DISCUSSION
PAPERS

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Wages and occupational flexibilities as determinants of the interactive QuBe labour market model

A methodological report on the basic projection of the 3rd wave of the BIBB-IAB qualifications and occupational field projections

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The Fraunhofer Institute for Applied Information Technology (FIT)

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A brief summary of the most important aspects

The qualifications and occupational field projections (QuBe Project), which are conducted by the Federal Institute for Vocational Education and Training (BIBB) and the Institute for Employment Research (IAB) working in conjunction with the Fraunhofer Institute for Applied Information Technology (FIT) and the Institute of Economic Structural Research (GWS), use model calculations as a basis for showing how the supply of and demand for skills and occupations may develop on a long-term basis up until the year 2030. The results of the first wave of the QuBe Project appeared in 2010 and were supplemented in 2012 by the outcomes of the second wave. The projections are characterised by the fact that they are based on common systematisations on both the supply and demand sides and on harmonised data sets. They also take account of empirically demonstrable compensatory processes between labour supply together with occupation trained in and the required labour demand by occupation exercised via occupational flexibility matrices.

This discussion paper presents the assumptions, data and methods which form the foundations for the basic projection of the third wave of the QuBe Project. Whereas the fundamental assumptions for the basic projection applied to previous waves, the changes in the data and methods used are significant. The third wave of projections reacts to the increasing migration to Germany in the wake of the economic crisis and assumes net immigration of 200,000 persons from the year 2020 (previously 100,000 persons from the year 2014). The population forecast is also adjusted to the latest preliminary census results. In addition to this, occupation and qualification specific wages are built into the modelling in order to allow interactions between supply and demand.

The empirically based, dynamised exchange process between supply and demand by qualifications and occupations forms the fulcrum of the redesigned model for the third projection wave and thus also provides a framework for the refinement of the modelling methodology. This means that, on the demand side, the occupation specific labour supply available is taken into account per capita and by hour with regard to the determination of wages for the occupations. On the supply side, the existing two supply models BIBB-FIT and BIBB-DEMOS are unified in a single model and elasticities of occupational flexibility are estimated so as to enable a reaction of the labour supply to the changing wages in the occupational fields in the model.

This publication documents the individual calculations that were necessary for an endogenisation of supply and demand. The intention was, however, for the result of the modelling to illustrate the effects and modes of operation of previously observable empirical correlations in a more detailed manner than before rather than being understood as the prognosis of an inevitable future for the labour market. Because such correlations can now be investigated in even more detail, we also conclude by discussing the effectiveness of the model and further opportunities for development.

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a	Age group
ahw	Annual hours worked
aw	Annual wage
aww	Annual weeks of work
BA	Bundesagentur für Arbeit, *Federal Employment Agency*
BEH	Beschäftigtenhistorik, *Employee History Data*
BIBB	Bundesinstitut für Berufsbildung, *Federal Institute for Vocational Education and Training*
BLK	Bund-Länder-Kommission für Bildungsplanung und Forschungsförderung, *Federal Government-Federal States Commission for Educational Planning and Research Promotion*
BGR	Bildungsgesamtrechnung, *National Educational Accounts*
EGS	Erhebung des gesamtwirtschaftlichen Stellenangebots, *Job Vacancy Survey*
FAO	Food and Agriculture Organization
FIT	Fraunhofer-Institut für Angewandte Informationstechnik, *Fraunhofer Institute for Applied Information Technology*
$flex_{rc}$	Occupational flexibility *(r = row, c = column)*
GWS	Gesellschaft für wirtschaftliche Strukturforschung, *Institute of Economic Structural Research*
i	Industry
IAB	Institut für Arbeitsmarkt- und Berufsforschung, *Institute for Employment Research*
ILO	International Labour Organization
ISCED	International Standard Classification of Education 1997
KldB92	Klassifikation der Berufe 1992, *Classification of Occupations 1992*
KMK	Kultusministerkonferenz, *Conference of the Ministers of Education and Cultural Affairs in the Federal Republic of Germany*
ld	Labour demand
lpp	Labour productivity per person
ls	Labour supply
MZ	Mikrozensus, *Microcensus*
o	Occupational field
OECD	Organisation for Economic Co-operation and Development
output	Production in real terms
P	Prices
pop	Population
pop_f	Population Forecast on the basis of the 1987 Census
pop_k	Population – 12th Coordinated Population Forecast
pop_z	Population – results of the 2011 Census
q	Qualification

qs	Qualification share
QuBe	Qualifikations- und Berufsfeldprojektion, *Qualifications and occupational field projections*
s	Sex
sl	Saturation level
stayer	Proportion of stayers
t	Time
tb	Time of birth
ulc	Unit labour costs
VGR	Volkswirtschaftliche Gesamtrechnungen, *National Accounts*
vow	Volume of work
W	Wage
w_o	Wage in occupational field
$w_{o,ref}$	Reference wage in occupational field
whw	Weekly hours worked
$\hat{\varepsilon}$	Estimation error
$\hat{\varepsilon}_i^{BF}$	Estimation error at the current margin

1 Labour market projections as an instrument of policy guidance

Labour market projections are an instrument of policy guidance and serve to reveal developments on the labour market and within the educational system, enabling these to be steered via targeted concepts if necessary. Nevertheless, a useful interpretation of the results is only ensured if the demand for qualifications and occupations can also be compared with an available supply of such qualifications and occupations. Standardised databases and systematisations for the supply and demand sides are indispensable for this purpose. Also, especially on a labour market that is structured along occupational lines, such as in Germany, the occupation is an institutional link between the educational and employment system and therefore an essential characteristic in order to be able to uncover bottlenecks in certain professions.

Previous studies (BLK 1995, BLK 2002, Bonin et al. 2007, Dostal 2002, Weidig et al. 1999) were forced to restrict themselves to individual branches or abstract areas of activity when making projections of supply and demand at the qualifications level. Projections at the occupational level were not feasible because of the absence of systematisations and characteristics making an alignment between supply and demand possible. This meant that supply and demand were only comparable under the premise that new supply completely migrated into the respective exercised matching occupation – occupational flexibility between the occupation learned and the occupation carried out could not be represented. Even in more recent studies (CEDEFOP 2009, CEDEFOP 2012, VBW 2012, VBW 2008, Vogler-Ludwig and Düll 2013), occupational flexibility of labour demand and volume of work are not considered or else are only taken into account in a very simplified form as a market compensatory mechanism.

In order to place projections on a well-founded and broadly positioned basis, a cooperation project for "qualifications and occupational field projections (QuBe)" came into being in 2007, conducted by the Federal Institute for Vocational Education and Training (BIBB) and the Institute for Employment Research (IAB) working in conjunction with the Fraunhofer Institute for Applied Information Technology (FIT) and the Institute of Economic Structural Research (GWS). This was occasioned by the discontinuation of the projections of the Federal Government-Federal States Commission for Educational Planning and Research Promotion, BLK (BLK 1995, BLK 2002, Bonin et al. 2007), previously extremely far-reaching in nature, caused by the "Federalism Resolution" (changing the nature of the relationship between the Federal Government and federal states) and the subsequent dissolution of the BLK. Three workshops were staged, in which data availability and technical data foundations were initially checked (July 2007), an inventory of national and international labour market projection models was undertaken (September 2007) and the results of the first BIBB-IAB model calculation were discussed (December 2009). For the first time, the projection results enabled occupational fields with homogeneous activities (Tiemann u. a. 2008) to serve as a basis for a comparison of labour demand in an occupation and labour supply in the relevant occupation with the potential labour supply for an exercisable occupation whilst taking occupational flexibility into account.

A reader ("Beruf und Qualifikation in der Zukunft *[Occupations and qualifications in the future]*" (Helmrich und Zika 2010)) was published in 2010 to accompany the first wave of the BIBB-IAB qualifications and occupational field projections, in which the methodological and technical data approaches were described in detail and the results of the first wave reviewed. In the second wave of the project in 2012, the projections were repeated using an expanded per capita database (Helmrich et al. 2012d), and a consideration of volume of work was introduced (Zika et al. 2012). In addition to this, alternative scenarios were created drawing on the developed reference scenario (Helmrich u. a. 2013), which present various development pathways in the field of education, in labour demand, in migration (Maier et al. 2012) and in foreign trade (Maier et al. 2012, Mönnig et al. 2013). The QuBe model system was also used in

order to analyse possible bottlenecks in individual occupations and branches in more detail, e. g. those caused in the construction occupations by the renovation of buildings to meet energy requirements (Helmrich et al. 2012b) or in the care occupations (Afentakis and Maier 2010, Maier and Afentakis 2013).

This publication presents the methods and assumptions of the third wave of the BIBB-IAB qualifications and occupational field projections. The next logical step in the projection of labour supply and demand is completed – the linking of the demand side with the supply side. Our objective here is to illustrate possible adaptation opportunities and their potential modes of operation rather than a neo-classical depletion of the market by non-restricted price adaptations.

In the following, we will begin by presenting below the basic principles that are still in place compared to the previous project waves (Section 2.2), the structure of the QuBe Project (Section 2.4) and the databases (Section 2.4). This is followed by the more detailed presentation of a dynamic demand projection (Chapter 3), the approach adopted in estimating labour supply (Chapter 4) and the endogenisation of occupational flexibilities (Chapter 5). The publication concludes with a discussion of the effectiveness of the model (Chapter 6).

2 Basic principles of the QuBe Project

2.1 Preliminary remarks

The modelling of labour market projections can take place in two different ways. The aim of the following metaphor is to help visualise the problem. Imagine we are in a car on a country road, and the windscreen is so dirty that it cannot be cleaned. How can we continue without veering off the road?

If we had experienced people sitting in the car with us, we could ask them what direction they suppose the road will take based on their experience or on their knowledge of similar routes. However, since none of the experts is actually familiar with the route – the future is and remains uncertain – we would take a vote and ultimately follow the consensus reached rather than being able to rely on any single opinion. We would then continue our journey on the basis of the Delphi forecast conducted with the people sitting in the car. This means that steering movements are based on their general experiences.

Alternatively, we could also use the existing facts and start by looking in the rear mirror to deduce the further course of the road by considering its previous route, and secondly we could pay attention to the distance between the wheels and the edge of the road, make relevant corrections as this distance becomes smaller and thus steer the car back into the middle of the road. Steering movements are thus based on specific empirical observations and on the current findings of those sitting in the car.

Our approach adopts the second model, and we base our projection on the updating of trends observed in the past in the educational system and on the labour market. Insofar as dependencies between different variables in the past are observable, we also take these dependencies into account for the future. If no trends can be recognised in certain values, we update the status quo. As soon as new databases are available, we renew our projection and thus correct our estimation. In our view, this facilitates a transparent approach, since changes and the effects of such changes are visible to everyone and such an approach ensures a projection that shows us where we will end up if we retain our current and past behaviour in future. Although alternative considerations of deviating behaviour cannot be excluded, our opinion is that these should be reflected in a basic projection in order to reveal the effects and modes of operation that may arise from a departure from previous behaviour.

2.2 Basic principles of the QuBe Project

Although looking in the rear mirror and out of the side windows provides the essential points of orientation for the continuation of the journey, there is no way of preventing certain ideas of future developments from entering into the projections. The driver of an automobile has a certain experience of driving, upon which he or she can rely even when visibility is poor. We will now leave the image of the car driver behind and present the principles of the basic projection of the third wave of the BIBB-IAB qualifications and occupational field projections in specific terms. This presentation will provide transparency in respect of the factors influencing our projection and thus enable the reader to gain a picture of why certain developments are projected which, instinctively, may not have been presumed in such a form.

- **Labour supply**
  We take labour supply as a per capita number of members of the working age population aged over 15 (working and not working) in accordance with the definition of the International Labour Organization (ILO). In projecting the labour supply, we update past trends and do not stay with the status quo (see also participation in employment). Labour supply in hours is a hypothetical construct that states in hours how high the maximum labour supply actually is. For this purpose, we use the Microcensus as a basis for calculating the highest observable weekly working time wished for (insofar as this is higher than the weekly working time realised) by the labour supply by age, qualification and occupation and then transfer this value to the entire labour supply with the same characteristics (further details are provided in Chapter 4.3). With regard to the labour supply, we differentiate between new supply and residual supply.
- **Labour demand**
  A long-term projection and a short-term projection must be evaluated in fundamentally different ways. Whereas in the case of a short-term projection certain demand indicators such as the number of vacancies are of great interest, such indicators are less suitable for a long-term projection. We define labour demand as the number of workers and hours of work needed to manufacture and provide the total number of goods and services produced in Germany. We refer to this as realised demand. By its very definition, the demand of companies is independent of age and gender. For this reason, no replacement demand is calculated. On the other hand, expansion demand can be calculated via a comparison of the realising demand between two points in time. The number of persons leaving working life can be calculated via labour supply (see labour supply). So-called vacancies are not taken into consideration in the QuBe long-term projections for four reasons.
  – Micro-macro problem At the micro-economic level, the non-filling of a vacancy leads to a loss if this causes the company affected to refuse orders and thus have to restrict or not be able to expand production capacity. This does not, however, necessarily mean that there is a corresponding loss in production for the economy as a whole, i. e. at the macro-economic level. Indeed, it may instead lead to the acceptance of the order by another domestic company, meaning that this company can exploit its existing production capacities and thus prevent a cutting of staff. In such a case, despite the non-filling of the vacancy observable at the micro-level, the macro-economy would not have sustained any loss in demand.
  – Methodology Without further background knowledge, no expansion demand can be deduced solely from the number of vacancies or from an increase in the number of vacancies. The reason for such a rise may also simply be an increased replacement demand. The number of vacancies cannot be differentiated according to replacement demand and expansion demand.
  – Long-term observation: In an economy, there will always be vacancies within the scope of the vacancy-filling process. From an economic point of view, vacancies only become a problem – if they become a problem at all – when they cannot be filled. Even if we do not impute any complete information (transparency) or a rational agent,

such problems with filling vacancies should, however, be resolved at some point as a result of adaptation reactions to the supply and/or demand side. For this reason, when considering vacancies, the assumption would have to be made that the number of vacancies will return to its frictional level in the long term.

– Data quality: The statistics on reported vacancies issued by the Federal Employment Agency (BA) also contain vacancies that do not need to be filled. The reasons for this may be multifarious. Having successfully filled a vacancy, the company may have forgotten to report this to the BA or vacancies may be included more than once because a company has engaged one or more human resources services providers to seek suitable staff. Although this problem does not arise in the case of the Job Vacancy Survey conducted by the IAB, the data here is not available to a sufficient depth of occupational disaggregation.

- **Population development**
  The 12th Coordinated Population Forecast (first and second wave: "Version 1 – W1: Lower limit of the medium population"; third wave: "Version 1 – W2: Upper limit of the medium population") currently (still) forms the basis for population growth. Demographic development strongly influences future labour supply. In the case of persons of working age, the assumed number of external migration has the greatest influence on supply. A possible increase in fertility does not gain significance until near the end of the projection period (2030) and thus only has a small influence on the projection results. Changes to mortality (increase in life expectancy) exert a relatively slight influence with regard to the future supply of persons of working age (see also Chapter 4.1).
- **Participation in education and training**
  In the case of an isolated consideration of supply and demand, behavioural parameters (entry rates, transitional rates between training centres and success rates) are stipulated at their last known status. Decisions to participate in education and training are ultimately determined by a multitude of motives, the full mapping of which has not been possible in the case of long-term projections thus far. The non-updating of these behavioural parameters in line with trends therefore assists with easier interpretability and transparency of the results in the same way as the use of external status quo education and training forecasts. For this reason, any changes that may occur in participation in education and training and career choice as a reaction to bottlenecks on the labour market are not taken into account in the projection period (see also Chapter 4.3).
- **Empirical evidence**
  Modes of behaviour which were not identified in the past cannot be projected for the future. For this reason, they also do not form part of the basic projection. Only changes in behaviour that have been empirically demonstrable up until now are updated in the basic projection.
- **Labour force participation**
  Empirically provable changes in behaviour in labour force participation are attenuated in the projection period (with expiring trends), especially in the case of middle-aged women and older persons. If no changes in behaviour are discernible, employment rates are stipulated at their last known status, this being in particular the case for middle-aged men (see also Chapter 4.5).
- **Bottom-up principle**
  Overall economic growth is the consequence of decisions and the resulting behaviour of the stakeholders the state, companies and households. Overall societal changes have differing effects on the branches (EUROSTAT 2008). Effects unfold "bottom up" (see also Chapter 3).
  Nevertheless, certain exogenous stipulations are necessary to serve as benchmarks for the determination of economic growth. These include important leading indicators such as the oil price, the exchange rate between the dollar and the euro and the interest rate of the European Central Bank as well as growth assumptions for Germany's trading partners

in the world. We are guided in this regard by the results of other institutions such as the International Energy Agency (IEA 2012), the International Monetary Fund (IMF 2013), the European Commission (EC 2013) and the "Food and Agriculture Organization" (FAO 2013).

- **Globalisation and Europe**
  Ties with abroad are becoming stronger, especially with regard to the supply chain. Many export-oriented companies relocate work cost intensive production processes to countries with low wage levels, for example (Jannsen and Kooths 2012: p. 370). Integration into international supply chains is becoming visible in the form of a rising rate of import of German export goods. This rate differs considerably according to sector. Whereas the manufacturing and transport sectors in particular are exhibiting a high rate of import of export goods, this rate is below average in many service sector areas (EC 2012: p. 30).
- **Theoretical basis**
  In the QuBe Project, the decision as to whether the labour market follows Keynesian or neo-classical elements is empirically based on hypothesis tests rather than being a question of faith. The results show that markets are not perfect and thus full transparency and unrestricted rational action is rarely observed. On the other hand, however, the labour market is also characterised by scarcities and wage negotiations.
  This empirical understanding, which is perhaps also pragmatic in nature, is expressed in the branch-specific observation. They are modelled in detail, and the correlations found must continue to produce plausible developments in the future. Plausibility is in place if there are no contradictions between the past and the current situation.
  Whereas, at least in their simple variations, neo-classicism and Keynesianism each emphasise one side of the market (supply or demand), we assume that there is an interplay between supply and demand.
- **Consistency**
  The whole system is calibrated for consistency. Within the economic context of the model, this means that the amounts of income and expenditure are balanced and that there is compliance with the necessary accounting stipulations of the System of National Accounts. In broadly simplified terms, therefore, gross domestic product needs to equal on the input side (value creation by the branches) and on the output side (consumption, investment and external contribution).
  With regard to socio-economic correlations, each person within the population also needs to be recorded precisely once. Each person can only be allocated to one type of household (e. g. based on size). Each person can only be either unemployed, employed or economically inactive.
- **Pacta sunt servanda**
  Matters which have not yet been legally decided do not form part of the basic projection.
  - Educational system
    The structure of the general education and vocational education and training system remains as it is. Changes to training periods which have already been decided and which have an effect during the projection period (e. g. earlier school enrolment, double upper secondary school leaving cohorts until 2016, suspension of military service) are taken into account.
  - Social insurance
    The social insurance system remains unchanged. No general conversion of statutory pension insurance or the health insurance system to a funded scheme is taken into account. The pay-as-you-go process and general duty of insurance continue as before. The pension age of 67 has already been decided and thus forms part of the basic projection.
  - Continuation principle
    Although it may appear self-evident, in the light of the current sovereign debt crisis in Europe, it is important to point out that the QuBe Projection assumes that Germany

can maintain its status as a “going concern”. In simple terms, this means that the Federal Republic of Germany remains financially viable. It also needs to be emphasised that we continue to base the projection on the assumption that, unlike in the United States or the United Kingdom for example, in Germany the industrial core will still be the engine of our national economy and something which policymakers and companies will continue to hold on to, an assumption which has been empirically supported thus far. For this reason, we also assume that Germany will remain in the European Union and in the euro zone.

- **Path dependences**
  Capital stocks may be exchanged on a step-by-step basis, technological diffusions take place gradually, inventories, (including the population) have properties which can change only slowly in some cases. The differences in the starting data (initial allocation) influence results in the future.
- **Simultaneousness and differences in maturity**
  Although the branches, the state system and the population are mutually dependent, there are various time lags. Population effects are slow, export shocks take effect quickly, the actions of the state and branch developments may have both short-term and long-term impacts.
- **Technological developments**
  Technological developments take place in the form of changing branch-specific work productivities on the labour market. Apart from trends, developments in real wages also have an effect on the ratio of deployment of hours to output. Technological changes are further revealed in process innovations, which result from changes in the compositions of production input. Investments become “more valuable” in qualitative terms. The introduction of hedonic pricing means that increases in quality lead to more “real” investments whilst sales remain the same (example IT).

Because future developments may deviate from past developments in some cases, it also makes sense to highlight various alternative development pathways (Helmrich et al. 2013). In this case, the principles of the basic projection of the third wave presented here would change at one or more points. Alternative calculations may be based on political objectives and assumed anticipatory adaptation reactions of the labour market. From the point of view of a basic projection, these results may then be discussed as a reference (e. g. basic projection) (Helmrich et al. 2012a, Maier et al. 2012, Mönnig et al. 2013).

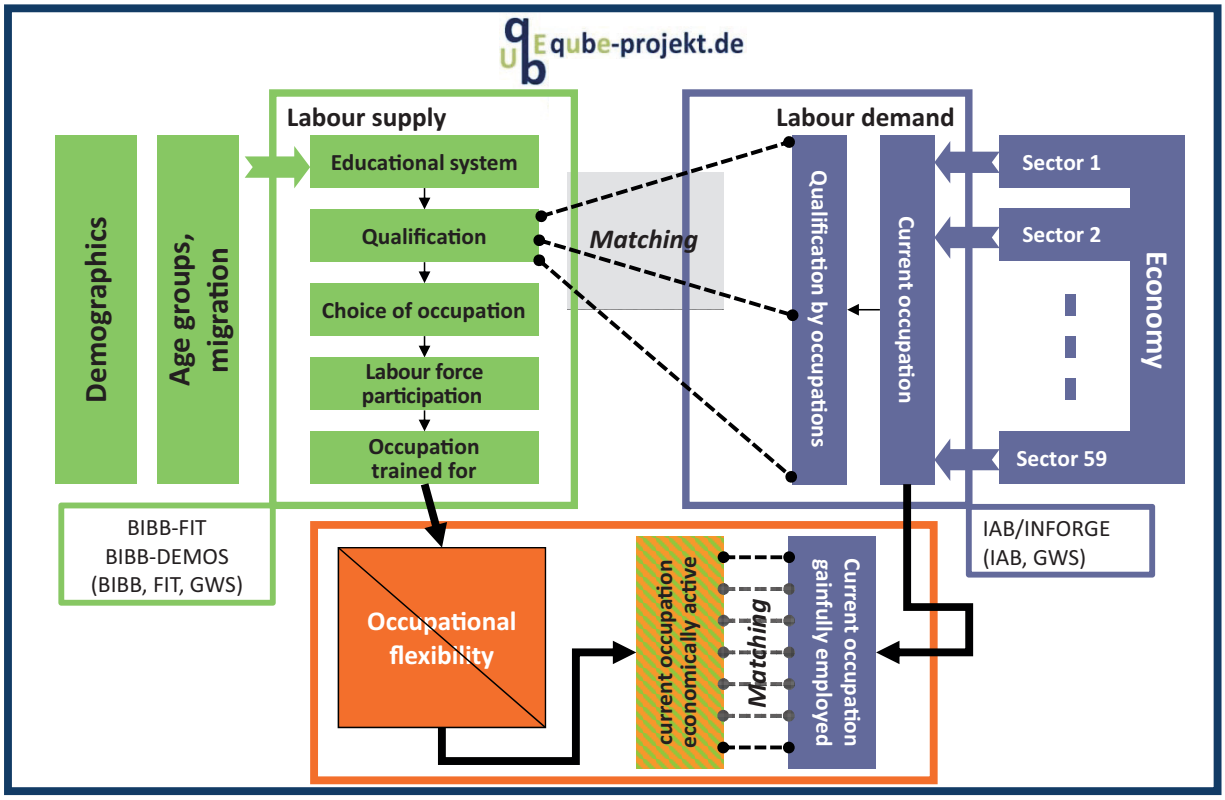
2.3 Structure of the QuBe Project

The QuBe Project undertakes projections for branches (Table 5 in the Annex), occupational fields (see Table 4 in the Annex) and qualifications (Table 1) up until the year 2030 in order to make future developments visible. An initial view of the approach adopted in the QuBe Project is provided by the heavily simplified presentation of the approach for the second projection wave in Figure 1. The labour market is essentially determined by two processes – demographics (green) and economic structural change (blue) (Figure 1). Whereas the number of persons available to the labour market is determined by “occupation trained for” (from the population via the educational system to participation in employment), companies in branches stipulate their requirement for activities, the “occupations exercised” on the basis of changes to competition opportunities or technical change. Both sides would face each other without any prospect of a link if occupational flexibility (orange) were not taken into account, this being determined by a willingness to adapt by both sides of the labour market.

The structure depicted in Figure 1 does not take into account the extent to which wage changes in the occupations arise on the basis of occupation specific scarcities and how far these wage changes alter the occupational mobility of the labour supply and the demand for

labour. The integration of these adaptation reactions is a main object of the updated model of the third wave of the QuBe Project and is described below (see also Figure 8).

Figure 1: QuBe Project – an overview of the modelling of the 2nd wave



Source: Presentation of the QuBe Project

2.4 The databases and their harmonisation

As was the case with the first (Helmrich and Zika 2010) and second wave (Helmrich et al. 2012d, Zika et al. 2012) of the QuBe Project, the third wave of the project uses a unique data set created by using the Microcensus of the Federal Statistical Office. The data set creates a correlation between labour demand according to 63 sectors (Classification of Economic Activities used by the Federal Statistical Office – "Wirtschaftszweigsystematik (WZ) 2008" – see Table 5) and 54 occupational fields (see Table 4) and covers the whole of the national economy in Germany. The 54 occupational fields are an activity-specific aggregation of the 369 occupational categories (3-digit code) of the 1992 Classification of Occupations (KldB92) (Tiemann et al. 2008). This prevents artefacts in the modelling of changes of occupation, which particularly occur due to the fact that manufacturing industry is mapped in a much more differentiated way in KldB92 than the service sector. The KldB92 is not able to circumvent this problem at the two-digit code level either. In order to provide a clearer representation of the results, the occupational fields are aggregated to form 12 (or 20) main occupational fields (or extended main occupational fields) (see Table 4). The data set also includes information on the formal qualifications acquired within individual occupational fields. It is harmonised with the gross national product calculation, which forms part of the National Accounts by the Federal Statistical Office.

The data of the Microcensus is the main source of information for the composition of labour demand with regard to age, gender, educational level on the basis of the **International Standard Classification of Education 1997** (ISCED, see Table 1), occupation trained for and current occupation according to the BIBB occupational fields (Tiemann et al. 2008).

Table 1: Correspondence of the ISCED level and qualification levels

ISCED level	Qualifications level
1, 2 & 3a	Not completed vocational education and training
3b & 4	Completed a company-based apprenticeship or full-time vocational school
5b.	Trade and technical school qualification such as master craftsman or technician examination
5a & 6	University of Applied Sciences and higher education degree, doctorate
-	Pupils, students, apprentices

No statistics other than the Microcensus deliver a more complete picture for all these characteristics within a single survey. Despite these merits, the data from the Microcensus cannot, however, be used in the projection models without further processing steps. The data from the National Accounts is mainly used for the updating of the labour requirement, which is based on a modelling of the economic development. The National Accounts thus form the underlying data framework, to which the Microcensus data needs to be adapted. This affects the following.

1. Number of economically active persons and their distribution across the economic sectors (Federal Statistical Office: Specialist Publications Series 18, Series 1.4)
2. Classification of the economic sectors in the 2008 structuring system (Federal Statistical Office 2010) for the survey years 1996 to 2008, which were previously only available in the 2003 or 1993 structuring system
3. Annual volume of work according to economic sectors (Federal Statistical Office: Specialist Publications Series 18, Series 1.4)

The points stated are explained in greater detail below.

2.4.1 Number of economically active persons and their distribution across the economic sectors

The Microcensus under-records the number of economically active persons by about 2 million (as an example for the year 2005) compared to the labour demand calculation carried out by the Federal Statistical Office (cf. Köhne-Finster and Lingnau 2008). This discrepancy is not negligible and gives rise to the alignment of the data to the marginal distribution of the National Accounts via an iterative margin adjustment procedure (cf. Bachem and Korte 1979). This process involves a re-extrapolation of the figures for the number of persons in active employment produced by the Microcensus to the figures for the number of persons in active employment resulting from the National Accounts in accordance with branches of trade and industry (2008 Classification of Economic Activities – 64), whereby the respective marginal totals of the population as a whole for the characteristics of age, gender, educational level (ISCDED) and occupation learned within the Microcensus are kept constant (constant population structure). This restrictive approach ensures that the central structural information of the Microcensus, which is central to the projections, is retained.

2.4.2 Classification of the economic sectors in the 2008 Classification of Economic Activities for the survey years 1996 to 2008

From the survey year 2009 onwards, the industry of the main occupation is surveyed in the Microcensus in the 2008 Classification of Economic Activities (WZ 2008). In the same year, the obsolete structuring system from 2003 (2003 Classification of Economic Activities) was used one final time in a parallel process. Prior to the survey year 2009, this characteristic is available as amended in 2003 or 1993. Such changing characteristics need to be harmonised

for long-term series. For economic sectors in the 2008 version, there is the associated difficulty that no clear key exists for the coding of the 2008 economic sectors on the basis of older classifications of economic sectors. Even at the deepest structuring level (five digits), clear alignments are not possible for all sectors. The circumstance that a sector is only recorded at three-digit level in the Microcensus exacerbates a precise alignment still further. For this reason, a two-stage procedure is required in order to enable the time series from 1996 onwards to be used with the 2008 version of economic sectors. The first step is to carry out all the clear alignments that are possible on the basis of the respective old system. The empirical frequency distribution of the new sector to the old sector is then used for a multiple imputation on the basis of the parallel survey of the old and new system in 2009.[1] In addition to the branches of trade and industry of 2003 or 1993, information on occupation exercised is used in order to improve the quality of the imputation.[2]

2.4.3 Determination of volume of work and potential work volume according to economic sectors and occupational fields

Alongside the number of weekly hours regularly worked, the Microcensus also surveys the number of weekly hours of work wished for. This information provided by the labour supply enables calculating a potetial work volume that comprises the realised and non-realised volume of work. The procedure adopted is as follows.

If the number of weekly working hours an individual wishes to have is greater than the weekly hours actual regularly worked, this is interpreted as non-exploited labour supply. The difference between these two values extrapolated for the year provides a figure for the non-exploited individual potential work volume. If the ratio between desired and realised weekly working time is the other way around or balanced (smaller or the same), working time wished for is not taken into account because the fact that the working time actually realised is higher, thus making it clear that the potential is larger than the working time wished for.

Individual volumes of work realised and individual work volume potential are aggregated separately by gender, age groups, qualification levels and occupational fields so that a weighted average of realised volumes of work and potential work volume extrapolated to the population is calculated for each resulting partial group. This procedure can only be used in the way described here for persons who are gainfully employed. For this reason, unemployed persons are assumed to behave in precisely the same way or exhibit the same work volume potential as economically active persons with the same characteristics (age, gender, qualification).

The annual working time is calculated first of all by feeding volume of work by sectors vow_i into the Microcensus data where $i = 1, 2, .., 63$.[3] On the basis of weekly hours worked whw_i where $i = 1, 2, .., 63$ and labour demand by sector of the economy $ld_{i,t}$ (in the Microcensus), annual weeks of work $aww_{i,t}$ are calculated for every sector of the economy and for every year t where $t = 2005, ..,2011$.

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[1] The probability for each system position is calculated in the new system relative to the corresponding observed system position in the old system on the basis of the empirical frequency distribution of the new system (WZ 2008) to the old system (WZ 2003). The imputation on the basis of the probabilities proportional to size takes place in 20 separate repetitions. The mean value is then calculated.

[2] Our warmest thanks are due at this point to Dr. Robert Herter-Eschweiler from the Federal Statistical Office in Bonn (Group F2) in Bonn for making available his extensive work with regard to the concept and technical realisation in SAS(c) (FEDERAL STATISTICAL OFFICE 2010).

[3] The volumes of work by industry ("Hours of work performed by persons who are economically active" from Specialist Publications Series 18 Series 1.2 Table 2.2.8) are only reported for 48 economic sectors in the National Accounts. Extension to the necessary 63 structure takes place under the assumption that volumes of work in the individual sub-sectors are distributed similarly to labour demand per capita.

[1] $aww_{i,t} = \frac{vow_{i,t}}{ld_{i,t} * whw_{i,t}}$ where $i = 1, 2, .., 63$ and $t = 2005, ..,2011$

On the basis of the annual weeks of work calculated in [1], actual annual hours worked [2] and maximum (desired) annual hours worked [3] can be calculated for each individual aggregate:

[2] $vow_t = whw_t * aww_t$ where $t = 2005, ..,2011$

[3] $vow^{max} = \max_t(whw_t{}^{max} * aww_t)$ where $t = 2005, ..,2011$

The total of all aggregates calculated on the basis of equation [2] corresponds to the actual annual hours worked, whereas the total of all aggregates calculated on the basis of equation [3] represents the maximum potential annual working time. For the projection, we assume that the maximum volume of work or potential work volume reached on a single occasion remains retrievable in the future (cf. Zika et al. 2012: 8).

3 Structural change and realised demand

This section explains the modelling of labour market demand. This relates labour demand to realised labour demand. We define realised demand as the number of workers and hours of work needed to manufacture and provide the total number of goods and services produced in Germany. In determining labour demand, so-called vacancies are not taken into account (see Section 2.2). Because of the large number of relevant parameter values, a model-based projection system for forecasting the labour market is used to record the economic complexity. Although in the short term it is crucial how rapidly the consequences of the euro crisis can be overcome, future structural change is the essential long-term determinant of the labour demand. In order to be able to cover structural change sufficiently, we use the QINFORGE model developed by GWS mbH, a further development of the INFORGE model. INFORGE is an econometric prognosis and simulation model for the Federal Republic of Germany that is deeply disaggregated by production areas and groups of goods. Detailed descriptions of the model are contained in Meyer et al. (2007) and in Schnur and Zika (2009). In the model, labour demand and volume of work are disaggregated by 63 economic sectors (Table 5) and industry (Table 5), 54 occupational fields (Table 4) and 5 qualification levels (Table 1). The demand-side modelling of the labour market in the QINFORGE model ultimately pursues two key objectives.

1. Industrially and occupational field specific structural change should have recognisable effects in the projection of labour demand and hours worked. Particular consideration should be accorded to the interdependences between economic sectors and occupational fields.
2. The projections of labour supply and labour requirement, which hitherto have been largely independent of each other, should be more strongly linked. Although labour supply was taken into account in the previous modellings, this only took place at a highly aggregated level with regard to determination of the macro-wage (Schnur and Zika 2009). In the new modelling, labour supply is now also included at the occupational field level by integrating a measure of scarcity in the determination of the wage for the occupational field to reflect the supply-side labour market situation at the occupational field level.

In order to be able to model the wage dependency of the labour demand in the occupational field within the industry, additional data information is required that makes the wage identifiable per occupational field and sector. For this purpose, data needs to be extracted from three different sources and matched. Data information relevant to the demand side comes from the

Employee History Data (BEH) of the IAB, from the Microcensus and from the National Accounts. The last of these acts as a benchmark for data adaptations.

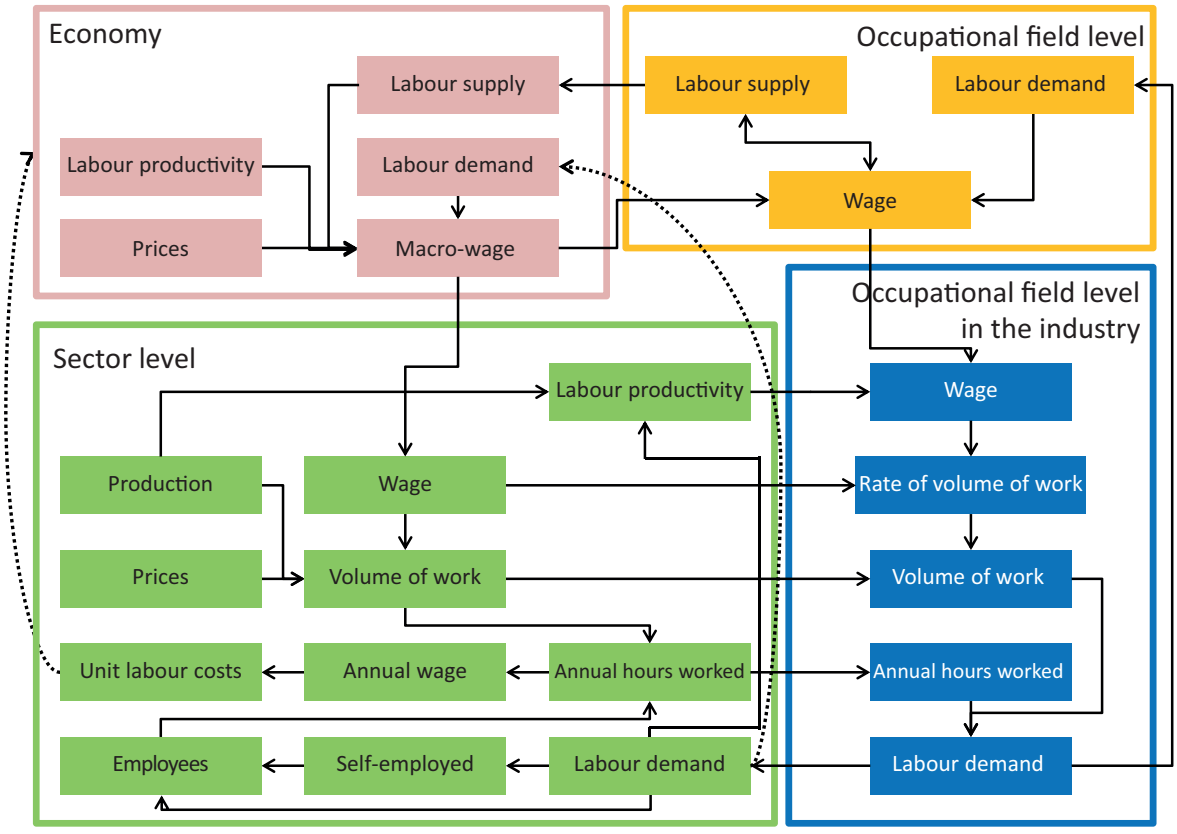
The following information from the various data sources is used.

- Employee History Data: employees subject to social insurance contributions, working days per person and wage totals for the years 1993 to 2011 by economic sectors, occupations exercised and qualifications.
- Microcensus: Labour demand, weekly hours worked and weekly working time for the years 1996 to 2011 by economic sectors, occupation exercised and qualifications.
- National Accounts: labour demand, wage totals, volumes of work and hourly wages by areas of trade and industry for the years 1991 to 2011.

3.1 Labour demand by occupational fields and economic sectors

As previously, the modelling of the labour market is based on the concept of labour demand. Labour demand by 63 economic sectors (2008 Classification of Economic Activities) and 54 occupational fields (cf. Tiemann et al. 2008) is the result of the ratio between volume of work and annual hours worked. Whereas annual hours worked within the occupational field and industry are, as in the publications relating to the first and second wave of the QuBe Project, mainly determined by a time trend and by the number of public holidays in the sector, the modelling of the volume of work in particular has been adapted for the third wave. The order of determination for labour demand by economic sectors and occupational fields can, insofar as this is effectively possible in an iterative solution procedure, be represented as in Figure 2 below.

Figure 2: Summary of the demand side of the labour market modelling within the economic context



Source: own representation

The individual modelling steps are described in more detail below on the basis of Figure 2. The different colours in the figure mark the various disaggregations. The pink boxes are economic values, green stands for the sector level, orange for the occupational field level and finally blue for the occupational field level in the economic sector. The arrows indicate the channels. The starting point for the representation is the wage formation in the economy in the top left-hand corner. This initially connects with the wage formations in the further disaggregation levels, the derivation of the volume of work and the calculation of the annual hours worked. We then move to consider interaction with the economic core. In the following remarks, the general principle is that designations of variables in capital letters relate to the economy whereas variable in lower case letters are disaggregated values.

The occupational field wage is defined as wage per person per working day in the occupational field (see equation [4]), which is taken from then BEH. The ratio states the amount of the wage earned per full-time worker on one working day. Wage in occupational field (w_o) is based on an estimated approach in which the wage (W) in hours and as a measure of scarcity the ratio between labour demand (ld_o) and labour supply (ls_o) in the occupational field exercised are used as explanatory variables. W in turn is dependent on labour productivity per person (LPP), prices (P) and the aggregated labour market situation, i. e. the ratio of labour demand (LD) to labour supply (LS), and is determined in the INFORGE economic core model (see equation [5]).

[4] $w_o = \beta_1 + \beta_2 * W + \beta_3 * \frac{ld_o}{ls_o}$ o = [1 – 54]

[5] $W = \beta_1 + \beta_2 * LPP + \beta_3 * \frac{LD}{LS}$

The estimating equation [4] provides results with a high degree of explanation. 53 of the 54 occupational field wages reach a coefficient of determination (R^2) of over 90 %, which allows us to conclude a high statistical correlation between the dependent and independent variables.

The influence of the measure of scarcity is, however, not observable in all occupational fields. In some occupations, such as chemicals and plastics, the mismatch between supply and demand per capita has a significant influence on wage development. In other occupations, such as in the case of the administrative occupations in the public service sector wages are not affected by this, this influence does not occur. The reason for this may be that no scarcities were observable in some occupational fields in the past or a disproportionately large impact exerted by wage (W), which superimposes the effect of the measure of scarcity.

The wage development of the occupational field in the specific sector is then explained using the wage in occupational field (w_o) and labour productivity in the industry (lpp_i). In the present approach, two data sets (Employee History Data and National Accounts) are used as explanatory variables. Whereas wage in occupational field in the industry ($w_{o,i}$) is produced from the Employee History Data and is thus aligned to employees subject to social insurance contributions, sector-specific nominal work productivity is determined on the basis of labour demand numbers. 3402 elements are estimated via the approach adopted in equation [6]. In light of the scope involved, automation of the estimating procedure was undertaken requiring defined testing measures to be passed. The autocorrelation test (Durbin Watson) and the test for systematic differences within the time series (t-Test) were also conducted.

For some sector-specific wages in occupational fields no significant correlation could be identified. For this reason, in such cases the prevailing wage in occupational field (w_o) was used for updating). The regression approach enabled a total of 1811 elements to be estimated, where over 4/5 of all cases achieved an R^2 of over 70 %. Per capita, 72 % of the labour demand are reached by the estimation approach adopted in equation [6]. Only 28 % of labour demand need to follow the default case.

[6] $w_{o,i} = \beta_1 + \beta_2 * w_o + \beta_3 * lpp_i$ o = [1 – 54], i = [1 – 63]

Volume of work by occupational field and sector ($vow_{o,i}$), which is defined in millions of hours, is subsequently determined with the aim of integrating an occupational field and sector-specific wage correlation. The objective was for wage changes in sector-specific occupational fields to influence the relevant demand for hours of work. The hypothesis is that volume of work falls when the wage in occupational field in the industry rises more quickly than the average wage in the sector as a whole. Alongside the wage correlation, the time trend (t) is included in the estimating equation as a main explanatory variable. This assumes an autonomous influence on volume of work as can be caused, for example, by technological progress (KLAUDER 1986). The database for volume of work by sectors and occupational fields is formed by the Microcensus, which has been scaled to the marginal totals of the National Accounts (see Chapter 2.4). Various alternative estimation approaches were tested, the best proving to be the estimation of rates of volume of work by occupational field in the industry ($uow_{o,i} / vow_i$) (equation [7]). A total of 3402 elements need to be determined in equation [7]. Nevertheless, gaps arise in the time series in the case of volume of work, for which reason the matrix elements are reduced to 2032 combinations. As is the case with the wage estimate, testing measures also apply when estimating the volume (Durbin-Watson and t-Test). In case of exclusion, the rates are left constant. Because, however, a scaling of the estimated rates to 100 percent finally needs to be performed, a movement of all rates of volume of work is guaranteed.

[7] $\frac{vow_{o,i}}{vow_i} = \beta_1 + \beta_2 * \frac{w_{o,i}}{w_i} + \beta_3 * t$ o = [1 – 54], i = [1 – 63]

Volume of work by occupational field and economic sector ($vow_{o,i}$) is finally obtained by multiplying rates of volume of work by occupational field in the sector ($vow_{o,i} / vow_i$) with the volume of work by sectors (vow_i). The latter is determined in the economic core model INFORGE depending on real sector-specific production ($output_i$) and the real hourly wage rate (w_i / p_i). Autonomous technological time trends (t) are also tested as explanatory variables here.

[8] $vow_i = \beta_1 + \beta_2 * output_i + \beta_3 * \frac{w_i}{p_i} + \beta_4 * t$ i = [1 – 63]

[9] $vow_{o,i} = \frac{vow_{o,i}}{vow_i} * vow_i$ o = [1 – 54], i = [1 – 63]

In order to ultimately arrive at labour demand by occupational fields in the economic sectors ($ld_{o,i}$), annual hours worked by occupational fields in the sector ($ahw_{o,i}$) need to be determined. The database for this is once again the Microcensus, which provides the necessary data on volume of work and the labour demand. Annual hours worked in the occupation are updated with the sector-specific annual hours worked per person (ahw_i).

[10] $ahw_{o,i,t} = ahw_{o,i,t-1} * \frac{ahw_{i,t}}{ahw_{i,t-1}}$ o = [1 – 54], i = [1 – 63]

Equation [9] and [10] produce labour supply by 54 occupational fields exercised and 63 economic sectors.

[11] $ld_{o,i} = {vow_{o,i}}\Big/{ahw_{o,i}}$ o = [1 – 54], i = [1 – 63]

The improvements described for the projection of realised development in demand on the labour market mean that it has been possible for the first time to integrate labour scarcity at occupational field level into the modelling of the labour demand. The ratio between realised labour demand ($\_d_o$) and labour supply (ls_o) thus now has an influence on wage formation.

Alongside this, the sector-specific structures and dynamics of the economic core modelling exert a stronger influence on composition and development in the individual occupational fields than in the second wave of the QuBe Project. Sector-specific volume of work (vow_i), annual hours worked (ahw_i) and wage (w_i) in particular are closely tied to the structures specific to the occupational field.

The effects emerging from the labour market for the rest of the economy are in particular realised via annual wage (aw_i) and unit labour costs (ulc_i) and therefore via the macro-economic price level (P), the real wage (w_i / p_i) and production in real terms ($output_i$). Disposable income, which is essentially determined by real wages, influences the consumer behaviour of private households. Investment decisions, on the other hand, depend on production expectations in the individual sectors. They generate sector-specific labour demand, which in turn will bring about changes in wages, labour demand and volume of work by occupational field.

3.2 Labour demand by qualification levels

As at the industry and occupational field level, labour requirement is projected at the qualifications level both in hours (volume of work) and in persons (labour demand). Notwithstanding this, annual hours worked do not need to be estimated at the qualifications level. Labour demand and volume of work are determined using the same methodology, for which reason estimation of the qualification trend will only be explained on the basis of the example of the estimation of labour demand.

The starting point for the projection of labour demand by qualifications is the projection by occupational fields described in the preceding chapter. As in the previous waves, structural information from the Microcensus is used for this purpose. A new aspect compared to the second wave is that wage information from the Employee History Data collected by the IAB is also included. The Microcensus enables us to determine how many people working in an occupational field have acquired a certain formal qualification. This information enables qualification shares to be calculated for every occupational field. For the projection, these qualification shares within an occupational field are updated for the future using the logistic trend approach, in which both the time trend and qualifications-specific wages within the occupational field have an impact (equation [12]). The latter are taken from the IAB Employee History Data. Taking the time trend into account means that an autonomous technological influence on qualification development within the occupational field is also assumed here.

$$[12]\quad qs_{q,o} = \frac{sl_{q,o}}{1 + exp(\beta_1 + \beta_2 * t + \beta_3 * \Delta w_{1,o} + \beta_4 * \Delta w_{2,o} + \beta_5 * \Delta w_{3,o})} \qquad o = [1-54],\ q = [1-5]$$

$qs_{q,o}$ designates the qualification share of the *q*-th qualification level in the occupational field $(o = 1, \cdots, 54)$. A total of 5 qualification levels are differentiated on the basis of the ISCED (cf. Table 1). The choice of the logistic trend estimate ultimately assumes that the shares to be estimated approach the saturation level $sl_{q,o}$ asymptotically from below. $\Delta w_{1,o}$ is the growth rate of the wage of a low-skilled person (ISCED 1, 2 & 3a) or of a school pupil. $\Delta w_{2,o}$ is the growth rate of the wage of a person who has completed a company-based apprenticeship or full-time vocational school (ISCED 3b & 4) or may have gone on to obtain a trade and technical school qualification such as master craftsman or technician (ISCED 5b) and $\Delta w_{3,o}$ refers to a highly qualified person (ISCED 5a & 6) in the occupational field *o*.

The choice of the logistic trend estimate ultimately assumes that the shares to be estimated approach the saturation level $sl_{q,o}$ asymptotically from below. The time index *t* has been omitted in the interests of clarity.

Qualification-specific wages in the occupational field or the growth rates of such wages were estimated depending on specific wages in the occupational field, i. e. wages by occupational fields exercised w_o.

Notwithstanding this, equation [12] only applies to qualification shares that exhibit a rising trend. Because shares must, by their very nature, always lie between 0 and 1, the following approach is estimated in the case of a decreasing trend.

$$[13]\quad qs_{q,o} = 1 - \frac{sl_{q,o}}{1 + exp(\beta_1 + \beta_2 * t + \beta_3 * \Delta w1_{,o} + \beta_4 * \Delta w2_{,o} + \beta_5 * \Delta w3_{,o})} \qquad o=[1-54],\ q=[1-5]$$

Equations [13] and [14] can be combined to form:

$$[14]\quad qs_{q,o} = X_{q,o} + \frac{sl_{q,o}}{1 + exp(\beta_1 + \beta_2 * t + \beta_3 * \Delta w1_{,o} + \beta_4 * \Delta w2_{,o} + \beta_5 * \Delta w3_{,o})} \qquad o=[1-54],\ q=[1-5]$$

where $$X_{q,o} = \begin{cases} 1 & decreasing\ trend \\ 0 & rising\ trend \end{cases}$$

and $$sl_{q,o} \in \begin{cases} -\left[\left(1 - \min_{t\in[1996;2011]} qs_{q,o,t}\right); 1\right] & decreasing\ trend \\ \left[\max_{t\in[1996;2011]} qs_{q,o,t}; 1\right] & rising\ trend \end{cases}$$

It should be noted that the saturation level must always be larger than any value observed in the past (rising trend) or smaller than the smallest value (falling trend).

Conversion produces

$$[15]\quad log\left(\frac{sl_{q,o}}{qs_{q,o} - x_{q,o}} - 1\right) = \beta_1 + \beta_2 * t + \beta_3 * \Delta w_{1,o} + \beta_4 * \Delta w_{2,o} + \beta_5 * \Delta w_{3,o} \qquad o=[1-54],\ q=[1-5]$$

Although the parameters of the equations [15] are relatively easy to determine, these parameters and the resulting test statistics are dependent on the choice of the saturation level $sl_{q,o}$. Because no saturation levels can be derived from the available literature, they are determined on the basis of statistical criteria. In order to determine the saturation level, therefore, tests were carried out on steps of 0.001 for every possible value of $sl_{q,o}$. For this purpose, initially it was tested which of the variables are significant at the 10 percent level, and the Durbin-Watson test statistics were subsequently determined. Of the saturation levels fulfilled by the Durbin-Watson test statistics, those with the highest coefficient of determination were ultimately taken.

Because by definition all qualification shares within an occupational field must add up to one, it would be useful to estimate the five qualification shares of an occupational field as a model system with a constraint. Nevertheless, it has emerged that no useful parameter estimation is possible. For this reason, the shares were estimated individually and normed to one:

$$[16]\quad \widehat{qs_{q,o,norm}} = \frac{\widehat{qs_{q,o}} + \widehat{\varepsilon_{q,o}}}{\sum_{i=1}^{5}\left(\widehat{qs_{q,o}} + \widehat{\varepsilon_{q,o}}\right)} \qquad \text{where } \widehat{\varepsilon_{q,o}} = qs_{q,o,2011} - \widehat{qs_{q,o,2011}} \qquad o=[1–54],\ q=[1–5]$$

A consideration of the estimation error at the current margin $\widehat{\varepsilon_{q,o}}$ ensures that inexplicable leaps do not occur in the the first year of the projection. By multiplying the projected qualification shares with labour demand by occupational fields and then calculating a total across all occupational fields, we finally arrive at labour demand by qualification level:

[17] $ld_{q,o} = \widehat{qs_{q,o}} \cdot ld_o$ o=[1–54], q=[1–5]

[18] $ld_q = \sum_{o=1}^{54} ld_{q,o}$ q = [1 – 5]

As mentioned at the beginning of this section, qualification-specific volumes of work are determined according to the same methodology.

4 Labour supply by qualifications and occupational fields

For reasons of model plurality, the first and second waves of the QuBe projections used two supply models in order to learn more about the effects of different ways of modelling. Whereas the BIBB-FIT model (Kalinowski and Quinke 2010) was already used in the Federal Government-Federal States Commission for Educational Planning and Research Promotion (BLK) projections (BLK 1995, BLK 2002, Bonin et al. 2007) and placed its focus on an explicit modelling of the vocational education and training system and of the transitions between the VET system and the labour market, the BIBB-DEMOS model (Drosdowski and Wolter 2010) models qualification trends from the Microcensus that are recognisable on a long-term basis. The BIBB-DEMOS model also exhibits interfaces to the IAB-INFORGE model, which also ultimately links supply to demand data. The benefits of the two supply models are combined in the third wave of the QuBe Project. The BIBB-FIT model develops a population projection by qualification levels and occupations (Chapter 4.1 to 4.3). This population projection is subsequently integrated into the BIBB-DEMOS model (Chapter 4.4), and the rates of employment of individuals are updated (Chapter 4.5). Ultimately, labour demand is available to the labour market with the occupation trained for. Depending on economic development and the occupational flexibility linked with the occupation learned (Chapter 5), such persons form a potential labour supply for every occupational field.

4.1 Demographics and population development

The aim of labour projections is to determine the amount of future labour supply. If a population prognosis is in place for the projection period, then the fundamental labour potential is determined in advance. For this reason, the results of a projection of the future labour supply depend strongly on the selected model of population forecast available and from the current validity of such a forecast (Chapter 4.2).

In contrast to the first two waves, the third wave of the qualifications and occupational field projections takes into account Version 1-W2 of the 12th Coordinated Population Forecast published by the Federal Statistical Office. The strong decrease in net migration observed in the year from 2008 to 2010 proved to be a statistical effect caused by corrections to the electoral register and official deregistrations (Federal Statistical Office 2013b). From 2010, on the other hand, net immigration increased strongly. This is the key argument for using the “upper limit of the medium population” as the reference for future population development rather than the “lower limit of the medium population”. The net migration currently being observed even considerably exceeds the assumptions of the “upper limit of the medium population” of the Coordinated Population Forecast. Preliminary results from the migration statistics of the Federal Statistical Office show that net migration rose to around 369,000 persons in 2012

(Federal Statistical Office 2013a). According to version of the Coordinated Population Forecast currently being used, Version 1-W2, net migration for the year 2012 is only 80,000 persons. The assumption is that the current relatively high level of net immigration to Germany is a reaction to the recent crisis in some European countries (Bertoli et al. 2013) and that, in the light of the impending demographic challenges facing Germany, migration movements will in the long term stabilise at a higher level than the average of the last decade.

The most important assumptions of the selected version, "upper limit of the medium population" of the Coordinated Population Forecast, may be summarised as follows (cf. Federal Statistical Office 2009).

- Fertility rate (children per woman) will remain virtually constant in the projection period at a value of 1.4.
- Life expectancy (basic assumption) will rise by 7.8 years for men and by 6.8 years for women by 2060.
- Upper limit of the population: from the year 2020, an annual net migration rate (arrivals minus departures) of 200,000 persons is calculated.

This version of the population takes adequate account of both the actual status of the population and of currently expected developments.

4.2 Consideration of the results of the 2011 Census

Publication of the results of the 2011 Census made it necessary to correct the previous results of the population forecast by around 1.5 million persons. In this process, as Table 2 shows, deviation by age class is not evenly distributed.

Table 2: Comparison between the previous population forecast and results of the 2011 Census

Absolute	Difference: 2011 Census – Population Forecast as of 30.04.2011					
	Total	Year of birth from … to …				
		2011-1994	1993-1982	1981-1962	1961-1947	1946 and earlier
Germany	-1 509,5	- 96,6	- 247,7	- 564,1	- 275,3	- 325,8
Schleswig-Holstein	- 33,7	- 4,6	- 9,9	- 15,8	4,4	- 7,7
Hamburg	- 82,8	- 4,2	- 10,0	- 45,5	- 9,7	- 13,4
Lower Saxony	- 136,5	- 11,2	- 30,4	- 43,8	- 18,8	- 32,3
Bremen	- 9,3	- 1,1	,1	- 2,2	- 3,1	- 3,1
North Rhine-Westphalia	- 297,5	- 38,6	- 73,0	- 71,8	- 51,7	- 62,4
Hessen	- 98,6	- 4,1	- 9,8	- 28,1	- 22,6	- 33,9
Rhineland Palatinate	- 9,2	1,0	- 2,4	- 1,1	2,1	- 8,9
Baden-Württemberg	- 271,3	- 6,7	- 17,6	- 125,2	- 62,9	- 58,9
Bavaria	- 148,3	- 8,2	- 24,9	- 56,9	- 20,6	- 37,8
Saarland	- 15,7	- 2,6	- 2,7	- 6,7	- ,5	- 3,3
Berlin	- 179,4	- 7,0	- 31,2	- 77,3	- 36,6	- 27,4
Brandenburg	- 43,5	- 1,8	- 7,4	- 18,1	- 10,6	- 5,4
Mecklenburg-Western Pomerania	- 28,3	- 1,0	- 2,3	- 12,0	- 8,1	- 5,0
Saxony	- 84,4	- 3,5	- 14,8	- 32,5	- 20,2	- 13,3
Saxony-Anhalt	- 40,1	- 3,0	- 9,9	- 11,2	- 8,3	- 7,7
Thuringia	- 40,7	- 2,1	- 2,6	- 19,9	- 10,7	- 5,5

Figures in thousands of persons.

Source: www.zensus2011.de, calculations and representations of the QuBe Project.

The most current population prognosis of the Federal Statistical Office is based on the results of the 2008 Population Forecast. This means action is urgently required. In order to be able to include the current developments in the population in both absolute terms and in terms of their changed age structure, the version of the population prognosis used was adapted to the

new results of the Census. The population (pop) used in the model takes into account – in line with the Coordinated Population Forecast (pop_k) – the deviation of the population forecast (pop_f) in the initial year t_0 from the available results of the Census (pop_z) in the initial year t_0 by times of birth tb and gender s. Population amounts for all $t > t_0$ were calculated on the basis of the following scheme:

[19] $$pop_{t,tb,s} = pop_{k_{t,tb,s}} * \frac{pop_{z_{t_0,tb_0,s}}}{pop_{f_{t_0,tb_0,s}}} \qquad \text{where } tb_0 = \min(t_0, tb); t = 2012,\ldots,2030;\ t_0 = 2011$$

Notwithstanding the adaptation, the fundamental assumptions of the selected version of the 12th Coordinated Population Forecast and the amount of natural population movement and of net migration from the initial year apply.

4.3 Qualification and occupation specific population projection

Available population projections do not deliver any information on future qualifications or occupational structure. They simply act as if-then models, providing an indication of how the population will develop in overall terms under the assumptions made. The objective of the qualifications and occupational field projections is, however, to represent the population amount in the projection period by qualifications levels and occupation trained for and to use projected labour force participation (cf. Chapter 4.5) to help determine the future labour supply by qualification levels and occupation learned. Those leaving the educational system together with their formal qualification and the occupation for which they have been trained are of particular significance. They determine, together with migration, the future qualifications and occupational structure of the population.

As in the supply projections previously published (cf. Bonin et al. 2007, Helmrich et al. 2012d, Kalinowski and Quinke 2010), the BIBB-FIT model is based on partial models which are linked with and build on one another. The foundation for the construction of the model is the division of the population into three groups. The first group is represented by children who have not yet reached school age and pupils in general schooling. The second group comprises pupils at vocational schools (including schools within the healthcare system), apprentices in company-based vocational education and training and students at institutes of higher education. This area is also designated as “vocational education and training system”. All other persons, who are referred to in abbreviated form as “persons not in training”, including those performing military and civilian service, form the third group. This comprehensive approach means that the model can be harmonised with the official population projection, whereby the first group is included in a rudimentary way only. The models are calibrated in such a way so that the benchmark data of the population corresponds to the population forecast and, from 2012, to Version 1-W2 of the 12th Coordinated Population Forecast, adapted to the results of the 2011 Census (cf. Federal Statistical Office 2009).

The projection is based on two essential elements. The first module is made up of the population of the base year of 2011, which is structured according to age, gender, qualification level and occupational field. The basis for this is the detailed evaluations of the Microcensus carried out by the BIBB (cf. Chapter 2.4). The second module is the model of the vocational education and training system including the institutes of higher education, which maps the populations of the individual training centres and the transitions between the individual educational and training establishments and the labour market. The FIT transition model of the vocational education and training system and of the institutes of higher education build on methods and results from the National Educational Accounts (BGR) prepared by the IAB (see Reinberg and Hummel 2002 in this regard). The most important objective is a consistent mapping over the

course of time of populations and transitions in the educational system in order to facilitate analyses of cohort, age and period effects.

Unlike the BGR, the primary objective of the transition model of the FIT is the mapping of persons leaving the educational system and thus the projection of new supply of human capital on the labour market. Analyses of leavers and their qualifications structure in the past form an important basis for forecasts of the future qualification structure of the population and enable a better interpretation of the projection results.

The conventions of the BGR dictate that numbers of persons are recorded at the beginning and end of the year and that these persons must be allocatable to a population stock account. This already creates a major initial hurdle with regard to the creation of an arithmetic unit that is consistent over the course of time and which aims to enable an overall consideration of stocks and flows in the educational system. One problem area in the development of a consistent model is based on the circumstance that although there are a large number of statistics and surveys mapping the educational and employment system, these are largely available in the form of differing recording concepts and delineations and provide various levels of aggregation. This means that surveys such as the Microcensus offer a good opportunity to analyse the educational and employment system but that evaluations of smaller sub-populations can attract not inconsiderable sampling errors.

The use of different data sources necessarily leads to double counts and thus to inconsistencies in the stock data during the actual period. An iterative RAS algorithm is initially used to cleanse the stock data of the BGR and to adapt it to the population structure at the end of the year and to the stocks in the respective status accounts (Blien et al. 1990). This stock data forms the basis for the determination of the transitions between the individual status accounts and thus the empirical foundation for the further calculations. Because the BGR has been discontinued by the IAB, the FIT has taken over the updating process for the projection of necessary population stocks and transitions in vocational education and training including institutes of higher education.

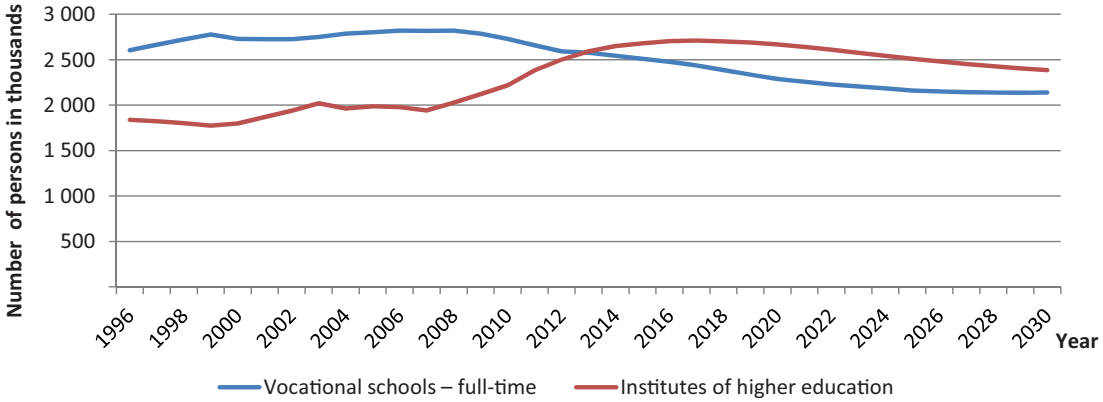
During the projection period, the arithmetic unit is adapted to the benchmark values of external forecasts of the future development in the school and higher education sector. The forecasts used here (KMK 2012, KMK 2013) should be interpreted as conditional projections, the assumptions of which are set out in the respective publications of the Conference of the Ministers of Education and Cultural Affairs in the Federal Republic of Germany (KMK). In order to secure the quality of the results achieved, however, the current validity of such results must, as is the case with the population forecast, be guaranteed or else the results need to be supplemented by current developments in the school and higher education sector.

Whereas the forecast in the school sector contains pupil populations and leavers, only an interim status of the forecast of persons entering higher education study was available at the time when the projection was drawn up. The number of higher education graduates is the result of the forecast number of persons entering higher education using transition and success rates from the year 2011 which are kept constant over the projection period.

Adaptation of the model to the benchmark values of the KMK forecasts and of values derived for the higher education sector has been carried out via suitable adaptation of the transition rates. This means that departures from the vocational education and training system correspond to the future development set out by the KMK forecasts. The KMK forecasts, which crucially determine new supply from the educational system, end with the year 2025. For the projection period following 2025, internal transition rates within the model have been stipulated at the status of the year 2025. The rates which have led to the KMK results for the year 2025 are thus used for the period after 2025. The overall assumption is of structural constancy in the educational system from 2025.

During the projection period, the development of the population stocks in the educational system is characterised by a relatively high increase in the numbers of higher education students until the winter semester of 2017/18. This is caused by the recent relatively high increase in the number of persons entering higher education. If transitional behaviour in the higher education sector remains constant from the year 2012, for demographic reasons the number of persons entering higher education will fall and also, after the relevant time lag, a corresponding decrease in the numbers of students in higher education will resume. A decrease in the numbers of students in the vocational school sector has been observable since as long ago as 2008, and this will, according to the KMK forecast, continue during the project period for demographic reasons. The assumptions regarding the development of stocks of pupils and students are presented in graphical form in Figure 3.

Figure 3: Assumptions regarding the development of the stock of pupils and students



Source: (KMK 2012, KMK 2013), calculations and representations of the QuBe Project

A further partial model subdivides net transitions from the educational system to the labour market by age, gender, qualification level and occupational field. The distribution of the new supply by occupation is based on the Microcensus-based evaluations of leavers from the VET system by occupational field provided by BIBB. Updating of the population to persons outside the educational system by occupational field, qualification, gender and age to the end of the year respectively takes place in a concluding partial model. Within this process, the population at the end of the year is the same as the population of the previous year plus net transitions from the educational system, plus net migration and minus deaths. The projection assumes that net migration exhibits the same qualifications and occupational structure as those leaving the educational system (neutrality hypothesis). Qualification and occupational field specific participation rates then enable the labour supply by qualification levels and occupational fields to be determined from the identified stocks of persons (cf. Chapter 4.5). For this purpose, however, the population projection firstly needs to be integrated into the overall QuBe model.

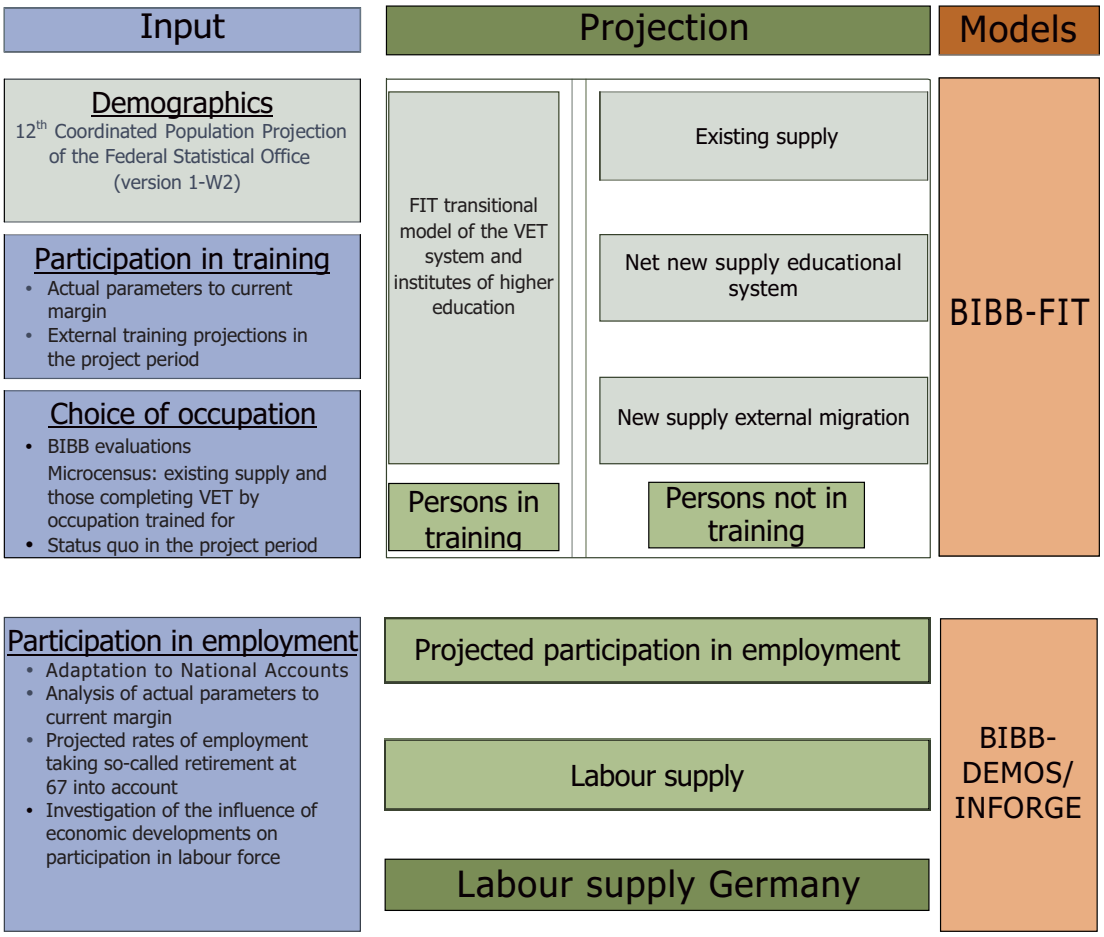
4.4 Integration of the BIBB-FIT model into the overall QuBe model

In contrast to work carried out within the BIBB-Fit model thus far (cf. Bonin et al. 2007, Helmrich et al. 2012c, Kalinowski and Quinke 2010), the stage of determining future labour supply via projected participation rates is omitted. Projection of participation rates and determination of the future labour supply takes place in the third wave of the QuBe Project within the BIBB-DEMOS model. The closer integration of both supply models (BIBB-DEMOS and BIBB-FIT) is initially conducted on a step-by-step basis.

The first stage of the model integration comprises data exchange between the two models. This solution was realised with the third wave in 2013. In this process, BIBB-FIT projection

results regarding the future population by sex, age class, qualification levels and occupational fields, in each case separated according to persons in training and persons not in training, are adopted from the BIBB-DEMOS model, and the labour supply is subsequently calculated (cf. Figure 4). A second stage of model integration can conceivably involve focusing on the implementation of endogenous market clearing processes on the supply side. This then requires a more intensive data exchange between the three partial models of BIBB-FIT, BIBB-DEMOS and IAB-INFORGE.

Figure 4: Integrated labour projection, 3rd wave



Source: Presentation of the QuBe Project

4.5 Development of labour force participation

Once the qualification and occupation specific population projection has been integrated into the BIBB-DEMOS partial model, the participation rate is determined. In determining the labour force participation (rate), the selection of the denominator population is crucial to the size of the rate. If the ratio of the total labour supply compared to total population is taken, then the average participation rate is 53.6 % (Federal Statistical Office 2013c). Because, however, a large section of the population is generally viewed as being incapable of working, the ratio which is usually taken is labour supply compared to the population capable of working. This refers to the number of persons aged over 14 and under 65. This age-group specific participation rate is significantly higher at 81.5 %. Whereas since 2005 the average participation rate has risen by 0.9 percentage points from 52.7 % to 53.6 %, the age-group specific rate of employment has increased by 2.5 percentage points from 79 % to 81.5 % (Microcensus evaluations carried out by BIBB and the Federal Statistical Office 2013c). A different choice of denominator population thus also produces a different dynamic in the participation rate. The par-

ticipation rates stated below are all age-specific, i. e. the numerator and denominator population have the same properties with regard to age. If the labour supply is related to all age groups, they are designated as average (rates) of the propensity to participate.

The data available for the years 2005 to 2011 is based on Microcensus evaluations conducted by BIBB (Chapter 2.4). As described, this process involves adjusting the labour supply to the results of the National Accounts. The rates of employment ls / pop by sex (s), age groups (a) and formal qualification levels (q) (ISCED) are updated with decreasing trends.

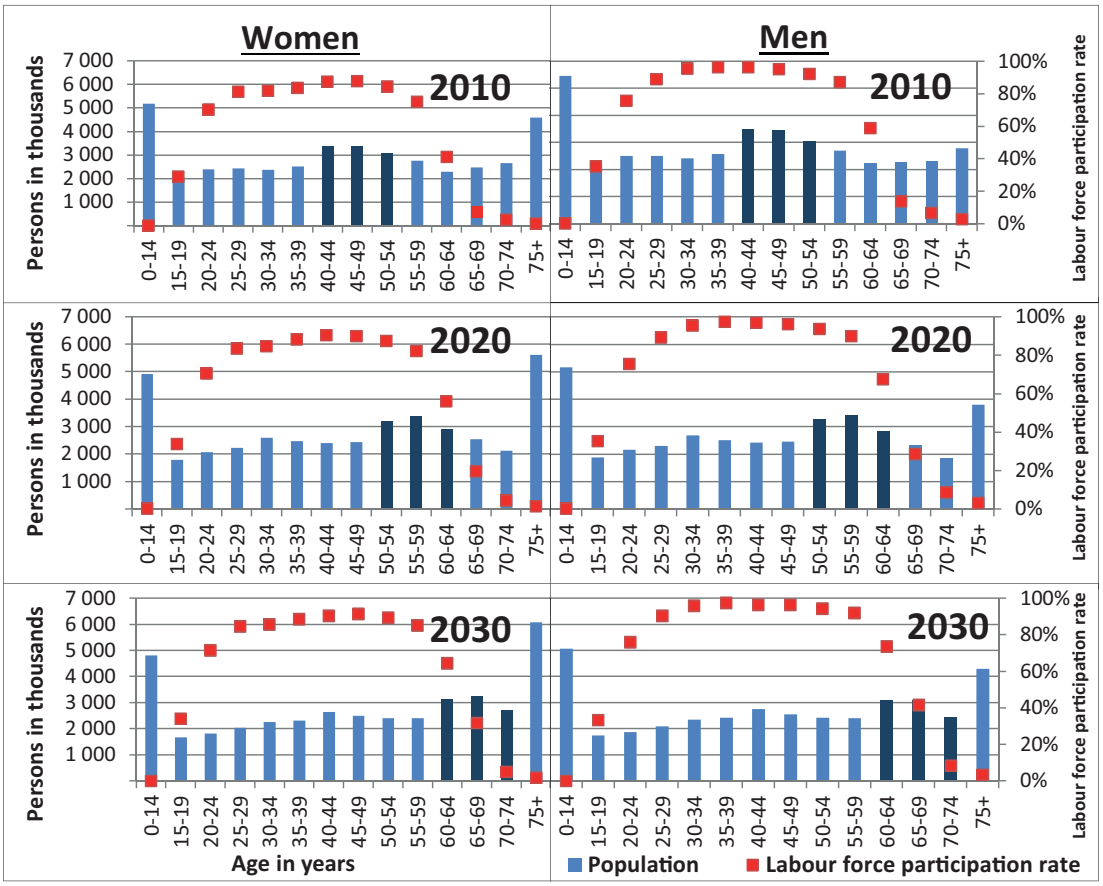
$$[20]\ \ln\left(\frac{ls_{s,a,q}}{pops,a,q}\right) = a + b * \ln\left(\frac{1}{t-c}\right)$$

The parameter c makes it possible to adjust the slope of the trend to the development in the past, insofar as the estimated results – measured on the basis of the t-statistics and R^2 – improve using this process. t represents a linear time trend and the coefficient b is the elasticity due to the double logarithmic representation. The calculated labour force participation rates are transferred in terms of their dynamic to the development of participation rates by occupational fields. 14 age groups and four qualification levels (see Table 1) are differentiated for women and men. Persons in training are also once again subdivided by their previous qualification status in accordance with the status quo of the year 2011 (ISCED 0 – 3a, ISCED 3b and 4, ISCED 5b, ISCED 5a and 6). The labour force participation rates produced are then tested for plausibility. The following assumptions are made for the reference scenario, which below applies as the forecast against which all alternative calculations are reflected.

- Participation rates above 10 % are not permitted. Such participation rates are reset to 99.8 %.
- If participation rates of women from a certain group are historically below the participation rates of men from the same group (e. g. ISCED 3a, age group 35 to 39 years) and if the trend estimates cause the participation rates of the women to rise above the rates of men in future, such a case is prevented. An “excess” participation by women in groups previously dominated by men (ISCED, age) is seen as implausible.
- In a few cases, the rates of employment fall historically. In these cases, the assumption is made that such rates do not fall below the last historic status. It is assumed that these are special developments that will not continue in the future.
- The basic projection assumes that retirement at the age of 67 is implemented. This affects persons between 65 and 67 years of age. It is assumed that these ages will catch up with the propensity to work of the preceding age group (60 to 64) by 2030 at the last historic value. If the last historic value of the 60-to-64-year-olds was 60 %, then the 65-to-67-year-olds will also reach this participation rate by 2030. In comparing the 60-to-64 age group with the 65-to-69 age group, we need to take into account that the 68 and 69 year-olds are not affected by this rule. In overall terms, raising the retirement age has a significant effect on labour supply. By this assumption it will have risen by 1.5 million persons by the year 2030.
- Age groups older than 70 retain the participation rates of the starting year.
- In order to include the current results of the National Accounts for the year 2012, the participation rates for this year are adjusted so that the labour supply of the National Accounts is achieved overall (see Chapter 2.4).

Although the assumption is made that the age-specific propensity to work increases, the average participation rates in relation to total population fall for both women and men. The reason for this reverse development is the ageing process. This becomes clear when the three strongest age groups of the year 2010 are followed until the year 2030 (Figure 5).

Figure 5: Ageing process and propensity to work



Example: The dark blue coloured bars are the cohorts of the years with the highest birth rates. Those aged between 45 and 49 in 2010, for example, are in the 55 to 59 age group in the year 2020 and in the 65 to 69 age group in 2030.

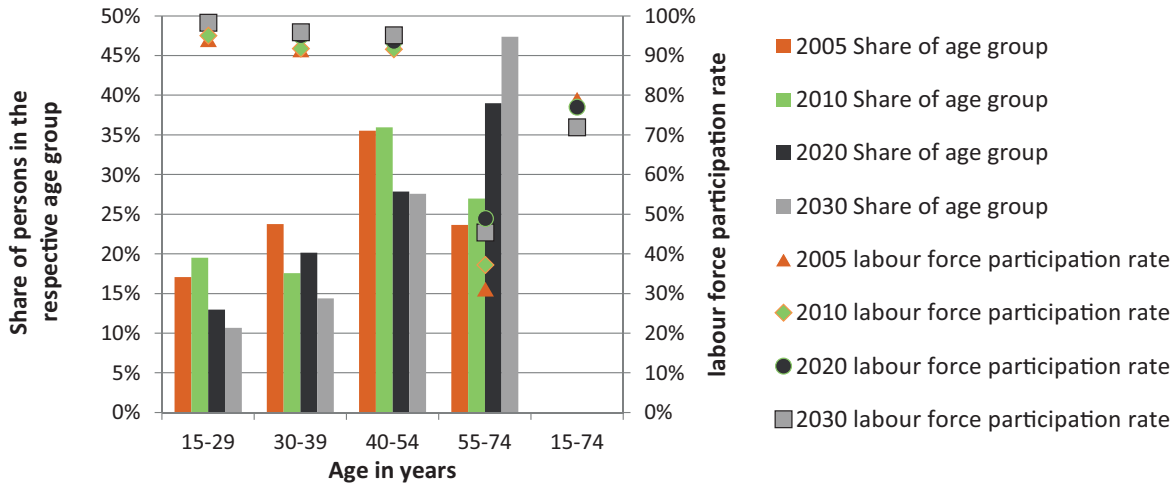
Source: Microcensus calculations and representations of the QuBe Project

In the year 2010, the three age groups of those aged between 40 to 54 are the most populated (blue bars). In the years up until 2030, these age groups age by 20 years and thus progress into the ages of 60 to 74. In 2020, the consolidated age group 50 to 75 achieves the highest participation rates. The three largest age groups have also made a contribution in this regard. In the year 2020 in particular, all three groups are in the age group of 50 to 69 whilst at the same time still exhibiting high participation rates (Figure 5). Although in the year 2030 the three most populous groups are in the 60 to 74 age group, only low participation rates for these groups are reflected in the calculation. This result signifies nothing other than the fact that rising propensity to work in the age cohorts is not sufficient to compensate for the decline in the population. Also this means that, in relation to total population, propensity to work also falls. It decreases in overall terms from its current level of approximately 54.5 % to 52.5 % in the year 2030. This applies although participation rates of those aged over 65 rise in line with assumptions due to the raising of the pension age to 67.

As far as the projection of the labour supply by occupational fields is concerned, the development of labour force participation rates for a group depends upon the age-specific propensity to work and upon distribution of the population with the predetermined characteristics of sex and qualification level to the age groups. For this reason, highly different developments in participation rates are produced for the occupational fields if we compare the gainfully employed persons in an occupational field in which they have trained with the overall number of persons who have been trained in this occupational field. On the one hand, there are always

differences in the propensity to work. Secondly the demographic process influences the propensity to work. The fundamental assumption may be made that average participation rates in occupational fields fall particularly sharply if the number of older people as a proportion of those who have trained in the occupational field is large.

Figure 6: Average propensity to work and age structure in the occupational field of cooks (trained in the occupation)



Source: Federal Statistical Office, Microcensus, calculations and representations of the QuBe Project

The aim is to illustrate this by using the occupational field of cooks as an example (Figure 6). Although participation rates increase in all age groups, particularly in the 55 to 74 age group, where the participation rate rises by almost 10 percentage points between 2005 and 2030, the average propensity to work of persons aged between 15 to 74 falls by around 5 percentage points during the same period. This development is particularly caused by the age shift. The fact that more and more persons fall into the age group of those aged over 55 in proportionate terms serves to counter the effect of the increasing rates of employment.

Figure 6 shows the change in the labour supply of those who have been trained as cook. The crucial factor determining the actual labour supply are those persons who are able to work in the relevant occupational field with a qualification obtained in another occupation (or with no vocational qualification) rather than merely the persons who have trained in the relevant occupation. For this purpose, we firstly need to calculate the occupational flexibilities, entries to and departures from an occupational field, and secondly estimate the extent to which a change in the labour requirement could exert an influence on these flexibilities in certain occupational fields.

5 Occupational flexibility of the workers

Whether the potential future supply of workers for a certain occupational field will be sufficient in order to satisfy the existing labour demand in such an occupational field does not merely depend on how many people will have trained in a certain occupation in future. The number of workers who will exercise the occupation in which they have been trained in is also crucial. In order to take this information into account, we make use of an empirical flexibility matrix developed as the basis of the Microcensus. This compares the formal vocational qualification of employees with the occupations actually exercised.

Until now, the most recently observed distribution of the occupational flexibility was kept constant for various sub-groups (Maier u. a. 2010). Because, however, the labour supply will change on the basis of demographic ageing processes and developments in qualification and due to the fact that the demand for occupations is subject to structural change, a dynamisation of occupational flexibilities is needed for an endogenous model. Below we present below how such a dynamisation of occupational flexibilities can be modelled at a macro level in an empirically-based manner.

Investigations of the behaviour of the occupational flexibility are widespread in sociology and economics. Analyses are mostly based on individual longitudinal data sets due to the fact that such an approach enables the causal influences of certain structural and individual determinants of occupational mobility to be precisely identified. On the basis of these investigations, it is safe to say that the point in time and general economic conditions of career entry (Blossfeld 1985, Hillmert 2004), the status position of the chosen occupation (Carroll and Mayer 1986) and the strong segmentation of the German labour market in international comparison (Allmendinger 1989) exert an effect on individual occupational histories (Blossfeld und Mayer 1988). Occupational mobility also differs because of the different job selection behaviour of men and women (Konietzka 1999b). The prospect of better working conditions (Pollmann-Schult 2006) or a higher salary (Clark and Fahr 2001, Fitzenberger and Kunze 2005) may be stated as motives for a change of occupation, even though income gains as a result of a change of occupation are less common in Germany than, for example, in the Anglo-Saxon countries (Nisic and Trübswetter 2012). The cause of this may be traced back to the segmentation of the German labour market mentioned above. Occupational or task-specific human capital can be transferred between occupations that involve similar tasks, meaning that a change in occupation between “similar” occupations is often accompanied by a gain in wage (Gathmann and Schönberg 2010, Geel and Backes-Gellner 2011). On the other hand, in the cases of changes between occupations that are dissimilar, usually a loss in income can be identified. The main reason here is involuntary change, e. g. because of temporary unemployment (Dütsch et al. 2012, Erlinghagen 2004, Konietzka 2002).

In contrast to those investigations mentioned above, the QuBe model is not based on individual data. This means that not all known causal mechanisms can be included in the modelling of the occupational change processes. Changes of the wage may, for example, partially explain changes in labour supply in certain occupations. For this reason, changes at work that do not influence the wage amount itself (e. g. working climate as opposed to shift work which is separately remunerated) and intrinsic motivations of workers must remain excluded from the modelling. Nevertheless, including wages in the model enables supply and demand to be consistently linked. We also use the information available in the relevant literature to obtain a modelling for the German labour market that is as close to reality as possible. We accord consideration to the structural characteristics of the labour market and of the labour supply rather than making the neo-classical assumptions of a wage-driven perfect flexibility/substitutability of occupations as is usual in an endogenous supply-demand model (cf. Meagher and Pang 2011).

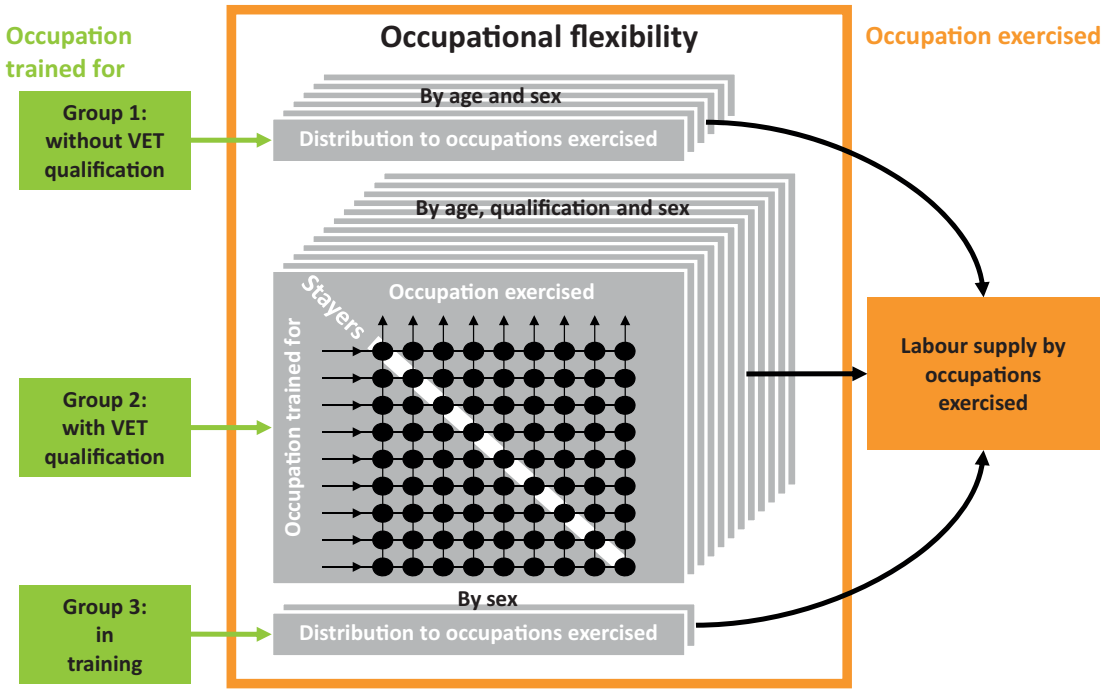
For this purpose, we divide the flexibility matrices for the 54 BIBB occupational fields obtained from the Microcensus into sub-groups. We differentiate between women and men due to their varying behaviour concerning career choice and occupatonal mobility (KONIETZKA 1999a). We also capture the varying mobility at different status positions (CARROLL and MAYER 1986) by subdividing the matrices by four qualification levels (ISCED including persons in training) (see Table 1). As was the case with the estimation of the qualification shares (Chapter 3.2), the groups ISCED 3b, 4 and ISCED 5b are combined due to the fact that the wage data from the BEH collected by the IAB does not differentiate between the two groups. We also sub-divide the matrices by three age groups (15 to 34, 35 to 49 and persons over 50) in order to take account of differing flexibility behaviours caused by periodical, cohort and age effects.[4] This approach ultimately provides us with 20 different flexibility matrices which can be divided into three groups according to the occupation trained for, which are treated differently for the projection.

- Group 1: Persons without a vocational qualification (ISCED 1,2, or 3a)
  Because these persons have not trained in an occupation, they can only be differentiated according to age groups (15 to 34, 35 to 49 and over 50), sex and occupation exercised. Due to expected low induction costs for this group, for the projection it can be assumed that their distribution across occupations exercised is in line with labour demand. Nevertheless, this is only possible in occupational fields in which they comprised at least three percent (related to all persons without a vocational qualification in the respective group) in the starting year (2011).
- Group 2: Persons with a vocational or academic qualification (ISCED 3b to 6)
  In this group, a differentiation can be made between occupation learned and occupation exercised. Further differentiations are made according to the pre-defined age groups, sex and two qualification levels (ISCED 3b, 4, 5b and ISCED 5a, 6). This produces a total of 12 flexibility matrices, which each have 54 rows and columns. As far as possible, wage responsiveness is determined on an empirical basis for each occupational field. It is assumed that the relative change in the wage in the occupational field trained for compared to the weighted wages of all alternative occupations within the specific occupational field shifts the proportion of stayers (proportion of skilled workers in the respective occupation exercised). If wages rise, for example, more persons will remain proportionally in the occupational field in which they have been trained. The determined elasticities are then used for all persons who have trained in the relevant occupation in the 12 matrices. The basis for this estimation is presented in the next section.
- Group 3: Persons in education and training (pupils, students, apprentices) whilst being employed at the same time
  Because of the similar age and qualification structure, these persons are differentiated only according to sex. Persons in education or training are allocated to an exercised occupational field according to the information obtained from the last available data point (year 2011).

The flexibility matrices used generate a total of 20 pieces of link information. For persons with a vocational or academic qualification (Group 2), there are a total of 34,992 theoretically possible transition probabilities from an occupation learned to an occupation exercised (2*2*3*54*54). For groups 1 and 3, there are 324 (2*3*54) and 108 (2*54) respectively. Figure 7 provides a summary of the link information used and or the transition probabilities.

[4] We assume age-specific flexibility behaviour for the projection period. The labour supply is distributed across the relevant occupations in accordance with age and does not retain current, cohort-specific flexibilities.

Figure 7: Flexibility matrices between occupation trained for and occupation exercised



Source: Own representation

5.1 Dynamisation of change of occupation

Economic development and differing branch structure within an occupational field cause wages to change differently according to occupational field. The dependence of the occupational field on wage development in the economy and by scarcities that may occur in the occupational field are influencing factors (Chapter 3). When supply and demand in an occupational field converge to the same level, the wage increases in this occupational field are affected. We assume that persons who have been trained for an occupation are most likely to perceive these wage increases and react the most. In the projection, they are more likely to decide to work in the occupation in which they have been trained if the specific wages in the occupational field learned rise more strongly than the outside option of being trained for this occupation but working in another occupational field. Within this process, we need to take into account that not every person can work in every occupation. If it has not been possible in the past to find someone who has been trained for occupation A (e.g. cook) and has worked in occupation B (e.g. healthcare occupations requiring a medical practice licence), then this will also not be possible in the future. It will also be shown that in some occupations no dependencies can be recognised between wage development in the occupational field and the proportion of persons who have been trained for the occupation. For these occupations, the basic projection also assumes that they will not react to wage developments in the future.

The construction of the BIBB occupational fields as units which are homogeneous with regard to tasks (see Tiemann et al. 2008) means that possibilities of deployment with an occupational field learned are largely concentrated on a small number of occupational fields only, in which the occupational field in which training has taken place also mostly covers the majority of the labour demand with this qualification (Maier et al. 2010). In order to estimate the wage responsiveness of an occupation learned in Group 2 mentioned above, it is therefore sufficient merely to estimate the change in the proportion of persons who are working in the occupation in which they have trained (proportion of stayers) to the wage changes in the occupational field. If there is an increase or reduction in the proportion of stayers, the transition probabilities of the relevant occupation learned to the other occupations are adjusted while keeping

the proportions in the distribution fixed. In order to exclude implausible occupational changes, however, proportions of stayers of over 90 % and of under 10 % are not changed further.

For the final estimation of the wage elasticities of proportions of stayers $stayer_o (o \in [1,\ldots,54])$, we use the Microcensuses of the years 2005 to 2011[5] to calculate the proportions of stayers within Group 2 (Figure 7) by sex, age (15 to 34, 35 to 49 and over 50) and qualification level (ISCED 3b, 4 ,5b and ISCED 5a, 6). For each of the 12 combinations of sex*age*qualification level, we create an (unbalanced) panel data set, so that we have a maximum of 54 observations of $stayer_o$ at 6 different points in time t.[6]

Because we currently have no wage information on gross wages by occupational fields and formal qualification level for self-employed persons, civil servants and family members helping out in businesses, we use the average wage per person per day in the exercised occupation (w_o) of full-time workers subject to social insurance contributions as shown in the BEH as an approximate indicator of all wages paid in the occupational fields. This wage data is based on calculations of the IAB.

If we now consider the flexibility matrix with the occupation learned in the row ($o_{r.}$) and the occupation exercised in the column ($o_{.c}$), we get the explanatory variable which is the wage paid in the occupational field exercised ($w_{o,.c}; r = c$) in relation to the reference wage $w_{o,ref}$ [21]:

[21] $w_{o,ref} = \sum_{c=1}^{54} (flex_{rc} * w_{o,.c})$.

$w_{o,ref}$ designates the wage which on average can be received with training in the relevant occupation averaged across all possible wages ($w_{o,.c}$) in other occupations which are exercisible with the occupation learned in accordance with the occupational flexibilities ($flex_{rc}$). Because the proportions of stayers vary according to occupational field, we permit the constant of the estimating equation (α_1) vary with the occupational field (Frees 2004: p. 22). This implies that, alongside wage development, there are also other motives for remaining within an occupational field and that the preceding occupational choice, therefore, ultimately also depends upon these motives which are not revealed here. The equation for the estimation of the proportion of stayers can thus be described as a *fixed-effects* model.

[22] $stayer_{o,t} = \alpha_o + \beta_1 w^*_{o,t}$; where $w^*_{o,t} = \frac{w_{o,.c,t}}{w_{o,ref,t}}$; where $c = o$

Because we wish to estimate elasticities (wage responsiveness), we work with logarithms of both the proportions of stayers and the occupation-specific wages. The estimates indicate empirically demonstrable wage effects on the amount of the proportion of stayers, whilst on the other hand the approach also needs to be feasible. As already mentioned, although we already know the amount of the proportion of stayers in the occupational field in all combinations of age*sex*qualification level, the theoretical hourly wages provided by the IAB are only available by occupational field and qualification level. Inclusion of sex (s), age (a) and qualification-specific (q) flexibilities ($flex_{s,a,q}$), however, enables us to approximate different reference wages for every combination.

[23] $w_{o,ref\,s,a,q} = \sum_{c=1}^{54} \left(flex_{rcs,a,q} * w_{o,.cq}\right)$

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[5] Occupation learned has only been reconstructable in the Microcensus since 2005 (Bott et al. 2010a).

[6] In order for the estimates not to be influenced by strong jumps in the proportions of stayers in unusual sex*qualification*age combinations, we exclude all proportions of stayers which contain fewer than 40 persons in the sample.

Variation of the different sex, age and qualification combinations now provides several possibilities of estimating the wage dependencies of the shares of stayers – either specifically in the 12 possible combinations of the three dimensions or with dependency on only one or two dimensions. It was, however, ultimately revealed that, when only considering the wages and occupational flexibility of highly qualified persons, hardly any evidence of wage responsiveness for this sub-group can be demonstrated. The reason for this is presumably the fact that due to legal censorship of wage information in the BEH changes in the wage above the income ceiling for social security contributions are not recorded. Any change that may take place in the proportion of stayers cannot be correlated with a wage change since the latter is not visible in the data. In order to obtain more robust results for the occupational fields, we therefore analyse persons with vocational and academic qualifications jointly and do not make any further differentiation with regard to age and sex in the elasticities. Instead, the share of stayers is estimated depending on the reference wages for all persons in Group 2 [24], and the calculated elasticity for the basic projection is applied to all occupation specific shares of stayers in all 12 matrices.

[24] $stayer_{o,t} = \alpha_o + \beta_1 w^*_{o,t}$

In order to take account of the occupational segmentation of the labour market in Germany in the estimates, a two-stage process was adopted. Firstly, a simple regression of the reference wage to the proportion of stayers was carried out for each individual occupational field for the period from 2005 to 2011. The second stage then involved grouping occupational fields with similar positive elasticitics and structure of qualifications. The panel estimation as given in equation [24] was then conducted with robust standard errors for these four groups. In overall terms, this approach made it possible to demonstrate a positive influence of the wage change on the proportion of stayers four 36 of the 54 occupational fields. These wage elasticities by occupational field groups are summarised in Table 3.

The first group comprises occupational fields with a high elasticity and with a larger proportion of highly qualified persons or with a very small proportion of those with non-formal qualifications. Although a somewhat higher elasticity is found for the second group, in terms of structure of qualifications it is characterised by the medium qualification level. A higher proportion of persons with non-formal qualification also works in these occupational fields. The third group exhibits a qualification structure similar to the second group. However, the elasticity is lower. The fourth group is heterogeneous in terms of its qualification structure. It contains miscellaneous occupations, which have weakly reacted to wage changes in the past. It is also likely that the structure of the wage data plays a role in this case. The wage data of gainfully employed persons and the legal censorship in the upper income range probably do not represent an ideal measurement, particularly with regard to the occupational fields of “managing directors, auditors, management consultants” and “legal occupations”. In the case of “healthcare occupations not requiring a medical practice licence”, for example, which also show a higher proportion of self-employed persons and a higher income, no positive elasticities can be demonstrated. Nevertheless, because of the absence of a more exact database, it seems appropriate to use the elasticities as given in Table 3. Within the scope of a scenario calculation, however, it would be conceivable to derive the elasticities from theoretical assumptions, particularly in the area of highly qualified persons.

The results show that by stipulating theoretically founded assumptions we can provide evidence for wage responsiveness in the occupational flexibility even without using individual data. In this way, bottlenecks within an occupational field may be partially relieved, because wages rise in the event of scarcity (Chapter 3), and the proportion of stayers rises as a consequence. This reaction will cause the labour supply in the affected occupational field to rise a bit, whereas labour supply will fall in occupational fields in which persons with the relevant occupation learned would otherwise have been able to work. The greater the responsiveness of

the labour supply with regard to the exercised occupation, the better it will prove possible to compensate for bottlenecks on the labour market. At the same time, the increase in the share of stayers leads to an easing of the situation in the relevant occupational field and thereby also exerts a cushioning effect on later wage development. Alongside wage determinations in the occupational field, dynamised occupational flexibility thus represents the major link between supply and demand in the QuBe model of the third wave depending on labour scarcities and over supply (Chapter 3). Notwithstanding this, further linkages and alternative modellings are conceivable for the future.

Table 3: Wage elasticities of the proportions of stayers by groups of occupational fields (2005 to 2011)

Occupational fields	Elasticity
Group 1: 21 Engineers | 22 Chemists, physicists, scientists | 31 Advertising specialists | 36 Administrative occupations in the public sector | 51 Journalists, librarians, translators, related academic research occupations | 46 Designers, photographers, advertising creators | 24 Technical draughtsmen/ draughtswomen, related occupations	2.2
Group 2: 16 Cooks | 34 Packers, warehouse operatives, transport processors | 40 Auxiliary office occupations, telephone operators | 52 Body care occupations	2.59
Group 3: 1 Agriculture, husbandry, forestry, horticulture | 2 Miners and mineral extraction workers | 5 Paper manufacture, paper processing, printing | 9 Vehicle and aircraft construction, maintenance occupations | 10 Precision engineering and related occupations | 14 Bakers, pastry cooks, production of confectionary goods | 15 Butchers | 18 Construction occupations, wood and plastics manufacture and processing occupations | 41 Personal protection, guards| 49 Social occupations | 54 Cleaning and disposal occupations	1.27
Group 4: 6 Metal production and processing | 7 Metal, plant, and sheet metal construction, installation, fitters | 13 Textile processing, leather manufacture | 17 Production of beverages, foods and tobaco, other nutrition occupations | 23 Technicians | 25 Surveying and mapping | 26 Specialist skilled technicians | 27 Sales occupations (retail) | 30 Other commercial occupations (not including wholesale, retail, banking) | 32 Transport occupations | 35 Managing directors, auditors, management consultants | 39 Commercial office occupations | 44 Legal occupations | 53 Hotel and restaurant occupations, housekeeping	0.57

Source: Microcensuses 2005 to 2011 and Employee History Data 2005 to 2011; own calculations

6 Model performance

The BIBB-IAB qualifications and occupational field projections are characterised by the fact that they are based on common systematisations on both the supply and demand sides and on harmonised data sets. In addition to this, they were, even in the first wave of the projections, in a position to use a reconstruction of the occupation learned in the Microcensus (Bott et al. 2010a, Maier and Helmrich 2012), to take account of empirically founded flexibilities between occupation trained for and occupation exercised (Maier et al. 2010). However, due to insufficient data,[7] for these flexibilities it had to be assumed that they will remain constant in future. Because of demographic change and the related scarcities which emerge in certain occupational fields, however, it is probable that labour supply also reacts accordingly to these bottlenecks. Nevertheless, comparison of labour demand with labour supply by occupation trained for and potential labour supply according to the occupational flexibility was an important indicator for possible bottlenecks and for overcoming such bottlenecks (Bott et al. 2010b).

Because demographic change proved to be one of the main influencing factors for the development of the labour supply, the second wave of the QuBe Project explored the actual potential on the supply side. For this purpose, similar to the concept for potential labour supply, a hypothetical construct was determined for the supply side – the potential work volume (see also Chapter 2.4.3). If we consider this maximum supply in hours worked on the supply side and compare it with volume of work actually required, bottlenecks in some occupational fields can be resolved by the year 2030, at least in theory (Zika et al. 2012). Nevertheless, it was not possible to take into account the extent to which the labour demand may reduce due to skilled worker shortages.

In the third wave of the QuBe Project, we now take account of the interactions between supply and demand. To do so, we combine the benefits of the two previous supply models BIBB-FIT and BIBB-DEMOS in a single supply model. We also react to the increasing immigration to Germany in the wake of the economic crisis and use Version 1-W2 of the 12th Coordinated Population Forecast ("upper limit of the medium population") as the basis for our model system instead of "Version 1-W2: lower limit of the medium population". Version 1-W2 assumes net immigration of 200,000 persons from the year 2020. For the interaction of both sides of the market, the following two points were realised and described in this report.

1. On the demand side, the available occupation specific labour supply is taken into account per capita and by hours with regard to the determination of wages for the occupations. The estimation equations for these interactions are based on the BEH, the Microcensus and the National Accounts (Chapter 3).
2. The labour supply reacts to the changed wages and rises in the more attractive occupational fields in terms of remuneration in line with the task options associated with the occupation learned. The elasticities of occupational flexibility were also estimated based on the BEH and data from the Microcensus. The occupation specific structure of the labour market was taken into account in the modelling (Chapter 5).

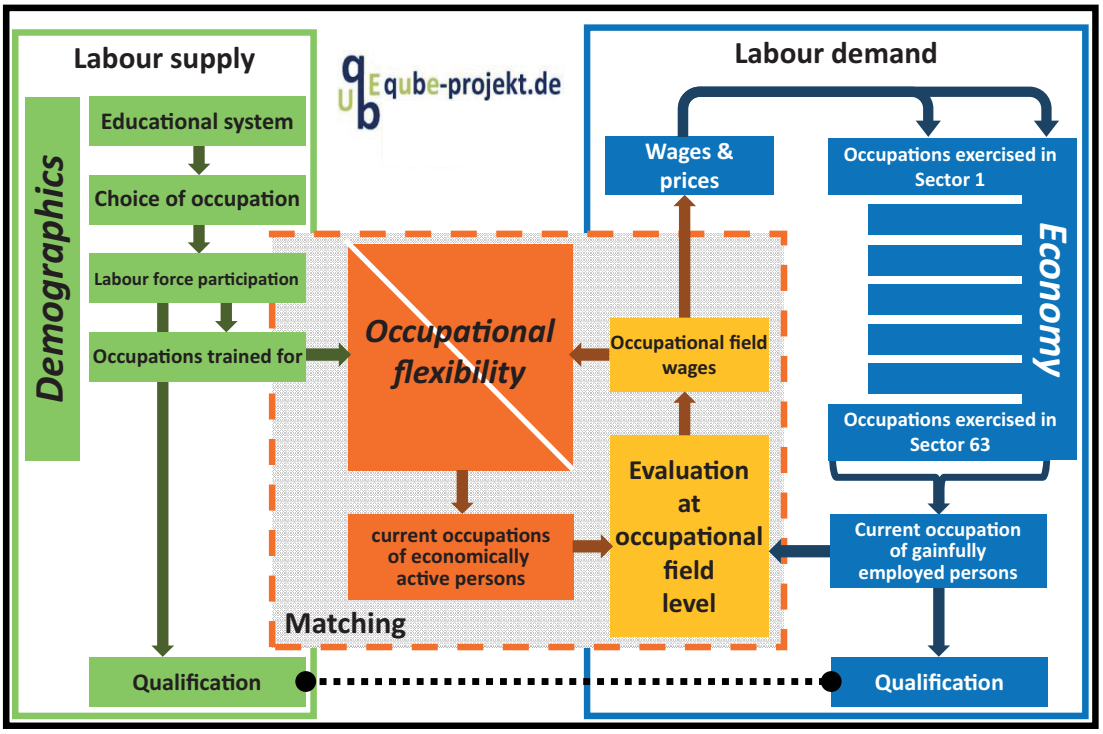
The changed structure of the QuBe Project is depicted in Figure 8.

We are aware that the endogenisation undertaken in the third wave does not represent a full mapping of the interactions between both sides of the market. The performance of a model, however, crucially depends upon the available data. Whereas for the first wave the occupation trained for could only be determined in the 2005 Microcensus survey year, the years from 2005 to 2011 are available for the third wave. Further significant wage development statistics

[7] It has only been possible to reconstruct the occupation trained for in the Microcensus since 2005 (Bott et al. 2010a, Maier and Helmrich 2012).

are also integrated into the model for the third wave by the BEH. Further data sources are thus able to provide a deeper insight into complex causal chains. This means that further interaction mechanisms can be taken into account, and these are outlined below.

Figure 8: QuBe Project – an overview of the modelling of the 3rd wave



Source: Presentation of the QuBe Project

6.1 Possible future enhancements on the demand side

Alongside wage adaptations in the event of occupational shortages, the question arises on the demand side as to the extent to which employers react to the changed qualification structure of the labour supply. The modelling of the third wave is steered by compensatory processes at the level of the occupational fields. Adjustment reactions with regard to the demanded and actual level of requirement of companies have thus far not been integrated. It would therefore be conceivable that a larger supply of persons with higher formal qualification is taken on by the companies. However, for empirical modelling, firstly, a changed recruitment behaviour must be observable in the past. So far, there is no evidence for competition between Bachelor graduates and those who have completed vocational education and training (Bott and Wünsche 2014 (awaiting publication)).

For economic development, we rely on the results of third parties (EC 2013, FAO 2013, IEA 2012, IMF 2013). This is a further area in which there would be an opportunity to consider alternative pathways for advancement in scenarios of world economic development. The INFORGE foreign trade module (TINFORGE) is, for example, currently being significantly expanded. The effects and repercussions of world trade on Germany are being investigated and modelled for over 60 countries and regions. Alongside bilateral trade relations and dynamic trade shares, for a majority of the countries macro models are being constructed to enable a significantly more detailed modelling of Germany's foreign trade and its integration into international trade (Mönnig et al. 2013).

6.2 Possible future enhancements on the supply side

In the modelling of the third wave, the adjustment of supply to demand takes place via a dynamisation of the occupational flexibilities resulting from occupation specific wage changes. On the supply side too, however, it would also be conceivable that, alongside occupational flexibilities, apprentices, students and immigrants react to the changed demands of the economy. New supply from the educational system and from abroad would change accordingly. Because assumptions regarding future participation in education and training have a major influence on the future qualification structure of the population, it needs to be empirically investigated which changes in the domestic participation in education and training shall be part of the modelling. Exploratory data evaluations need to be initially performed for this purpose.

In the case of migration movements across the borders of Germany, both the qualification structure of the immigrants and emigrants and the size of such migration flows are crucial for labour supply and demand. There exist first research approaches by the FIT on the basis of the Microcensus (Kalinowski and Hänisch 2010), which could enable a re-examination of the assumptions currently made regarding qualification and occupational structure. They show that the qualification structure of immigrants was subject to significant change in the past. The proportion of immigrants with an academic qualification has risen from 10 percent to over 30 percent since the beginning of the 1990's. Statutory regulations such as the law to implement the EU Directive on the Entry and Residence of Highly Qualified Workers, which facilitates the immigration of highly qualified persons in occupations with labour shortages, is likely to foster this trend further. The Law on the Recognition of Foreign Professional and Vocational Qualifications should also bring about an increase in the trend towards more qualified workers (Maier 2013). Whereas the Microcensus can be used as a source of structural information for immigrants, a greater research demand arises for the determination of the qualification structure of emigrants. Knowledge of the latter is, however, necessary in order to record the qualification changes in the population caused by migration.

Alongside the qualification structure of immigrants, the amount of net migration is also crucial to the existing labour supply. Whereas the assumption was that net migration was balanced on average between 2006 and 2009 (Maier et al. 2012: p. 24), the strong rise in immigration that has occurred as a result of the economic crisis caused us to assume a net immigration of 200,000 persons beginning in the year 2020 (se Section 4.1). Changes in (world) economic development could, however, cause net immigration to deviate from the basic projection in future. Furthermore, at first sight, increased net immigration represents a good opportunity to reverse shortages on the labour market. Investigations for Austria (Bock-Schappelwein et al. 2009) have, for example, shown that immigration leads to additional impetuses for growth under certain circumstances and therefore also generates an increased demand for workers. A higher number of persons, and thus of households, results in a greater need for housing, vehicles and other consumer goods amongst other things.

Alongside the occupational flexibility, participation in education and training and immigration can change the economic development of labour force participation rates (propensity to work). Research work carried out by the IAB shows that, in the case of an economic downturn some of those who become unemployed leave the labour market completely and, by the same token, some of those persons recruited following an economic upturn were previously economically inactive (Fuchs and Dörfler 2005, Fuchs and Weber 2005). Such persons form part of the so-called "hidden reserve". By a definition of the IAB, they are "persons who are not in work, are no longer in work or not yet in work because of a bad labour market situation, but who would be prepared and would be in a position to pursue employment in the event of an improvement in the situation" (Fuchs and Weber 2005: p. 8 f.). The extent to which ongoing positive economic development can bring about further increases in the propensity to work in the light of the current rising age-specific labour force participation rates would also need to be the object of empirical investigation.

6.3 Conclusion

Larger and expanded databases create the opportunity to analyse past behaviour in more detail and take such behaviour into account in the projections. Consideration can also be given to alternative enhancements that differ from the basic principles presented here in one or more aspects. From the perspective of the basic projection, these alternative scenarios could be discussed as a reference in order to draw conclusions regarding the strength of effects of individual measures or to arrive at assumptions. Nevertheless, the following applies to the basic projection of the third wave presented in this report.

We update developments which have either been decided in policy or which are empirically demonstrable. The inclusion of interaction effects between the two sides of the market enables us to illustrate effects and causal chains on the basis of observed dependencies rather than creating a prognosis of an inevitable future for the labour market. For precisely this reason, alternative developments should be taken into account in alternative scenarios, regardless of whether these developments are in the form of additional interaction effects or based on changed assumptions. They will help us to forecast possible future developments and arrive at appropriate conclusions to achieve desirable outcomes and avoid undesirable effects.

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8 Annex

Table 4: Main occupational fields, extended main occupational field and occupational fields according to main tasks and main focus of the economic sector

Main occupational field (MOF) Extended occupational field (MOFx) Occupational field (OF)	Main tasks according to the Microcensus	Main focus of the economic sector according to 2008 Classification of Economic Activities in the year 2010
MOF 1: Raw material extraction occupations		
OF 1 Agriculture, husbandry, forestry, horticulture	Planting, breeding, cultivating, harvesting, fishing	Agriculture
OF 2 Miners and mineral extraction workers	Setting up, controlling, monitoring, maintaining machines, technical plants or equipment	Mining, extraction of stones and earth
MOF 2: Processing, manufacturing and repair occupations		
MOFx 2a Auxiliary workers/janitors		
OF 20 Auxiliary workers without further specified task	Manufacturing, processing and producing, constructing/ extending, installing, fitting	Placement and hiring of workers
OF 42 Janitors	Repairing, renovating, maintaining, mending	Service providers not mentioned elsewhere
MOF x 2b Metal construction, plant construction, sheet metal construction, installation, fitters, electrical occupations		
OF 7 Metal, plant and sheet metal construction, installation, fitters	Manufacturing, processing and producing, constructing/ extending, installing, fitting	Construction sector
OF 11 Electrical occupations	Manufacturing, processing and producing, constructing/ extending, installing, fitting	Construction sector
MOFx 2c Construction, woodworking, plastics manufacture and processing occupations		
OF 18 Construction, woodworking, plastics manufacture and processing occupations	Manufacturing, processing and producing, constructing/ extending, installing, fitting	Construction sector
MOF 2d: Other processing, manufacturing and repair occupations		
OF 3 Stoneworking, construction materials production, ceramics and glass related occupations	Manufacturing, processing and producing, constructing/ extending, installing, fitting	Manufacture of glass products, manufacture of ceramics, processing of stones and earth
OF 9 Vehicle and aircraft construction, maintenance occupations	Repairing, renovating, maintaining, mending	Motor trade, maintenance and repair of motor vehicles
BF 10 Precision engineering and related occupations	Manufacturing, processing and producing, constructing/ extending, installing, fitting	Manufacture of furniture and other goods
OF 13 Textile processing, leather manufacture	Manufacturing, processing and producing, constructing/ extending, installing, fitting	Manufacture of textiles, clothing, leather goods and shoes

(Table 4 continued)

Main occupational field (MOF) Extended occupational field (MOFx) Occupational field (OF)	Main tasks according to the Microcensus	Main focus of the economic sector according to 2008 Classification of Economic Activities in the year 2010
OF 15 Butchers	Manufacturing, processing and producing, constructing/ extending, installing, fitting	Manufacture of food and drink, tobacco processing
MOF 3: Occupations involving the control and maintenance of machines and plants		
OF 4 Chemical and plastics occupations	Setting up, controlling, monitoring, maintaining machines, technical plants or equipment	Manufacture of chemical products
OF 5 Paper manufacture, paper processing, printing	Setting up, controlling, monitoring, maintaining machines, technical plants or equipment	Manufacture of printing products, reproduction of sound, picture and data storage media
OF 6 Metal production and processing	Setting up, controlling, monitoring, maintaining machines, technical plants or equipment	Manufacture of metal products
OF 8 Industrial mechanics, tool mechanics	Setting up, controlling, monitoring, maintaining machines, technical plants or equipment	Engineering
OF 12 Weaving occupations, textile manufacturers, textile finishers	Setting up, controlling, monitoring, maintaining machines, technical plants or equipment	Manufacture of textiles, clothing, leather goods and shoes
OF 17 Production of beverages, food and tobaco, other nutrition occupations	Setting up, controlling, monitoring, maintaining machines, technical plants or equipment	Manufacture of food and drink, tobacco processing
MOF 4: Occupations involving the trading and sale of goods		
MOFx 4a Occupations involving the trading and sale of goods Sales occupations (retail)		
OF 27 Sales occupations (retail)	Buying/selling, acting as an agent, acting as a cashier	Retail (not including retail of motor vehicles)
MOFx 4b Occupations involving the trading and sale of goods Commercial employees		
OF 28 Wholesale/retail service occupations	Buying/selling, acting as an agent, acting as a cashier	Retail (not including retail of motor vehicles)
OF 30 Other commercial occupations (not including wholesale, retail, banking)	Buying/selling, acting as an agent, acting as a cashier	Retail (not including retail of motor vehicles)
MOF 5: Occupations involving traffic, warehousing, transport, security, guarding		
MOFx 5a Occupations involving traffic, warehousing, transport		
OF 19 Goods inspectors, dispatch processing operators	Driving vehicles, packing, loading, unloading, sorting, forwarding	Retail (not including retail of motor vehicles)
OF 32 Transport occupations	Driving vehicles, packing, loading, unloading, sorting, forwarding	Land transport and transport in pipelines

(Table 4 continued)

Main occupational field (MOF) Extended occupational field (MOFx) Occupational field (OF)	Main tasks according to the Microcensus	Main focus of the economic sector according to 2008 Classification of Economic Activities in the year 2010
OF 33 Aviation, shipping occupations	Driving vehicles, packing, loading, unloading, sorting, forwarding	Warehousing, other transport service providers
OF 34 Packers, warehouse operatives, transport processors	Driving vehicles, packing, loading, unloading, sorting, forwarding	Post, courier and express services
MOFx 5b Security and guarding		
OF 41 Personal protection, guards	Securing, protecting, guarding/monitoring, regulating traffic	Service providers not mentioned elsewhere
OF 43 Security occupations	Securing, protecting, guarding/monitoring, regulating traffic	Public administration, defence, social security
MOF 6: Hotel, restaurant and cleaning occupations		
MOFx 6a Hotel and restaurant occupations		
OF 14 Bakers, pastry cooks, production of confectionary goods	Serving, accommodating, preparing food	Manufacture of food and drink, tobacco processing
OF 16 Cooks	Serving, accommodating, preparing food	Hotel and restaurant trade
OF 53 Hotel and restaurant occupations, housekeeping	Serving, accommodating, preparing food	Hotel and restaurant trade
MOFx 6b Cleaning and disposal occupations		
OF 54 Cleaning and disposal occupations	Cleaning, removing waste, recycling	Service providers not mentioned elsewhere
MOF 7: Office, commercial service occupations		
OF 29 Banking and insurance professionals	Carrying out paperwork, calculations and data processing work, booking transactions, preparing drawings	Financial services providers
OF 36 Administrative occupations in the public sector	Carrying out paperwork, calculations and data processing work, booking transactions, preparing drawings	Public administration, defence, social security
OF 37 Finance, accounting, bookkeeping	Carrying out paperwork, calculations and data processing work, booking transactions, preparing drawings	Legal and tax consultancy, management consultancy
OF 39 Commercial office occupations	Carrying out paperwork, calculations and data processing work, booking transactions, preparing drawings	Legal and tax consultancy, management consultancy

(Table 4 continued)

Main occupational field (MOF) Extended occupational field (MOFx) Occupational field (OF)	Main tasks according to the Microcensus	Main focus of the economic sector according to 2008 Classification of Economic Activities in the year 2010
OF 40 Auxiliary office occupations, telephone operators	Carrying out paperwork, calculations and data processing work, booking transactions, preparing drawings	Service providers not mentioned elsewhere
MOF 8: Technical and scientific occupations		
MOFx 8a IT and scientific occupations		
OF 21 Engineers	Researching, preparing, constructing, designing of products, plans, programmes	Architectural and engineering companies, technical support
OF 22 Chemists, physicists, scientists	Researching, preparing, constructing, designing of products, plans, programmes	Research and development
OF 38 Core IT occupations	Researching, preparing, constructing, designing of products, plans, programmes	IT and information service providers
MOFx 8b Technical occupations		
OF 23 Technicians	Setting up, controlling, monitoring, maintaining machines, technical plants or equipment	Engineering
OF 24 Technical draughtsmen/ draughtswomen, related occupations	Carrying out paperwork, calculations and data processing work, booking transactions, preparing drawings	Architectural and engineering companies, technical support
OF 25 Surveying and mapping	Measuring, monitoring, testing, checking in accordance with stipulated procedures	Architectural and engineering companies, technical support
OF 26 Specialist skilled technicians	Measuring, monitoring, testing, checking in accordance with stipulated procedures	Manufacture of chemical products
MOF 9: Legal, management and economics occupations		
OF 35 Managing directors, auditors, management consultants	Management, direction and leadership activities	Legal and tax consultancy, management consultancy
OF 44 Legal occupations	Applying and interpreting laws/regulations/directives; certifying	Legal and tax consultancy, management consultancy
MOF 10: Media, humanities, social science and artistic occupations		
OF 31 Advertising specialists	Advertising, marketing, public relations	Service providers not mentioned elsewhere
OF 45 Artists, musicians	Pursuing artistic, journalistic, entertainment activities	Art and culture, gambling

(Table 4 continued)

Main occupational field (MOF) Extended occupational field (MOFx) Occupational field (OF)	Main tasks according to the Microcensus	Main focus of the economic sector according to 2008 Classification of Economic Activities in the year 2010
OF 46 Designers, photographers, advertising creators	Researching, preparing, constructing, designing of products, plans, programmes	Freelance, scientific, technical services not mentioned elsewhere, veterinary medicine
OF 51 Journalists, librarians, translators, related academic research occupations	Pursuing artistic, journalistic, entertainment activities	Education and teaching
MOF 11: Healthcare and social occupations		
MOFx 11a Healthcare occupations		
OF 47 Healthcare occupations requiring a medical practice licence	Providing health/social assistance and care, providing medical/cosmetic treatments	Healthcare system
OF 48 Healthcare occupations not requiring a medical practice licence	Providing health/social assistance and care, providing medical/cosmetic treatments	Healthcare system
OF 52 Body care occupations	Providing health/social assistance and care, providing medical/cosmetic treatments	Other services providers mainly providing personal services
MOFx 11b Social occupations		
OF 49 Social occupations	Educating, training, teaching	Education and teaching
MOF 12: Teaching occupations		
OF 50 Teachers	Educating, training, teaching	Education and teaching

Table 5: Structure of the 2008 Classification of Economic Activities that has been used

	Devisions of the economic sectors (collated)
1	Agriculture
2	Forestry
3	Fishing
4	Mining, extraction of stones and earth
5	Manufacture of food and drink, tobacco processing
6	Manufacture of textiles, clothing, leather goods and shoes
7	Manufacture of wood, wicker, basket and cork goods (not including furniture)
8	Manufacture of paper, cardboard and of paper and cardboard products
9	Manufacture of printing products, reproduction of sound, picture and data storage media
10	Manufacture of coke and refined petroleum products
11	Manufacture of chemical products
12	Manufacture of pharmaceutical products
13	Manufacture of rubber and plastic products

(Table 5 continued)

	Devisions of the economic sectors (collated)
14	Manufacture of glass products, manufacture of ceramics, processing of stones and earth
15	Metal production and processing
16	Manufacture of metal products
17	Manufacture of computer, electronic and optical products
18	Manufacture of electrical equipment
19	Engineering
20	Manufacture of motor vehicles and motor vehicle components
21	Other vehicle construction
22	Manufacture of furniture and other goods
23	Repair and installation of machines and equipment
24	Energy supply
25	Water supply
26	Sewage, waste disposal, materials recovery
27	Construction sector
28	Motor vehicle trade, maintenance and repair of motor vehicles
29	Wholesale (not including the motor vehicle trade)
30	Retail (not including retail of motor vehicles)
31	Land transport and transport in pipelines
32	Shipping
33	Aviation
34	Warehousing, other transport service providers
35	Post, courier and express services
36	Hotel and restaurant trade
37	Publishing
38	Audiovisual media and radio
39	Telecommunications
40	IT and information service providers
41	Financial services providers
42	Insurance and pension funding
43	Activities associated with financial and insurance services
44	Real estate
45	Legal and tax consultancy, management consultancy
46	Architectural and engineering companies, technical support
47	Research and development
48	Advertising and market research

(Table 5 continued)

	Devisions of the economic sectors (collated)
49	Freelance, scientific, technical services (not mentioned elsewhere), veterinary medicine
50	Renting of mobile goods
51	Placement and hiring of workers
52	Travel agencies and tour operators
53	Service providers (not mentioned elsewhere)
54	Public administration, defence, social security
55	Education and teaching
56	Healthcare system
57	Residential homes and social services
58	Art and culture, gambling
59	Sport, entertainment and recreation
60	Lobbying, religious associations
61	Repair of computers and used goods
62	Other providers of mainly personal services
63	Housekeeping services

Abstract

The BIBB-IAB qualification and occupational field projections describe the labour demand and supply development until 2030.

The discussion paper includes the underlying data, methods and assumptions of the third wave of the long-term BIBB-IAB Qualification and occupational field projections (QuBe project). Taken into account in the present third wave was the increased future net immigration as a consequence of the European economic crisis. In addition, empirically founded dynamic interaction processes between labour supply and demand by qualifications and occupations have been modelled for the first time. On the demand side, for example, the available occupation-specific labour supply in persons and hours is taken into account when determining wages for the respective occupations. On the supply side, the advantages of the two hitherto applied supply models BIBB-FIT and BIBB-DEMOS have been combined in one supply model and the wage elasticity coinciding with occupational flexibility has been estimated at the same time.

Keywords: Labour market, qualification, occupations, occupational fields, wage developments, long-term projection, forecast, employment, occupational flexibility, labour supply, labour demand, immigration, potential hours worked