

## Demographic effects on the German labour supply: a decomposition analysis

Fuchs, Johann; Söhnlein, Doris; Weber, Brigitte

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Institut für Arbeitsmarkt-  
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Die Forschungseinrichtung der  
Bundesagentur für Arbeit

IAB

# IAB-Discussion Paper

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Beiträge zum wissenschaftlichen Dialog aus dem Institut für Arbeitsmarkt- und Berufsforschung

## Demographic Effects on the German Labour Supply

A Decomposition Analysis

Johann Fuchs  
Doris Söhnlein  
Brigitte Weber

# Demographic Effects on the German Labour Supply

## A Decomposition Analysis

Johann Fuchs (IAB)

Doris Söhnlein (IAB)

Brigitte Weber (IAB)

Mit der Reihe „IAB-Discussion Paper“ will das Forschungsinstitut der Bundesagentur für Arbeit den Dialog mit der externen Wissenschaft intensivieren. Durch die rasche Verbreitung von Forschungsergebnissen über das Internet soll noch vor Drucklegung Kritik angeregt und Qualität gesichert werden.

The “IAB-Discussion Paper” is published by the research institute of the German Federal Employment Agency in order to intensify the dialogue with the scientific community. The prompt publication of the latest research results via the internet intends to stimulate criticism and to ensure research quality at an early stage before printing.

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## Abstract

Forecasts show a substantially decreasing and ageing labour force in Germany. This paper provides a decomposition of the projected change in the overall labour force into three parts. The first, called the “demographic component”, shows the effects of fertility, mortality and a changing age structure of the population. The second effect is the migration component. This part is due to the cumulative net inflow of migrants, but includes their reproductive behaviour as well. Changes in the participation rates give the third effect, the participation component. The decomposition was conducted by comparing different labour force scenarios until 2050. The method can easily be extended for decomposition into more than three factors.

Not surprisingly, the downward trend in the labour force is attributable only to population effects. Ageing of the baby-boom generation and low birth rates both are the responsible factors behind. Neither a strong increase in labour force participation nor large immigration flows can halt this trend in the labour force.

As the age structure is almost given and increasing fertility rates only have positive effects in the very long run, the projected decline in the labour force should be taken as a fact.

## Zusammenfassung

Die vorliegende Arbeit untersucht die Faktoren, von denen das künftige Arbeitskräfteangebot beeinflusst wird. Die Veränderung des sog. Erwerbspersonenpotenzials wird dazu in die Haupteinflussfaktoren Demografie im engeren Sinne (natürliche Bevölkerungsbewegung einschließlich der Alterung), Wanderungen und Erwerbsverhalten zerlegt. Die Methode beruht auf einem Vergleich verschiedener Szenarien. Als Daten lagen vom Institut für Arbeitsmarkt- und Berufsforschung (IAB) veröffentlichte Szenarien für das Erwerbspersonenpotenzial bis 2050 vor.

Die Dekomposition führt zu dem erwarteten Ergebnis, dass vor allem die Demografie das Erwerbspersonenpotenzial sinken lässt, wobei die Alterung der Bevölkerung einen erheblichen Teil dazu beiträgt. Überraschend ist allerdings die Stärke des demografischen Effekts. Weder ein starker Anstieg der Erwerbsquoten noch eine im langfristigen Durchschnitt hohe Zuwanderung können den Rückgang des Erwerbspersonenpotenzials stoppen.

Die Alterung der Bevölkerung lässt sich zuverlässig weit vorausschätzen. Auch wirkt ein deutlicher Abbau des Geburtendefizits erst sehr langfristig. Deshalb muss davon ausgegangen werden, dass die Projektionen bezüglich Richtung und wohl auch Stärke einen hohen Grad an Eintretenswahrscheinlichkeit haben. Der Rückgang des Erwerbspersonenpotenzials dürfte über einen sehr langen Zeitraum kaum mehr aufzuhalten sein.

**JEL classification:** J11, J21, F22

**Keywords:** Decomposition, demographic change, labour supply, labour force, labour participation, migration

# 1 Introduction

Germany is currently experiencing a growing public and political interest in demography. According to the most up-to-date projection of the Federal Statistical Office population in Germany will probably shrink and, furthermore and maybe more important, the share of older individuals will become larger. An ageing population could have dramatic implications in various areas of society. One important outcome of the ageing process is a decreasing number of people in the working age. As a consequence forecasts show a substantially decreasing and ageing labour force in Germany. Therefore, far fewer workers will be at the disposal of firms than is the case today. Because of this development there are already fears today that Germany could be faced with a shortage of skilled labour.

As any projection implies a high degree of uncertainty, the question arises here, how reliable the projections are, since in particular rising labour force participation and high immigration flows could counteract a demographically related shortage of labour.

The supply of labour develops as a result of changes in its factors of “natural population change” (births and deaths), migration and labour force participation. The degree to which the components can be predicted differs. The trends of fertility and mortality in particular are fairly stable and their labour market effects can be estimated long in advance. In the case of labour force behaviour it is at least possible to draw an upper limit for the activity rate, and the impact of migration can be quantified with different variants. Separating the influences on the projected labour force allows to assessing how sensitive the projection is in respect to the assumptions.

In demography there are approaches which are used to trace back the development of the population or other quantities, e.g. demographic rates, to the factors that are behind them (e.g. Das Gupta 1978).

Similar decompositions are found in the context of labour supply projections.<sup>1</sup> The changes in the supply of labour are broken down into the factors “demographic changes”, which reflects the impact of births, deaths and migration, and “changes in the activity rates” (e.g. EUROSTAT 2003). In addition, this decomposition comprises an interaction effect from the simultaneous change of the population and the labour participation rates.

However, the decomposition into two components (plus interaction effect) is insufficient especially for countries with strong migration movements. In order to estimate the total impact of migration, which includes secondary effects of the migration caused by birth and death of the migrants, this study takes a method which Dinkel &

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<sup>1</sup> These so-called decomposition procedures are largely equivalent in formal terms to the principle of the well-known deterministic “shift-share” analysis, which is often used in regional studies for example in order to isolate the impact of factors such as industry structure on regional employment growth (e.g. Wolf 2002).

Meinl (1991) used for the population development of West and East Germany, and applies it to the projected changes in the labour supply. So, this approach allows to separating the influence of the pure demographic change and the total migration effect.

Due to the age-specific labour participation rates there is also a structural population effect on the supply of labour. This means that there should be a differentiation between the size and the structure of population change. There is presumably general agreement that the ageing of the population has an influence on the labour supply. As no quantification is available so far – at least for Germany – this aspect is to be examined more closely in the following.

All in all the primary concern of this paper is to show how the overall change in the labour supply can be decomposed into several population related components using available labour force projections. In the empirical part the method is applied to a recently published forecast of the German labour force.

The paper is structured as follows: Chapter 2 gives a brief overview of the development of the labour supply until 2050, including the population and labour participation trends. This chapter also presents the projection model, which provides the data for the empirical analysis. Then the third chapter explains the model used for the decomposition. In Chapter 4 the isolated results are first shown for each individual component. This is followed by a comparison of the components. Furthermore, the chapter looks into the question of how reliable the estimations are, since in connection with findings on the sensitivity of population projections as regards the influence of fertility and mortality and in connection with considerations on the future development of migration and labour force participation, it is possible to derive well-founded statements about whether the supply of labour can be influenced. Finally, the summary looks into the consequences.

## **2 Long term trends of labour supply**

The decomposition analysis in this paper uses a labour force projection which was published at the Institut für Arbeitsmarkt- und Berufsforschung (IAB) (see Fuchs/Dörfler 2005). The IAB labour force projections are based on estimations of the long term trends of population growth and labour participation rates. Their combination results in a variety of long term labour force scenarios, defined by alternative assumptions on the major determinants.

### **2.1 Population trends until 2050**

The IAB extrapolated the population according to age and gender until 2050 using the component method.<sup>2</sup> This was done separately for the German population in

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<sup>2</sup> The IAB population scenarios are on the whole approximately comparable with the corresponding variants from the 11<sup>th</sup> coordinated population projection of Germany's Federal Statistical Office (2006).

western and eastern Germany and for the foreign nationals in Germany as a whole (see Fuchs/Söhnlein 2005).

Fertility has the greatest cumulative effect of all components of population growth. Germany faces a tremendous demographic challenge in the coming decades. The baby-boom of the mid-50s and 60s ended abruptly with a sharp decline in birth rates in the early 70s. The birth rates even fell to sub-replacement level in 1971. Since then birth rates have been year after year far below the value necessary to keep population constant in the long run.

Total fertility rate is currently about 1.4 children per woman, which means only two-thirds of each generation is replaced by children. In all scenarios being used in this analysis fertility will remain stable at this level. Low fertility will cause a steadily declining younger generation in future, followed by a shrinking size of population.

There is a noticeable difference between East and West Germany fertility rates. After the fall of the Berlin Wall birth rates in East Germany dropped sharply. Despite of some perceptible improvements, they have not recovered completely since then. At present total fertility rate in West Germany is about 1.34 and in East Germany ca. 1.30 children per women.

Mortality fell considerably in the past. Especially the mortality of elderly people has significantly decreased since the seventies, whereas the death risk of the infants and children has only improved to a smaller degree, because mortality of the younger had already reached a very low point. It is expected that life expectancy will still increase, but this improvement will more affect the elderly than the younger.

All in all, mortality does not have a major impact on the working population. For this reason only a single variant was conducted in respect to the development of life expectancy. In the IAB scenarios an annually one per cent reduction in mortality for the German population was assumed and mortality rates of the non-German population were kept constant.

International migration is highly volatile and has a more rapid effect upon population size and age distribution than fertility. For the German population external migration has been of primary significance. In the past fifty years net migration was about 190,000 persons per annum on average (Federal Statistical Office 2007). This migration surplus was made up of about 50,000 (ethnic) Germans and 140,000 foreigners moving to Germany. Immigration of ethnic Germans, however, has largely phased out since the early 90s, and what is more, since 2005 net migration of Germans has been negative. In addition, migration of foreigners has been declined considerably since the mid-90s. Net migration was less than 23,000 in 2006, the latest available figures, being composed of -52,000 Germans and 75,000 foreigners.

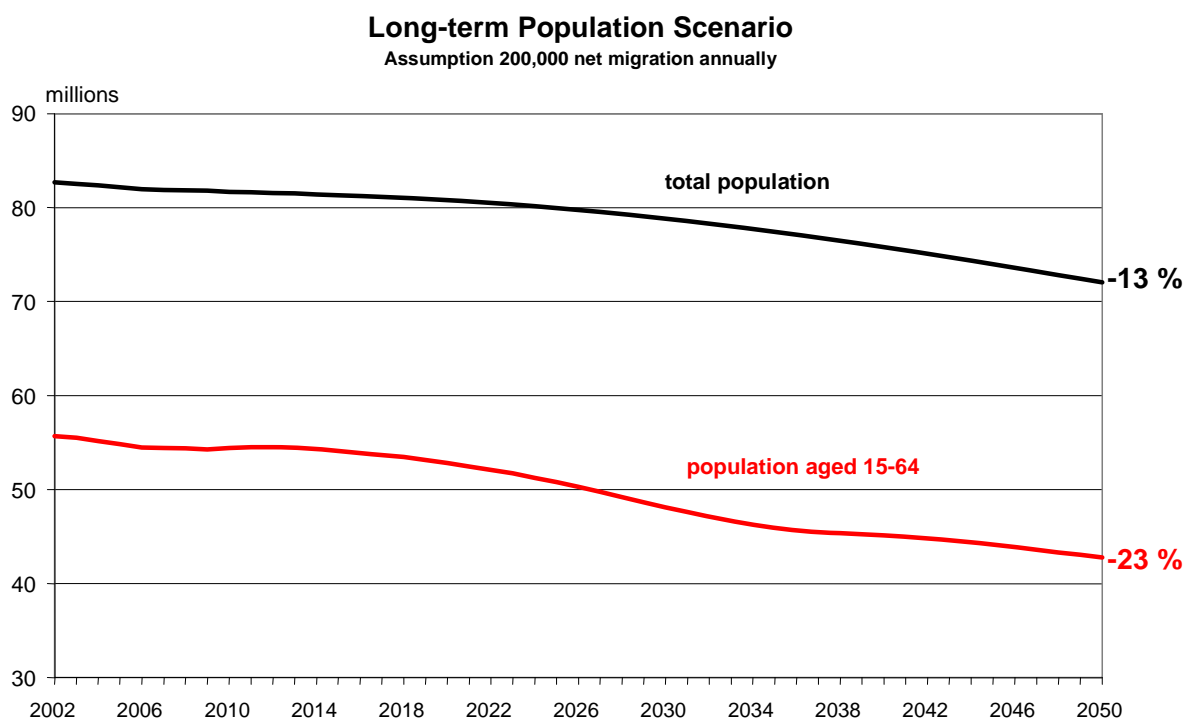
Nevertheless, most German research institutes assume that there will be a considerable migration surplus in future. Due to the highly fluctuating migration figures, the



IAB estimated several population scenarios which differ with regard to the migration assumption. The variants range – in stages of 100,000 - from a zero migration balance to an annual net inflow amounting to 500,000 people (total population, i.e. not only workers). In addition there is also a variant which does not take migration into account at all. According to these scenarios immigration can reduce the fall in the population, but only if net migration exceeded a surplus of at least 400,000 immigrants, the size of the population and of the labour force would not decrease in the very long run.

Assuming 200,000 net migrations annually, total population shows a fall of 13 per cent over the period from 2002 to 2050. Figure 1 makes clear that the working age population (15-64 years of age) will decline even more (-23 per cent change) than the total population (-13 per cent change).

**Figure 1**



Source: Fuchs/Söhnlein (2005).

The baby-boom generation has grown up and dominates the large group of prime-age workers these days. In the next 20 years the labour force will be affected by the ageing of the baby-boom cohort. A person born in 1960 is aged 46 in 2006. But in 2020 this person will be 60. Around 2020 the baby-boomers will mark the peak in the number of the older workers (see Figure 2). After 2020 the baby-boomers will start to change from the labour market into the retirement system.

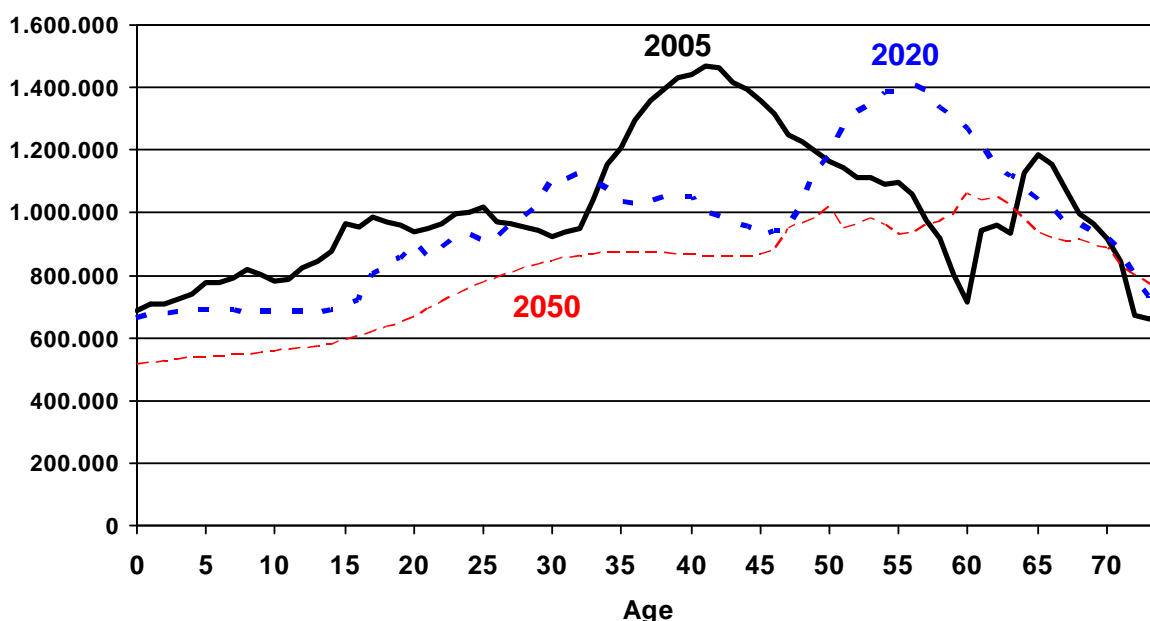
The working population in Germany will age considerably and even stronger than the total population. In fact, since fewer young people enter working age the working-age population will shrink in the long run only, whereas its ageing is already in progress.

As foreigners moving to Germany are on average younger than those who leave the country, migration dampens the ageing process (for the assumptions in respect to the age structure of the migrants, see Fuchs/Söhnlein 2005). Without migration the development of the age structure, as illustrated in Figure 2, would be even worse.

**Figure 2**

**Population aged 0 - 74, 2005, 2020 and 2050**

- Net migration 200,000 annually -



Source: Federal Statistical Office, Fuchs/Söhnlein (2005).

## 2.2 Labour participation trends

The participation rate is the proportion of the population in work or seeking work. Potential activity rates are defined as the activity rates from the labour force survey plus an estimate for hidden unemployment.<sup>3</sup>

Projection of potential activity rates<sup>4</sup> are modelled by gender, age, nationality (German and non-German) and region (West and East Germany) (see Fuchs/Dörfler 2005).

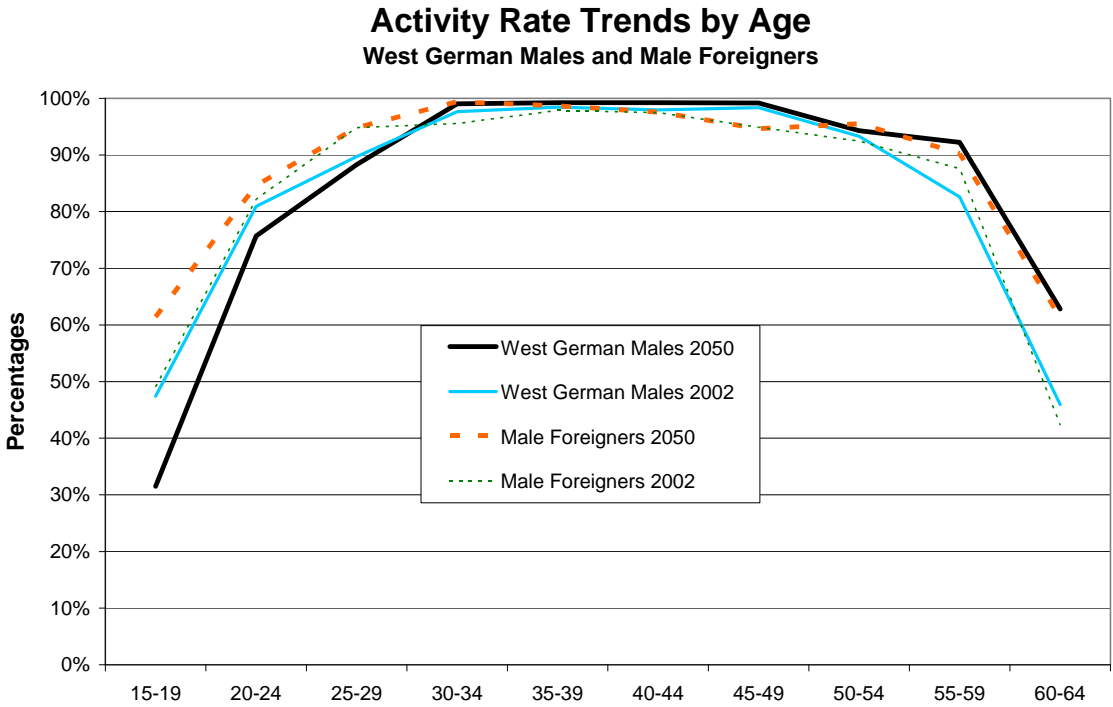
<sup>3</sup> The hidden labour force (hidden unemployment, discouraged workers) includes those people who are willing to work in principle but for various reasons no longer appear in official statistics when the labour market situation is poor. When the labour market situation improves, people in the hidden labour force have at least the same chances as unemployed people (Holst & Schupp 2000). The hidden labour force should therefore be understood as part of the labour supply.

<sup>4</sup> Participation rate and activity rate are used interchangeably in the text. For sake of simplicity the remaining part of the paper refers to the terms “participation rate” and “activity rate” as synonyms for the potential activity rate.

Activity rate projections for the West Germans and the foreigners are given in figures 3a to 3c.<sup>5</sup> The projections indicate that the age specific activity rates for men will remain higher than those for women, although the gap between the rates of men and women will lessen considerably. Especially there is a strong rise in participation rates of West German women. On the other hand, activity rates of foreign females only show a small increase (see Figure 3b). Furthermore, younger Germans might participate less in future due to the educational trends.

Figure 3c sets out the development of the participation rates of prime aged German female workers. These rates have improved substantially since the mid-60s.<sup>6</sup> Presumably the strong upward trend from the past will not continue with the same growth rate. The scenario projects a still increasing but dampened development.

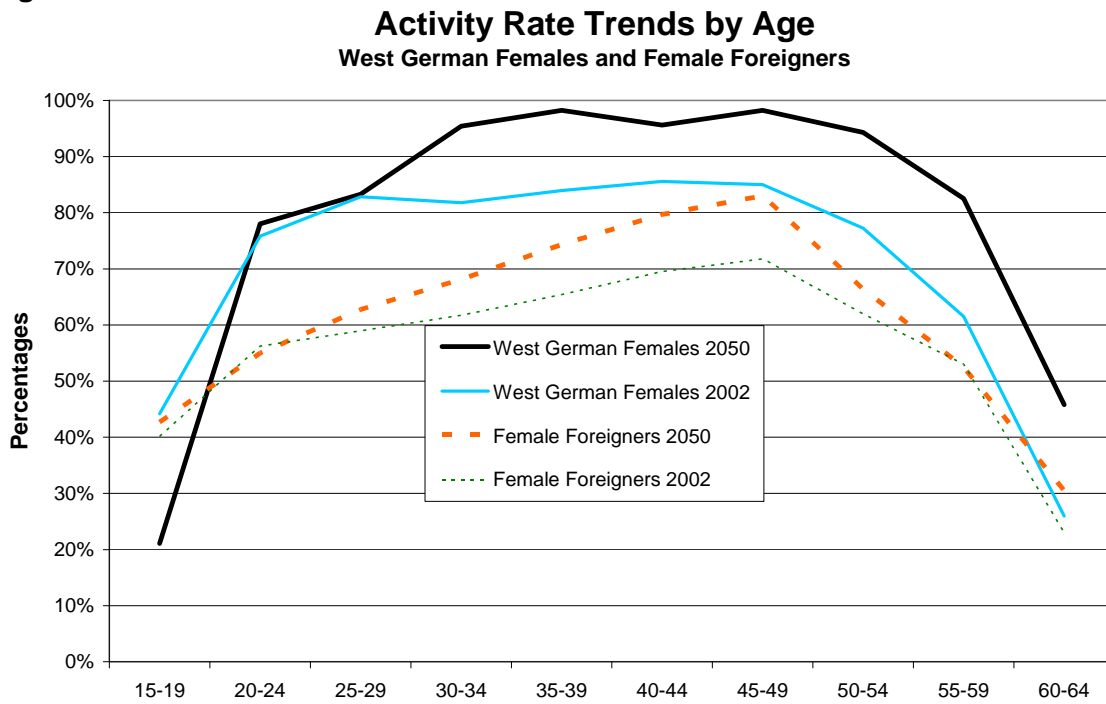
**Figure 3a**



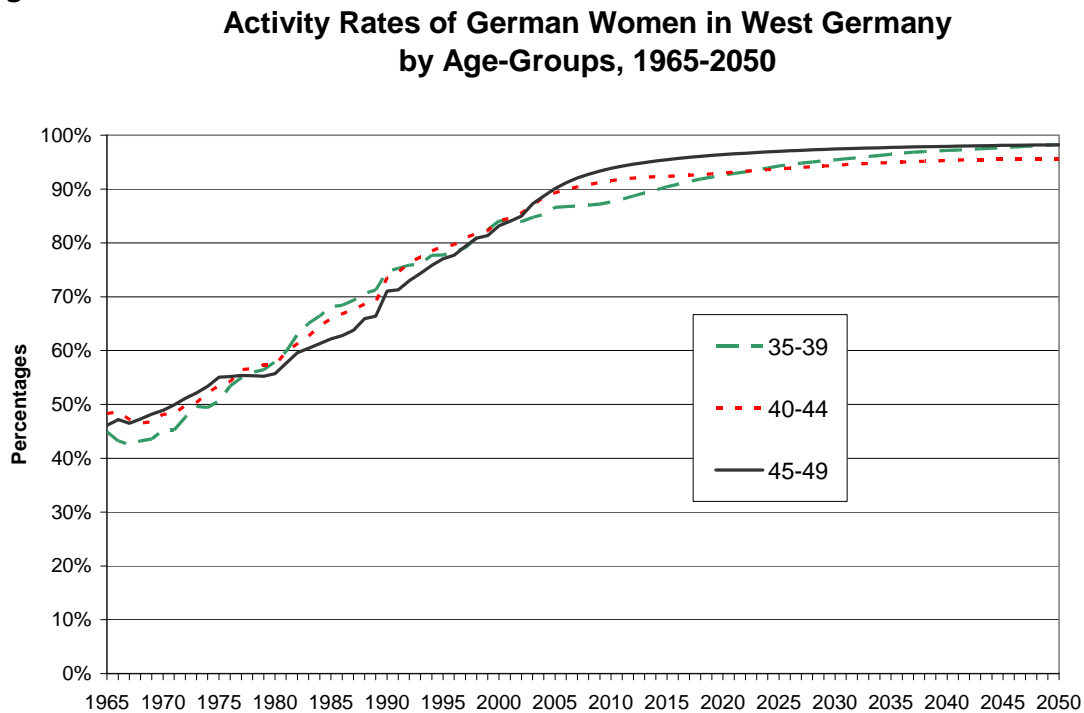
<sup>5</sup> The labour participation rates of the immigrants are unknown. In the IAB projection it was assumed that the immigrants' labour participation agrees with those of the resident population.

<sup>6</sup> International statistics often show comparatively low female labour participation rates in Germany. In contrast, German statistics as well as the IAB offer much higher rates. Those inconsistencies can be attributed to different definitions of unemployment, to the inclusion of the hidden unemployed and, furthermore, considerable underestimation of marginal part-time jobs in the labour force survey.

**Figure 3b**



**Figure 3c**



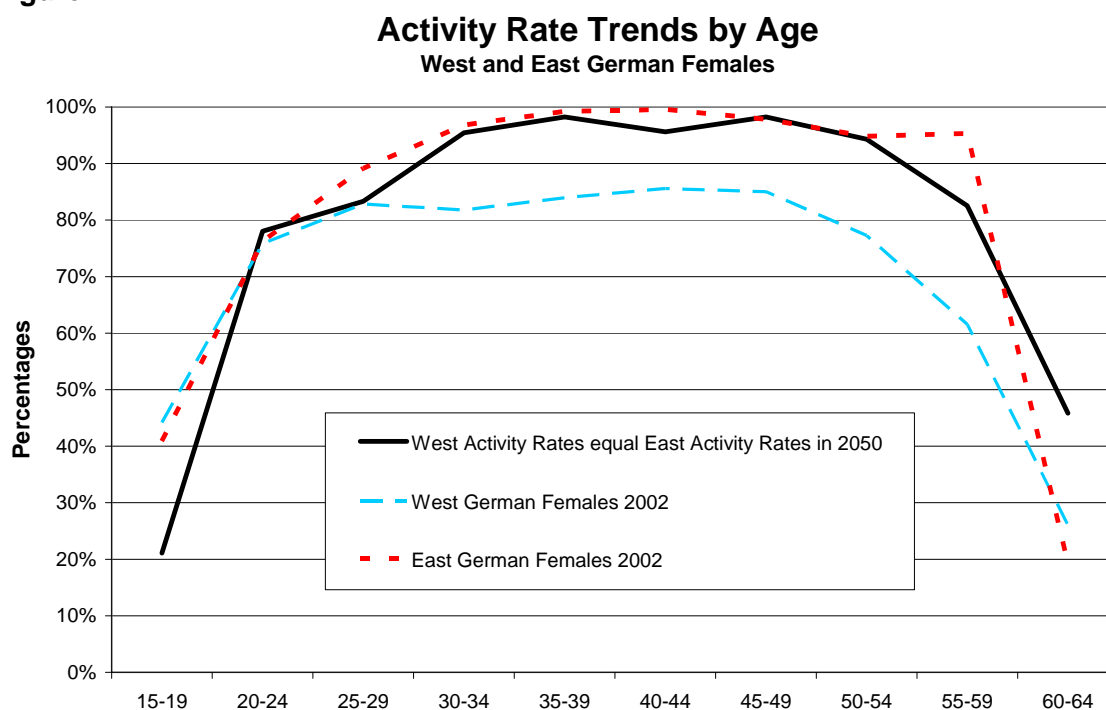
Source: Fuchs/Dörfler 2005.

Activity rates of East and West German females still differ considerably at present. All in all age specific activity rates in East Germany are higher than in West Germany (see Figure 4).

The future activity rates of the West German population and of the non-German population were estimated by the use of an econometric model (see Fuchs/Dörfler

2005). On the contrary, trends in the activity rates of the East German population are based on a scenario that assumes some convergence to the West German rates (see Fuchs/Dörfler 2005). Labour participation of young East Germans who enter into the labour market should match the West German rates throughout their life. As a consequence, there should be a step by step adaptation of the participation rates. Recent statistics show some evidence in favour of this hypothesis. Therefore, the gap between female participation rates in East and West will have been closed by 2050 (see Figure 4).

**Figure 4**



Source: Fuchs/Dörfler 2005.

### 2.3 Labour force projections until 2050

By combining the assumptions concerning population development and labour force participation, the IAB formed a multitude of projection variants. The results of the most important labour force variants for this paper are described briefly (see Figure 5 and the table in the Appendix).

The labour force includes people who are either employed or unemployed. The IAB labour force potential adds an estimate of the hidden unemployed to the labour force. In this way labour demand effects on labour supply are taken into account.

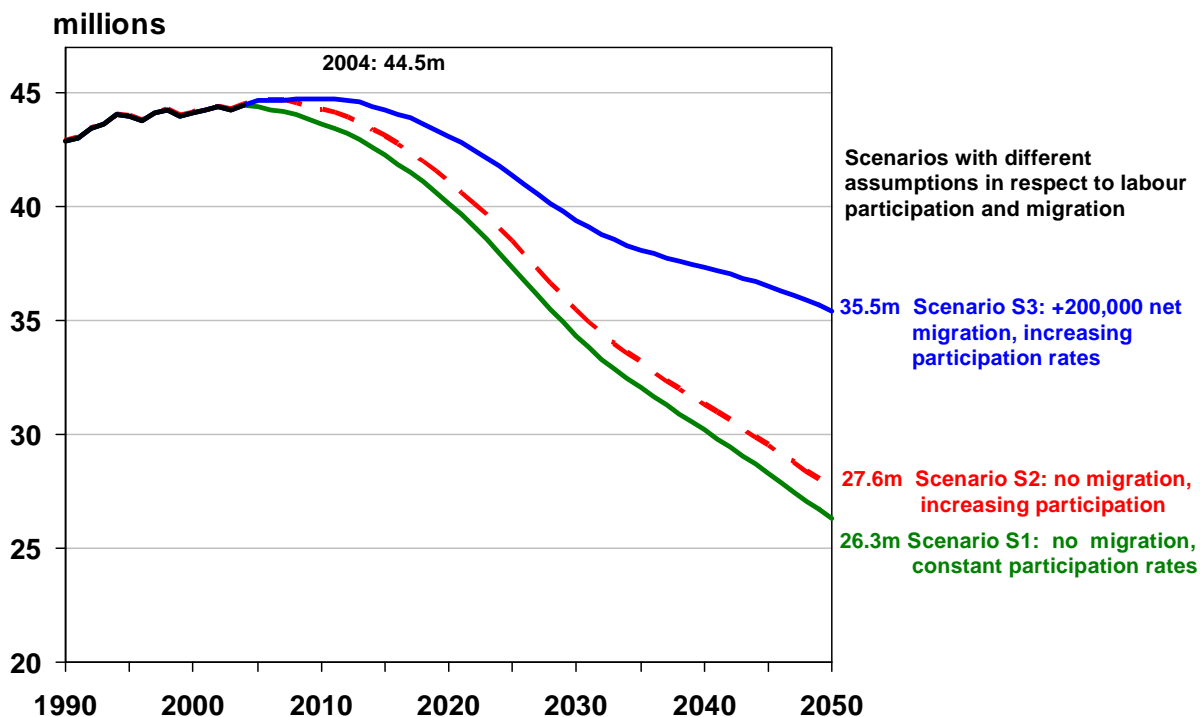
This labour force potential will remain stable until 2010 (see Figure 5). From 2010 the projection shows a slightly decreasing labour force. Most important, the trend accelerates enormously after 2015.

In one scenario the activity rates were held constant and no immigration was taken into account. This projection variant corresponds to the scenario denoted as S1

here. From Figure 5 it is clear that in the case of S1 the labour force potential would fall to around 26 million workers by 2050.

Figure 5

### Labour Force Potential in Germany, 1990 - 2050



Source: Fuchs/Dörfler (2005).

Should the activity rates of women and older workers increase strongly, the labour force potential would decrease less considerably (scenario S2). With this scenario too, however, only 27.6 million potential workers are left towards the end of the projection horizon.

It is only with an annual net immigration of some 200,000 people (aged between 0 and 99, in other words not only workers) and increasing activity rates that a clearly weaker reduction in the potential labour force emerges according to the IAB projections (scenario S3). A potential of 35.5 million workers was forecast for the year 2050. This would be “only” 9 million workers less than in 2004.

But in respect to the latest migration numbers, which report a net inflow of only 75,000 foreigners to Germany, low migration could be a more reliable assumption. If one assumes low migration (+100,000 per year) total labour force would decrease by about 13 million workers from 44.5 million in 2004 to 31.5 million 2050 (-30 per cent change).

On the basis of these scenarios the isolated influence of demography, employment behaviour and immigration is quantified in the following.

### 3 Decomposing labour force growth

For the decomposition of the labour supply, the overall change in the labour supply is split into different components. In general the influence of the components is not to be understood as a causal influence. There are factors which are “behind” the components and determine them. For example, labour force participation depends on basic social conditions, on the labour market situation, on wages etc. An examination of these causal chains would go beyond the aim of the following analysis, however.<sup>7</sup>

#### 3.1 The analytical model

The total labour force  $L$  is divided into  $i$  groups, e.g. by age and sex. Let  $L_{xt}$  be the labour force at time  $t$  for group  $x$ . Let  $a_{xt}$  be the group specific activity rate (participation rate) and  $P_{xt}$  the population of group  $x$  ( $x = 1, \dots, i$ ) at time  $t$ .

An individual group of the labour force potential is therefore made up as follows:

$$L_{xt} = a_{xt} P_{xt}$$

The total labour force at time  $t$  is given by summing over the subscript  $x$ .

$$L_t = \sum_x a_{xt} P_{xt}$$

Applying a simple decomposition analysis, the change in the labour force ( $\Delta L_t$ ) between a year  $t$  and the base year ( $t=0$ ) can be decomposed and transformed as follows:

$$\begin{aligned} (1) \quad \Delta L_t &= \sum_x (L_{xt} - L_{x0}) \\ (2) &= \sum_x (a_{xt} P_{xt} - a_{x0} P_{x0}) \\ (3) &= \sum_x \{ [a_{x0} (P_{xt} - P_{x0})] + [(a_{xt} - a_{x0}) P_{x0}] + [(a_{xt} - a_{x0}) (P_{xt} - P_{x0})] \} \end{aligned}$$

Let  $a_t$  be a  $1 \times i$  row vector of group specific participation rates ( $a_{1t}..a_{2t}....a_{it}$ ) in period  $t$ , and  $P_t$  an  $i \times 1$  column vector ( $P_{1t}..P_{2t}....P_{it}$ ) whose elements represent the number of people in group  $x$  in period  $t$ .

The first term  $[a_0 (P_t - P_0)]$  of (3) shows the population effect, due to changes in size and structure of the population when age specific participation rates remain constant. The total population effect at time  $t$  is calculated by summing the effects over all groups.

$$\text{Population component: } a_0 (P_t - P_0) = a_0 P_t - a_0 P_0$$

The second part of (3),  $[(a_t - a_0) P_0]$ , is the participation rate effect due to changes in the age specific participation rates, given the population from the base year  $t=0$  of

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<sup>7</sup> Our model is a purely deterministic one. An interesting more recent approach can be found in the thesis by Babel (2007). There the impact of the components on the size of the population and other demographic parameters was estimated by means of a regression analysis using stochastic simulation calculations. These comparatively complex calculations are not necessary for the question that we are investigating here.

the projection. The total participation effect is again obtained by summing the effects over all groups.

Participation component:  $(a_t - a_0) P_0 = a_t P_0 - a_0 P_0$

The third part of (3) represents a second order change. This is the interaction effect from the simultaneous change in the population and the activity rates. In some demographic applications this is shared out between the remaining main components (Das Gupta 1978, Liao 1989, Kim/Strobino 1984). Here it is added to the participation component, which is justified below.

### 3.2 Decomposition using simulation scenarios

As already mentioned the age-specific labour participation rates causes a structural population effect on the supply of labour. This ageing effect is part of the overall demographic effect. To the best of our knowledge, isolating the pure population ageing effect on the labour supply has not been treated in decomposition analysis.

Moreover, the population component of equation (3) includes the impact of migration on population and thus on labour supply. As migration is of high importance for the population development one might be interested to quantify its impact. If one wishes to exclude solely the annual migration flows, this could be done simply by subtracting the total net migration. This would, however, lead to an underestimation of the secondary migration effect which results from the immigrants' generative behaviour (births, deaths). How important this secondary effect can be is shown by simulations conducted by Salzmänn (2007) on the basis of the population development of some federal states.

It seems, however, to be impossible to derive an analytical estimate for the effect of migration that includes the effects of the generational behaviour (fertility and mortality) of the migrants (Salzmänn 2007). The reason for this is its dependence on earlier events, which would have to be taken into account accordingly.

In order to be able to isolate a migration component, that includes the second order effect, and the influence of population ageing an approach was adopted that Dinkel & Meini (1991) employed for decomposing demographic factors of population development (see also Salzmänn 2007). They extrapolated a given initial population ( $P_0$ ) under various assumptions with regard to mortality, the birth trend and migration. Depending on the set of assumptions made they received different simulations for the population at time  $t$ . From the differences in the variants they derived the sought-after effects.

This method is applied to the labour force potential in this paper. It can be shown that by comparing different labour force scenarios the usual decomposition method can be easily expanded. This flexible, scenario based approach generates estimates for the impact of ageing and the importance of migration in the context of labour force growth.



### Scenarios used for the decomposition

The labour force potential in year  $t$  is extrapolated on the basis of the assumptions made. Different assumptions result in different scenarios, which are denoted as S1, S2 etc. in the following. These scenarios have been already described in Chapter 2.3 (see Figure 5).

### Demographic component without the influence of migration

For calculating the demographic component<sup>8</sup>, the initial population upon which the labour force potential is based is extrapolated using the age-specific fertility and mortality rates, whereas Migration is not taken into account. This population is denoted as  $P_t^h$ .

Furthermore, the activity rates were held constant at the values observed in 2004.

For time  $t$  this labour force scenario (S1) is calculated as follows:

$$S1_t = a_0 P_t^h$$

The demographic effect is equal to the difference in this labour force potential between two points in time. Because migration was excluded and labour participation rates were kept constant, the demographic effect results solely from the birth deficit and the changes in the initial population structure (base year 2004). The demographic effect is estimated by the change of scenario S1, evaluated at time  $t$  and in relation to the base year of the projection ( $t=0$ ):

$$\text{Demographic effect at time } t = S1_t - S1_0 = a_0 (P_t^h - P_0^h) = a_0 P_t^h - a_0 P_0^h$$

### Participation component

The effect of changing age-specific activity rates on the labour force potential is specified in equation (3) with the term  $[(a_t - a_0) P_0]$ . The change in behaviour is weighted according to the decomposition above using the population of the base year  $t=0$ . With a decomposition using simulation models it would be necessary to calculate a variant which combines the initial population  $P_0$  with the activity rates  $a_t$  from year  $t$  since

$$(a_t - a_0) P_0 = a_t P_0 - a_0 P_0$$

$a_t P_0$  does not yield a “normal” scenario (which is therefore not published). It can be seen, however, that the participation effect with a weighting from the current year includes the interaction effect from equation 3:

$$(a_t - a_0) P_t = a_t P_t - a_0 P_t = (a_t - a_0) P_0 + [(a_t - a_0) P_t - (a_t - a_0) P_0]$$

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<sup>8</sup> In the terminology of demography the demographic component includes migration. For simplification reasons the terms demographic component etc. refer in this entire text only to population change without the migration component. This probably also corresponds largely with the usage outside the field of demography in the meantime.

For a participation effect calculated in this way it is necessary to have scenarios in which activity rates are held constant and are combined with the population of the current year  $t$ . Such scenarios are published both as a variant without migration (S2) and as a variant with migration (S3).

In the following the interaction effect mentioned in equation 3 is added to the participation effect. In addition to the practical reason mentioned, this can also be justified by the fact that the interaction effect should be quite small in empirical terms (for the EU average see for example: EUROSTAT 2003). Moreover, migration effects are excluded, i.e. the population which is taken as a basis is  $P_t^h$ . The participation effect is described as the difference between the scenarios S2 and S1, evaluated at time  $t$ :

$$\text{Participation component} = S2_t - S1_t = a_t P_t^h - a_0 P_t^h$$

### Migration component

In order to calculate the migration component, a scenario which includes future migration is compared with a scenario without migration. Both of the scenarios are based on the same development of activity rates.

The migration effect includes the generative consequences of migration, in other words the births and deaths of immigrants. It also covers the effect of the age structure of the net migration on the labour force potential because the immigrated population ( $P_t^m$ ) is zero at the beginning of the observation period ( $t=0$ ).

Let  $P_t^h$  be a population scenario that omits any migration flows. Therefore only births and deaths influence population size. This scenario was also used for calculating the demographic effect ( $S1_t = a_0 P_t^h$ ) and the participation rate effect ( $S2_t = a_t P_t^h$ ).

The migration effect can be calculated for both constant and changing activity rates. The migration effect shown in the empirical section includes the effects of the immigrants' increasing activity rates.

Let  $P_t$  be a population scenario including migration flows:

$$P_t = P_t^h + P_t^m.$$

$P_t^m$  includes not only the sum of migrants but the outcome of their reproductive behaviour as well. The migration effect is the difference between  $P_t$  and  $P_t^h$  multiplied by the participation rates, thus the difference of scenario S3 and scenario S2 in Figure 5.

$$\text{Migration component} = S3_t - S2_t = a_t P_t - a_t P_t^h = a_t (P_t - P_t^h)$$

The migration effect thus contains an interaction effect from a change in behaviour and migration. It appears to make sense to assign this combined effect to the migration component because the higher activity rates only yield an additional labour force potential when interacted with migration.

In order to work out a migration effect without a change in behaviour, the migration variants have to be compared on the basis of constant activity rates. This then says how much additional potential results from the net migration if the activity rates remain at the initial level. This effect is only referred to here in order to complete the picture. It is not examined in any further detail.

**Note:**

The overall change in the labour force potential between a year t and the base year 0 is equal to the sum of the demographic effect, the participation effect (including the interaction effect from participation by age structure) and the migration effect (including the interaction effect from participation by migration) since

$$\Delta L_t = (S1_t - S1_0) + (S2_t - S1_t) + (S3_t - S2_t) = S3_t - S1_0 = a_t P_t - a_0 P_0$$

Furthermore  $S3_0 = S2_0 = S1_0$ , where  $P_0 = P^h_0$  and  $P^m_t = 0$

**Ageing effect**

The demographic component comprises the effect of an ageing population on labour supply. Due to age specific labour participation rates an ageing population could have some negative outcome on the size (and structure) of the labour force. In order to quantify this effect a labour force scenario (S1k) was calculated that keeps the age structure of the population constant (age structure from base year t = 0) but not the size of the population.

A constant age structure is obtained by applying the age structure of the base year to the projected total population. The population upon which the labour force potential is based in this case is of the size projected for year t (without immigration) but has the age structure from t=0.

$$S1k_{gt} = \sum_j a_{gj0} (P^h_{gj0} / \sum_j P^h_{gj0}) \sum_j P^h_{gjt}$$

where j = age group, g = {East/West German males/females, non-German males/females}

$$S1k_t = \sum_g S1k_{gt}$$

$P^h_{gj0} / \sum_j P^h_{gj0}$  is the proportion of age group j in the total population (of the same sex etc.) at time t=0. This structure transfer is done separately for both sexes and according to German nationals/foreign nationals so that a pure age-structure effect is quantified. The impact of changes in the composition according to gender or nationality was not modelled here.

The difference between this scenario (S1k) and the scenario with a changing population structure (S1) yields the age-structure effect. It is a result of the age-dependent labour force participation – which remains constant in this version – and the shift in the age structure of the population. The effect is understood as part of

the overall demographic effect because it mainly reflects earlier generative processes.<sup>9</sup>

Ageing effect =  $S1k_t - S1_t$ , where  $S1_t = a_0 P_t^h$

## 4 Empirical results

### 4.1 Development of the isolated components until 2050

#### The demographic component

If the labour force potential were determined solely by the demographic component, then it would decline only slowly at first, but this process gains speed rapidly (see again scenario S1 in Figure 5). In the year 2020 the potential labour force, with 40.1 million people, would be approximately 4.3 million smaller than in 2004 when it still numbered 44.5 million people. In 2050, however, it would be 40.9 percent below the 2004 value. The demographic effect thus amounts to a good 4.3 million people in 2020 and just under 18.2 million people in 2050 (Figure 6).

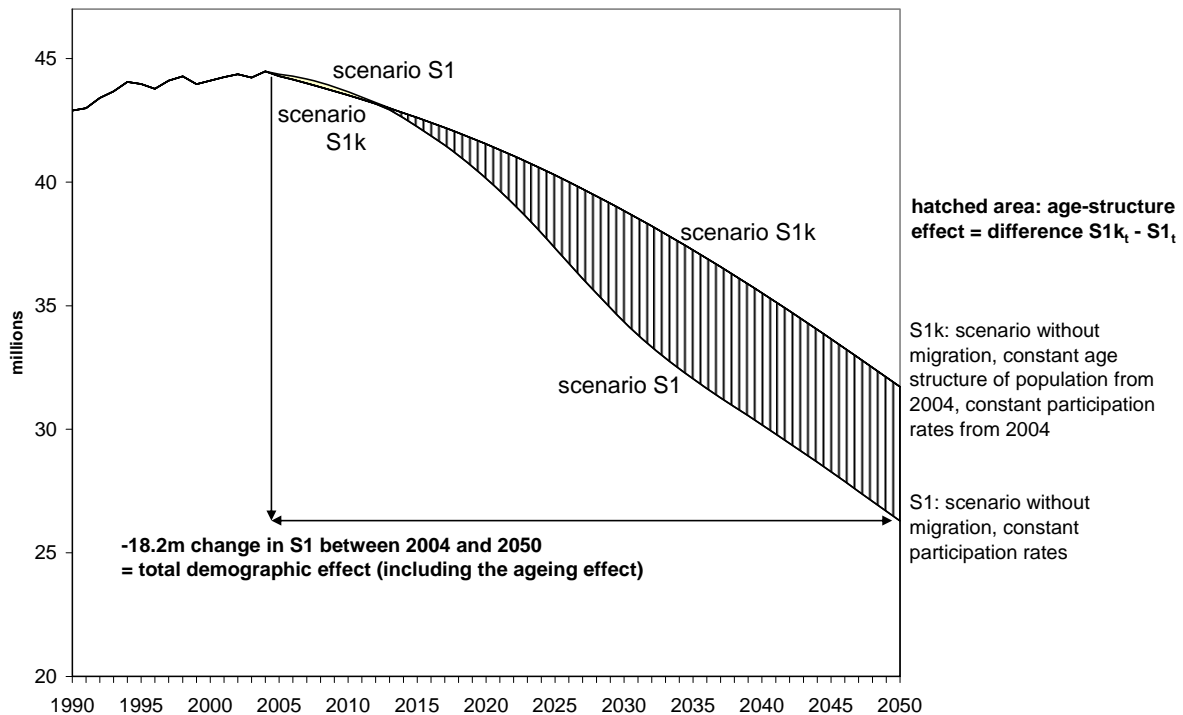
Population ageing will become more and more important (see hatched area in Figure 6) when many more people will change from the prime aged to the older age groups that have lower participation rates. By means of a comparison with the scenario based on a constant age structure of the population of 2004 (S1k) it is possible to calculate the age-structure effect. A considerable part of the demographic process is obviously already laid down in the age distribution of today's population. If the age structure remained constant, the labour force potential would fall by 12.8 million people (28.7 percent) by 2050. If this value is compared with that from scenario S1 then it follows that ageing alone reduces the labour force potential by a good 5.4 million people.

Figure 6 also suggests that the age-structure effect turns in the course of time. With an age structure of the population of 2004, the labour force potential would even be smaller by 2012 than with the structure of the year under observation. The ageing of the population thus even leads to a slight increase in the supply of labour in the next few years.

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<sup>9</sup> The current age structure also covers previous migration events. Seen from  $t=0$ , the ageing of those who immigrated earlier contributes to the age-structure effect.

**Figure 6**  
**Demographic effect and ageing**



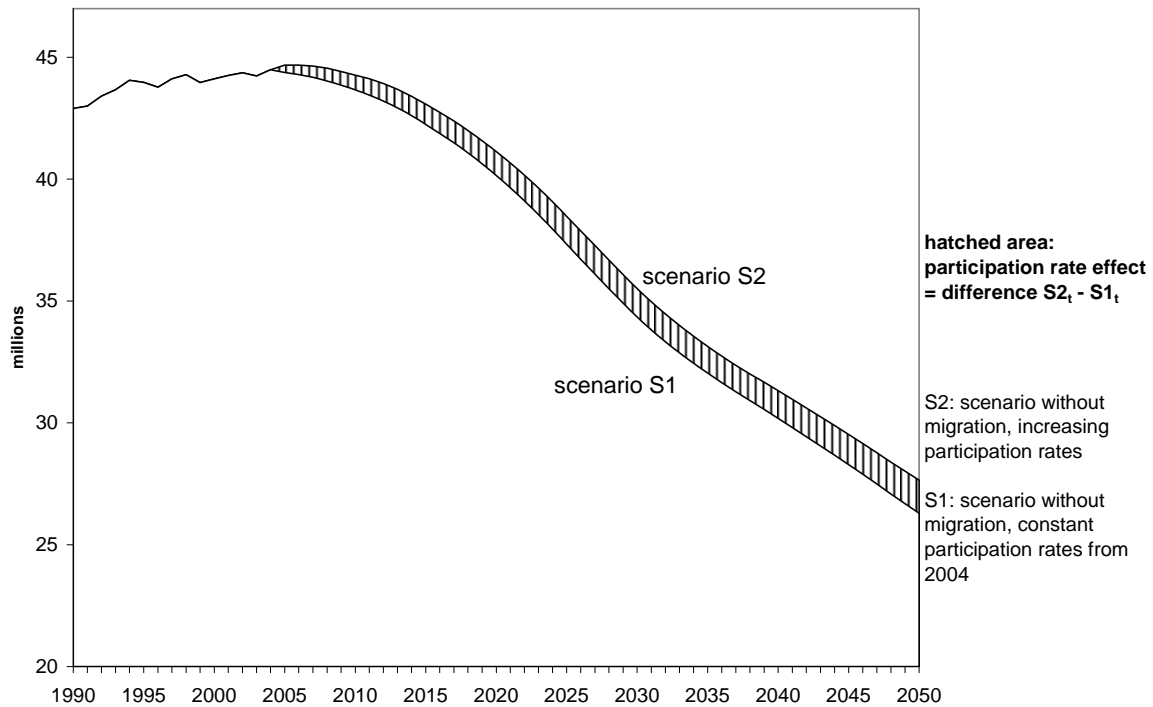
Source: Own calculations.

### The participation component

The fall in the labour force will be mitigated by rising age-specific participation rates. The difference between the scenario with increasing activity rates and the one with constant activity rates, S2 minus S1, is the participation effect. This amounts to not quite a million people in 2020 and to around 1.35 million people in 2050 (Figure 7).

As already mentioned, the given participation effect includes the interaction effect from behaviour by population change. Using a special evaluation which was calculated at the IAB it is possible to quantify the interaction effect for the present scenarios. If the participation component is calculated using the population from the base year  $t = 2004$ , in other words  $(a_t - a_0) P^h_0$ , the resulting participation effect for 2050 for example is 1.7 million people. The interaction effect thus amounts to some 360,000 people. Related to the total change in the labour force potential by the year 2050 (including 200,000 net immigrations per year) of about 9 million, this is just under four percent. This is somewhat more than the result for the whole of the EU on average. In a projection of Europe's labour supply, EUROSTAT estimates a decrease of 21 million people between 2000 and 2050 and calculates an interaction effect of 0.5 million, i.e. approx. 2.4 percent with reference to the total change (EUROSTAT 2003).

**Figure 7**  
**Participation rate effect**



Source: Own calculations.

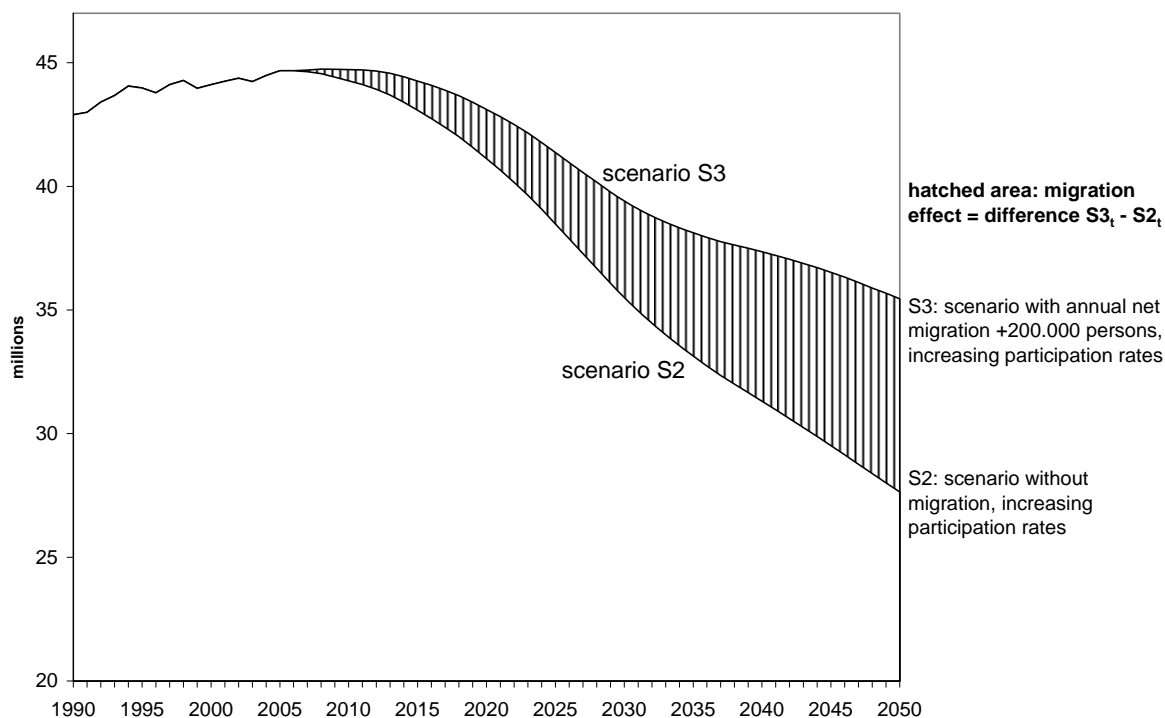
While including the interaction component the participation effect was about 7.7 per cent of the change in the labour force potential. Excluding the interaction component would result in a somewhat higher participation rate effect. In this case the pure participation effect would be ca. 9.3 per cent of the change in the overall labour force potential.

### The migration component

Inflows from abroad are of paramount importance for Germany's population development. Scenario S3 in Figure 5 assumes an annual net inflow of somewhat over 200,000 people (200,000 foreigners plus an average of about 9,000 Germans). S3 is also based on increasing activity rates.

The labour force potential falls clearly less strongly with migration (S3) than it does without (scenario S2). The additional supply of labour resulting from the migration assumption amounts to 7.8 million workers for the year 2050. Therefore even immigration of the assumed level can not compensate for the demographic influence on the labour force potential.

**Figure 8**  
**Migration effect**



Source: Own calculations.

Scenario S3 assumes net inflows which remain constant from year to year. If the net inflows were distributed differently over time, a somewhat different result would be obtained for S3 and thus for the migration effect in the meantime. At the end of the projection period, differences can only be caused by the generative behaviour. More immigration at the beginning means, for example, that some children are born earlier than in the case of the assumed equal distribution of the net inflows. This should not cause any strong impact on the estimated migration effect.

## 4.2 Comparison of the components

The following Table 1 compares the isolated effects for different periods of time. What is clearly visible is the dominance of the demographic effect, which gains further strength in the course of time. In contrast, the participation effect weakens in the longer-term – a result of the activity rates gradually reaching their upper limits. The migration effect, too, becomes stronger despite annual net inflows remaining constant. This is not only due to the consequences of the migrants' generative behaviour but also due to their age structure. The following section discusses the reliability of these estimates.

**Table 1**  
**Components of labour force change, 2004-2050 - in millions of persons -**

	Demography <sup>1)</sup>	Participation <sup>2)</sup>	Migration <sup>3)</sup>	Total <sup>4)</sup>
2004 to 2020	-4.3	+1.0	+2.0	-1.4
2020 to 2050	-13.9	+0.4	+5.8	-7.7
2004 to 2050	-18.2	+1.4	+7.8	-9.0

1) Includes the ageing effect.

2) Includes the interaction effect of demography and participation.

3) Assumes an annual net migration of ca. 200,000 persons and increasing participation rates.

4) Sum of components may not equal total due to rounding.

Source: Own calculations.

### 4.3 Impact of alternative assumptions

The demographic effect of -18.2 million for the years until 2050 is made up of the age-structure effect (approx. -5.4 million) and the effect of a declining population figure (approx. -12.8 million).

The demographic component can be predicted reliably for a long period because, in accordance with the logic of the decomposition, besides the population structure from the base year only the births and deaths of this “base year population” are taken into account, but not the generative effects of migration. However, there is currently no reason to assume any considerable changes or even jumps in fertility or mortality in the short and medium term. Furthermore, deaths are of very little significance for the working-age population (15 to 64 years of age).

An increase in the number of births, on the other hand, would be certain to have clear effects on the population in the long term and thus on the future labour force potential. However, this effect begins on the labour market with a time lag as the newborn do not count as part of the labour supply until 15 years after their birth at the earliest. Because at the age of 15 young people have generally not completed their education or training, it is even necessary to reckon with a clearly longer period. Analyses based on replacement fertility (total fertility rate 2.1) show that it takes approximately 30 years for the decline in the working-age population to be slowed down and even longer for the decline to be halted – at a lower level than today (Fuchs/Söhnlein 2006). This means that if birth figures were to begin rising considerably from now onwards, they would not be able to stop the fundamental downward trend in the labour force potential until the year 2020 at the earliest and probably not until much later.

The impact of the increasing labour force participation rates is surprisingly small although by 2050 the activity rates of German nationals in the middle age groups have reached a level which can probably not be increased further (see Chapter 2.2). In the case of female foreigners there is some upward margin with regard to the activity rates, but even if the rates were to rise strongly it would have only little im-



pact on Germany's labour force potential due to the fact that female foreigners are so few in number.<sup>10</sup>

An increase in the length of the working life is more promising. An estimate regarding the consequences of a postponement of the statutory retirement age ("pension at 67") in Germany obtains an additional labour force potential of 0.8 to 2.5 million older workers for the year 2050 (Fuchs 2006). Other researchers judge the supply effect of retirement at the age of 67 more sceptically (Ottnad/Schnabel 2006). They point out that a decision to retire later leads to an increase in pensions. In theory higher pensions cause the labour supply to decline. Therefore the scenario with 2.5 million additional workers should probably be regarded as the upper limit by which the participation effect described above could increase in the longer term due to retirement at 67.

The estimated migration effect is based on a scenario with an annual net immigration of somewhat more than 200,000 people. As can be calculated from the table in the appendix, the migration effect is virtually proportional to the assumed migration balance in each case. Together with participation change, net migration into the country would have to average at least 400,000 people per year in order to be able to compensate for the demographic effect. This net migration would be roughly twice as much as the average migration balance in the last 50 years.

Immigration also has an effect caused by the age and gender structures. The overall structural effect of the migration can be roughly quantified by comparing the scenarios "migration not taken into account" and "zero migration balance" (see table in the appendix). In the scenario "zero migration balance" the number of moves out of the country is equal to the number of moves into the country, but the age and gender structures of immigrants and emigrants differ. If migration is not considered at all, there is of course no impact on the structures. In the year 2050 the difference between these two scenarios is at any rate 1.2 million in favour of the variant with a zero migration balance.

A more favourable age structure or a larger share of women in the immigration could lead to a stronger migration effect (Dinkel/Lebok 1993). There are two reasons for this: firstly because, all other things being equal, the future child figures would be higher, and secondly because younger migrants still go through a phase of high labour force participation. On the other hand a larger share of women in the immigration could weaken the migration effect in view of their lower labour force participation.

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<sup>10</sup> A higher labour force participation of the future female migrants in particular would be conceivable. In numerical terms this effect would become noticeable in the migration effect.

It is doubtful, however, whether the immigration structure assumed for Germany in the projection can be improved much – in view of the global competition for the “the best brains” and the fact that even now it is mainly younger people who are immigrating to Germany whilst moves out of Germany predominate among older people.

## 5 Summary

The labour force projections in this paper are based on a set of assumptions about demographic developments and labour force participation. In respect to its assumptions any projection is uncertain. This paper provides some sort of sensitivity analysis. Alternative scenarios were used to evaluate the uncertainty of the projected long term trends.

The decomposition has shown the extent to which the most reliable factor, the demographic development, considered in isolation, could reduce the supply of labour. Domestic labour reserves can no longer compensate for this demographically related loss, since even far higher activity rates would slow down the trend only slightly.

A stronger counteraction would probably result from migration. However, even with quite high net immigration of some 200,000 people per year the downward trend in the labour supply can no longer be halted in the foreseeable future. In order to stop this process we would need at least twice as much immigration. From the viewpoint of the labour market, qualified workers would be necessary in particular – but they are also in demand in other countries. This impedes the possibilities of German immigration policy to a considerable extent.

The analysis was restricted to a pure per-capita examination. In actual fact, however, working hours should also be taken into account since longer annual working hours counteract the person-related effect. However, one should not expect too much from an extension of working hours. An analysis conducted by Deutsche Bank Research shows that with an annual net immigration of 200,000 people, working time would have to increase by 15 hours per week in order to balance out the demographically related decline in the supply of labour (Gräf 2003, 20).

German society should prepare itself for the labour supply being considerable smaller – and at the same time older – in the long term. It takes time for countermeasures to have an effect. Domestic labour reserves which could still be activated can be found in the longer term mainly in female foreigners and older workers. Measures aimed at integrating female foreigners into the labour market and at a longer working life thus become more important.

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## Annex

**Table**  
**Labour force potential in Germany to 2050 – scenarios for different assumptions**

- Numbers in thousands –

	natural population growth: constant TFR 1.4, rising life expectancy							
	net migration per year							
	no migration <sup>1)</sup>	no migration <sup>1)</sup>	no migration <sup>1)</sup>	zero <sup>2)</sup>	+100000	+200000	+300000	+400.000
	constant participation rates		rising participation rates					
S1k	S1	S2	S3					
<b>1990</b>	42.897	42.897	42.897	42.897	42.897	42.897	42.897	42.897
<b>2000</b>	44.108	44.108	44.108	44.108	44.108	44.108	44.108	44.108
<b>2004</b>	44.487	44.487	44.487	44.487	44.487	44.487	44.487	44.487
<b>2010</b>	43.519	43.655	44.267	44.283	44.500	44.719	44.938	45.157
<b>2020</b>	41.546	40.146	41.120	41.296	42.141	43.109	44.077	45.044
<b>2030</b>	38.840	34.350	35.509	36.024	37.504	39.415	41.326	43.237
<b>2040</b>	35.517	30.185	31.319	32.263	34.369	37.361	40.353	43.344
<b>2050</b>	31.718	26.290	27.642	28.870	31.527	35.451	39.375	43.299

1) No migration: This scenario does not take any migration into account

2) Zero: Immigration and emigration are equal in numbers, but differ in respect to age and sex

S1k: constant age structure of population from 2004

Source: IAB (Fuchs/Dörfler 2005).

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### For further inquiries contact the author:

Johann Fuchs

Phone +49.911.179 5216

E-mail [johann.fuchs@iab.de](mailto:johann.fuchs@iab.de)