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Monitoring the duration of active working life in the European Union

Final Report

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by
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Contents

Tables

Charts

Annex Tables

Abbreviations

AR	Activity rate
CV	Coefficient of variation
DWL	Duration of working life
EES	European Employment Strategy
EU15	European Union with 15 Member States, previous the enlargement in 2004
EU27	Present European Union with 27 Member States
EWCS	European Working Conditions Survey
LFS	Labour Force Survey
IDLT	Increment decrement life table
MDLT	Multiple decrement life table
MLE	Maximum likelihood estimator
MSLT	Multistate life table
NM12	12 New Member States
PLT	Prevalence life table
WHO	World Health Organisation
WLE	Working life expectancy

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Executive summary

Research aims: With this study the EU Commission seeks to investigate the duration of working life indicator (DWL) which should complement the monitoring instruments of the European Employment Strategy by focussing on the entire life cycle of active persons and persons in employment.
The study suggests three indicators for the measurement of the DWL:

- d*uration of active working life indicator* based on average annual activity rates
- d*uration of employment indicator* based on average employment rates
- d*uration of working time indicator* based on annual working hours

All three indicators have their counterparts in the form of the duration of non-active working life, the duration of non-employment, and the duration of non-working time. They are calculated for the time period 2000 to 2007, and are separated by 27 EU countries, the age span from 15 to 100 years old and the two genders.

Results: In 2007 the average EU27 person aged 15 could expect 34.2 active years during lifetime, and 31.8 years of employment with a working time of 61,295 hours in total. For the 45 years old, the duration of active working life was 13.2 years and 0.8 years at the age of 65. Since 2000 an increase of one year can be observed, which mainly happened after 2004.
The duration of active working life for males aged 15 was 6.4 years longer than for females (a difference of 20%). For females however the duration of active working life increased more rapidly since 2000 (+1.6 years compared to 0.5 years for males).
The longest active working life could be measured for the Swedish population, where a 15 year old person could be expected to work for 39.9 years. Denmark and the Netherlands were close to these values. At the shorter end were Italy, Hungary and Malta with duration under 30 years. This is a difference of 11.1 years between Malta and Sweden.

Assessment of indicators: The DWL indicators provide sufficiently accurate and easily understandable results. They

- are highly stable over time, even for single ages
- show great continuity over the lifespan
- react directly to changes of activity rates and working hours
- and reveal the expected differences between gender, ages and countries

The LFS database provided a comprehensive and comparable data input for all EU countries and the subgroups of its population. This also holds for the inclusion of working hours. The country profiles of different working life indicators correlate with average levels of activity rates, the exit age, or unemployment rates. Limitations appear as the indicators are descriptions of the whole lifecycle rather than specific periods of working life. Moreover, they describe the present state of working life participation over all ages rather than providing a forecast of future working life.

Recommendations: Based on the positive assessment of the indicators, the study recommends using the DWL indicator as one of the core labour market indicators at European and national level. Out of the six indicators, the duration of active working life receives a dominating position.
The application of the methodology requires extensive preparatory work to amend the data basis and extend the age span to the maximum of 100 years. It is recommended to apply these methods in order to achieve accurate results.
The calculation of the DWL indicators depends on the availability of life tables for all EU Member States. As soon as such life tables will be available form EUROSTAT, they should be integrated into the calculation system.

Kurzfassung

Untersuchungsziele: Mit dieser Studie beabsichtigt die EU-Kommission den Indikator zur Dauer des Arbeitslebens (DAL) zu untersuchen. Damit soll das Beobachtungsinstrument für die Europäische Beschäftigungsstrategie ergänzt werden mit einem Indikator, der den Blick auf das gesamte Arbeitsleben der aktiven bzw. beschäftigten Personen richtet.
Die Studie empfiehlt drei Indikatoren für die Messung:

- Die *Dauer des aktiven Arbeitslebens,* die auf den durchschnittlichen jährlichen Aktivitätsraten beruht
- Die *Dauer der Beschäftigung,* die sich auf durchschnittliche Beschäftigungsraten stützt
- Die *Dauer der Arbeitszeit,* die jährliche Arbeitszeiten verwendet

Alle Indikatoren haben ein Gegenstück in Form der Dauer der Nicht-Aktivität, der Dauer der Nicht-Beschäftigung, und der Nicht-Arbeitszeit. Sie werden für die Zeitperiode 2000 bis 2007 berechnet und nach 27 EU-Ländern, der Alterspanne von 15 bis 100 und den beiden Geschlechtern differenziert.

Ergebnisse: Im Jahr 2007 hatte der durchschnittliche EU-Bürger im Alter von 15 ein aktives Arbeitsleben von 34,2 Jahren vor sich, mit 31,8 Jahren in Beschäftigung und einer Arbeitszeit von 61.295 Stunden. Für 45jährige betrug die aktive Arbeitszeit noch 13,2 Jahre, und 0,8 Jahre für 65jährige. Seit dem Jahr 2000 ist die Dauer des aktiven Arbeitslebens um ein Jahr angestiegen. Der Anstieg war hauptsächlich nach 2004 festzustellen.
Die aktive DAL war für 15jährige Männer um 6,4 Jahre länger als für Frauen (ein Unterschied von 20%). Allerdings stieg die aktive DAL von Frauen seit 2000 schneller an (+1,6 Jahre verglichen mit 0,5 Jahren für Männer).
Die längste aktive Dauer konnte mit 39,9 Jahren für die schwedische Bevölkerung gemessen werden. Ähnlich Werte ergaben sich für Dänemark und die Niederlande. Die geringste Dauer ergab sich für Italien, Ungarn und Malta mit Werten unter 30 Jahren. Dies ergibt eine Differenz von 11,1 Jahren zwischen Malta und Schweden.

Bewertung der Indikatoren: Die DAL Indikatoren liefern hinreichen genaue und leicht verständlich Messungen. Insbesondere sind sie

- hoch stabil über den Zeitverlauf, auch auf der Ebene einzelner Altersgruppen,
- verlaufen kontinuierlich über den gesamten Lebenszyklus hinweg,
- reagieren direkt auf Änderungen der Aktivitätsraten bzw. der Arbeitsstunden,
- und weisen die erwarteten Unterschiede zwischen Geschlecht, Alter und Ländern auf.

Die Arbeitskräfteerhebung lieferte umfassende und vergleichbare Daten für alle EU-Länder und die Teilgruppen der Bevölkerung. Dies gilt auch für die Arbeitsstunden. Die Länderprofile der verschiedenen DAL Indikatoren korrelieren mit den durchschnittlichen Aktivitätsraten, dem Austrittsalter aus dem Arbeitsmarkt und den Arbeitslosenraten. Die Grenzen der Indikatoren bestehen darin, dass sie das gesamte Arbeitsleben beschreiben und nicht einzelne Phasen. Außerdem messen sie die Dauer des Erwerbslebens mit der aktuellen Erwerbsbeteiligung aller Altergruppen, machen aber keine Prognosen über den künftigen Verlauf des Erwerbslebens.

Empfehlungen: Auf Grund der positiven Bewertung der Indikatoren empfiehlt die Studie die Anwendung der DAL Indikatoren als Teil des Beobachtungsinstrumentariums auf europäischer und nationaler Ebene. Unter den sechs Indikatoren kommt der Dauer des aktiven Arbeitslebens eine zentrale Bedeutung zu.
Die Anwendung der Methode setzt umfangreiche Vorbereitungen zur Verbesserung und Erweiterung der Datenbasis auf die maximale Alterspanne bis 100 Jahre voraus. Es wird empfohlen, diese Methoden anzuwenden, um zu verbesserten Schätzungen zu kommen.
Die Berechnung der DAL Indikatoren hängt von der Verfügbarkeit von Sterbetafeln für alle EU-Länder ab. Sobald diese Tabellen von EUROSTAT verfügbar sind, sollten sie in die Berechnungen integriert werden.

Résumé

Objectif de l'étude: Par la présente étude la Commission Européenne cherche à analyser et évaluer l'indicateur sur la durée de la vie active (DVA). Cet indicateur devrait compléter un ensemble d'indicateurs pour le suivi de la stratégie européenne de l'emploi en mettant l'accent sur toute la vie active des personnes.
L'étude propose trois indicateurs pour mesurer la DVA:

- L'indicateur *sur durée de la vie active*, qui repose sur la moyenne annuelle des taux d'activité
- L'indicateur *sur la durée de l'emploi* , qui est basé les moyennes annuelles des taux d'emploi
- L'indicateur *sur la durée du temps de travail*, qui utilise des données sur le temps de travail annuel.

Chacun de ces indicateurs peut être aussi formulé par son contraire : la durée de la vie non-active, la durée du temps passé sans emploi et le temps passé ne travaillant pas. Ces indicateurs sont calculés pour la période 2000 – 2007, par 27 pays, par âge (entre 15 et 100 ans) et par genre.

Résultat: En 2007, un citoyen européen âgé de 15 ans avait une vie active d'une durée de 34,2 années et 31,8 années en emploi et un volume de travail de 61.295 heures devant lui. Pour une personne âgée de 45 ans le temps de vie active qui lui reste est de 13.2 années et de 0.8 ans pour une personne âgé de 65 ans. Depuis l'année 2000 la durée de la vie active a augmenté d'un an. Cette augmentation a été réalisé surtout après 2004.
La durée de la vie active des hommes ayant 15 ans était de 6.4 années plus longue que celle des femmes du même âge, ce qui représente un différence de 20%. Par contre, la durée de la vie active a augmenté plus fortement pour les femmes que pour les hommes (+1.6 années pour les femmes contre 0.5 années pour les hommes).
C'est en Suède que la vie active est la plus longue. Les jeunes Suédois âgés de 15 ans avait 39.9 années de vie active devant eux. Pour le Danmarque et les Pays Bas les résultats étaient similaires. L'Italie, la Hongrie et Malte se situaient en bas de l'échelle avec une vie active de moins de 30 ans. L'écart entre la durée de la vie active à Malte et en Suède est donc de 11.1 ans.

Evaluation de l'indicateur: Les indicateurs sur la durée de la vie active sont suffisement précis et facile à comprendre. De plus,

- ils sont d' une grande stabilité au cours du temps, et ceci même au niveau des groupes d'âge.
- ils sont d' une grande continuité tout au cours du cycle de vie
- ils réagissent directement sur des changements des taux d'activité et des volumes d'heures de travail
- ils montrent les écarts attendus entre hommes et femmes, entre groupes d'âge, et entre pays.

L'enquête sur la population active a fourni des données détaillées et comparables pour tous les pays de l'UE ainsi que pour les sous-groupes concernés et ceci aussi pour les heures de travail. Les profils pays indiqués par les indicateurs sur la durée de la vie active montrent une corrélation signifiante avec les moyennes des taux d'activitité, l'âge moyen de sortie du marché du travail et les taux de chômage. Les limites de ces indicateurs consistent dans le fait que les indicateurs décrivent tout le cycle de la vie active et non pas des phases spécifiques. De plus ils mesurent la participation actuelle à la vie active et ne représentent pas des prévisions de la vie active dans le futur.

Recommandations: Sur la base des résultats positifs de l'évaluation des indicateurs sur la durée de la vie active, cette étude recommande de les utiliser parmi les indicateurs clés du marché du travail tant au niveau européen qu'au niveau national. Parmi les trois indicateurs, l'indicateur sur la durée de la vie active est central. L'application de cette méthode exige en amont un travail substantiel sur la base de données et son extension jusqu'à l'âge maximal de 100 ans. Il est recommandé d'utiliser ces méthodes afin d'obtenir des estimations plus précises. Le calcul des indicateurs de la durée de la vie active dépend de la disponibilité des tables de mortalité pour tous les états membres. Dès qu'EUROSTAT rendra ces données disponibles elles pourront être introduite dans les calculs.

Summary

With this study the Commission Services seek to investigate an indicator which allows the (expected) duration of working life (DWL) in the EU and the different EU Member States to be monitored in the context of the European Employment Strategy (EES). The indicator should complement existing EES indicators by focussing on the entire life cycle of active persons and persons in employment rather than on specific states in the life cycle, such as youth unemployment or early withdrawal from the labour force.

Three indicators for the measurement of the DWL are suggested:

- *Duration of active working life indicator* based on average annual activity rates. This indicator measures the number of years a person at a given age can be expected to be active on the labour market
- *Duration of employment indicator* based on average employment rates. This indicator measures the number of years a person at a given age can be expected to be employed
- *Duration of working time indicator* based on annual working hours. The indicator measures the number of working hours a person at a given age can be expected to spend in employment

All three indicators have their counterparts which are defined as the duration of non-active working life, the duration of non-employment, and the duration of non-working time. They are calculated for single years and are separated by country, age and gender.

The DWL indicators deliver information about the expected length of working life at different ages, under various institutional arrangements in the different Member States and in the context of the still deviating social and economic conditions for men and women. It describes the average of individual life cycle expectancies and can thus be used as the explanatory variable of various decisions: participation in working life, training investments, lifelong learning, etc. Moreover, the DWL indicators provide information about the influence of political and institutional changes on the expected lengths of working life.

The study is based on the preceding analysis of the average exit age in the European Union which came to the conclusion that a working life expectancy approach is best qualified to measure this phenomenon (Economix 2008). The present study extends this methodology to measure different types of working life expectancies, including a time-based measurement. It contains a literature review on life cycle statistics (Chapter 2), the definition of the principal methodology (Chapter 3), the description and completion of the data basis (Chapter 4), a first analysis of results (Chapter 5), the assessment of the indicators (Chapter 6), and recommendations (Chapter 7).

Literature review

Life cycle approaches have gained increasing attention in recent years as they are important to achieve more flexibility in the transitional stages of the life cycle in particular. The approach includes the integration of young persons into the labour market, flexible arrangements to balance work and child care, as well as retaining older employees in the labour market. The EU promotes the implementation of social policies to facilitate transitions during the life course. Moreover, education and training – lifelong learning in particular – are strongly linked to lifetime considerations. Life cycle approaches are therefore used to analyse economic and social behaviour and develop efficient policy programmes.

One-dimensional measurement concepts known as the "prevalence life table method" were already developed in the 1940s. Modern research tries to extend the principle methodology to multidimensional life tables which allow several population groups to be observed and the transitions between these groups. Nurminien applied the method to the Finnish labour market.

Methodological approach

The calculation of DWL indicators for all EU Member States in a gender and age breakdown requires using the common LFS database and applying a uniform calculation approach. This excludes complicated and data-intensive transition models as well as micro-based estimates of activity rates. The approach used by this study therefore starts with decision to use LFS data as the major data input and to apply the robust prevalence life table method for the calculation of the DWL.

The indicators developed by the study are defined as follows:

Duration of active working life	Number of years which an average person at a certain age is expected to be active over his/her lifetime. This is also called the working life expectancy.
Duration of non-active working life	Number of years which an average person at a certain age is expected to be inactive over the lifetime. This is the life expectancy minus working life expectancy.
Duration of employment	Number of years an average person at a certain age is expected to be employed.
Duration of non-employment	Number of years an average person at a certain age is expected to be not employed. This is the difference between the duration of active working life and the duration of employment.
Duration of working time	Number of working hours an average person at a certain age is expected to work in employment during his/her lifetime.
Duration of non-working time	Number of hours an average person at a certain age is expected not to work in employment during his/her lifetime. The reference is the available living time for 24 hours a day and 365 days a year. The duration of working time is subtracted from this sum.

Data basis

The calculation of DWL indicators is based on:

- life tables taken from the WHO data basis and interpolated linearly between the five year age groups
- activity rates and employment rates from the LFS data basis
- actual annual working hours, calculated on the basis of weekly working hours from LFS

All data is structured by 27 Member States, gender and covers the age span of 15 to 100 years old.

In the case of missing values or statistical interference, activity rates were estimated on the basis of an age-based logistic function for single countries and genders. The estimators were highly significant. They were therefore used to:

- identify irregular data among activity rates
- measure the cohort and age effects on activity rates
- extend the age span to 100 years old

Irregular data and missing values were a problem in smaller EU countries with a limited sample size. The estimation approach appeared to be adequate to smooth out irregularities efficiently.

In parallel, the measurement of the cohort and age effects – which was used to identify irregularities – revealed a strong explanatory power in the majority of countries. This means that LFS activity rates measure both the cohort related behaviour of labour market participation as well as the age related effect of institutional settings, as given by the education and training system or retirement regulations.

On the basis of this explanatory power, the age span of the calculation was extended to the maximum age of 100. This was necessary because there is no theoretical reason why activity rates must be zero at a certain age, and in effect they remain high in some of the Member States even at the age of 75. Omitting the extension would therefore create a bias in country rankings.

Working hours were calculated for the years 2005 to 2007. From 2005 onwards the LFS is based on continuous surveys throughout the year. This provides data on working hours which reflect all components of seasonal and arbitrary fluctuations in weekly working hours. The initial idea to estimate annual working hours on the basis of data regarding absence hours was omitted, as the new LFS data suits the needs of the calculations in a much better way.

Results

In 2007 the average EU27 person aged 15 could expect 34.2 active years during his/her lifetime and 31.8 years of employment with a working time of 61,295 hours in total.

For a 45 year old, the duration of active working life was 13.2 years and 0.8 years at the age of 65.

Since 2000 an increase of one year is apparent which mainly happened after 2004. The rise can be associated with the upswing in European labour markets. The duration of active working life increased in the EU15 countries by 1.8 years between 2000 and 2007. In the New Member States a reduction of 1.5 years was measured.

In 2007, active DWL for 15 year old males was 6.4 years longer than for females (this was a difference of 20%). For females, however, the duration of active working life increased more rapidly (+1.6 years compared to 0.5 years for males).

The longest active working life could be expected by the Swedish population, where a 15 year old person had 39.9 years. Denmark and the Netherlands were close to these values. At the other end of the spectrum were Italy, Hungary and Malta with an expected active DWL of under 30 years. This is a difference of 11.1 years between Malta and Sweden.

The corresponding non-active DWL was 32.2 years for 15 year olds in EU27. Males could expect 26 years and females 38.3 years.

The duration of employment is parallel to the duration of active working life. The duration of non-employment, however, reveals great differences among Member States. In Slovakia, Germany, and Portugal the duration of non-employment was over 3.0 years. In Luxembourg and Malta, the values were 0.5 years over the whole lifetime. In relative terms this means that in the first group of countries between 8% and 11% of the active time was spent in non-employment, while it was less than 2% in the second group.

While the average EU27 person aged 15 was expected to spend 61,295 working hours during his/her lifetime, a person aged 45 had to anticipate 23,938 hours. The duration of working time for a 65 year old person was 1,190 hours.

For males aged 15 the duration of working time was 72,903 hours, and 49,388 hours for females. Males' future working hours were thus 50% above the level of females. At the age of 45 the difference was 63%. Older men at the age of 65 expected more than twice the working hours of women of the same age. Between 2005 and 2007 the average duration of working time increased by 1,420 hours (+2.4%). The countries with the longest duration of working time are Cyprus, Latvia, and Estonia. They range around 70,000 hours. The shortest duration is measured in Italy, Hungary and Malta with approximately 55,000 hours.

Compared to the overall lifetime (measured in hours) working time has a rather small share: at the age of 15 males were expected to use 13.5% of their total lifetime in work. Females used 8.3%. On average of the EU27 population 10.8% were dedicated to work.

Assessment of indicators

The DWL indicators

- are highly stable over time – even for single ages
- show great continuity over the lifespan
- react directly to changes in activity rates and working hours
- reveal the expected differences between gender, age and country

Most importantly, the balances of non-working life indicators have the same positive attitudes as their working life counterparts. This is particularly true for the duration of non-employment.

The LFS database provided a comprehensive and comparable data input for all EU countries and the subgroups of its population. With limited corrections of instable or incomplete values and amendments regarding the age span the uniform calculation approach could be applied. This provides the optimum of comparability presently achievable at the European level.

This also holds true for the inclusion of working hours. The calculation of annual working hours (based on the continuous LFS measurement of weekly working hours) provided comparable and stable data for all countries, ages and gender.

The country profiles of different working life indicators correlate with average levels of activity rates, or exit age, or unemployment rates. These results indicate that the DWL indicators are being measured correctly and are sufficiently coherent with other data sources, particularly with the indicators of the EES.

The DWL indicators are extremely stable throughout the observation years. Even for small countries like Luxembourg or Malta, the time series stability is extremely high. This is due to the ability of DWL indicators to absorb fluctuations of the input data at an extraordinary extent. Moreover, it reacts to shifts of activity rates between single ages only moderately.

The stability of the indicators, however, is also a limit for measurement. As the DWL indicators provide weighted averages of the probabilities of being active over the whole lifetime, they are useful for the description and analysis of long-term behavioural and institutional conditions of national employment systems rather than the observation of short-term changes. The essential differences of the DWL indicators among countries, ages and gender can be expected to stay the same over long periods.

The DWL indicators provide sufficiently accurate and easily understandable results. Similar to the well-known life expectancy concept, they measure the number of future working years or working hours to be expected at a certain age. There is no need for additional explanations or to understand the mathematical formula. This can be seen as one of the great advantages of life table based indicators.

Uncertainties may arise regarding the ability of the indicators to describe the future of individuals regarding their working life. This however is not intended by the approach. The indicators describe working life expectancies under present physical and economic conditions of the population. This amendment to the definition of the DWL indicators is always necessary.

Being a measure for the expected length of working life, DWL indicators provide information on the population's activity from a life cycle perspective. They can therefore be used to monitor labour market behaviour of the population from a longitudinal view. The indicators supply expected variables which can be used to explain current decisions in work participation, education, lifelong learning, retirement, etc. Moreover, they can be used to analyse various age-related effects of employment policies, working time policies, social security regulations, and education and training systems.

Recommendations

Based on the positive assessment of the indicators, the study recommends using the measurement of the DWL as one of the core labour market indicators at both European and national levels.

Out of the six indicators defined for measurement, the duration of active working life receives a dominating position, as this indicator describes the labour force in total and covers the time period from 2000 to 2007. It describes the duration of active working life for all countries, ages, and gender. The other indicators can be used for additional information on the duration of employment, non-employment and the measurement of working time.

The application of the methodology requires extensive preparatory work to amend the databases and extend the age span to the maximum of 100 years. It is also recommended to apply such methods in order to achieve accurate results.

The indicators provide expectations for the population rather than its subgroups of active persons, persons employed and others. It would be an interesting but nevertheless extensive continuation of the work to calculate DWL indicators for such subgroups. This would require additional data on transition probabilities between employment and unemployment for example or on activity and non-activity. Moreover, specific survival functions are required for the subgroups. Such calculations are beyond the task of this study. Nevertheless, the approach has the potential to be used for more differentiated calculations.

The calculation of the DWL indicators depends on the availability of life tables for all EU Member States. The use of WHO data is not more than an interim solution for demonstration purposes. European life tables should be integrated into the calculation system as soon as they are available.

1. Introduction

Objectives of the project

With this study the Commission Services seek to investigate an indicator which allows the (expected) duration of working life (DWL) in the EU and the different EU Member States to be monitored in the context of the European Employment Strategy (EES). The indicator should complement existing EES indicators by focussing on the entire life cycle of active persons and persons in employment rather than on specific states in the life cycle, such as youth unemployment or early withdrawal from the labour force.

Economix herewith presents the final report with a review of recent developments in the literature regarding the principles of life table methodologies (Chapter 2), the description of the principal methodological approach used by this study (Chapter 3), the steps undertaken to adjust and complete the data basis (Chapter 4), and the main results of the first calculation of the DWL indicators (Chapter 5). In total data is presented for 27 EU countries and three EU aggregates (EU27, EU15 and NM12), subdivided by gender and covering the age span of 15 to 100 years old. A uniform dataset with 800,000 data entries is provided on the CD attached to this report. Chapter 6 undertakes the assessment of the calculated DWL indicators, and Chapter 7 gives recommendations for the application of the approach in the EES monitoring system.

The aim of the study is to assess the proposed indicators on their relevance, accuracy, timeliness and punctuality, accessibility and clarity, comparability and coherence with existing structural indicators. The assessment includes the sensitivity analysis of the indicators to changes in the underlying assumptions of the model.

The research is based on the investigation of the exit-age indicator which came to the conclusion that using a life cycle approach for the estimation of the average exit age from the labour force provides significant improvements (Economix 2008). This study extends the work by analysing the application of this approach for estimating the DWL.

Research approach

The DWL is defined as the expected future time which the population of a given age will spend as part of the active labour force, employment or other states of active working life. To estimate the life span of the initial population is principally classified into three different states: being active, inactive or dead. DWL calculations are based on the probability estimates of being in one of the states during a lifetime.

The study will focus on the estimation of active working life rather than going into the details of survival function estimates. The main question is how the duration of active working life can be measured adequately. This study proposes not stopping with the transformation of life expectancy into DWL by simply introducing age-specific activity rates into the calculation, but rather to go further and raise the question of how much work is provided during the working life. This requires the use of working time indicators, which reflect the sum of annual working hours over the ages.

Three principal approaches will therefore be analysed:

- *Duration of active working life indicator* based on average annual activity rates. This indicator measures the number of years a person at a given age can be expected to be active in the labour market.
- *Duration of employment indicator* based on average employment rates. This indicator measures the number of years a person at a given age can be expected to be employed.
- *Duration of working time indicator* based on annual working hours. The indicator measures the number of working hours a person at a given age can be expected to be involved in employment.

All three indicators have their counterparts which are defined as the duration of inactive working life, the duration of non-employment, and the duration of non-working time. They are calculated for single years and are separated by country, gender and age.

The methodological part of the study develops the measurement concepts, particularly the introduction of annual working hours. The empirical part concentrates on the selection of adequate data sources, the adjustment of activity rates, employment rates and working hours in order to eliminate irregularities, extending the age limit of the input data to the maximum of 100 years old, and the substitution of missing values. Finally, the assessment analyses the statistical characteristics of the indicators as regards stability, comparability, plausibility and other essential attitudes.

2. Literature review

2.1. Life cycle approach in the policy context

The development of life course policies is important in order to achieve more flexibility in the working life according to different stages of the life cycle. The life cycle approach includes the integration of young persons into the labour market, flexible arrangements to balance work and child care, as well as retaining older employees in the labour market. Thus, the EU promotes the implementation of social policies to facilitate necessary transitions during the life course such as transitions between education, work and retirement.

Life course policies start with the integration of young persons in the labour market. The average EU youth unemployment rate of 17.4% points out that the smooth and quick transition from education to work is still a challenge in some Member States (European Commission 2007). Programmes to familiarise young persons with the world of work through internships or vocational training are an important way to improve the labour market situation of youths.

Regarding the age-cohort patterns of employment rates in most developed countries the need for life course policies becomes visible (OECD 2007). In the majority of countries, both high employment rates and the period with the strongest family constraints can be observed in the median age group. To balance professional, private and family life, different measures – especially for women – are necessary, such as childcare facilities, entitlement for parental leave and flexible working arrangements. In order to strengthen parents' legal entitlement to family related leave, the European Commission (2008a) conducted a work-life balance package. Main goals included the extending maternity leave from 14 to 18 weeks and more flexible work arrangements for women returning from maternity leave. These measures help to unfold women's potential in the labour market.

Furthermore, fathers are encouraged to take parental leave. In order to reconcile family constraints and working life, there are different regulations in the Member States for so called "sabbaticals". Social partners, employers and trade unions are currently working on improving the EU's existing parental leave legislation (European Commission 2008b). The EU encourages the application of flexible working arrangements to help families. In several EU Member States parents are allowed to reduce their working hours to achieve a positive work-life balance. The possibility to combine work and family responsibilities can also be interpreted as a key dimension of job quality.

Another important part of the life cycle approach is to retain older persons in the labour force. The EES (as an important element of the Lisbon Strategy for Growth and Jobs) requests Member States to develop and implement active ageing strategies to raise the labour market participation of older persons. Due to the ageing population, low fertility rates and increasing life expectancies, this seems necessary in order to support economic growth and to ease the pressure on social protection systems in the EU (European Commission 2007).

To adjust to rapid changes in the working environment lifelong learning plays a major role in keeping older workers in their jobs. However, in the majority of Member States low participation rates in lifelong learning (especially of aged workers) are observed. On one hand, upgrading the basic knowledge and skills of the present stock of older workers is one of the key challenges in active aging policies. On the other hand, the transfer of human capital of skilled older workers to younger generations should also be assured.

The OECD (2007) describes that public policy affects the DWL via two channels. Firstly, the impact of expected gains and losses associated with an individual decision (e.g. to continue or stop working), and secondly its effect on the time-horizon of individual choices (e.g. by retirement age).

However, the decision of older persons to stop working is not the only explanation of low activity rates at higher ages. Older employees are often confronted with low hiring rates and difficulties to re-enter the labour market after a period of unemployment. Thus, more access to employment can only be achieved by changing the attitudes of employers to hire older workers.

Life cycle models in economic research
The life cycle model is a standard framework which economists often use to think about the intertemporal allocation of money and activities. For example, Attanasio and Brugiavini (2003) examined the impact of reducing pension wealth on the saving rate of several year-of-birth cohorts and different occupational groups in a life cycle approach. They presented evidence that saving rates increase as a result of reducing pension wealth.

Moreover, the intertemporal allocation of consumption and saving, a life cycle model was used for estimating optimal labour supply. For example, Heckman and Macurdy (2002) presented an empirical framework of life cycle oriented labour supply decisions of married women in an environment of perfect certainty. They only examined the decisions of women, because men were widely expected to work without discontinuity.

Benefit of the DWL indicators for the life cycle approach
The DWL indicators deliver information about the expected length of working life at different ages, under various institutional arrangements in the different Member States and in the context of the still deviating social and economic conditions for men and women. It describes the average of individual life cycle expectancies and can thus be used as the explanatory variable of various decisions: participation in working life, training investments, lifelong learning etc. Moreover, the DWL indicators provide information about the influence of political and institutional changes on the expected lengths of working life.

2.2. Types of life tables

Life cycle tables are needed to calculate DWL. Two types of life tables can be distinguished: period life tables (also called current life tables) and cohort life tables (also known as generation life tables).

Period life table
The period life table is based on observations over a special period of time (e.g. one year or an average over a period) and assumes the prevalence of observed survival rates for the remaining lifetime of all ages. The period life table can be seen as a snapshot of current mortality. It does not represent the expected mortality rates of an actual birth cohort as far as mortality rates will change in future.

Cohort life table
The cohort life table follows a specific birth cohort (e.g. all persons born in 1960) from their birth through each age until each of them dies. For the construction of a cohort life table data over long periods are needed. As life expectancy of the present population is the main issue of interest, the calculation of cohort life tables requires forecasting mortality rates.

The estimation of cohort life tables is complex as it requires a forecasting model for very long periods of time. Most of the life tables are therefore period life tables. They will also be the basis for the following calculations.

Application of period life tables
The period life expectancy tells us the number of years an “average” person at a given age would live if the age-specific mortality rates stay constant. This indicator, however, provides no information about the status of the population (e.g. active or inactive, healthy or unhealthy, married or single).

Various qualitative dimensions have therefore been introduced by population and health statistics. Mortality rates in life tables were combined with demographic data to create more complex life expectancy indicators. They contain information about the time expected to be spent in defined states, such as economic activity, marital status, disability, types of disease etc. Thus, these indicators simultaneously provide information about the quality and quantity of the expected years alive. “Isolating and measuring the time spent in a specific status, within the total life expectancy, provides a substantial gain in information” (Cambois et al. 1999).

2.3. Principal calculation methods

The literature distinguishes three different types of life table models:

- prevalence life table method (PLT)
- multiple decrement life table method (MDLT)
- multistate life table method (MSLT)

The PLT technique, developed by Durand, Wolfbein and Sullivan (1948 and later), provides a stationary DWL indicator which assumes that current age-specific conditions, such as the mortality rate, will stay constant throughout the cohort’s lifetime. Therefore, the actual observed rates can be used as an estimate of status probabilities.

The multiple decrement methods were developed by Katz et al. (1983) to describe various causes of exits from the labour force. The Katz model calculates the *active life expectancy* by using the so-called double decrement life table methods. It allows the calculation of exit probabilities with more than just one reason. The increment-decrement life table method (IDLT) is an extension of the multiple decrement approach. It was developed by Hoem (1977) and allows for entry to and exit from the labour force, however it excludes re-entrances.

To overcome this shortcoming of the IDLT method, the multistate method was introduced. It uses transition probabilities for changes between different states and is able to describe the dynamics of the status observed – labour force participation. The disadvantage of this method is that probabilities of status change normally have to be taken from longitudinal data. This problem was addressed by Davis et al. (2001) who developed a procedure to estimate probabilities by using cross-sectional data of subsequent years.

2.4. Prevalence life table method

The first method used to calculate the DWL, based on a prevalence life table technique (PLT), was constructed by Durand (1948) in the field of labour economics. The expression "prevalence" stands for the number of cases being in a specific state in the life cycle ("active" or "inactive").[1] Durand investigated the DWL of 25 year old white and non-white men in the United States. As Durand applied the indicator on different groups, we will also do calculations for different groups in the labour market (males and females). He used activity rates from a cross-sectional survey and gained mortality data from the civil register. In addition to that, Wolfbein (1949) introduced a similar approach to investigate labour market dynamics for men only (aged 25) in the post-war economic context.

In the field of health science, Sullivan (1971) combined mortality and morbidity in one life table to estimate the *disability free life expectancy* for men and women and whites and non-whites. Thus he developed the approaches of Durand and Wolfbein further and the method was finally named after him (Cambois et al. 1999). He calculated the indicator by using cross-sectional health expectancies in single calendar years, based on conventional period life tables. His method contains both period and cohort considerations: the period element comes from the use of standard life tables and the cohort element arises typically from survey design to estimate the prevalence of health states (Davis et al. 2001).

WLEs are conceptually the same as health expectancies, thus the developments are also applicable to labour force activities. In the case of DWL the percentage of persons is estimated who were active or inactive at a given point in time.

2.4.1. Calculation of the PLT index

Life expectancy is calculated by

(1) $$\varepsilon_x = \frac{T_x}{l_x}$$ *Life expectancy at age x*

with

(1a) $$T_x = \sum_{y=x}^{\omega} L_y$$ *Sum of future living years expected at age x*

and

(1b) $$L_x = \frac{(l_x + l_{x+1})}{2}$$ *Average number of persons alive at age x*

ε_x	Life expectancy at age *x*
y	Index of age range
x	Base age
ω	Maximum age of life table
l_x	Number of survivors at the beginning of an age interval
L_x	Number of person-years lived between age *x* to *x+1*
T_x	Sum of future living years expected at age *x*

[1] In epidemiology, the prevalence of a disease in a statisical population is defined as the total number of cases of the disease in the population at a given time. From a staistical point of view, prevalences can be interpreted as probability and can be related to observable quantites of a parameter via a probabilistic model (Nurminen 2008).

This represents the usual life expectancy formula which gives the number of years a person at age *x* can expect to live if the mortality rates of a given year are assumed to persist in future.

The duration of working life is calculated accordingly by using age-based activity rates:

(2) $$\varepsilon_x^w = \frac{T_x^w}{l_x}$$ *Duration of working life*

with

(2a) $$T_x^w = \sum_{y=x}^{\omega} L_y^w$$ *Number of expected years in labour force at age x*

and

(2b) $$L_x^w = L_x \, r_x$$ *Average number of active persons at age x*

ε_x^w	Duration of working life at age *x* in years
T_x^w	Sum of working years expected at age *x*
L_x^w	Number of active persons at age *x*
r_x	Activity rate at age *x* $(0 \le r_x \le 1)$

The duration of non-working life (or the number of years outside the labour force) is the difference between life and DWL:

(3) $$\varepsilon_x^{nw} = \varepsilon_x - \varepsilon_x^w$$ *Duration of non-working life*

2.4.2. Application by Hytti and Nio

Hytti and Nio (2004) examined changes in labour force participation from a life cycle perspective. The authors used the PLT method to calculate the expected period of time spent in the labour force. For achieving estimates of the “survival in the labour market” they multiplied survival rates with activity rates as shown in Section 2.4.1. The proposal was based on the critique addressed towards the prevailing dynamic exit age indicator, which appeared to be highly instable (Economix 2008). They pointed out that this macro-level demographic method is well suited for monitoring employment programmes. One of the advantages is that the impact of the life cycle perspective on the labour force participation and the impact of demographical change can be monitored separately.

Table 1 Calculated working life expectancy
Finland, 2002

Age	Number alive at age x	Years lived in the age interval x	Years lived at age x and beyond	Life expectancy	Activity rate	Years in labour force at age x	Years in labour force at age x and beyond	Expected period spent in the labour force	Expected period spent outside the labour force
	l_x	L_x	T_x	ε_x	r_x	L_x^w	T_x^w	ε_x^w	ε_x^{nw}
15	99,513	99,505	6,332,328	63.6	0.151	15,002	3,525,581	35.4	28.2
25	98,916	98,880	5,339,672	54.0	0.815	80,614	3,030,822	30.6	23.3
35	98,108	98,051	4,354,142	44.4	0.891	87,359	2,180,284	22.2	22.2
45	96,479	96,354	3,380,139	35.0	0.898	86,561	1,302,979	13.5	21.5
55	92,802	92,556	2,431,297	26.2	0.809	74,852	473,197	5.1	21.1
65	85,464	84,930	1,535,681	18.0	0.062	5,243	32,660	0.4	17.6
75	69,399	68,174	750,087	10.8	0.000	0	0	0.0	10.8

Source: Hytti and Nio (2004), p. 32

2.4.3. Advantages and disadvantages

The DWL indicator based on the Sullivan methodology provides stable and easily interpretable data (Economix 2008). Observations of states' prevalence can be taken from cross-sectional surveys and survival functions are delivered by life tables. Comparability across countries and gender groups is sufficient as long as LFS data is used. The coverage of countries, ages and gender is also ensured, in contrast to longitudinal data or other specific data sources. These are strong reasons why this robust methodology is used quite often. However, the Sullivan method is only an appropriate method if transaction rates can be expected to remain stable over time. If there are huge differences between age cohorts for example, then the method provides biased estimates (Jagger 2002).

2.5. Multiple decrement life table method

2.5.1. Double decrement life table method

A double decrement table is an example of a multiple decrement life table in which two exits (or decrements) from an initial cohort are possible. One exit of the initial cohort is the case of death and the other can be some change in the social or economic status. For example, Katz et al. (1983) demonstrated the forecasting of functional health for the elderly and calculated the *active life expectancy* by using the double decrement life table method. They used data from the two-round Massachusetts Health Care Panel Study and distinguished between the states "active", "dependent" (when individuals rely on assistance for daily activities) or "dead". This allowed the estimation of age-specific probabilities of survival in the "active" state.

The multiple decrement method is a way to split life tables into conditional tables for each cause or status of interest. For each conditional group *(c)* and age, the number of survivors results from:

(4) $$l_{x,c} = l_x \, q_{x,c}$$

with $q_{x,c}$ as the proportion of survivors in sub-group *c*. At all ages, the number of survivors is the sum over the conditional groups:

(5) $$l_x = \sum_c l_{x,\,c}$$

Life expectancy is calculated for each sub-group, and total life expectancy is the average of the multiple decrement life expectancies for the separate causes, weighted by the proportion of each cause:

(6) $$\varepsilon_x = \frac{\sum_c (l_{x,\,c}\ \varepsilon_{x,c})}{l_x}$$

It is important to note that in a double decrement life table any return to the previous state is impossible. Generally, the multiple decrement life table is constructed either on the basis of age-specific probabilities, that an event will occur or on the basis of prevalence ratios (e.g. labour force participation ratio), obtained from censuses or surveys (Siegel et al. 2004).

2.5.2. Increment-decrement life table method

The IDLT method is also a multiple decrement life table method which allows calculating the transitions between states, so that entrants to and exits from the labour force can be described. These life tables are constructed by disaggregating a conventional life table into those which were active or inactive. The first application of this model was published by Hoem (1977), where he calculated DWL for men in the Danish labour market.

However, the method has an important shortcoming: working life tables which are constructed by this method assume a unimodal curve of labour force participation, reaching a maximum in young adulthood and then falling to zero in older ages (Siegel et al. 2004). Due to this assumption not all possible transitions (e.g. re-entrance) can be considered. The IDLT method was therefore replaced by the MSLT method (Section 2.6), which handles entrants and exits in a better way.

2.6. Multistate life table method

This method accounts for transitions between status groups. It is based on probabilities of group members changing their status during the period observed. Usually net changes are observed which means that the status of a person at the beginning and the end of a period are observed. Multiple changes of the employment status within the period are neglected. Calculations are mostly based on panel data and the estimates are derived from period-related transition probabilities between different states.

2.6.1. Construction of a MSLT model

A good example of multistate working life tables was given by Smith (1986) for U.S. males between 1979 and 1980. He used the Current Population Survey which allowed comparisons of individuals for four consecutive months over two years. Thus the transition in and out of the labour force could be observed. When the states of the respondents were identical on both dates they were classified as “active” or “inactive”. If their status changed, they were classified as “entrants” or “exits”. In Table 2 the possible labour force flows have been mapped (Siegel et al. 2004).

The age-specific transition probabilities p_x indicate the likelihood that an individual at given age *x* and labour force status will be in one of the three possible states (active, inactive or dead) one year later. The three transition probabilities in each base-month labour force status add up to 1 (Siegel et al. 2004). The transition probability of moving from active to inactive is calculated as follows:

(7) $$ {}^{a}p_x^{i} = \frac{Exits_x}{Group\ A_x} $$ *Probability of exiting the labour force at age x*

${}^{a}p_x^{i}$ Transition probability

the prefixed superscript *a* (*a* stands for active) refers to the state at time 1 and *i* (*i* stands for inactive) refers to the state at time 2

Equation (7) shows one example of transition probability. The other possible transition probabilities (shown in Table 2) are calculated accordingly.

Table 2 Transition matrix of labour force flows

State at time 1, age x	State at time 2, age x+1			
	Total	In the labour force *(a)*	Not in the labour force *(i)*	Dead *(d)*
In the labour force	Group A	Active Non-transition probability: ${}^{a}p_x^{a}$	Exits Transition probability: ${}^{a}p_x^{i}$	Death of active Transition probability: ${}^{a}p_x^{d}$
Not in the labour force	Group B	Entrants Transition probability: ${}^{i}p_x^{a}$	Inactive Non-transition probability: ${}^{i}p_x^{i}$	Death of inactive Transition probability: ${}^{i}p_x^{d}$

Source: Siegel et al. (2004), p. 333

The number of survivors in each state at age *x* results from the number of individuals in that state at previous age *x-1* plus the number of persons entering the state, minus the number of persons who exited the state and those who died during the period. For example, the number of inactive persons at age *x* is:

(8) $$ {}^{i}l_x = {}^{i}l_{x-1} + {}^{a}t_{x-1}^{i} - {}^{i}t_{x-1}^{a} - {}^{i}t_{x-1}^{d} $$ *Number of inactive survivors at age x*

${}^{i}l_x$ Number of survivors at state *i* (inactive) and age *x*

${}^{i}t_{x-1}^{d}$ Number of status transfers from i to d (or other status categories)

The MSLT approach allows observing changes in the population between different states. This appears to be a main advantage of this approach. For this purpose transfer rates are calculated. The age-specific transfer rates between states (m_x) measure the number of transfers from state 1 to state 2 between exact ages *x* and *x+1* per thousand cohort members age *x* in the stationary population. As an example, the transfer rate from Group A (being active) to Group B (being inactive) is defined as follows:

(9) $$ {}^{a}m_x^{i} = \frac{4 \cdot {}^{a}p_x^{i}}{(1+{}^{a}p_x^{a})(1+{}^{i}p_x^{i}) - ({}^{a}p_x^{i} \cdot {}^{i}p_x^{a})} $$ *Transfer rate*

${}^{a}m_x^{i}$	Transfer rate from state 1 to state 2, while the prefixed superscript *a* (*a* stands for active) refers to the state at time 1 and *i* (*i* stands for inactive) refers to the state at time 2

2.6.2. Estimation of health expectancies

Davis et al. (2001, 2002) presented an empirical framework to estimate health expectancies from cross-sectional surveys. Thus, they met the predominant cohort problem (see Section 2.7) in cross-sectional data.

The authors estimated probabilities of belonging to different states of health (state 0 "alive"; 1 "free of disability"; 2 "disabled"; 3 "dead"). Due to the lack of satisfactory longitudinal data, they first used the estimation of a logistic parameterization of probabilities of the various states, at the basis of available cross-sectional data. They used age specific log odds and estimated the parameters by weighted least squares. Thus, they could derive cohort health expectancies. This method was also the basis for Nurminen's calculations of the DWL (Section 2.6.3.).

Estimation framework of Davis et al. (2001, 2002)
The life expectancy is defined in the common way as in Section 2.4.1. (equation 1). Furthermore, the calculation of health expectancies at age *x* in state *j* was estimated as follows (assuming that the absorbing state 3 "death" will be the reference category in further calculations):

(10)
$$\varepsilon_j(x) = \frac{1}{l_x}\sum_{y=x}^{\infty}\frac{1}{2}\{l_j(y)+l_j(y+1)\}$$
$$= \frac{1}{l_x}\left\{\frac{1}{2}l_j(x)+\sum_{y=x+1}^{\infty}l_j(y)\right\}$$

$$= \frac{1}{2}\pi_j(x)+\sum_{y=x+1}^{\infty}p_j(x,y) \quad j=1,2$$ *Health expectancy*

with

(10a)
$$\pi_j(x) = p_j(x,x) = \frac{l_j(x)}{l_x}$$

$\pi_i(x)$	Estimate of the prevalence of state *j* at age *x* ($\pi_j(x)$ is equivalent to the activity rate r_x in case of the DWL)
l_x	Number of survivors at the beginning of an age interval
$l_j(x)$	Survivors at state *j* at age *x*
$p_j(x,y)$	Conditional probability that an individual, known to be alive at age *x* is in state *j* at the age *y* (*j* = 0, 1, 2, 3)

It is assumed, that l_x – the total number alive at the initial age *x* – is known, but that counts $l_j(y)$ at later ages are unknown and must be estimated from data at hand.

Furthermore, the assumption of homogeneity – that individuals in the same cohort independently obey the same probabilistic laws and that cohorts are stochastically independent– must be fulfilled. This assumption underlies the classical distribution theory of life tables. Furthermore, we need a large l_x to ensure that the random vector is approximately normally distributed with zero mean and a covariance matrix of rank 2.

The procedure used by Davis et al. (2001, 2002) estimated the probabilities and hence the health expectancies by using the odds of a state with respect to a reference state. For example, if state 3 (death) is the reference state, let the following equation for j = 1, 2 be the logarithm of the odds of state j relative to state 3 at age y.

(11) $$\zeta_j(x,y) = \log\left\{\frac{p_j(x,y)}{p_3(x,y)}\right\} = \log\left\{\frac{l_j(x,y)}{l_3(x,y)}\right\},$$

To yield estimates of probabilities throughout the equation (11), the following logistic form must be satisfied:

(12) $$p_3(y) = \left\{1 + \sum_{j=1}^{2} \exp\zeta_j(y)\right\}^{-1}$$

Parameterised form:

(12a) $$p_j(y) = p_3(y)\exp\zeta_j(y) \qquad j = 1,2$$

The essential difference of the approach of Davis et al. (2001, 2002) to other methods based on longitudinal data is that the number of persons in state j at age y can not be observed and thus were replaced by parameterized probabilities which were estimated by using logistic regressions.

To estimate the odds in (11) random variables are needed. Superimposing a tilde on a letter indicates that it is a random variable, while the letter without a tilde is its expectation. Under the multinomial distribution of frequencies, the expectation of $l_j(y)$ is:

(13) $$E\left(\tilde{l}_j(y)\right) = l_x \cdot p_j(x,y) = l_j(y)$$

And the maximum likelihood estimator (MLE) of $p_j(x,y)$ is:

(14) $$\tilde{p}_j(x,y) = \frac{\tilde{l}_j(y)}{l_x}$$

The equation is obtained by a vector logistic regression, which is used to model and estimate the probabilities of states.

Additionally, the distribution of $\tilde{l}_j(y)$ is multinomial if the assumption of homogeneity is fulfilled and all individuals in the cohort are independent and identically distributed over the states.

The estimate of the log odds of (11) is: [2]

(15) $$\tilde{\zeta}_j(x,y) = \log\left\{\frac{\tilde{p}_j(x,y)}{\tilde{p}_3(x,y)}\right\} = \log\left\{\frac{\tilde{l}_j(x,y)}{\tilde{l}_3(x,y)}\right\}$$

Now, it is possible to consider the vector regression

(16) $$\tilde{\zeta}_j(x,y) = \zeta_j(x,y;\beta) + \mu(x,y)$$

2 Asymptotic normality is shown in Davis et al. (2001)

$\zeta_j(x,y;\beta)$	Parameterised population log odds
$\mu(x,y)$	Error terms

As error terms are often not independent, the Liang-Zeger procedure was used to correct them. A working assumption was adopted that the error random vectors are independent with covariance matrices. Under this working assumption the vector could be estimated (for details see Davis et al. (2001)).

Under the working assumption of independence and with data available for a sequence of ages, the weighted least square loss function can be minimised to achieve the vector β.

(17) $$L(\beta)=\sum_y(\tilde{\zeta}(y)-Z(y)'\beta)'V^{-1}(y)(\tilde{\zeta}(y)-Z(y)'\beta)$$

with the matrix *Z(y)* which specifies the design of the regression:

(17a) $$Z(y)=\begin{pmatrix} z & 0 \\ 0 & w \end{pmatrix}$$

z and w	Known vectors depending on age and perhaps on further variables

and the matrix of weights which appears in standard form: [3]

(18b) $$V^{-1}(y)=l_x\begin{pmatrix} p_1(1-p_1) & -p_1p_2 \\ -p_1p_2 & p_2(1-p_2) \end{pmatrix}$$

Furthermore, the weighted least squares estimator $\hat{\beta}$ of β can be defined as:

(18c) $$\hat{\beta}=\left(\sum_y Z(y)V^{-1}(y)Z(y)'\right)^{-1}\left(\sum_y Z(y)V^{-1}(y)\tilde{\zeta}(y)\right)$$

The reason for using a matrix of weights is because transition probabilities cannot be estimated directly from cross-sectional data. To overcome this fact, the working assumption, above, was adopted and the weight matrix in the loss function was used.

Finally, the estimated health expectancy of state *j* at age *x*, is:

(19) $$\hat{\varepsilon}_j(x)=\sum_{y=0}^{\infty}p_j(x+y,\hat{\beta})$$ *Estimated health expectancy*

while the estimator of $p_j(y)$ is obtained by the substitution of $\zeta_1(y),\zeta_2(y)$ into (12). Thus, equation (19) contains the expectancies of being in state *j* at age *y* of interest.

[3] For calculations, the p_j were replaced by realisations of $\tilde{l}_j(y)/l(0)$

Standard errors
As working life tables (or tables about health states) are generated from survey data, sampling variations are important (due to population dynamics or interview methods), especially for comparing results from different samples. In most cases the results are presented without convenient associated standard errors. For example, the Finish official research institutes acknowledge this problem but they do not provide standard error estimates for their active WLE (Nurminen 2008).

Davis et al. calculated standard errors by using the Liang-Zeger procedure in their paper published in 2001 and by using the Monte Carlo methods in 2002. The numerical differences are not large.

Diehr et al. (2007) developed a new approach with an "equilibrium" estimate with 3 health states. They derived a function of the local transition probabilities to estimate the expected number of years spent in one healthy state by using longitudinal data on self-reported health status. The derived estimates are similar to those calculated by other MSLT methods, but they have the advantage of providing associated standard errors.

2.6.3. Application of the MSLT method by Nurminen

The life cycle approach (also known as the life-course approach) has gained lots of attention in recent years in different disciplines. In labour market research Nurminen (2008) presented an up-to-date application of an indicator to assess the DWL. As a database he used the Finish Labour Force Survey and occupational health data derived from three cross-sectional surveys of a cohort carried out by the Finish Institute of Occupational Health.

In his thesis he used estimates of DWL based on a MSLT technique by following the empirical framework of Davis et al. (2001, 2002). The model distinguished between four activity states: 1 "employed" (permanently employed, employed for fixed-term, self-employed); 2 "disabled" (currently outside the labour force); 3 "other alive" (e.g. unemployed, students, old-age pensioners) and 4 "deceased" (while the model of Davis et al. distinguished between three health states). Standard errors were calculated using the Monte Carlo procedure.

As shown in Section 2.4.2., Hytti and Nio presented estimations of expectancies with two states, classified as "active" (in the labour force) and "inactive" (out of the labour force). Nurminen pointed out, that he used a MSLT technique – with four states – to overcome the limitations of traditional prevalence life table methods, as traditional life table techniques are limited when applied to intrinsically dynamic processes with multiple decrements, like the labour force process (Nurminen 2008).

For examining the DWL between the years 1980-2001, Nurminen first estimated year dependent and age dependent marginal transition probabilities for the four labour force activity states explained above by large sample multivariate logistic regressions for men and women aged 16-64 years old. Thus, he estimated the DWLs jointly for multiple years throughout the study period. Using a multivariate sample regression model gives more information about working life behaviour. As a result of this multivariate sample regression model it was possible to present a projection for 2006 based on data from 2004.

Probabilities

The probabilities p_j, that an individual is in activity state *j* at a subsequent age *x*, is written as $p_j(x)$ and is very important for the estimation of DWL. Nurminen defines the DWL as follows:

(20) $$e_j(z) = \int_z^{64} p_j\langle x|y\rangle\ dx$$

While e_j is the expectancy for the duration of being in a specific occupation state *j*, expressed as a definite integral of the conditional probabilities $p_j(x / y)$, j= 1, 2, 3, 4 over the relevant span of age *x*, $16 \leq x < y \leq 64$. The probabilities can be estimated from aggregate data available at ages $y = 16, 17, \ldots, \omega$, while ω is the maximum age at work before retirement, which is defined as 64 in this case. Estimation of p_j is done by logistic regression.

Nurminen transformed the health expectancies of Davis et al. to estimate DWLs with four states instead of three and he used integrals to define the expectancies. The explanatory variables of his approach were age and year, combined in a cubic estimate. Table 3 shows the estimated numbers of expected years in different states.

Table 3 Expectancies of three activity states
Finland; Activity states: 1 employed, 2 on disability pension, 3 other alive; for selected years and ages, with projections for 2006

Age x	State j	Females				Males			
		1981	1991	2001	2006	1981	1991	2001	2006
25	Employed	27.85	27.08	26.79	26.50	29.74	28.92	28.25	27.91
	Disability pension	4.09	4.53	3.99	4.02	5.25	5.09	4.55	4.12
	Other alive	7.95	8.31	9.14	9.41	4.72	5.76	7.04	7.81
55	Employed	7.29	7.00	7.33	7.36	8.30	7.64	7.32	7.15
	Disability pension	3.28	3.78	3.26	3.31	4.20	4.17	3.69	3.32
	Other alive	4.37	4.18	4.38	4.29	2.36	3.08	3.90	4.45

Source: Nurminen (2005), p.576

2.6.4. Advantages and disadvantages

The advantage of the MSLT method is its dynamic nature. If participation rates change over time, these trends are incorporated more accurately than in the PLT method (Section 2.4.1.). However, this model is very sensitive to changes in labour force activities. Calculations could therefore overstate the labour force involvement in times of expansion and understate the situation in a recessionary period (Richards 2000).

Unlike the IDLT method, the multistate tables of working life are not limited to a unimodal curve of labour force participation and thus can handle re-entries into the labour force. Another advantage of the MSLT method is the possibility of estimating transition probabilities of entering or leaving a state by logistic regressions. Thus, the method is able to handle a great number of variables which might affect the transitions. By using estimation procedures transition probabilities could be gained on the basis of cross-sectional data and longitudinal data is not necessarily needed.

A disadvantage lies in the problems of substantial stochastic variability which appear in transition ratios from age interval to age interval, even if relatively large samples are available. The problem grows if specific population groups should be observed. The number of cases for these groups may quickly decrease. Thus, the changes in age-specific rates may become irregular or even “sample zeros” may appear (Land et. al. 1994). To tackle the problem of irregular state proportions, methods of graduation often have to be used.

Moreover, longitudinal data is required to calculate transition probabilities (except Davis' method is applied). Thus, the lack of appropriate longitudinal data about states is a strong reason why it is not used more often (Jagger 2002).

2.7. The cohort problem

The cohort problem appears in cross-sectional research design. Cross-sectional data sources involve the risk of interpreting changes as age-specific which in fact occur from generational changes.

The calculations presented in the former sections were all based on period life tables which are based on cross-sectional surveys and which are a snapshot of mortality in a specific period. The advantage is the availability of these life tables in all countries of interest. To locate the cohort problem Davis et al. (2001) and Nurminen (2008) used estimation frameworks to estimate the expectancies of changing a status (health or working life statuses). These estimation methods help to overcome the cohort problem which appears in cross-sectional data sources.

While the estimation of mortality rates appears to be a serious problem, the estimation of activity rates or employment rates is even more severe. Forecasting activities even for a limited number of years appears to be a courageous undertaking. One approach to overcome these difficulties could be the labour supply estimates which are presently undertaken by the Warwick Institute of Employment Research and ROA. The results of this study (which covers all EU Member States) will be published by CEDEFOP.

Using forecasted activity rates would make the DWL indicator more meaningful, but it would also include the uncertainties of forecasts. Thus, we based our calculations on the LFS.

2.8. Exit age indicator

In the study "Analysis of the Average Exit Age from the Labour Force" Economix (2008) compared existing indicators to measure the exit age from the labour force with a new DWL indicator.

The exit age indicator is defined by the probabilities of being part of the labour force at the time of observation. The weighted average of the working life expectancies over the ages of 50-70 years old (or 74) is the exit age. Hence, the exit age is a good origin to examine the duration of the working life.

(21) $$e^{w} = \frac{\sum_{x=50}^{\omega}\left(x+\varepsilon_x^{w}\right)L_x^{w}}{\sum_{x=50}^{\omega}L_x^{w}}$$ *Exit age indicator*

The study came to the conclusion that the exit age indicator based on WLE has clear advantages compared to the static and dynamic indicators, because of its higher time series stability –particularly in comparison to the dynamic exit age indicator which was recently used to assess the EES. The exit age indicator based on working life is superior to the dynamic and static indicator, because of its additive aggregation of age-specific probabilities. Thus, this approach can deal with the growing variance in higher age groups better.

3. Methodological approach

3.1. Principal requirements

The calculation of DWL indicators for all EU Member States in a gender and age breakdown sets particular requirements for the methodological approach. The data output has to be comparable over all countries and should simultaneously reflect the institutional and societal specificities at the national level. The calculation method has to be applicable to all countries, robust enough to withstand data irregularities and easy to use in order to allow rapid updates. Finally, data input has to use consistently measured variables covering all Member States with sufficient accuracy.

There is not much leeway for experimental approaches. As far as the data input is concerned, there is no alternative to LFS data, as this is the only source which provides complete and comparable data on activity rates, employment and working hours. The variables are surveyed with the same type of questioning and sampling and are available within the same timeframe. Other sources (on working hours in particular) have to be excluded for this reason.

Among the calculation methods, it would have been attractive to use micro-based estimates of participation rates and transition probabilities as they are applied by the multistate life table approaches. These, however, had to be excluded due to the complexity of the approaches and their sensitivity to sampling errors. As the exit-age study demonstrated, sampling errors were the main reasons for the irregular results of the dynamic exit age indicator. Considering this, such ambitious approaches could not be recommended.

The approach used by this study therefore starts with the decision to use LFS data as the major data input and to apply the robust prevalence life table method for the calculation of the DWL.

3.2. Definition of duration of working life approaches

Based on these decisions three alternative DWL indicators are suggested together with their corresponding counterparts:

Duration of active working life	Number of years which an average person at a certain age is expected to be active over his/her lifetime. This is also called the working life expectancy.
Duration of non-active working life	Number of years which an average person at a certain age is expected to be inactive over his/her lifetime. This is the life expectancy minus working life expectancy.
Duration of employment	Number of years an average person at a certain age is expected to be employed.
Duration of non-employment	Number of years an average person at a certain age is expected to be not employed. This is the difference between the duration of active working life and the duration of employment.
Duration of working time	Number of working hours an average person at a certain age is expected to work in employment during his/her lifetime.
Duration of non-working time	Number of hours an average person at a certain age is expected not to work in employment during his/her lifetime. The reference is the available living time for 365 days a year with 24 hours a day. The duration of working time is subtracted from this sum.

All indicators are calculated separately for gender, country and year:

(22) $d_x^a = \frac{T_x^a}{l_x}$ ***Duration of active working life***

with

(22a) $T_x^a = \sum_{y=x}^{\omega} L_y^a$ *Sum of expected years in labour force at age x*

and

(22b) $L_x^a = L_x \cdot r_x$ *Average number of active persons at age x*

l_x	Number of survivors at the beginning of an age interval
L_x	Number of person years lived between *x* and *x+1*
T_x	Sum of future living years expected at age *x*
T_x^a	Sum of working years expected at age *x*
L_x^a	Average number of active persons at age *x*
ω	Maximum age of life table
r_x	Activity rate at age *x* $(0 \le r_x \le 1)$

(23) $d_x^{na} = \varepsilon_x - d_x^a$ ***Duration of non-active working life***

with

(23a) $\varepsilon_x = \frac{T_x}{l_x}$ *Life expectancy at age x*

(24) $d_x^e = \frac{T_x^e}{l_x}$ ***Duration of employment***

with

(24a) $T_x^e = \sum_{y=x}^{\omega} L_y^e$ *Sum of expected years in employment at age x*

and

(24b) $L_x^e = L_x \cdot u_x$ *Average number of persons employed at age x*

T_x^e	Sum of expected years in employment at age *x*
L_x^e	Average number of persons employed at age *x*
u_x	Employment rate at age *x* $(0 \le u_x \le 1)$

(25) $d_x^{ne} = d_x^a - d_x^e$ ***Duration of non-employment***

(26) $d_x^{wt} = d_x^e \cdot h_x$ *Duration of working time*

h_x Number of annual working hours at age *x ('000 hours)*

(27) $d_x^{nwt} = \varepsilon_x \cdot 365 \cdot 24 - d_x^{wt}$ *Duration of non-working time*

4. Data basis

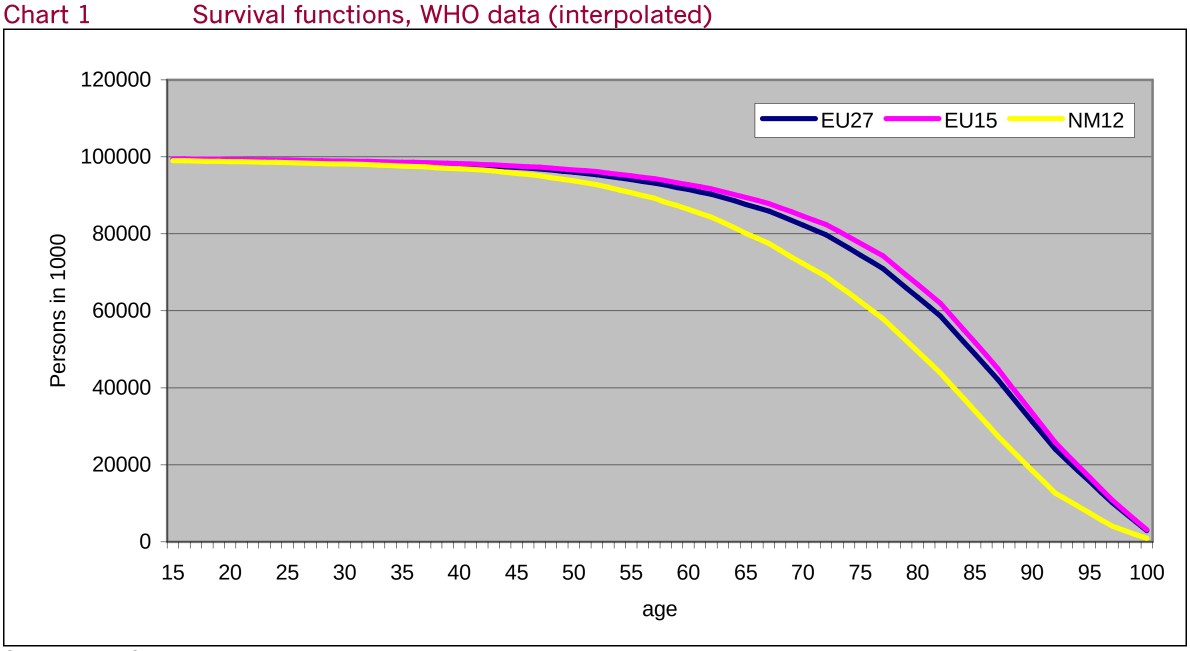
For our calculation of the DWL indicators life tables, activity rates and working hours are needed. Furthermore, additional data inputs as population, labour force and persons employed have been used for weighting purposes. The following chapter describes how the data has been adjusted and completed for the purpose of this study.

4.1. Life tables

The survival functions for the years 2000-2007 are taken from the World Health Organisation's (WHO) statistical database. The WHO tables cover all 27 EU Member States and supply data by five year age groups. Standardised life tables are constructed by national statistical offices on the basis of official death registrations and population figures (WHO 2001). Single age values were calculated by linear interpolation.

Chart 1 presents the survival functions of EU27, EU15 and the NM12 for 2007. The aggregated values were calculated on the basis of national data, weighted by the population. The results show that significant differences appear at the aggregated level as regards ages above 5.

Chart 1 Survival functions, WHO data (interpolated)



Source: WHO, Economix

The use of the WHO life tables is a substitute until Eurostat has finished the publication of life tables.

4.2. Activity rates

4.2.1. Data source

The datasets provided by Eurostat for the purpose of this study originate from the Labour Force Survey and include the data for:

- the years 2000 - 2007
- 27 Member States and 9 country aggregates
- gender (male, female, male and female)
- single ages from 15 to 75 years old

for the following indicators:

- original activity rates
- population
- labour force
- employed population
- employment rates

4.2.2. Definition of activity rate

The activity rate is the economic active population divided by the total population at each age and gender. Thereby, the economic active population comprises employed and unemployed persons (Eurostat 2006):

Employed persons are persons aged 15 years and over, who during the reference week performed work, even for just one hour a week, for pay, profit or family gain or were not at work but had a job or business from which they were temporarily absent because of, e.g. illness, holidays, industrial dispute and education and training.

Unemployed persons are persons aged 15-74 who were without work during the reference week, were currently available for work and were either actively seeking work in the past four weeks or had already found a job to start within the next three months.

4.2.3. Quality and variance of data

Missing Values
For original activity rates the dataset contains a limited number of missing values. Out of 39,528 observations in 27 countries, the years 2000-2007 and the three gender groups (male, female and both), 666 values were missing. The values are concentrated on countries (especially LU and MT), aged 15, upper ages (above 65), and females (see Tables 4 to 6). This is mainly due to an insufficient representation of ages in the sample.

Table 4 Missing values in original activity rates by year, 2000-2007
Numbers of zero values

Year	All	Female	Male
2000	26	54	31
2001	18	46	27
2002	15	57	19
2003	18	46	24
2004	18	53	24
2005	15	30	17
2006	13	31	17
2007	16	34	17
Total	139	351	176

Source: Economix

Table 5 Missing values in original activity rates by country, 2000-2007
EU 27

Country	All	Female	Male
AT		1	
BE	1	14	3
BG		1	1
CY		12	
CZ		2	1
DK	8	19	9
EE	9	15	15
ES	8	10	8
FI	8	12	8
FR		7	2
GR		2	
HU	9	10	11
LT	5	17	10
LU	34	66	43
LV	6	11	7
MT	20	83	24
NL	1	9	1
RO	4	5	4
SE	8	14	9
SK	10	33	12
UK	8	8	8
Total	139	351	176

Source: Economix

Table 6 Missing values in original activity rates by age, 2000-2007
Numbers of zero values

Age	All	Female	Male
15	26	43	38
16	1	4	3
61	0	1	1
62	1	6	0
63	0	5	1
64	0	5	1
65	0	6	1
66	0	8	0
67	4	10	6
68	3	9	3
69	7	16	8
70	4	22	5
71	4	23	6
72	7	33	10
73	12	34	16
74	13	44	15
75	57	82	62
Total	139	351	176

Source: Economix

Variance analysis

Excluding missing values, the variance analysis shows that the coefficient of variation (CV) of original activity rates is very high up until the age of 20 and rises again at higher ages.

Chart 2 presents the variance of original activity rates in EU27. The standard deviation is very stable and low between the ages of 25-55 (the main period of working). High values of standard deviation indicate both behavioural diversity among the Member States (and years) and a small sampling size regarding labour force participation. The sampling rates for the LFS vary between 0.2% and 3.3% (Eurostat, 2006). Assuming a sampling rate of 1 % in Germany 9,095 persons aged 15 were in the sample, while in Finland only 714 persons aged 15 were surveyed.

Furthermore, institutional differences between Member States can also cause higher variances. The higher standard deviation at the age of 25 could also indicate that the vocational education and training systems differ from country to country and thus influence the age at which one starts to work. The rise of standard deviation between 56 and 66 years old (of females) points to differences in retirement regulations between the Member States.

4.2.4. Handling of missing and extreme values

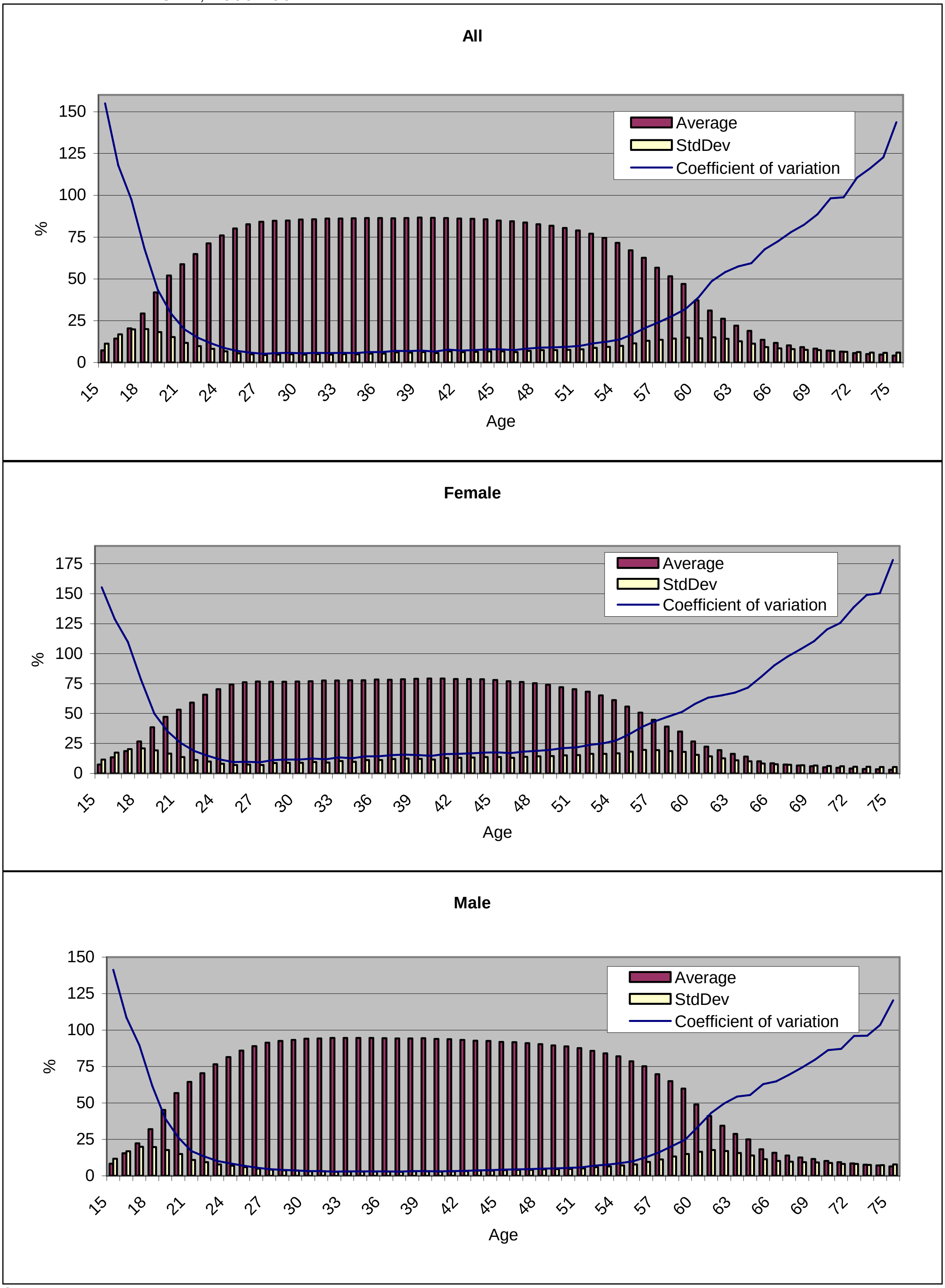
An overview about the methods used to insert missing values is given in Table A2 in the Annex. Missing values were substituted by the following rules:

- If more than 8 values were missing in one country and for a gender, the estimated values for the activity rates (ARs) where inserted. If up to 7 values were missing in one country and for a gender, the average AR of age *x* over all available years was inserted.

- If original ARs showed massive irregularities at higher ages, they were inserted by the average AR (without the outliner). This was the case in Lithuania and Slovenia (for more detail see Table A2 in the Annex).

Furthermore, in 14 of the 27 Member States values were missing for the 15 and 16 year olds. With the exception of the UK and Spain, there were less than 8 values missing in each country and for each gender. These missing ARs were inserted by the average AR above all available years at the age of interest. In the UK and Spain for all 8 years, the ARs for persons aged 15 were missing, as only persons aged 16 and older were polled. In the UK, these rates could be calculated by the average rate of change over the last 5 years (the same procedure as in equation 33). In Spain this calculation was not suitable, thus the ARs had to be estimated. In this case, ARs of persons up to the age of 30 were included, and the explanatory variables year, age and age squared were used. A single estimation for each gender was undertaken.

Chart 2 Variance of original activity rates by age
EU 27, 2000-2007



Source: Economix

4.2.5. Estimation of activity rates at higher ages

The rising coefficient of variation in Chart 2 showed that ARs at higher ages became more unstable. To handle this, the estimation of ARs was necessary for three reasons:

- To substitute missing values at higher ages
- To estimate ARs above 75, if the ARs between 70 and 75 were comparably high. In this case, it can be assumed that participation in the labour market will continue for subsequent ages
- To control rising variation at higher ages

Table 7 presents the number of missing values, average ARs between the ages 70-75 and the coefficient of variation of ARs for the 27 Member States. On the basis of these characteristics we decided in which countries the estimation of ARs was necessary.

Activity rates were estimated if:

- The number of missing values at higher ages was ≥ 8 (orange)
- The average activity rate between ages 70-75 years old was ≥ 5 (yellow)
- The variation coefficient was ≥ 30 (green)

Table 7 Reasons for estimation of activity rates at higher ages
EU 27, 2000-2007

Country	Gender	Number of missing values at age 15-49	Number of missing values at age 50-75	Average activity rate at age 70-75	Coefficient of variation activity rates at age 50-75
AT	All	0	0	3.06	21.43
	Female	0	1	2.05	28.27
	Male	0	0	4.41	23.17
BE	All	0	1	1.38	23.33
	Female	2	12	1.01	36.77
	Male	1	2	2.15	24.24
BG	All	0	0	2.86	21.98
	Female	0	1	1.59	30.67
	Male	1	0	4.54	21.58
CY	All	0	0	9.93	14.94
	Female	2	10	5.17	25.40
	Male	0	0	17.28	16.46
CZ	All	0	0	3.24	13.51
	Female	2	0	1.91	21.68
	Male	1	0	5.20	14.41
DE	All	0	0	2.46	12.90
	Female	0	0	1.51	18.80
	Male	0	0	3.64	12.43
DK	All	0	8	4.62	17.63
	Female	0	19	2.55	21.35
	Male	0	9	7.86	19.18
EE	All	1	8	8.89	21.07
	Female	4	11	7.15	28.13
	Male	4	11	13.84	27.02
ES	All	8	0	1.19	15.05
	Female	8	2	0.69	23.95
	Male	8	0	1.81	15.58
FI	All	0	8	2.97	17.92
	Female	0	12	1.69	26.70
	Male	0	8	4.83	18.44
FR	All	0	0	1.00	20.59
	Female	0	7	0.73	28.80
	Male	0	2	1.53	22.31

GR	All	0	0	3.25	8.55
	Female	0	2	1.57	16.56
	Male	0	0	5.37	7.93
HU	All	1	8	1.40	21.65
	Female	2	8	0.85	31.42
	Male	3	8	2.26	19.83
IE	All	0	0	7.56	9.30
	Female	0	0	2.76	21.19
	Male	0	0	13.14	7.26
IT	All	0	0	2.78	9.11
	Female	0	0	1.19	18.39
	Male	0	0	4.82	8.92
LT	All	2	3	4.63	24.85
	Female	5	12	3.73	32.73
	Male	4	6	7.96	25.94
LU	All	3	31	0.99	34.53
	Female	5	61	1.39	37.50
	Male	4	39	2.06	28.44
LV	All	0	6	8.50	22.67
	Female	2	9	6.65	29.57
	Male	0	7	12.93	26.24
MT	All	1	19	2.46	29.65
	Female	1	82	2.79	31.49
	Male	2	22	5.14	30.67
NL	All	0	1	3.59	22.99
	Female	0	9	2.08	32.39
	Male	0	1	5.86	23.29
PL	All	0	0	5.70	13.38
	Female	0	0	3.98	17.59
	Male	0	0	8.29	14.86
PT	All	0	0	19.18	6.34
	Female	0	0	14.30	10.30
	Male	0	0	25.50	7.87
RO	All	0	4	27.44	20.12
	Female	0	5	25.46	20.81
	Male	0	4	30.95	19.14
SE	All	0	8	6.20	11.29
	Female	0	14	3.01	17.47
	Male	1	8	10.44	15.05
SL	All	0	0	7.83	16.00
	Female	0	0	6.08	23.95
	Male	0	0	10.69	19.04
SK	All	3	7	0.98	29.34
	Female	6	27	0.97	38.63
	Male	4	8	1.72	29.88
UK	All	8	0	4.79	10.21
	Female	8	0	3.25	13.89
	Male	8	0	6.63	9.82

Explanation of colours:
- Grey: an estimation was undertaken
- Blue: more than 7 values were missing for 15-49 year olds
- Orange: more than 7 values were missing for 50-75 year olds
- Yellow: the average activity rate between 70-75 year olds was higher than 5
- Green: the variation coefficient exceeded 30

Source: Economix

Estimation model

For the estimation of ARs it was necessary to convert the original AR into a logistic form to generate estimates between 0 and 1.

(28) $$\tau_{c,s} = \log\left(\frac{r_{c,s}}{1-r_{c,s}}\right)$$

r	Activity rate
τ	Log activity rate
c	Country
s	Gender

Separate estimations were necessary for each country and gender. Due to the selection criteria defined in the previous subsection and Table 7, 51 estimations of ARs were undertaken. The dependent variable was always $\tau_{c,s}$ – the logarithm form of the AR of the country and gender of interest, as shown in equation 28. As explanatory variables year, age and age squared were alternatively combined. Furthermore, the examined age interval was sometimes varied and the data of the years 2000-2007 were included in the regressions. In most cases, ARs of persons aged 45 and older were taken for the estimations.

In the majority of cases the estimator was calculated with the following form (equation 29). In some countries other compositions of theses explanatory variables were used to achieve significant coefficients only.

(29) $$\tau = \alpha + \beta_1 year + \beta_2 age + \beta_3 age^2$$

After the estimation, the predictors were transformed back into an estimated activity rate by:

(30) $$\hat{r}_{c,s} = \frac{\exp(\tau)}{1+\exp(\tau)}$$

Table 8 shows a few examples of estimations. In Table A1 in the Annex the results of all 51 estimations were mapped. Regarding Table 8, the adjusted R^2 of all regression models shows a satisfying fit. The T values are comparably high and thus indicate a high explanatory value.

Table 8 Estimated activity rates 2000-2007

Extract from Table A1 in the Annex

Country	Gender	Age interval	Explanatory variables					Adjusted R^2	F Statistic
				Intercept	Year	Age	Age_2		
Estonia	Male	45+	Coefficient	10.762		-0.176		0.868	1547.070
			T Value	40.088		-39.333			
	Female	45+	Coefficient	-141.716	0.077	-0.209		0.915	1268.784
			T Value	-4.541	4.938	-50.235			
	Total	45+	Coefficient	-109.814	0.061	-0.194		0.934	1683.913
			T Value	-4.314	4.772	-57.845			
Finland	Male	45+	Coefficient	-68.325	0.037		-0.002	0.955	2517.096
			T Value	-2.789	3.064		-70.886		
	Female	50+	Coefficient	-147.038	0.078		-0.003	0.934	1380.858
			T Value	-3.762	3.996		-52.503		
	Total	45+	Coefficient	-104.325	0.053	0.209	-0.004	0.957	1759.685
			T Value	-3.942	3.992	3.883	-8.570		

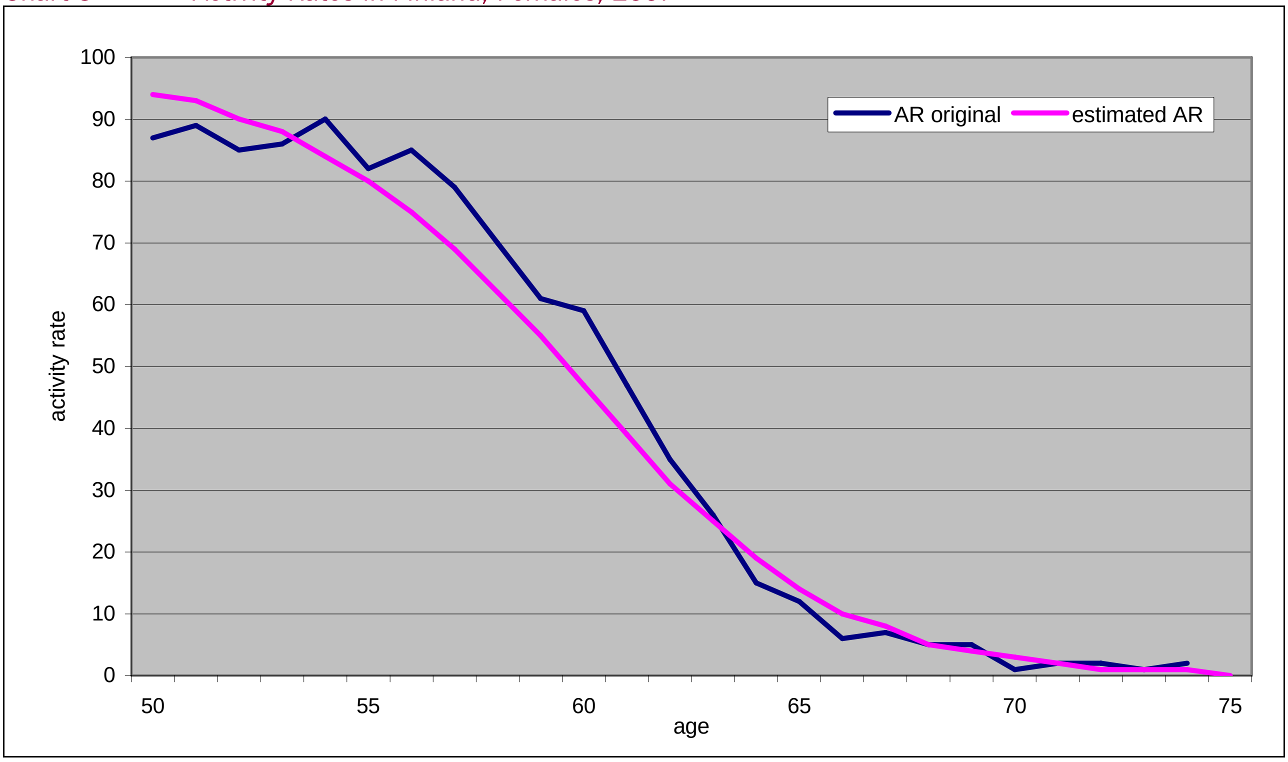
Source: Economix

If the variations in activity rates after the insertion of estimated values were too big, another correction measure was used which smoothed out theses jumps.

Results

Chart 3 shows the original and estimated AR for females in Finland. We can see deviations between the original and estimated activity rate. The estimation model was not always able to map particularities of pension schemes and retirement ages in every single country. This was also due to the limited number of explanatory variables. Nevertheless, the estimation model was able to indicate the substantial information about the decline of activity rates at higher ages which was the most important. Thus, it was used to estimate subsequent activity rates of persons older than 75 years old.

Chart 3 Activity Rates in Finland, Females, 2007



Source: Economix

To measure the fit of the estimated ARs, the standard deviation between the original and the estimated AR was calculated. This ranged between 2.8 and 11.1 percentage points (Table 9).

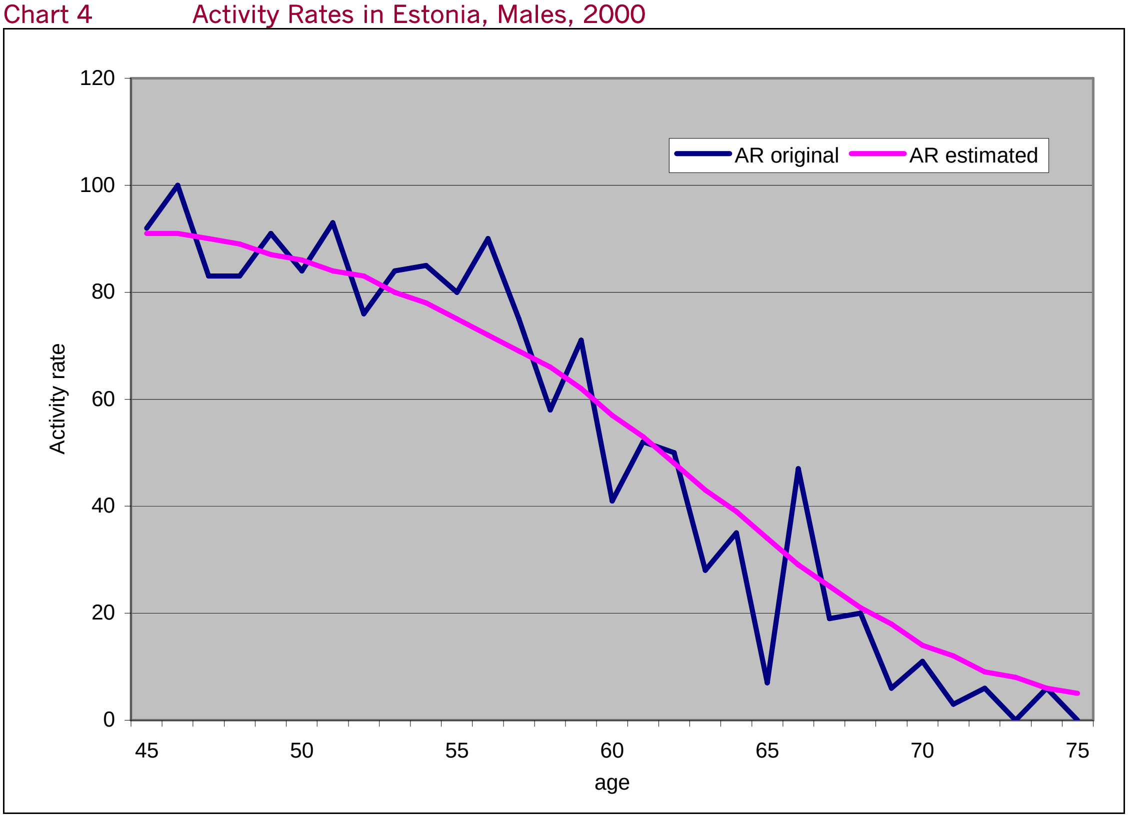
Table 9 Standard deviation between original and estimated activity rates
Countries and gender, where estimation of activity rates was necessary
2000-2007

Country	Standard deviation between original and estimated activity rate		
	Male	Female	All
Belgium		4.5	
Bulgaria		7.5	
Cyprus	6.3	6.5	5.3
Czech Republic	7.4		
Denmark	9.3	11.1	
Estonia	9.4	7	6.2
Finland	5.5	5.4	5.2
Greece	3.1		
Hungary	7.7	7.8	6.7
Ireland	4.3		5
Lithuania	9.8	8.6	
Luxembourg	6.3	5.9	7.1
Latvia	7.9	7.3	5.7
Malta	10.6	9	9.3
Netherlands	4.2	6.5	
Poland	3.6		2.8
Portugal	3.6	3.5	3
Romania	4.8	5.9	5.6
Slovenia	7.7	8.8	6.8
Slovakia	10.5	8.2	
Sweden	6.9	5.5	6
United Kingdom	3.2		

Source: Economix

The example of Estonia shows how estimated values were used to substitute unstable values of activity rates (Chart 4).

Chart 4 Activity Rates in Estonia, Males, 2000



Source: Economix

4.2.6. Cohort and age effects

In order to decide if erratic increases of ARs from one age to another maps the reality or should be interpreted as a sign of a high sampling error, we developed a procedure to control the cohort and age effect. The following regression model was separately estimated for each country and gender of interest:

(31) $$(r_{t,x} - \hat{r}_{t,x}) = \beta_0 + \beta_1(r_{t-1,x-1} - \hat{r}_{t-1,x-1}) + \beta_2(r_{t-1,x} - \hat{r}_{t-1,x})$$

$\hat{r}$	Estimated activity rate
x	Age
t	Year

The first coefficient *ß1* shows how strong the progression of the original AR was influenced by a cohort effect as it compares the activity of persons of the same age cohort in two subsequent years. Thus, we estimated the correlation between the differences of the original and estimated ARs of persons in an age cohort *x* for the year *t* and the differences of the original and estimated ARs of persons in the same age cohort *x-1* for the previous year *t-1*. For example, it is possible that one cohort is more active than others, and thus the AR is shifted upwards in every subsequent year. Then the first coefficient would have a strong impact.

The second coefficient *ß2* controls the age effect. The correlation of the difference of the original and estimated ARs in age *x*, in two subsequent years are calculated. For example in a country where it is very common to stop working at the age of 60, the age effect is strong as this behaviour of persons at the age of 60 is repeated every year.

The adjusted R^2 of this estimation shows how much of the progression of the original AR can be explained by age and cohort effects. The accordingly adjusted R^2 are mapped in Table 10. If the adjusted R^2 of this estimation is high, we can assume that the progression of the original AR maps the reality and can be explained by age and cohort effects. If the fit of the model is low, we can assume that the curve progression of the original AR can not be explained by age or cohort effects – as it was the case in Estonia, Latvia and Portugal. Then, it is likely that jumps in ARs originate from sampling errors.

In Table 11 the unexplained deviation is mapped. It describes the deviation between the original and the estimated AR which is not explained by cohort or age effects. It is calculated as follows:

(32) $$\delta = \lambda(1 - AdjR^2)$$

δ	Unexplained deviation between original and estimated AR
λ	Standard deviation between original and estimated activity rates (in percentage points)
$AdjR^2$	Adjusted R^2 of equation 31

The unexplained deviation is an important measure to evaluate the reliability of ARs. Regarding the values of unexplained deviation comparably high values for Estonia, Latvia and Malta stand out. Due to these results we decided whether original activity rates had to be substituted by estimated rates. This was the case for example in Estonia, Latvia and Malta (females) for ARs above the age of 45 years old.

Table 10 **Adjusted R^2 of regression models about age and cohort effects**
Estimations for 2000-2007

Country	Adjusted R^2		
	Male	Female	All
Belgium		0.487	
Bulgaria		0.897	
Cyprus	0.427	0.34	0.426
Czech Republic	0.912		
Denmark	0.739	0.831	
Estonia	0.076	0.182	0.211
Finland	0.86	0.751	0.763
Greece	0.603		
Hungary	0.892	0.906	0.926
Ireland	0.78		0.884
Lithuania	0.664	0.625	
Luxembourg	0.573	0.559	0.771
Latvia	0.237	0.447	0.473
Malta	0.796	0.419	0.75
Netherlands		0.766	0.786
Poland	0.445		0.46
Portugal	0.272	0.268	0.373
Romania	0.472	0.748	0.772
Slovenia	0.671	0.824	0.758
Slovakia	0.903	0.917	
Sweden	0.749	0.862	0.891
United Kingdom	0.741		

Source: Economix

Table 11 **Unexplained deviations**
Estimations for 2000-2007

Country	Unexplained deviation		
	Male	Female	All
Belgium		2,31	
Bulgaria		0,77	
Cyprus	3,61	4,29	3,04
Czech Republic	0,65		
Denmark	2,43	1,88	
Estonia	8,69	5,73	4,89
Finland	0,77	1,34	1,23
Greece	1,23		
Hungary	0,83	0,73	0,50
Ireland	0,95		0,58
Lithuania	3,29	3,23	
Luxembourg	2,67	2,60	1,63
Latvia	6,03	4,04	3,00
Malta	2,16	5,23	2,33
Netherlands		0,98	1,39
Poland	2,00		1,51
Portugal	2,62	2,56	1,88
Romania	2,53	1,49	1,28
Slovenia	2,53	1,55	1,65
Slovakia	1,02	0,68	
Sweden	1,73	0,76	0,65
United Kingdom	0,83		

Source: Economix

4.2.7. Extrapolation of activity rates up to the age of 100 years old

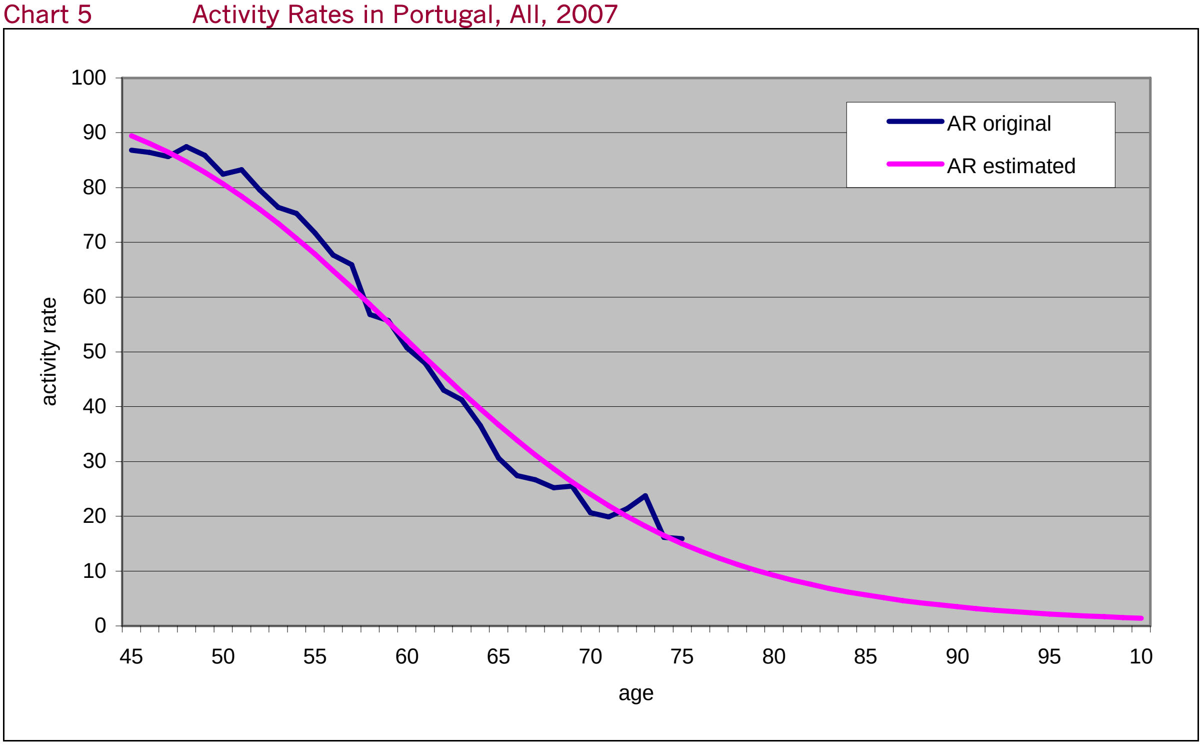
Estimation

In countries where the average AR between 70-75 years old was higher than 5%, we used the estimation procedure explained in Section 4.2.5 to extrapolate ARs for subsequent ages up to 100 years old. We did not fix a maximum age for active participation as some persons at high ages remain active until they die. Thereby, there is no theoretical reason for setting activity rates to zero at a certain age.

The estimation procedure therefore uses the available information for the Member States on the participation behaviour of their population and extrapolates this behaviour to ages above 75 years old.

Chart 5 shows the original and estimated AR of Portugal, where the estimations where used to extrapolate the ARs up to the age of 100 years old. Estimation was necessary, especially in Portugal, because of very high activity rates at the age of 75.

Chart 5 Activity Rates in Portugal, All, 2007



Source: Economix

Calculation

In countries, where no estimation was necessary (in AT, DE, ES, FR, IT) the ARs were extrapolated up to the age of 100 by subtracting the average rate of change as follows:

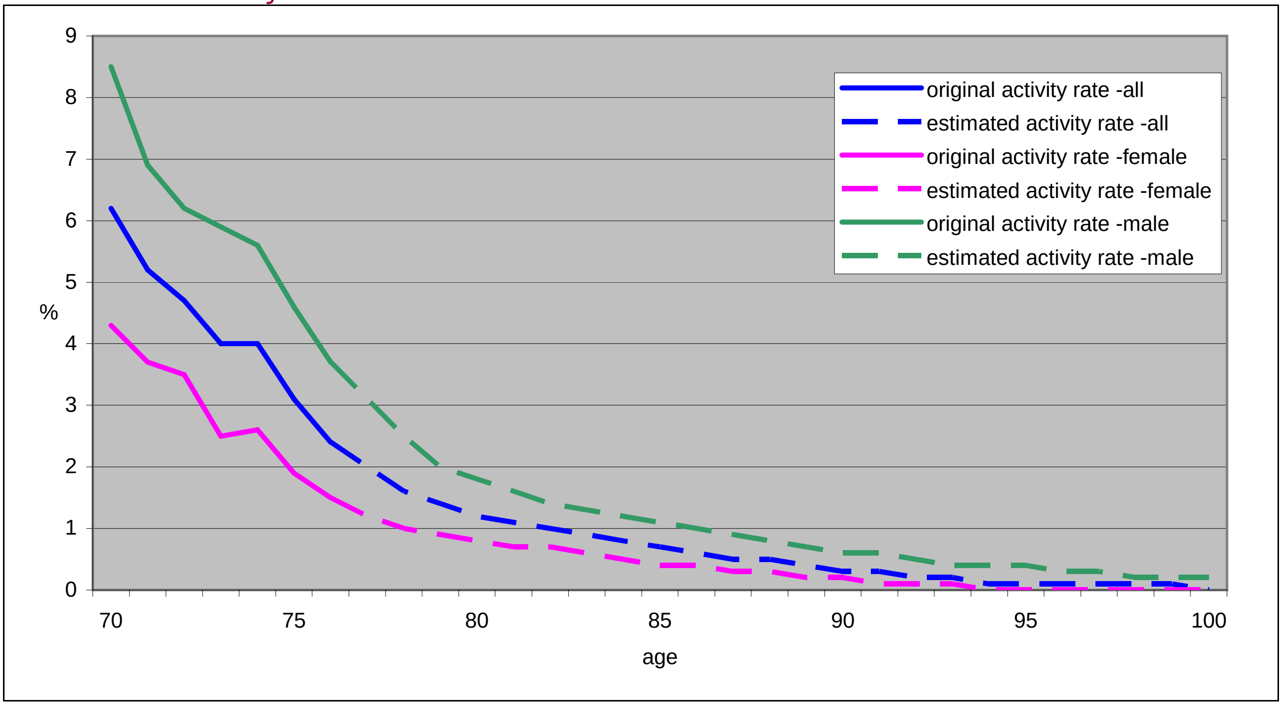
(33) $$r_{t,x} = r_{t,x-1} - \left(\frac{mean_t(66;70) - mean_t(71;75)}{5} \right)$$

$mean_{t,a}(x;y)$ Mean of activity rates in year *t* between ages *x* and *y*

Table A2 in the Annex presents an overview of which extrapolation procedure was used for each country and gender.

Chart 6 presents the extrapolated activity rates for males, females and all for EU27. As expected, the activity rate of males exceeds the rates of females. On average the EU27 activity rate of males is 9 percentage points higher than the activity rate of females.

Chart 6 Activity Rates 2007 – EU27



Source: Economix

4.3. Working hours

4.3.1. Alternative data sources

Possible data sources for working hours were the Harmonised European Time Use Survey (HETUS), the European Working Conditions Survey (EWCS) and the LFS from Eurostat.

Harmonised European Time Use Survey (HETUS)
The Harmonised European Time Use Survey (HETUS) is a data sample about persons' activities according to time diaries. Respondents fill in time diaries for two diary days, distributed over the whole year. The results, presented as average time per day over the whole year, provide a basis of how time was spent. In the early 1990s Eurostat fostered the implementation of time use surveys in collaboration with national statistic institutes, to ensure that the Member States implement surveys on a comparable European basis. Currently, data is available for 15 EU Member States, the age is denoted by five year age groups and the highest age contained is 65 years old (HETUS 2007).

Thus, the use of HETUS is limited for examining the duration of working time indicator, because data is not available in the required age and country disaggregation. To examine the duration of working time in the EU, we need information for each age and for all EU Member States.

European Working Conditions Survey (EWCS)
The EWCS, carried out by the European Foundation for the Improvement of Living and Working Conditions, is a survey about time use, work organisation, perceived health hazards and access to training. It was carried out the last time in 2005 in all 27 Member States whereby also a question about usual working time was asked. Overall, roughly 20,000 persons were interviewed (compared to 1.5 million cases in the LFS). The small sample size and the fact that the EWCS only cover persons in employment show that it would not be an appropriate source for the calculations for the duration of working time

indicator. Moreover, the EWCS is primarily designed for obtaining results on the EU level (European Commission 2007).

Labour Force Survey
The LFS provides data for usually and actually worked hours per week for all 27 EU Member States and the reasons for shorter or longer working hours. Since 2005 data on working hours is provided as quarterly averages of continuous population surveys as the changeover to a continuous quarterly survey between 1999 and 2004 was completed. This ensures all types of seasonal fluctuations of weekly working hours are captured without additional estimation. In particular, the fluctuation of absence hours is due to holidays, short-time work and illness but also due to the effects of overtime and other working time changes. Due to the advantages of the availability of data in the required country, gender and age disaggregation, the LFS was used for the following calculation of annual working hours.

Eurostat dataset
The datasets provided by Eurostat include data for weekly usual working hours and weekly actual working hours in the first job:

- from 2000 to 2007
- 4 quarters
- 27 Member States and 9 country aggregates
- separation by gender (male, female, male and female)
- 5 year age groups

Due to the changeover to a continuous quarterly survey of the LFS between 1999 and 2004, we only used the data between the years 2005-2007. To achieve single age values the five year age groups were linearly interpolated between the middle ages of each age group.

4.3.2. Definition of working hours

Number of hours usually worked per week
Eurostat defines the number of hours usually worked per week as all hours including extra hours, either paid or unpaid, which the person normally works, but excludes the travelling time between home and workplace and the time taken for the main meal break (usually at lunchtime). Persons who usually also do homework are asked to include the number of hours they usually work at home. Apprentices, trainees and other persons learning a job are asked to exclude any time spent at college or in other special training centres. Some persons, particularly self-employed persons and family workers, may not have usual hours, in the sense that their hours vary considerably from week to week or month to month. If a respondent is unable to provide a figure for usual working hours for this reason, the average of hours actually worked per week over the past four weeks is used as a measure of usual hours.

Number of hours actually worked during the reference week
The number of hours actually worked during the reference week covers all hours including extra hours regardless of whether they were paid or not. Travel time between home and the place of work as well as the main meal breaks (normally taken at midday) are excluded. Persons who have also worked at home are asked to include the number of hours they have worked at home. Apprentices, trainees and other persons in vocational training are asked to exclude the time spent in school or other special training centres.

In Table 12 reasons for shorter or longer working hours are mapped.

Table 12 Reasons for differences between usual and actual working hours

Person has worked *more* than usual due to:	• variable hours (e.g. flexible hours) • overtime • other reasons
Person has worked *less* than usual due to:	• bad weather • slack work for technical or economical reasons • labour disputes • education or training • variable hours (e.g. flexible hours) • own illness, injury or temporary disability • maternity leave or parental leave • special leave for personal or family reasons • annual holidays • bank holidays • start of/change in job during reference week • end of job without taking up a new one during reference week • other reasons

Source: EU Labour Force Survey database User Guide (2008), p. 16

4.3.3. Quality and variance of working hours

Overall, the data of working hours showed low standard deviations and coefficients of variation compared to the data of ARs. One reasons for this is the specification of data in 5 year age groups.

Variance Analysis
Chart 7 shows the variance of actual working hours in the first job by age groups for all 27 Member States for the years 2005-2007. The coefficient of variation is high in the first age group and starts rising again at the age of 60. Comparing females to males, the coefficient of variation for females is on average about 7 percentage points higher. The higher variance in usual working hours of women reflects the behaviour of females in the labour market; their working hours vary more because they have more family commitments.

The variance of usual working hours by age groups was very similar to actual working hours, with a high coefficient of variation in the first age group and older ages.

To control variations between observations of weekly working hours in different years, the following regressions were undertaken: the dependent variable was the weekly actual working hours and the explanatory variable was a lagged value (the weekly actual working hours of the quarter in the previous year). Apart from Malta and Luxembourg, the adjusted R^2 of these regressions per country and gender ranged between 0.474 and 0.994 for males and females together, which points to a high consistency in the data. In Table A3 in the Annex, the results of these regressions are presented. In Malta and Luxembourg the adjusted R^2 was below 0.2. This could be explained with sampling errors.

Missing values
The quarterly data about actual working hours in the first job only showed missing values in two countries: Luxembourg and Malta (see Table 13). Furthermore, the survey in Luxembourg provides data for the whole reference year only between 2005 and 2006. In absence of quarterly results, the same yearly figures are repeated for each quarter of that year (Eurostat, 2006).

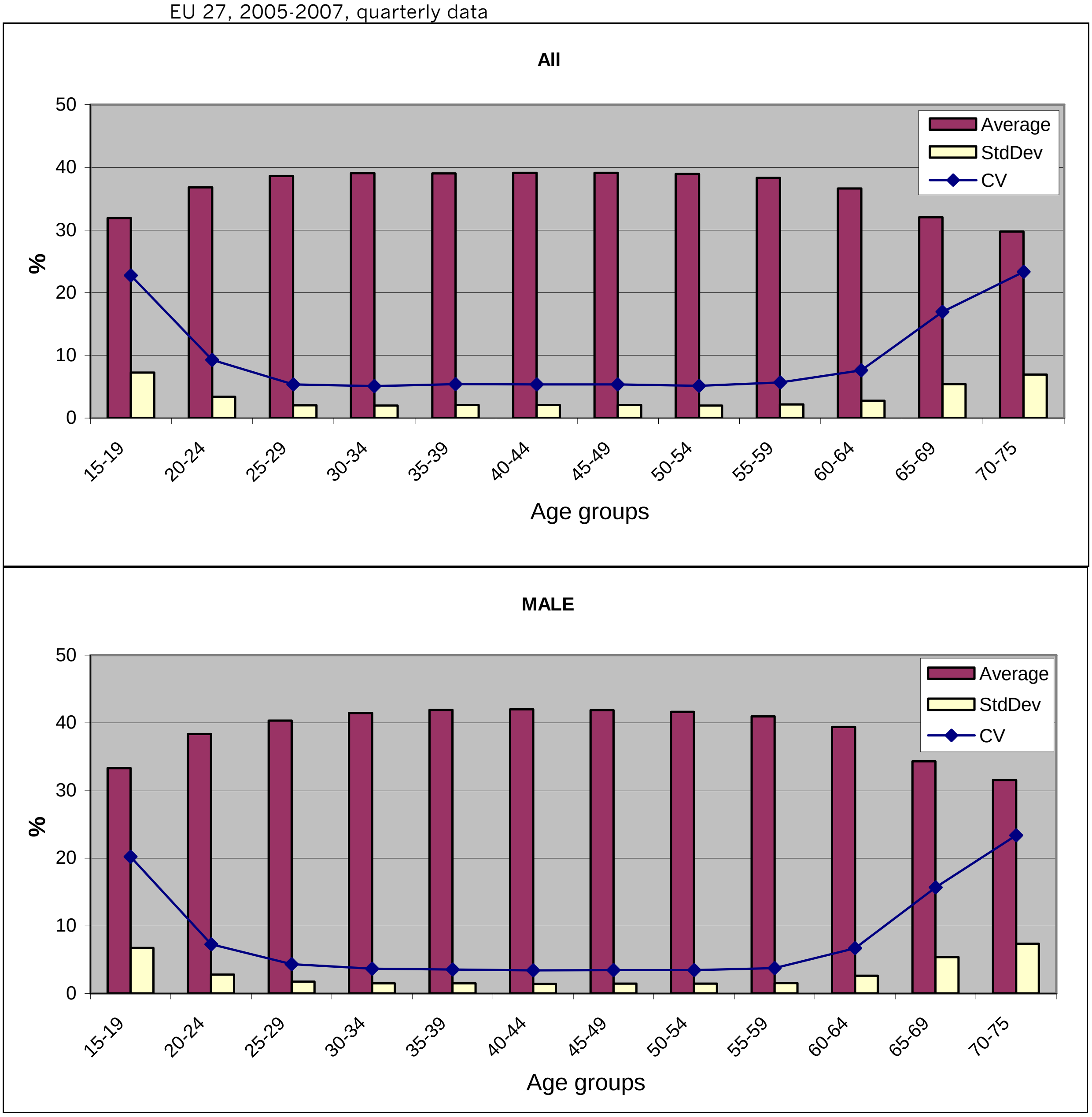
Table 13 Missing values of actual working hours in the first job
2005-2007

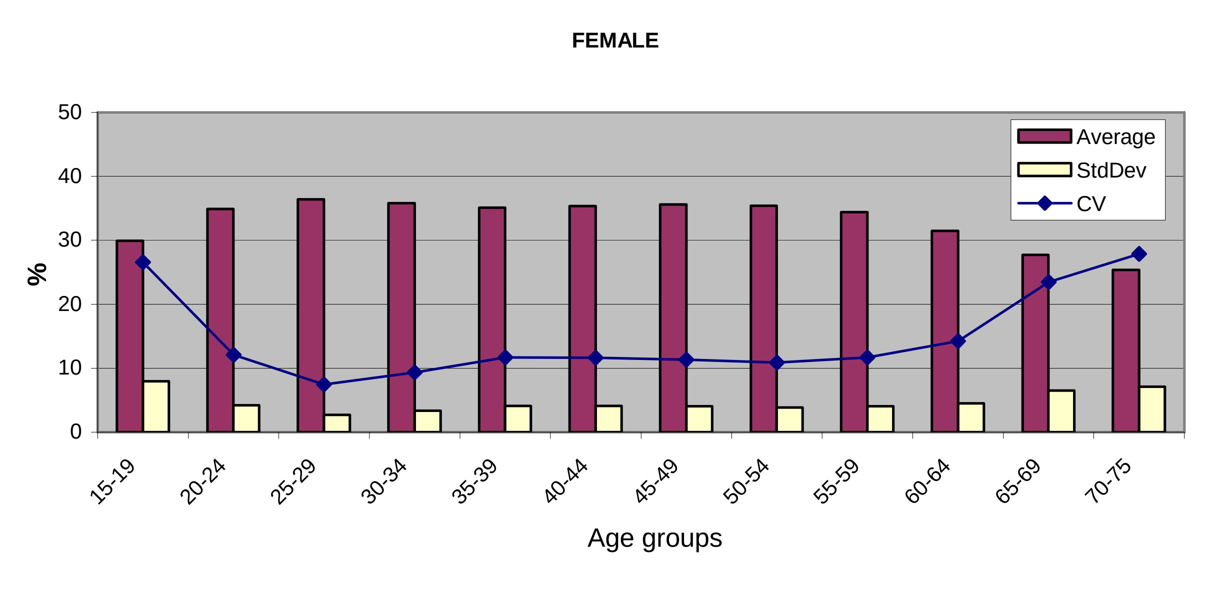
Country	Gender	Number of missing values
LU	All	3
	Female	10
	Male	4
MT	All	1
	Female	14
	Male	1
Total		33

Source: Economix

These missing values were substituted by age-specific averages of the available quarterly observations of 2005-2007.

Chart 7 Variance of actual working hours in the first job by age groups
EU 27, 2005-2007, quarterly data





Source: Economix

4.3.4. Reasons for absence

For the calculation of yearly working hours, it is important to examine the reasons why usual and actual working hours differ. There are 13 reasons surveyed by Eurostat why a person worked less than usual hours in the reference week. Since the EU LFS became a continuous survey, it covers all weeks of the year. As interviews are done every week and spread rather uniformly, we can assume that possible seasonal variations in hours of absence are covered by the LFS data.

Nevertheless, we checked if there are differences between quarters in the average number of hours of absence. Therefore, regressions with the number of absence hours for one reason of absence as a dependent variable and dummy variables for the quarters (quarter 4 was the reference category) as explanatory variables were estimated. The results are presented in Table A4 in the Annex. Basically, only very few explanatory variables had a significant influence. In the second and third quarter the number of absence hours is significantly lower than in the fourth quarter due to bank holidays. Moreover, the R^2 of all regressions ranged between 0,001 and 0,217. Due to comparably low values of R^2, we can assume that there is no considerable difference in absence hours between the quarters. Thus, we can use the weekly actual working hours for the calculations of annual working hours without seasonal adjustments.

4.3.5. Calculation of annual working hours

The calculation of annual working hours will be based on weekly actual working hours as these include overtime either paid or unpaid and times of absences. As quarterly observations are available the annualising was not problematic as all weeks per year are investigated due to the continuous survey design of the LFS.

To achieve actual annual working hours the average of actual weekly working hours of the four quarters was multiplied by 52 weeks.

(34) $$h_x = \frac{\sum_{q=1}^{4} wh_{x,q}}{4} \cdot 52$$ *Annual working hours at age x*

wh_x Quarterly value of weekly actual working hours in the first job at age *x*

In Table 14 annual working hours calculated with the presented formula above are mapped. The values show a high stability of country ranking during the three years of observations: the Spearman correlation coefficient for males and females ranges between 0.940 and 0.966. For males it ranges between 0.927 and 0.969 and for females between 0.971 and 0.987. These very high and significant correlation coefficients demonstrate the consistency of annual working hours in different years, as the rank order remained constant over the three years. Thus, the independent surveys between 2005 and 2007 represent reliable results which can be used for the calculation of the duration of working time.

Table 14 Annual hours actually worked – EU 27

Country	Annual actual working hours in the first job (LFS)			OECD 2007	Eurofound 2007
	2005	2006	2007		
AT	1,931	1,924	1,868	1,652	1,723
BE	1,798	1,826	1,828	1,566	1,730
BG	2,043	2,093	2,092		1,808
CY	1,956	1,966	1,954		1,733
CZ	2,038	2,028	2,021	1,985	1,710
DE	1,804	1,762	1,755	1,433	1,651
DK	1,696	1,681	1,681		1,635
EE	1,986	2,000	1,996		1,856
ES	1,952	1,941	1,939	1,652	1,698
FI	1,801	1,792	1,773	1,698	1,680
FR	1,843	1,855	1,850	1,561	1,568
GR	2,160	2,125	2,113		1,816
HU	1,967	1,986	1,968	1,986	1,840
IE	1,907	1,890	1,878	1,630	1,802
IT	1,966	1,951	1,950	1,824	1,672
LT	1,909	1,909	1,944		1,816
LU	2,018	2,062	1,926	1,542	1,732
LV	2,076	2,082	2,040		1,832
MT	1,978	1,914	1,916		1,776
NL	1,512	1,523	1,508	1,392	1,705
PL	1,905	1,901	1,911	1,976	1,848
PT	1,943	1,931	1,917	1,728	1,707
RO	2,006	1,990	1,986		1,856
SE	1,708	1,698	1,721	1,562	1,620
SL	1,961	1,926	1,943		1,816
SK	2,024	1,982	2,006		1,737
UK	1,728	1,721	1,726	1,670	1,696

Source: Economix, OECD Employment Outlook 2008, p. 353, Eurofound 2008

4.3.6. Comparison of annual working hours with other sources

Values for annual working hours are also available from OECD and Eurofound. The values are likewise presented in Table 14. Differences between results from LFS, OECD and Eurofound occur from different calculation methods as described below.

Calculation procedures of OECD estimates

The majority of the presented annual working hours by the OECD are based on National Accounts concepts (AT, DK, FI, FR, DE, GR, HU, IT, SL, SE) which take the number of work days, holidays, standard weekly hours by industrial sector etc. into account. In BE, IE, NL and PL, OECD Secretariat estimates of annual working time were used. These are estimates based on the Spring European Labour Force Survey (EULFS). As the Spring LFS corresponds to one single reading in the year, adjustments for holidays and annual leave were necessary. Further, the estimated 50% underreporting of times of absence are taken into account (OECD 2004). In PL and CZ the annual working hours presented by the OECD are based on LFS calculations. There we find much smaller differences between OECD and LFS values.

The OECD (2004) gives some reasons for the differences between annual working hours estimated on the basis of National Accounts and LFS:

- national accounts estimations are based on differentiated sources compared to approximate LFS estimates
- LFS does not cover persons living in institutions, collective households, armed forces and it especially does not cover cross boarder workers
- LFS are benchmarked to population censuses which are only conducted every 5 to 10 years
- LFS based estimates are suspected of over-reporting working hours compared to time use surveys
- in some countries hours of absence are underestimated compared to administrative sources

In the Employment Outlook 2008, the OECD points out that due to different measuring concepts used for the estimates, the comparability between countries is limited. As the comparison between Member States is one of our main objectives, this source is not appropriate for our purpose. Another reason against the use of the OECD estimates is the non-existence of values for 10 EU Member States.

Annual working time by Eurofound
Eurofound (2008) presents average collectively agreed normal annual working time for 2007 (see Table 14). They multiply the weekly working hours by 52 weeks and subtract average annual leave and public holidays. Sources for annual leave and holidays are EIRO (European Industrial Relations Observatory) national centres. But these estimates only map collectively agreed working hours and average numbers of holidays. No variation due to overtime or any time of absence is considered. Thus, it only represents institutional conditions and is far from mapping real working hours. Furthermore, these values do not contain self-employed and part-time workers. Accordingly, the annual working hours presented by Eurofoud can hardly be compared to annual working hours based on LFS.

4.3.7. Extrapolation of working hours up to the age of 100 years old

For the extrapolation of actual working hours in the first job a proportional depreciation was used:

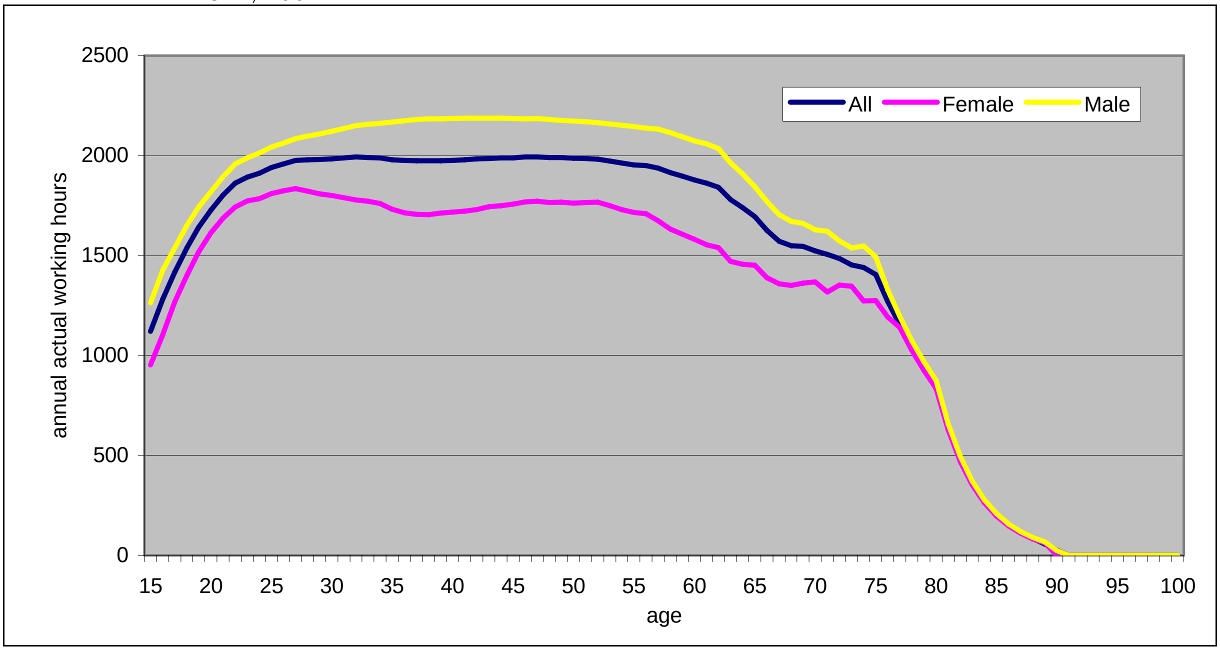
- between 76-80 years old working hours of the previous age depreciated by 10%
- between 81-90 years old working hours of the previous age depreciated by 25%
- between 91-100 years old working hours of the previous age depreciated by 50%

The attempt to extrapolate working hours by subtracting the average rate of change of the last two age groups observed delivered unstable and implausible results. As we assume that the working hours are declining for ages above 75, we chose the depreciation method to handle the rising instability in higher age groups.

Chart 8 presents annual actual working hours in the first job for males, females and all for EU27. The annual working hours of women lie considerably below the annual hours of males. Between the ages of 27 and 37 years old a decline of annual working hours of females is visible, as a result of intensified family constraints during this period. Chart 9 shows the annual actual working hours for EU27, EU15 and the NM12. The annual working hours in the New Member States apparently exceed the working hours of the EU15.

Chart 8 Annual actual working hours in the first job by gender – EU27

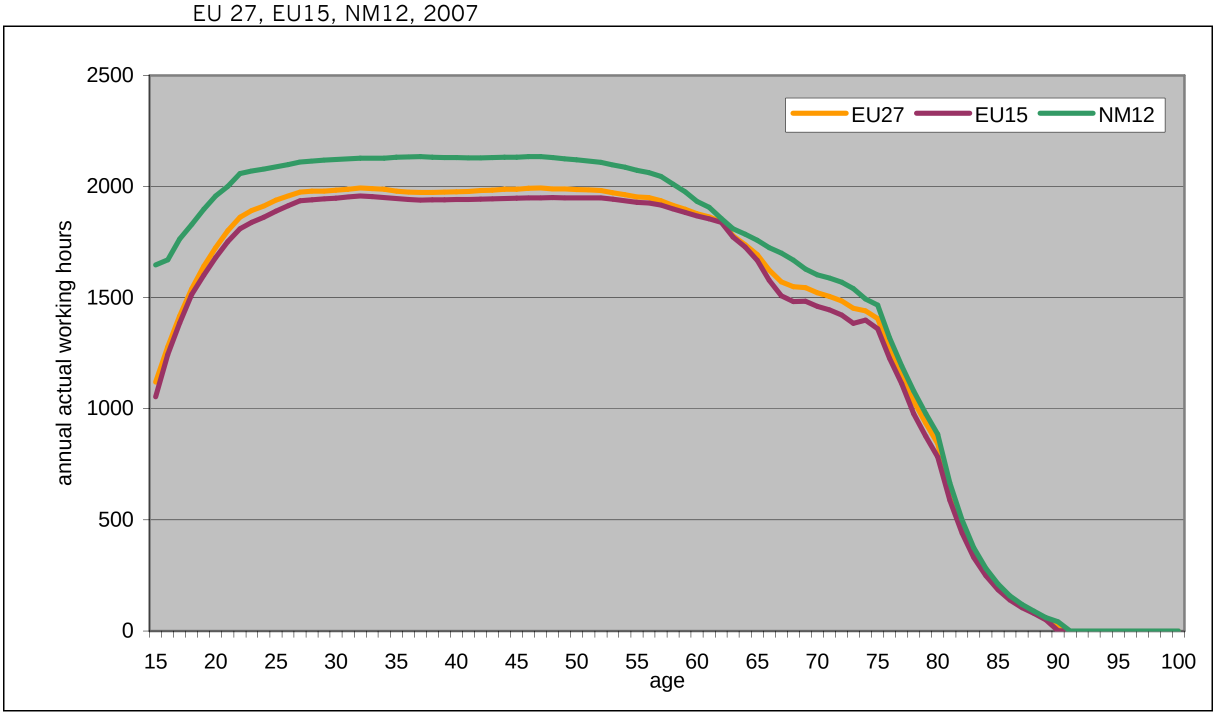
EU27, 2007



Source: Economix

Chart 9 Annual actual working hours in the first job by EU aggregates – EU27

EU 27, EU15, NM12, 2007



Source: Economix

4.4. Additional data inputs

4.4.1. Population

Eurostat provides data about the population for all 27 Member States aged 15-75 years old, for the years 2000-2007 and gender. Values between 76-100 years old were extrapolated with the survival function from the WHO life tables as shown in the following equation:

(35) $$P_x = \frac{S_{x+1}}{S_x} = P_{x+1}$$

P_x Population at age x

S_x Survival rate at age x

4.4.2. Labour Force

Eurostat provides a dataset of the labour force in all Member States for 15-75 year olds, for the years 2000-2007 and gender. The extrapolation of this data was based on adjusted activity rates which were already extrapolated up to the age of 100 (Section 4.2.7). For males and females the extrapolation was calculated for ages 76 to 100 years old as follows:

(36) $$LF_x = P_x \cdot r_x$$

LF_x Labour force at age x

r_x Activity rate

After the calculation of the labour force for males and females, these values were aggregated to achieve the labour force for “all” at every age *x* and year *t*. This was necessary to achieve a consistent data basis. These recalculated values for the gender “all” were then used as a data basis to recalculate the activity rates for total.

4.4.3. Persons employed

In the dataset about persons employed, which was provided by the labour force, missing values had to be inserted and values had to be interpolated up to the age of 100 years old.

Insertion of missing values:

- if only a few values were missing at a single age *x*, the average above the available years 2000-2007 was inserted.
- if values were missing for age 15, the average change rate between values at age 16 and 17 were used to calculate the values for age 15
- if all values of one age *x* were missing for all years, the average change rate of previous values were used

Extrapolation of persons employed was calculated as follows:

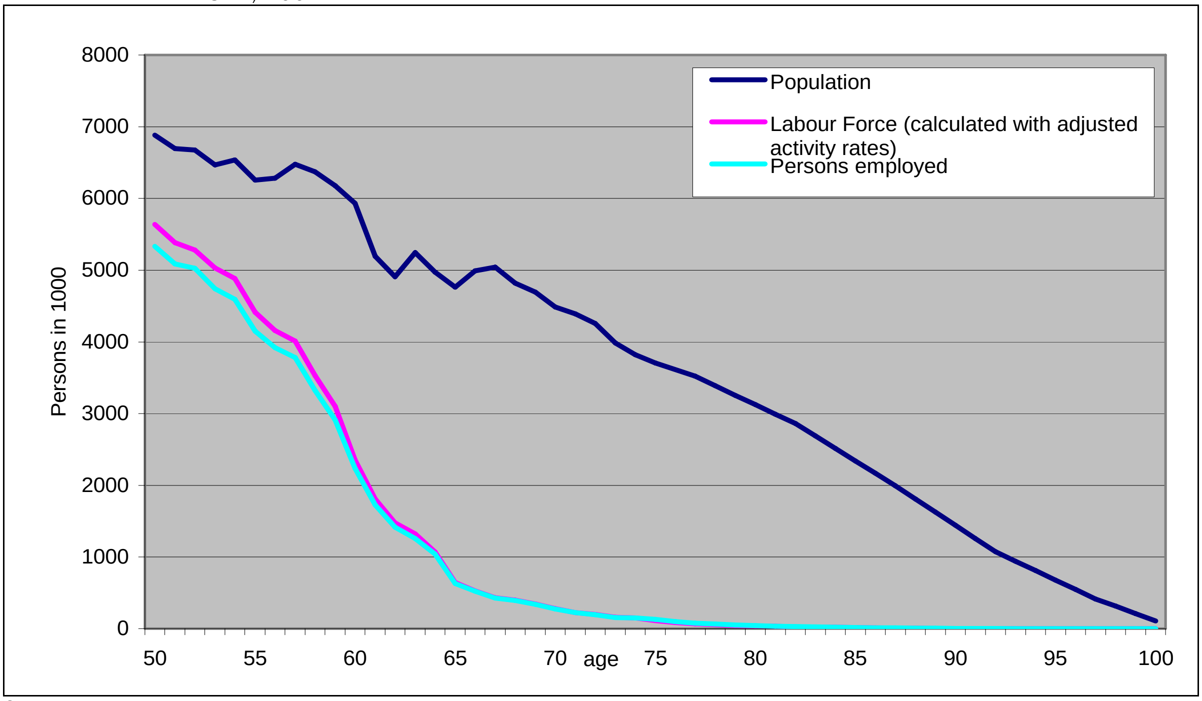
(37) $$E_x = E_{x-1} \cdot \frac{LF_x}{LF_{x-1}}$$

E_x Persons employed at age x

To achieve consistent values, the gender aggregate “all” was recalculated by the sum of values for males and females, in order to achieve consistent data.

Chart 10 shows the population, labour force and persons employed for the EU27 aggregate up to the age of 100 years old. For ages above 50 years old the labour force only minimally exceeds the number of persons employed.

Chart 10 Population, labour force and number of persons employed
EU27, 2007

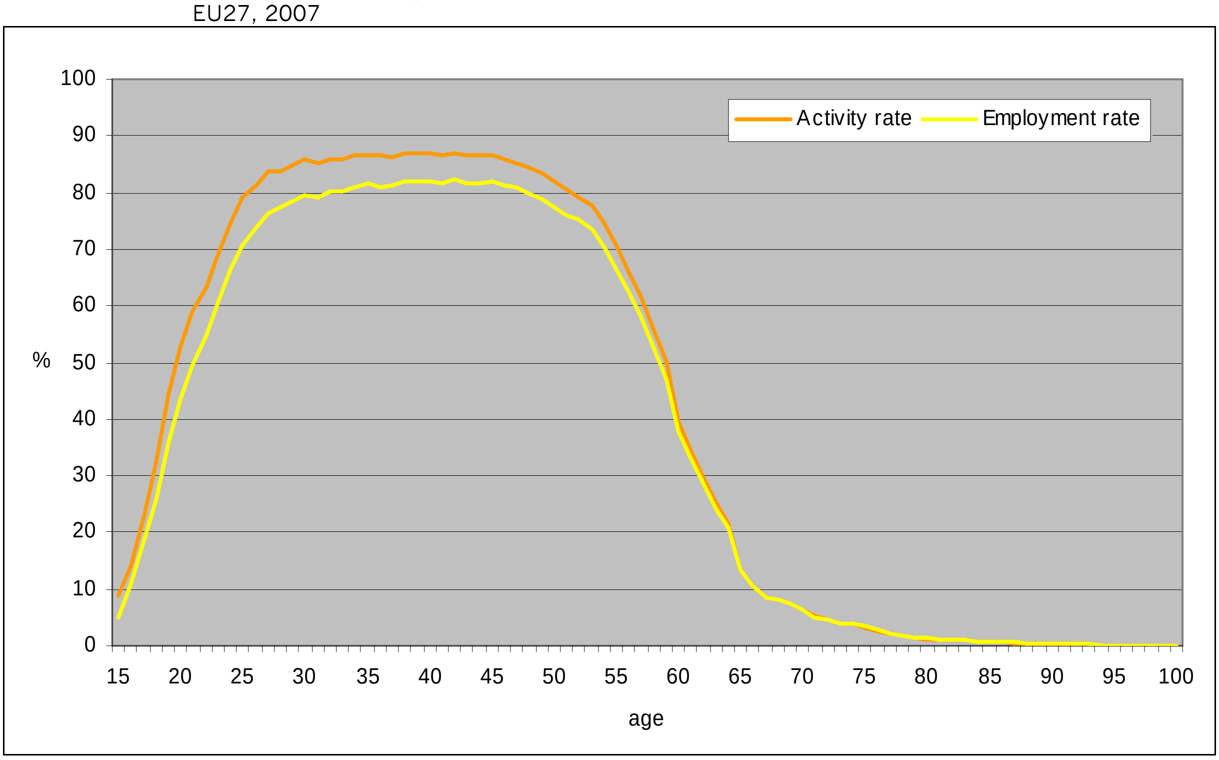


Source: Economix

4.4.4. Employment rate

We calculated the employment rate by dividing the number of persons employed by the labour force for each country, age, year and gender. The employment rate was needed for calculating the duration of (non-) employment and (non-) working time. Chart 11 presents the activity and employment rate for the EU27 aggregate up to the age of 100 years old.

Chart 11 Activity and employment rate
EU27, 2007



Source: Economix

5. Results

The following part presents the results calculated on the basis of the approaches defined in Chapter 3. Data is mainly provided for EU27, the country breakdown and the age and gender profile of the estimated indicators. Detailed results for all countries, gender and ages are available on the CD-ROM attached to this report.

5.1. Duration of active working life

At the age of 15 the average EU27 person could expect 34.2 active working life years in 2007. For the 45 years old, the duration was 13.2 years and 0.8 years at the age of 65 (Table 15). Since 2000 an increase of one year can be observed for 15 year olds which mainly happened after 2004. It might therefore be associated with the upswing in European labour markets. The rise can also be measured for the 45 year olds. For workers aged 65 it is less expressed.

Table 15 Duration of active working life – EU27

Years per person

	2000	2001	2002	2003	2004	2005	2006	2007
Males and females								
aged 15	33.2	33.1	33.1	33.3	33.4	33.7	34.1	34.2
aged 45	12.1	12.1	12.2	12.4	12.5	12.7	13.0	13.2
aged 65	0.8	0.8	0.7	0.8	0.7	0.7	0.8	0.8
Males								
aged 15	36.9	36.7	36.6	36.8	36.8	37.0	37.3	37.4
aged 45	14.0	14.1	14.1	14.3	14.3	14.5	14.7	14.9
aged 65	1.0	1.0	1.0	1.0	1.0	1.0	1.1	1.1
Females								
aged 15	29.4	29.5	29.5	29.7	30.0	30.4	30.9	31.0
aged 45	10.2	10.3	10.3	10.5	10.7	11.0	11.2	11.4
aged 65	0.6	0.6	0.6	0.6	0.5	0.5	0.5	0.6

Source: Economix

In 2007, the active working life expectancy for 15 year old males was 6.4 years longer than that for females (37.4 years compared to 31.0 years). For females, however, the active working life expectancy increased more rapidly since 2000 (+1.6 years compared to 0.5 years for males).

The longest active working life could be expected by the Swedish population, where a 15 year old person could be expected to work for 39.9 years (Table 16). Denmark and the Netherlands were close to these values. At the shorter end of the scale were Italy, Hungary and Malta with an active working life expectancy of below 30 years. This is a difference of 11.1 years between Malta and Sweden.

Between 2000 and 2007 the average duration of active working life of 15 year olds rose in 23 of the 27 EU countries. Significant increases of around 3 years were achieved in Latvia, Sweden, the Netherlands and Spain. In six other countries the prolongation was above 2 years. The duration of active working life decreased in Poland, Lithuania and Romania.

As a result the active working life expectancy increased in the EU15 countries by 1.8 years between 2000 and 2007. In the NM12 countries a reduction by 1.5 years was measured. This is partly due to instabilities in the time series (e.g. for Romania). Between 2002 and 2007, the decline of active working life expectancy is much smaller (-0.2 years). Nevertheless, it remains in decline.

Table 16 Duration of active working life by country
Years per person aged 15; countries sorted according to 2007 values

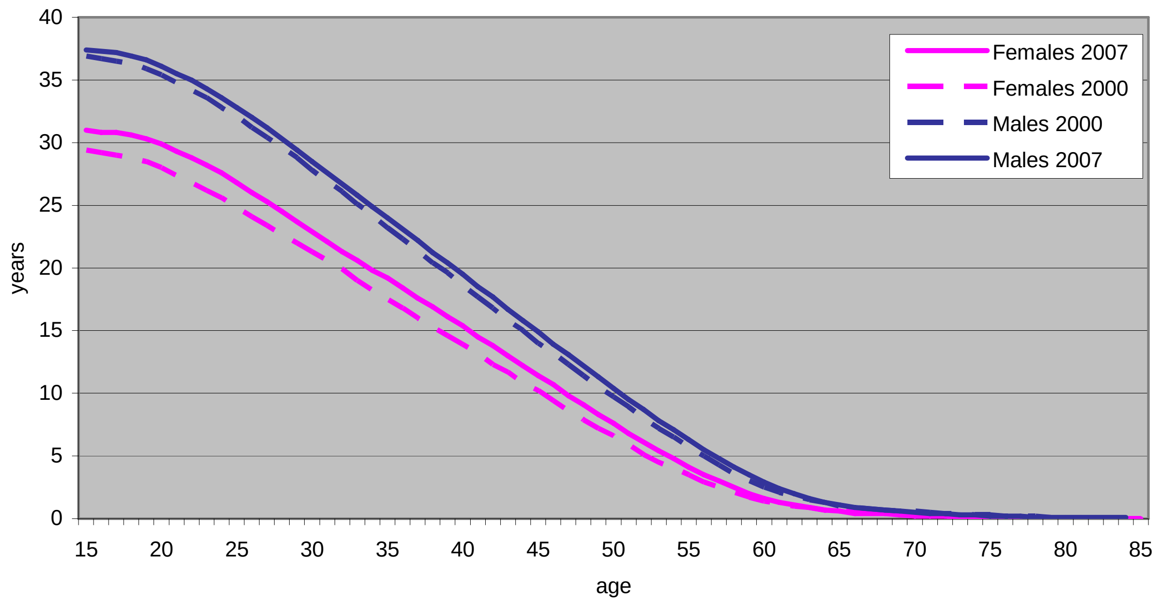
	2000	2001	2002	2003	2004	2005	2006	2007
SE	36.9	38.4	38.5	38.6	38.5	39.2	39.4	39.9
DK	38.6	38.2	38.7	38.6	39.1	39.1	39.6	39.7
NL	35.7	36.2	36.8	37.0	37.4	37.5	37.9	38.6
UK	37.0	36.8	37.1	37.2	37.2	37.3	37.8	37.6
PT	36.3	36.6	37.2	37.0	36.7	37.0	37.4	37.6
FI	36.5	36.8	36.9	36.9	36.6	37.1	37.4	37.0
DE	34.4	34.6	34.8	35.1	35.0	35.9	36.5	36.7
CY	34.3	35.4	35.1	36.3	36.3	36.0	36.3	36.6
AT	33.6	33.6	34.1	34.2	33.6	34.7	35.4	36.2
IE	33.4	33.4	33.6	33.6	33.8	34.7	35.1	35.6
LV	32.1	32.9	33.6	33.8	33.6	33.8	34.6	35.3
EE	33.7	33.5	32.8	33.6	34.3	34.3	35.2	35.3
SI	32.2	32.3	32.8	31.7	33.5	33.8	34.1	34.3
CZ	33.7	33.5	33.6	33.4	33.5	33.9	34.0	33.9
FR	31.9	31.9	32.1	32.7	32.8	33.1	33.4	33.6
ES	30.8	30.3	30.9	31.5	32.0	32.7	33.3	33.6
RO	37.5	36.7	33.0	32.9	32.5	31.7	32.4	32.4
SK	32.2	32.6	32.3	32.6	32.6	32.4	32.2	32.2
LT	33.9	33.4	33.1	34.5	33.0	32.3	32.0	32.1
BE	30.3	29.6	29.8	30.0	30.6	31.5	31.5	32.0
BG	29.2	30.2	30.1	29.6	30.1	29.8	30.9	31.8
GR	31.3	30.8	30.9	31.2	31.7	31.6	31.8	31.8
PL	31.4	31.6	31.0	30.7	30.5	30.9	30.4	30.3
LU	29.2	29.3	29.9	29.4	29.7	30.1	30.5	30.3
IT	28.5	28.6	28.9	29.2	29.7	29.5	29.6	29.6
HU	27.7	27.6	27.7	28.3	28.1	28.6	28.9	29.0
MT	28.0	28.3	28.0	28.1	27.8	28.0	28.2	28.8
EU27	33.2	33.1	33.1	33.3	33.4	33.7	34.1	34.2
EU15	33.2	33.3	33.6	33.8	34.1	34.5	34.9	35.0
NM12	33.0	32.7	31.7	31.6	31.4	31.3	31.5	31.5

Source: Economix

Active working life expectancy annually decreases by ¾ of a year between the ages of 20 to 60 years old (Chart 12). For younger and older ages the decrease is even lower. This means that active working life expectancy is not directly proportional to age and – over all ages – is not a linear function of age.

Males start at 15 with a higher level, but the annual reduction is stronger: the annual decrease between 20 and 60 years of age is 0.82 years, yet for females it is only 0.70. At the age of 65 the differences become smaller in absolute terms. In relative terms, however, the gender difference is continuously rising. At the age of 15, the active working life expectancy of men is 20% above the level of women. At the age of 50 the difference is 38% and rises to 200% at the age of 75. In spite of the shorter life expectancy of men they can be expected to work longer than women at all ages. For the older generation this attitude is more expressed than in younger generations. However, the difference exists for all ages.

Chart 12 Duration of active working life by gender
EU27, working life expectancy, at ages between 15 and 85



Source: Economix

5.2. Duration of non-active working life

This is calculated as the difference between the duration of active working life and the overall life expectancy. Non-working life therefore measures the number of years during which a person is expected not to be available on the labour market. The reasons for this can be education and training, child care, retirement and others.

Table 17 Duration of non-active working life – EU27
Years per person

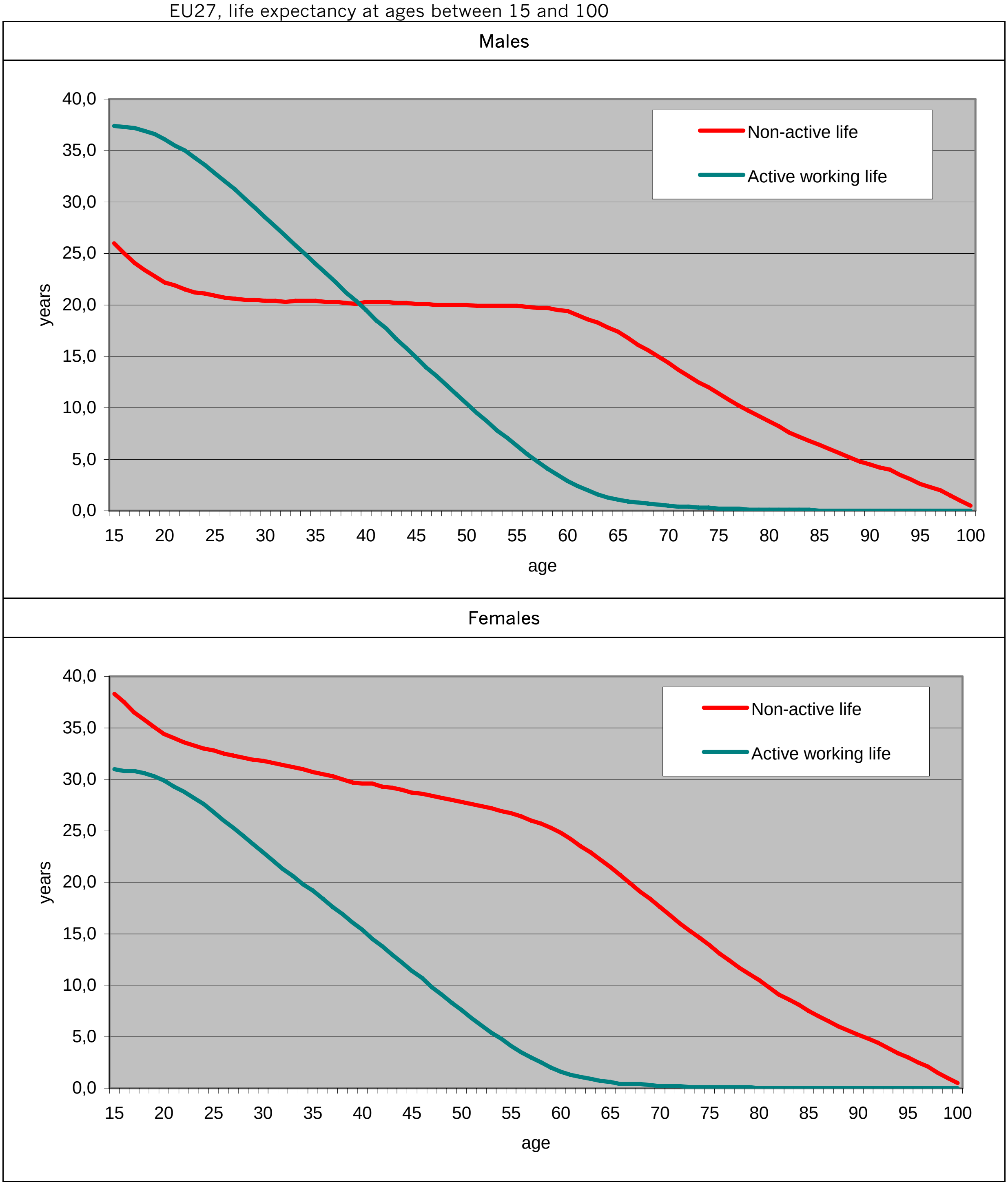
	2000	2001	2002	2003	2004	2005	2006	2007
Males and females								
aged 15	31.3	31.5	32.0	32.2	32.1	32.1	32.1	32.2
aged 45	23.7	23.9	24.4	24.4	24.4	24.4	24.5	24.5
aged 65	18.1	18.3	18.7	18.9	19.0	19.2	19.4	19.6
Males								
aged 15	24.3	24.6	25.2	25.4	25.6	25.7	25.8	26.0
aged 45	18.9	19.1	19.7	19.7	19.9	19.9	20.0	20.1
aged 65	15.8	15.9	16.4	16.7	16.8	16.9	17.2	17.4
Females								
aged 15	38.3	38.3	38.7	38.9	38.6	38.5	38.3	38.3
aged 45	28.3	28.4	28.8	28.9	28.8	28.7	28.8	28.7
aged 65	20.1	20.2	20.6	20.8	20.9	21.1	21.3	21.5

Source: Economix

Table 17 reveals significant differences of non-active working life between men and women. A 15 year old woman in EU27 can expect 38.3 non-active years during her life-time, while a man of the same age can expect 26.0 years. Over the course of their lives the non-active life expectancy changes until the age of 60 to 24.8 years for women and 19.4 years for men. Between 25 and 60 years of age the non-active life expectancy of men remains more or less stable at the level of 20 years, and starts to decrease thereafter. For women the non-active life expectancy decreases by 8 years during this age span.

Chart 13 Active and non-active life expectancy 2007

EU27, life expectancy at ages between 15 and 100



Source: Economix

5.3. Duration of employment

The expected duration of employment at the age of 15 increased from 30.2 years in 2000 to 31.8 years in 2007 (Table 18). A slightly smaller increase from 11.3 to 12.5 years can be observed at the age of 45, while at the age of 65 the duration of employment remains unchanged at the level of 0.8 years.

For males the values were generally higher than for females. On average during the period 2000-2007, the difference was 6.7 years for 15 year olds, 3.5 years for 45 year olds and 0.4 years for 65 year olds. In relative terms this means that men's duration of employment was 25 % higher at the age of 15 but 69% at the age of 65. The differences between men and women declined over the 2000-2007 period.

Table 18 Duration of employment – EU27
Years per person

	2000	2001	2002	2003	2004	2005	2006	2007
Males and females								
aged 15	30.2	30.3	30.1	30.3	30.4	30.7	31.2	31.8
aged 45	11.3	11.4	11.4	11.6	11.6	11.9	12.2	12.5
aged 65	0.8	0.8	0.7	0.8	0.8	0.8	0.8	0.8
Males								
aged 15	33.9	33.8	33.6	33.6	33.6	33.9	34.3	34.9
aged 45	13.2	13.2	13.2	13.3	13.4	13.6	13.9	14.2
aged 65	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.1
Females								
aged 15	26.4	26.7	26.6	26.9	27.1	27.5	28.1	28.6
aged 45	9.5	9.6	9.6	9.8	10.0	10.3	10.5	10.8
aged 65	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6

Source: Economix

The ranking of countries according the 2007 levels of the duration of employment is more or less the same as was observed for the duration of active working life (Table 19). The Scandinavian countries have the longest employment expectations and some of the New Member States have the lowest. This was to be expected as activity rates and employment rates do not differ strongly.

Table 19 Duration of employment by country

Years per person aged 15, countries sorted according to 2007 values

	2000	2001	2002	2003	2004	2005	2006	2007
DK	36.8	36.5	37.0	36.4	37.0	37.2	38.0	38.2
SE	34.9	36.5	36.7	36.5	36.0	36.1	36.6	37.6
NL	34.6	35.4	35.8	35.6	35.6	35.7	36.2	37.2
UK	34.6	34.9	35.0	35.2	35.3	35.4	35.6	35.5
CY	32.6	34.0	34.0	34.7	34.7	34.1	34.7	35.1
PT	35.0	35.2	35.6	34.8	34.4	34.2	34.6	34.6
AT	32.0	32.2	32.4	32.5	31.8	32.9	33.6	34.5
FI	32.3	32.9	32.9	32.8	32.6	33.3	34.0	34.5
IE	32.0	32.2	32.3	32.2	32.4	33.3	33.7	34.0
EE	29.3	29.5	30.2	30.5	31.2	31.8	33.5	33.9
DE	31.7	31.9	31.8	31.6	31.2	31.9	32.7	33.5
LV	27.6	28.5	29.5	30.0	30.5	30.8	32.2	33.2
SI	30.1	30.5	30.9	29.6	31.5	31.6	32.0	32.7
CZ	30.7	30.8	31.2	30.9	30.7	31.2	31.5	32.1
FR	28.6	29.1	29.3	29.8	29.7	30.1	30.2	30.8
LT	28.7	27.9	28.8	30.1	29.3	29.6	30.2	30.8
ES	26.6	27.2	27.5	27.9	28.4	29.6	30.4	30.7
RO	35.0	34.5	30.5	30.8	30.6	29.8	30.0	30.6
LU	29.0	29.0	29.3	28.6	28.7	29.4	29.4	29.7
BE	28.2	27.8	27.8	27.7	28.3	28.9	28.9	29.6
BG	24.4	24.1	24.6	25.5	26.4	26.7	28.1	29.6
GR	27.9	27.6	27.9	28.3	28.4	28.5	29.0	29.1
SK	26.2	26.5	26.4	27.2	26.7	27.3	28.0	28.7
MT	27.3	27.6	26.9	27.2	26.9	27.4	27.6	28.3
IT	25.3	25.7	26.1	26.5	27.2	27.0	27.5	27.6
PL	26.4	26.0	25.0	24.9	24.9	25.6	26.3	27.5
HU	25.9	26.0	26.1	26.6	26.5	26.5	26.7	26.8
EU27	30.2	30.3	30.1	30.3	30.4	30.7	31.2	31.8
EU15	30.4	30.8	31.0	31.1	31.2	31.6	32.1	32.5
NM12	29.3	28.6	27.7	27.7	27.7	27.8	28.4	29.2

Source: Economix

5.4. Duration of non-employment

For the average EU27 person there is a difference of 2.4 to 3.0 years between the duration of active working life and the duration of employment. For men, the difference is 2.5 years and for women 2.4 years (Table 20). This period of non-employment is due to unemployment spells and other periods during which persons are not employed but are looking for a job. It is not equal to registered unemployment.

At all ages and in both gender groups the duration of non-employment has decreased since 2005. This may be associated with the cyclical upswing of labour demand during that period.

The ranking of countries by non-employment expectations shows a wide dispersion (Table 21): for Slovakia, Germany, and Portugal the duration of non-employment is above 3.0 years. In Luxembourg and Malta, the values are only 0.5 years over the whole lifetime. In relative terms this means that in the first group of countries between 8% and 11% of the active time is spent in non-employment, while it is less than 2% in the second group.

Table 20 Duration of non-employment – EU27

Years per person

	2000	2001	2002	2003	2004	2005	2006	2007
Males and females								
aged 15	3.0	2.8	3.0	3.0	3.0	3.0	2.9	2.4
aged 45	0.8	0.7	0.8	0.8	0.9	0.8	0.8	0.7
aged 65	0.0	0.0	0.0	0.0	-0.1	-0.1	0.0	0.0
Males								
aged 15	3.0	2.9	3.0	3.2	3.2	3.1	3.0	2.5
aged 45	0.8	0.9	0.9	1.0	0.9	0.9	0.8	0.7
aged 65	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0
Females								
aged 15	3.0	2.8	2.9	2.8	2.9	2.9	2.8	2.4
aged 45	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.6
aged 65	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Source: Economix

Table 21 Duration of non-employment by country

Years per person aged 15, countries sorted according to 2007 values

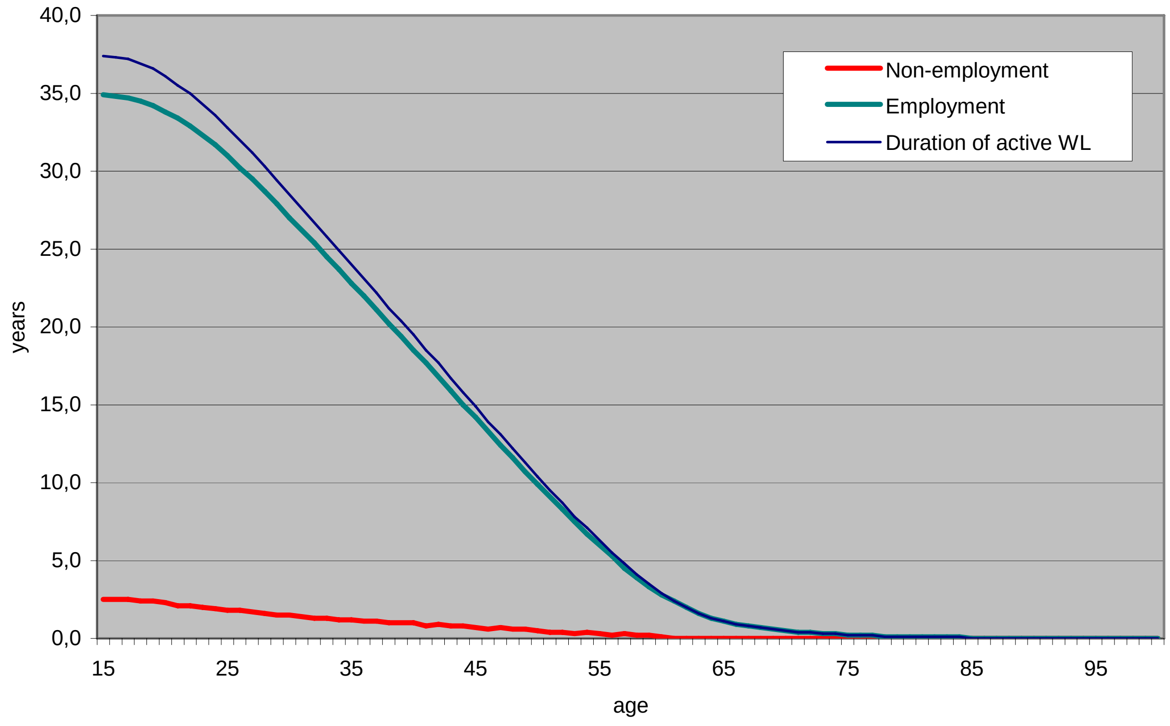
	2000	2001	2002	2003	2004	2005	2006	2007
SK	6.0	6.2	5.9	5.5	6.0	5.2	4.2	3.5
DE	2.7	2.7	3.0	3.5	3.8	4.1	3.8	3.2
PT	1.3	1.4	1.6	2.2	2.3	2.8	2.8	3.0
ES	4.2	3.1	3.4	3.6	3.6	3.1	2.9	2.9
PL	5.0	5.6	6.0	5.8	5.6	5.3	4.1	2.8
FR	3.3	2.8	2.8	2.8	3.1	3.0	3.2	2.8
GR	3.5	3.2	3.1	2.9	3.3	3.2	2.9	2.7
FI	4.2	3.9	4.0	4.0	4.0	3.7	3.5	2.5
BE	2.0	1.8	2.0	2.3	2.3	2.6	2.6	2.4
SE	2.0	1.9	1.8	2.1	2.5	3.1	2.8	2.3
BG	4.8	6.1	5.5	4.1	3.7	3.0	2.8	2.2
HU	1.8	1.5	1.6	1.7	1.6	2.1	2.2	2.2
UK	2.4	1.9	2.1	2.0	1.9	1.9	2.2	2.2
LV	4.5	4.4	4.2	3.8	3.1	3.0	2.4	2.1
IT	3.2	2.8	2.8	2.7	2.5	2.4	2.2	1.9
RO	2.4	2.3	2.4	2.1	1.9	1.9	2.4	1.8
CZ	2.9	2.7	2.4	2.5	2.8	2.7	2.4	1.8
SI	2.1	1.8	1.9	2.0	2.0	2.2	2.0	1.7
AT	1.6	1.4	1.7	1.7	1.9	1.9	1.7	1.6
DK	1.8	1.6	1.7	2.1	2.1	1.9	1.6	1.6
IE	1.4	1.2	1.3	1.4	1.4	1.4	1.4	1.6
CY	1.7	1.4	1.0	1.5	1.6	1.9	1.7	1.4
NL	1.0	0.8	1.0	1.3	1.8	1.8	1.7	1.4
EE	4.4	4.1	2.7	3.2	3.1	2.5	1.8	1.4
LT	5.2	5.5	4.3	4.4	3.7	2.7	1.8	1.4
LU	0.2	0.3	0.5	0.8	1.0	0.7	1.0	0.5
MT	0.7	0.7	1.1	0.9	0.8	0.6	0.6	0.5
EU27	3.0	2.8	3.0	3.0	3.0	3.0	2.9	2.4
EU15	2.8	2.5	2.6	2.7	2.9	2.9	2.8	2.5
NM12	3.7	4.1	4.0	3.9	3.7	3.5	3.1	2.3

Source: Economix

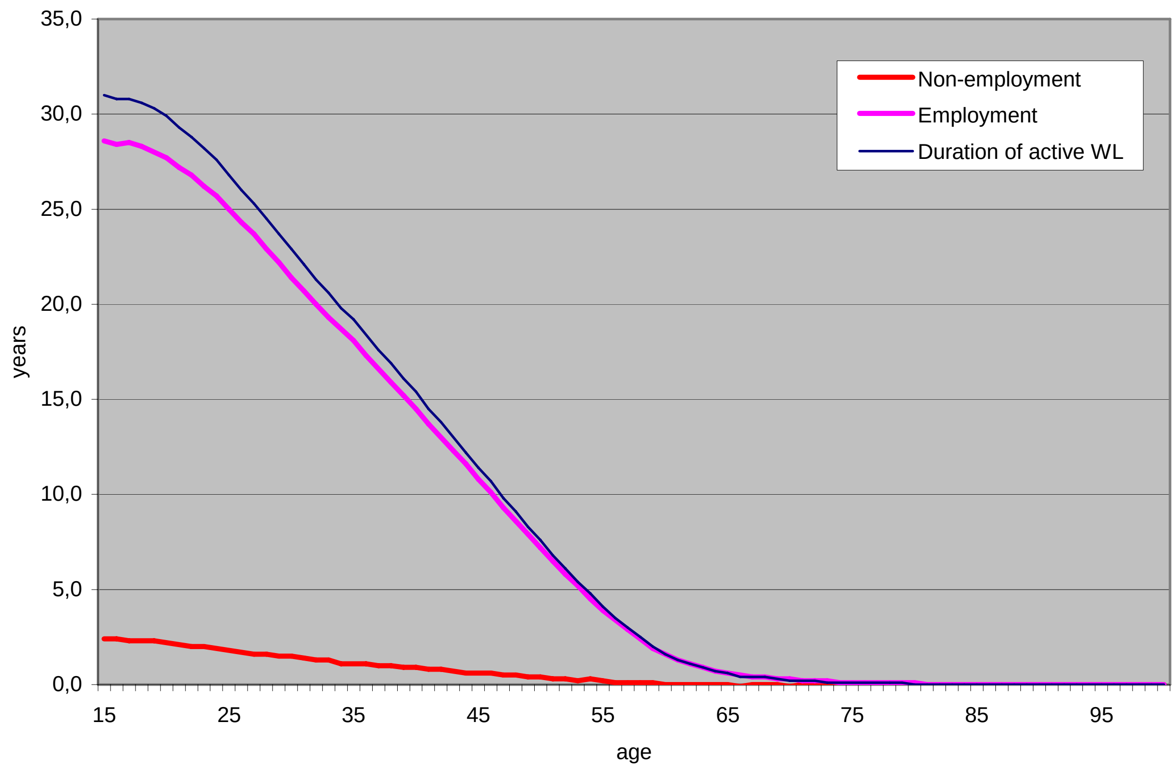
Chart 14 Duration of employment and non-employment 2007 – EU27

Life expectancy for ages between 15 and 100 years old

Males



Females



Source: Economix

5.5. Duration of working time

In 2007 the average EU27 person aged 15 was expected to spend 61,295 working hours during his/her lifetime (Table 22). For a person aged 45 the future working time was 23,938 hours, and for 65 year olds it was 1,190 hours.

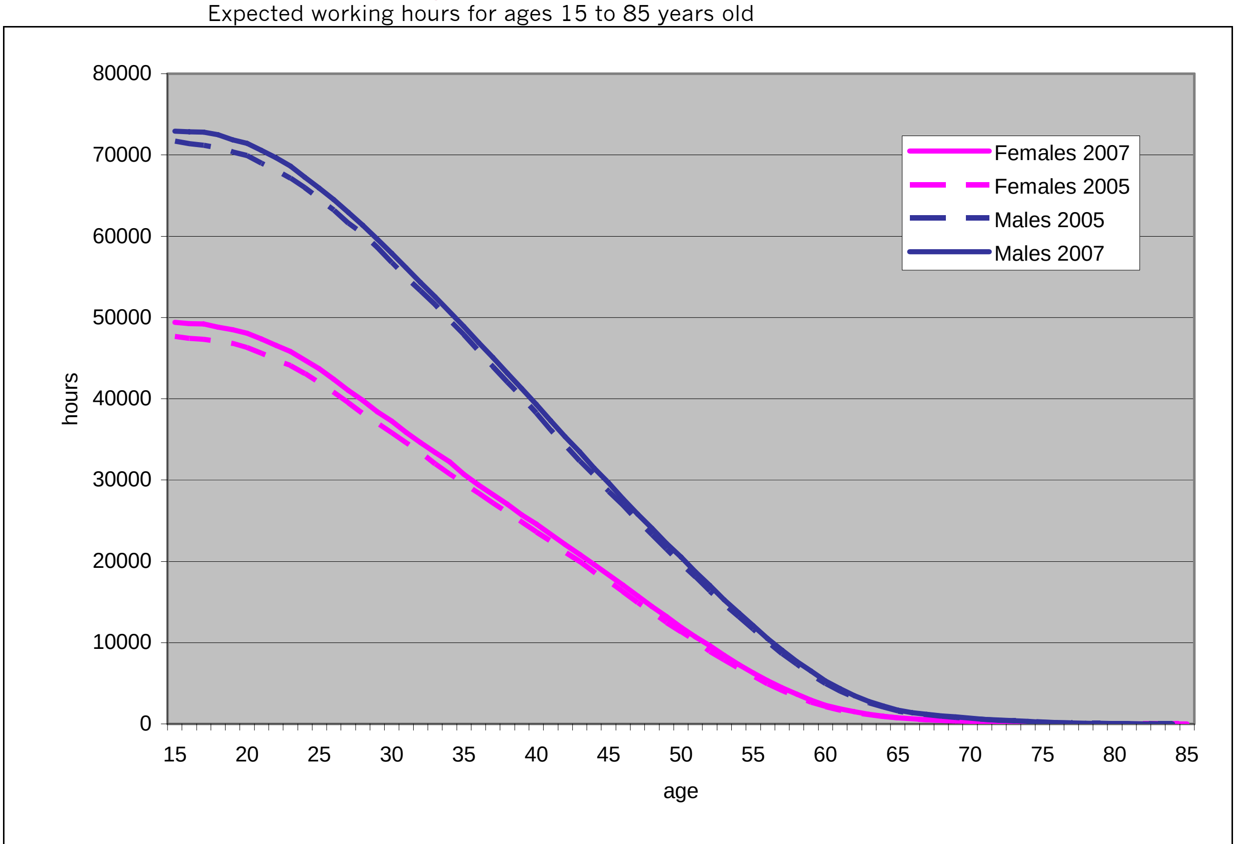
For males aged 15 the duration of working time was 72,903 hours and 49,388 hours for females. Males' future working hours thus were 50% above the level of females. At the age of 45 the difference was 63%. Older men at the age of 65 could expect more than twice the working hours of women at the same age.

Between 2005 and 2007 the average duration of working time increased by 1,420 hours (+2.4 %). The rise can be observed for all ages and for both genders (Chart 15). For males the increase was 1,199 hours (+1.7%), and for females 1,708 hours (+3.6 %). Among women the 45 year olds had a strong increase (+4.4%), while among men the highest figure was measured for the 65 years olds (+7.4%).

The countries with the longest duration of working time are Cyprus, Latvia, and Estonia. They range around 70,000 hours (Table 23). The shortest duration is measured in Italy, Hungary and Malta with approximately 55,000 hours per year.

The strongest increase of the duration of working time appears in the Baltic States and other New Member States. It is close to zero in Ireland, the United Kingdom, Greece and Hungary, and it has declined slightly in Luxembourg and Romania.

Chart 15 Duration of working time – EU27
Expected working hours for ages 15 to 85 years old



Source: Economix

Table 22 Duration of working time – EU 27

Expected working hours per person

	2005	2006	2007
Males and females			
aged 15	59,875	60,320	61,295
aged 45	23,036	23,368	23,938
aged 65	1,124	1,130	1,190
Males			
aged 15	71,705	71,853	72,903
aged 45	28,603	29,009	29,668
aged 65	1,574	1,613	1,691
Females			
aged 15	47,680	48,385	49,388
aged 45	17,546	17,842	18,320
aged 65	728	710	748

Source: Economix

Table 23 Duration of working time by country

Expected working hours per person aged 15, countries sorted according to 2007 values

	2005	2006	2007
CY	68,665	69,738	70,687
LV	66,036	68,973	69,833
EE	65,726	69,258	69,693
SE	66,353	67,141	68,854
CZ	67,451	67,795	68,740
DK	66,715	67,735	68,074
AT	65,890	67,120	67,839
PT	67,574	67,779	67,305
SI	65,552	65,174	66,622
UK	65,334	65,486	65,550
FI	63,499	64,395	65,308
IE	64,429	64,802	64,830
BG	56,391	59,948	63,314
DE	60,934	61,015	62,604
GR	61,971	62,416	62,169
RO	60,743	61,136	61,772
LT	58,628	59,849	61,611
ES	59,345	60,709	61,064
NL	57,758	59,105	60,432
SK	57,966	58,298	59,905
FR	57,509	57,600	58,825
LU	57,476	57,349	57,357
PL	53,192	54,806	57,275
BE	54,773	55,224	56,877
MT	55,227	54,169	56,098
HU	55,456	55,780	55,603
IT	53,505	54,168	54,450
EU27	59,875	60,320	61,295
EU15	60,262	60,749	61,451
NM12	58,617	59,051	60,845

Source: Economix

5.6. Duration of non-working time

For the purpose of comprehensiveness the duration of non-working time was calculated according to the working time. Starting from the life expectancy of the population, the lifetime expectancy was calculated by using a 24 hour day and a standard year with 8,760 hours. From this lifetime expectancy, the working time expectancy was subtracted to receive the non-working time expectancy.

Table 24 Duration of non-working time – EU 27
Expected non-working hours per person

	2005	2006	2007
Males and females			
aged 15	516,530	518,726	518,890
aged 45	300,451	303,262	304,588
aged 65	173,595	175,991	176,991
Males			
aged 15	477,240	479,820	480,321
aged 45	270,510	273,776	275,569
aged 65	155,415	158,226	159,496
Females			
aged 15	555,350	557,022	557,079
aged 45	328,765	331,232	332,170
aged 65	188,714	190,955	191,691

Source: Economix

As Table 24 reveals, the sum of 518,890 hours could be expected in 2007 by the average 15 year old EU27 citizen as non-working time during his/her lifetime. For males the sum was 480,321 hours and for females 557,079 hours. Of course these “non-working” times include all unpaid activities like housework, childcare, voluntary work, education and training etc. Moreover, sleeping hours are included. The working hours represent economic activities only.

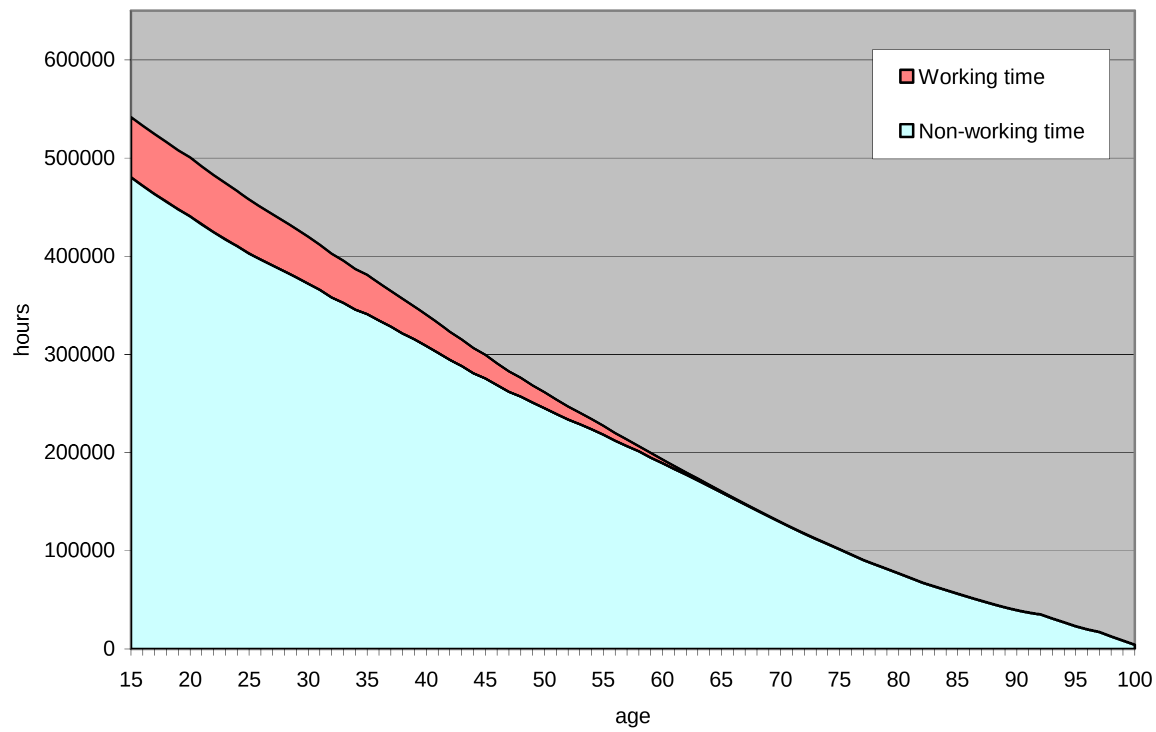
The result nevertheless indicates that for the average EU27 citizen a relatively small share of the overall time capacities of life are used for economic activities (Chart 16). At the age of 15, males expect to use 13.2% of their total lifetime at work. Females use 8.1%. On average 10.6% of the EU27 population are dedicated to work at that age.

The shares continuously decrease with age. At 45 years of age 7.3% of the future lifetime will be used for work, yet at the age of 65 this will only be 0.7%.

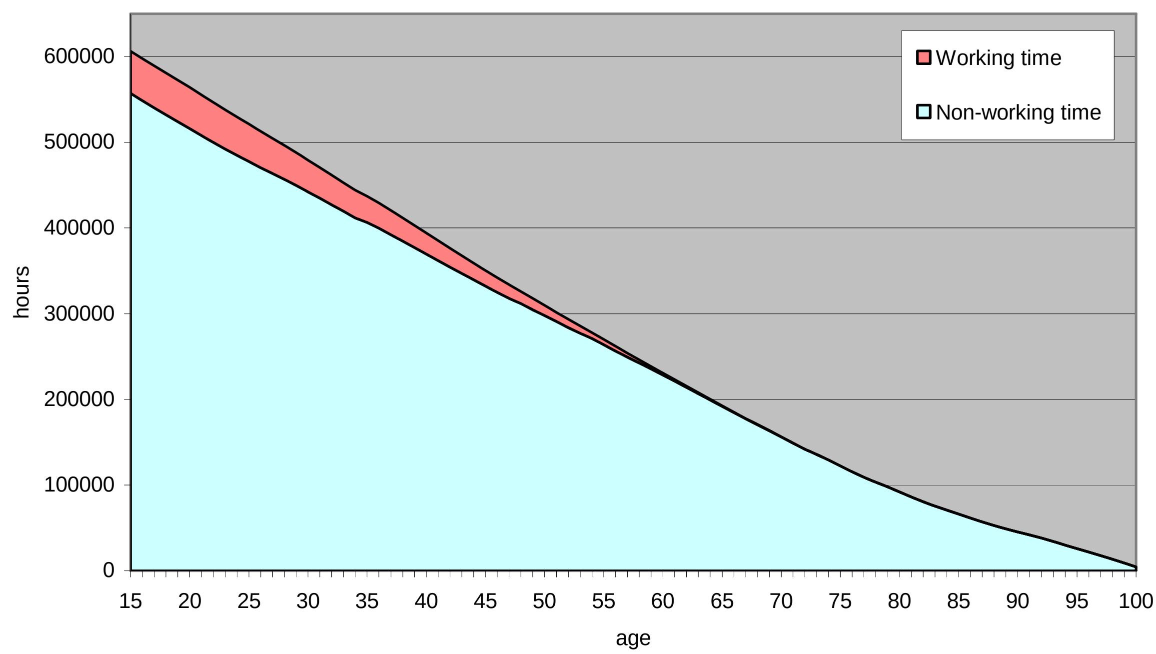
Chart 16 **Duration of working and non-working time 2007**

EU27; expected working and non-working time for ages 15 to 100 years old

Males



Females



Source: Economix

6. Assessment of the duration of working life indicators

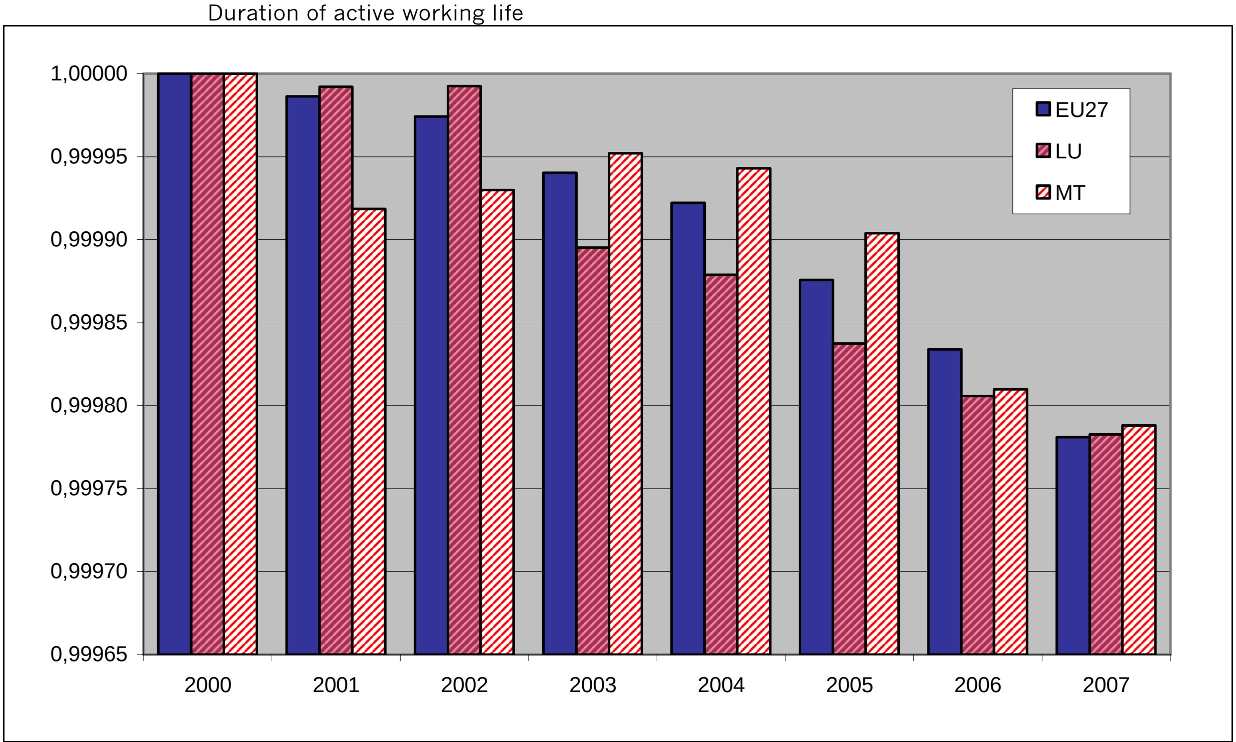
6.1. Stability and sensitivity to changes of time allocation

As the previous presentation of results revealed, the DWL indicators are extremely robust over the years of observation. The correlation of age vectors over the period 2000-2007 shows that all correlation coefficients between two years are almost identical to 1.0. Even for small countries like Luxembourg or Malta the correlation is extremely high (Chart 17). The correlation decreases with the time distance between the two age vectors. Nevertheless, it deviates from 1 only at the 10^{-4} position.

The DWL indicators are able to absorb fluctuations of the input data to an extraordinary extent. This is due to the fact that changes in activity rates are summed up by a weighted average over the age span of 15 to 100 years old. It does not react to statistical errors as long as they average zero over the total age vector. Moreover, it reacts only moderately to shifts of activity rates between single ages. For example the shift of the baby pause which can be observed in women's activity rates affects the average DWL only as long as the weights from the survival function are different. This, however, can be compensated by adequate changes of the activity rates at younger ages. Similar absorbing effects can be expected for the change of retirement age.

This, however, means that the sensitivity of the indicators to changes in time allocation of activities remains limited. They can be used to show the overall effects of all changes in time allocation rather than for the analysis of specific reasons. This runs parallel to life expectancy data which also do not show the reasons for change of mortality rates. The analysis of the DWL indicators therefore requires one to address the changes of input data, life tables, activity rates, and working hours.

Chart 17 Correlation of age vector 2000 with age vectors 2001-2007
Duration of active working life



Source: Economix

6.2. Accuracy

The accuracy of the DWL indicators depends on measurement errors for the survival function L_x, activity rates r_x, and optionally on working hours h_x. The following analysis of accuracy concentrates on activity rates and working hours. The survival functions result from specific estimates undertaken by the national statistical offices. The error size for this statistic is not published.

The DWL indicators react proportional to uniform changes of the activity rates. A general decrease or increase of activity rates by 10% shifts the indicator by 10%. This follows in formula 38:

(38) $$d_x^a = \frac{\sum L_x \, r_x \, (1+\delta)}{l_x} = (1+\delta) \frac{\sum L_x \, r_x}{l_x}$$

$(1+\delta)$ constant relative error

Changes in activity rates during the business cycle therefore affect the DWL indicators proportionally – at least if all ages are affected to the same extent. This is also valid for cyclical changes of working hours.

Random errors in activity rates, however, are not directly proportional as they are compensated within the age vectors. The simulation of a random error of ±10% for activity rates results in an average standard deviation of 1.6% between the unmodified and the biased DWL. This is the average deviation for 27 countries over the 8 years of observation. It means that measurement errors for activity rates are compensated in the calculation of the DWL by a factor of 1/6.

The duration of working time indicator is additionally affected by errors in the estimation of working hours. Assuming an additional random error of 10% for working hours, the average standard deviation of initial and biased indicators rises to 2.1%. This is due to the fact that errors among activity rates and working hours are multiplied.

Finally, systematic measurement errors within the age vector depend on the weighting which is given by the survival function L_x. The example calculated to demonstrate this effect assumed:

- the overestimation of activity rates by 10% for the ages between 15 and 40 years old
- the underestimation of activity rates by 10% for ages between 41 and 100 years old

This results in an average standard deviation between observed and biased values for 27 countries and 8 years is 0.6%. A similar effect can be observed when the shift of activity rates is reversed towards older ages. The compensation mechanism for this type of systematic measurement errors therefore appears to be weaker than in the case of random errors.

6.3. Age span

Substantial efforts were undertaken in this study to extend the age span of calculations beyond the limit of 75 years old. This was done for theoretical reasons as there is no argument that economic activity must be terminated before death. Moreover, it was done for empirical reasons as the observed activity rates at the age of 75 are still considerably high in some Member States. The study followed one of the recommendations expressed in the exit age study (Economix 2008, p. 53).

While the average effect on the level of DWL indicators remains limited (+1.1%), the effect is much stronger in a small number of countries (Table 25). In Romania and Portugal the extended indicators are 3.8% - 6.9% higher compared to the age limit of 75 years old. In Cyprus, Slovenia and Ireland the effect still ranges between 1.2% and 2.4%. The extension of the age span is therefore able to correct the country rankings.

Table 25 Effects of the extension of age span on working life indicators
Difference of extended age span to shortened DWL indicator in %
Sorted by duration of active working life 2007

	Duration of active working life			Duration of working time	
	2000	2005	2007	2005	2007
RO	6.90	4.35	4.90	3.26	3.34
PT	4.05	3.75	4.14	2.27	2.45
CY	1.80	2.43	1.70	1.38	1.07
SI	1.61	1.62	1.61	1.09	0.99
IE	1.46	1.56	1.22	1.28	1.20
EE	0.79	1.12	1.14	0.69	0.52
AT	0.35	0.48	0.97	0.33	0.53
LV	0.84	0.69	0.86	0.65	0.86
SE	0.70	0.42	0.79	0.31	0.77
PL	0.99	0.95	0.73	0.55	0.40
NL	0.54	0.51	0.72	0.33	0.33
MT	0.92	0.70	0.65	3.47	2.11
UK	0.53	0.77	0.60	0.42	0.38
DK	0.50	0.59	0.55	0.37	0.34
GR	0.50	0.46	0.51	0.43	0.48
LT	0.50	0.28	0.48	0.31	0.35
IT	0.44	0.43	0.42	0.42	0.42
CZ	0.27	0.47	0.40	0.24	0.25
FI	0.23	0.31	0.33	0.28	0.41
BE	0.30	0.32	0.29	0.38	0.41
DE	0.29	0.31	0.29	0.22	0.18
BG	0.40	0.32	0.29	0.24	0.25
ES	0.13	0.20	0.18	0.18	0.15
SK	0.07	0.18	0.12	0.14	0.12
FR	0.09	0.12	0.12	0.10	0.11
HU	0.16	0.12	0.11	0.07	0.08
LU	0.09	0.10	0.10	0.58	0.52

Source: Economix

6.4. Plausibility

The analysis of the DWL indicators in Chapter 5 did not reveal implausible results, at least not at first sight. The indicators:

- are highly stable over time, even for single ages
- show great continuity over the lifespan
- directly react to changes of activity rates and working hours
- reveal the expected differences between gender, age and country

Most importantly, the balances of non-working life indicators have the same positive attitudes as their working life counterparts. This is particularly true for the duration of non-employment.

The country profile of DWL indicators correlates with average levels of activity rates, exit age, and unemployment rates:

- The correlation with activity rates is very high (0.969). This confirms the direct reaction of the duration of active working life to the activity rates.
- The association with exit age – calculated according to the working life approach – is also very high (0.780).
- The comparison of the duration of non-employment indicator with unemployment rates at national level shows a correlation coefficient of 0.706.

These results indicate that the DWL indicators are sufficiently coherent with other data sources, particularly with the indicators of the European Employment Strategy.

6.5. Timeliness

The calculation of the DWL indicators depends on LFS data and life tables. For this exercise data from 2007 was the most updated information available. Life tables do not yet exist at a European level but are provided by the WHO. The data for 2007 is still provisional. Accepting these limitations, the minimum lag of calculations is approximately one year. As this lag affects most of the monitoring indicators of the European Employment Strategy, the DWL indicators can be provided in time.

6.6. Comparability and coherence

The use of a uniform approach and of LFS data is the basis for calculating and comparable indicators across ages, gender and countries.

The methodology avoided using different sources as this would have generated additional problems. Populations, sampling structures and weighting methods usually vary between alternative surveys. Definitions of variables are not used uniformly. The representation of countries is often incomplete. This is particularly the case for the alternative statistical sources for working hours. As it was stated in the exit age study there is no alternative to using the LFS (Economix 2008, p. 52).

The LFS database provided a comprehensive and comparable data input for all EU countries and the subgroups of its population. With limited corrections of instable or incomplete values and amendments regarding the age span, a uniform calculation approach could be applied. This provides the optimum of comparability presently achievable at the European level.

This is also valid for the inclusion of working hours. Considerable improvements were achieved regarding the measurement of working hours by the LFS. The continuous surveying of the population throughout the year guarantees the inclusion of all working time components which fluctuate considerably over the year. The calculation of annual working hours – based on the LFS measurement of weekly working hours – thus provides comparable data for all countries, ages and gender with high stability.

6.7. Clarity

Based on the previous assessments of the different attitudes of the DWL indicators, the approach provides accurate and easily understandable results. Similar to the well-known life expectancy concept, the indicators measure the number of future working years or working hours to be expected at a certain age in time. There is no need for additional explanation or understanding of the mathematical formula. This can be seen as one of the great advantages of the indicators.

Uncertainties may arise regarding the ability of indicators to describe the future of individuals regarding their working life. This is not intended by the approach as it would require complex forecasting models for life tables and economic activities. The indicators therefore describe working life expectancies under present physical and economic conditions of the population. This amendment to the definition of the DWL indicators is always necessary.

A second limitation appears because the indicators provide expectations for the population rather than its subgroups of active persons, persons employed and others. It would be an interesting but nevertheless extensive continuation of the work to calculate DWL indicators for such subgroups. This would require data on various transition probabilities between employment and unemployment (e.g. activity and non-activity). Moreover, specific survival functions are required for the subgroups. Such calculations are beyond the task of this study. Nevertheless, the approach has the potential to be used for calculations which separate manual and non-manual workers, different levels of formal education and other groups of the European population.

6.8. Use of DWL indicators for policy monitoring and research

Being a measure for the expected length of working life, DWL indicators provide information on the population's activity from a life cycle perspective. They can therefore be used to monitor labour market behaviour of the population from a longitudinal view. The indicators supply expected variables which can be used to explain current decisions concerning work participation, education, lifelong learning and retirement. Moreover, they can be used to analyse various age-related effects of employment policies, working time policies, social security regulations, and education and training systems.

The DWL indicators deliver information on the expected length of working life over the complete life cycle. Different phases of working life can thus be observed by regarding the expected DWL at different ages. The DWL indicators can describe changes over periods of time and differences between countries and gender. It reflects labour market decisions of the population over the whole life cycle, including both life expectancy and labour market participation. As long as expectations are adaptive the DWL indicators can be used as an indication of what the population expects for its working life. In comparison to the average age of persons employed, the DWL indicators measure the expected time worked in a lifetime at any age, and the indicators are independent from the current age structure of the population.

The DWL indicators are useful for monitoring age effects of employment policies. Furthermore, the indicators reflect the effects of all age-related policies rather than single programmes, and they measure the response of the population rather than the direct impact of policies. This is due to the fact that different policy programmes might have a compensating effect - for example, if the retirement age was raised and education periods were prolonged at the same time. The effects of policies become visible when comparing the DWL indicators for different years with and without the policy measures of interest. Simulations can show the potential effects of policy measures. Moreover, the impact of policies on different countries or specific person groups can also be revealed.

With the indicator for the duration of working time (based on annual working hours) monitoring the effects of working time policies is possible. In particular, effects of public regulations and collective agreements on working times on the DWL can be observed. Due to the fact that the annual working hours published by the OECD (Section 4.3.6) are not suitable for international comparisons and do not cover all EU Member States, the presented duration of working time indicator gives a starting point for a differentiated analysis about working times and overall time use in the Member States.

The DWL indicators can also map trends of retirement and thus deliver valuable information for monitoring the impacts of social security systems. The expected length of active working life could be a helpful input for the calculation of the expected financial streams with social protection systems. The development of a long-term perspective for pension and health insurance could be supported. The calculations also provide evidence for the expected duration of non-employment which might help to draw conclusions for unemployment insurance systems.

The DWL can be interpreted as the use of human capital over the lifetime. The data can thus be used to monitor the impact on education and training systems, the expected returns from education and training, and participation behaviour in lifelong learning. Additionally, the DWL indicators may deliver the input for the observation of different educational groups with different education levels. This, however, requires additional data.

Without being complete, this list of applications reveals the potentially broad use of DWL indicators. Moreover, it creates the basis for the extension of life cycle analysis in economic and social research.

7. Recommendations

The assessment of the DWL indicators comes to the conclusion that the life cycle approach provides data which is stable as far as statistical interferences are concerned, comparable across countries, coherent with the monitoring indicators for the EES, and clear as regards the interpretation of outcomes. The results show clear differences among Member States, ages and gender. They react moderately to changes of activity rates and working hours. The analysis did not detect any oddities which demand further explanation. From this point of view it is recommended to use these indicators for the description of the DWL in the European Union and its Member States.

Out of the six indicators defined for measurement the duration of active working life receives a dominating position, as this indicator describes the labour force in total. It covers the time period from 2000 to 2007, describes the duration of active working life for all countries, ages and gender. The other indicators can be used for additional information on the duration of employment, non-employment, and the measurement of working time. As working time information is only available from 2005, the indicator will have to be observed in future as regards the variance of average actual working hours. The time-based indicator nevertheless provides useful information on time use.

The stability of the indicators also has to be addressed to the extensive preparatory work which was done for this study. The reduction of irregularities in the data was the basis for covering all 27 EU Member States with a uniform approach. The extension of the age span to the maximum age of 100 years old was required to avoid a bias of the indicators in country rankings. Both steps were solved by an age-based estimator for activity rates, separated by countries and gender. Even if this requires substantial efforts, future applications of indicators will need this preparatory work in order to achieve accurate and unbiased data.

The stability of the indicators, however, set boundaries for the use of the indicators. It appears to be useful for the description and analysis of long-term behavioural and institutional conditions in national employment systems rather than the observation of short-term changes. For the latter purpose, periodic data on employment, activity rates, working hours etc. should be used, while the DWL indicators provide weighted averages of the probabilities to be active over the whole lifetime. The essential differences of the DWL indicators among countries, ages and gender will therefore remain the same over long periods.

The calculation of indicators depends on the availability of life tables for all EU Member States. The use of WHO data is not more than an interim solution for demonstration purposes. As soon as European life tables are available, they should be integrated into the calculation system.

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Annex

Table A 1 Estimation of activity rates 2000-2007

Country	Gender	Age interval	Explanatory variables					Adjusted R^2	F Statistic	Standard deviation between original and estimated activity rate	Adjusted R^2 of cohort and age effect-regressions	Un-explained deviation
				Intercept	Year	Age	Age_2					
Belgium	Female	52+	Coefficient	-68.080	0.053	-1.062	0.006	0.922	702.156	4.5	0.487	2.31
			T Value	-1.966	3.123	-8.885	6.661					
Bulgaria	Female	45+	Coefficient	-102.960	0.058	-0.252		0.938	1852.107	7.5	0.897	0.77
			T Value	-3.185	3.609	-60.770						
Cyprus	Male	45+	Coefficient	12.483		-0.196		0.916	2696.770	6.3	0.427	3.61
			T Value	54.655		-51.930						
	Female	45+	Coefficient	9.164		-0.169		0.926	2951.164	6.5	0.34	4.29
			T Value	48.952		-54.325						
	All	45+	Coefficient	-46.457	0.028	-0.161		0.947	2227.590	5.3	0.426	3.04
			T Value	-2.464	2.964	-66.681						
Czech Republic	Male	45+	Coefficient	-57.879	0.036	-0.248		0.952	2459.319	7.4	0.912	0.65
			T Value	-2.089	2.627	-70.084						
Denmark	Male	45+	Coefficient	-59.566	0.036	-0.219		0.898	1051.141	9.3	0.739	2.43
			T Value	-1.582	1.937	-45.824						
	Female	45+	Coefficient	13.68		-0.24		0.894	1921.817	11.1	0.831	1.88
			T Value	42.39		-43.84						
Estonia	Male	45+	Coefficient	10.762		-0.176		0.868	1547.070	9.4	0.076	8.69
			T Value	40.088		-39.333						
	Female	45+	Coefficient	-141.716	0.077	-0.209		0.915	1268.784	7	0.182	5.73
			T Value	-4.541	4.938	-50.235						
	All	45+	Coefficient	-109.814	0.061	-0.194		0.934	1683.913	6.2	0.211	4.89
			T Value	-4.314	4.772	-57.845						
Finland	Male	45+	Coefficient	-68.325	0.037		-0.002	0.955	2517.096	5.5	0.860	0.77
			T Value	-2.789	3.064		-70.886					
	Female	50+	Coefficient	-147.038	0.078		-0.003	0.934	1380.858	5.4	0.751	1.34
			T Value	-3.762	3.996		-52.503					
	All	45+	Coefficient	-104.325	0.053	0.209	-0.004	0.957	1759.685	5.2	0.763	1.23
			T Value	-3.942	3.992	3.883	-8.570					
Greece	Male	45+	Coefficient	14.28		-0.24		0.987	19320.89	3.1	0.603	1.23
			T Value	138.37		-139.00						

Hungary	Male	45+	Coefficient	-70.514	0.042	-0.230		0.951	2299.815	7.7	0.892	0.83
			T Value	-2.739	3.235	-67.743						
	Female	45+	Coefficient	-106.218	0.060	-0.262		0.948	2189.118	7.8	0.906	0.73
			T Value	-3.532	3.995	-66.048						
	All	45+	Coefficient	-87.021	0.050	-0.244		0.961	2974.988	6.7	0.926	0.50
			T Value	-3.631	4.182	-77.023						
Ireland	Male	45+	Coefficient	-28.320	0.019	-0.173		0.967	3606.03	4.3	0.78	0.95
			T Value	-1.774	2.446	-84.889						
	All	45+	Coefficient	-76.060	0.042	-0.154		0.953	2500.77	5	0.884	0.58
			T Value	-4.460	4.976	-70.546						
Lithuania	Male	45+	Coefficient	12.249764		-0.205		0.877	1714.32	9.8	0.664	3.29
			T Value	41.106654		-41.404						
	Female	45+	Coefficient	13.625		-0.237		0.909	2339.43	8.6	0.625	3.23
			T Value	46.322		-48.368						
Luxembourg	Male	45+	Coefficient	18.043		-0.315		0.931	2787.276	6.3	0.573	2.67
			T Value	51.796		-52.795						
	Female	45+	Coefficient	-127.835	0.062	0.320	-0.005	0.909	620.616	5.9	0.559	2.60
			T Value	-3.931	3.800	3.974	-6.701					
	All	45+	Coefficient	1.928		0.167	-0.004	0.928	1388.529	7.1	0.771	1.63
			T Value	0.868		2.181	-5.690					
Latvia	Male	45+	Coefficient	-184.242	0.092	0.194	-0.003	0.898	702.168	7.9	0.237	6.03
			T Value	-6.142	6.142	3.225	-6.183					
	Female	45+	Coefficient	-163.723	0.085		-0.002	0.918	1335.772	7.3	0.447	4.04
			T Value	-5.641	5.837		-51.248					
	All	45+	Coefficient	-171.786	0.087	0.093	-0.002	0.946	1408.521	5.7	0.473	3.00
			T Value	-7.743	7.874	2.089	-6.288					
Malta	Male	45+	Coefficient	14.882		-0.255		0.879	1640.901	10.6	0.796	2.16
			T Value	39.628		-40.508						
	Female	45+	Coefficient	-53.759	0.028	-0.037	-0.001	0.814	499.864	9	0.419	5.23
			T Value	-1.992	2.066	-2.159	-3.313					
	All	45+	Coefficient	4.429			-0.002	0.870	1523.463	9.3	0.750	2.33
			T Value	28.289			-39.032					
Netherlands	Male	45+	Coefficient	-139.297	0.077	-0.239		0.937	1824.181	6.5	0.786	1.39
			T Value	-4.508	4.971	-60.204						
	Female	45+	Coefficient	-160.768	0.080	0.186	-0.003	0.938	1198.226	4.2	0.766	0.98
			T Value	-5.587	5.612	3.271	-7.237					

Poland	Male	45+	Coefficient	38.133	-0.013	-0.288	0.001	0.976	3283.617	3.6	0.445	2.00
			T Value	2.892	-1.903	-11.375	4.802					
	All	45+	Coefficient	66.463	-0.025	-0.379	0.002	0.985	5468.995	2.8	0.46	1.51
			T Value	6.270	-4.811	-18.598	10.146					
Portugal	Male	45+	Coefficient	15.688		-0.355	0.002	0.974	4558.002	3.6	0.272	2.62
			T Value	22.107		-14.792	8.495					
	Female	45+	Coefficient	-52.177	0.028		-0.001	0.966	3479.801	3.5	0.268	2.56
			T Value	-4.579	4.876		-83.282					
	All	45+	Coefficient	-18.723	0.014	-0.191	0.001	0.980	4075.816	3	0.373	1.88
			T Value	-2.046	3.103	-10.838	3.509					
Romania*	Male	45+	Coefficient	17.597		-0.464	0.003	0.872	615.311	4.8	0.472	2.53
			T Value	10.602		-8.228	5.976					
	Female	45+	Coefficient	5.098		-0.092		0.890	1463.669	5.9	0.748	1.49
			T Value	35.040		-38.258						
	All	45+	Coefficient	6.442		-0.111		0.800	725.204	5.6	0.772	1.28
			T Value	25.893		-26.930						
Slovenia	Male	45+	Coefficient	-44.263	-0.187	0.028		0.916	1352.626	7.7	0.671	2.53
			T Value	-1.575	-51.975	1.964						
	Female	45+	Coefficient	-109.242	0.059	-0.183		0.874	861.442	8.8	0.824	1.55
			T Value	-3.155	3.442	-41.365						
	All	45+	Coefficient	-77.506	0.044	-0.184		0.925	1516.141	6.8	0.758	1.65
			T Value	-2.960	3.357	-54.964						
Slovakia	Male	45+	Coefficient	-81.265	0.049	-0.299		0.919	1365.842	10.5	0.903	1.02
			T Value	-1.861	2.253	-52.261						
	Female	45+	Coefficient	-136.310	0.083	-0.731	0.004	0.944	1242.509	8.2	0.917	0.68
			T Value	-3.646	4.450	-9.260	5.272					
Sweden	Male	45+	Coefficient	-7.976		0.498	-0.006	0.934	1703.464	6.9	0.749	1.73
			T Value	-5.036		9.222	-12.938					
	Female	45+	Coefficient	-17.317		0.837	-0.009	0.945	2012.829	5.5	0.862	0.76
			T Value	-10.124		14.298	-18.300					
	All	45+	Coefficient	-11.331		0.617	-0.007	0.950	2294.600	6	0.891	0.65
			T Value	-7.795		12.435	-16.725					
United Kingdom	Male	45+	Coefficient	-84.936	0.041	0.332	-0.004	0.980	4123.351	3.2	0.741	0.83
			T Value	-5.806	5.585	11.816	-19.126					

* Estimations of Romania could not be used for extrapolation of activity rates as they underestimated the original activity rates too much (about 10%) in higher ages.

Source: Economix

Table A 2 Extrapolation and substitution of missing values of activity rates

EU27, 2000-2007

Country	Extrapolation from ages 76 to 100 by:			Substitution of missing values by:		
	All	Female	Male	All	Female	Male
AT	Calculation	Calculation	Calculation	/	Mean	/
BE	Calculation	Calculation	Calculation	Mean	Estimation	Mean
BG	Calculation	Calculation	Calculation	/	Mean	Mean
CY	Estimation	Estimation	Estimation	/	Estimation	/
CZ	Calculation	Calculation	Estimation	/	Mean	Mean
DE	Calculation	Calculation	Calculation	/	/	/
DK	Calculation	Estimation	Calculation	Mean	Estimation	Mean
EE	Estimation started at age 45	Estimation started at age 45	Estimation started at age 45	Age 15: Mean	Age 15: Mean	Age 15, 16: Mean
ES	Calculation	Calculation	Calculation	Age 15: Estimation#	Age 15: Estimation# Others: Mean	Age 15: Estimation#
FI	Calculation	Calculation	Calculation	Estimation	Estimation	Estimation
FR	Calculation	Calculation	Calculation	Mean	Mean	Mean
GR	Calculation	Calculation	Estimation	/	Mean	/
HU	Calculation	Calculation	Calculation	Age 15: Mean Others: Estimation	Age 15: Mean Others: Estimation	Age 15: Mean Others: Estimation
IE	Estimation	Calculation	Estimation	/	/	/
IT	Calculation	Calculation	Calculation	/	/	/
LT**	Calculation	Calculation	Estimation	Mean	Estimation	Mean
LU	Estimation	Estimation started at age 45	Estimation	Age 15: Mean Others: Estimation	Age 15: Mean Others: Estimation	Age 15: Mean Others: Estimation
LV	Estimation	Estimation	Estimation from age 45	Age 15,16: Mean Others: Estimation	Estimation	/
MT	Estimation	Estimation started at age 45	Estimation	Age 15: Mean Others: Estimation	Age 15: Mean	Age 15: Mean Others: Estimation
NL	Calculation	Calculation	Estimation	Mean	Estimation	Estimation
PL	Estimation	Calculation	Estimation	/	/	/
PT	Estimation	Estimation	Estimation	/	/	/
RO***	Calculation started at age 74	Calculation started at age 74	Calculation started at age 74	/	/	/
SE	Estimation started at age 74	Calculation started at age 74	Estimation started at age 74	Estimation	Calculation	Age 15: Mean Others: Estimation
SL**	Estimation	Estimation	Estimation	/	/	/
SK	Calculation	Estimation	Calculation	Mean	Age 15: Mean Others: Estimation	Age 15: Mean Others: Estimation
UK	Calculation	Calculation	Estimation	Age 15: Calculation#	Age 15: Calculation#	Age 15: Calculation#

* The extrapolation procedure *Calculation* is according to equation 33 in Section 4.2.7. The *Estimation* procedure is explained in Section 4.2.5.

** Due to massive irregularities in higher ages, original activity rates were inserted by the average activity rate over the available years 2000-2007 (without the outliner) In LT this was the case in: year 2000; All, aged 71,75; Female, aged 71,75; Male, aged 70, 71, 74, 75; in SL: year 2002, Male, aged 75.

*** RO: Calculations only for years 2002-2007. 2000-01 lack comparability due to significant changes of definitions.

\# More information about *Estimation* and *Calculation* of activity rates aged 15 is given in Section 4.2.4.

Source: Economix

Table A 3 Regressions of actual working hours – first job
EU27, 2005-2007

Country	Gender		Explanatory variables		Adjusted R^2	N
			Intercept	Lag_hours		
AT	All	Coefficient	-3.941	1.090	0.829	95
		T Value	-2.088	21.491		
BE	All	Coefficient	10.803	0.698	0.565	95
		T Value	4.914	11.149		
BG	All	Coefficient	14.583	0.645	0.755	95
		T Value	9.717	17.134		
CY	All	Coefficient	5.399	0.856	0.814	95
		T Value	3.398	20.414		
CZ	All	Coefficient	1.696	0.953	0.971	95
		T Value	2.553	56.504		
DE	All	Coefficient	-0.817	1.010	0.970	95
		T Value	-1.294	55.367		
DK	All	Coefficient	0.508	0.980	0.962	95
		T Value	0.769	49.321		
EE	All	Coefficient	10.911	0.718	0.749	95
		T Value	6.664	16.878		
ES	All	Coefficient	2.272	0.936	0.865	95
		T Value	1.596	24.670		
FI	All	Coefficient	0.632	0.974	0.878	95
		T Value	0.486	26.155		
FR	All	Coefficient	10.665	0.702	0.538	95
		T Value	4.505	10.572		
GR	All	Coefficient	7.968	0.796	0.675	95
		T Value	3.423	14.094		
HU	All	Coefficient	6.699	0.824	0.832	95
		T Value	4.611	21.693		
IE	All	Coefficient	0.039	0.991	0.927	95
		T Value	0.038	34.748		
IT	All	Coefficient	8.872	0.760	0.548	95
		T Value	3.335	10.769		
LT	All	Coefficient	13.497	0.641	0.474	95
		T Value	5.315	9.302		
LU	All	Coefficient	6.882	0.815	0.148	92
		T Value	0.898	4.121		
LV	All	Coefficient	8.326	0.783	0.650	95
		T Value	3.532	13.317		
MT	All	Coefficient	22.466	0.384	0.204	94
		T Value	7.754	5.005		
NL	All	Coefficient	-0.112	1.003	0.919	95
		T Value	-0.123	32.847		
PL	All	Coefficient	1.450	0.962	0.973	95
		T Value	2.368	58.308		
PT	All	Coefficient	-0.674	1.011	0.958	95
		T Value	-0.833	46.770		
RO	All	Coefficient	1.145	0.965	0.940	95
		T Value	1.187	38.577		
SE	All	Coefficient	2.827	0.917	0.909	95
		T Value	2.852	30.816		
SL	All	Coefficient	4.640	0.871	0.892	95
		T Value	3.947	28.020		
SK	All	Coefficient	9.879	0.739	0.680	95
		T Value	4.921	14.258		
UK	All	Coefficient	-0.217	1.006	0.994	95
		T Value	-0.827	129.198		

Source: Economix

Table A 4 Estimation for reasons of absence
EU 27, 2007, Total

Reason		Explanatory Variables				R^2	N
		Intercept	Quarter 1	Quarter 2	Quarter 3		
03. Person worked less than usual due to bad weather	Coefficient	14.601	.024	-1.707	-2.175	.020	855
	T Value	32.146	.039	-2.466	-3.242		
04. Person worked less than usual due to slack work	Coefficient	12.877	.054	-.434	-.341	.001	929
	T Value	30.885	.092	-.726	-.572		
05. Person worked less than usual due to labour dispute	Coefficient	12.204	-1.904	-.492	.743	.017	259
	T Value	15.377	-1.564	-.426	.611		
06. Person worked less than usual due to education or training	Coefficient	13.445	-.993	1.557	-.850	.021	611
	T Value	24.032	-1.266	1.978	-1.027		
07. Person worked less than usual due to variable hours	Coefficient	8.675	.619	.185	-.173	.004	1188
	T Value	33.410	1.684	.504	-.471		
08. Person worked less than usual due to own illness	Coefficient	16.428	1.321	1.460	.611	.008	1046
	T Value	39.924	2.271	2.486	1.039		
09. Person worked less than usual due to maternity or parental leave	Coefficient	14.999	-.165	-.300	.927	.003	436
	T Value	19.408	-.145	-.264	.815		
10. Person worked less than usual due to special leave	Coefficient	11.649	.047	.988	-.549	.008	776
	T Value	26.960	.077	1.614	-.887		
11. Person worked less than usual due to annual Holidays	Coefficient	16.348	-.609	-.733	1.037	.021	1124
	T Value	55.765	-1.463	-1.781	2.563		
12. Person worked less than usual due to bank Holidays	Coefficient	13.307	-3.347	-3.916	-4.382	.217	1226
	T Value	72.420	-12.972	-15.245	-15.938		
13. Person worked less than usual due to start of change in job	Coefficient	17.208	1.332	.396	-.949	.012	551
	T Value	23.557	1.394	.411	-.987		
14. Person worked less than usual due to end of job	Coefficient	17.799	-1.034	-1.377	-1.241	.004	411
	T Value	20.336	-.829	-1.086	-.965		
15. Person worked less than usual due to other reasons	Coefficient	12.259	-.242	-.575	-.459	.001	1050
	T Value	31.816	-.444	-1.053	-.832		

Source: Economix