Estimating the latent effect of unemployment benefits on unemployment duration

Dynamics of Low Wage, Low Pay and Transfer Receipt
November 15, 2013
Nuremberg
Motivation

Effects of unemployment benefits

• Reservation wages increase with generosity of unemployment benefit system (Moffitt/Nicholson 1982, Mortensen 1970)

• Spikes in outflow rates may occur during times of benefit exhaustion (Mortensen 1977, van den Berg 1990, Boone/van Ours 2009)

Competing risks

• Generosity of the benefit system may affect competing risks differently (for instance, a less generous system may induce workers to take up a low wage job earlier instead of further searching for a better paid one)

• Competing risks are probably not independent from each other, which complicates identification of marginal distributions of latent failure times

Heterogeneous groups

• Generosity of benefit system affects heterogeneous groups differently

• In particular, low wage workers may receive complementary unemployment assistance, moderating the effects of the unemployment benefit system
Contribution of this paper

**Competing risks**
- Consider five different exit states from unemployment
  - In detail: Recall, low-wage full-time job, other full-time job, subsidized self-employment, unknown and other
  - Application of a recently developed regression model for the Copula Graphic Estimator for dependent competing risks (Lo/Wilke 2013)

**Econometrics**
- Operates under fewer ad-hoc assumptions than are commonly applied
- Estimation of bounds for the marginal distribution functions of failure times for all risks

**Identification**
- Natural experiment (cut in benefit duration)
- Difference-in-differences approach

**Heterogeneous groups**
- Previous low-wage earners (up to 2/3 of the national medium wage)
- Previous non low-wage earners
Related empirical literature

**Competing risks**
- Local or distant job: Arntz/Lo/Wilke 2010
- Local job finding, migration, or subsidized employment: Arntz/Wilke 2009
- Recall or new job: Alba-Ramirez/Arranz/Monoz-Bullón 2007
- Open-ended/fixed-term/part-time/government-provided work, self-employment, or labor force-withdrawal: Portugal/Addison 2008

**Heterogeneous groups**
- Low-wage and other men and women: Arntz/Wilke 2009
- High-skilled single and married males, less-skilled males: Arntz/Lo/Wilke 2010
Institutional background
German system of unemployment compensation

Unemployment benefits (ALG I)

- **Insurance contributions** by workers and firms (no experience rating)
- **Level:** Depends on former wage, replacement rate of 60 / 67 percent of previous wage
- **Entitlement length:** Depends on employment history

Unemployment assistance (ALG II)

- **Means tested assistance** for needy job-seekers and their households
- **Tax-funded**
- **Level:** Since 2005 not dependent on former wage
- **Entitlement length:** Unlimited

Active labor market programs

- **Further training, wages subsidies, job creation schemes …**
- **Subsidized self-employment**: Previous two instruments were merged into a new one since August 2006, which required a remaining unemployment benefit claim of at least 90 days
2006 reform of unemployment benefit durations

<table>
<thead>
<tr>
<th>Age group</th>
<th>Maximum entitlement length</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2/2006 until</td>
</tr>
<tr>
<td></td>
<td>until 1/2006</td>
</tr>
<tr>
<td>&lt;45</td>
<td>12</td>
</tr>
<tr>
<td>45-46</td>
<td>18</td>
</tr>
<tr>
<td>47-51</td>
<td>22</td>
</tr>
<tr>
<td>52-54</td>
<td>26</td>
</tr>
<tr>
<td>55-56</td>
<td>26</td>
</tr>
<tr>
<td>&gt;56</td>
<td>32</td>
</tr>
</tbody>
</table>

We will compare those of age 40-44 and those of age 45-46

We do not consider older groups because of
• a change in the inflow rate after the reform
• early retirement is unlikely for employees aged <47
Previous results regarding reform effects on inflows in unemployment

<table>
<thead>
<tr>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td>Basis</td>
<td>0.2</td>
</tr>
<tr>
<td>Age group 45-46</td>
<td>16.3**</td>
</tr>
<tr>
<td>Age group 47-51</td>
<td>19.9**</td>
</tr>
<tr>
<td>Age group 52-54</td>
<td>52.4**</td>
</tr>
<tr>
<td>Age group 55-56</td>
<td>53.1**</td>
</tr>
<tr>
<td>Age group &gt;56</td>
<td>117.7**</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Post-reform (since 2/2006)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Basis</td>
<td>-25.4**</td>
</tr>
<tr>
<td>Age group 45-46</td>
<td>-2.1</td>
</tr>
<tr>
<td>Age group 47-51</td>
<td>-1.1</td>
</tr>
<tr>
<td>Age group 52-54</td>
<td>-11.9**</td>
</tr>
<tr>
<td>Age group 55-56</td>
<td>-9.4**</td>
</tr>
<tr>
<td>Age group &gt;56</td>
<td>-22.3**</td>
</tr>
</tbody>
</table>

N of individuals 389235

Exclude anticipation period from analysis

2006 reform had no significant impact on post-reform unemployment inflows of workers aged 45-51

**) \( \alpha = 0.01 \)

Relative marginal effects

Source: Dlugosz/Stephan/Wilke (2013)
Data
Sample

Data set

25-percent-sample from the Integrated Employment Biographies V8.01 (times of employment, unemployment, job search, program participation)

- Entries into unemployment 2004 to 2008, age 40-46, maximum entitlement length at the beginning of the unemployment spell under the pre-reform regulations, last job full-time (around 60,000 observations)

Sample

Unemployment

- Definition: Registered unemployed and/or unemployment benefit recipient and/or participant in active labor market program - excepted subsidized employment or self-employment and long training
- Duration censored at 2 years

RHS variables

Individual characteristics (education, family status, nationality), labor market history of last 7 years, characteristics last job (daily wage rate, status, sectoral affiliation, firm size), federal state, unemployment rate
<table>
<thead>
<tr>
<th></th>
<th>Low-wage men</th>
<th></th>
<th>Non low-wage men</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Age 40-44</td>
<td>Age 45-46</td>
<td>Age 40-44</td>
<td>Age 45-46</td>
</tr>
<tr>
<td></td>
<td>Pre</td>
<td>Post</td>
<td>Pre</td>
<td>Post</td>
</tr>
<tr>
<td>Recall</td>
<td>0.18</td>
<td>0.15</td>
<td>0.20</td>
<td>0.15</td>
</tr>
<tr>
<td>Low-wage full time</td>
<td><strong>0.32</strong></td>
<td><strong>0.34</strong></td>
<td><strong>0.33</strong></td>
<td><strong>0.35</strong></td>
</tr>
<tr>
<td>Other full time</td>
<td>0.11</td>
<td>0.14</td>
<td>0.10</td>
<td>0.12</td>
</tr>
<tr>
<td>Subsidized self-employment</td>
<td>0.08</td>
<td>0.08</td>
<td>0.07</td>
<td>0.08</td>
</tr>
<tr>
<td>Unknown and other</td>
<td>0.19</td>
<td>0.20</td>
<td>0.17</td>
<td>0.21</td>
</tr>
<tr>
<td>-- Part-time</td>
<td>0.02</td>
<td>0.03</td>
<td>0.02</td>
<td>0.04</td>
</tr>
<tr>
<td>-- Long training</td>
<td>0.02</td>
<td>0.04</td>
<td>0.02</td>
<td>0.04</td>
</tr>
<tr>
<td>-- Secondary labor market</td>
<td>0.04</td>
<td>0.02</td>
<td>0.03</td>
<td>0.02</td>
</tr>
<tr>
<td>-- Unknown</td>
<td>0.11</td>
<td>0.11</td>
<td>0.10</td>
<td>0.11</td>
</tr>
<tr>
<td>Censored</td>
<td>0.12</td>
<td>0.10</td>
<td>0.12</td>
<td>0.10</td>
</tr>
<tr>
<td>N of observations</td>
<td>7,134</td>
<td>5,126</td>
<td>1,817</td>
<td>1,346</td>
</tr>
</tbody>
</table>

---

**Recall**

**Low-wage full time**

**Other full time**

**Subsidized self-employment**

**Unknown and other**

---

**Part-time**

---

**Long training**

---

**Secondary labor market**

---

**Unknown**

---

**Censored**

---

**N of observations**

7,134 5,126 1,817 1,346 19,148 15,051 5,740 4,526
## Means of selected right-hand side variables

<table>
<thead>
<tr>
<th></th>
<th>Low-wage men</th>
<th>Non low-wage men</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Age 40-44</td>
<td>Age 45-46</td>
</tr>
<tr>
<td>Low education (0/1)</td>
<td>0.08</td>
<td>0.09</td>
</tr>
<tr>
<td>Vocational training or Abitur</td>
<td>0.87</td>
<td>0.86</td>
</tr>
<tr>
<td>University (0/1)</td>
<td>0.05</td>
<td>0.05</td>
</tr>
<tr>
<td>Married (0/1)</td>
<td>0.55</td>
<td>0.51</td>
</tr>
<tr>
<td>Non-German (0/1)</td>
<td>0.18</td>
<td>0.21</td>
</tr>
<tr>
<td>Years of employment</td>
<td>5.52</td>
<td>5.45</td>
</tr>
<tr>
<td>Years of tenure at last employer</td>
<td>3.21</td>
<td>3.10</td>
</tr>
<tr>
<td>Years of unemployment</td>
<td>0.71</td>
<td>0.89</td>
</tr>
<tr>
<td>Past recall (0/1)</td>
<td>0.19</td>
<td>0.20</td>
</tr>
<tr>
<td>Daily wage rate</td>
<td>43.30</td>
<td>43.00</td>
</tr>
<tr>
<td>Manufacturing (0/1)</td>
<td>0.21</td>
<td>0.18</td>
</tr>
<tr>
<td>Hotels and restaurants (0/1)</td>
<td>0.09</td>
<td>0.11</td>
</tr>
<tr>
<td>Temporary agency sector (0/1)</td>
<td>0.11</td>
<td>0.11</td>
</tr>
<tr>
<td>N of observations</td>
<td>15423</td>
<td>5126</td>
</tr>
</tbody>
</table>
Econometric strategy
Identification

Natural experiment
- Treatment group of age 45-46, control group of age 40-44

Difference-in-difference
- Compare group-specific differences in competing risks \( j \) to exit unemployment between time periods:

\[
\text{DiD}_j = (F_{45-46, \text{post-reform}} - F_{40-44, \text{post-reform}}) - (F_{45-46, \text{pre-reform}} - F_{40-44, \text{pre-reform}}),
\]

where \( F_j(t) = \text{Pr}(T_j \leq t) \) is the marginal distribution function of risk \( j \)

- Identifying (untestable) assumption: Trends in failure times would have been the same for both age groups in the absence of the reform

Challenge
- Identify marginal distributions of latent durations in the presence of competing risks
Competing risks

- \((T_1, \ldots, T_J)\) = latent duration times of risks \(j = 1 \ldots J\)
- Observed: \(T = \min_j\{T_j\}\) and destination state \(r\)

**Basics**

- \(Q_j(t) = \Pr(T_j \leq t, j = r)\) = cumulative incidence of risk \(j\)
- \(S(t) = \Pr(T_1 > t, \ldots, T_J > t)\) = joint survival function at \(t\) (or survival of the minimum)
- \(S_j(t) = \Pr(T_j > t) = 1 - F_j(t)\) = marginal survival function of risk \(j\)

**Problem**

- **Unknown dependence structure between risks**: Marginal distributions of latent failure times \(S_j(t)\) cannot be identified from observed risks (Cox 1962)
- \(S(t)\) and \(Q_j(t)\) are identified, but \(Q_j(t)\) does not have a causal interpretation (ignores exits due to other risks, does not attain 1 as \(t\) goes to infinity)

**Proposed approaches**

- Consider cumulative incidence functions (weak assumptions, medical research)
- Assume semi-parametric hazard rate (ad hoc specification, econometrics)
- **Assume dependence structure** (Zheng/Klein 1995)
(1) Dependence Structure (Copula)

(2) Marginal Distributions $F_j(t)$

(3) Joint survival function $S(t)$, cumulative incidence functions $Q_j(t)$

(1) + (2) generate (3)
(3) does not identify (1) + (2)
Cox and Kaplan-Meier assume independence
(Mixed) proportional hazard models assume (1) and impose functional form on $F_j(t)$
### The Copula Graphic Estimator

**Copula (= link) function**

Joint distribution of the ranks of the duration variables, which **describes the dependence structure of failure times** for all competing risks.

\[ C(f_1, \ldots, f_J) = \Pr(f_1 \leq F_1, \ldots, f_J \leq F_J) \]

- Dependence structure between risks (copula) and marginal distributions \( F_j(t) \) generate \( S(t) \) and \( Q_j(t) \)

**Idea of the Copula Graphic Estimator**

- Identify \( S_1(t_1) \) \( \ldots \) \( S_J(t_J) \), using \( S(t) \) and \( Q_1(t_1) \) \( \ldots \) \( Q_J(t_J) \) for a known or assumed copula (solving an equation system)

**Literature**

- Extended to model with more than 2 dependent risks when copula is Archimedean by Lo/Wilke (2010), using a risk-pooling approach
- **Extended to regression model** by Lo/Wilke (2013)
A regression model for the Copula Graphic Estimator

**General approach**
- Closed form expression of $S_j(t;x)$ as a function of $Q_j(t;x)$ and the copula
- Two-stage estimation procedure

**Estimation**
- **First stage**: Estimate proportional hazard model for $Q_j(t;x)$ (Fine/Gray 1999, *stcrreg*).
- **Second stage**: Use first stage results to estimate $S_j(t;x)$ under the assumption of the Frank copula, computing a grid for the support of the copula dependence parameter.
- **Obtain bounds** for $S_j(t;x)$ by taking the min and max over all values of the dependence parameter.

**This paper**
- Presentation of bounds for the difference-in-differences estimator for $F_j(t;x) = 1 - S_j(t;x) = \Pr(T_j \leq t | x)$, where $x$ is the sample mean in our application.
- Assumption: Copula does not depend on time periods or age groups.
- In the first step we estimate $5*4*2 = 40$ cumulative incidence curves.
Empirical results: Cumulative incidence
Cumulative incidence curves

(a) Low-wage men

(b) Non low-wage men

Recall | Low-wage full time | Other full time | Self-employment | Unknown and other

Duration of unemployment (in days)

σ


Prediction at variable means of respective sample
DiD estimator for cumulative incidence curves

(a) Low-wage men

(b) Non low-wage men

Prediction at variable means of respective sample, 95-percent-CI (bootstrapping)
Empirical results: Copula Graphic Estimator Regression
Example for one of the 40 first stage estimates (excerpt)

<table>
<thead>
<tr>
<th>Risk to enter non low-wage job</th>
<th>Low-wage men</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Age 40-44</td>
</tr>
<tr>
<td>Selected variables</td>
<td>Pre</td>
</tr>
<tr>
<td>Vocational training or Abitur</td>
<td>1.927 **</td>
</tr>
<tr>
<td>University</td>
<td>2.901 **</td>
</tr>
<tr>
<td>Married</td>
<td>1.415 **</td>
</tr>
<tr>
<td>Non-German</td>
<td>0.767 *</td>
</tr>
<tr>
<td>Years of employment</td>
<td>1.156 **</td>
</tr>
<tr>
<td>Years of tenure at last employer</td>
<td>0.885 **</td>
</tr>
<tr>
<td>Years of unemployment</td>
<td>0.917</td>
</tr>
<tr>
<td>Past recall</td>
<td>0.905</td>
</tr>
<tr>
<td>Daily wage rate</td>
<td>1.030 **</td>
</tr>
<tr>
<td>Hotels and restaurants</td>
<td>0.623 *</td>
</tr>
<tr>
<td>Temporary agency sector</td>
<td>0.795</td>
</tr>
<tr>
<td>N of observations</td>
<td>7134</td>
</tr>
<tr>
<td>N of failures</td>
<td>770</td>
</tr>
</tbody>
</table>
DiD estimator of bounds for the reform effects on marginal distributions

Recall Low-wage full time Other full time Self-employment Unknown and other

Duration of unemployment (in days)

(a) Low-wage men

(b) Non low-wage men

Duration of unemployment (in days)

Prediction at variable means of respective sample
Robustness checks

Variations of **sample and unemployment definition** obtained very similar results:

- Excluding a longer time period around the reform (8/2005 to 4/2006)
- Including the anticipation period
- Using a wider definition of unemployment, interpreting also times in an unknown destination as unemployment
- Taking those of age 47 to 51 as the treatment group

**Specification**

**Uncertainty**

Estimation of standard errors using a **bootstrap** for an example: Shows that uncertainty due to random sampling does not play an important role

**Copula assumption**

Re-estimation of model **without assumption** that copula is independent of time periods and age groups: Results in much wider bounds
Conclusions
Cut in unemployment benefit duration affected unemployment exits

**Strategy of the paper**
Exploit a natural experiment to identify bounds on the marginal distribution functions for different **competing risks to leave unemployment**, using large administrative data and applying a Copula Graphic Estimator Regression model

**Main results**
In Germany, shorter benefit durations since 2006 induced in particular previous non low-wage workers
• to take up a low-wage or other full time job earlier
• to enter subsidized self-employment earlier

**Policy conclusions**
• Reform was successful in the sense that it **affected exit behavior** from unemployment (but: reform had partly been withdrawn in 2008)
• Results fit very well into the recent discussion that the decrease in unemployment in Germany during the last years is mainly the result of a **rising low-wage sector**

(a) Low-wage men

(b) Non low-wage men

Prediction at variable means of respective sample
Anticipation period of reform not excluded

Recall
Low wage full time
Other full time
Self employment
Unknown and other

(a) Low-wage men

(b) Non low-wage men

Prediction at variable means of respective sample
Wider definition of unemployment

(a) Low-wage men
(b) Non low-wage men

Prediction at variable means of respective sample
Age group 47-51 as treatment group

(a) Low-wage men

(b) Non low-wage men

Prediction at variable means of respective sample
Relaxing assumption that copula does not depend on time period or age

(a) Low-wage men
(b) Non low-wage men

Prediction at variable means of respective sample
Partial identification vs. random sampling

90% bootstrap CI for risk self-employment, non low-wage

Prediction at variable means of respective sample
Appendix II
Families of Copula Functions

- **Copula**
  - (joint distribution function)

  - **Archimedean Class**
    - Laplace Transform
      - e.g. Frailty Model (Mixed Proportional Hazard)
    - Non-Laplace Transform
      - e.g. Gumbel’s Family

  - **Other Class**
    - (e.g. Gaussian’s Family)

  - Different Families
    - (e.g. Clayton’s Family, Frank’s Family, Morgenstern’s Family etc)
Estimation of the reform effect on latent durations

Identification of the reform effect, with T as the reform period dummy and G as the reform group dummy:

\[ \Delta_j(t; \bar{x}) = F_j(t; T = 1, G = 1, \bar{x}) - F_j(t; T = 0, G = 1, \bar{x}) \]

\[ - (F_j(t; T = 1, G = 0, \bar{x}) - F_j(t; T = 0, G = 0, \bar{x})) \]

Semi-parametric model for the sub-distribution hazards (Fine/Gray 1999), with

\[ \phi_j(t; x) = \lim_{\Delta t \to 0} \frac{1}{\Delta t} P(t \leq T \leq t + \Delta t, \delta = j; T \geq t \cup (T \leq t \cap \delta \neq j), x) \]

\[ = -d \log\{1 - Q_j(t; x)\} / dt, \]

Estimation for pre-/post-reform, control/treatment group at sample mean
Assumption of the Frank copula

- F is not identified as the dependence structure (τ) is unknown; we assume a one parameter Frank copula with generator function ξ

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

- For this reason we compute for a grid on the support of τ and determine a lower and upper bound for the treatment effect

\[
\Delta_j(t; \bar{x}, \tau) = \tilde{F}_j(t; T = 1, G = 1, \bar{x}, \tau) - \tilde{F}_j(t; T = 0, G = 1, \bar{x}, \tau) - \left( \tilde{F}_j(t; T = 1, G = 0, \bar{x}, \tau) - \tilde{F}_j(t; T = 0, G = 0, \bar{x}, \tau) \right)
\]

\[
\Delta_j(t; \bar{x}) = \min_\tau \Delta_j(t; \bar{x}, \tau)
\]

\[
\overline{\Delta}_j(t; \bar{x}) = \max_\tau \Delta_j(t; \bar{x}, \tau)
\]