Estimating the latent effect of unemployment benefits on unemployment duration

Simon M.S. Lo*, Gesine Stephan†, Ralf A. Wilke‡

August 2011

Keywords: dependent censoring, partial identification, difference-in-differences
JEL: C34, C41, J64

Abstract: We apply a new method to infer changes in latent distributions of competing risks based on observable changes in the cumulative incidences. Our analysis takes into account that the competing risks model is not identified and we derive bounds for treatment effects of the 2006 reduction in unemployment benefit entitlement lengths in Germany (Hartz reform). In many cases these bounds are tight enough to identify the direction and the timing of the effect. By having access to very large administrative individual data we are able to estimate heterogeneous treatment effects on a number of highly policy relevant risks. We find only little evidence for effects on unemployed with low pre-unemployment earnings, but an increase in the probability of entering full-time employment and in particular subsidized self-employment for unemployed with higher pre-unemployment earnings.

*Lingnan University, Rm 218, Ho Sin Hang Building, Lingnan University, Hong Kong, E–mail: simonlo@ln.edu.hk .

†Institute for Employment Research (IAB) and University of Erlangen Nuremberg, Regensburger Str. 104, 90478 Nuremberg, Germany, E–mail: gesine.stephan@iab.de

‡University of Nottingham, School of Economics, University Park, Nottingham NG7 2RD, United Kingdom, Phone: +441159515248, E–mail: ralf.wilke@nottingham.ac.uk

1 Introduction

The effect of unemployment benefits on unemployment duration has been investigated by numerous theoretical and econometric studies. First, it is an important policy topic how the unemployment compensation system affects individual labor market outcomes. Second, the identifiability of the effect is hampered by several important methodological problems, which still need to be resolved. Various contributions have developed advanced economic theory and econometric models and have performed detailed empirical analysis. The results, however, are still subject to a number of assumptions, which are hard to verify. In this paper we contribute to this literature by choosing an unconventional empirical strategy, which has been just recently developed. In particular, we estimate a competing risks unemployment duration model in which the unemployed can make a transition to various destination states. Without assuming the dependence structure between risks or the functional form of the marginal distributions of latent durations, the competing risks model is not identified. In our approach, we do not assume non-identifiability away, but construct bounds for the estimated treatment effect on unemployment duration to reflect the problem of partial identification. As an extension to previous empirical approaches we use a regression model with many covariates to control for observable variables and to be able to estimate treatment effects on conditional distributions. In contrast to related empirical studies we do not directly estimate the marginal distributions of latent durations. Instead, we estimate cumulative incidence curves for all risks using a semiparametric hazard model for the subdistribution function (Fine and Gray, 1999). Then we apply a regression version of the Copula Graphic estimator (Zheng and Klein, 1995) to determine the conditional latent marginal distributions (Lo and Wilke, 2011). This model has the attractive feature that it directly estimates an identified quantity without imposing direct functional form assumptions on the latent distributions – something that would be hard to verify given the nonidentifiability of the model.

Our study also benefits from access to a rich data source. We use a large and recent sample of administrative individual data to evaluate an important policy change in Germany. In 2006, the unemployment benefit entitlement lengths were reduced for older unemployed while they remained constant for the younger. We exploit this nicely designed policy change by estimating its effect on the distribution of failure times to various destination states. In particular, we consider recalls to the pre-unemployment employer, transitions to low-wage full-time employment, other

full-time employment, and subsidized self-employment. Empirical research on previous reforms of the German unemployment benefits uses inferior data. Hunt (1995) uses rather small German household survey panel data. As in this paper, Lee and Wilke (2009), Arntz et al.(2008) and Lo and Wilke (2010) use large administrative individual data but they do not comprise information on training measures, subsidized self-employment and job search which are used in this paper. For this reason we are able to employ a model with more risks. Moreover, we apply a semiparametric regression framework for the subdistributions to control for covariates- in contrast to the previous nonparametric analysis- and we therefore estimate conditional treatment effects. Despite not being able to determine the exact magnitude of the effects due to the nonidentifiability of the model, our resulting bounds are tight enough to make a number of interesting observations. We obtain empirical evidence for the existence of sizable treatment effects for a number of risks. We also observe a different timing of the effects – some arise at expiration of benefits, while others after expiration.

The structure of the paper is as follows. Section 2 describes the institutional framework in Germany and the data. Section 3 sketches the econometric approach, followed by the presentation of the empirical results in Section 4. The final section draws several policy implications which are derived from the novel insights of the empirical analysis.

2 Institutional Background and Data

The German unemployment compensation system consists of contribution based unemployment benefits and tax funded basic income support for needy unemployed. Unemployment benefits are financed mainly through unemployment insurance contributions of workers and firms; experience rating does not occur. The replacement rate amounts to 60–67 percent of the previous wage (dependent on whether there are dependent children in the household or not), while the duration varies with the employment history of workers. After the exhaustion of unemployment benefit entitlements, needy unemployed jobseekers are entitled to basic income support whose level does (since 2005) not depend on former earnings. A fundamental shortening of maximum unemployment benefit entitlement lengths – announced already during 2003 – took place in February 2006 (see Table 1). While the reform affected all workers of age 45 and older, the reduction was larger for older age groups. Since basic income support does not depend on pre-unemployment earnings,

Table 1: The 2006 reform of unemployment benefit entitlement lengths in Germany.

	Maximum entitlement length in months		
Age	Until 1/2006	2/2006 to 12/2007	Reduction
<45	12	12	0
45–46	18	12	6
47–51	22	12	10
52–54	26	12	14
55–56	26	18	8
>56	32	18	14

the decrease in unemployment compensation at expiration of unemployment benefits is greater for high pre-unemployment earners. For low earners there is actually no decrease if they are entitled for means tested basic income support. This motivates why we split our sample into low and non-low pre-unemployment earners as we expect larger effects for the latter group. Following convention, as low-wage workers we define those whose last wage rate amounted to less than two third of the median wage (BA Statistik 2010).

The 2006 reform was a well defined natural experiment. Dlugosz et al. (2009) analyse changes in unemployment inflows in response to the same reform and find evidence for a decrease for workers age 52 and older. They also observe anticipation effects of the reform in the three months ahead of the policy change (11/2005 to 1/2006) for all affected age groups. Although these effects were rather small for the aged 45-51, they were quite large for workers aged 52 and older with an increase in the transition rate into unemployment by at least (dependent on the age group) one half. The results of Dlugosz et al. (2009) therefore suggest that the composition of unemployed has changed in response to the reform in particular for the aged 52 and older. We focus in our analysis on the aged 45-46 as for this group the anticipation effect was the smallest among the affected groups and there was no systematic decrease in unemployment inflows after the reform. In order to eliminate anticipation effects we exclude inflows from the period 10/2005 to 2/2006 from our analysis. We have checked the sensitivity of our results by increasing this window by a few months and did not find any evidence for changes in the results.

Our analysis uses a 25-percent-sample of the Integrated Employment Biographies of the Institute for Employment Research (IAB). These individual data are drawn from several linked administrative sources and contain daily spell information about employment periods subject to social security contributions, job seeking periods, participation in active labor market programs, and unemployment benefit and unemployment assistance claim periods. While employment periods

and unemployment compensation claim spells are available since 1991 for the whole of Germany, the other registers are not fully available before the year 2000. Our version of the data is right censored at the end of 2008.

Our sample of unemployment durations consists of unemployment inflows between January 2004 and December 2007, except the period 10/2005 to 2/2006 for the reasons mentioned above. The period 2004-2005 is the pre-reform period while the period 2006-2007 is the post-reform (inflow) period. For the reasons already provided, our analysis restricts itself to a comparison of the age groups 40–44 (control group) and 45–46 (treatment group). We restrict our sample to unemployed who would have had the maximum entitlement length for unemployment benefits under pre-reform regulations. This ensures the comparability of the pre- and post reform sample. We focus on the group of male unemployed with full-time employment before unemployment. While part-time employment among males is rare in the data and probably due other unobservable reasons, females were only considered in some preliminary analysis. We do not present results for females as they do not provide important additional new insights and would have doubled the amount of results to be presented. Because special regulations apply to seasonal unemployment in the construction sector, we exclude workers whose last job was located in this sector.

The data consist of employment periods subject to social security contributions and contact periods with the German Federal Employment Agency. They do not contain information if an individual is unemployed but not registering at the employment agency, has (temporarily) withdrawn from the labor market, is life time civil servant, or self-employed without being subsidized. This implies that unemployment duration can be defined in various ways in these data, depending how is dealt with unobserved periods. For the following analysis we define an unemployment spell as a sequence of spells of registered unemployment, unemployment benefit receipt, or participation in an active labor market program (with the exception of subsidized employment or self-employment or a long training program of at least 3 months), without any gap of more than a month. This is a lower bound of the true unemployment duration. We have also computed an upper bound for the true unemployment duration, which also comprises the unobserved periods (see also Arntz et al., 2008). A sensitivity analysis has shown that the point estimates were similar for the two definitions. We censor all unemployment spells at 720 days, as this is well after the treatment period between 365 and 550 days. If an observation is censored in our data, it is independently censored. Our sample contains overall around 60,000 observations (see Table 2) among them around 15,000

with low pre-unemployment earnings. The number of multiple spells is low (around 1,000) in our sample.

Because the level of unemployment benefits might affect for example the duration of taking up a low paid job or a high paid job differently, we perform a competing risks analysis. In particular, we distinguish between five states: Recall to the previous employer, low-wage full-time employment, other full-time employment (non low-wage), subsidized self-employment, and other or unknown states. Other states includes entry into part-time employment, into the secondary labor market, and into long training programs. Unknown states are exits from unemployment whose destinations are not observed in the data. The last risk is thus a pooled risk and therefore it does not have a direct interpretation. We do not assume independence between the five risks.

Note that in 8/2006 eligibility criteria for self-employment subsidies for unemployment benefit claimants were altered. Before the change any unemployment benefit claimant was eligible for these subsidies, while after the change it required a remaining entitlement period of of 90 days. As will be seen later, this policy change is clearly visible in cumulative incidence curves (entries into self-employment occur earlier during an unemployment spell after this modification took place). As this modification affected treatment and control group in the same way it does not hamper our approach to identify the effects of unemployment benefits.

Table 2 describes the distribution of destination states in our sample. 15 to 20 percent of males with low pre-unemployment wages return to the previous employer. Around a third enter a low-wage full time job and around 10 percent a non low-wage full time job at another employer. Less than 10 percent take up subsidized self-employment, and around 20 percent exits into the pooled remainder state. For unemployed with non low pre-unemployment wages there are around 10 percent recalls and entries into low-wage jobs at another employer, while around 40 percent enter a new non low-wage job. Around 15 percent take up subsidized self-employment and around 20 percent exit into an unknown or other state. Of those exiting into an unknown or other state, entry into an unknown state turned out to be most important option.

In our econometric analysis we employ a regression model to control for a number of observable variables which affect the duration of unemployment. These include socio-demographic characteristics (married, education, nationality), labor market history (since the 1990s), characteristics of last job (wage, status, sectoral affiliation, firm size), regional characteristics (federal state), and the monthly unemployment rate at the time of unemployment entry. In order to eliminate incon-

Table 2: Distribution of observed transitions, sample size, and median unemployment duration (in days) by group and destination state

Group	Low-wage males				Non low-wage males			
Age	40–44		45–46		40–44		45–46	
Time period	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Column percent								
Recall	0.18	0.15	0.20	0.15	0.10	0.07	0.09	0.06
Low-wage full time	0.32	0.34	0.33	0.35	0.13	0.11	0.12	0.12
Other full time	0.11	0.14	0.10	0.12	0.38	0.42	0.38	0.40
Subsidized self-employment	0.08	0.08	0.07	0.08	0.15	0.16	0.15	0.15
Unknown and other	0.19	0.20	0.17	0.21	0.16	0.19	0.17	0.22
– Part-time	0.02	0.03	0.02	0.04	0.02	0.01	0.02	0.01
– Long training	0.02	0.04	0.02	0.04	0.03	0.05	0.04	0.05
– Secondary labor market	0.04	0.02	0.03	0.02	0.01	0.004	0.01	0.01
– Unknown	0.11	0.11	0.10	0.11	0.11	0.13	0.11	0.15
Censored	0.12	0.10	0.12	0.10	0.07	0.04	0.09	0.05
N of observations	7,134	5,126	1,817	1,346	19,148	15,051	5,740	4,526
Median duration	191	146*	198	153*	174	122*	207	138*

*Only entries until end of 2006

sistencies in the education and the nationality variable, we impute these variables along the lines suggested by Fitzenberger et al. (2006) and Wichert and Wilke (2011). Table 3 in the Appendix presents descriptive statistics of the regressors, for the entire groups of low- and non low-wage males as well as separately by age group and treatment status. Comparing the groups of previous low-wage and non low-wage earners, those with a low-wage job had been working more frequently as unskilled blue-collar workers, in the temporary agency sector, in smaller firms and in East German federal states. Previous non low-wage earners more often have a university degree, had worked as white collar workers, and had been employed in manufacturing. The wage rate in the previous job has been more than twice as high among previous non low-wage workers. Table 4 in the Appendix describes the sample by destination state.

3 Econometric Model

This section sketches our econometric approach to estimating the effects of the reform before we come to the empirical results. We consider a competing risks unemployment duration model with five risks ($j = 1, ..., 5$) which were outlined in the previous section. T_j is the latent duration until a transition to risk j would take place. It is a random variable which is drawn from a marginal

distribution function $F_j(t;\mathbf{x}) = P(T_j \leq t;\mathbf{x})$ with $\mathbf{x}$ is a row vector of observable covariates. The marginal survival function is $S_j(t;\mathbf{x}) = 1 - F_j(t;\mathbf{x})$. Due to the competing risks structure it is only possible to observe $(T, \delta, \mathbf{x})$, where $\delta = \text{argmin}_j\{T_j\}$ is the observed destination state and $T = \min_j\{T_j\}$ is the observed length of the unemployment period. Let $Q_j(t) = P(T_j \leq t, \delta = j;\mathbf{x})$ be the cumulative incidence curve for risk j. This is the distribution of observed transitions to risk j; it is also called a subdistribution as it does not attain the value 1 as t goes to infinity. An attractive feature of Q_j is that it is identifiable and that various parametric and semiparametric estimators have been developed (e.g. Jeong and Fine, 2007, Peng and Fine, 2009). In this paper we apply the semiparametric proportional hazard model for Q_j which was suggested by Fine and Gray (1999). In this model it is assumed that

$$\phi_j(t;\mathbf{x}) = \phi_{j0}(t)\exp(\mathbf{x}\beta),$$

where $\phi_j(.)$ is the hazard of the subdistribution and is defined as

$$\begin{aligned}\phi_j(t;\mathbf{x}) &= \lim_{\Delta t\to 0}\frac{1}{\Delta t}P(t \leq T \leq t+\Delta t, \delta = j;\ T \geq t \cup (T \leq t \cap \delta \neq j), \mathbf{x}) \\ &= -d\log\{1 - Q_j(t;\mathbf{x})\}/dt, \end{aligned} \quad (1)$$

$\phi_{j0}(t)$ is unknown but nonnegative. β is a column vector of unknown coefficients. While Q_j and ϕ_j are identifiable, they do not have a causal interpretation as a change in Q_j is determined by a change in F_j and the dependence structure between risks. Still subdistribution models are often considered in biometrics as the observed distributions are also of interest itself. In empirical economics it is the industry standard to estimate F_j directly by imposing various assumptions on it and on the dependence structure to achieve identification. In this paper we follow a different approach, where we first estimate Q_j and then estimate the bounds for F_j without imposing any direct parametric assumptions on it. Thus we apply a two-step estimator.

The dependence structure between the risks is determined by the copula $C(f_1, ..., f_5;\mathbf{x}) = \Pr(f_1 \leq F_1, ..., f_5 \leq F_5;\mathbf{x})$, the joint distribution of the ranks of the duration variables. Knowledge of the copula function ensures identifiability of $F_j(t;\mathbf{x})$, while if it is unknown, only bounds for $F_j(t;\mathbf{x})$ can be determined. For the nonparametric model these bounds were derived by Peterson (1976). Our model is a special case of the model of Lo and Wilke (2011), who show identifiability if the copula function is known, independent of $\mathbf{x}$ and belongs to the Archimedean family. Here we assume that the copula is a Frank copula with one unknown parameter. The Frank copula has

the nice feature that – depending on its parameter – the correlation between the competing risks can be highly positive and highly negative with independence as a special case. The correlation is measured by the so called Kendall τ, which is in $[-1, 1]$ in the case of the Frank copula (see Nelsen, 2006, for more details on copula functions). As there is a 1-1 relationship between τ and the copula parameter we only refer here to τ. Depending on the value of τ, application of the Copula Graphic Estimator yields

$$\tilde{F}_j(t; \mathbf{x}, \tau) = 1 - \xi_\tau^{-1} \left[- \int_0^t \xi'_\tau (1 - \sum_{j=1}^{5} Q_j(u; \mathbf{x})) Q'_j(u; \mathbf{x}) du \right], \quad (2)$$

where $\xi_\tau(.)$ is the copula generator of the Frank copula. Depending on the choice of τ, the resulting $\tilde{F}_j(t; \mathbf{x}, \tau)$ will attain any point in the identification bounds for F_j and $\tilde{F}_j = F_j$ for the true value of τ. Due to the non-identifiability of the model the true dependence structure (τ) cannot be determined in an application if it is not known.

Due to the design of the policy reform under investigation, we can apply a difference-in-differences (DiD) approach for the identification of the reform effect. In particular, we assess the effect of the reform by determining $\Delta_j(t; \bar{\mathbf{x}})$, the change in the conditional distributions of risk j at the sample means of the covariates, $\bar{\mathbf{x}}$:

$$\begin{aligned} \Delta_j(t; \bar{\mathbf{x}}) = {} & F_j(t; T = 1, G = 1, \bar{\mathbf{x}}) - F_j(t; T = 0, G = 1, \bar{\mathbf{x}}) \\ & - (F_j(t; T = 1, G = 0, \bar{\mathbf{x}}) - F_j(t; T = 0, G = 0, \bar{\mathbf{x}})) \end{aligned}$$

with T is the post reform period dummy and G is the treatment group dummy. As F_j is not identified we compute the DiD changes for all values of τ. In particular, we compute

$$\tilde{\Delta}_j(t; \bar{\mathbf{x}}, \tau) = \tilde{F}_j(t; T = 1, G = 1, \bar{\mathbf{x}}, \tau) - \tilde{F}_j(t; T = 0, G = 1, \bar{\mathbf{x}}, \tau) \quad (3)$$

$$- \left(\tilde{F}_j(t; T = 1, G = 0, \bar{\mathbf{x}}, \tau) - \tilde{F}_j(t; T = 0, G = 0, \bar{\mathbf{x}}, \tau) \right) \quad (4)$$

for a 0.05 grid for $\tau \in [-0.95, 0.95]$. Most popular duration models such as the accelerated failure time model and the (mixed) proportional hazard model make various assumptions on C and F_j (see Oakes, 1989, and Bond and Shaw, 2006, for more details) which imply that C is independent of P, G and $\mathbf{x}$. While we avoid direct assumptions on F_j we assume $C(f_1, ..., f_5; T, G, \mathbf{x}) = C(f_1, ..., f_5)$ and C is Archimedean. The independence assumption likely holds locally in the regressors but it is difficult to find an economic justification for it. As a matter of fact it is required by the Copula

Graphic regression model but it also greatly simplifies the construction of the lower and upper bound for the treatment effect. They are given by:

$$\underline{\Delta}_j(t;\bar{\mathbf{x}}) = \min_\tau \tilde{\Delta}_j(t;\bar{\mathbf{x}},\tau) \quad (5)$$

$$\overline{\Delta}_j(t;\bar{\mathbf{x}}) = \max_\tau \tilde{\Delta}_j(t;\bar{\mathbf{x}},\tau), \quad (6)$$

with $\Delta_j(t;\bar{\mathbf{x}}) \in [\underline{\Delta}_j(t;\bar{\mathbf{x}}), \overline{\Delta}_j(t;\bar{\mathbf{x}})]$. We determine the bounds for the treatment effect for all durations t and all risks j. If the lower (upper) bound is greater (smaller) than zero, we have identified the direction of the treatment effect. This would provide evidence for a left (right) shift of F_j in response to the shortening of the unemployment benefit entitlement lengths. In our application Q_j in equation (2) are replaced by their sample analogues which will then determine the estimator for $\tilde{F}_j$. The latter are then used to obtain a sample analogue of the τ specific treatment effect in equation (4) and the bounds for the treatment effect in equations (5) and (6). As the model of Lo and Wilke (2011) requires continuity of $Q_j(t;\mathbf{x})$ in t, we apply a local polynomial Kernel smoother to the estimate of the baseline cumulative incidence. Working with discontinuous Q_j would produce numerical problems and can results in implausible jumps in the estimates for $\tilde{F}_j$. All estimations were performed with Stata 11MP.

As has already been mentioned in Section 3, we have a missing data problem for time periods that were not covered by the administrative data. The data only provides information about the lower and upper bound for the true unemployment duration. Arntz et al. (2008) develop bounds for Q_j resulting from partially observed unemployment durations. While we have this nice property for Q_j, it is not inherited by $\tilde{F}_j$. Suppose we can only observe a lower bound and upper bound of the true unemployment duration in the data, which we denote as a and b, respectively. Then we have $Q_j^a \leq Q_j \leq Q_j^b$ but this does not imply that $\tilde{F}_j^a \leq \tilde{F}_j \leq \tilde{F}_j^b$ (see equation (2) in Lo and Wilke 2011). We have also tested this empirically and observed a number of rejections of the monotonicity for data bound for $\tilde{F}_j$. For this reason, we do not construct double bounds which combine the problem of partially identified interval data (Lee and Wilke, 2009) and the nonidentifability of the model (Cox, 1962, Tsiatis, 1975). While a sensitivity analysis in the definition of unemployment produced very similar point estimates, this does not reveal the endpoints for the data bounds for the treatment effect.

Due to the flexibility of our model for Q_j, the asymptotic covariance matrix for Q_j is unknown except the diagonal elements (Fine and Gray, 1999). As in our model each F_j depends on all Q_j

(see Lo and Wilke, 2011, for details) the asymptotic distribution for F_j is unknown, too. For this reason we apply the bootstrap to determine confidence intervals for the estimator for $\tilde{F}_j(t;\mathbf{x},\tau)$ and $\tilde{\Delta}_j(t;\bar{\mathbf{x}},\tau)$. As $\underline{\Delta}_j(t;\bar{\mathbf{x}})$ and $\overline{\Delta}_j(t;\bar{\mathbf{x}})$ are determined by all values of τ, it was not feasible for us to obtain confidence intervals for the bounds of the treatment effect. For this reason we only present confidence intervals for $\tilde{\Delta}_4(t;\bar{\mathbf{x}},\tau)$ for two values of τ in Figure 3 in the Appendix. It is apparent that the uncertainty due random sampling is less important than the uncertainty about the true value of τ. While this is supportive for our approach to mainly focus on the non-identifiability, the confidence intervals appear to be rather wide given the large sample size.

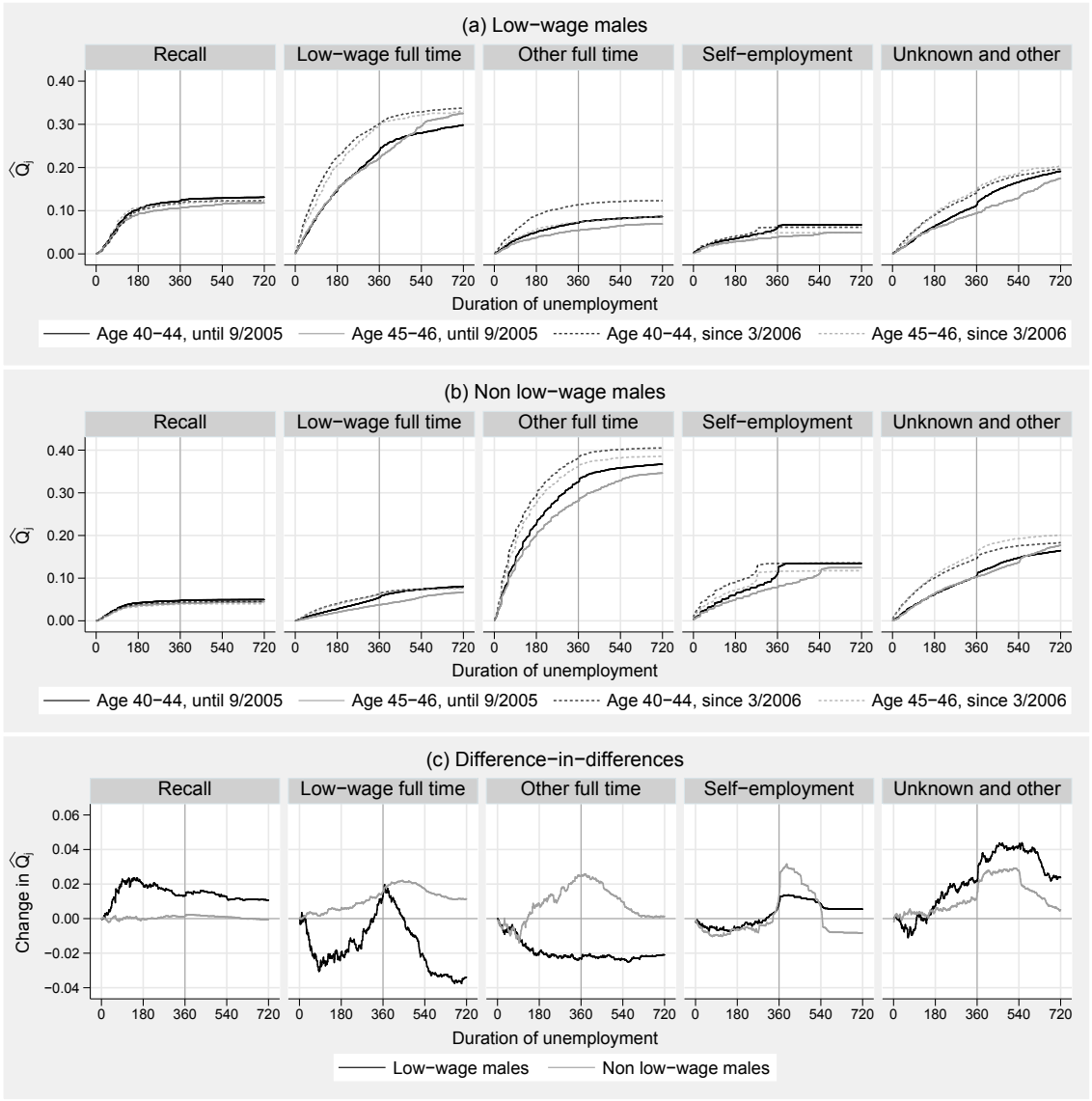
4 Results

We first briefly discuss first stage estimation results for the subdistribution regressions before we present the estimated bounds for the reform effect on F_j. Figure 1 displays the estimated cumulative incidence curves Q_j at the sample mean of the regressors for previous low-wage earners (a), previous non low-wage earners (b), and the DiD estimator for the changes in cumulative incidence (c). A positive (negative) DiD estimator can be interpreted as a left (right) shift of the subdistribution Q_j.

Panels (a) and (b) differ from the information in Table 2 by controlling for the observable characteristics and exceed it by providing information for all durations. Similar to the descriptive evidence, we observe that previous (non) low-wage earners are mostly inclined to take up (non) low-wage employment. The observed probability to experience a recall is higher for low-wage workers, while the observed probability to take up subsidized self-employment is higher for non low-wage workers. Panel (c) suggests considerable changes in subdistributions. For low-wage males we observe a left shift of Q_j for recalls and subsidized self-employment (thus observed transitions into these states occurred earlier during an unemployment period). In contrast, transitions to low-wage and non low-wage full-time employment seem to take place rather later during the first year of unemployment. But the cumulative incidence for low-wage employment increases during the treatment period between 365-540 days. For non low-wage males, subdistributions shift to the right for the risks low-wage full-time employment, other full-time employment, and subsidized self-employment. For the latter the shift is observed only during the treatment period.

We have estimated in total 40 regressions for the two wage and age groups, the two time

Figure 1: Estimated cumulative incidences at the mean of the regressors.



periods, and the five risks. Tables 5-9 in the Appendix present the estimated hazard ratios of the semiparametric proportional hazard subdistribution model (Fine and Gray 1999). In many cases the hazard ratios vary across groups and risks, which motivates our stratified competing risks approach. The results also reveal a number of interesting strong statistical relationships between the observable covariates and the observed transitions into the five states. As the amount of information is these tables is too big to be described in detail we only provide a brief summary of the main findings:

- For recalls we observe that white collar workers have an around 50% lower subdistribution hazard rate than unskilled blue collar workers, everything else equal. Unemployed who

have already experienced a recall out of unemployment in the past have a 50-300% higher hazard. If an unemployed participated already in a labor market program during a foregoing unemployment spell, the hazard for being recalled is 20-40% lower. Observing a recall in agriculture is much more common than in other business sectors with the hazard being twice to four times higher than in manufacturing, while it is also higher (often 30-60%) for temporary work agencies. A one percentage point increase in the unemployment rate increases the hazard for observing a recall by 30%, suggesting that recalls are related to dismissals during a weaker labour market environment. Recall is the sole risk for which we observe a statistical relationship between the unemployment rate and the probability of observing a transition.

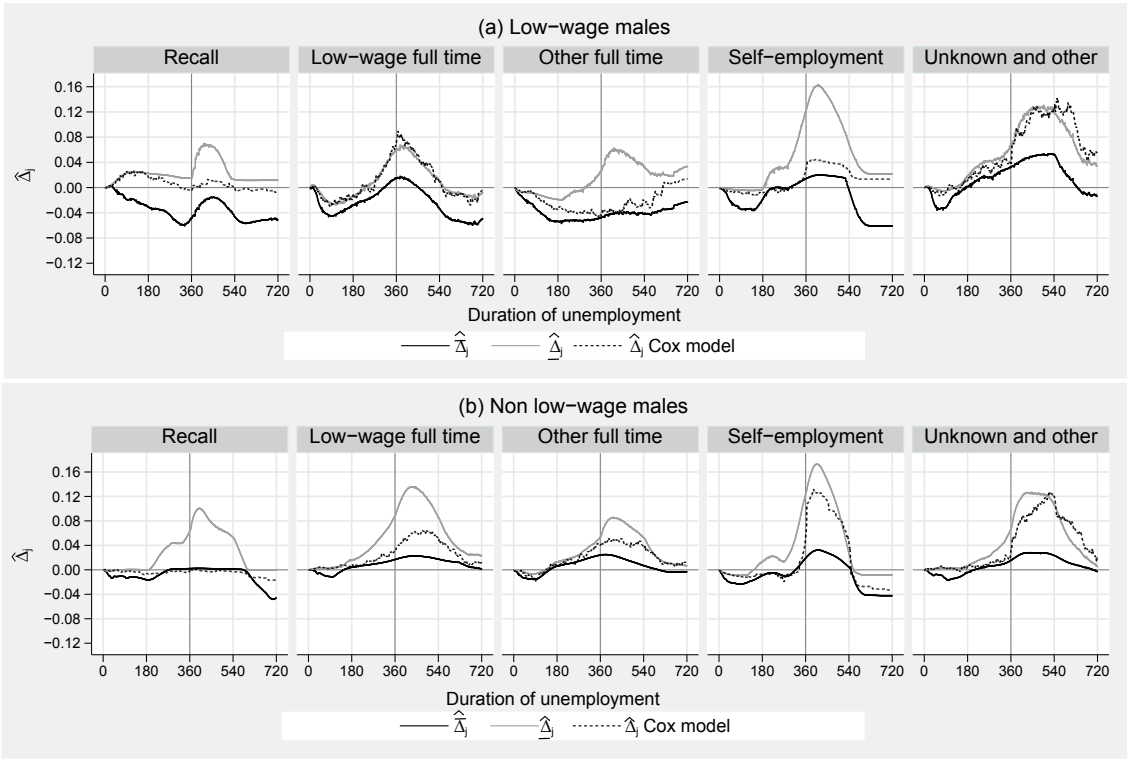
- For transitions into low-wage employment we observe some differences across previously low-wage and non low-wage workers. Educated or skilled workers with non low pre-unemployment earnings have a 20-50% lower hazard to take up a low-wage job; a lack of skills and formal education makes it therefore much less likely to leave the low paid sector. Previously low-wage workers who have already experienced a recall in the past have a lower hazard to take-up a low-wage job at another employer (20-35%). If the last job was in agriculture (compared to manufacturing), it is less likely to observe a transition to a low paid job (30-60% lower hazard). Unemployed with a non low-paid work history who were working in a small firm (up to 50 employees), have a 20-70% higher hazard to accept a low-wage job than those who have been working in larger firms. The hazard to take up a low-wage job is up to twice as high in Eastern Germany compared to Western Germany.

- For non low-wage employment, we observe that skills and formal education greatly increase the hazard of a transition. For unemployed with university degree it is 250% higher compared to those with a low education, and it is often 30% higher for skilled or white collar workers compared to an unskilled without formal qualification. For those entering unemployment from a low-wage job, the hazard is 20% lower if the last employer was a large firm, and it is 30% lower if the unemployed had been recalled in the past. The hazard for observed transitions into non low-paid employment is up to 50% lower in Eastern Germany, and it is up to 200% higher in particular West German states (compared to Nordrhein-Westfalen) for previously low-wage workers.

- The hazard to take up subsidized self-employment is 200-300% higher for white collar workers. It is 50% lower in agriculture than in manufacturing, but 50% higher if the last job has been in financial or public services. If the unemployed was previously employed in a large firm, the hazard is often 30-50% lower, suggesting a negative relationship between firm size and entrepreneurial activity of (previous) employees.

While the results in Figure 1 suggest that the reform under investigation lead to various changes in Q_j, it remains unclear whether this is also true for F_j. Figure 2 presents estimated lower and upper bounds for Δ_j, stratified by low pre-unemployment (Panel a) and non low pre-unemployment wage (Panel b). In order to provide a familiar comparison benchmark for these bounds, we also plot $\hat{\Delta}_j$ when F_j has been directly estimated by the Cox proportional hazard regression. As it is apparent from the figure, in most cases the Cox estimator lies within our identification bounds. It can fall outside because the Cox model imposes a different structure on F_j than our model. Our model identifies the sign of the treatment if $\hat{\overline{\Delta}}_j$ (or $\hat{\underline{\Delta}}_j$) is less (or greater) than zero. Although, the width of the bounds is generally rather wide, in most cases they reveal the direction of the effect.

Figure 2: Estimated bounds for the reform effects on F_j at the mean of the regressors.



For low-wage males we observe – as has already been indicated by Figure 1 – a left shift for the probability to enter a low or non low-wage full time job after a short time of unemployment. This corresponds to a decrease in job taking probabilities, which might be explained by a change in job search strategy by low-wage unemployed, who may be made more discouraged to look for a higher paid job in the presence of shorter benefit entitlement length. During the treatment period, the probability of entering a low-wage job increases with the lower bound slightly above zero. In contrast, we observe a sizable right shift of F_j for subsidized self-employment and the pooled remainder state. This may suggest that the shortening of benefit entitlement lengths has been driving individuals with low earning capacities into subsidized self-employment and part-time work (compare also Table 2).

For the non low-wage males we observe a right shift of F_j for almost every risk, which confirms that this group is more likely to react in response to shorter benefit entitlements. For this group we find also different timings of the peak of the treatment effect. While it seems to be at or shortly after expiration of benefits for the risks other full-time employment and subsidized self-employment and the upper bound for recall, it is a bit later for low-wage employment. This might indicate that for transitions into the first two states there is some strategic waiting until benefits are about to expire, while taking up a low-wage job becomes more likely some time after benefits have been expiring.

Summing up, the most important changes in F_j in response to the reform can be identified for the risk subsidized self-employment, where marginal distribution function increases by 0.02-0.17 units percent in response to the shortening of the benefit entitlement lengths. Given that the sample average of transitions into this state is less than 15%, it is indeed a sizeable effect. Further reform effects can be identified for the group of previous non low-wage earners. For risks non low-wage and low-wage employment, the effect turns positive after less than half a year of unemployment duration. This suggests that the job taking speed of this group increases already before entitlements have expired, while for transitions of low-wage males into low-paid jobs there is also some evidence for a positive reform effect shortly after benefit expiration.

5 Summary and Policy Implications

Our empirical analysis presents a number of unprecedent insights, how the unemployment benefit system affects the duration of unemployment – despite our econometric approach taking the partial identification of the competing risks model into account. By using very large and rich data we are able to estimate a model with five competing risks and stratify the sample by pre-unemployment wage level. While previous analysis for Germany has mainly focused on exits to employment, we have enough observations to distinguish between recalls, low-wage jobs and non low-wage jobs. Moreover, we include subsidized firm creation as an additional highly policy relevant risk. Although our bounds for the non-identification of the model make it often impossible to identify the exact magnitude of the effect, in many cases the direction of the effect is identified.

Surprisingly we are not able to identify an effect for the distribution of recalls, although there is potentially a sizeable effect for the non low-wage earners. Our results therefore do not provide evidence that there is strategic waiting until unemployment benefits are exhausted before a recall offer is made and accepted. This is in sharp contrast to the timing of firm-foundation out of unemployment. The probability distribution of starting a claim of self-employment subsidy clearly reacts on the expiration date of unemployment benefits, with a "mass point" in the distribution at the time of expiration. Our results therefore suggest that these subsidies may be to some extent used as a follow up funding for unemployed who would loose benefit entitlements otherwise. Indeed, the institutional setup in Germany is to some extent encouraging free riding, as the eligibility for self-employment subsidies is not means tested and has to be granted by law if the business plan satisfies some minimum standards.

We identify an – potentially large – increase in the probability of entering full-time employment for non low-wage males, something probably intended by the reform. However, we do not find evidence for this for the low-wage males. As this group has typically entitlements for means tested basic income support at the same level as unemployment benefits, we would not expect sizable effects here (see also Lee and Wilke, 2009, for a longer discussion and similar result pattern). But our results are indicative that in particular the speed of taking up a full-time job outside the low-wage sector decreases among the low-wage group. This could be due to a decrease in job search efforts for higher paid jobs by focusing on safer alternatives, something our model is not able to answer. This would imply that shorter benefit entitlement lengths may have a negative

impact on future labor market outcomes of the low-wage males.

Our results are important for policy makers in many European countries with a similarly designed unemployment compensation system. Contribution based unemployment benefits, whose level are dependent on the pre-unemployment income, are mainly affecting the labor market outcomes of previous non low-wage individuals; they are thus "nice to have" for individuals who do not pass means tests. The design of the self-employment subsidies for unemployed in Germany casts some doubts whether all start-ups had occurred in response to a promising business idea. It partly might have been an easy way for unemployed to increase household income once benefits have expired. In fact, plans on a current labor market reform in Germany propose to alter access conditions to subsidized self-employment by requiring 150 days (instead of 30 days) of remaining unemployment benefit claims and shortening the duration of subsidization to 6 months (instead of 9 months). This would imply that self-employment may prolong unemployment benefit receipt by only one month and would therefore make the subsidy much less financially attractive. Of course, this will probably come at the "expense" of lower firm creation rates and higher unemployment rates as self-employed do not appear in the unemployment count.

Appendix

Table 3: Sample means of variables by age group and time period

Group	Low-wage males					Non low-wage males				
Age	40–46	40–44		45–46		40–46	40–44		45–46	
Time period	Both	Pre	Post	Pre	Post	Both	Pre	Post	Pre	Post
Individual characteristics										
Low education	0.08	0.07	0.09	0.06	0.08	0.04	0.04	0.04	0.03	0.05
Vocational training or Abitur	0.87	0.88	0.86	0.89	0.86	0.76	0.76	0.75	0.77	0.76
University	0.05	0.04	0.05	0.05	0.05	0.20	0.20	0.21	0.20	0.20
Unskilled blue collar	0.47	0.45	0.51	0.42	0.49	0.27	0.27	0.27	0.26	0.27
Skilled blue collar	0.40	0.43	0.34	0.46	0.38	0.28	0.29	0.26	0.31	0.28
White collar	0.13	0.12	0.15	0.12	0.13	0.45	0.43	0.47	0.43	0.45
Married	0.55	0.55	0.51	0.61	0.56	0.63	0.63	0.59	0.68	0.65
Non-German	0.18	0.17	0.21	0.15	0.17	0.12	0.12	0.13	0.11	0.13
During last 7 years										
Years of employment	5.52	5.40	5.45	5.90	5.89	6.24	6.17	6.21	6.40	6.48
Years of tenure at last employer	3.21	3.10	3.10	3.66	3.66	3.58	3.48	3.54	3.78	3.87
Years of unemployment	0.71	0.68	0.89	0.44	0.60	0.28	0.30	0.33	0.20	0.18
Number of employers	2.79	2.86	2.87	2.54	2.51	2.55	2.62	2.58	2.42	2.36
Past recall	0.19	0.19	0.20	0.20	0.19	0.14	0.14	0.14	0.15	0.14
Past labor market program	0.35	0.35	0.40	0.25	0.33	0.20	0.19	0.24	0.16	0.19
Characteristics last job										
Daily wage rate	43.30	43.40	43.00	43.75	43.23	95.62	92.71	98.69	94.18	99.55
Manufacturing	0.21	0.23	0.18	0.23	0.19	0.36	0.38	0.33	0.39	0.36
Agriculture, mining, energy	0.06	0.06	0.06	0.07	0.07	0.03	0.03	0.03	0.03	0.03
Retail sector	0.17	0.16	0.17	0.17	0.18	0.20	0.19	0.22	0.19	0.20
Hotels and restaurants	0.09	0.08	0.11	0.07	0.09	0.02	0.01	0.02	0.01	0.02
Transport sector	0.14	0.14	0.15	0.14	0.16	0.09	0.08	0.10	0.09	0.10
Economic and financial services	0.13	0.13	0.14	0.12	0.16	0.17	0.16	0.18	0.16	0.17
Public services	0.08	0.08	0.08	0.08	0.08	0.11	0.12	0.11	0.12	0.11
Temporary agency sector	0.11	0.12	0.11	0.12	0.08	0.02	0.02	0.02	0.02	0.02
Firm size up to 50	0.67	0.67	0.66	0.67	0.67	0.52	0.54	0.51	0.53	0.50
Firm size 51-100	0.17	0.17	0.16	0.18	0.15	0.17	0.17	0.16	0.17	0.16
Firm size 101-250	0.11	0.10	0.12	0.09	0.11	0.14	0.13	0.14	0.13	0.13
Firm size 251 and more	0.06	0.06	0.06	0.05	0.07	0.18	0.16	0.19	0.16	0.20
Federal state										
Nordrhein-Westfalen	0.22	0.21	0.22	0.23	0.24	0.27	0.27	0.27	0.26	0.26
Schleswig-Holstein/Hamburg	0.04	0.04	0.04	0.04	0.04	0.06	0.06	0.06	0.06	0.05
Niedersachsen/Bremen	0.08	0.08	0.09	0.05	0.08	0.11	0.11	0.11	0.10	0.11
Hessen	0.05	0.05	0.05	0.04	0.06	0.08	0.08	0.08	0.08	0.08
Rheinland-Pfalz/Saarland	0.04	0.04	0.05	0.03	0.04	0.06	0.06	0.06	0.06	0.07
Baden-Württemberg	0.06	0.06	0.07	0.06	0.08	0.13	0.13	0.13	0.12	0.13
Bayern	0.09	0.08	0.09	0.08	0.09	0.15	0.15	0.15	0.16	0.16
Brandenburg/Berlin	0.14	0.15	0.13	0.14	0.12	0.06	0.07	0.06	0.06	0.06
Mecklenburg-Vorpommern	0.06	0.07	0.05	0.08	0.06	0.02	0.02	0.02	0.02	0.02
Sachsen	0.14	0.14	0.12	0.16	0.13	0.04	0.04	0.04	0.04	0.04
Sachsen-Anhalt	0.08	0.09	0.07	0.10	0.08	0.03	0.03	0.02	0.03	0.03
Unemployment rate										
Monthly unemployment rate	10.60	11.24	9.72	11.26	9.73	10.55	11.20	9.74	11.19	9.75
N of observations	15423	7134	5126	1817	1346	44465	19148	15051	5740	4526

Table 4: Sample means of variables by destination state

	Low-wage males					Non low-wage males				
Destination	R	LWJ	NLWJ	SE	UO	R	LWJ	NLWJ	SE	UO
Individual characteristics										
Low education	0.06	0.06	0.04	0.07	0.11	0.06	0.05	0.02	0.02	0.06
Vocational training or Abitur	0.91	0.90	0.90	0.83	0.83	0.85	0.90	0.74	0.65	0.73
University	0.03	0.03	0.06	0.11	0.06	0.10	0.05	0.24	0.33	0.21
Unskilled blue collar	0.38	0.48	0.44	0.35	0.53	0.35	0.46	0.21	0.12	0.30
Skilled blue collar	0.56	0.42	0.41	0.35	0.32	0.47	0.35	0.28	0.19	0.24
White collar	0.06	0.11	0.15	0.30	0.15	0.18	0.19	0.51	0.69	0.45
Married	0.58	0.56	0.61	0.56	0.50	0.66	0.60	0.66	0.65	0.58
Non-German	0.14	0.16	0.15	0.18	0.22	0.13	0.13	0.10	0.11	0.14
During last 7 years										
Years of employment	5.66	5.62	5.72	5.44	5.33	6.15	6.20	6.34	6.24	6.16
Years of tenure at last employer	3.93	2.96	2.64	3.50	3.18	4.20	3.53	3.19	3.70	3.90
Years of unemployment	0.71	0.71	0.59	0.56	0.71	0.39	0.36	0.24	0.22	0.27
Number of employers	2.36	3.07	3.19	2.49	2.76	2.23	2.70	2.77	2.43	2.37
Past recall	0.34	0.14	0.15	0.15	0.19	0.34	0.14	0.10	0.11	0.17
Past labor market program	0.31	0.38	0.34	0.32	0.36	0.17	0.24	0.21	0.18	0.20
Characteristics last job										
Daily wage rate	43.91	43.68	46.07	41.70	42.08	79.03	75.54	101.06	112.76	94.93
Manufacturing	0.22	0.22	0.22	0.16	0.20	0.36	0.41	0.37	0.28	0.36
Agriculture, mining, energy	0.17	0.04	0.05	0.03	0.04	0.13	0.02	0.02	0.01	0.02
Retail sector	0.13	0.17	0.17	0.22	0.16	0.14	0.20	0.21	0.23	0.18
Hotels and restaurants	0.09	0.08	0.06	0.11	0.11	0.03	0.02	0.02	0.02	0.02
Transport sector	0.14	0.16	0.18	0.12	0.13	0.12	0.13	0.09	0.05	0.08
Economic and financial services	0.09	0.13	0.13	0.18	0.14	0.09	0.10	0.17	0.27	0.18
Public services	0.05	0.06	0.07	0.14	0.10	0.12	0.10	0.10	0.14	0.15
Temporary agency sector	0.11	0.14	0.12	0.04	0.10	0.02	0.03	0.02	0.01	0.01
firm size up to 50	0.78	0.63	0.66	0.74	0.64	0.70	0.48	0.53	0.55	0.46
Firm size 51-100	0.13	0.18	0.17	0.17	0.17	0.12	0.18	0.18	0.16	0.15
Firm size 101-250	0.06	0.12	0.11	0.06	0.11	0.08	0.16	0.14	0.12	0.15
Firm size 251 and more	0.03	0.06	0.06	0.03	0.08	0.09	0.18	0.15	0.17	0.24
Federal state										
Nordrhein-Westfalen	0.18	0.21	0.23	0.23	0.23	0.20	0.25	0.27	0.26	0.28
Schleswig-Holstein/Hamburg	0.03	0.03	0.05	0.04	0.05	0.05	0.05	0.06	0.05	0.06
Niedersachsen/Bremen	0.06	0.07	0.10	0.08	0.08	0.13	0.10	0.11	0.10	0.11
Hessen	0.03	0.04	0.07	0.06	0.06	0.06	0.07	0.08	0.09	0.08
Rheinland-Pfalz/Saarland	0.03	0.03	0.05	0.05	0.05	0.06	0.06	0.07	0.06	0.06
Baden-Württemberg	0.04	0.06	0.10	0.06	0.08	0.07	0.11	0.14	0.13	0.13
Bayern	0.07	0.08	0.12	0.11	0.10	0.21	0.13	0.15	0.16	0.15
Brandenburg/Berlin	0.15	0.15	0.09	0.13	0.13	0.06	0.08	0.05	0.07	0.06
Mecklenburg-Vorpommern	0.10	0.06	0.04	0.05	0.05	0.04	0.03	0.01	0.02	0.01
Sachsen	0.20	0.16	0.08	0.14	0.10	0.06	0.07	0.03	0.04	0.03
Sachsen-Anhalt	0.11	0.10	0.06	0.06	0.06	0.05	0.05	0.02	0.02	0.02
Unemployment rate										
Monthly unemployment rate	10.78	10.59	10.53	10.57	10.55	10.82	10.63	10.52	10.51	10.45
N of observations	2617	5090	1829	1171	2997	3849	5441	17527	6923	8075

Note: R = Recall, LWJ = Low-wage job, NLWJ = Non low-wage job, SE = Self-employment, UO = Unknown or other

Table 5: Estimated sub-distribution hazard ratios for risk recall

Group	Low-wage males								Non low-wage males							
Age	40–44				45–46				40–44				45–46			
Time period	Pre		Post		Pre		Post		Pre		Post		Pre		Post	
Individual characteristics (reference: low education, unskilled blue collar, not married, German)																
Vocational training or Abitur	1.196		0.979		1.092		1.649		0.939		0.770		0.978		0.748	
University	0.732		1.040		1.353		1.504		1.025		0.997		1.142		0.762	
Skilled blue collar	1.250	**	1.249	**	1.240		1.288		1.242	**	1.300	**	1.054		1.241	
White collar	0.674	**	0.674	**	0.328	**	0.903		0.445	**	0.541	**	0.452	**	0.554	**
Married	1.154	*	1.110		1.151		0.961		1.209	**	1.088		1.054		1.327	*
Non-German	0.863		0.850		0.824		0.908		1.019		1.012		1.066		1.040	
During last 7 years																
Years of employment	0.994		0.982		1.036		0.928		1.012		1.017		1.097		0.948	
Years of tenure at last employer	1.094	**	1.031		1.074		1.078		1.057	**	1.018		1.051		1.041	
Years of unemployment	1.132	**	1.097	*	1.063		0.970		1.242	**	1.422	**	1.505	**	1.682	**
Number of employers	0.951	*	0.956		0.957		0.947		0.923	**	0.890	**	0.910	*	0.830	**
Past recall	1.621	**	2.314	**	1.592	**	2.280	**	2.065	**	2.912	**	1.846	**	2.219	**
Past labor market program	0.831	*	0.894		0.824		0.717		0.784	**	0.674	**	0.640	**	0.574	**
Characteristics last job (reference: manufacturing, firm size up to 50)																
Daily wage rate	1.012	**	1.004		0.999		1.013		0.991	**	0.990	**	0.991	**	0.985	**
Agriculture, mining, energy	2.517	**	2.312	**	1.964	**	2.462	**	3.149	**	2.612	**	4.246	**	3.504	**
Retail sector	0.828		0.919		0.783		1.006		0.784	**	0.752	**	0.560	**	0.712	
Hotels and restaurants	1.160		1.567	**	0.996		1.988	*	1.339		1.373		1.317		1.800	
Transport sector	0.992		1.091		1.088		1.079		1.096		1.302	*	1.190		1.419	
Economic and financial services	0.897		0.908		0.876		1.120		0.938		0.778	*	0.756		1.071	
Public services	0.823		0.915		0.639		1.452		1.652	**	1.623	**	1.313		1.621	*
Temporary agency sector	1.747	**	1.226		1.432		3.307	**	1.610	**	1.344		1.340		1.347	
Firm size 51-100	0.651	**	0.708	**	0.629	**	0.536	*	0.580	**	0.534	**	0.567	**	0.740	
Firm size 101-250	0.611	**	0.459	**	0.516	**	0.374	**	0.507	**	0.478	**	0.605	**	0.519	**
Firm size 251 and more	0.595	**	0.488	**	0.341	**	0.469		0.489	**	0.377	**	0.356	**	0.419	**
Federal state (reference: Nordrhein-Westfalen)																
Schleswig-Holstein/Hamburg	1.034		0.962		0.818		0.806		1.245		1.313		0.552	*	0.554	
Niedersachsen/Bremen	0.881		1.229		1.311		1.240		1.452	**	1.551	**	1.483	*	1.534	*
Hessen	0.977		0.845		0.593		0.804		1.328	**	1.202		1.065		1.039	
Rheinland-Pfalz/Saarland	0.882		1.353		0.429		1.747		1.455	**	1.010		1.359		1.031	
Baden-Württemberg	0.892		0.857		0.534		0.539		0.859		0.850		0.796		1.024	
Bayern	1.195		1.145		1.031		0.764		1.840	**	1.935	**	1.799	**	1.853	**
Brandenburg/Berlin	1.212	*	1.355	*	0.974		1.383		1.350	**	1.381	*	1.034		1.149	
Mecklenburg-Vorpommern	1.499	**	1.567	**	1.344		2.314	**	2.186	**	1.793	**	1.100		2.328	**
Sachsen	1.603	**	1.627	**	1.203		1.908	**	1.571	**	1.828	**	1.782	**	1.559	
Sachsen-Anhalt	1.357	**	1.377	**	1.166	**	1.919	**	1.718	**	2.354	**	1.322	**	1.557	**
Unemployment rate																
Monthly unemployment rate	1.239	**	1.003	**	1.330	**	1.069	**	1.430	**	1.013	**	1.322	**	1.115	**
N of observations	7134		5126		1817		1346		19148		15051		5740		4526	
N of failures	1300		750		369		198		1955		1062		538		294	

Note: ** $p < 0.01$, * $p < 0.05$

Table 6: Estimated sub-distribution hazard ratios for risk low-wage job

Group	Low-wage males								Non low-wage males							
Age	40–44				45–46				40–44				45–46			
Time period	Pre		Post		Pre		Post		Pre		Post		Pre		Post	
Individual characteristics (reference: low education, unskilled blue collar, not married, German)																
Vocational training or Abitur	1.124		1.179		1.169		1.876	**	1.315	*	1.221		1.153		0.972	
University	0.771		0.795		0.930		1.318		0.716	**	0.578	**	0.540	*	0.452	*
Skilled blue collar	0.947		0.972		0.971		0.831		0.797	**	0.695	**	0.789	**	0.737	**
White collar	0.817	*	0.823	*	0.908		0.845		0.568	**	0.497	**	0.618	**	0.496	**
Married	1.007		1.010		1.028		1.071		0.924		0.902	*	0.974		0.791	*
Non-German	1.023		0.952		0.840		1.154		1.045		0.976		0.837		0.773	
During last 7 years																
Years of employment	1.077	**	1.071	**	1.069		1.097		1.066	**	1.005		1.034		1.183	*
Years of tenure at last employer	0.958	**	0.974		0.978		0.984		0.992		1.031	*	1.010		1.040	
Years of unemployment	0.886	**	0.998		1.033		1.090		1.066		1.009		0.906		1.036	
Number of employers	1.076	**	1.093	**	1.061		1.050		1.045	**	1.071	**	1.085	**	1.108	**
Past recall	0.773	**	0.698	**	0.643	**	0.656	**	0.740	**	0.840	*	1.052		1.030	
Past labor market program	1.185	**	1.078		1.010		1.175		0.966		1.096		1.009		1.172	
Characteristics last job (reference: manufacturing, firm size up to 50)																
Daily wage rate	1.004	*	1.002		1.005		1.002		0.975	**	0.974	**	0.971	**	0.975	**
Agriculture, mining, energy	0.649	**	0.736	*	0.423	**	0.913		0.433	**	0.365	**	0.415	**	0.613	
Retail sector	1.068		1.087		0.908		0.970		1.019		0.937		0.981		1.106	
Hotels and restaurants	0.970		0.919		0.983		0.622		1.012		0.837		0.854		0.923	
Transport sector	1.125		0.975		0.877		0.924		0.973		0.902		0.945		0.954	
Economic and financial services	0.940		1.042		0.776		0.884		0.786	**	0.835	*	0.800		0.999	
Public services	0.739	**	0.805		0.800		0.771		0.834	**	0.832		0.607	**	1.099	
Temporary agency sector	1.283	**	1.251	*	1.245		1.310		0.924		1.093		1.335		1.474	
Firm size 51-100	1.041		1.230	**	0.946		1.224		1.239	**	1.194	**	1.395	**	1.478	**
Firm size 101-250	1.135		1.151		1.132		0.914		1.507	**	1.385	**	1.383	**	1.696	**
Firm size 251 and more	0.868		1.154		1.239		1.288		1.553	**	1.454	**	1.194		1.557	**
Federal state (reference: Nordrhein-Westfalen)																
Schleswig-Holstein/Hamburg	0.836		0.986		0.988		0.703		0.960		1.226		1.366		0.884	
Niedersachsen/Bremen	0.968		0.992		0.996		0.875		0.811	**	1.018		1.127		0.915	
Hessen	0.834		0.939		1.349		0.631		0.998		1.065		1.121		1.338	
Rheinland-Pfalz/Saarland	0.806		0.968		1.055		0.766		0.832		0.933		1.068		0.952	
Baden-Württemberg	0.882		0.862		0.920		0.715		0.943		0.882		1.428	**	0.934	
Bayern	0.781	**	1.050		0.796		0.792		0.829	**	0.920		1.068		0.901	
Brandenburg/Berlin	1.137		1.294	**	1.448	**	0.788		1.425	**	1.483	**	1.735	**	1.790	**
Mecklenburg-Vorpommern	1.221	*	1.315	*	1.297		0.786		1.461	**	1.553	**	1.719	*	1.379	
Sachsen	1.441	**	1.436	**	1.252		1.311		1.978	**	1.824	**	2.130	**	1.415	
Sachsen-Anhalt	1.376	**	1.650	**	1.528	**	1.131		2.155	**	1.906	**	2.678	**	1.652	*
Unemployment rate																
Monthly unemployment rate	1.017		1.003		0.953		0.937		1.010		1.067	**	1.039		0.985	
N of observations	7134		5126		1817		1346		19148		15051		5740		4526	
N of failures	2272		1739		607		472		2508		1712		685		536	

Note: ** $p < 0.01$, * $p < 0.05$

Table 7: Estimated sub-distribution hazard ratios for risk non low-wage job

Group	Low-wage males								Non low-wage males							
Age	40–44				45–46				40–44				45–46			
Time period	Pre		Post		Pre		Post		Pre		Post		Pre		Post	
Individual characteristics (reference: low education, unskilled blue collar, not married, German)																
Vocational training or Abitur	1.917	**	2.401	**	2.512	*	1.425		2.160	**	1.948	**	2.342	**	2.071	**
University	2.883	**	2.340	**	2.460		1.582		2.492	**	2.162	**	2.452	**	2.447	**
Skilled blue collar	1.420	**	1.213	*	1.089		1.689	**	1.283	**	1.176	**	1.311	**	1.101	
White collar	1.324	*	1.287	*	1.416		1.398		1.287	**	1.234	**	1.189	*	1.059	
Married	1.415	**	1.351	**	1.415	*	1.176		1.170	**	1.132	**	1.323	**	1.168	**
Non-German	0.766	*	0.760	*	0.959		0.536	*	0.894	**	0.794	**	1.096		0.907	
During last 7 years																
Years of employment	1.157	**	1.070		1.025		1.132		1.155	**	1.120	**	1.164	**	1.130	**
Years of tenure at last employer	0.885	**	0.889	**	0.938		0.860	**	0.936	**	0.937	**	0.946	**	0.938	**
Years of unemployment	0.916		0.919		0.558	**	0.702	*	0.845	**	0.986		0.799	**	0.958	
Number of employers	1.069	**	1.000		1.174	**	1.105		1.041	**	1.069	**	1.073	**	1.096	**
Past recall	0.905		0.992		0.837		0.612		0.780	**	0.644	**	0.736	**	0.695	**
Past labor market program	0.992		0.986		0.904		1.302		1.095	**	1.107	**	1.069		1.003	
Characteristics last job (reference: manufacturing, firm size up to 50)																
Daily wage rate	1.030	**	1.026	**	1.030	**	1.022	*	1.004	**	1.001	*	1.005	**	1.001	
Agriculture, mining, energy	0.842		1.051		1.275		0.823		0.814	**	0.811	*	0.654	*	0.589	**
Retail sector	0.974		0.840		1.132		0.992		0.909	**	0.936		0.992		0.939	
Hotels and restaurants	0.623	*	0.604	**	0.578		1.044		0.927		0.968		0.881		0.751	
Transport sector	0.952		1.264		1.372		1.154		1.088		0.897	*	1.122		0.919	
Economic and financial services	1.119		0.772	*	1.105		0.655		0.784	**	0.780	**	0.820	**	0.823	**
Public services	0.915		0.708	*	0.895		0.684		0.723	**	0.703	**	0.921		0.701	**
Temporary agency sector	0.793		1.210		0.795		0.607		0.927		0.871		0.788		1.055	
Firm size 51-100	0.988		0.793	*	1.662	**	0.898		1.022		1.088	*	0.980		0.934	
Firm size 101-250	0.863		0.992		0.811		1.402		0.926	*	0.969		0.919		0.808	**
Firm size 251 and more	0.899		0.992		0.680		1.054		0.800	**	0.836	**	0.792	**	0.780	**
Federal state (reference: Nordrhein-Westfalen)																
Schleswig-Holstein/Hamburg	1.102		1.186		1.941		1.866		0.964		1.040		1.050		0.930	
Niedersachsen/Bremen	1.531	**	1.236		0.847		1.545		1.037		0.994		0.914		0.911	
Hessen	1.464	*	1.758	**	1.335		1.433		0.964		1.004		1.010		0.991	
Rheinland-Pfalz/Saarland	1.224		1.608	**	1.540		0.568		1.139	*	1.105		1.138		1.030	
Baden-Württemberg	1.425	*	1.822	**	2.323	**	2.507	**	1.133	**	1.201	**	0.963		1.080	
Bayern	1.338	*	1.674	**	0.969		1.972	*	1.008		1.021		0.913		0.931	
Brandenburg/Berlin	0.488	**	0.776		0.524	*	0.679		0.647	**	0.775	**	0.747	**	0.615	**
Mecklenburg-Vorpommern	0.458	**	0.648	*	0.549		0.974		0.593	**	0.715	**	1.078		0.553	*
Sachsen	0.407	**	0.607	**	0.835		0.268	**	0.609	**	0.675	**	0.827		0.680	**
Sachsen-Anhalt	0.542	**	0.783		0.638		0.785		0.720	**	0.729	**	0.666	**	0.504	**
Unemployment rate																
Monthly unemployment rate	0.966		1.033		0.956		1.027		0.986		0.997		1.012		1.004	
N of observations	7134		5126		1817		1346		19148		15051		5740		4526	
N of failures	770		708		188		163		7256		6304		2163		1804	

Note: ** $p < 0.01$, * $p < 0.05$

Table 8: Estimated sub-distribution hazard ratios for risk subsidized self-employment

Group	Low-wage males								Non low-wage males							
Age	40–44				45–46				40–44				45–46			
Time period	Pre		Post		Pre		Post		Pre		Post		Pre		Post	
Individual characteristics (reference: low education, unskilled blue collar, not married, German)																
Vocational training or Abitur	1.353		0.872		1.619		1.439	*	1.061		1.102		1.473		1.608	
University	2.022	**	1.262		1.758		2.716		0.991		1.015		1.432		1.246	
Skilled blue collar	1.151		1.445	**	1.642		1.057		1.257	**	1.458	**	1.502	**	1.514	**
White collar	2.565	**	2.168	**	3.193	**	1.808		2.275	**	1.952	**	2.838	**	2.259	**
Married	1.184	*	1.101		1.218		1.376		1.155	**	1.062		1.148		1.104	
Non-German	0.826		1.085		0.667		1.334		1.038		1.085		1.147		1.108	
During last 7 years																
Years of employment	0.912	*	0.913	*	0.868		0.901		0.915	**	0.914	**	0.888	**	0.933	
Years of tenure at last employer	1.110	**	1.033		0.987		1.069		1.037	**	1.037	**	1.043	*	1.042	
Years of unemployment	0.827	**	0.845	*	0.739		0.719		0.975		0.785	**	0.734	**	0.803	
Number of employers	1.004		0.924		0.866		0.856		0.987		0.928	**	1.005		0.955	
Past recall	0.644	**	0.632	**	1.212		0.670		0.862	*	0.826	**	0.843		0.838	
Past labor market program	1.093		0.932		1.202		1.042		1.005		1.041		1.094		1.206	
Characteristics last job (reference: manufacturing, firm size up to 50)																
Daily wage rate	0.977	**	0.997		0.976	*	1.016		1.010	**	1.010	**	1.008	**	1.013	**
Agriculture, mining, energy	0.507	*	0.658		0.220		0.449		0.891		0.540	**	0.747		1.279	
Retail sector	1.162		1.423		2.812	**	0.823		1.369	**	1.225	**	1.218	*	1.094	
Hotels and restaurants	1.484	*	1.265		2.768	*	0.888		1.334		1.149		1.586		0.868	
Transport sector	1.234		0.857		1.868		0.980		0.908		0.847		1.142		0.844	
Economic and financial services	1.413	*	1.507	*	2.330	*	1.133		1.508	**	1.432	**	1.379	**	1.242	
Public services	1.338		2.298	**	3.050	**	1.289		1.309	**	1.376	**	1.275	*	1.302	
Temporary agency sector	0.452	**	0.568		1.124		0.603		1.007		0.988		1.714		0.725	
Firm size 51-100	0.975		0.989		1.041		1.300		0.862	**	0.848	**	0.969		0.894	
Firm size 101-250	0.749		0.519	**	0.860		0.529		0.754	**	0.673	**	0.831		0.933	
Firm size 251 and more	0.604	*	0.485	*	0.610		0.499		0.769	**	0.691	**	0.856		0.721	**
Federal state (reference: Nordrhein-Westfalen)																
Schleswig-Holstein/Hamburg	0.939		1.130		0.630		0.208		0.833		0.763	*	0.862		1.089	
Niedersachsen/Bremen	0.965		0.810		1.099		0.722		0.970		0.977		1.059		1.077	
Hessen	1.266		0.949		1.770		1.324		0.948		1.005		0.989		0.934	
Rheinland-Pfalz/Saarland	1.335		0.861		1.374		1.833		0.969		1.183		0.845		1.079	
Baden-Württemberg	1.301		0.828		0.596		1.170		0.969		1.055		1.047		1.100	
Bayern	1.366		0.763		2.323	**	1.365		1.007		1.018		0.942		1.229	
Brandenburg/Berlin	0.977		0.668	*	0.885		1.244		1.172		1.066		1.191		1.637	**
Mecklenburg-Vorpommern	0.853		0.636		0.595		0.140		1.247	*	0.776		0.901		1.374	
Sachsen	0.952		1.028		0.933		0.765		1.225	*	1.237		1.231		1.328	
Sachsen-Anhalt	0.769		0.580	*	0.560		0.642		0.883		0.882		0.856		1.539	
Unemployment rate																
Monthly unemployment rate	0.885	*	1.023		0.832		0.989		0.953	*	1.012		0.969		1.025	
N of observations	7134		5126		1817		1346		19148		15051		5740		4526	
N of failures	558		387		124		102		2920		2472		845		686	

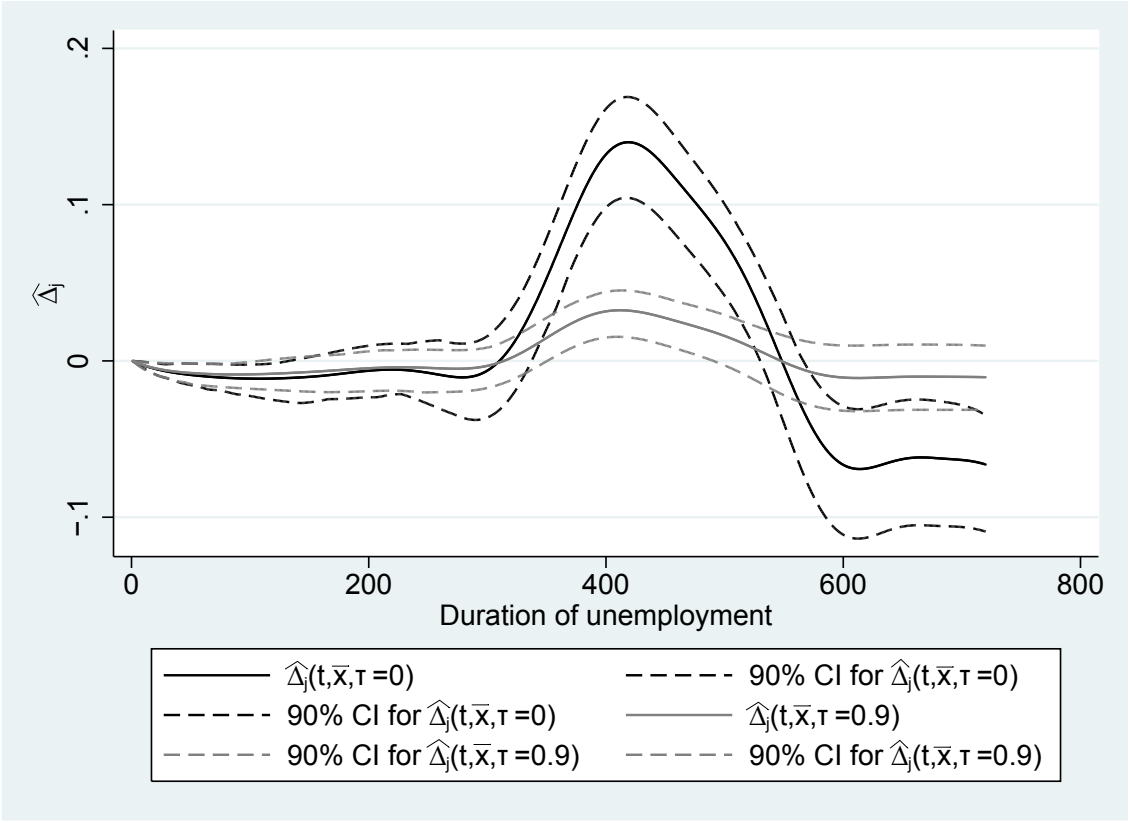
Note: ** $p < 0.01$, * $p < 0.05$

Table 9: Estimated sub-distribution hazard ratios for risk unknown and other states

Group	Low-wage males								Non low-wage males							
Age	40–44				45–46				40–44				45–46			
Time period	Pre		Post		Pre		Post		Pre		Post		Pre		Post	
Individual characteristics (reference: low education, unskilled blue collar, not married, German)																
Vocational training or Abitur	0.864	**	0.906		0.728	*	0.619	**	0.770	**	0.731	**	0.743	*	0.695	**
University	0.947		1.061		0.728		0.984		0.781	**	0.754	**	0.990		0.765	
Skilled blue collar	0.908	**	0.742	**	0.935		1.028		0.788	**	0.895	**	0.871	**	1.054	
White collar	0.997		0.991		1.075		1.035		1.038		0.989		0.845		1.134	
Married	0.832	**	0.820	**	0.819	*	0.876		0.796	**	0.911	**	0.747	**	0.915	**
Non-German	1.090	*	1.039		1.234		0.890		1.093	*	1.175	**	0.931		1.221	*
During last 7 years																
Years of employment	0.917	**	0.951		0.903		0.923		0.858	**	0.885	**	0.879	**	0.848	**
Years of tenure at last employer	1.001		1.051	*	1.019		1.061		1.063	**	1.071	**	1.039		1.036	*
Years of unemployment	0.990		0.858	**	0.902		0.997		0.862		0.876	**	1.004	*	0.834	
Number of employers	0.978	*	0.998		0.991		1.075		1.003		0.991		0.950	**	0.919	**
Past recall	1.037		0.888		0.969		1.068		1.077		1.188	**	1.002		1.134	
Past labor market program	1.013		1.182	*	1.283		0.878		1.062		0.913		0.981		0.931	
Characteristics last job (reference: manufacturing, firm size up to 50)																
Daily wage rate	0.992	**	0.990	**	0.987		0.982	**	0.997	**	0.998	*	0.997	**	0.997	**
Agriculture, mining, energy	0.595	**	0.596	**	0.850		0.533	*	0.569	**	1.015		0.463	**	0.737	
Retail sector	0.982		0.954		0.752		0.979		0.931		0.908		0.994		1.037	
Hotels and restaurants	1.141		0.997		1.081		0.781		0.895		0.866		0.941		1.014	
Transport sector	0.944		0.927		0.524		0.849		0.900	**	1.074		0.714	**	1.189	
Economic and financial services	0.991		0.893		1.040		0.914		1.116	*	1.207	**	1.262	**	1.043	
Public services	1.240	*	0.981		1.013		0.867		1.334	**	1.219	**	1.130		1.149	
Temporary agency sector	0.828	**	0.842		0.817		0.622		0.712	*	1.020		0.515		0.611	
Firm size 51-100	1.088		1.117		0.935		0.969		1.155	**	1.058		0.969		0.965	
Firm size 101-250	1.131	**	1.107		1.201		1.259		1.256	**	1.387	**	1.242	**	1.302	**
Firm size 251 and more	1.471	**	1.184		1.610	**	0.840		1.353	**	1.652	**	1.508	**	1.578	**
Federal state (reference: Nordrhein-Westfalen)																
Schleswig-Holstein/Hamburg	1.350		0.916		0.791		1.327		1.062		0.960		0.995		1.130	
Niedersachsen/Bremen	0.933		0.989		0.834		0.806		0.919		0.952		0.906		1.078	
Hessen	0.992		0.906		0.912		1.182		0.951		0.882		0.931		1.017	
Rheinland-Pfalz/Saarland	1.394		0.794		1.288		1.366		0.889	*	0.799	**	0.993		0.940	
Baden-Württemberg	1.274		1.010		1.030		1.436		1.050		0.933		1.252		1.009	
Bayern	1.117		0.862		1.079		1.322		0.987	*	0.902		1.102		0.991	
Brandenburg/Berlin	1.026		0.725	*	0.971		1.158		1.082		0.891		0.787		0.907	
Mecklenburg-Vorpommern	0.908		0.839		1.069		1.287		0.715	**	0.954		0.824		0.954	
Sachsen	0.709	**	0.586	**	0.710		1.100		0.791	**	0.747	**	0.525	**	0.968	
Sachsen-Anhalt	0.924	*	0.642	**	0.639		0.532	*	0.633	**	0.810		0.826		1.079	
Unemployment rate																
Monthly unemployment rate	0.935	**	0.997		0.910	*	1.028		0.910	**	0.967		0.908	**	0.938	
N of observations	7134		5126		1817		1346		19148		15051		5740		4526	
N of failures	1380		1039		302		276		3158		2930		1003		984	

Note: ** $p < 0.01$, * $p < 0.05$

Figure 3: Estimated reform effects on $\tilde{F}_j$ for subsidized self-employment of non low-wage males at the mean of the regressors.



References

[1] Arntz, M., Lo, S.M.S. and Wilke, R.A. (2008) Bounds Analysis of Competing Risks: A Non-parametric Evaluation of the Effect of Unemployment Benefits on Migration in Germany, FDZ Methodenreport, 06/2008, IAB Nuremberg.

[2] BA Statistik (2010), Beschftigungsstatistik: Sozialversicherungspflichtige Arbeitsentgelte, Sonderbericht der Statistik der BA.

[3] Bond, S.J. and Shaw, J.E.H. (2006) Bounds on the covariate-time transformation for competing-risks survival analysis, *Lifetime Data Analysis*, 12, 285–303.

[4] Cox, D.R. (1962), *Renewal Theory*, London.

[5] Dlugosz, S., Stephan, G. and Wilke, R.A. (2009), Fixing the leak: Unemployment incidence before and after the 2006 reform of unemployment benefits in Germany, IAB Discussion Paper, 25/2009.

[6] Fine J.P. and Gray R.J. (1999), A proportional hazards model for the subdistribution of a competing risk, *Journal of the American Statistical Association*, 94, 496–509.

[7] Fitzenberger, B., Osikominu, A. and Völter, R. (2006), Imputation rules to improve the education variable in the IAB employment subsample, *Schmollers Jahrbuch*, 126, 405–436.

[8] Hunt, J. (1995), The Effect of Unemployment Compensation on Unemployment Duration in Germany *Journal of Labor Economics*, 13, 88–120.

[9] Jeong, J.H. and Fine, J.P. (2007), Parametric regression on cumulative incidence function, *Biostatistics*, 8, 184–196.

[10] Lo, S.M.S. and Wilke, R.A. (2010), A copula model for dependent competing risks, *Journal of the Royal Statistical Society Series C*, 59, 359–376.

[11] Lo, S.M.S. and Wilke, R.A. (2011), A Regression Model for the Copula Graphic Estimator., *Discussion papers in Economics*, No. 11/04, University of Nottingham.

[12] Lee, S. and R.A. Wilke (2009), Reform of Unemployment Compensation in Germany: A nonparametric Bounds Analysis using Register Data, *Journal of Business and Economic Statistics*, 27, 176-192.

[13] Nelsen, R.B. (2006), *An Introduction to Copulas*, 2nd Edition, Springer, New York.

[14] Oakes,D. (1989), Bivariate survival models induced by frailties, *Journal of the American Statistical Association*, 84, 487-493.

[15] Peng, L. and Fine, J.P. (2009), Competing Risks Quantile Regression, *Journal of the American Statistical Association*, 104, 1440–1453.

[16] Peterson, A.V. (1976), Bounds for a Joint Distribution With Fixed Sub-Distribution Functions: Application to Competing Risks, *Proceedings of the National Academy of Science*, 73, 11–13.

[17] Tsiatis, A. (1975), A Nonidentifiability Aspect of the Problem of Competing Risks, *Proceedings of the National Academy of Sciences*, 72, 20–22.

[18] Wichert, L. and Wilke, R.A. (2011), Which factors safeguard employment? An analysis with misclassified German register data. *Journal of the Royal Statistical Society A*, forthcoming.

[19] Zheng, M. and Klein, J.P. (1995), Estimates of marginal survival for dependent competing risks based on assumed copula. *Biometrika*, 82, 127–138.