Specific measures for older employees and late career employment [*]

Bernhard Boockmann[†]

IAW Tübingen

Jan Fries[‡]

ZEW Mannheim

Christian Göbel[§]

ZEW Mannheim

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Abstract

Many firms implement specific measures for older employees (SMOE). Our interest is to analyze the effects on individual employment duration of the elderly when the establishment provides specific measures. Using German longitudinal employer-employee data, we are able to account for individual as well as establishment heterogeneity. We find a positive relation of certain age-specific measures to individual employment duration. Older employees stay longer in establishments that apply SMOE.

Keywords:	older workers, human resources policies, job duration, linked
[-3pt]	employer-employee data.
JEL classification:	J14, J21, J26.

1 Introduction

Against the background of demographic changes and the risk of skill shortages, the employ-ment of older workers becomes an increasingly important subject. In the OECD countries, average retirement age is currently 62 (OECD, 2009). While many firms have actively pro-moted early retirement in the past, there is an increasing awareness that firms are relying on their existing workforces. Therefore, many firms are developing strategies to preserve the potential of older employees and to induce them to stay longer in employment (Harper et al., 2006; von Nordheim, 2004).

The advantage of employing older as opposed to younger workers is their experience, high firm-specific human capital, low fluctuation and good job matching quality. Among potential disadvantages, declining psychological, mental and physical abilities and productivity, human capital obsolescence, and low flexibility are most frequently mentioned. To deal with the specific requirements of older workers, firms apply a variety of different human resources policies specifically targeted at this group. These policies typically consist in the age-specific equipment of the workplace, reduced working time, reduced work intensity, re-organization, health or training measures. We refer to these measures as specific human resource measures for older employees (SMOE).

While these approaches are often mentioned as suitable instruments to deal with performance-related consequences of an ageing workforce (Avolio et al., 1990), there is in-sufficient knowledge about their effects on individual late career employment. In this paper, we are interested in the question whether SMOE are associated with longer individual employ-ment duration in the company. We estimate job exit rates for employees between 50 and 65 years of age. For our analysis, we use representative longitudinal employer-employee data for Germany. In the data, we observe the existence of SMOE at the establishment level and job duration of individual employees. The data contain information on the application of the fol-lowing measures: age-specific part-time work, age-specific equipment of workplaces, reduced work requirements, mixed-age work teams, standard training that is also offered to older em-ployees, and specific training for older employees. In our sample, 50 percent of establishments

employing older workers apply at least one such measure.

Many existing studies estimate the determinants of job duration and include age or work experience among the regressors without explicitly addressing job exits due to (early) retirement (Abowd et al., 2006; **?**; Bronars and Famulari, 1997; Dohmen and Pfann, 2004; Mumford and Smith, 2004). Given our focus on older employees, the effect of age on job exit has to be taken into account more carefully. In particular, the effects of tenure and age on job duration have to be separated. Considering employment duration, a 60-year-old employee who just started a new job differs substantially from another having been in the current job for 30 years. Considering age, a 60-year-old employee is likely to have a higher risk of leaving employment than a 30-year-old if both have the same job duration. We disentangle the effects of age and duration by setting up a transition model with simultaneous consideration of duration and age dependence. The identification is based on Imbens (1994), who models duration and calendar time effects simultaneously (see also van den Berg and van der Klaauw (2001); Dohmen and Pfann (2004)). We are not aware that the Imbens (1994) model has previously been used for the joint estimation of duration and age effects. Our transition model consists of a part for age dependence, a part for duration dependence, and a covariate function. The latter takes into account heterogeneity by exploiting a large set of covariates. Furthermore, the richness of the data allows for including fixed effects for establishments. In this way, we take into account the recent evidence of substantial heterogeneity between firms with respect to job duration (e.g. Abowd et al., 2006).

Representative sampling of the observations is a problem when analyzing older employees with long employment histories. On the one hand, using a flow sample of inflows into jobs could avoid length-bias and left-censoring. On the other, the group of older employees starting a new job is highly selective. Moreover, workers starting their jobs at younger ages would have to be followed for a long period of time until they are observed to be 'old' in the data. Instead of using an inflow sample, therefore, we draw from the stock sample of older employees employed at a particular date. In stock samples, long employment durations are over-represented compared to short durations (Lancaster, 1990). Our estimator corrects for

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the stock sampling bias, following Berger and Black (1998). Applying this correction, we obtain a representative stock sample of older employees.

Our estimation results show that employment spells of older workers last longer in firms applying SMOE. While we do not claim that our results have a causal interpretation, they provide strong empirical evidence that SMOE are related to employment of older workers. They should, therefore, be considered as relevant policy instruments by human resources managers and policy-makers.

This paper is structured as follows: in the next session, we briefly review previous research on employment duration of older employees. In section 3, we discuss specific human resource measures for older employees. Section 4 presents the empirical approach. We introduce the data set in section 5 and show estimation results in section 6. Section 7 concludes.

2   Employment duration of older employees

These is a large empirical literature on the determinants of job exit and retirement among older workers. Since job exit is more directly influenced by companies' human resources policies than retirement, our main interest is in this outcome. However, there is a close link between job exit of older workers and the transitions to retirement as both decisions often coincide. This is particularly true for countries such as Germany, where "bridge jobs" (Ruhm, 1990; Macunovich, 2009) are not frequently used in the job-stopping process. Even where "bridge jobs" exist, it has often been observed that older workers faced with the alternative to retire early or change jobs in order to cut back in terms of working time or job requirements mostly choose the first option (Hurd, 1993; Abraham and Houseman, 2004).

Early retirement decisions have been studied frequently, for instance in Börsch-Supan (2000) and Gruber and Wise (2004). In this literature, the transition from employment to (early) retirement is modeled as a voluntary transition. Accordingly, optimization models based on dynamic programming methods are used, such as in the structural models of Blau (1994) and Gustman and Steinmeier (2004). It is, however, obvious that transitions out of employment can not always be considered a voluntary decision of the employee, in particular

in countries in which strong institutional rules exist for the transition to retirement. The same applies to job durations.

These institutions may either be related to the workplace or be government regulations. For our study, workplace-related attributes matter most. A number of determinants have been singled out as institutional reasons for job exit of older workers. Blau and Shvydko (2007) estimate effects of labor market rigidities on the job separation probability. These rigidities, such as lack of part-time and flexible-hours work schemes as well as lack of training and promotion opportunities for older workers, may be responsible for the abrupt (and permanent) change from full time employment into complete retirement.

Hurd and McGarry (1993) study the effects of job characteristics on retirement for US workers. Among job characteristics, they look at physical and mental requirements and job flexibility. They find that physical and mental job requirements have a only a small influence on prospective retirement. By contrast, job flexibility and employer policies have a large stabilizing effect on employment and delay the transition to retirement. Closely related to the subject of this paper, the study by Cottini et al. (2009) for Denmark address the question whether voluntary turnover is influenced by adverse workplace conditions and human resources measures. In particular, they look at the influence of High-Involvement Work Practices (HIWPs) on employee turnover. The authors define HIWPs as "a variety of human resource policies and workplace practices which aim at taping into the ability of frontline workers to produce valuable local knowledge through their efforts and share it with management; and deal with local shocks autonomously". More concretely, they look at whether the worker has influence on decisions concerning his/her work, whether the worker is informed of the decisions affecting his/her workplace, and whether the worker has participated in courses or on-the-training at his/her present workplace. They find that the first of these variables indeed reduces the propensity to separate from the employer. Furthermore, they show that the positive impact of some adverse workplace conditions is mitigated by the use of HIWPs.

For the German case, there is evidence that employment duration of older employees is influenced by firm-specific characteristics (Wübbeke, 1999). Moreover, the empirical personnel

literature (Beckmann, 2007; Henseke and Tivig, 2008) suggests that firm characteristics and working conditions are important determinants of employment and re-employment after age 50.

Apart from adverse workplace conditions and employer measures to alleviate them, technological change and human resource policies to deal with it may be related to job exit and retirement. Thus, Bartel and Sicherman (1993) find that unexpected technological change induces workers to retire earlier, and that training in industries with rapid technological chance induces workers to retire later. In a similar vein, Schleife (2006) investigates the effect of computer use on employment of older workers. While it is reasonable to hypothesize that older workers using PCs have successfully adjusted to technological change and are, therefore, more likely to retire later than other workers (see also Friedberg (2003), there is little empirical support for this proposition. In contrast, Biagi et al. (2007) do find evidence that computer use prolongs employment among Italian men.

Finally, demand changes may affect older workers more strongly than younger workers if firms adjust to changing demand by promoting early retirement. Consistent with this view, Gielen and van Ours (2006) find that older employees are more affected by firm-specific fluctuations than younger employees in the Netherlands.

In addition to workplace conditions or other determinants related to the firm, social security institutions create incentives for retirement by defining age criteria for eligibility to certain benefits. Rust and Phelan (1997) show that social security institutions shape the distribution of retirement. For instance, they show that eligibility of early retirements benefits at the age of 62 produce a spike in the retirement distribution. Incentives such as these are present in most social security systems, in particular in the pension system (Börsch-Supan, 2000; Berkel and Börsch-Supan, 2004; Hakola and Uusitalo, 2005; Euwals et al., 2006; Coile and Levine, 2007) and the system of unemployment insurance (Dlugosz et al., 2009; Fitzenberger and Wilke, 2010). As we only consider transitions out of employment in the year 2002, our data covers a time-constant institutional setting. Hence, we do not aim to identify the effects of these institutions.

3 Specific human resource measures for older employees

Many firms implement human resource measures that are directed specifically at older employees. Figure 1 shows the application of SMOE by establishments employing older workers between 50 and 65 in 2002, the year of our investigation. We expect that SMOE are personnel measures that influence labor supply of the elderly. These measures are based on the insight that older employees have different competencies and requirements than their younger colleagues (Boockmann and Zwick, 2004; Skirbekk, 2008). In this section, we provide an overview of the following measures: specific equipment of workplaces, reduced work requirements, mixed-age work teams, standard training offered to older employees, specific training for older employees, and reduced work time. These six measures have been surveyed in the 2002 wave of the German LIAB data (see section 5).

Figure 1: Specific measures for older employees in 2002
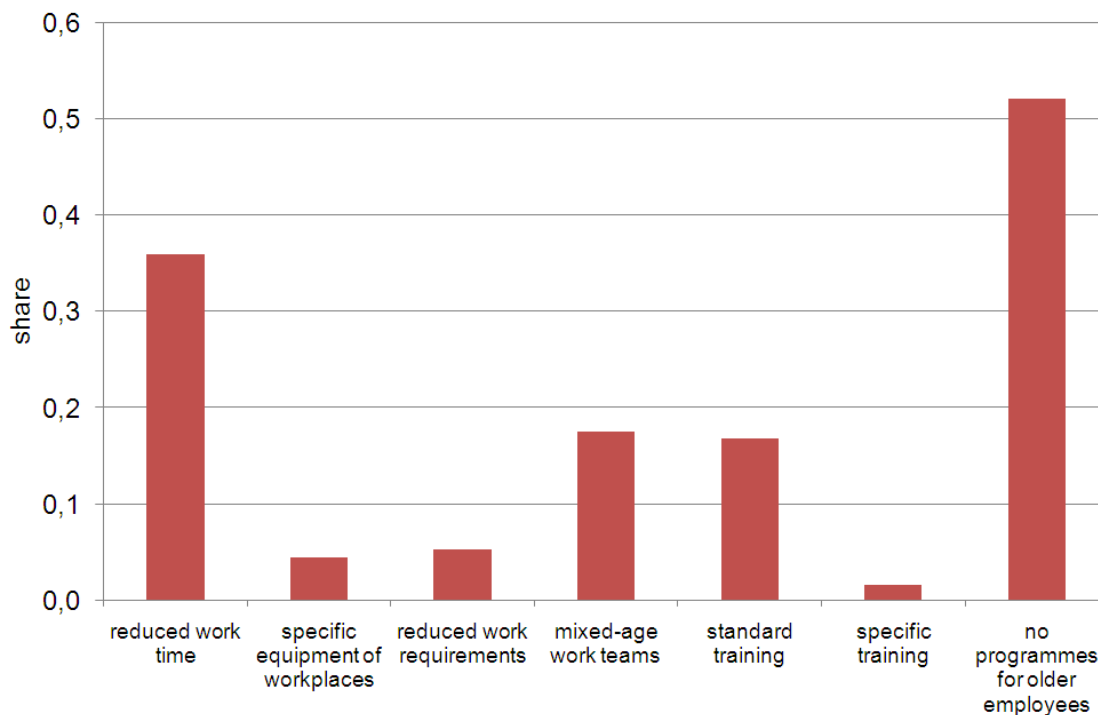
Application of SMOE by establishments. Source: LIAB data, own computations.

A **specific equipment of workplaces** is typically set up to compensate constraints in hearing or seeing capabilities of older employees (Harper and Marcus, 2006). Examples for

constraints in capabilities are an increased illumination of the workplace, higher font size on screens, a higher contrast in signs, or protection from excessive environmental noise (Magrain and Boulton, 2007; Spirduso et al., 2005). Implementation of specifically equipped workplaces for older employees is likely to be associated with prolonged employment duration. We suppose that there can be two effects of specifically equipped workplaces. First, older employees that work in an environment that serves their age-specific needs are more productive than without the measure. Göbel and Zwick (2010) support this hypothesis: specifically equipped workplaces increase productivity of workers aged 40 and above. Second, on an age-specific workplace, older employees feel more comfortable and do not leave their job due to workplace-related reasons.

Workplaces with **reduced work requirements** allow participating employees to stay on their job until statutory retirement age is reached, but with a reduced work load. Being offered reduced work requirements, an employee is expected to stay in employment. We expect that jobs with reduced demands prolong employment duration of older employees. These employees are likely to stay in jobs that impose less pressure and stress.

Mixed-age work teams is another measure for the integration of older employees. The idea is that older and younger employees have different strengths and weaknesses stemming from varying experience, perspectives, and social networks (Kearney et al., 2009). A mixture of different age groups can create cross-fertilization of ideas, a transfer of knowledge and experience, and a combination of resources for all age groups since younger and older employees can concentrate on their comparative advantages (Backes-Gellner and Veen, 2008). On the other hand, compulsory mixing of age groups might be stressful for older employees. A job charged with stress is more likely to be quitted by the employee. The study by Börsch-Supan and Weiss (2007) finds no age differences in productivity for workers of one assembly line at Daimler AG. Göbel and Zwick (2010), in contrast, analyze representative data for Germany and find that productivity increases for older and younger employees in establishments that apply mixed-age work teams. Given previous evidence, there is no strong expectation that mixed-age work teams lead to increasing employment duration of older workers.

General training participation declines with age (Ben-Porath, 1967; Becker, 1975). This can be explained by a lack of motivation of older employees in improving human capital (Warr and Fay, 2001). At the same time, some establishments offer older employees access to their standard training programs in order deal with higher adaptability requirements of older workers in innovative firms or in firms investing in information and communication technology (Aubert et al., 2006). Since older employees might have different training needs than younger employees because they have a different motivation for training participation or simply different skills to be trained, several firms offer **specific training** for older employees. Provision of training should increase employment duration of older employees. Age-specific training is likely to have even stronger effects on employment than unspecific training. But, on the contrary, training for the elderly may yield opposite effects when employees feel to be bound to participate in training courses. When participation creates stress and pressure, older employees are even likely to quit earlier than in absence of the training courses. We separately analyze whether training or specific training is correlated with longer employment duration.

Reduced work time phases the elderly from work to retirement and passes their workplaces to younger employees. The measure offers a reduction of work time in combination with a prolonged employment contract. Within the phasing time span, human capital shall be preserved within the firm (Graf et al., 2009). When applying reduced work time, firms have the opportunity to preserve valuable skills and knowledge of their older employees. Until 2009, age-specific part-time work was subsidized by the German Federal Employment Agency. The subsidy was paid to the employer for an employee older than 55 who reduces work time to 50 percent or less. Comparable part-time schemes have been evaluated in Austria (Graf et al., 2009), the UK (Gielen, 2009), and Sweden (Wadensjö, 2006). For Austria and the UK, the authors find that the programmes are not successful in prolonging work life of older employees, but that subsidization costs are high. For Sweden, (Wadensjö, 2006) isolates a positive effect on labor supply of older employees. His finding is explained by the consideration that the incentive to work part-time instead of full-time is higher than the incentive to

work part-time instead of retiring. On the other hand, Charles and Decicca (2010) implicitly emphasize the importance of flexible work time for older employees because their labor supply preferences conflict with firms' hours constraints. Given these results, our expectation is that reduced working time does not alter employment duration of older employees beyond 63 when the measure merely reflects a deadweight loss of the subsidy. When firms are committed to the idea of age-specific part-time work, prolongation of employment is a realistic result of the measure.

4   Estimation approach

We specify a model that allows identification of age-specific transition rates out of employment. The transition model to estimate simultaneous duration and age effects is

$$\theta(\mathrm{a}|t, X) \quad = \quad \theta_0(\mathrm{a}) \cdot d_0(t) \cdot e_0(X), \tag{1}$$

with the transition rate θ at age a, given employment duration t and covariates X. The transition rate can be written as the product of a baseline transition rate $\theta_0(\mathrm{a})$ which is determined by age, duration dependence $d_0(t)$, and and the explanatory part $e_0(X)$.

Specification of the likelihood

Employment information in our data set is present on a daily basis. This justifies the application of a duration model in continuous time. The specification of the likelihood contribution includes the stock-sampling correction. We refer to a study by Imbens (1994), who uses a likelihood framework to estimate duration and calendar time effects simultaneously. He suggests that a similar model could be used to estimate duration and age effects simultaneously.

For the age-specific transition rate, we specify a piecewise constant baseline $\theta_0(a) = \exp(a_1)$ for $0 < a \leq \mathrm{a}_1$, where a_1 is the end of the first period. For further periods, $\theta_0(a) = \exp(a_k)$ for $a_{k-1} < a \leq a_k$, with t_k as the end of period k. We impose the nor-

malisation that $a_1 = 0$. a_t denotes the end of the job.

In principle, duration dependence could be specified as a piecewise constant baseline in an analogous way. For reducing parameters, we give duration dependence a Weibull-parametric functional form with a single parameter α.[1] The Weibull specification allows positive, negative, or the absence of duration dependence.

The specification of the explanatory part is given by a vector of covariates X and a vector of parameters β.

We specifiy the transition rate in equation 1 as

$$\theta(a|t, X) \quad = \quad \theta_0(a) \cdot \alpha t^{(\alpha-1)} \cdot \exp(X'\beta). \tag{2}$$

The estimator controls for exogenous right-censoring when employment continues after December 31st, 2002. The individual likelihood contribution in our model including stock sampling correction from equation 2 (with $c = 1$ when the job is right-censored and $c = 0$ otherwise) is

$$L_i \quad = \quad [\theta_0(a|t, X) \cdot S(a_t|t, X)]^{(1-c)} \cdot [S(a_t|t, X)]^{c}. \tag{3}$$

Some details on computation and solution are given in technical appendix A.1.

Stock sampling

Within the framework of employment durations for older employees, sampling is particularly important as durations can be very long. An employee who started a job at age 16 has a duration of 44 years at age 60. Flow sampling of jobs for older employees is selective, as employees who have job entries at age 50+ are a specifically selected group of the population of older employees. With a flow sample, we could sample only jobs with a duration of at most

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[1]Either duration or age dependence has to be specified parametrically to identify the model (compare Imbens, 1994).

9 years.[2] In the context of older employees, it is necessary to draw a stock sample to analyze long-lasting jobs.

In the following we discuss stock sampling at January 1st, 2002, when the individual is a_s years old. Stock sampling generates a bias, i.e. long jobs are overrepresented as compared to shorter jobs (e.g. Lancaster, 1990; Berger and Black, 1998). This affects the distribution of unobservables in the sample. In the literature we do not find any discussion of the bias induced by stock sampling within the framework of age-specific transition rates. However, if transition rates are linked to age of the individuals, the bias that can occur as a result of stock sampling is closely related to length-biased sampling, as discussed for standard duration models.

For correcting the bias in our transition model, we follow Berger and Black (1998) and augment the individual contribution to the likelihood function for the estimation by conditioning on the survival until a_s, e.g. multiplying the term $\frac{1}{S(a_s-a_0)}$; a_0 is age at the start of the job.[3] Consequently, $S(a_s - a_0)$ is the survival probability at spell length $(a_s - a_0)$.

Given a transition function $\theta(a|t, X)$ that depends on age, duration and covariates, this survival rate can be written as $S(a_s - a_0) = \exp(-\int_{a_0}^{a_s} \theta(a|X)d\,a)$. Putting the survival rate in the individual likelihood contribution for an observed transition at t yields

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\begin{aligned}
L_i &= \theta(a|t, X) \cdot \frac{S(a_t|t, X)}{S(a_s - a_0|t, X)} \\
&= \theta(a|t, X) \cdot exp(-\int_{a_s}^{a_t} \theta(a|t, X)d\,a),
\end{aligned}
\tag{4}
$$

so the part of the integral before stock sampling cancels out in the case without unobserved heterogeneity. We refer to Bergemann and Mertens (2004) who indicate that age effects before the date of stock sampling drop out when correcting for stock sampling. The individual likelihood contribution with the correction for stock sampling is

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[2]In the LIAB data, full information on employees is available from 1993 to 2006 only. With a flow sample in 2002, at most 9 years of duration can be covered.

[3]In other words, it is a probability that is conditional on survival up to age_s. See Lancaster (1990, p. 183) or Berger and Black (1998).

$$L_i \;\; = \;\; [\theta_0(a|t,X) \cdot S(a_t - a_s|t,X)]^{(1-c)} \cdot [S(a_t - a_s|t,X)]^c. \tag{5}$$

5 Data

We use the LIAB, a German longitudinal employer-employee data of the Institute for Employment Research (IAB).[4] This data set contains survey information on establishments in the years 2000 to 2002, and register data of all their employees. We are able to follow employees back to 1975.[5] Employee data stem from German social security employment registers, and from unemployment registers by the Federal Employment Agency. In this data, individual information on wages, tenure, education, experience, profession, and benefit recipiency status is available on a daily basis. Employer information is collected at the establishment level in yearly surveys that typically entail questions on industrial relations, establishment characteristics, and personnel policies.[6] Only employees subject to social security contributions are covered, which is about 80 percent of the German work force. Civil servants, self-employed and inactive individuals are not covered. In the 2002 wave, which is used for our analysis, establishments are interviewed about their application of age-specific measures for older employees.

We sample 2,774 West German establishments and link all their employees they employ in 2002, that is 113,904 employees. We are interested in 'older employees' aged 50 to 65. Establishments with less than five older employees are dropped as we implement establishment fixed effects.

The definition of employment duration in our study is the following: employment duration is the time t an employee spends within the same establishment. An employment duration

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[4]The version of the data set is LIAB longitudinal model 1.

[5]The data set covers full information on employment and unemployment from 1993 on. But we also have information on the start of the current job, given it started after January 1st, 1975. In 1975, register data collection was introduced by the German Federal Employment Agency. Eight percent of jobs are left-censored, e.g. they start before 1975.

[6]The data set is described in more detail in Boockmann and Steffes (2007). Their paper describes definitions of employment, unemployment, and non-employment.

is the period from the start until the end of an employment relationship within a particular establishment. Similar to **?**, we allow the job to be interrupted by up to 92 days, which might be caused by seasonal employment or non-employment. The authors assume this to be a recall to the same employer. Employment ends if either the individual turns to unemployment, another job, non-employment (including the public sector and self-employment), or if the current employer reports the end of the employment relationship to the social insurance institution (compare **?**, who apply the same definition of employment).

Within the LIAB questionnaires in 2002, establishments are asked about SMOE with respect to the six measures discussed in section 3: reduced working time, specific equipment of workplaces, reduced work requirements, age-mixed teams, standard training offered to older employees, and specific training for older employees. The empirical analysis is based on several subsamples of older employees. Establishments are grouped according to application of SMOE. In this way, we obtain six groups of establishments that apply the respective measure, and six different comparison groups that do not apply the respective measure. Descriptive statistics for all establishment groups are shown in table 1. The first obvious difference between establishments offering or not offering SMOE is size, e.g. the number of employees. As an example, establishments that provide training employ on average 2091, those not offering training 1206 employees. Another noticeable difference is the sex ratio, e.g. the share of female employees. Establishments with SMOE have on average fewer female employees. This difference is particularly distinctive for establishments that provide specifically equipped workspaces (24 percent) and offer reduced work requirements (22 percent). Striking differences in establishment characteristics are whether the firm is subject to collective agreements and possesses a works council. Both are clearly more prevalent in establishments with SMOE. Correspondingly, the share of blue collar workers and white collar workers differs.

Our specification uses all individual-specific variables at-hand: sex, nationality, daily wage (mean set to zero), formal education, job position, and type of occupation. We apply fixed effects to capture unobserved heterogeneity on the establishment level. The following section describes the estimation and discusses the empirical results.

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6 Estimation

In this section we consider the empirical relation of SMOE to employment duration of older workers. We investigate age-specific transitions out of employment, since SMOE are expected to affect employment transitions at certain ages. The empirical analysis compares transition rates of establishments with and without SMOE. In fact, the results support the hypothesis that establishments with certain SMOE have fewer transitions of older employees.

Figure 2 shows transition rates of the age profile for all employees aged 20 to 65. The profile shows high transition intensities for younger and for older employees. For middle-aged employees between 30 and 50, the age-specific transitions are low. For the youngest employees, there are higher risks, meaning that employment relationships are unstable. Strong employment risks also exist for older employees reaching official retirement age, i.e. workers aged 60 years and above. After 65, only few transitions out of employment occur.

Figure 2: Age profile of transition rates
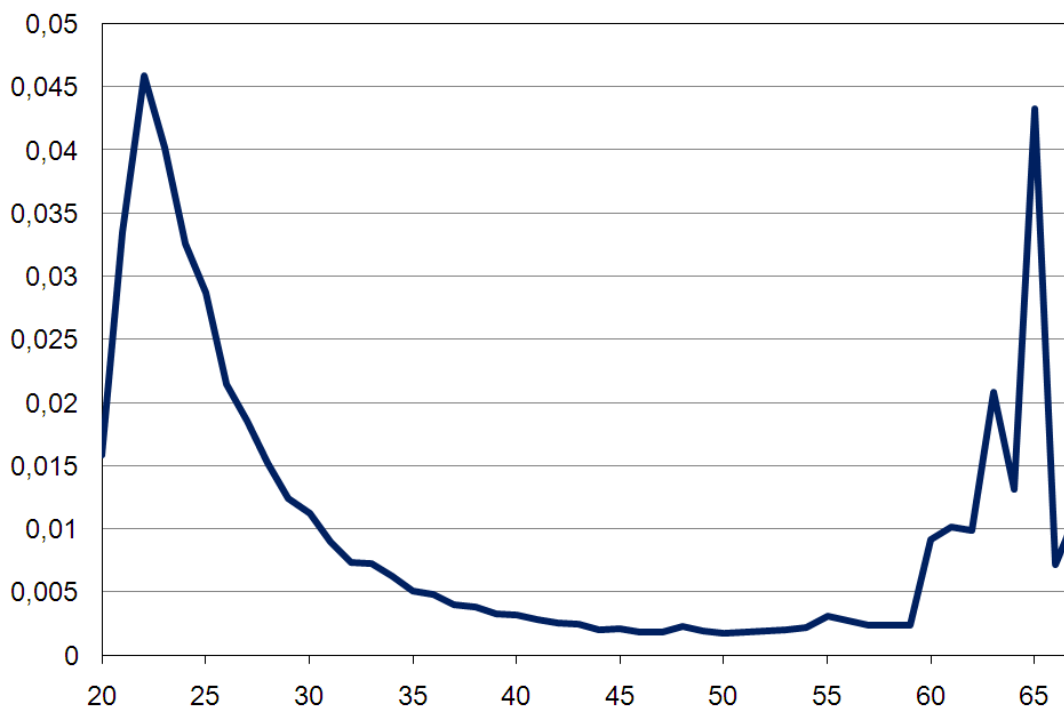
Job exit rates by age. Profile conditional on individual explanatory variables and establishment fixed effects.

In figure 3, descriptive transition rates show the duration profile of older employees. The

profile differs from employment duration of middle-aged employees (compare **?**). By starting employment, transition rates are comparably low. The figure reveals that duration dependence for older employees is less distinctive than for their younger colleagues. These transition rates depict raw data and do neither control for the presence of age dependence nor the bias induced by stock sampling. The following estimations, however, control for age dependence and correct the stock sampling bias.

Figure 3: Duration profile of transition rates
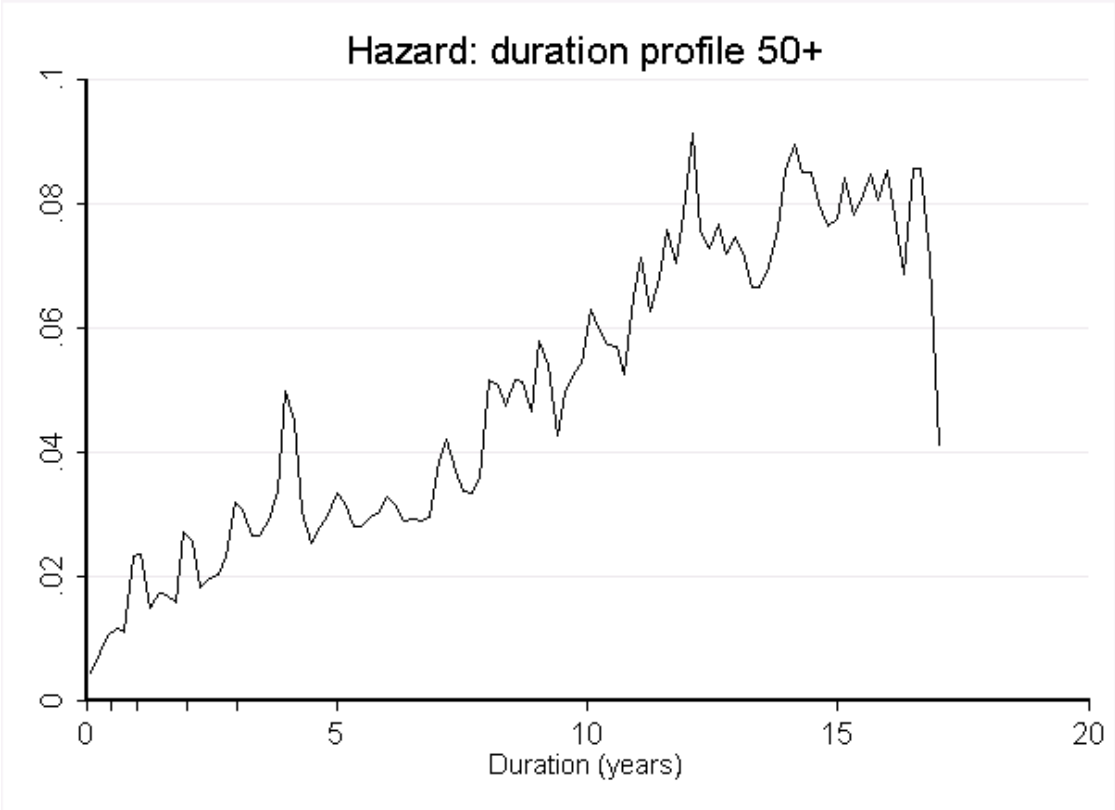
Smoothed Kaplan-Meier transition rates out of employment for older employees; Epanechnikov kernel. Source: LIAB data, own computations.

All age profiles are specified piecewise-constant for each year of age between 50 and 65. We estimate age profiles within establishment groups that apply a certain measure. This leads to six types of establishments. We compare the profile of one establishment type to all other establishments that do not apply the respective SMOE. For comparing profiles between establishment types, all transition rates are normalised by the unconditional baseline without

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covariates.

Age profiles of SMOE are shown in figures 4 to **??**. These figures depict baseline transition rates; the full estimation results can be found in the appendix. In all figures, the solid green line denotes the baseline within establishments that apply the certain SMOE, and the dashed blue line denotes the baseline within establishments that do not apply the respective measure. At a first sight, in nearly all figures the green lies below the blue line, meaning that establishments with SMOE have a reduced baseline transition rate compared to establishments without SMOE.

For establishments offering **reduced work requirements**, the estimated age profile can be found in figure 4. Transition rates are lower for employees of age 54 to 59 and of age 61 to 64. The survival function shows that the measure destinctively prolongs employment up to age 59, where employees have an about 20 percentage points higher probability of remaining in employment than employees in establishments without the measure. Reduced work requirements actually influence employment duration of the elderly.

Transition profiles for **mixed-age work teams** are given by figure 5. Overall, transition rates of establishments with the measure do not differ from establishments that do not apply mixed-age work teams. At age 62, the measure relates to slightly increased transitions, whereagainst at 63, transitions are slightly reduced. Survival of the elderly in employment is practically identical within both types of establishments. The application of mixed-age work teams is not related to employment duration.

We analyse the transition profile of establishments that apply **specific equipment of workplaces** in figure 7. A specifically equipped workplace can be related to longer employment duration, when an employee would leave the job due to physical deficiencies. This relation depends on individual capabilities and age, so we do not expect a collective effect at a certain age. Older workers in establishments with specifically equipped workplace have clearly reduced transitions. At ages 60 and 63, transitions are not related to the measures, which could mean that external influence drives workers to exit employment. Workers that conjecturally use the measure stay in employment with a much higher probability: at age 59,

the difference to employees that work in other establishments is highest with about 25 percentage points. A specific equipment of workplaces is positively related to prolonged employment duration of the elderly.

In figure 6 we find the transition profiles of those establishments that do and those that do not offer **reduced work time**. A reduction in work time is related to reduced transitions before age 61, and higher transitions afterwards. This might be an influence of the part-time scheme, which in many cases implied that workers were employed full-time until 63 and were allowed to retire at this age. This finding is confirmed by the survival functions: establishments that offer reduced work time are more able to keep older employees. At age 60, about 45 percent of the elderly are still working, against only 20 percent in establishments that do not offer the measure. Afterwards, survival functions do not differ sustantially. Overall, the measure is related to longer employment duration of the elderly.

Finally, figures 8 and **??** show the profiles for **general training** and **age-specific training**, respectively. While giving older workers access to the standard training program of the firm, the employer is probably interested in keeping them in employment. Transition rates of these establishments show the same pattern like establishments without the measure. At age 62, transitions of participants are lower, whereagainst at 60 and 63 they are higher than for nonparticipants. But overall, survival of older employees is thoroughly higher in establishments that allow them to participate in the standard training program.

In all estimated models, the estimated Weibull parameter of duration dependence is larger than one. This means that duration dependence is actually positive, though close to constant. The Weibull distribtion depicts the underlying transition pattern of figure 3. Positive duration dependence for older employees contrasts the typical finding of negative duration dependence for the employment of prime-aged workers (compare **?**).

7 Conclusions

Many firms acutally apply specific human resource measures for older employees: every other establishment applies at least one specific human resource measure for older employees

(SMOE). A variety of measures is used by firms to react to the employment of the elderly. These measures cover different aspects, like the equipment of workspaces, work time and intensity, mixed-age work teams, and training.

We show that some SMOE are positively related to employment of older employees, i.e. transitions out of employment are lower in firms that apply SMOE. Reduced work requirements, reduced work time, and a specific equipment of workplaces reduce transition rates of older employees, in particular for those employees who are 55 to 59 years old. Surprisingly, a reduction in work time is actually related to longer employment duration. We did not expect this result, as reduced work time is mostly adopted in combination with a pathway to early retirement. We suppose that employees with reduced work time retire early compared to statutory retirement age, but late compared to employees in establishments that do not apply the measure. The application of mixed-age work teams and the offer to access the standard training program of the firm are not related to age-specific tranistion rates of older employees. Explanations for the noneffectiveness of these measures are that they either lack of proper implementation or that the underlying mechanisms are not able to alter transitions of older employees. None of the analysed measures relates to employment duration in a negative way, e.g. that the measure shortens employment duration of older employees. We suggest that these measures do not cause occupational stress which drives employees to quit.

Our analysis is based on the relation of SMOE to employment duration of older employees. We are not able to draw causal conclusions on the effectiveness of these measures. For further research, we address causal analysis of SMOE on employment duration. As questions on SMOE have been resurveyed in the waves of 2006 and 2008, future analysis of their effectiveness can be based on longitudinal application of these human resource measures by establishments.

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Appendix

A.1 Question #50 from 2002 wave of the IAB establishment panel survey

'Which of the following measures concerning employment of older workers do you apply in your establishment?'

- reduced working time

- specific equipment of workplaces

- reduced work requirements

- mixed-age work teams

- involvement of older workers in general training program

- specific training for older workers

- no measures for older workers.

A.2 Technical appendix

Starting with the likelihood contribution for an individual that has a transition out of employment at a certain *age* and duration t, we obtain the following equation:

$$
\begin{aligned}
f(\text{age}, t, X, V) &= h(\text{age}|t, X) \cdot S_e(\text{age}|t, X) \qquad\qquad (6) \\
&= h(\text{age}|t, X) \cdot exp(-\int_{age_0}^{age} h(\text{age}|t, X) \, d\,\text{age}).
\end{aligned}
$$

The integral is computed over age and duration simultaneously, since with each time period the individual stays in employment she also grows one period older. In other words, the duration corresponds to age at a certain point in time minus age at employment start, $t = \text{age} - \text{age}_0$:

$$f(\text{age}, t, X) \quad = \quad h(\text{age}|t, X) \cdot exp(-\int_{age_0}^{age} h(\text{age}|\text{age} - \text{age}_0, X) \, d\,\text{age}). \tag{7}$$

This involves the computation of the integrated age-specific transition rate

$$\int_{age_0}^{age} h(\text{age}|\cdot) \, d\text{age} = \int_{age_0}^{age} h_0(\text{age}) \cdot \theta(\text{age} - \text{age}_0)^{\theta-1} \cdot \exp(X'\beta) \, d\text{age}, \tag{8}$$

where $h_0(\text{age})$ is a piecewise constant baseline transition rate, $(\text{age} - \text{age}_0)^{\theta}$ is the parametric form of duration dependence and $\exp(X'\beta)$ is the explanatory part. Solving this integral involves summing up the piecewise parts of the integral, which is computed analytically by using maximum likelihood.

Table 1: Descriptive statistics on employees and establishments

Variable	reduced work time				specific equipment of workplaces				reduced work requirements			
	with measure		without measure		with measure		without measure		with measure		without measure	
	mean	s.d.	mean	s.d.	mean	s.d.	mean	s.d.	mean	s.d.	mean	s.d.
Employee characteristics												
sex	0.32	0.47	0.40	0.49	0.24	0.43	0.35	0.48	0.22	0.41	0.36	0.48
job position												
unskilled	0.25	0.43	0.27	0.44	0.37	0.48	0.23	0.42	0.35	0.48	0.23	0.42
skilled	0.16	0.37	0.19	0.39	0.19	0.39	0.16	0.37	0.21	0.41	0.16	0.36
white-collar	0.39	0.49	0.31	0.46	0.31	0.46	0.40	0.49	0.33	0.47	0.40	0.49
other	0.19	0.39	0.22	0.42	0.13	0.33	0.21	0.41	0.11	0.32	0.22	0.41
education												
lower secondary	0.21	0.41	0.29	0.45	0.27	0.44	0.21	0.41	0.24	0.43	0.21	0.41
higher secondary	0.60	0.49	0.54	0.50	0.57	0.50	0.59	0.49	0.53	0.50	0.61	0.49
lower tertiary	0.01	0.08	0.00	0.06	0.00	0.06	0.01	0.08	0.00	0.06	0.01	0.08
higher tertiary	0.02	0.14	0.02	0.13	0.02	0.12	0.02	0.14	0.01	0.11	0.02	0.14
polytec	0.05	0.21	0.02	0.15	0.05	0.21	0.04	0.20	0.05	0.22	0.04	0.20
university	0.06	0.25	0.04	0.18	0.05	0.22	0.06	0.25	0.04	0.20	0.07	0.25
other	0.06	0.23	0.09	0.29	0.05	0.21	0.06	0.25	0.12	0.33	0.05	0.21
daily wage	100.12	35.62	77.36	39.53	102.51	32.84	96.99	37.30	106.61	32.30	95.74	37.34
nationality: not German	0.11	0.32	0.10	0.31	0.14	0.35	0.11	0.31	0.16	0.36	0.10	0.30
job type												
standard full-time	0.89	0.31	0.91	0.28	0.90	0.30	0.89	0.31	0.91	0.29	0.89	0.31
old-age part-time	0.09	0.29	0.01	0.10	0.09	0.29	0.08	0.28	0.08	0.28	0.08	0.28
other	0.02	0.13	0.08	0.27	0.01	0.11	0.03	0.16	0.01	0.09	0.03	0.16
age in 2002	54.99	3.82	55.32	4.19	54.82	3.72	55.07	3.88	54.78	3.70	55.09	3.90
entry after 1975	1.00	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00	0.00
exit before 2003	0.12	0.32	0.19	0.39	0.10	0.30	0.13	0.34	0.10	0.31	0.13	0.34
N of individuals	69,436		7,460		12,920		63,976		15,404		61,492	
Establishment characteristics												
employees in 2001	833.60	1628.14	154.99	349.05	906.14	1319.77	545.08	1350.29	1066.23	2247.00	519.19	1168.66
employees in 2002	826.44	1650.12	153.42	357.47	895.98	1327.18	540.58	1368.49	1077.86	2315.09	511.86	1172.27
ICT	0.79	0.41	0.58	0.49	-	-	0.69	0.44	-	-	0.69	0.46
collective agreement (industry)	0.82	0.38	0.61	0.49	-	-	0.74	0.44	0.80	0.40	0.74	0.44
collective agreement (firm)	0.09	0.29	-	-	-	-	0.08	0.27	-	-	0.07	0.26
wages above agreement	0.07	0.26	0.20	0.40	-	-	0.12	0.33	-	-	0.13	0.33
legal form												
individual firm	-	-	0.09	0.29	0.00	0.00	0.04	0.20	-	-	0.04	0.19
partnership	0.08	0.28	0.11	0.32	-	-	0.09	0.29	-	-	0.09	0.29
private limited	0.41	0.49	0.59	0.49	0.48	0.50	0.48	0.50	0.48	0.50	0.48	0.50
public limited	0.18	0.38	-	-	-	-	0.12	0.33	-	-	0.12	0.33
corporate	0.25	0.43	0.07	0.26	-	-	0.18	0.38	-	-	0.18	0.39
other	0.07	0.26	0.09	0.29	-	-	0.08	0.28	-	-	0.08	0.28
works council	0.93	0.25	0.43	0.50	-	-	0.72	0.45	-	-	0.73	0.45
employment change	-0.01	0.15	0.01	0.30	0.01	0.10	0.01	0.23	0.00	0.10	-0.01	0.23
share of. . .												
blue collar (unskilled)	19.03	22.56	27.79	29.45	26.65	24.97	21.73	25.70	29.43	26.90	21.30	25.34
blue collar (skilled)	21.59	22.73	28.09	29.35	26.28	23.81	23.71	25.75	26.06	22.20	23.71	25.96
white collar (low-skilled)	4.51	10.41	6.79	15.92	6.21	13.55	5.25	12.67	5.17	10.51	5.38	13.04
white collar (high-skilled)	50.11	30.56	31.28	29.89	37.05	28.55	43.91	31.92	35.16	26.93	44.24	32.08
age of employees	41.60	3.23	42.50	4.40	41.90	2.92	41.94	3.81	41.27	3.11	42.02	3.80
share of female employees	0.38	0.27	0.40	0.29	0.33	0.26	0.40	0.28	0.34	0.26	0.40	0.28
share of older employees	0.27	0.10	0.31	0.15	0.28	0.10	0.29	0.12	0.26	0.10	0.29	0.12
N of establishments	569		332		96		805		106		795	

Variable	mixed-age work teams				standard training				specific training			
	with measure		without measure		with measure		without measure		with measure		without measure	
	mean	s.d.	mean	s.d.	mean	s.d.	mean	s.d.	mean	s.d.	mean	s.d.
Employee characteristics												
sex	0.32	0.47	0.34	0.47	0.30	0.46	0.35	0.48	0.32	0.47	0.33	0.47
job position												
unskilled	0.26	0.44	0.24	0.43	0.24	0.43	0.26	0.44	0.21	0.41	0.25	0.43
skilled	0.19	0.39	0.15	0.36	0.19	0.39	0.15	0.36	0.09	0.29	0.17	0.38
white-collar	0.37	0.48	0.40	0.49	0.40	0.49	0.37	0.48	0.54	0.50	0.38	0.48
other	0.17	0.38	0.21	0.41	0.17	0.38	0.21	0.41	0.15	0.36	0.20	0.40
education												
lower secondary	0.23	0.42	0.21	0.41	0.21	0.41	0.22	0.42	0.16	0.36	0.22	0.42
higher secondary	0.60	0.49	0.58	0.49	0.58	0.49	0.60	0.49	0.46	0.50	0.60	0.49
lower tertiary	0.00	0.07	0.01	0.09	0.01	0.08	0.01	0.08	0.01	0.08	0.01	0.08
higher tertiary	0.02	0.14	0.02	0.13	0.02	0.14	0.02	0.13	0.02	0.14	0.02	0.14
polytec	0.04	0.20	0.05	0.21	0.04	0.21	0.04	0.20	0.05	0.23	0.04	0.20
university	0.06	0.25	0.06	0.24	0.07	0.25	0.06	0.23	0.09	0.29	0.06	0.24
other	0.04	0.19	0.07	0.26	0.07	0.25	0.06	0.23	0.21	0.41	0.05	0.22
daily wage	99.80	34.66	96.79	37.73	102.73	35.17	94.35	37.30	113.46	35.58	96.99	36.50
nationality: not German	0.12	0.32	0.11	0.31	0.12	0.32	0.11	0.31	0.08	0.27	0.11	0.32
job type												
standard full-time	0.89	0.31	0.89	0.31	0.89	0.31	0.89	0.31	0.86	0.34	0.89	0.31
old-age part-time	0.09	0.29	0.08	0.27	0.09	0.29	0.08	0.27	0.12	0.33	0.08	0.27
other	0.02	0.13	0.03	0.16	0.02	0.13	0.03	0.16	0.02	0.12	0.02	0.15
age in 2002	54.90	3.77	55.10	3.91	54.96	3.79	55.07	3.91	54.99	3.89	55.03	3.86
entry after 1975	1.00	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00	0.00
exit before 2003	0.12	0.33	0.13	0.33	0.11	0.32	0.13	0.34	0.15	0.35	0.12	0.33
N of individuals	28,696		48,200		32,726		44,170		4,331		72,565	
Establishment characteristics												
employees in 2001	841.48	1304.99	498.71	1355.98	983.17	1773.58	446.57	1141.42	-	-	566.19	1337.85
employees in 2002	823.61	1269.49	497.81	1390.13	972.33	1778.51	443.43	1166.44	-	-	561.12	1355.56
ICT	0.80	0.40	0.68	0.47	0.85	0.36	0.66	0.47	-	-	0.71	0.45
collective agreement (industry)	0.80	0.40	0.72	0.45	0.78	0.42	0.73	0.44	-	-	0.75	0.43
collective agreement (firm)	-	-	0.09	0.28	0.09	0.29	0.08	0.27	-	-	0.08	0.27
wages above agreement	0.12	0.32	0.12	0.33	0.12	0.32	0.12	0.33	-	-	0.12	0.33
legal form												
individual firm	-	-	0.05	0.21	-	-	0.05	0.21	-	-	0.04	0.19
partnership	0.10	0.30	0.09	0.29	0.10	0.30	0.09	0.29	-	-	0.10	0.30
private limited	0.42	0.49	0.50	0.50	0.37	0.48	0.51	0.50	-	-	0.48	0.50
public limited	0.18	0.39	0.11	0.31	0.23	0.42	0.09	0.29	-	-	0.13	0.33
corporate	0.20	0.40	0.18	0.38	0.19	0.39	0.18	0.38	-	-	0.18	0.39
other	-	-	0.08	0.27	0.10	0.29	0.07	0.26	-	-	0.08	0.27
works council	0.90	0.30	0.70	0.46	0.90	0.30	0.69	0.46	-	-	0.74	0.44
employment change	-0.02	0.12	0.01	0.24	0.01	0.13	-0.01	0.24	-	-	-0.01	0.22
share of...												
blue collar (unskilled)	20.82	24.86	22.73	25.91	18.21	21.92	23.65	26.68	-	-	22.27	25.62
blue collar (skilled)	26.55	26.53	23.14	25.18	21.02	22.72	25.00	26.39	-	-	24.11	25.68
white collar (low-skilled)	4.34	9.80	5.69	13.59	5.45	12.64	5.32	12.82	-	-	5.42	12.87
white collar (high-skilled)	43.28	31.10	43.14	31.83	50.37	31.32	40.71	31.39	-	-	42.96	31.61
age of employees	41.65	3.26	42.02	3.87	41.50	3.52	42.08	3.79	-	-	41.97	3.73
share of female employees	0.38	0.28	0.39	0.27	0.38	0.27	0.39	0.28	-	-	0.39	0.28
share of older employees	0.28	0.11	0.29	0.13	0.28	0.11	0.29	0.12	-	-	0.29	0.12
N of establishments	223		678		230		671		19*		882	

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Table 2: Estimation: reduced work requirements

	with measure			without measure		
variable	estimate	std. err.		estimate	std. err.	
entry after 1975	0.803	0.051	***	0.925	0.035	***
sex	-0.059	0.054		-0.005	0.041	
nationality: not German	-0.173	0.065	***	-0.275	0.046	***
daily wage	-0.017	0.001	***	-0.012	0.001	***
job position (ref.: unskilled)						
skilled	-0.149	0.065	**	0.182	0.054	***
white-collar	0.164	0.065	**	0.057	0.054	
other	-0.387	0.080	***	0.066	0.058	
job type (ref.: standard full-time)						
old-age part-time	0.596	0.078	***	0.005	0.056	
other	0.368	0.169	**	0.022	0.070	
education (ref.: lower secondary)						
higher secondary	0.211	0.052	***	0.035	0.038	
lower tertiary	-1.322	0.297	***	-0.089	0.198	
higher tertiary	-0.486	0.123	***	0.322	0.121	***
polytec	0.263	0.121	**	-0.075	0.087	
university	0.736	0.154	***	0.355	0.090	***
other	-0.581	0.100	***	0.720	0.077	***
age: 50 (normalized)	-20.172	0.215	***	-16.994	0.144	***
51	0.556	0.124	***	0.414	0.087	***
52	0.689	0.130	***	0.430	0.088	***
53	0.700	0.130	***	0.711	0.084	***
54	0.668	0.131	***	0.925	0.083	***
55	1.029	0.124	***	1.301	0.078	***
56	0.872	0.127	***	1.506	0.080	***
57	0.976	0.128	***	1.256	0.084	***
58	0.805	0.128	***	1.217	0.083	***
59	1.122	0.127	***	1.203	0.084	***
60	2.608	0.112	***	1.955	0.076	***
61	2.377	0.114	***	2.381	0.075	***
62	2.471	0.127	***	2.368	0.082	***
63	3.271	0.124	***	3.030	0.076	***
64	3.166	0.128	***	2.948	0.081	***
65	4.250	0.154	***	3.571	0.095	***
66	4.231	0.259	***	3.745	0.108	***
67	1.831	0.288	***	4.007	0.284	***
Weibull: α^2	1.700	0.009	***	1.581	0.006	***
establishment dummies	$\surd$			$\surd$		

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Table 3: Estimation: mixed-age work teams

variable	with measure			without measure		
	estimate	std. err.		estimate	std. err.	
entry after 1975	0.861	0.037	***	0.882	0.042	***
sex	0.036	0.039		-0.069	0.046	
nationality: not German	-0.338	0.045	***	-0.181	0.059	***
daily wage	-0.014	0.000	***	-0.016	0.001	***
job position (ref.: unskilled)						
skilled	0.110	0.048	**	-0.148	0.063	**
white-collar	0.119	0.050	**	0.334	0.057	***
other	-0.110	0.052	**	0.186	0.060	***
job type (ref.: standard full-time)						
old-age part-time	0.173	0.054	***	0.319	0.056	***
other	0.033	0.069		-0.443	0.074	***
education (ref.: lower secondary)						
higher secondary	0.091	0.036	**	0.022	0.045	
lower tertiary	-0.059	0.213		-0.604	0.158	***
higher tertiary	0.448	0.119	***	0.310	0.141	**
polytec	0.292	0.087	***	-0.004	0.092	
university	0.534	0.085	***	0.312	0.099	***
other	0.511	0.075	***	-0.123	0.075	
age: 50 (normalized)	-18.159	0.150	***	-16.473	0.162	***
51	0.565	0.089	***	0.536	0.103	***
52	0.538	0.093	***	0.570	0.102	***
53	0.711	0.090	***	0.718	0.100	***
54	0.936	0.088	***	0.600	0.105	***
55	1.427	0.082	***	0.877	0.098	***
56	1.434	0.084	***	0.993	0.100	***
57	1.449	0.086	***	0.649	0.106	***
58	1.267	0.087	***	0.732	0.101	***
59	1.329	0.087	***	0.864	0.100	***
60	2.438	0.078	***	2.012	0.088	***
61	2.634	0.079	***	2.231	0.088	***
62	2.672	0.084	***	2.201	0.093	***
63	3.149	0.083	***	2.984	0.088	***
64	3.178	0.089	***	2.807	0.099	***
65	3.684	0.095	***	3.687	0.106	***
66	4.026	0.127	***	4.257	0.122	***
67	4.510	0.337	***	3.079	0.175	***
Weibull: α^2	1.700	0.009	***	1.581	0.006	***
establishment dummies	$\sqrt{}$			$\sqrt{}$		

Table 4: Estimation: specific equipment of workplaces

	with measure			without measure		
variable	estimate	std. err.		estimate	std. err.	
entry after 1975	0.843	0.063	***	0.846	0.038	***
sex	-0.028	0.071		-0.070	0.042	*
nationality: not German	-0.012	0.076		-0.321	0.047	***
daily wage	-0.018	0.001	***	-0.013	0.001	***
job position (ref.: unskilled)						
skilled	0.108	0.076		0.047	0.051	
white-collar	0.109	0.084		0.182	0.054	***
other	-0.122	0.093		0.015	0.057	
job type (ref.: standard full-time)						
old-age part-time	0.277	0.079	***	0.162	0.059	***
other	0.190	0.145		0.007	0.067	
education (ref.: lower secondary)						
higher secondary	0.078	0.066		0.061	0.037	
lower tertiary	0.382	0.387		-0.351	0.263	
higher tertiary	-0.408	0.127	***	0.624	0.126	***
polytec	0.263	0.160	*	0.221	0.095	**
university	0.500	0.146	***	0.446	0.093	***
other	0.004	0.123		0.130	0.068	*
age: 50 (normalized)	-19.399	0.257	***	-18.489	0.157	***
51	0.662	0.165	***	0.617	0.093	***
52	0.490	0.170	***	0.722	0.095	***
53	0.758	0.162	***	0.980	0.093	***
54	0.802	0.161	***	1.046	0.093	***
55	1.231	0.154	***	1.577	0.086	***
56	1.295	0.156	***	1.610	0.087	***
57	1.179	0.158	***	1.575	0.092	***
58	1.119	0.156	***	1.451	0.090	***
59	1.285	0.156	***	1.493	0.090	***
60	2.835	0.139	***	2.303	0.084	***
61	2.658	0.146	***	2.638	0.083	***
62	2.885	0.150	***	2.641	0.088	***
63	3.610	0.149	***	3.158	0.086	***
64	3.464	0.169	***	3.254	0.092	***
65	4.478	0.170	***	3.915	0.095	***
66	4.692	0.270	***	4.323	0.134	***
67	4.323	0.438	***	4.468	0.318	***
Weibull: α^2	1.624	0.010	***	1.585	0.006	***
establishment dummies	$\sqrt{}$			$\sqrt{}$		

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Table 5: Estimation: reduced work time

variable	with measure			without measure		
	estimate	std. err.		estimate	std. err.	
entry after 1975	0.933	0.034	***	1.084	0.106	***
sex	0.040	0.036		-0.459	0.085	***
nationality: not German	-0.197	0.044	***	0.043	0.105	
daily wage	-0.015	0.000	***	-0.018	0.001	***
job position (ref.: unskilled)						
skilled	-0.008	0.048		-0.093	0.110	
white-collar	0.201	0.045	***	0.336	0.108	***
other	0.128	0.052	**	0.196	0.119	*
job type (ref.: standard full-time)						
old-age part-time	0.304	0.048	***	0.090	0.319	
other	-0.071	0.073		-0.440	0.134	***
education (ref.: lower secondary)						
higher secondary	0.076	0.035	**	-0.012	0.090	
lower tertiary	-0.316	0.151	**	-0.043	0.455	
higher tertiary	0.531	0.110	***	-0.339	0.205	*
polytec	0.152	0.078	*	0.153	0.207	
university	0.256	0.082	***	0.394	0.222	*
other	-0.226	0.071	***	0.452	0.130	***
age: 50 (normalized)	-18.331	0.140	***	-11.614	0.282	***
51	0.572	0.083	***	0.478	0.147	***
52	0.761	0.084	***	0.489	0.156	***
53	0.683	0.087	***	0.912	0.145	***
54	0.794	0.085	***	0.761	0.147	***
55	0.868	0.084	***	1.101	0.147	***
56	0.926	0.085	***	1.049	0.155	***
57	0.775	0.088	***	0.984	0.172	***
58	0.802	0.086	***	0.784	0.168	***
59	1.092	0.083	***	1.107	0.156	***
60	2.176	0.075	***	1.607	0.145	***
61	2.448	0.075	***	1.713	0.145	***
62	2.492	0.080	***	1.515	0.159	***
63	3.249	0.077	***	2.368	0.144	***
64	3.340	0.083	***	2.433	0.162	***
65	3.913	0.092	***	2.754	0.185	***
66	4.199	0.126	***	2.564	0.223	***
67	4.425	0.282	***	2.667	0.396	***
Weibull: α^2	1.598	0.006	***	1.236	0.013	***
establishment dummies	$\checkmark$			$\checkmark$		

Table 6: Estimation: standard training for older employees

	with measure			without measure		
variable	estimate	std. err.		estimate	std. err.	
entry after 1975	0.791	0.036	***	1.013	0.046	***
sex	0.057	0.039		0.027	0.050	
nationality: not German	-0.248	0.043	***	-0.092	0.056	
daily wage	-0.013	0.000	***	-0.015	0.001	***
job position (ref.: unskilled)						
skilled	0.224	0.048	***	-0.029	0.068	
white-collar	0.197	0.049	***	-0.065	0.065	
other	0.049	0.053		-0.084	0.070	
job type (ref.: standard full-time)						
old-age part-time	0.234	0.050	***	0.110	0.068	
other	0.043	0.072		-0.130	0.099	
education (ref.: lower secondary)						
higher secondary	0.052	0.037		0.073	0.048	
lower tertiary	-0.225	0.145		-0.030	0.274	
higher tertiary	0.134	0.090		0.404	0.173	**
polytec	0.192	0.083	**	0.098	0.117	
university	0.388	0.083	***	0.414	0.116	***
other	0.399	0.070	***	0.426	0.113	***
age: 50 (normalized)	-17.733	0.143	***	-16.841	0.183	***
51	0.577	0.096	***	0.459	0.094	***
52	0.503	0.099	***	0.550	0.098	***
53	0.740	0.094	***	0.740	0.095	***
54	1.039	0.091	***	0.682	0.097	***
55	1.465	0.087	***	0.819	0.097	***
56	1.585	0.088	***	0.913	0.098	***
57	1.435	0.089	***	0.865	0.102	***
58	1.364	0.089	***	0.851	0.099	***
59	1.421	0.090	***	0.953	0.098	***
60	2.531	0.081	***	1.703	0.088	***
61	2.665	0.082	***	2.115	0.087	***
62	2.642	0.087	***	2.203	0.097	***
63	3.406	0.084	***	2.723	0.091	***
64	3.336	0.089	***	2.768	0.099	***
65	3.930	0.099	***	3.486	0.124	***
66	4.231	0.130	***	3.422	0.154	***
67	4.816	0.294	***	2.371	0.207	***
Weibull: α^2	1.612	0.006	***	1.514	0.007	***
establishment dummies	$\checkmark$			$\checkmark$		

Table 7: Estimation: specific training for older employees

|	with measure			without measure		
variable	estimate	std. err.		estimate	std. err.	
entry after 1975	0.950	0.094	***	0.092	0.045	**
sex	0.153	0.085	*	-0.085	0.049	*
nationality: not German	-0.496	0.139	***	-0.026	0.057	
daily wage	-0.014	0.002	***	-0.013	0.001	***
job position (ref.: unskilled)						
skilled	-0.084	0.164		0.084	0.061	
white-collar	-0.087	0.123		0.139	0.061	**
other	-0.339	0.117	***	-0.041	0.066	
job type (ref.: standard full-time)						
old-age part-time	0.278	0.108	**	0.380	0.068	***
other	-0.036	0.222		-1.268	0.104	***
education (ref.: lower secondary)						
higher secondary	0.342	0.097	***	0.039	0.047	
lower tertiary	0.208	0.321		-0.036	0.269	
higher tertiary	0.505	0.322		0.166	0.136	
polytec	0.298	0.203		0.119	0.104	
university	0.738	0.193	***	0.079	0.096	
other	0.754	0.177	***	-0.078	0.110	
age: 50 (normalized)	-20.291	0.371	***	-3.864	0.132	***
51	0.309	0.168	***	12.767	0.094	***
52	0.588	0.187	***	12.948	0.095	***
53	0.546	0.197	***	12.936	0.095	***
54	0.346	0.200	***	13.084	0.095	***
55	0.841	0.183	***	13.101	0.095	***
56	0.474	0.194	***	13.285	0.095	***
57	0.714	0.205	***	12.999	0.101	***
58	0.403	0.216	***	12.980	0.100	***
59	0.497	0.216	***	13.311	0.095	***
60	1.869	0.180	***	14.263	0.084	***
61	2.060	0.168	***	14.456	0.086	***
62	2.540	0.185	***	14.513	0.093	***
63	3.633	0.190	***	15.177	0.088	***
64	3.032	0.199	***	15.253	0.102	***
65	3.901	0.257	***	15.555	0.106	***
66	5.836	0.428	***	15.876	0.175	***
67	5.240	0.848	***	15.965	0.238	***
Weibull: α^2	1.717	0.015	***	0.000	0.000	***
establishment dummies	$\sqrt{}$			$\sqrt{}$		

Figure 4: Reduced work requirements
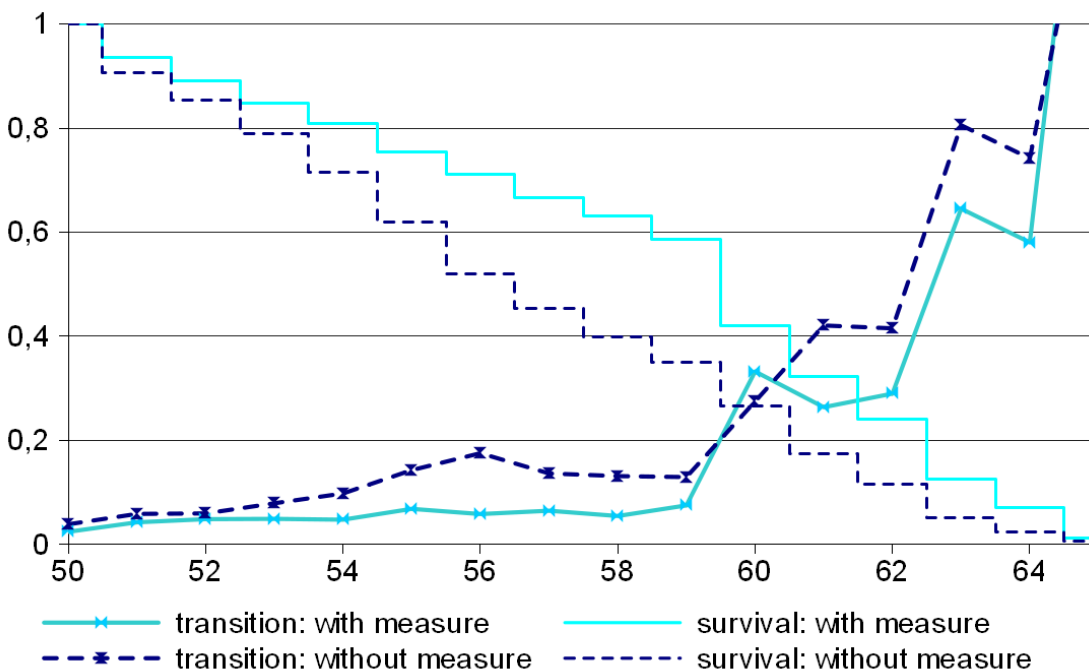
Transition rates by age.
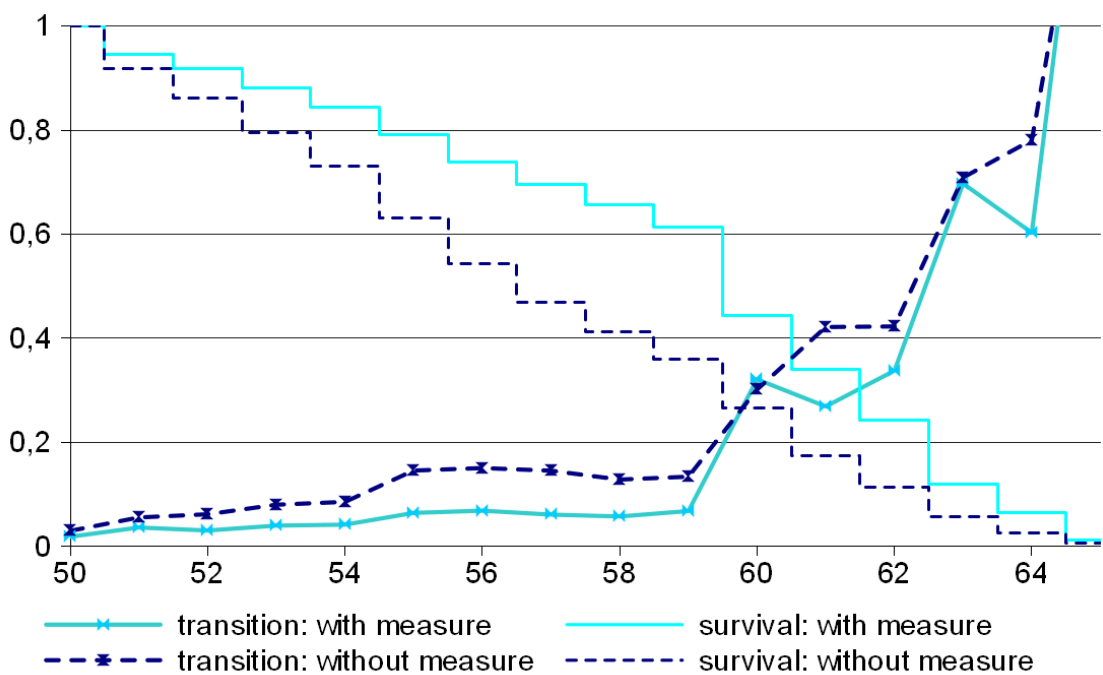

Figure 5: Mixed-age work teams
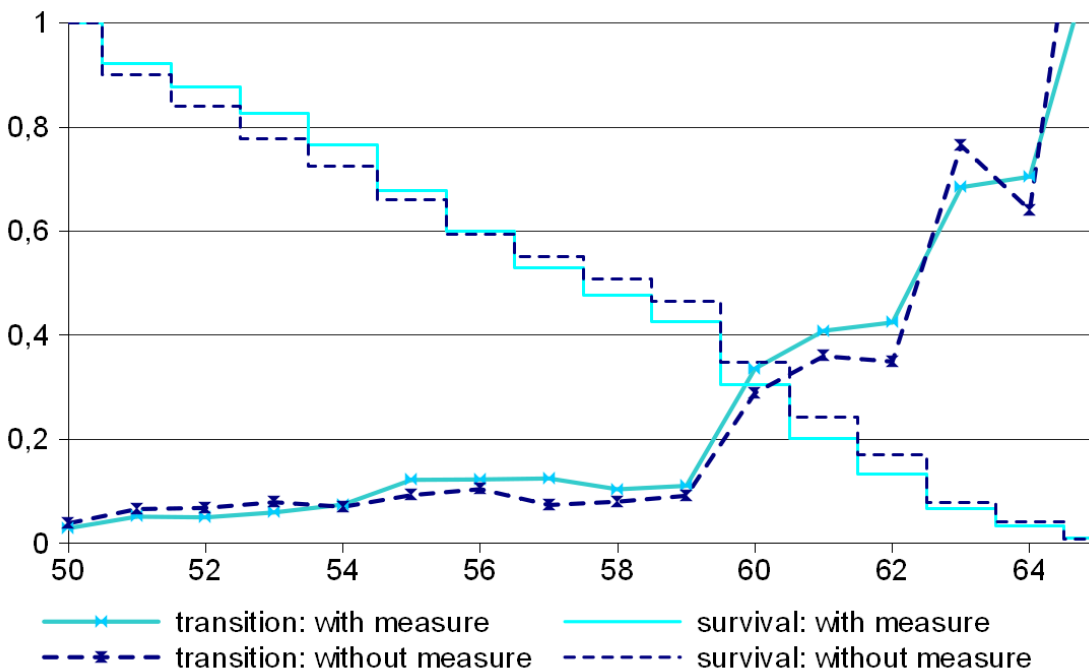
Transition rates by age.
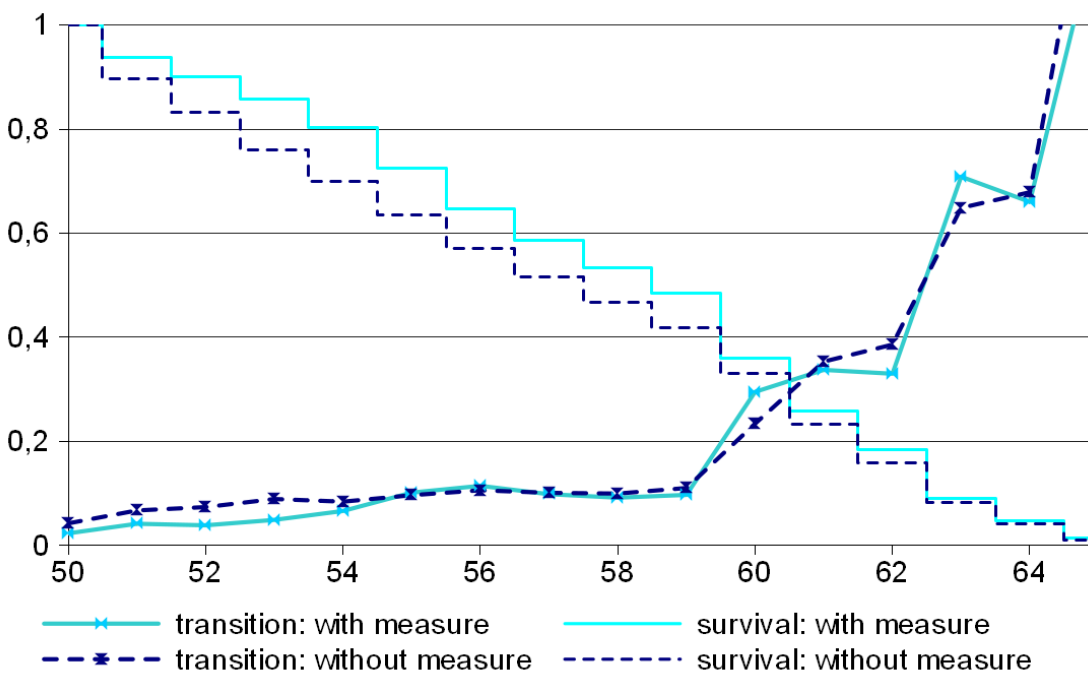
Figure 6: Reduced work time
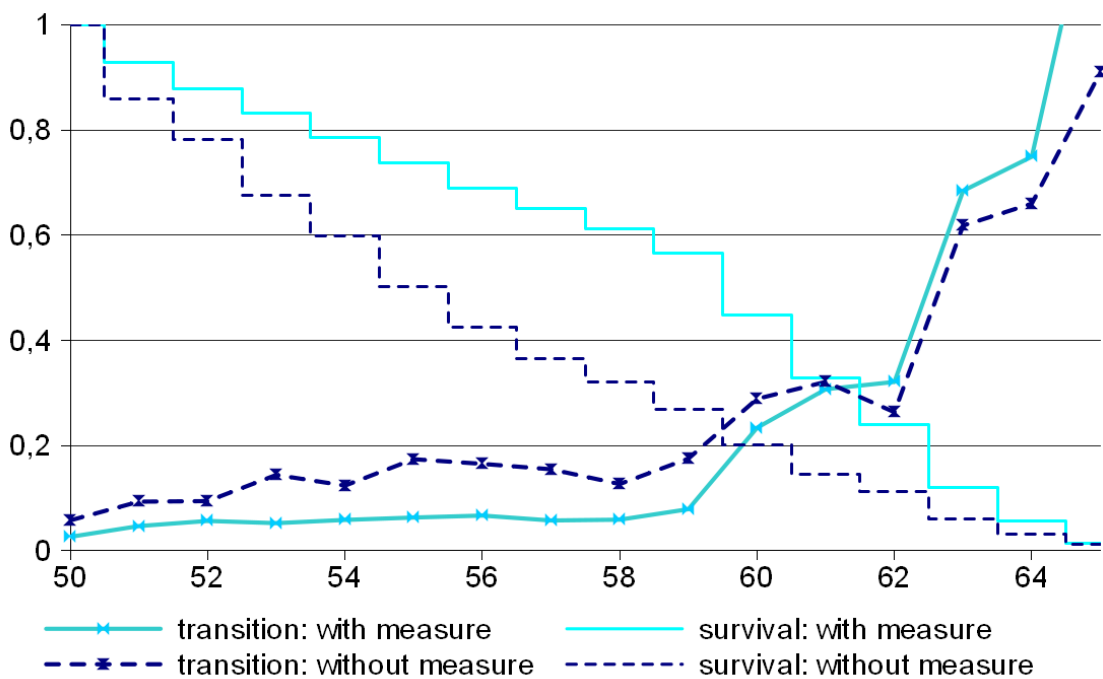
Transition rates by age.

Figure 7: Specific equipment of workplaces

Transition rates by age.

Figure 8: Standard training for older employees

Transition rates by age.