Thünen-Series of Applied Economic Theory

Thünen-Reihe Angewandter Volkswirtschaftstheorie

Working Paper No. 73

Aging in German Industries and Selected Professions

(Alterung der Erwerbspersonen in Deutschland)

by

Golo Henseke, Pascal Hetze and Thusnelda Tivig

Universität Rostock

Wirtschafts- und Sozialwissenschaftliche Fakultät
Institut für Volkswirtschaftslehre
2007

Aging in German Industries and Selected Professions

Golo Henseke, Pascal Hetze**, Thusnelda Tivig****

Abstract:

Population aging translates into aging of the labor force. However, the impact of the former on the latter is neither straightforward nor uniform over specific groups. The reason is that economic decisions concerning, for example, duration of schooling or labor-market participation of women and those aged 60+ as well as industry-specific requirements on the demand side affect age-specific employment rates and thus the age structure of labor. In this paper we describe and use different measures of aging to obtain a picture of the aging process in selected German industries and professions between 1980 and 2000. Our results reveal pronounced differences in the age structure, timing and dynamics of aging. However, we find that aging is, in general, subject to convergence towards a homogenous age composition: Subgroups that were relatively young in 1980 aged faster, and vice versa.

JEL classification: J21, J11, J01

1 Introduction

German population ages at a high pace. Life expectancy at birth has risen from 68.2 years for men and 75.2 for women in 1975 to 76.2 and 81.8 years in 2005 and is projected to further increase to 83.5-85.4 for men and 88-89.8 for women until 2050[1]. In addition to increasing longevity through declining mortality at older ages, most Western societies are aging because of low fertility, implying decreasing shares of the young in total population.[2] The general shift in age structures towards older ages, as well as the accompanying perspective of shrinking,[3] commonly known as demographic change, pose major problems for social security systems and are believed to threaten, in the long run, innovation and economic growth. In a medium term perspective, political interest in aging focuses on infrastructure planning and labor market effects. Regarding the latter, Börsch-Supan (2003) projected a heavy decline in size and a permanent increase in mean age as well as share of older workers in Germany, even under optimistic assumptions. Fuchs and Söhnlein (2007) show that this drop is tightly connected to ongoing demographic processes.

Labor force aging is a relevant research topic to the extent that age groups (young vs. old) are found or believed to differ in certain economically relevant characteristics, like mobility or productivity. Older workers are, for example, found to be less mobile in terms of job and

* *Corresponding author.* Rostock Center for the Study of Demographic Change and University of Rostock, Institute of Economics, Ulmenstr. 69, 18057 Rostock, golo.henseke@uni-rostock.de.

** Office of the Federal President. pascal.hetze@bpra.bund.de.

*** Rostock Center for the Study of Demographic Change, tivig@rostockerzentrum.de, and University of Rostock, Institute of Economics, tivig@uni-rostock.de.

[1] See the 11th Coordinated population projection of the German Federal Statistical Office.

[2] For an analysis of the aging process as a function of fertility, mortality, and migration see a.o. Preston, Himes and Eggers (1989) as well as Liao (1996) who draws on

[3] Germany's population is shrinking since 2005. However, without immigration, its population would have declined since 1972.

geographically mobility.[4] But they are also less likely to lose their job. However, if they do lose it, the following unemployment period is longer (Frosch 2006, 2007). A higher share of older workers is furthermore believed to put an upward pressure on wage costs and to reduce the overall activity rate (Dixon, 2003). Finally, there is discussion that a possibly outdated knowledge of older workers could dominate the stock of human capital in future and thus reduce innovative capacity.[5]

To assess labor market effects of demographic change it might be worth taking a closer look on shrinking and aging processes of the workforce as compared to overall population. On the one hand, changes in birth rates take some 20 years to affect the age composition of the working-age population (normally persons aged 20-64). Also, entrance of the young into the labor market is delayed if duration of schooling/education increases. On the other hand, being in the labor market is a matter of individual decisions taken under given institutional settings. For example, age-specific labor force participation rates of women vary heavily across times and regions, depending on economic conditions and social norms as reflected, among other things, in availability of institutional child-care and institutional help in old-age care. Finally, leaving the labor market is largely independent from increasing longevity, it is rather a matter of retirement legislation, so far. Obviously, prolonged periods of formal education and a low legal or effective retirement age have opposing effects on labor's age structure. The effect of an increase in female labor force participation is, to the contrary, less clear (see below). All in all, aging and shrinking do not translate one to one from overall population to working-age population. Nevertheless, demographic change does influence the size and age structure of a country's labor force, as several papers show. Morrison (1983), for example, discusses the general impact of population aging on the age composition of U.S. labor force. More recently Fullerton and Toosi (2001) analyzed past and future labor force trends for the U.S.. Both studies conclude that baby-boomer cohorts had the biggest impact on demographic dynamics, but their influence on the workforce would soon diminish as they reach retirement age. Disentangling demographic change from other determinants of the workforce's age structure (and size) thus seems a necessary step in order to better assess labor market effects of demographic change.

Official statistics show that West-German labor force[6] increased by 5.1 million people between 1970 and 1995, out of which 1.64 million were foreigners. Thon and Bach (1998) estimate for the same period a total West-German labor supply[7] increase of 5.5 million, migration adding 3.9 million people and changes in vital rates 2.2 million, while changes in labor participation rates had a negative net effect of minus 0.5 million persons. Interestingly, aging was quite different between men and women. Thus, between the early 1980s and 2000,

[4] Already Spengler (1941) was concerned that declining population growth causes an aging of the labor force with the consequences of declining interoccupational and interregional mobility and less favorable job opportunities for younger worker.

[5] See Johnson and Zimmermann (1993) for an in depth analysis of labor force aging and possible economic effects. Dixon (2003) gives a comprehensive survey of the current literature.

[6] Defined according to the Statistical Office's own concept, not to the International Labor Organisation's workforce definition. For differences see: http://www.destatis.de/jetspeed/portal/cms/Sites/destatis/Internet/EN/press/abisz/ILO-Arbeitsmarktstatistik__e,templateId=renderPrint.psml

[7] For definition see, again, the IAB.

mean age of West German male labor force rose from about 39 to roughly 41 years. Female labor force, to the contrary, was and remained younger, still aged more heavily: Mean age grew from around 37 to approximately 40 years.[8] However, while 90% of male labor force aging is explained by demographic change, only 43% of female labor force aging can be attributed to demography (Prskawetz, et al., 2005). Henseke, Hetze and Tivig (2007) confirm that demographic impacts have been more pronounced for male than female workers. Interestingly, they could find, gender independently, only very minor effects of demography on the development of unemployment. The diversity of aging processes increases further when leaving the aggregate level for the micro level. It then becomes evident that aging on the macro level can even come along with rejuvenation on the micro level.

In this paper we analyze the process of aging in selected German industries and professions by using different measures of aging. There are only a few papers in the literature dealing with related topics. Naegele (2001) draws attention to the fact that general population aging in Germany comes along with rejuvenation of labor on firm level. Brasche and Wieland (2000) report that the age composition of labor varies by industries and firms. When referring to manufacturing they use a similar dataset to ours but compare the situation 1996 with the one prevailing in 1990, and conjecture that the observed diversity is caused by differences in demand and productivity patterns. Thus, big firms (with more than 1000 employees), for example, were able to benefit from early retirement policies and layed off older workers in the 1990s and hence rejuvenated their workforce, while smaller companies did not. Niebuhr and Stiller (2005) compare German regional age-specific labor force data and draw some conclusions about expected regional labor shortage. The Rostock Center presents figures showing profession- and firm-size specific age distributions and concludes that roughly each second employee is robustly between 35 and 49 years old, the share of young workers falling continuously (Tivig and Hetze, 2007). On an international level, Orzechwska-Fischer (2004) performs a comparative study for Japan over the period 1960-2000 and Australia over 1971-2001. She considers 11 industries grouped into primary, secondary and tertiary industries. In 2000, Japanese tertiary industries changed roles with secondary ones that had been youngest in 1960. In Australia, tertiary industries had always been youngest. In Japan grid-bound infrastructure (electricity, gas and water supply: median age 41.1 in 2000) had the youngest employees, closely followed by services (median age 41.8 years in 2001), whereas in Australia wholesale, retail and trade, as well as finance, insurance, property and business were among the industries with lowest median age (34.2 and 38 years, respectively). Orzechwska-Fischer decomposes changes in industry-specific employment rates into demographic and employment effects showing that for most industries the demographic effect tended to be unfavorable, in the sense that an increasing share of older workers in the labor force let *ceteris paribus* to declining employment in these sectors. Aging of the labor force favored employment in primary industries, only. However, for tertiary industries the employment effect acted in the opposite direction.

[8] This is partly the reason why there is not much rejuvenation potential for Germany's labor force left. Current estimations of Germany's hidden labor force reveal that it is largely female and middle to highly educated but offers litte rejuvenation potential (Tivig/Hetze 2007, p.76).

The paper is organized as follows. Section 2 introduces measures of aging. Section 3 applies them to German data. Section 4 discusses the explanatory power of the various measures and Section 5 summarizes and concludes.

2 Measures of Aging

To estimate labor market effects of demographic change it is necessary to first know more about aging of the labor force. One question is which measure to apply, as there are several common measures of population aging. Ultimately, they all rely on fertility, mortality, and migration rates. However, age groups are affected in distinct ways by demographic processes, causing measures of aging to react differently. Using a single measure of aging could be misleading in the sense of under- or overestimating aging of the labor force.

Standard measures of the age structure are the mean and median age, as measures of central tendency, and ratios of age-subgroups. In the following we use three ratio: Ratio 1 is defined as ratio of persons aged under 40 to persons aged 40 and over; Ratio 2 is defined as proportion of persons aged under 30 and Ratio 3 as proportion of persons aged 50 and over, in a given (sub-) group. Mean, median and ratios change over time indicating a population's aging or rejuvenation. Preston, Himes and Eggers (1989) decompose the time derivative of mean age of a population into effects of contemporaneous vital rates (birth rates, death rates, and migration rates). Liao (1996) extends this work to other measures of aging like the median and different measures related to proportions. In this section we rely on this literature and apply it to our question.

Mean Age. In the discrete case, mean age, A, of a population (here the labor force) is given by

$$A = \frac{\sum_{\alpha}^{\omega} n_a \cdot a}{\sum_{\alpha}^{\omega} n_a} = \sum_{\alpha}^{\omega} p_a \cdot a \qquad (1)$$

where a is the age or the middle of an age-group, respectively, n_a is the number of persons living at age a (frequencies) and p_a is the relative frequency of age-group a. The lower bound α is determined by the entrance age into labor, typically a value between 15 and 20, and the upper bound ω by legal or effective retirement age, normally a value between 60 and 64. The precise bounds may thus differ. Mean age is a frequently used measure of aging. It relies on information about the entire age distribution, is easy to calculate and analyze, and is found to be highly correlated with other indictors of age structure (e.g. Preston, Himes and Eggers 1989, p. 692). Disadvantages are its sensitivity to skewness of the population distribution and difficulties brought in by open-ended age intervals (Hobbs, 2004). The latter can be disregarded in the context of labor force analysis. The former, however, may bias results.

Median Age. The median, M, is a second and more robust measure of central tendency for an age distribution (e.g. Hobbs 2004). It divides the population into two halves: 50 percent are younger and 50 percent older than the median. The discrete version is given by

$$\mathrm{M} = \mathrm{I} + \left(\frac{\frac{\mathrm{N}}{2} - \sum_{\alpha}^{\mathrm{I}-1} \mathrm{n_a}}{\mathrm{n_M}} \right) \mathrm{b} \qquad (2)$$

Where I is the lower limit of the class containing the middle (cumulative frequency exceeds 0.5), N is population size, $\sum_{\alpha}^{I-1} n_a$ is the sum of frequencies from α to one class below the one that contains the middle, n_M and b are the frequency and size, respectively, of the class containing the middle element. Hence, to calculate the median it is necessary to identify the age-group that contains the middle element, first.

Ratio 1: Persons aged under 40 to persons aged 40 and over. Ratio 1, *R*(1), represents the age structure on a broad base. Changes in this figure are dominated by changes in the middle of the age distribution because the middle age groups outnumber the rest. It is calculated as

$$R(1) = \frac{\sum_{\alpha}^{39} n_a}{\sum_{40}^{\omega} n_a}. \quad (3)$$

Aging of baby-boomers will be strongly reflected in this measure. Generally, it is of economic interest if people change behavior in the second part of their professional career – like, for instance, change their labor supply, their job-related and regional mobility due to stronger or looser family ties, or their work motivation.

Ratio 2: Proportion of persons aged under 30. The proportion of people under age 30 in a subgroup is sensitive to socio-economic changes at the lower end of the age distribution, like e.g. extended educational periods. But it is as well a lead indicator of demographic change, revealing shortage of young people through low birth rates that will affect future age structure. This measure is termed *R*(2) and defined as:

$$R(2) = \frac{\sum_{\alpha}^{29} n_a}{\sum_{\alpha}^{\omega} n_a} = \sum_{\alpha}^{29} p_a \quad (4)$$

Ratio 3: *Proportion of persons aged 50 and over.* The ratio *R*(3) is defined in analogy to the proportion of persons aged 65 and over - a frequently used measure of aging for total population. It summarizes changes at the upper end of the age distribution, e.g. impact of early retirement schemes or demographic aging through aging of the baby boomers. The measure is calculated as

$$R(3) = \frac{\sum_{50}^{\omega} n_a}{\sum_{\alpha}^{\omega} n_a} = \sum_{50}^{\omega} p_a \quad (5)$$

R(2) and *R*(3) are percentage values when multiplied by 100.

Aging is generally described as shifts in the age distribution over time towards higher ages. Using the five measures defined above, aging takes place if the mean, the median and *R*(3) increase, while *R*(1) and *R*(2) decline. However, as Liao (1996) and Hobbs (2004) demonstrate, these measures might not give a consistent indication of population aging, since they react differently to changes in the age distribution. The mean, for example, is particularly sensitive to changes at the margins, while changes in the median depend mainly on changes in its neighborhood and thus in the middle of the age distribution. Similar conclusions hold true for different ratios.

Changes in measures of aging are the direct result of changes in the underlying age distribution. To capture such changes we differentiate the indicators with respect to time as follows

$$\Delta A = \sum_{\alpha}^{\omega} (p_a^{t+1} - p_a^{t})\, a \quad (6)$$

$$\Delta R(1) = \frac{\sum_{\alpha}^{39} (n_a^{t+1} - n_a^{t})}{\sum_{40}^{\omega} (n_a^{t+1} - n_a^{t})} \quad (7)$$

$$\Delta R(2) = \sum_{\alpha}^{29}(p_a^{t+1} - p_a^t) \quad (8)$$

$$\Delta R(3) = \sum_{50}^{\omega}(p_a^{t+1} - p_a^t) \quad (9)$$

Calculation of changes in the median is not that straightforward because of its non-parametric nature.[9] Changes in M may be caused by changes in either of the following variables: I, the lower limit of the class containing the middle; total population size N; the class n_M which contains the middle item; the age distribution $\sum_{\alpha}^{I-1} n_a$ below the age-group containing the middle item; and finally the frequency n_M of the middle age-group. Under the assumption of one year age groups ($b = 1$) changes in the median are given by.

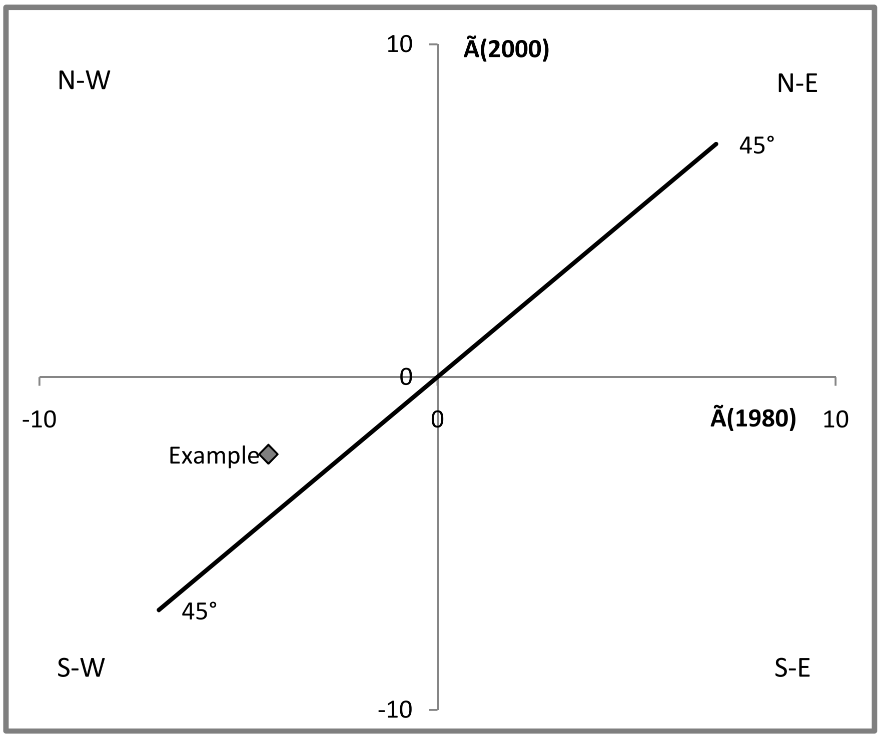
$$\Delta M = I^{t+1} - I^t + 0.5 \cdot \left(\frac{N^{t+1}}{n_M^{t+1}} - \frac{N^t}{n_M^t}\right) + \left(\frac{\sum_{\alpha}^{I^t-1} n_a^t}{n_M^t} - \frac{\sum_{\alpha}^{I^{t+1}-1} n_a^{t+1}}{n_M^{t+1}}\right) \quad (10)$$

Graphical representation

In addition to aging within subgroups of the labor force, we analyze relative aging between subgroups as compared to a reference group (here: employed persons). For the latter we construct a diagram displaying information about the relative 'age-position' of subgroups at two different dates as well as changes in this position in the time between, hence about the speed of relative aging within a period. Take Figure 1 as an example. As measure of the relative age-position of subgroup *i* we define the difference, $\tilde{A}^t = A_i^t - A^t$, between a subgroup's and the reference group's mean age, A_i and A, respectively, whereby values for 1980 are plotted on the abscissa and values for 2000 on the ordinate.

[9] The interpretation of the median is independently of the underlying distribution. It always represents the value which separates the distribution into two halves. The mean on the other hand works best for symmetric distributions. The more skewed a distribution is and/or the more extreme scores it contains the less the mean is appropriate as measure of central tendency.

Figure 1: Example of graphical representation



All data points in the North-East quadrant (N-E) show an age distribution, which is at both times older than the reference group. In the North-West quadrant (N-W) subgroups are plotted that were younger than the reference group in the past, but older at the end of the observation period. In the South-West (S-W) quadrant subgroups were younger at both dates. Finally, a position in the South-East quadrant implies a relative old age structure in the past which has become relatively young over time. Additionally, values below and above the 45°-line give information about relative shifts in the age distribution. All values above the line represent subpopulations that aged faster than the reference group, while values below the 45°-line reveal a relatively slow aging process. The data point in Figure 1, for instance, is located in S-W above the 45°-line. It indicates that the particular subgroup was younger at both dates, but aged faster than the reference population. A movement towards the average has taken place.

3 Aging in Selected Industries and Professions

In this section we apply our previously defined measures of aging to the IAB employment sample to investigate ageing processes in industries and occupations.

Data

Our data is taken from the Employment sample based on administrative social insurance data of the Institute of Employment Research (IAB). We analyze the subgroup of employees, which are all employed persons liable to contributions to the social security system; working students, public officials and self-employed persons are not included in this group. We subsequently use this kernel of the "labor force" as reference population when relative aging of subgroups is analyzed. The data set comprises two percent of the labor force thus defined between 1975 and 2001. It contains information about individual characteristics like gender, education, nationality, wage, profession, industry, tenure etc. over professional careers. The data is drawn from the IAB employee history, supplemented by information on periods of unemployment from the IAB recipient history (Drews, et al. 2006).

We only use information on employed persons aged 18 to 65 years. To analyze population aging we aggregate information on industry and occupational level for four years: 1980, 1990, 1995 and 2000. To reduce the influence of stochastic variations we use three-year aggregates. Thus, data for 1980 are aggregates over 1979-1981, and correspondingly for the other years. The classification of industries is based on two-digit taxonomy of 1973 (WZ73); professions are classified by a scheme of the German Federal Agency of Labor (BA).

Results

Between 1980 and 2000, mean age of the reference group has risen from 37.3 to 39.1, that is by roughly 0.3% per year, on average. Median age increased at approximately the same speed, although absolute values differ. In 1980 it was 38, decreased till 1990 to 36.9 years, and grew again till 2000 to 39.2 years. Ratio 1, indicating the proportion of those under 40 as compared to those aged 40 or over, fell by approximately 0.9% per year, from 1.3 in 1980 to 1.1 in 2000. The proportion of persons younger than 30 declined, too, from 33% to 22%, while Ratio 3 remained almost constant. Thus, for the reference population "labor force", 4 out of 5 measures indicate that aging took place over the considered interval. On lower aggregation levels the picture is more differentiated.

3.1. Industry-specific age structures

There are great differences in the age distribution across industries. Table 1 in the Appendix contains the mean age, median age and the three ratios for the reference group and 32 industries, the latter representing roughly 85% of persons in the data. In 1980, mean age of labor subgroups ranged from 31.8 years in consultancy to 41.4 years in mining and energy. This 10-years variation fell over the observation period to at most 7 years in 2000, when extreme values for mean age were 36.3 years in consultancy and 43.4 in public administration. However, variation over time within industries was much smaller than among industries at one point in time. We found maximum aging in cleaning and hairdressing, where mean age had increased by almost 6 years within the 20 years period, from 32.3 in 1980 to

38.2 in 2000 Consultancy also experienced heavy aging, mean age increasing from 31.8 in 1980 to 36.3 in 2000. In many industries aging was not a uniform process over time, though. For example, in agriculture, mining and energy, chemical, machinery, electrical equipment, mean age *fell* between 1980 and 1990 and increased afterwards. Often, strongest aging is observed between 1990 and 1995, as e.g. in precision and optical instruments, where mean aging increased by 4.2 years, followed even by a decrease of 2.5 years up to 2000. The rather low annual rates of change in mean age may thus be a misleading indicator of the dynamics of aging.

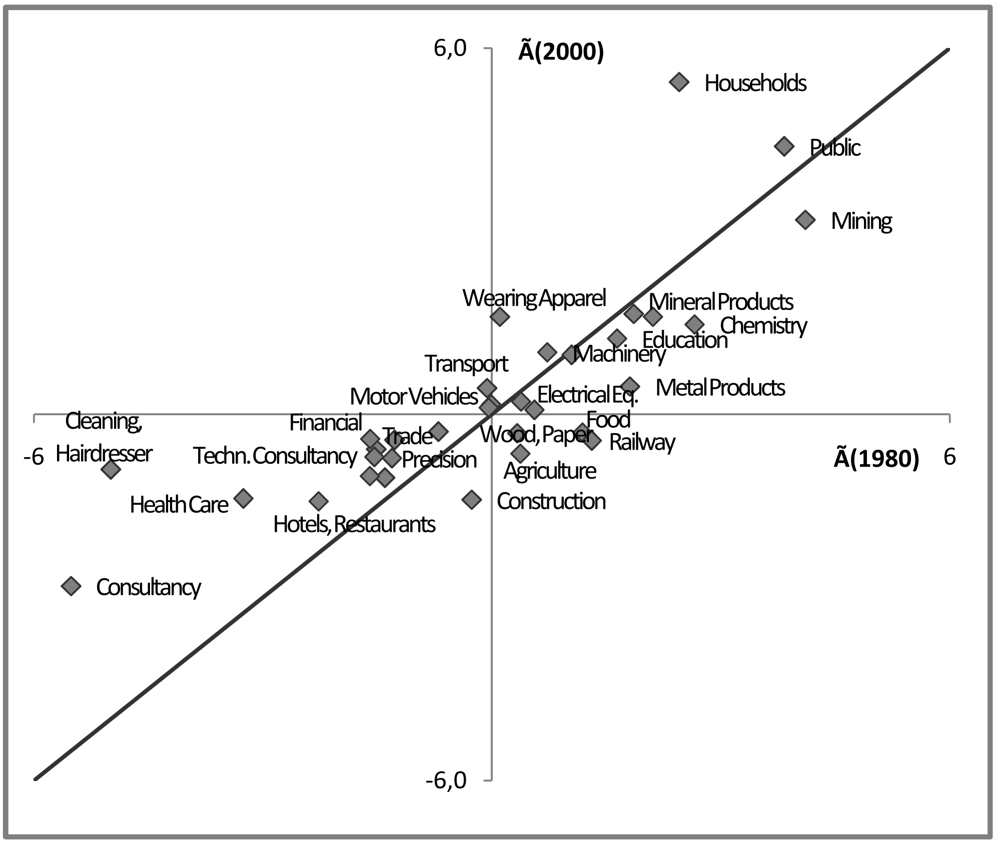
Several factors contribute to differences in the industry-specific (relative) age structures and aging processes. For example, some industries may have unchanged requirements that rather fit the younger (like construction or railway and post) or demand a mix of actual knowledge and experience that is best offered at certain ages (like chemical, metals or education), such that mean age remained almost unchanged at 37-38 and 39-40 years, respectively. In still other branches, mean age might be higher and aging still advancing because the industry is shrinking (Jaffe 1967), like in mining, for instance. However, there exists almost no research on the determinants of age-structure differences between industries.

On closer inspection data in Table 1 also reveal that the main driving force behind shifts in the age structure of the labor force and its subgroups are reductions in Ratio 2 (share of workers aged under 30). Relatively fast aging industries are characterized by a decline in $R(2)$ over the whole period, as opposed to those industries that display a first increasing and then decreasing share of the young. However, strong reductions in Ratio 1 (share of workers under 40 to those aged 40 and over) also significantly contributed to aging. For example, if in consultancy more than 3 employees aged 40 and less worked on average with one aged 40 or over in 1980, twenty years later the ratio was already less than two to one. $R(1)$ decreased in all but five industries. The change is, again, not uniform over the time period 1980-2000. In general, $R(1)$ increased until 1990 and decreased afterwards. It is mainly in those industries that were and stayed relatively young, like trade, transports, consultancy, financial intermediation, and cleaning and hairdressing, that the fall in $R(1)$ was steady, contributing through aging in the middle of the age distribution to what we called ‘fast aging’ above.

The share of older employees, Ratio 3, remained, to the contrary, relatively constant over time; when looking at average annual rates. It was only in construction, precision and optical instruments, cleaning and hairdressing, architectural and engineering activities that it increased considerably, thus contributing to (fast relative) aging in these industries. However, as was the case with the other two ratios, the dynamics of aging as measured by $R(3)$ was, in most cases, far from being uniform over the periods considered. Thus, heavy aging between 1980 and 1990 was followed by rejuvenation in mineral products, wood and paper, wearing and leather, construction and food. In machinery, precision and optical instruments, as well as consultancy, education, transports and trade, aging continued up to 1995. It was only in a few industries like agriculture, financial intermediation, cleaning and hairdressing, hotels and restaurants that $R(3)$ increased throughout.

From the data we can conjecture that formerly old industries, meaning: older than the average in 1980, aged slower than formally younger ones. Interestingly, the fastest aging industries belong to the service sector, which has been the most dynamic one over the last decades.[10] Figure 2 underlines the described development. Industries like mining, chemistry, mineral products, metals and metal products were at both points of time older than the labor force on average, but aged slower. Service-sector industries like health care, consultancy, hotels and restaurants, on the other hand, were younger throughout, but aged faster. Hence, even though 'old' and 'young' industries stayed old and young, respectively, a regression to the mean took place. There are, however, a few exceptions to the observed trend, like the railway and post industry that started with a higher than average mean age and ended up as rejuvenated in relative terms, despite constancy of its mean age. A reason might be the still ongoing restructuring process in this industry. Basic restructuring also took place in the precision and optical instruments industry in the 1990s explaining, perhaps, the outstanding dynamics of aging reflected in all measures of aging.

Figure 2: Relative Aging in Selected Industries, 1980-2000



3.2. Age distributions in selected occupations

Like industries, occupations are characterized by different age structures. Reasons are, for example, differences in physical, knowledge and skill requirements, from which some are set by institutions, job-specific working conditions, other institutional settings like wage policies

[10] In 1980, the service sector accounted for around 57% of value added. Twenty years later it already amounted to 68.5% (StBA, National Accounts 2006).

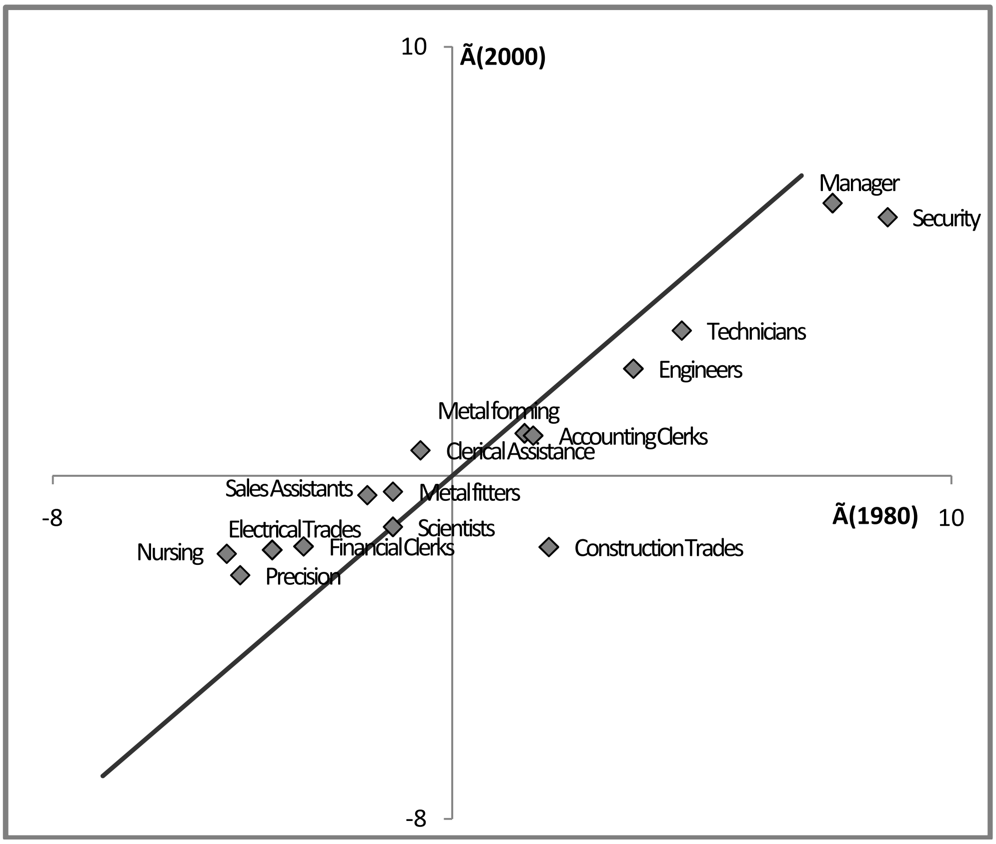
(seniority rules), job linkage due to hierarchal structures and technological change (Kaufman and Spilerman 1982, Hirsch at al. 2000).

For our analysis we selected and compare 15 professions that represent slightly more than 50 percent of the employees in the sample. Our selection gives a first overview of aging processes in a variety of different occupations. The occupations chosen can be roughly grouped into innovators (scientists, engineers and technicians), administrative and secretarial occupations (financial clerks, accounts, clerical assistance) and skilled metal and electrical trades (metal forming, metal fitters, precision instruments, electrical trades). Additionally, we selected managers, sales assistants, nursing assistants, security guards and construction trades as single professions.

All measures of age structure expose a large cross-sectional and longitudinal variety (see Table 2 in the Appendix). Mean age ranged from 32.8 in nursing to 46 years for security guards in 1980. Like for industries, differences decreased over time: In 2000 mean age varied between 36.8 in precision instruments and 45.5 years in management, only. Managers thus changed places with security guards as oldest professions while fastest aging for a single profession was observed in nursing which was youngest in 1980: Mean age of this group grew by around 4.5 years within 20 years, median age by even 8 years and the proportion of young, $R(2)$, decreased with an annual rate of 3.6% on average.. Interestingly, aging was much more uniform within professions than it was within industries. In 7 professions: Scientists, financial clerks, clerical, sales and nursing assistance, precision instruments and electrical trades, aging as measured by at least 3 out of the 5 employed measures took place throughout the periods considered. However, as mentioned before, general aging and rejuvenation on the micro level are not contradictory. Security guards, for example, grew younger over time and construction traders by some measures of aging, too. All in all, it is again $R(2)$ - the proportion of workers under the age of 30 - that is the indicator of aging with the highest dynamics whereas $R(3)$ - the proportion of workers aged 50 and above - exposes the lowest dynamics. We can therefore safely conclude that between 1980 and 2000 aging within professions was mainly driven by changes in the lower or ‘younger’ part of the age distribution.

Figure 3 shows the relative age position and relative aging of professions as compared to the reference group. On the one hand, engineers, technicians, managers and security guard were and remained significantly older throughout the 20 years period as compared to the reference group but aged slower. On the other hand, profession like nursing, precision mechanics and most clerical jobs were and stayed younger, but aged faster than employees on average. Nearly all data points are situated either in the N-E or S-W quadrant, indicating that though aging processes ran at different speeds, ‘young’ professions stayed young and ‘old’ professions stayed old as compared to all employees here considered. The only clear exception are construction trades which were older than the average in 1980 but younger in 2000.

Figure 3: Comparative dynamics of selected occupations, 1980-2000



From an economic point of view, the age distribution of innovators and managers is of particular interest because of the conjectured drop in innovative performance or declining economic performance, in general, due to the growing share of older employees. Inventive tasks differ by the demanded knowledge structure. Typically, successful scientists are supposed to possess new and up to date knowledge, while engineers and even more so, technicians, need experience, too, in order to be highly productive or even successful innovators[11]. The profession-specific age structure we found might be seen as a reflection of this conjecture. Scientists are younger than engineers and engineers are younger than technicians. However, the speed of aging differs: engineers and technicians hardly aged at all, while scientists aged at pace with the workforce.[12] Last not least, managers are an interesting profession when it comes to aging processes. Managers organize inventive and other operational processes for their institution. Though up-to-date knowledge and certain teachable skills are necessary, experience plays a crucial role. Besides knowledge requirements, managing occupation represents the upper end of career ladders implying jointly with seniority a relatively high age of aspirants. This might explain why managers are almost the

---

[11] See for example Levin and Stephan (2004) for a model and empirical evidence of scientific research productivity over the lifecycle. Weinberg (2004) analyses the connection between experience, educational level and technology adoption and Skirbekk (2003) surveys the existing literature on cognitive abilities, human capital and individual productivity.

[12] The explanation for this inconsistency may be found in institutional particularities of the German academic system.

oldest group in our dataset, as judged by all measures of age. Additionally, mean age remained nearly constant at 45 years over the 20 years period.

3.3 Testing Convergence

Our data reveal a process of convergence. That is the age distribution of the various subgroups (industries or occupations) appears to get more similar over time. To test this observation, we use the Theil Entropy Index as measure of diversity. Calculation is based on a multistep procedure and is taken from McKibben, Faust (2001). Firstly, the reference group's entropy score is calculated by

$$E = \sum_{j=1}^{Z} p_j \cdot ln\left(\frac{1}{p_j}\right) \qquad (11)$$

p_j is the share of agegroup j in the total population and Z is the highest age group in the data. The higher the resulting number, the more heterogeneous the age distribution. Secondly, the subunits' entropy scores are calculated from

$$E^i = \sum_{j=1}^{Z} p_j^i \cdot ln\left(\frac{1}{p_j^i}\right) \qquad (12)$$

where p_j^i is the share of age group *j* in subunit *i*.

Thirdly, the generated numbers are used to calculate the final Theil index, which is the weighted average deviation of each subgroup's entropy score from total population's measure and computed from

$$H = \sum_{i=1}^{N} [t^i \cdot (E - E^i)] / ET \qquad (13)$$

with t^i as total (population) size of subgroup i and T corresponds to the size of total population. The resulting index varies between 0 and 1, zero indicates similar composition of subunits and reference group, while one is reached if each subunit contains only one age group.

We calculated the index for industries and the selected occupations with all employed persons in the dataset as reference group. The resulting index values were at both points of time and for both categories, industries and occupations, very close to zero, pointing to virtually identical age distributions over subgroups. However, the index scores still decreased over the observation period and were in 2000 clearly below 1980's values.[13]

4 Comparing Aging Measures

In Section 3 we showed that employees and their various subgroups generally aged, on average, between 1980 and 2000. Subgroups, however, aged at different paces: Industries and profession that were older than average in 1980 tended to age slower than industries and professions that were younger at the beginning of the observation period. Now we investigate the explanatory power of the measures of aging employed.

Tables 1 and 2 expose five measures of aging with their respective percentage change from period to period; in the last row of each subgroup the average annual change is given. Aging

[13] For industries the values are 0.0066 in 1980 and 0.0004 in 2000. Age structures of professions are slightly more diverse. In 1980 the index value was 0.0083, it fell 0.0047 in 2000.

is defined as an increase in mean age, median age and *R*(3) and decline in *R*(1) and *R*(2). Since the measures are calculated differently, they also react differently to changes in the age structure. As can easily be seen on closer inspection, it is rather exceptionally that all five measures point into the same direction. Take the reference group, for instance (second row in both Tables). Mean age increased steadily for industries as well as professions. Median age, to the contrary, first decreased (until 1990) and then increased until 2000, reaching a comparable level to that of mean age. *R*(1), the proportion of workers aged under 40 to those aged 40 and over, first increased and then decreased. *R*(2), the proportion of young, did not change until 1990 but decreased heavily afterwards. Finally, *R*(3), the proportion of older, hardly changed throughout. Such inconsistencies in the dynamics of aging as measured by different indicators can be found in almost all industries and roughly half of the professions analyzed. Two conclusions seem particularly worth noting. First, it is especially *R*(3) that often points into the opposite direction than the other measures. Secondly, the frequency of inconsistencies between changes in mean and median age is independent from the investigated category (industry or occupation) and occurred in around 13% of the observed cases. Table 3 shows simple correlation coefficients for the five aging measures, defined according to equation (6) to (10).

Table 3: Correlation between Aging Measures

	Mean	Median	Ratio 1	Ratio 2	Ratio 3
Mean	1.00				
Median	0.85	1.00			
Ratio 1	-0.84	-0.85	1.00		
Ratio 2	-0.61	-0.57	0.69	1.00	
Ratio 3	0.45	0.16	-0.23	0.22	1.00

All measures of aging are correlated in the expected way. Faster aging is express in rising mean and median age, a falling share of persons aged 30 and younger, a declining number of persons aged 40 to the number of persons aged 40 and over and a rise in the share of persons aged 50+. Changes in the mean, median and ratio 1 are strongly, though not perfectly, correlated, whereas correlation with the other two measures is much weaker, particularly with Ratio 3. The explanation regarding, for example, the very low coefficient is mathematically explained by reference to equations (2) and (5): Calculation of the median is based on the first half of the age distribution, only and hence relatively insensitive to changes at the upper end of the age composition, on which *R*(3) relies. Based on correlation coefficients, mean age is the most summarizing measure of aging.

Besides inconsistencies, a further issue is over- or underestimation of aging by single measures, depending on the reason or source of aging. Taken all observed subgroups together, average annual changes are 0.33% and 0.39% growth in the mean and median age, respectively, a decline of 0.92% in *R*(1), a drop of 2.17% in *R*(2) and an increase of 0.49% in *R*(3). So, compared to the other measures, mean age seems to underestimate aging processes, while ratio 2 clearly overestimates aging. The average annual change in ratio 2 is around seven times higher than the change in the mean. The median, as the other measure of central tendency, reacts slightly more sensitive. Values for ratio 1 are situated between the extremes.

5 Summary and Conclusion

In this paper we performed an analysis of five different measures of aging and applied them to German employment data on the level of industries and for selected professions: Mean and median age, number of workers below 40 to those aged 40 and over, proportion of workers aged under 30, and the share of workers aged 50 and over. Our empirical results show that at least this part of the German workforce is definitely aging. However, there are exceptions to the general trend on the micro level. A few industries and profession rejuvenated or hardly aged between 1980 and 2000. We further showed that aging was, so far, mainly driven by a declining share of young employees under 30. The average annual change in their share is around 4.5 times higher than changes in the proportion of employees aged 50+.

We concluded that the mean is the most comprehensive measure of aging. However, it tends to underestimate the extent of aging in our dataset. Median age is often preferred to the mean as measure of central tendency, and indeed, it underestimates aging slightly less than the mean. Its drawback is that we can only find low correlation with changes at the upper end of the age distribution. A good measure seems Ratio 1, defined as number of workers below 40 to those aged 40 and over. It is reasonable well correlated with the other measures and reacts rather sensitive to changes in the underlying age composition. Ratios 2 and 3, on the other hand, the proportions of young and old, respectively, are lead indicators for future changes and offer insightful additional information about the source of aging. Taken alone, they would nevertheless give a distorted view of aging in most cases, over- or underestimating it heavily, respectively. Also, these indicators are only weekly correlated with the measures of central tendency of the age distributions.

A natural further step is to investigate determinants of the dynamics of aging in more detail. In order to give recommendations to firms and policy about consequences of demographic change in different industries, professions and regions where these prevail, we need to learn more about the development and maturing of industries and occupations in economic *and* demographic terms. .

Acknowledgement

We gratefully acknowledge use of the weakly anonymous IAB Employment Sample IABS (1975 –2001). Data access was provided via an on-site use at the Research Data Centre (FDZ) of the German Federal Employment Agency (BA) at the Institute for Employment Research (IAB).

Our thanks also go to participants at the 2nd European Workshop - Labor Markets and Demographic Change and the annual DGD conference 2007 for helpful comments and discussions.

References

Börsch-Supan, A. (2003), Labour Market Effects of Population Aging, Labour 17 (Special Issues), 5-44.

Brasche, U. and S. Wieland (2000), Alter und Innovation Befunde aus der Beschäftigungsstatistik, Vierteljahreshefte zur Wirtschaftsforschung.

Dixon, S. (2003), Implication of Population Ageing for the Labour Market, Labour Market Trends, 67-76.

Drews, N. and S. Harman in: Köhler, M., Krug, G., Wübbeke, C. et al. (2006), Variablen der schwach anonymisierten Version der IAB-Beschäftigten-Stichprobe 1975-2001, FDZ Datenreport, 01-2006.

Frosch, K. (2006), Reemployment Rates over the Life Course: Is there still Hope after Late Career Job Loss?, Thuenen-Series of Applied Economic Theory, 64.

Frosch, K. (2007), Zu alt für einen neuen Job? Altersspezifische Wiederbeschäftigungschancen nach Verlust des Arbeitsplatzes, in: Wirtschaftspolitische Blätter, 4/2007, Vienna (forthcoming).

Fuchs, J. and D. Söhnlein (2007), Einflussfaktoren auf das Erwerbspersonenpotenzial – Demografie und Erwerbsverhalten in Ost- und Westdeutschland, IAB Discussion Paper, 12.

Fullerton, H. N. and M. Toosi (2001), Labor force projections to 2010: steady growth and changing composition, Monthly Labor Review, 124, 21-38.

Henseke, G., Hetze, P. And T. Tivig (2007), Alterung der Erwerbsbevölkerung in Deutschland, Wirtschaftspolitische Blätter, 4/2007, Vienna (forthcoming).

Hirsch, B.T., Macpherson, D.A. and M.A. Hardy (2000), Occupational Age Structure and Access for Older Workers, Industrial and Labor Relations Review, 53, 3, 401-418.

Hobbs, F.B. (2004), Age and Sex Composition, in: J. S. Siegel and D.A. Swanson (Ed.), The Methods and Materials of Demography, 2nd Edition, Elsevier Academic Press.

Jaffe, A.J. (1967), From New Entries to Retirement: The Changing Age Composition of the U.S. Male Labor Force by Industry, Demography, 4, 1, 273-282.

Johnson, P. and K.F. Zimmermann, eds. (1993), Labour Markets in an Ageing Europe, Cambridge: Cambridge University Press.

Kaufman, R. L. and S. Spilerman (1982), The Age Structure of Occupations and Jobs, The American Journal of Sociology, 87, 4, 827-851.

Levin, S. G. and P. E. Stephan (1991), Research Productivity Over the Life Cycle: Evidence for Academic Scientists, The American Economic Review, 81, 1, 114-132.

Liao, T. F. (1996), Measuring Population Aging as a Function of Fertility, Mortality, and Migration, Journal of Cross-Cultural Gerontology, 11, 1, 61-79.

McKibben, J. N., and K. A. Faust (2004), Population Distribution – Classification of Residence, in: J. S. Siegel and D.A. Swanson (Ed.), The Methods and Materials of Demography, 2nd Edition, Elsevier Academic Press.

Morrison, M. H. (1983), The aging of the U.S. population: human resource implications, Monthly Labor Review, May, 13-19.

Naegele, G., 2001, Demographischer Wandel und Erwerbsarbeit, Aus Politik und Zeitgeschichte 3-4, S. 3-4.

Niebuhr, A. and S. Stiller (2005), Demografischer Wandel und Arbeitsmärkte in Norddeutschland, HWWA-Forum 5 – 2005.

Orzechowska-Fischer, E. (2004), Labour Force Aging: Its Impact on Employment Level and Structure, paper presented at the Australian Population Association's Biennial Conference.

Preston, S.H. Himes, C. and M. Eggers (1989), Demographic Conditions Responsible for Population Aging, Demography, 26, 4, 691-704.

Prskawetz, A., Zagaglia, B., Fent, T. and V. Skirbekk (2005), Decomposing the change in labour force indicators over time, Demographic Research, 13, 7, 163-188.

Skirbekk, V. (2003), Age and Individual Productivity: A Literature Survey, MPIDR Working Paper, 2003-028.

Spengler, J.J. (1941), Some Effects of Chnages in the Age Composition of the Labor Force, Southern Economic Journal, 8, 2, 157-175.

Thon, M. and H.-U. Bach (1998), Die Schätzung von Potential-Erwerbsquoten, Stiller Reserve und Erwerbspersonenpotential für die alten Bundesländer 1970-1995, IAB Werkstattbericht, 8.

Tivig, T., and P. Hetze, eds. (2007), Deutschland im Demografischen Wandel, Rostocker Zentrum zur Erforschung des Demografischen Wandels, Rostock.

Weinberg, B. A. (2004), Experience and Technology Adoption, IZA Discussion Paper, 1051.

Appendix

Table 1: Age Composition of German Industries and the changes over time, 1980-2000

			Mean		Median		Ratio 1		Ratio 2		Ratio 3	
				change in %		change in %		change in %		change in %		change in %
1	Reference	1980	37.3		38.0		1.2		32%		20%	
		1990	37.5	0.6	36.9	-2.9	1.3	7.3	32%	1.4	22%	10.9
		1995	38.5	2.7	38.0	3.1	1.2	-6.8	25%	-21.4	21%	-1.1
		2000	39.1	1.6	39.2	2.9	1.1	-10.0	22%	-14.9	21%	-4.0
		1980-2000 p.a.		0.3		0.3		-0.9		-2.4		0.0
2	Agriculture	1980	35.8		35.8		1.4		39%		18%	
		1990	34.7	-3.1	31.3	-12.4	1.9	38.8	46%	18.1	19%	4.5
		1995	36.8	6.2	35.4	12.8	1.6	-16.3	32%	-30.0	19%	0.6
		2000	38.6	4.7	38.6	9.1	1.2	-28.0	24%	-26.3	20%	2.8
		1980-2000 p.a.		0.6		1.0		-1.7		-3.1		0.4
3	Mining and Energy	1980	41.4		43.4		0.7		21%		31%	
		1990	40.1	-3.2	40.1	-7.6	1.0	46.6	27%	27.3	29%	-5.1
		1995	40.8	1.7	40.6	1.1	0.9	-5.3	18%	-31.6	27%	-9.1
		2000	42.3	3.8	42.5	4.8	0.7	-25.9	13%	-28.8	28%	5.8
		1980-2000 p.a.		0.3		0.1		-0.5		-3.1		-0.4
4	Chemical and Chemical Products	1980	40.0		41.2		0.9		22%		24%	
		1990	39.3	-1.6	39.7	-3.5	1.0	20.6	26%	18.8	26%	8.6
		1995	39.9	1.5	39.8	0.3	1.0	-0.6	20%	-23.0	24%	-5.3
		2000	40.6	1.7	40.6	1.9	0.9	-9.4	15%	-21.9	24%	-3.3
		1980-2000 p.a.		0.2		0.0		0.0		-2.4		-0.3
5	Rubber and Plastic Products	1980	37.9		38.8		1.2		29%		19%	
		1990	37.2	-1.8	36.3	-6.5	1.4	23.3	33%	14.0	20%	2.8
		1995	38.5	3.5	37.7	4.0	1.3	-8.9	24%	-25.5	20%	1.6
		2000	39.2	1.9	39.0	3.5	1.1	-11.6	19%	-22.4	19%	-8.0
		1980-2000 p.a.		0.3		0.3		-0.6		-2.7		-0.3
6	Non-Metallic Mineral Products	1980	39.4		41.0		0.9		24%		22%	
		1990	39.8	1.0	40.5	-1.2	1.0	8.9	26%	10.2	29%	29.0
		1995	40.1	0.6	39.8	-1.6	1.0	6.6	20%	-22.0	25%	-13.1
		2000	40.7	1.7	40.9	2.6	0.9	-13.1	15%	-24.9	23%	-6.8
		1980-2000 p.a.		0.2		0.0		-0.1		-2.8		-0.4
7	Metals and Metal Products	1980	39.1		40.8		0.9		25%		23%	
		1990	38.4	-1.8	38.5	-5.6	1.1	24.3	31%	21.4	25%	11.1
		1995	39.0	1.3	38.5	0.1	1.2	4.4	23%	-24.1	22%	-11.0
		2000	39.6	1.6	39.6	2.8	1.1	-10.1	19%	-16.4	22%	-3.6
		1980-2000 p.a.		0.1		0.0		0.4		-2.0		-0.6
8	Machinery and Equipment n.e.c	1980	37.3		38.1		1.3		30%		18%	
		1990	37.5	0.6	37.3	-2.1	1.3	1.4	32%	6.4	21%	16.7
		1995	38.5	2.6	38.2	2.4	1.2	-5.1	25%	-20.5	21%	0.6
		2000	39.3	2.0	39.3	3.0	1.1	-10.9	20%	-19.2	21%	-1.0
		1980-2000 p.a.		0.3		0.3		-1.0		-2.4		0.5
9	Machinery	1980	38.0		39.2		1.1		29%		21%	
		1990	37.8	-0.6	37.4	-4.5	1.2	13.3	31%	8.4	23%	9.6

		1995	39.5	4.5	39.5	5.5	1.1	-15.1	22%	-29.7	24%	6.3
		2000	40.2	1.6	40.3	2.0	1.0	-8.6	18%	-17.7	23%	-3.4
		1980-2000 p.a.		0.4		0.4		-1.1		-2.9		0.5
		1980	35.9		36.2		1.5		35%		16%	
		1990	36.5	1.5	35.5	-1.9	1.5	0.8	35%	1.0	19%	20.4
10	**Motor Vehicles**	1995	37.0	1.4	36.4	2.6	1.5	0.2	29%	-18.2	17%	-8.7
		2000	38.1	3.0	38.1	4.5	1.3	-15.2	24%	-16.2	18%	7.2
		1980-2000 p.a.		0.3		0.4		-1.0		-2.3		0.6
		1980	37.7		38.1		1.3		26%		18%	
		1990	37.8	0.4	37.7	-1.1	1.3	-4.6	26%	-2.6	17%	-3.5
11	**Office Machinery and Computers**	1995	38.1	0.8	37.9	0.5	1.4	7.8	19%	-24.3	15%	-11.1
		2000	38.5	0.9	38.4	1.4	1.3	-9.1	20%	2.2	16%	4.4
		1980-2000 p.a.		0.1		0.1		-0.2		-1.6		-0.6
		1980	38.2		37.7		1.2		29%		20%	
		1990	36.7	-3.9	37.4	-0.8	1.4	12.1	32%	7.8	20%	2.6
12	**Electrical Equipment**	1995	38.4	4.5	38.7	3.4	1.2	-11.4	23%	-28.7	20%	-1.9
		2000	39.2	2.2	39.4	1.8	1.1	-8.6	18%	-18.9	19%	-2.1
		1980-2000 p.a.		0.3		0.3		-0.9		-2.9		-0.2
		1980	36.0		35.5		1.5		37%		17%	
		1990	36.7	1.9	35.4	-0.1	1.6	2.8	34%	-7.4	19%	12.8
13	**Precision and Optical Instruments**	1995	40.9	11.5	39.3	11.1	1.1	-31.8	29%	-16.0	34%	75.0
		2000	38.4	-6.1	38.5	-2.2	1.2	14.8	25%	-14.6	19%	-44.4
		1980-2000 p.a.		0.4		0.6		-1.0		-2.3		2.5
		1980	38.4		39.7		1.0		29%		22%	
		1990	38.0	-1.0	37.2	-6.1	1.3	21.6	32%	10.7	24%	7.9
14	**Manufacturing n.e.c**	1995	39.2	3.2	38.5	3.5	1.2	-6.8	23%	-28.5	23%	-2.6
		2000	40.1	2.3	40.0	3.8	1.0	-15.0	17%	-23.9	22%	-4.5
		1980-2000 p.a.		0.3		0.3		-0.7		-3.1		-0.2
		1980	37.7		38.8		1.1		31%		20%	
		1990	37.7	0.1	36.7	-5.4	1.3	14.7	34%	9.5	24%	19.7
15	**Wood and Paper Products**	1995	38.1	1.0	36.9	0.5	1.4	4.9	28%	-17.8	22%	-9.0
		2000	38.8	1.9	38.5	4.3	1.2	-10.5	22%	-20.2	20%	-6.8
		1980-2000 p.a.		0.2		0.1		0.1		-2.2		-0.4
		1980	37.4		38.8		1.1		33%		20%	
		1990	38.2	2.1	38.2	-1.5	1.2	3.5	33%	1.2	26%	29.2
16	**Wearing Apparel and Leather Clothes**	1995	39.8	4.2	39.9	4.4	1.0	-12.9	23%	-29.6	26%	-1.8
		2000	40.7	2.3	40.9	2.5	0.9	-11.5	17%	-26.7	25%	-2.0
		1980-2000 p.a.		0.5		0.4		-1.5		-3.7		0.7

17	**Food Products and Tobacco**	1980	36.6		37.6		1.3		35%		18%	
		1990	36.4	-0.5	35.5	-5.6	1.4	14.4	38%	10.5	22%	17.1
		1995	37.9	4.0	37.1	4.6	1.3	-8.7	29%	-23.5	21%	-2.8
		2000	38.9	2.6	38.9	4.8	1.1	-13.6	23%	-22.5	21%	-1.7
		1980-2000 p.a.		0.4		0.4		-1.0		-2.7		0.3
18	**Construction**	1980	37.1		38.6		1.2		31%		16%	
		1990	37.7	1.8	37.5	-2.7	1.2	2.5	34%	10.5	24%	49.0
		1995	37.3	-1.1	36.1	-3.7	1.5	22.5	30%	-10.9	20%	-17.7
		2000	37.7	1.2	37.5	3.9	1.4	-7.3	26%	-12.9	18%	-9.3
		1980-2000 p.a.		0.1		-0.1		1.1		-1.2		-0.2
19	**Wholesale and Retail Trade**	1980	36.0		36.0		1.5		36%		17%	
		1990	36.9	2.2	36.2	0.4	1.4	-5.9	35%	-3.6	20%	14.6
		1995	38.0	3.0	37.3	3.1	1.3	-6.3	28%	-20.4	20%	2.3
		2000	38.7	2.0	38.5	3.3	1.2	-9.2	23%	-17.0	20%	-2.2
		1980-2000 p.a.		0.4		0.4		-1.2		-2.6		0.5
20	**Railway and Post**	1980	38.5		40.4		1.0		30%		25%	
		1990	38.1	-1.0	39.0	-3.3	1.1	13.5	32%	4.8	26%	3.9
		1995	38.7	1.5	38.8	-0.6	1.1	4.7	25%	-20.3	22%	-14.8
		2000	38.8	0.4	39.5	1.7	1.1	-6.0	20%	-19.9	18%	-17.5
		1980-2000 p.a.		0.1		0.0		0.4		-2.5		-2.0
21	**Transport**	1980	37.3		37.3		1.4		29%		16%	
		1990	38.0	2.0	37.6	0.7	1.3	-5.3	29%	-1.2	20%	26.4
		1995	38.9	2.3	38.2	1.6	1.2	-4.6	23%	-19.6	21%	1.1
		2000	39.6	1.8	39.3	3.0	1.1	-11.6	19%	-18.0	20%	-1.6
		1980-2000 p.a.		0.3		0.3		-1.3		-2.6		0.8
22	**Financial Intermediation**	1980	35.7		34.3		1.7		39%		17%	
		1990	36.7	2.6	35.8	4.4	1.6	-7.4	33%	-13.9	17%	2.3
		1995	37.5	2.4	37.1	3.5	1.4	-13.2	29%	-14.0	18%	3.8
		2000	38.7	3.2	38.4	3.8	1.2	-13.3	23%	-19.8	19%	5.4
		1980-2000 p.a.		0.5		0.6		-2.0		-2.7		0.7
23	**Hotels and Restaurants**	1980	35.1		33.6		1.7		41%		17%	
		1990	35.6	1.5	34.2	1.8	1.8	2.3	39%	-5.5	17%	1.1
		1995	37.0	4.0	36.3	6.2	1.5	-15.1	31%	-19.4	18%	4.2
		2000	37.7	1.9	37.9	4.5	1.3	-13.8	27%	-13.1	18%	0.4
		1980-2000 p.a.		0.4		0.8		-1.9		-2.3		0.3
24	**Cleaning and Hairdressers**	1980	32.3		29.8		2.4		50%		12%	
		1990	34.2	5.6	31.8	6.8	1.9	-18.7	47%	-7.9	16%	30.4
		1995	36.9	8.2	36.5	14.7	1.4	-26.6	33%	-28.7	19%	16.6
		2000	38.2	3.5	38.7	6.1	1.2	-17.6	27%	-18.9	20%	6.0
		1980-2000 p.a.		1.0		1.6		-3.6		-3.4		2.5

25	Education	1980	39.0		39.1		1.1		26%		22%	
		1990	40.5	3.9	40.6	4.0	0.9	-15.4	20%	-23.8	27%	23.6
		1995	41.2	1.8	41.9	3.1	0.8	-13.4	18%	-12.5	29%	7.4
		2000	40.4	-2.0	41.2	-1.6	0.9	9.2	22%	24.7	27%	-6.1
		1980-2000 p.a.		0.1		0.2		-0.8		0.0		0.9
26	Media, Culture, Entertainment	1980	37.3		37.0		1.4		33%		20%	
		1990	38.1	2.1	37.2	0.3	1.4	-1.3	28%	-14.9	21%	5.0
		1995	39.1	2.7	38.6	3.8	1.2	-11.8	23%	-19.4	22%	4.6
		2000	39.2	0.4	39.4	2.1	1.1	-9.5	22%	-4.6	20%	-7.6
		1980-2000 p.a.		0.3		0.4		-1.5		-2.1		0.0
27	Health Care, Veterinary Services	1980	34.1		31.6		2.0		46%		15%	
		1990	34.9	2.4	33.0	4.5	2.1	3.8	40%	-13.4	15%	-4.2
		1995	36.5	4.5	35.6	7.7	1.7	-17.6	31%	-22.3	16%	5.9
		2000	37.8	3.6	37.9	6.6	1.3	-23.4	26%	-17.0	16%	4.8
		1980-2000 p.a.		0.6		1.1		-2.6		-3.1		0.6
28	Consultancy	1980	31.8		30.1		3.2		50%		9%	
		1990	33.8	6.3	32.2	7.2	2.4	-25.2	42%	-14.7	11%	29.4
		1995	35.7	5.5	34.4	6.8	1.9	-18.2	33%	-21.9	14%	23.1
		2000	36.3	1.8	35.4	2.7	1.9	-4.8	29%	-12.9	14%	-1.3
		1980-2000 p.a.		0.7		0.9		-2.4		-2.8		2.4
29	Architectural and Engineering Activities	1980	35.8		35.4		1.9		32%		12%	
		1990	37.4	4.6	36.5	3.1	1.5	-19.6	27%	-15.1	16%	37.8
		1995	38.3	2.4	37.1	1.7	1.4	-5.8	22%	-19.5	19%	13.3
		2000	38.4	0.3	37.4	0.9	1.5	3.5	20%	-9.7	17%	-8.6
		1980-2000 p.a.		0.3		0.3		-0.8		-2.4		1.6
30	Other Services	1980	38.6		39.0		1.1		26%		21%	
		1990	38.2	-1.2	37.6	-3.5	1.3	11.5	30%	14.9	22%	3.7
		1995	38.9	2.0	38.2	1.5	1.2	-4.2	24%	-21.0	22%	-0.2
		2000	38.7	-0.6	38.3	0.5	1.2	0.8	23%	-2.1	20%	-10.4
		1980-2000 p.a.		0.1		0.0		0.2		-1.0		-0.6
31	Non-Profit Organisations	1980	39.2		39.8		1.0		27%		24%	
		1990	39.1	-0.2	38.7	-2.8	1.2	12.3	24%	-9.8	24%	-0.3
		1995	40.6	3.9	40.7	5.3	0.9	-20.2	18%	-25.6	26%	7.5
		2000	40.8	0.4	41.6	2.3	0.8	-12.2	18%	-1.4	25%	-3.9
		1980-2000 p.a.		0.3		0.4		-1.8		-2.1		0.2
32	Private Households	1980	39.8		42.8		0.8		34%		35%	
		1990	40.5	1.7	41.6	-2.7	0.9	9.0	29%	-13.4	34%	-3.3
		1995	43.1	6.5	44.9	7.9	0.6	-29.3	18%	-38.7	37%	8.7
		2000	44.6	3.4	46.1	2.7	0.4	-32.8	10%	-43.3	36%	-4.4
		1980-2000 p.a.		0.7		0.6		-3.8		-5.9		0.2
33	Public Administration	1980	41.2		42.5		0.7		22%		30%	
		1990	41.0	-0.5	41.8	-1.6	0.8	12.9	22%	-1.1	31%	1.7
		1995	41.8	2.2	42.4	1.4	0.8	-10.2	16%	-28.5	30%	-2.3
		2000	43.5	4.0	44.3	4.5	0.6	-22.7	12%	-21.8	34%	12.9
		1980-2000 p.a.		0.4		0.3		-1.8		-3.4		0.8

Table 2: Age composition of selected professions and the changes over time, 1980-2000

Mean	Median	Ratio I	Ratio II	Ratio III

			change in %		change in %		change in %		change in %		change in %
	1980	37.3		38.0		1.2		32%		20%	
	1990	37.5	0.6	36.9	-2.9	1.3	7.3	32%	1.4	22%	10.9
1 Reference	1995	38.5	2.7	38.0	3.1	1.2	-6.8	25%	-21.4	21%	-1.1
	2000	39.1	1.6	39.2	2.9	1.1	-10.0	22%	-14.9	21%	-4.0
	1980-2000 p.a.		0.3		0.3		-0.9		-2.4		0.0
	1980	44.9		44.9		0.4		5%		34%	
	1990	46.2	2.9	48.0	6.8	0.3	-18.4	6%	17.4	42%	21.8
2 Manager	1995	44.5	-3.8	46.1	-4.0	0.5	40.3	10%	74.5	39%	-6.6
	2000	45.5	2.3	46.0	-0.3	0.4	-6.2	4%	-55.4	37%	-3.9
	1980-2000 p.a.		0.0		-0.1		1.7		1.9		0.0
	1980	36.1		34.8		2.5		21%		9%	
	1990	36.7	1.6	35.3	1.5	2.0	-18.2	22%	3.2	10%	10.3
3 Scientists	1995	37.8	2.9	36.1	2.0	1.7	-16.2	19%	-15.7	15%	47.9
	2000	37.9	0.4	36.4	1.0	1.6	-3.2	21%	13.2	15%	5.1
	1980-2000 p.a.		0.3		0.3		-1.9		-0.1		3.9
	1980	41.0		40.7		0.9		13%		21%	
	1990	41.1	0.4	40.4	-0.7	1.0	7.9	14%	5.7	25%	17.5
4 Engineers	1995	41.4	0.8	40.5	0.1	0.9	-1.3	10%	-26.6	26%	1.7
	2000	41.6	0.5	40.6	0.3	0.9	-2.4	9%	-15.2	24%	-7.4
	1980-2000 p.a.		0.1		0.0		0.0		-2.6		0.2
	1980	41.9		42.3		0.7		12%		25%	
	1990	42.6	1.5	43.6	3.0	0.7	-0.6	13%	9.7	31%	23.3
5 Technicians	1995	42.2	-0.9	42.2	-3.1	0.8	15.0	12%	-11.0	29%	-6.9
	2000	42.5	0.8	42.2	-0.2	0.7	-4.0	9%	-22.8	28%	-5.7
	1980-2000 p.a.		0.0		-0.1		0.7		-1.9		-0.1
	1980	34.3		32.3		2.2		43%		14%	
	1990	35.1	2.3	33.9	5.0	2.0	-7.2	38%	-11.3	14%	-4.2
6 Financial Clerks	1995	36.6	4.1	35.6	5.0	1.6	-19.2	31%	-18.0	15%	11.4
	2000	37.5	2.5	36.8	3.6	1.5	-10.9	27%	-14.1	16%	7.1
	1980-2000 p.a.		0.5		0.7		-2.2		-2.5		1.1
	1980	38.9		38.8		1.2		22%		20%	
	1990	39.6	1.7	39.6	2.2	1.0	-12.0	20%	-11.2	21%	4.2
7 Accounts Clerks	1995	40.4	1.9	40.3	1.8	1.0	-8.5	16%	-21.4	22%	6.7
	2000	40.1	-0.8	39.7	-1.5	1.0	8.5	15%	-4.3	20%	-9.6
	1980-2000 p.a.		0.1		0.1		-0.4		-2.1		-0.1

	1980	36.7		36.4		1.4		35%		20%	
	1990	37.4	1.9	37.1	2.1	1.3	-8.6	32%	-8.5	20%	0.3
8 Clerical Assistance	1995	39.0	4.4	39.0	4.9	1.1	-15.7	24%	-24.5	22%	12.1
	2000	39.7	1.9	39.9	2.3	1.0	-9.1	20%	-16.7	22%	1.5
	1980-2000 p.a.		0.5		0.6		-1.9		-3.0		0.9
	1980	35.6		35.8		1.5		37%		16%	
	1990	36.5	2.5	36.1	0.7	1.4	-9.5	37%	-0.8	20%	20.5
9 Sales Assistants	1995	38.2	4.6	37.8	4.8	1.2	-11.2	29%	-22.8	22%	10.6
	2000	38.7	1.3	38.7	2.3	1.2	-5.3	24%	-14.7	21%	-4.4
	1980-2000 p.a.		0.5		0.5		-1.4		-2.5		1.1
	1980	38.8		40.0		1.0		25%		21%	
	1990	38.1	-1.8	37.7	-5.6	1.2	19.9	31%	26.1	24%	15.0
10 Metal Forming	1995	39.2	3.0	39.0	3.3	1.1	-7.6	23%	-28.1	23%	-4.7
	2000	40.1	2.2	40.3	3.4	1.0	-13.7	19%	-15.7	23%	1.4
	1980-2000 p.a.		0.3		0.3		-0.8		-2.0		0.3
	1980	36.1		36.5		1.5		34%		17%	
	1990	36.1	-0.2	34.9	-4.4	1.5	5.7	38%	11.2	19%	16.6
11 Metal fitters	1995	37.7	4.7	37.2	6.6	1.3	-13.2	29%	-24.8	20%	5.1
	2000	38.8	2.7	39.0	4.8	1.1	-15.1	23%	-18.9	21%	1.8
	1980-2000 p.a.		0.5		0.6		-1.7		-2.5		1.0
	1980	33.1		30.8		2.4		48%		13%	
	1990	34.1	3.1	32.2	4.5	2.2	-7.9	43%	-9.0	14%	10.5
12 Precision Mechanics	1995	35.7	4.5	34.8	8.1	1.8	-16.0	35%	-19.0	16%	10.3
	2000	36.8	3.2	36.8	5.7	1.4	-21.1	31%	-12.5	17%	6.5
	1980-2000 p.a.		0.6		1.1		-2.7		-2.4		1.5
	1980	33.7		32.0		2.1		44%		13%	
	1990	34.2	1.5	32.6	1.9	2.1	0.8	43%	-3.7	14%	6.8
13 Electrical Trades	1995	35.9	4.8	35.2	8.1	1.7	-18.3	34%	-21.0	14%	4.2
	2000	37.4	4.3	37.5	6.5	1.3	-22.8	27%	-19.9	16%	14.3
	1980-2000 p.a.		0.7		1.0		-2.7		-2.9		1.5
	1980	39.3		41.4		0.8		24%		21%	
	1990	39.3	0.1	40.3	-2.7	1.0	21.3	31%	30.1	31%	48.3
14 Construction Trades	1995	37.6	-4.3	36.2	-10.2	1.5	48.1	30%	-3.5	22%	-29.0
	2000	37.5	-0.4	37.2	2.9	1.5	0.0	27%	-10.5	18%	-18.9
	1980-2000 p.a.		-0.3		-0.6		3.9		0.1		-1.6
	1980	46.0		47.6		0.3		8%		42%	
	1990	45.6	-0.9	48.9	2.5	0.4	31.4	12%	40.1	46%	8.4
15 Security Guards	1995	45.5	-0.4	47.1	-3.7	0.4	3.5	9%	-22.4	43%	-7.5
	2000	45.2	-0.7	46.7	-0.7	0.5	2.5	9%	1.5	39%	-8.2
	1980-2000 p.a.		-0.1		-0.2		1.4		-0.1		-0.8
	1980	32.8		29.3		2.4		52%		13%	
	1990	33.8	3.1	31.8	8.2	2.6	7.2	44%	-15.7	12%	-9.5
16 Nursing Assistants	1995	35.8	5.8	34.8	9.5	2.0	-24.3	32%	-26.1	13%	7.2
	2000	37.3	4.3	37.5	7.9	1.4	-27.8	26%	-19.6	14%	8.1
	1980-2000 p.a.		0.8		1.4		-3.2		-3.6		0.7