set.

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. The matrix of regression coefficients is then used to predict the distribution of people by qualification at each point in time, *t*. Note that categorical variables (country, age, gender, etc.) can be included in the model as an exhaustive set of dummy variables. The model has been applied separately to the total population, the economically active population and the employed workforce.

This method can, in principle, generate insights into the behavioural factors influencing historical changes (Jones and Wilson, 2006). In practice, the available data allow only limited behavioural content, and the focus is mostly on the use of aggregate rather than individual data. In this case, logistic or linear trends are fitted to the aggregate data. In either case the predicted shares are applied to the labour force population numbers derived from Module 1* (E3ME*).

Module 6: qualifications flow model (FlowMOD)

The participation ratio method can be used to complement the results of the methods to model changes in patterns of stocks described above. The results can serve as a robustness check on the stock-based results. The participation ratio method uses aggregate data from UOE on educational attainment by age groups and on graduates by level and field of education. The data come from the joint UIS/OECD/Eurostat questionnaires on education statistics, which constitute the core of the database on education. Each of the 27 countries considered provided data from administrative records based on commonly agreed definitions. ISCED 0-6 is the basis for international education statistics. This part of the project uses two variables: the number of students by ISCED level, age group (15-19, 20-24, 25-29 and 30-34) and gender for the period 1998-2005; and the number of graduates by ISCED level, age group and gender for the period 1998-2005. Student numbers and graduate numbers are linked by duration of study and completion rates.

The participation ratio method was applied in another Cedefop study to examine the demographic implications for the number of students and graduates and teachers by level and education field (Cedefop, 2008b). Cedefop published the projections for the five-year periods from 2005 up to 2050, differentiated by two broad age groups (15-19 and 20-24), four ISCED levels (2-5) and 10 education fields. The study argues that the participation ratio method for projecting graduates has several attractive characteristic features: it is a relatively simple and practical method, the necessary data are usually available and projections can be updated easily.

In the participation ratio method the focus is on graduation rates in population categories. These can be defined by a certain combination of age groups and other characteristics like gender. For the purpose of developing projections, graduation rates can be assumed to remain stable, to follow the observed trend or to change in some other way. The analysis tries to identify robust trends in graduation rates; however, the data for many countries are either limited in scale (short time span) or in scope (not differentiated by age groups or ISCED levels) or both. This limits considerably the range of possibilities in terms of dynamic components in the model.

To make the projections from this method suitable for meeting the objectives of this project, the method has to be modified and extended to encompass additional assumptions and to focus on flows through the education system and transitions from education to the labour market. For ISCED 2-5 it is possible to apply the flow and transition ratios to the number of graduates. For ISCED 6 it is necessary to develop new forecasts of the number of graduates by field of education and to calculate the inflow of graduates to the labour market by making similar assumptions.

Table 23. **Summary of the main dimensions used**

Demand side – employment (number of jobs) by:

1.	Sector: 42 E3ME Industries (compatible with NACE classification)
2.	Occupation: ISCO 2 digit
3.	Country (originally EU-25 + Norway and Switzerland to be extended to include Bulgaria and Romania)
4.	Qualifications (3 broad ISCED levels: low, medium, high – HATLEV1D in the latest Eurostat version of the LFS; ideally the 19 categories in HATLEVEL would be used but the inconsistencies over time and between countries were too great)
5.	Years (E3ME, employment 1970 to 2020 for 17 countries, 1993 to 2020 for 10 'new' countries; since extended to 2025; the EU LFS data set varies depending on country, generally 1993 to 2000)

Supply side – population and economically active workforce by:

1.	Gender
2.	Age: 15-19, 20-24, 25-29, 30-39, 40-49, 50-54, 55-59, 60-64, 65+
3.	Qualification levels (as for demand side above)
4.	Country (as for demand side above, although currently without Malta and Switzerland)
5.	Years (E3ME – aggregate labour supply, 2000 to 2025; EU LFS: various, depending on country/microdata, 1995 to 2002)

ANNEX D

Multi-sectoral macroeconomic model (E3ME)

Most countries have national macroeconomic modelling, in many cases including multi-sectoral and multi-regional sub-components. There have been a few attempts to develop cross-country models, perhaps the most widely used being E3ME.

E3ME is an energy-environment-economy (E3) model of Europe. The economy element includes detailed treatment of sectoral employment. The model has been used for general macro analysis and for more focused analysis of policies relating to the environment, as well as employment forecasting. Its pan-European coverage is appropriate for an increasingly integrated European market. E3ME provides a one-model approach in which the detailed industry analysis is consistent with the macro analysis: in E3ME, the key indicators are modelled separately for each sector, and for each region, yielding the results for Europe as a whole. More information is available on the E3ME website (http://www.e3me.com). A full online technical manual is available at http://www.camecon–e3memanual.com/cgi–bin/EPW_CGI.

The E3ME model provides:

(a) annual comprehensive forecasts up to the year 2030:
    (i) for 29 European regions including the EU-27, Norway and Switzerland ([26]);
    (ii) for industry output, investment, prices, exports, imports, employment and intermediate demand at a 42-industry level including 16 service industries; for consumer expenditure in 43 categories;
    (iii) for energy demand, split by 19 fuel uses of 12 fuels, and environmental emissions;
(b) full macro top-down and industrial bottom-up simulation analysis of the economy, allowing industrial factors to influence the macro-economic picture;
(c) in-depth treatment of changes in the input-output structure of the economy over the forecast period to incorporate the effects of technological change, relative price movements and changes in the

([26]) Work has been undertaken to incorporate Bulgaria and Romania into the E3ME model, and these countries are treated as part of the project's general geographical scope.

composition of each industry's output;

(d) dynamic multiplier analysis, illustrating the response of the main economic indicators, industrial outputs and prices to standard changes in the assumptions, such as changes in world oil prices, income taxes, government spending and exchange rates.

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 CGE models, providing analysis of the movement of the long-term outcomes for key E3 indicators in response to policy changes. It is essentially a dynamic simulation model of Europe estimated by econometric methods.

E3ME has the following advantages:

(a) model disaggregation: the detailed nature of the model allows the representation of fairly complex scenarios, especially those that are differentiated according to sector and to country. Similarly, the impact of any policy measure can be represented in a detailed way;

(b) econometric pedigree: the econometric grounding of the model makes it better able to represent and forecast performance in the short to medium term. It therefore provides information that allows for dynamic responses to changes in policy and that is closer to the time horizon of many policy-makers than pure CGE models, which provide long-term equilibrium solutions;

(c) E3 linkages: E3ME is a hybrid model. An interaction (two-way feedback) between the economy, energy demand/supply and environmental emissions is an undoubted advantage over models that may either ignore the interaction completely or only assume a one-way causation. For example, the EU ETS includes a cap on CO_2 emissions: the model can be used to solve for the CO_2 allowance price, allowing for effects on electricity prices and demand, as well as on macroeconomic variables.

Classifications used in E3ME

The main classifications follow the order of accounts in the European System of Accounts (Eurostat, 1995). These are displayed in a compressed form for convenience in the tables in PDF files on the E3ME site ([27]). They include considerable detail such as that shown in the table.

([27]) See http://www.e3me.com

Table 24. **Classifications used in E3ME**

Classification name	Name	Number of categories
R	countries	29
WR	world areas	20
C	consumer expenditure	43
G	government spending	5
J	fuel types	12
K	investment sectors	43
T	taxes	10
Y	industries	42

Labour-market participation rate equations

The theoretical model for labour-force participation rates stems from a paper by Briscoe and Wilson (1992). The standard analysis of participation in the labour force is based around the idea of a reservation wage, such that if the market wage is greater than an individual's reservation wage, they will actively seek employment, and vice versa. It should be noted here that this type of model assumes excess demand for labour.

The reservation wage is normally described by a group of personal characteristics such as non-wage income, educational level, age, etc. Many of these personal traits are inherently unobservable, for example the value of leisure, and the reservation wage can thus be written as:

$$W^* = w^* (X^*, o^*)$$

where W* is the reservation wage, X* is a vector of observed characteristics, and o* is a variable of unobserved characteristics.

Workers choose to participate in the labour force if W > W*, where W is the market wage. Combined with the factors determining the market wage, the decision to participate can then be represented by:

$$P = p (W, X^*, o^*)$$

where P is the participation rate.

In time-series studies, much of the personal background data usually used in cross-section studies is unavailable, so any model is necessarily limited to variables describing human wealth (in the narrowest of senses) and market wage determination. The variables that are available for inclusion are the market wage rate, a measure of market activity (output), a proxy for non-labour income and some measure of the tightness of the labour market, for example the unemployment rate. The basic model, capturing variables in both the co-integrating and dynamic regressions, can therefore be written as:

$$P = f(W, GDP, RUNR, RBEN, RSER)$$

where W is the real market wage, GDP is real output, RUNR is the unemployment rate, RBEN is a measure of social benefit and RSER is a measure of economic structure, i.e. manufacturing versus services.

The participation rate is estimated separately for men and women in an attempt to capture the different factors behind activity in the labour force between the sexes. Data limitations, however, mean that none of the explanatory variables are gender-specific. The equation is estimated in logistic form, which means that the dependent variable is subject to the transform Li = ln[Pi/(1 – Pi)]. This is because the participation rate, Pi, is constrained within the [0,1] interval, something which the shape of the resulting logistic transformation ensures. The labour-market participation rate function has been expanded to cover a series of age ranges, matching the LFS and Eurostat classifications.

ANNEX E

Producing benchmark projections of demand/supply pressure

Background

For reasons set out in the main text, it has not been possible to make direct comparisons between the present supply results and the previous demand-side projections. Possible ways of undertaking this in future work, when such problems of inconsistency have been resolved, have been explored. This annex sets out the main elements of such an approach.

Demand side

The occupational employment projections (as produced in the earlier demand-side project (Cedefop, 2008a)) can be taken for this purpose as fixed and independent of the supply projections (exogenous). Employment levels from these projections can be regarded as a proxy measure of demand, while recognising that employment levels are the result of both demand and supply influences and also recognising that this excludes any unfilled vacancies (which can be regarded as representing unfulfilled demand).

The qualification proportions within occupations then give the overall demand picture for qualification categories (with implied numbers in employment for highly-qualified, medium-qualified and low-qualified categories).

Assuming that they have been produced in a consistent fashion, using common data sets and underlying assumptions, these can then be compared with supply-side projections such as those presented in this report. This assumes that any complications caused by differences in definition/coverage, or problems due to differences between LFS and NA based employment estimates, or use of estimates based on heads versus jobs, residence versus workplace, etc., have all been resolved.

Supply side

Labour-force numbers by qualification can be taken from the stock-based model results as presented in Chapter 3 of the present report ([28]).

Unemployment levels are taken from E3ME. These are regarded as fixed (exogenous) for the purpose of these comparisons.

This unemployment can then be shared out between high-, medium- and low-qualified categories, based on an analysis of LFS historical data (i.e. by analysing and then projecting trends in shares of unemployment in the three categories, subject to unemployment rates remaining plausible for each of the categories).

Reconciliation

An iterative sort mechanism (algorithm) can then be developed to sort the available people (as given by the supply projections) into jobs (occupations, as given by the demand projections). This reconciles the projected supply numbers (net of unemployment) with projected demand. This is done in proportion to where the existing numbers are deployed, focusing attention on shifting patterns of qualification mix within occupations. This general approach builds on similar previous research, as set out in Wilson and Bosworth (2006) for the UK.

'Benchmark' information on qualification structure by occupation (as well as by sector and by country, separately and in limited cases in combination) for those in employment has been developed in the previous demand-side project, based primarily on changing patterns in LFS data. This focuses on outcomes, rather than supply or demand per se ([29]).

The observed patterns vary by both sector and country. However, given the limited sample sizes in the LFS, summary results can be developed focusing primarily on these two dimensions (sector and country) separately. In making a comparison with the supply side, the main focus is on results summed across all sectors and occupations within each country.

([28]) At a later stage this may be further modified by reference to results from the flow-based model (Module 6), but at present this complication is ignored.

([29]) Such information can help meet the needs of those who require indicative material about 'typical' qualification requirements in different jobs.

The general approach proposed for comparing demand and supply involves a number of interrelated steps, models and modules. Together they cover various aspects of the national supply of and demand for formal qualifications.

As noted in the previous demand-side projections, adding a qualifications dimension to analysis of employment trends raises a number of technical and conceptual issues. These have been addressed in a variety of ways, reflecting the availability of data and the prime objectives of the earlier study. The demand side is represented by Module 3 in the previous project. This delivers overall numbers of people in employment qualified at three broad ISCED levels.

The various different modules and those developed in the present project to project corresponding number of people holding qualifications and qualification shares at various different levels (the supply side) add to this conceptual framework.

Finally, a sort algorithm reconciles the two sets of estimates. This final element compares the supply numbers with the demand numbers and computes the employment patterns to bring the two into agreement (making certain assumptions about unemployment). Effectively it raises or lowers qualification proportions within occupations until demand and supply numbers match. This may not imply that demand and supply are equal however, since some people may be over- or under-qualified for the jobs they are employed to do.

The algorithm increases or decreases qualification proportions (for each of high-, medium- and low-level qualifications) within occupations until the overall numbers in the qualified categories for each country match the supply-side figures net of unemployment (ignoring any possible migration). Employment proportions of the high-level, medium-level and low-level qualification categories are constrained:

- to lie between 0 and 1 (1 and 100 %),
- to sum to 1 (or 100 %).

The final results indicate where there may be some over- or under-qualification compared with the initial demand-side projections.

Overview of the key elements required to compare supply and demand

The key elements are as follows:

(a) a stock model of supply (Module 5);
(b) a demand for qualifications model (as in the previous project, Module 3);
(c) a sorting model (algorithm), which sorts people classified by qualifications held into occupations in such a way that the results are made consistent.

Box 2 provides further details on how this sorting algorithm works.

The demand results can be compared with the results from the supply-side analysis, and the two reconciled using the qualifications sorting algorithm (SORT). The results obtained from the two models have been developed quite independently. This partly reflects the way the labour market operates. Supply-driven changes in education and the acquisition of credentials operate quite independently of changing demand-side patterns that affect the typical qualification requirements in jobs offered by employers. Typically, market forces will tend to bring supply and demand into balance. Generally, those who are better qualified will tend to find and retain employment more readily than those less well qualified. As shown in Table 25, for many countries there is a clear monotonic relationship between unemployment rates and the level of qualification held. The table shows the results for the EU-27. Although the differentials between qualification levels have narrowed over the past decade, the probability of unemployment for somebody with low-level formal qualifications is still almost twice as high as for someone with high-level qualifications across Europe as a whole.

Table 25. **Unemployment rates by qualification level (EU-27)**

	2000	2001	2002	2003	2004	2005	2006
Low	12.9	11.5	11.9	12.4	13.6	12.9	12.1
Medium	10.7	10.2	10.0	10.2	10.9	10.1	8.7
High	6.0	5.2	5.3	5.6	5.8	5.5	5.0
Total	**10.5**	**9.6**	**9.6**	**9.8**	**10.3**	**9.8**	**8.7**

Source: EU LFS microdata.

The way in which people find jobs, once they acquire their qualifications, is very complex. However the typical outcomes can be proxied by a simple sorting algorithm (as summarised in Box 2), which effectively 'shuffles' qualified people into jobs (occupations). The algorithm can be adjusted to allow for the differential unemployment probabilities set out in Table 25. Unemployment rates and levels can be projected, based on the assumption that the past share of total unemployment between the three qualification categories remains fixed at its 2007 value (or some other suitable working assumption). The implications for unemployment rates can then be checked for plausibility.

Based on the overall projected level of unemployment and the implications for how this is shared between those qualified at different levels, the iterative procedure is then used to adjust the total numbers qualified from the occupational/qualification shares (demand) results to match the results from the supply model (net of unemployment). This scaling process changes the occupational employment totals. The occupational totals are then readjusted to match the original levels. The qualification levels are then readjusted and the process repeated until a solution is reached in which both the qualification profile matches the supply model results and the original occupational results are restored.

Box 2. **A qualifications 'sorting' model (algorithm)**

This model or algorithm is designed to reconcile the projections from the stock model of supply (numbers available by the three qualification levels) with those from the earlier demand for qualifications model (number of jobs requiring particular qualification levels). The former provides a view of supply-side developments (the overall number of people who have acquired qualifications at the three different levels that are actively searching for work), while the latter is more concerned with changing demand for qualifications within occupations (the number of jobs available requiring particular levels of qualifications).

The sorting model uses an iterative RAS procedure to reconcile the two sets of estimates, constraining the overall qualification shares from the stock model of supply to match those from the demand for qualifications model, while at the same time maintaining the patterns of occupational deployment, and ensuring a plausible pattern of unemployment rates for the different qualification categories. It is focused on which occupations the people with different qualifications end up in.

Overall unemployment levels are taken from E3ME. This is taken as exogenous for these purposes. The overall level of unemployment is shared out between qualification categories, based on an extrapolation of patterns from historical LFS data. Checks are made to see that this results in plausible unemployment rates for the three qualification categories. The implied unemployment levels by qualification are then deducted from the overall supply numbers to get the number of people in employment by qualification level. The sorting model then reconciles this with the number of jobs available by altering the proportions of people with the three different qualification levels employed within each occupation until the overall numbers match the number of people available.

The final results may show over- or under-qualification of people in different occupations, depending on the overall demand supply balance.

The constraint (matching of numbers by the three qualifications levels) is imposed at the two-digit occupational level. The key dimensions are:

- occupation (27),
- qualification level (3).

The sorting model operates for each country separately.

There are assumed to be no adjustments via cross-border flows (migration or commuting).

ANNEX F

Contributing country experts

Country	Name	Organisation
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	VAN TRIER, Walter	Faculty of Economics & Business Administration – Gent University
Bulgaria	BRATOEVA, Liliya	Private consultant
	KUNEV, Ruslan	NCVT
Croatia	CRNKOVIĆ-POZAIĆ, Sanja	Bit Croatia
	MEŠTROVIĆ, Branka	Croatian Employment Service
	TOMIĆ, Iva	The Institute of Economics
Cyprus	MOUROUZIDES, Yiannis	Human Resource Development Authority
	OXINOS, George	Human Resource Development Authority
Czech Republic	HAVLÍČKOVÁ, Věra	National Training Fund
	LAPÁČEK, Michal	National Training Fund
	ŽÁČKOVÁ, Hana	National Training Fund
Estonia	KLOOSTER, Karin	Ministry of Education and Research
	LAMBING, Mario	Ministry of Economic Affairs and Communications
Finland	VOLANEN, Matti Vesa	Institute for Educational Research, University of Jyväskylä
	TIAINEN, Pekka	Ministry of Labour and Industries
France	BEFFY, Magali	DEPP – MEN

Country	Name	Organisation
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	OMALEK, Laure	Ministère de l'Emploi – DARES
	SAUVAGEOT, Claude	Ministère de l'Education Nationale
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Country	Name	Organisation
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	DUPUY, Arnaud	ROA
	KRIECHEL, Ben	ROA
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	LIVANOS, Ilias	IER
	POLLITT, Hector	Cambridge Econometrics
	WILSON, Rob	IER

Acronyms and definitions

Institutions and organisations

CE	Cambridge Econometrics
Cedefop	European Centre for the Development of Vocational Training
DG ECFIN	Directorate General for Economic and Financial Affairs
EU	European Union
Eurostat	Statistical Office of the European Communities
IER	Institute for Employment Research
ROA	Research Centre for Education and the Labour Market, University of Maastricht
Skillsnet	Cedefop's network on early identification of skill needs
UOE	Unesco-OECD-Eurostat
UIS	Unesco Institute of Statistics
Unesco	United Nations Educational, Scientific and Cultural Organisation

Others

AMECO	Annual macro-economic database of the European Commission's Directorate-General for Economic and Financial Affairs
CGE	Computable general equilibrium
E3	Energy-environment-economy
EU-27	The 27 EU Member States
EU-27+	The 27 EU Member States plus Norway and Switzerland
EU-25*	EU-25, excluding Malta but plus Norway
E3ME	Multi-sectoral macroeconomic model
E3ME*	E3ME augmented to include detailed labour supply model
EDMOD	Model to produce occupational demand projections (expansion demands)
FlowMOD	Model of flows into and out from the education system

GDP	Gross domestic product
ICT	Information and communication technologies
ISCED	International standard classification of education
ISCO	International standard classification of occupations
LFS	Labour force survey
NA	National accounts
p.a.	Per annum
QMOD	Model to produce qualification projections
R&D	Research and development
RDMOD	Model to produce projections of replacement demands
StockMOD	Model of numbers acquiring qualifications (stocks)
WTO	World trade organisation

Definitions of terms used

Conceptual	The general theoretical and methodological approach to modelling and projecting the demand for and supply of skills (as set out in Annex C).
Employment	The number of people in work (headcount), national accounts definition, (or the number of jobs in some cases), split by various dimensions, including sector, occupation, gender and highest qualification held.
Labour force	The number of people economically active (the sum over the various age ranges of the working age population * the relevant labour-market participation rate) which includes employed and unemployed.
Population (15+)	Anyone of age 15 or over is classified as part of the population in the context of the model. People over 65 are included in this definition, as these age groups have participation rates greater than zero.
Working age population	Anyone of age 15-64 (or 25-64 in case of qualification-related data) is classified as part of the working-age population.
Participation or activity rate	The percentage of the population that is either employed or unemployed (ILO definition of labour force). This is differentiated by gender and age group.
Qualifications	This term refers to the highest level of education/qualification held by the individual. The ISCED classification is used for this purpose. The most aggregate level distinguishes three main levels of education/ qualification: high (ISCED 5-6), medium (ISCED 3-4, excluding 3c short) and low (ISCED 0-2, plus 3c short).
Demand	In the context of the model, labour demand is taken to be the same as employment levels. It does not include (for example) unfilled vacancies.
Supply	In the context of the model, labour supply is taken to be the same as the labour force.

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This publication presents results of the first skill supply forecast in Europe until 2020 and complements the forecast of skills demand published by Cedefop in 2008. It builds upon a multisectoral macroeconomic model, extended to include a set of overall labour supply projections by age and gender. It focuses on changing patterns in the supply of people in the population and in the labour force according to the highest qualification attained. It provides results for Europe as a whole (EU-25 without Malta plus Norway) and for individual countries.

The forecast suggests a substantial increase of the adult labour force with high and medium qualifications. In contrast, the number and share of people with low levels or no qualifications is projected to decline in almost all European countries. These general trends are in line with the Lisbon goals to make Europe the most competitive and dynamic knowledge-based society in the world and will remain a key feature in the coming decade.

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