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# Social Interaction in Regional Labour Markets

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# Social Interaction in Regional Labour Markets <sup>\*</sup>

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## Abstract

Social interaction, i.e. the interdependence of agents' behaviour via non-market activities, has recently become the focus of economic analysis. Social interaction has been used to explain various labour market outcomes. An important result arising from the literature is the proposition that labour markets are characterised by multiple equilibria. Thus, social interaction is used as an explanation for regional unemployment disparities. Building on this, we construct a Pissarides (2000) type search model with social interaction. Despite social interaction, this type of model is characterised by only one stable equilibrium. Using a unique data set on un-/employment spell data for Germany we analyse whether multiple equilibria in regional labour markets exist. After controlling for structural differences we are able to show that the data supports the assumption of a unique equilibrium. As such, social interaction cannot explain regional unemployment disparities.

JEL: J6, R1.

Keywords: Social Interaction, Search Frictions, Survival Analysis, Regional Unemployment

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# 1 Introduction

Differences in the labour market performance (i.e. unemployment) in a cross-section of countries are usually explained by the different institutional settings between these countries, see Nickell and Layard (1999) or, more recently, Nickell et al. (2005) for example. However, we do not only witness large and persistent differences in unemployment rates between countries, but also within countries, i.e. at the regional level, see Elhorst (2003), for example. Since labour market institutions such as unemployment benefit legislations usually do not differ within a jurisdiction, we cannot explain these regional differences.

One possible reason for different regional unemployment experiences which has come under closer scrutiny is the notion of social interaction between agents at the regional level. Social interaction means that there is some (non-market) interdependence between agents (for example preference-based or constraint-based interaction, see Manski (2000)) which shapes agents' behaviour and thus influences the labour market performance.

Using preference-based interaction, Lalive and Stutzer (2004) argue that there is an attitude to the acceptability of living on the dole. This social norm exerts pressure on the unemployed and thus influences the unemployment rate. The strength of this norm, however, might differ across regions which, leads to regional unemployment differentials. They present convincing evidence for Switzerland that there is a correlation between the strength of this social norm and regional labour market performance.

Kolm (2005) puts forward very similar arguments. Her notion of social interaction is that the (dis-)utility of being unemployed depends on the unemployment rate of the region one lives in. This is due to the fact that stigmatisation in a high unemployment environment is lower, for example. Here, the pressure to find a new job is low. This form of social interaction results in persistence of shocks and in multiplicity of equilibria.

The classical reference of the labour market effects of constraint-based social interaction is Diamond (1982). In this paper the probability, of an agent finding a suitable trading partner (which in turn influences the production decision) is a function of the decisions of all other agents in the community. Thus, the decisions of others shape the form of the feasible consumption bundles (=constraint for utility maximisation). Diamond shows that this interaction results in multiple labour market equilibria.

Other constraint-based social interaction models, for example Topa (2001) and Topa and Conley (2002), argue that when searching for new jobs, unemployed agents face the constraint of finding a suitable job. This constraint, however, is affected by the social environment the agent lives in since the

majority of jobs are allocated via informal channels. Thus, an agent will c.p. find it easier to get a new job if she lives in a low unemployment environment and vice versa. Similar reasoning is applied by Selod and Zenou (2001), who postulate that the probability of finding a job is a function of the social network one lives in.

An important feature common to many of the models which incorporate social interaction is the existence of multiple equilibria. Regions which are identical in their economic structure (productivity, educational structure and so on) could thus experience different labour market outcomes.<sup>1</sup> In the Kolm (2005) framework, for example (structurally) identical regions could implicitly coordinate on different labour market equilibria.

The question as to whether the root of regional unemployment disparities is the multiplicity of equilibria or structural economic differences is highly important for policy-making. Multiple equilibria offer scope for governmental intervention to coordinate regions on the Pareto dominating labour market equilibrium. In contrast, the "structuralist" view of regional labour market disparities would not be that much in favour of regional policies.

Thus, the question begs whether social interaction inevitably results in multiple labour market equilibria and whether the data support the view of multiplicity of labour market equilibria. This is the starting point of this paper.

We amend a Pissarides (2000) type search model of the labour market with social interaction. We model social interaction as a leisure externality. The idea is that unemployed agents have to invest time in the search process. The opportunity costs of this time investment depend on the time investment of the other agents in the region. This is due to the fact that agents like to spend their leisure time together. Thus, the utility of consuming leisure time will be a function of the leisure time of the other individuals. We demonstrate that although this type of social interaction might lead to self enforcing processes, the labour market equilibrium in the economy is unique and only driven by structural parameters of the model. Thus, social interaction modelled as a leisure externality cannot explain regional differences in unemployment rates.

As the next step we empirically analyse the possibility of multiple regional labour market equilibria using a unique micro-level data set on unemployment spell data for Germany. We estimate the hazard rate for leaving unemployment, i.e. the probability of leaving unemployment in the next in-

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<sup>1</sup>Glaeser and Scheinkman (2003) analyse conditions under which preference-based social interaction generates multiple equilibria. Their model, however, is very general and thus does not directly address problems of search unemployment.

stant of time conditional on being unemployed, from 1999-2001. Controlling for individual and regional heterogeneity we find that the hazard rates do not significantly differ between regions. This supports our view that regional labour markets are characterised by a unique equilibrium and that regional differences in the labour market performance are due to economic differences between individuals living in structurally different regions.

The rest of the paper is organised as follows. The next section derives the first order conditions for the behaviour of individual agents and firms. These building blocks are put together in Section 2.5 to analyse a symmetrical general equilibrium. The empirical analysis follows in Section 3. First, we describe the empirical model and the data set. Second, we present regression results and analyse the regional distribution of the hazard rates. The last section, eventually, summarises our results and concludes.

## 2 The Theoretical Model

### 2.1 The Matching Technology

The basic framework for our analysis is the Pissarides (2000) model of frictional unemployment. In this model, (unemployed) workers are searching for jobs and firms are trying to fill vacancies. Both sides of the market are matched via a matching function. The rate  $m$  at which matching takes place depends positively on aggregate (=average) search intensity  $s$ , and the aggregate rates of unemployment  $u$  and vacancies  $v$ . We employ the familiar Cobb-Douglas specification of the matching function:

$$m = (u)^{1-\alpha}(v)^{\alpha}s. \quad (1)$$

Search intensity could be interpreted as input-augmenting efficiency of the matching function.<sup>2</sup> The probability of an efficiency unit of unemployment ( $=su$ ) to be matched to a vacant job is given by:

$$\frac{m}{su} = \theta^{\alpha}, \quad (2)$$

where  $\theta$  (defined as  $v/u$ ) reflects labour market tightness.

### 2.2 Individuals' Behaviour

An unemployed individual decides on how much search intensity to "invest". This decision has to be based on the subjective values of being employed or

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<sup>2</sup>A similar idea is found in Hosios (1990), for example.

unemployed. The Bellman equations for these states are given by:

$$rW_i = w_i + \lambda(U_i - W_i), \quad (3)$$

$$rU_i = \max_{s_i} \{b + l_i^\chi + q_i(W_i - U_i)\}, \quad (4)$$

where  $W_i$  is the value of being employed,  $U_i$  is the value of being unemployed,  $r$  is the rate of time preference (which is equal to the interest rate in a steady state),  $w_i$  is the wage the individual earns if employed,  $\lambda$  is the (exogenous) probability of destruction of a matched job and  $q_i$  is the individual probability of finding a job.

We assume risk neutrality on the part of the worker, i.e. utility is linear in the unemployment benefit  $b$ . The second argument in the flow utility function of unemployed workers captures the novel aspect of this framework:  $l_i$  is the amount of leisure the unemployed individual consumes. Individual leisure exhibits decreasing marginal utility (the utility function thus is quasi-linear). Since  $l_i = T - s_i$  (so searching for a job is only costly in terms of time, i.e. in terms of foregone utility), the marginal costs of searching are increasing.<sup>3</sup>

In addition to individual leisure  $l_i$ , aggregate leisure  $l$  also enters the unemployed's utility function. This captures the notion of agents being social individuals who would like to spend their leisure time together, because there is a complementarity in the consumption of free time. An agent needs other agents to play football or have a chat with in the pub, for example. We only assume the probability of finding another individual with whom these activities can be shared to increase with the overall leisure of all (unemployed) agents. Thus, leisure exerts a positive externality;  $\chi$  describes the strength of this effect.<sup>4</sup> The consequence of this externality is that an individual's marginal costs of searching decrease with an increase in overall search intensity.

The probability of an individual's finding a new job is given by:

$$q_i = s_i \theta^\alpha. \quad (5)$$

When choosing optimal search intensity, the unemployed person has to take the following trade-off into account. A lower  $s_i$  increases the flow utility of staying unemployed, but also increases the expected duration of the

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<sup>3</sup>The higher  $s_i$ , the lower  $l_i$  and hence the higher the marginal value of leisure (=marginal costs of searching). This is a standard assumption in the literature; see Pissarides (2000).

<sup>4</sup>We do not explicitly take into account leisure time of the employed since we assume their leisure time to be exogenously given, due to a fixed work contract. Since the time endowment of all agents is identical, we only have to consider the leisure time the unemployed have in excess of the employed.

unemployment spell. The latter effect is negative since the value of being employed is higher than the value of being unemployed. The first order condition of this problem is given by the derivative of equation (4) with respect to  $s_i$  (note that the individual agent assumes all aggregate variables to be unaffected by his or her choice):

$$\mu l_i^{\mu-1} l^x = \theta^\alpha (W_i - U_i). \quad (6)$$

In deriving this equation we took advantage of the fact that the value functions  $U_i$  and  $W_i$  depict values of being unemployed and employed respectively in the case of optimal behaviour of agents (see, for example Dixit and Pindyck (1994) or Shimer (2004) for a detailed argumentation). As such, these are *not* general functions of  $s_i$ . Thus, when deriving the condition for the choice of optimal search intensity, we do not have to take changes in the optimal state values into account.

The interpretation of the first order condition is straightforward. The left-hand side of the equation depicts the marginal cost of increasing search intensity which is the loss in flow utility due to less leisure time. The right-hand side, on the other hand, depicts the marginal value of higher search intensity which is equal to the increase in the probability of finding a job multiplied by the (optimal) net value of having a job.

The first order condition of individual search behaviour reveals two important points. First, an increase in labour market tightness  $\theta$  will c.p. increase individual search intensity.<sup>5</sup> Second, the net value of having a job must exceed some threshold level so that the agents will start investing into search intensity. Throughout the paper we assume this condition to hold.

## 2.3 Firm Behaviour

Firms choose whether to invest in offering a vacant job slot. The Bellman equations for a vacant and a filled job slot are given by:

$$rV = -cp + m/v(J - V), \quad (7)$$

$$rJ = p - w_i + \lambda(V - J), \quad (8)$$

where  $p$  is the productivity of a worker,  $cp$  denotes search costs and  $m/v$  is the probability of finding an adequate worker and turning the vacancy into

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<sup>5</sup>This is a point Shimer (2004) focuses on. He argues that this is counterfactual in a business cycle context. Note, however, that this result is only of partial equilibrium nature. The aggregate relation between search intensity  $s$  and labour market tightness  $\theta$  will become clearer later on.

a job. By free entry, the value of a vacancy must be zero. The matching function implies  $m/v = s\theta^{\alpha-1}$ . So the Bellman equations can be written as:

$$J = cps^{-1}\theta^{1-\alpha} \quad (9)$$

and

$$J = \frac{p - w_i}{r + \lambda}. \quad (10)$$

Combining these two equations gives the job creation curve:

$$\frac{p - w_i}{r + \lambda} - cps^{-1}\theta^{1-\alpha} = 0. \quad (11)$$

## 2.4 Wage Determination

The last element of our description of the economy concerns the wage equation. We assume the wage to be bargained between a worker and a firm upon meeting. To determine the wage rate the assumed timing structure must be made explicit:

1. Stage: *Agents* choose the amount of search intensity they want to invest rationally anticipating the outcome of the bargain. *Firms* determine the number of vacancies they want to offer, also anticipating the bargained wage.
2. Stage: Agents and Firms meet and bargain over the wage.
3. Stage: Vacancies are filled and production starts.

Thus, in the wage bargain the amount of search intensity has already been invested by agents and is thus fixed. The bargained wage maximises the following Nash product:

$$\Omega = (W_i - U)^\varphi J^{1-\varphi}, \quad (12)$$

where  $\varphi$  denotes the bargaining power of the worker. Moreover, we took advantage of the fact that the value of offering a vacancy must be zero by the free entry condition. Solving this wage bargaining problem (see Appendix 5.1) yields the following wage equation:

$$w_i = \varphi p + (1 - \varphi)(b + l_i^\mu l^X) + \varphi cp \frac{s_i}{s} \theta. \quad (13)$$



At the individual level, the effect of higher search intensity on the bargained wage is ambiguous. On the one hand, the individual value of being unemployed decreases with  $s_i$ , so that the firm can offer a lower wage. On the other hand, the agent has to be compensated for the higher search intensity, because the vacancy costs decrease. Moreover, the individual wage will decrease with an increase in aggregate search intensity in the economy.

Before turning to the determination of the general equilibrium in the economy, we will demonstrate how the endogeneity of the wage influences the decision making of agents concerning search intensity. Using equation (22) from Appendix 5.1 and (9), optimal search behaviour of agents is driven by the following first-order condition:

$$\mu l_i^{\mu-1} l^\chi = \frac{\varphi}{1-\varphi} c p s^{-1} \theta. \quad (14)$$

The right-hand side of equation (14) depicts the marginal value of additional search that holds with an endogenous wage. The interpretation is straightforward:  $c p \theta s^{-1}$  is the expected search costs the firm would have to bear if it did not fill the vacancy with the worker just met. This is therefore the cost the firm will save if it employs the worker, i.e. the matching rent. The bargained wage is such that the net value of having a job is a fraction of this matching rent. If the costs of filling a vacancy increased, the marginal gain of searching for an unemployed worker would also increase (since the net value of being employed would increase). Thus, their optimal search intensity would increase. The left-hand side is, as before, marginal utility of leisure. This is unchanged in the general equilibrium. The condition for optimal search behaviour of agents leads us to the following:

**Proposition 1** *Aggregate search intensity has countervailing effects on the optimal choice of an individual's search behaviour. For small  $s$ , individual search intensity will decrease with aggregate search intensity and vice versa.*

**Proof 1** *Take the differential of (14) to note:*

$$\begin{aligned} (\mu(1-\mu)l_i^{\mu-2}l^\chi) ds_i + (-\chi\mu l_i^{\mu-1}l^{\chi-1}) ds &= \left(-\frac{\varphi}{1-\varphi}c p s^{-2}\theta\right) ds \\ \Leftrightarrow (1-\mu)l_i^{-1}\frac{\varphi}{1-\varphi}c p s^{-1}\theta ds_i - \chi l^{-1}\frac{\varphi}{1-\varphi}c p s^{-1}\theta ds &= \left(-\frac{\varphi}{1-\varphi}c p s^{-2}\theta\right) ds \\ \Leftrightarrow \frac{ds_i}{ds} &= \frac{\chi l^{-1} - s^{-1}}{(1-\mu)l_i^{-1}} \begin{matrix} \geq \\ < \end{matrix} 0. \end{aligned}$$

The ambiguity of this expression is driven by the numerator. With  $l = T - s$  the following holds:

$$\frac{ds_i}{ds} \begin{cases} > 0 & \text{iff } s > \frac{T}{1+\chi} \\ < 0 & \text{iff } s < \frac{T}{1+\chi} \end{cases}$$

■

An increase in aggregate search intensity has two countervailing effects on an individual's choice. On the one hand, higher  $s$  will decrease the matching rent. In this situation firms will find it easier to fill vacancies. As a consequence there will be more firms entering the market with open job slots. However, here the value of a filled job slot must decrease.<sup>6</sup> Thus, the net value of having a job decreases, which in turn discourages individuals from searching intensively. On the other hand, marginal costs will decrease with aggregate search intensity. This is the impact of the leisure externality. With all other individuals searching intensively, it is very unlikely for them to find someone to spend their leisure time with. The marginal value of leisure decreases, i.e. the marginal costs of searching decrease and individuals are tempted to search more intensively. The latter effect will be the stronger, the larger  $s$  is (at least for  $\chi < 1$  which we assume). So for high values of  $s$ , this effect will dominate the former and agents will increase individual search intensity.

## 2.5 General Equilibrium

We will now derive and analyse the symmetric general equilibrium in the economy, i.e. a situation in which all agents and firms behave identically  $s_i = s$  and  $w_i = w$ . In the symmetric equilibrium, the three equations derived in the previous sections (the first order condition of individual agents (14), the job creation curve of firms (11) and the wage curve (13)) solve the model for the three endogenous variables  $\theta$ ,  $s$  and  $w$ . The wage is a function of average search intensity and labour market tightness:  $w = w(\theta, s)$  with  $w_\theta > 0$  and  $w_s < 0$ , where the subscript denotes the partial derivative with respect to this variable. The economic intuition for these properties is straightforward. The higher search intensity of the unemployed, the lower the value of being unemployed, hence the firm only has to pay a low wage (in the Nash bargaining interpretation: "the outside option of the unemployed decreases"). A tighter labour market increases the wage that firms are willing to pay, since search costs are high.

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<sup>6</sup>Since the higher  $s$  makes it easier to fill a job slot, the implicit barrier to entry which protects incumbent firms decreases. As such, the value of a filled job slot must decrease.

Using this wage equation, there are two relationships left which determine the equilibrium of the economy, namely the job creation curve and the optimal search behaviour of a representative individual:

$$(1 - \varphi)(p - (b + l^{\mu+\chi})) - \varphi c\theta - (r + \lambda)cps^{-1}\theta^{1-\alpha} = 0, \quad (15)$$

$$\mu l^{\mu+\chi-1} = \frac{\varphi}{1 - \varphi} cps^{-1}\theta, \quad (16)$$

where we used the expression for the bargained wage and the fact that in a symmetric equilibrium every agent will choose the same amount of search intensity, hence  $l_i = l$ .

In order to derive comparative static results, we have to calculate the slopes of these two equilibrium equations in the  $\theta$ - $s$ -space. Let us consider the job creation curve first. Totally differentiating equation (15) yields:

$$\begin{aligned} ((1 - \varphi)(\mu + \chi)l^{\mu+\chi-1}) ds - \varphi c d\theta - ((r + \lambda)cps^{-1}(1 - \alpha)\theta^{-\alpha}) d\theta \\ + ((r + \lambda)cps^{-2}\theta^{1-\alpha}) ds = 0 \end{aligned}$$

From this, the slope of the job creation curve is given by:

$$\frac{d\theta}{ds} = \frac{(1 - \varphi)(\mu + \chi)l^{\mu+\chi-1} + (r + \lambda)cps^{-2}\theta^{1-\alpha}}{\varphi c + (r + \lambda)cps^{-1}(1 - \alpha)\theta^{-\alpha}} > 0. \quad (17)$$

Both the denominator and the numerator are positive, hence, the job creation curve is positively sloped in the  $\theta$ - $s$ -space. Higher search intensity of unemployed agents makes it c.p. more profitable to offer vacant jobs, since the wage the firm has to pay decreases and the probability of filling a vacancy increases. This effect is also present in Diamond (1982), where more activity on one side of the market (in this case on the side of the unemployed searcher) induces activity on the other side. Next, we turn to the slope of the curve that describes optimal search behaviour of agents. Totally differentiating (16) yields the following equation:

$$\begin{aligned} \frac{d\theta}{ds} &= \frac{(1 - \mu - \chi)\varphi l^{\mu+\chi-2} + \frac{\varphi}{1-\varphi} cps^{-2}\theta}{\frac{\varphi}{1-\varphi} cps^{-1}} \\ &\Leftrightarrow \frac{d\theta}{ds} = ((1 - \mu - \chi)l^{-1} + s^{-1})\theta. \end{aligned} \quad (18)$$

The slope of the curve depicting optimal search behaviour in the  $\theta$ - $s$  space is ambiguous. This ambiguity is driven by the fact that  $(1 - \mu - \chi)$  does not have to be positive (in the aggregate, marginal costs of search intensity need not increase). If the leisure externality is zero or very small, i.e. situations

in which  $\mu + \chi < 1$ , the slope of the curve is strictly positive, i.e. an increase in  $\theta$  will increase search intensity. As such, the model resembles the results derived in Pissarides (2000) for the leisure externality,  $\chi$  being small. The economy is characterised by one stable equilibrium.

However, in the following we concentrate on the more interesting case (in our view) in which the leisure externality is strong enough, i.e. we will focus on the case of  $\chi + \mu > 1$ . Thus, we basically analyse the implication of aggregate increasing marginal utility to leisure for the equilibrium in the economy.

**Proposition 2** *Iff  $\chi + \mu > 1$ , the curve showing optimal (equilibrium) search intensity of agents will be hump shaped.*

**Proof 2** *Note that the slope of the curve is driven by:*

$$\begin{aligned} s^{-1} - (\mu + \chi - 1)l^{-1} \begin{matrix} \geq \\ \leq \end{matrix} 0 &\Leftrightarrow \frac{l}{s} \begin{matrix} \geq \\ \leq \end{matrix} (\mu + \chi - 1) \\ &\Leftrightarrow \frac{T}{\mu + \chi} \begin{matrix} \geq \\ \leq \end{matrix} s. \end{aligned}$$

For  $\bar{s} = \frac{T}{\mu + \chi} < T$ , this expression will hold true with equality and, hence the slope of the curve will be zero. For  $s < (>)\bar{s}$  the slope will be positive (negative). ■

The  $s$  associated with the positively and negatively sloped part of the curve showing agents optimal behaviour are in the choice set of agents  $s \in [0; T]$ . As such, both parts of the curve are relevant for the determination of the equilibrium.

The effect of a change in labour market tightness  $\theta$  on individual behaviour depends on the level of aggregate search intensity. This is due to the fact that by the leisure externality the individual marginal costs of search intensity are a function of search intensity exerted by other agents.

Higher labour market tightness  $\theta$  will on impact induce agents to increase their level of search intensity independently of aggregate search intensity. This is because marginal gains of search will c.p. increase. However, individual decisions change aggregate behaviour, i.e. aggregate search behaviour changes. This in turn feeds back on the optimal behaviour of the individual. For low-values of  $s$ , individual search intensity will decrease with higher  $s$ . The second round effect, therefore, dampens the impact effect of a higher  $\theta$ . But the impact effect will unambiguously dominate this second round effect. Search intensity will increase with higher  $\theta$ . This is the standard result which is also present in Pissarides (2000). Explaining the negatively sloped part is

not straightforward. Technically speaking, the curve depicts combinations of  $s$  and  $\theta$  where the marginal gain of search is equal to the marginal costs. An increase in  $\theta$  increases the marginal gain of search. As such,  $s$  must change in order to equate marginal costs and gains again. But this implies that for high levels of  $s$ , search intensity must decrease to close this gap. This reaction is due to the assumption of aggregate decreasing costs of searching.

However, this is only a description of the curve, but not of the behaviour of agents where  $s$  is large enough. As before, the increase in  $\theta$  will increase individual search behaviour  $s_i$  and thus,  $s$ . For high levels of  $s$ , however, this again will increase individual's search behaviour. Thus, any change in  $\theta$  will lead to an ever increasing search behaviour of agents. This process will not come to an end until all agents have invested their entire time endowment in search. As such, all points depicted by the negatively sloped part of this curve are unstable. This is important for the characterisation of the equilibrium in the economy.

**Proposition 3** *Consider an economy in which  $\mu + \chi > 1$ . If search intensity of agents is already very high, a change in labour market conditions will lead to a corner solution in which all unemployed agents will invest their entire time endowment in search.*

It is important to note that the corner solution is not the result of an explicit choice of agents. Every individual agent's utility function is well-behaved, i.e. at the individual level, agents face increasing costs of search activity. This would usually rule out a corner solution. However, the leisure complementary between individual and aggregate leisure results in the feedback effect (caused by aggregate decreasing costs of search intensity) described above. This causes the economy to end up in the corner situation. After having characterised the behaviour of individual agents and firms, we can eventually turn to the equilibrium of the economy. The shape of the curves reflecting the search behaviour of agents and the job offer of firms (which depicts the supply of vacancies for given search intensities) implies that the economy is characterised by two equilibria to which only one is stable.

Figure 1 depicts the equilibrium in the economy for different job offer constellations. The dashed line corresponds to a situation in which productivity in the economy is large, for example. The thick line delineates a job offer curve for different parameter values. By the form of the two equilibrium forming equations (15) and (16) there are at most two (real) solutions for the equilibrium. Since both equations start at the origin, point  $A$  is always an equilibrium. This point reflects the "no-action" equilibrium. This equi-

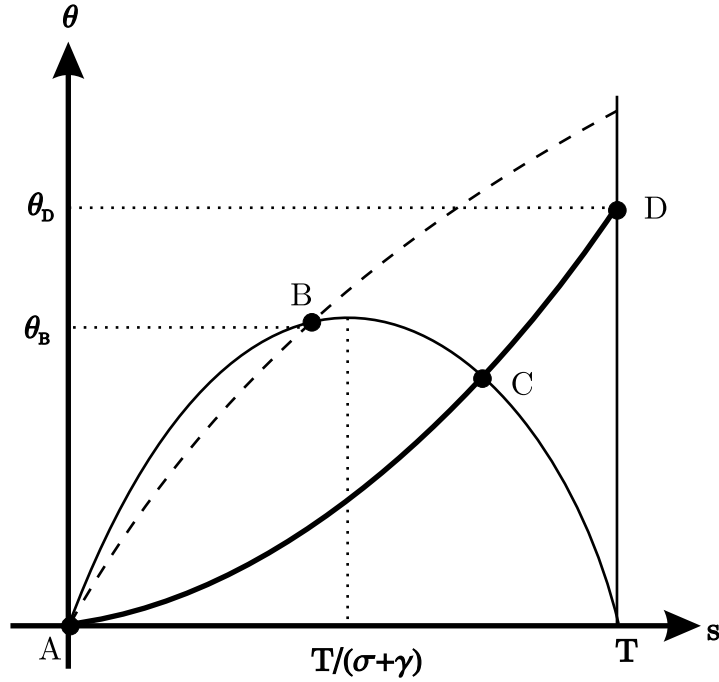


Figure 1: Equilibria in the Economy

librium is basically driven by the interdependence of the actions of agents on both sides of the market. If firms expect agents not to invest in search intensity for instance, they know that no vacancy will be filled. Thus, no vacancies will be offered. But with no vacancies being offered no agent will invest in search intensity. As such, this equilibrium is the result of a coordination failure as described in Diamond (1982), for example.

The "no-action" equilibrium, however, is not stable. A marginal increase in  $\theta$  will make an individual agent increase search intensity. This in turn makes all agents search more intensively until the new equilibrium is reached. Depending on the form of the job offer curve, this could be a point such as  $B$ , which is stable or a point such as  $C$ , which is not stable. If the economy is characterised by a job offer curve corresponding to the thick line in Figure 1, the economy will end up in the corner solution  $D$ . This is due to the fact that any change in labour market tightness  $\theta$  in a situation in which  $s > \frac{T}{\mu+\chi}$  will kick off a self-amplifying process of ever increasing search intensity until the corner is reached. In this situation firms will offer vacancies such that  $\theta = \theta_D$ . The equilibrium values of aggregate search intensity and labour market tightness determine the equilibrium (steady state) unemployment rate in the economy. The change of the rate of unemployment in the economy

is given by:

$$\dot{u} = \lambda(1 - u) - s\theta^\alpha u = 0.$$

In a steady state the unemployment rate is thus given by:

$$u^* = \frac{\lambda}{\lambda + s\theta^\alpha},$$

which is only a function of  $s$  and  $\theta$ . Thus, the equilibrium derived above unambiguously determines the unemployment rate in the economy. In the case illustrated above the corner solution is associated with a lower rate of unemployment than the "standard" equilibrium, point  $B$ , since both search intensity and labour market tightness are larger. Note, however, that this does hold necessarily not for all parameter values. Our model suggests that independently of whether social interaction exists or not, the economy is only characterised by one labour market equilibrium. This stands in contrast to the existing literature according to which social interaction could lead to multiple labour market outcomes. It was argued in the introduction that these two competing views have important policy implications. Thus, it is important to understand which of these is reconcilable with the data. In the next section we use unemployment spell data for Germany to analyse whether regional labour markets are characterised by multiple equilibria.

## 3 Empirical Analysis

### 3.1 Identification Strategy

#### 3.1.1 General Idea and Procedure

It was shown in the previous section that with social interaction, the labour market is only characterised by one equilibrium. In this section we test this proposition empirically. There are two huge problems which arise when testing for multiplicity in regional labour markets. First, and this is common to all testing for multiple equilibria, we can only observe the outcome of *one* equilibrium at a time. We tackle this problem by focusing on many regions and arguing that some of them are in the one or the other equilibrium. The second problem is even more severe. Social interaction (at least modelled as preference-based interaction) changes the behaviour of the unemployed, i.e. varying their search intensity, which then possibly gives rise to multiple equilibria. However, we cannot observe the behaviour of agents. We are only able to observe the outcome of this behaviour, e.g. the length of the unemployment spell an individual faces.

Facing these constraints, we stick to the following identification and estimation strategy. We estimate and analyse the hazard rate for leaving unemployment, i.e. the probability of leaving unemployment conditional to being unemployed. If regional labour markets were characterised by a unique equilibrium, the hazard rates of unemployed agents should be identical across regions. Thus, we would only have to analyse the regional hazard rates and compare their distribution in order to discriminate between models. A drawback of this simple approach, however, is that it totally neglects the differences in hazard rates which are due to regional or individual heterogeneity, e.g. due to self-sorting effects. Let us suppose that the population in region  $i$  is better educated than that in region  $j$ . If we believe in education as an important determinant for the chances of getting a job, our simple approach would identify significant differences in the hazard rate between the regions. These differences, however, would only be due to composition effects. The same would be true for other differences in structural parameters between regions. Remember that social interaction models which generate multiple equilibria (implicitly) state that regional labour market performance differs although structural characteristics are identical. Comparing hazard rates across regions while controlling for structural influences should indicate whether or not the data are consistent with multiple equilibria. If these regional differences were very small (large) we would conclude that when controlling for structural differences the regional labour markets perform identically (differently). This result would point to a labour market with a unique (multiple) equilibrium (equilibria).<sup>7</sup>

To get estimates of regional baseline hazard rates, we base our examinations on a stratified parametric survival specification. Thus, we assume that social interactions among unemployed individuals could be identified as unobserved regional heterogeneity and are detected by incorporating regional fixed effects. Depending on the assumed distribution for the failure times, we estimate either a Proportional Hazard (PH) or an Accelerated Failure Time (AFT) specification.

Within a PH framework, a stratified specification for the hazard rate of an individual  $i$  in region  $j$  may be written as:

$$h_{ij}(t_{ij}|x_{ij}, \sigma_j, \gamma_j) = h_0(t_{ij}, \sigma_j) \exp(x_{ij}\beta, \gamma_j), \quad (19)$$

with  $t_{ij}$  as unemployment duration of individual  $i$  in region  $j$ . The baseline hazard in region  $j$ ,  $h_0(t_{ij}, \sigma_j)$ , is allowed to depend on the location-specific

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<sup>7</sup>Our identification strategy is very indirect compared to the approach in Manning (1992), for example who directly tests the conditions of his model which generate multiplicity, i.e. increasing returns to scale. Due to data limitations, especially search intensity, we have to stick to an indirect strategy.



fixed effect  $\sigma_j$ . Since we use a stratified specification, a location-specific fixed effect  $\gamma_j$  is also included in the rescaling term  $\exp(x_{ij}\beta, \gamma_j)$ , where  $x_{ij}$  is a vector of both individual and regional covariates and  $\beta$  a vector of coefficients to be estimated.

Contrarily, in the case of an AFT model, a separation of the hazard rate into a baseline hazard and a rescaling term is not possible due to the properties of the assumed distribution of the failure times. Therefore, the following specification is used for a stratified estimation:

$$\ln t_{ij} = x_{ij}\beta + \gamma_j + z, \quad (20)$$

where  $z$  is the error term and follows the assumed distribution for the failure times.

To calculate regional hazard rates controlling for individual and regional heterogeneities, all covariates are reset to zero, leaving only the regional dummies for the specific region unchanged. Hereafter we refer to these hazard rates as *regional baseline hazard rates*.

### 3.1.2 Evaluation of the estimated baseline hazards and the Dip-Test

To evaluate and compare regional baseline hazard rates, we decided to calculate the hazards for different durations of unemployment spells. In detail, calculations have been made for unemployment durations of 30, 60, 90, 180, 270, 365, 455, 545, 635, 730, 820, 910, 1000 and 1095 days. For each duration, we evaluate whether there are significant variations among the regional baseline hazards. Remember that a unique regional labour market equilibrium implies that the regional baseline hazards should be more or less identical. To formalise this point, we argue that the distribution of regional baseline hazards should be characterised by a unimodal density function if the equilibrium is unique. On the other hand, if the data do not support the theoretical model, the baseline hazards should be significantly different over regions, leading to a multimodal density/distribution function. To control for such uni-/multimodal distribution of regional baseline hazard rates, we employ the "Dip-test" as proposed by Hartigan and Hartigan (1985).

This procedure is a non-parametric test for the unimodality of probability distributions. The idea is to calculate the minimum of the maximum distances between the empirical distribution and unimodal distribution functions which have to fulfil certain criteria. This minimum is the so-called *Dip*. Comparing the Dip with distances computed under the null-distribution which is the uniform distribution allows us to reject/accept the null-hypothesis that the distribution is unimodal.

## 3.2 The Data

### 3.2.1 General Description

To employ the identification strategy described above, we use the IAB employment subsample (IAB-Beschäftigtenstichprobe 1975-2001 [Regionalfile], IABS-R01) provided by the Institut für Arbeitsmarkt- und Berufsforschung (IAB) der Bundesagentur für Arbeit, Nuremberg.

The IABS-R01 is a unique micro-level data set, including the employment history as well as the history of unemployment benefit receipt for two percent of all German employees subject to social insurance contributions for the period 1975 to 2001.<sup>8</sup>

Two different sources of information are used for the creation of this data set. First, the dates concerning the employment history of individuals are generated using information provided by the social insurance institutions to whom employers yearly report the employment status of their employees, including daily dates concerning the beginning and/or ending of an employment spell. The data were amended by the periods of receipt of unemployment benefit<sup>9</sup>, as supplied by the German Federal Employment Office ("Bundesagentur für Arbeit" BA). It is important to notice that the data do not include periods of self-employment or employment as civil servants. Moreover, no information on the receipt of social security benefits are included in the data.

The data set contains information on 1,293,819 individuals, including 181,058 in East Germany, since 1992. Both the data on the individual employment status and the data on receipt of benefits are provided in spells with precise dates concerning the beginning and ending of the spell. Since 1980, the data has also allowed for a distinction to be made between 343 regions. These regions roughly correspond to actual German counties ("Kreise"). For purposes of anonymity, the actual counties have been aggregated to regional entities with at least 100.000 inhabitants. Thus, individuals can be assigned to a specific region.

For any individual, the data set includes information on characteristics like age, sex, education, income while employed, occupation, etc. as well as information on the individual employment status (part-time/full-time, internship, apprenticeship, etc.) or sectoral affiliation while employed or before unemployment.

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<sup>8</sup>A basic description of the data can be found in Bender et al. (2003).

<sup>9</sup>Note that the data allows for a distinction to be made between three different types of unemployment benefits. Since a distinction between the transfer payments is not relevant for this empirical investigation, we refer to Fitzenberger and Wilke (2004) for more details.

### 3.2.2 Two Proxies for Unemployment Durations

Though the IABS-R01 provides detailed information both on individual employment and benefit receipt histories, periods of registered unemployment according to the ILO standard cannot be inferred from the data.<sup>10</sup> Interpreting the receipt of periods of unemployment benefit registered in the IABS-R01 as actual periods of unemployment may lead to the incorrect measurement of the time spent in unemployment. To give an example, although transfer payments have expired, an individual might still be unemployed. The consequence would be an underestimation of the actual unemployment duration. On the other hand, an unemployed individual may still receive payment though she has stopped participating in the labour market and has already dropped out of the labour force. Therefore, Fitzenberger and Wilke (2004) suggest two proxies for unemployment durations instead of periods of transfer payments as registered in the IABS-R01. These are operationalised as follows:

- **Nonemployment (NE):**

The NE proxy consists of the time between two employment spells, containing at least one period of transfer payments by the BA. If no employment spell is registered after a period of benefit receipt, the NE spell is considered to be (right-)censored. Otherwise, a transition from unemployment to employment has occurred.

- **Unemployment Between Jobs (UBJ):**

In contrast to the NE proxy, the UBJ proxy is based on the durations of benefit receipt as registered in the IABS-R01. Since interruptions of these payments can be up to four, or in the case of cut off times up to six weeks, UBJ unemployment durations for an individual may be the combination of several spells of transfer payments. UBJ spells will exhibit a failure event, i.e. leaving unemployment, if the last spell of benefit receipt in a UBJ context indicates the end of the payments and the start of new employment.

We perform the empirical analysis using both definitions of individual unemployment duration.

### 3.2.3 Data in Use and Covariates

Individual unemployment durations from the years 1999 to 2001 were used for the regressions. By restricting the data, the problem of left-censoring

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<sup>10</sup>Fitzenberger and Wilke (2004)

could occur. Information on the individual unemployment history prior to 1999 may be lost. To avoid underestimations of unemployment durations due to left-censoring, we only focus on individuals with unemployment spells starting in this period.

For the regressions we focused on prime age males' unemployment spells, i.e. spells of males between the ages of 16 and 50. We concentrate on this subgroup since we want to make sure that the observed NE or UBJ unemployment durations correspond to periods of active participation in the labour market. This may not hold for older males due to generous early retirement schemes in Germany. Additionally, it may also not hold for women, since in most cases men are the breadwinners and women's contribution to the income of the household might be comparatively low.

To control for individual and regional characteristics, we include several covariates in the regressions. Individual characteristics include the age of the person observed as well as variables for educational attainment and sector affiliation before unemployment. For the dummy of individual sector affiliation, we have decided to group the data into three sectors, namely agricultural, industrial, and trade and services. Due to the lack of data <sup>11</sup> concerning the classification of the economic sector, we excluded 20 regions, leaving 323 regions to analyse. In the case of educational attainment, the data allow us to distinguish between four different categories: no professional training, secondary school and professional training, university-entrance diploma and university diploma (including degrees from universities of applied sciences).

To measure regional heterogeneity, we also include several regional covariates in the regressions. This includes the average age of all registered individuals in a region, the number of people in each category of educational attainment and the number of employees in each sector (as a proxy for the economic structure of the region). Furthermore, we control for regional labour market conditions by including the regional inflows into unemployment as proposed by Lalive and Stutzer (2004).

The regional inflows and all the other regional covariates are measured on an annual basis. Since both NE and UBJ unemployment spells may start in one year and may not end until the next year, we allow regional covariates and the individual age to change on December 31st. Further, as suggested by Kiefer (1988), all covariates are measured as deviations from their mean. A descriptive summary of the covariates used in the regressions is provided in Table 1 in Appendix 5.2.

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<sup>11</sup>The excluded regions are the cities of Braunschweig, Oldenburg, Remscheid, Solingen, Offenbach am Main, Heidelberg, Regensburg, Erlangen and Fürth and the following counties: Enzkreis, Vogelsbergkreis, Tuttlingen, Mühldorf am Inn, Erlangen-Höchstadt, Fürth, Aichach-Friedberg, Neu-Ulm, Nürnberger Land, Biberach, Bördekreis and Ohre-Kreis.

## 3.3 Results

### 3.3.1 Model selection and Regression Results

In the first step of this empirical analysis, we estimate five stratified parametric survival models for both proxies of unemployment durations.<sup>12</sup> After a check of the Cox-Snell residual plots<sup>13</sup> it turned out that the models based on a Log-Normal distribution provided the best fit for both the NE and the UBJ proxy.

The results for the NE and UBJ proxy are reported in Table 2. We have to keep in mind that survival models based on a Log-Normal distribution belong to the class of AFT models. Therefore, the displayed coefficients report the impact on (the natural logarithm of) the individual unemployment duration and not on the hazard rate.<sup>14</sup>

Table 2 around here

Since the interpretation of the coefficients is not the main concern of this empirical analysis, we keep the discussion brief. Let us first take a look at the coefficients on individual characteristics. We find that for both proxies of unemployment durations, age and educational attainment have the expected signs and are significant at the 95% level with the exception of the variable *university entrance-diploma*.<sup>15</sup> Therefore, older individuals will c.p. have more difficulty in finding new employment, while people equipped with a university diploma tend to leave unemployment earlier. Note that these results are by and large in line with the literature,( see for example Steiner (2001) or Biewen and Wilke (2005)).

Both regressions also indicate that an individual who has worked in the agricultural (trade and services) sector will c.p. experience shorter (longer) unemployment durations.

When turning to regional covariates, we observe that in the case of the NE proxy none of them had significant influence. On the other hand, we find significant coefficients for the number of individuals with no professional training, secondary education and university diploma using the UBJ defini-

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<sup>12</sup>The estimations were made using the following distributions for the failure times: Exponential, Weibull, Gompertz, Log-Logistic and Log-Normal.

<sup>13</sup>For a description of Cox-Snell residual plots see Klein and Moeschberger (2005).

<sup>14</sup>To avoid downward biased standard errors on regional covariates due to a clustering of individuals within regions (Moulton, (1990)), robust standard errors have been used for all regressions.

<sup>15</sup>We defined *secondary education* and *industry* as reference categories in the context of individual covariates and the *city of Kiel* for the regional dummies.

tion. Inspecting the signs of the significant coefficients, the unemployment duration of an individual reduced with a higher number of individuals with no professional training in the region. In contrast, the transition from unemployment to employment is slower the larger the number of individuals in the region with secondary education or university diploma.

Among the proxies for the region's industry structure, only one covariate in the UBJ context turned out to be significant. The larger the number of employed people in the industrial sector, the faster the transition from unemployment to employment.

Besides individual and regional covariates, 322 regional dummies and a constant were used both in the main equation and for estimating of the ancillary parameter of the Log-Normal distribution. We find that most regional dummies for the ancillary parameter,  $\sigma_j$ , turn out to be significant for both definitions of the left hand side variable. The picture changes for the dummies  $\gamma_j$ . Only about 15% (8%) within the NE (UBJ) proxy turn out to be significant.

### Investigation of the Baseline Hazards

To calculate the regional baseline hazard rate, we reset the values of the individual and regional covariates to zero, leaving only the regional dummies unchanged. The baseline hazard rate for a region  $j$  in the Log-Normal model yields:

$$h_j(t_{ij})|_{x_{ij}=0} = \frac{\frac{1}{(\hat{\sigma}_0 + \hat{\sigma}_j)\sqrt{2\pi}} t_{ij}^{-1} \exp\left[-\frac{1}{2} \left(\frac{\log(t_{ij}) - (\hat{\beta}_0 + \hat{\gamma}_j)}{\hat{\sigma}_0 + \hat{\sigma}_j}\right)^2\right]}{1 - \Phi\left(\frac{\log(t_{ij}) - (\hat{\beta}_0 + \hat{\gamma}_j)}{\hat{\sigma}_0 + \hat{\sigma}_j}\right)}, \quad (21)$$

where  $\Phi$  is the cumulative distribution of the standard normal distribution,  $\hat{\beta}_0$  the constant and  $\hat{\gamma}_j$  the regional dummy for region  $j$ . Moreover,  $\hat{\sigma}_0$  is the constant in the estimation for the ancillary parameter, while  $\hat{\sigma}_j$  represents the estimated regional dummy for region  $j$ .

Using (21) we calculate regional baseline hazard rates for durations  $t$  of 30, 60, 90, 180, 270, 365, 455, 545, 635, 730, 820, 910, 1000 and 1095 days. The means of the baseline hazard rate across the regions diminish, which holds true for the NE as well as the UBJ proxy, see Tables 6 and 5. This fits well with the general intuition that the probability of leaving unemployment decreases with increasing unemployment duration. Considering the resulting variances of the baseline hazard rates across regions, we observe that these tend to diminish, too (as can also be seen from the evolution of the coefficient of variation). Initial differences in the regional baseline hazard rate become smaller for larger unemployment durations. Our identification strategy is the

notion that if regional labour markets were characterised by a unique equilibrium, regional baseline hazards should be (randomly) distributed around this equilibrium. This in turn implies that the density function of regional baseline hazard rates should be uni-modal. Therefore, we use kernel density estimations<sup>16</sup> to characterise the density functions of the regional baseline hazards. The relevant plots can be found in Appendix 5.2 in Figures 2-5.

In the case of the NE proxy, none of the density plots apparently exhibits a second mode. Inspecting the plots in more detail reveals the following pattern. The spread of the distribution of regional baseline hazard rates decreases for higher unemployment durations. This is what was already noted after inspecting Table 5. In addition to this, however, the density plots show that for higher unemployment durations a small group of regions emerge whose hazard rates stabilise at a relatively high level. As such, the distribution of regional hazard rates becomes right-skewed. Note that these group of outlier regions is too small to form a second mode.

We apply the Dip-test (as introduced above) as a formal test of the uni-modality of distributions/density functions. If the density functions of the regional baseline hazards are in accordance with the theoretical model, the null-hypothesis (= uni-modal distribution) of the Dip-test should not be rejected. In the following, we present the results of the Dip-test for the particular unemployment durations. In both the NE and the UBJ cases, the null-hypothesis of uni-modality for the distributions of regional baseline hazard rates cannot be rejected for any unemployment duration (see Table 7 in Appendix 5.2).<sup>17</sup>

Two consequences may be deduced from this result. First, differences in the individual's probability of leaving unemployment are mainly driven by individual characteristics such as age, education and so on. Regional characteristics basically play no role in the explanation of the hazard rate for leaving unemployment. Second, regional labour markets do not seem to be characterised by multiple equilibria. As predicted by our theoretical model, we find evidence for the uniqueness of regional labour markets. As such, we have to reject the idea that due to social interactions individuals coordinate on different equilibria in different regional labour markets.

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<sup>16</sup>A standard Gaussian Kernel has been used for the estimation.

<sup>17</sup>Both the test-statistic and the plots of the densities are included in the Appendix. All calculations concerning the Dip-test were done with R 1.8.1, while for the survival analysis Intercooled Stata 8.2 was used.

## 3.4 Robustness Check and Discussion

Though the empirical results presented so far support the theoretical model, they might be misleading. For the empirical analysis in the section above, we focused on reunified Germany, including East and West Germany. Despite focusing on periods ten years after the German reunification, the general labour market situation in East Germany is by far worse than the West German labour market. We observe for example differentials of 10 percentage points in the unemployment rates between East and West Germany for the relevant periods. Therefore, a joint examination of East and West German regions may influence the distribution of the regional baseline hazards. Thus, we decided to run the empirical analysis separately for East and West German regions.

### 3.4.1 West Germany

#### Model selection and Regression Results

Considering only individuals located in West Germany, we get a sample consisting of 30,859 (38,171) individuals for the NE (UBJ) definition, with 39,671 (51,148) unemployment spells. Beside individual and regional covariates, 247 regional dummies are included. The model selection by means of Cox-Snell residual plots resulted in the choice of the Log-Normal model for both proxies of unemployment duration.

Inspecting the results of the estimations, we find these to be by and large the same as for Germany. Individual age and no professional training turn out to be significantly positive. This is also true for the coefficients on university diploma, agricultural sector and trade and services sector. As in the previous section, regional characteristics basically do not play a role in determining the hazard rate. This is at least true for the NE definition. With the UBJ definition, the coefficients on the number of individuals with *no professional training*, the number of individuals working in the *industrial and trade and services sector* are significantly negative and the number of individuals with a *university diploma* is significantly positive. A surprising point is the fact that the UBJ regression indicates a shorter period of unemployment with higher inflows into the regional labour market.

#### Baseline Hazard Rates and the Dip-Test

When calculating the baseline hazard rates for regions in West Germany, we get a similar picture to before. The means tend to diminish over time, and the variances of the baseline hazards are around zero.



As in the case of Germany, we did kernel densities estimations for various unemployment durations. Within the NE definitions, the plots turn out to be slightly right skewed. Inspecting the plots for unemployment durations equalling or longer than 60 days, we observe a small second peak on the right-hand tail of the densities.

Applying the Dip-test, however, we have to reject the hypotheses of multimodality proxies and for any unemployment duration.<sup>18</sup>

### 3.4.2 East Germany

#### Model selection and regression results

For East Germany the sample collapses to 15,486 (18,358) (NE/UBJ) individuals with 21,046 (25,765) unemployment spells in 75 regions. The parametric distribution function is again Log-normal.

The qualitative influence of the individual characteristics on the hazard of leaving unemployment in East Germany is by and large the same as for West Germany and Germany as a whole. Qualitatively some values differ, individuals with no professional training in the East find it harder to get a new job than the same individuals in the West, for example. This reflects the severe problem of low-skilled unemployment in East Germany.

The impact of regional covariates on the length of the unemployment spell turn out to be slightly different since some of the signs change. The inflow into unemployment has a negative effect on spell length in West Germany, for instance, whereas it is positive in East Germany.

#### Baseline hazards and the Dip-Test

Evaluating the baseline hazards for the NE and UBJ proxy for the chosen durations, we observe that the means again diminish with higher unemployment durations. In accordance with the results for Germany and West Germany, for both proxies the variances are around zero and decline with higher unemployment durations.

The plots for the NE definition turn out to be quite symmetric, becoming a little left-skewed with higher unemployment durations. We do not observe a clustering of baseline hazards as for Germany and West Germany. The picture changes when turning to the UBJ definition. Here the plots exhibit right skewed densities, and the clustering in regional baseline hazards already observed.

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<sup>18</sup>See Appendix 5.2 for the results of the Dip-test. The density plots are available on request.

The Dip-test rejects the hypothesis of multi-modality for both proxies. Thus, even when concentrating only on East German regions, no significant differences in regional baseline hazards are detected.

### 3.4.3 Discussion of the results

We will close the empirical part of the paper with a brief discussion of the results achieved so far. We have seen that with both proxies of unemployment duration, the baseline hazard rates are very similar across regions. Thus, regional labour markets seem to be characterised by one equilibrium, supporting our theoretical model. Though this result turned out to be robust, some topics are left for further discussion.

One point that became apparent in the regressions was the fact that at least with the NE definition hardly any of the regional characteristics had a significant influence on individual unemployment duration. In the case of East Germany, this was also true for the UBJ proxy. Since regional influences seem to be negligible, the location of an individual has no effect on her unemployment duration. To accelerate the transition from unemployment to employment, politics should foster the education of individuals rather than subsidising the economic structure of the region.

Another topic to be mentioned is a comparison of the means for German, West- and East German baseline hazard rates. This is done graphically in Figure 6 for the NE and the UBJ proxy. It turns out that the means of the baseline hazard rates are larger in East Germany than in West Germany, at least for the first 90 days of unemployment. With higher unemployment duration the baseline hazards for the three entities converge. Examining the NE definition, the extent to which East German baseline hazard rates differ in contrast to reunified Germany and West Germany is bigger than for the UBJ proxy.<sup>19</sup> Overall, this result appears to be rather awkward since one would expect a significantly worse labour market performance in East Germany.

One possible explanation for higher baseline hazard rates in East German regions may be work creation schemes (*Arbeitsbeschaffungsmaßnahmen*) implemented by the German government to improve the labour market situation in East Germany. Examining the figures for 1999, about 1,681,000 individuals in East Germany were employed in these kinds of schemes compared to

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<sup>19</sup>One may notice that in Figure 6 with both definitions of unemployment durations the observations for Germany lie above or below the observations for East and West Germany. This may be explained by the fact that the estimations of regional baseline hazards in reunified Germany, East and West Germany are based on different data. Hence, averaging East and West German results does not result in the observations for Germany.

only 663,000 people in (the much larger) West Germany. Thus, the higher baseline hazard rates for East Germany than for West Germany may be due to a transition of East German unemployed into jobs from state work creation schemes. Unfortunately, we are not able to control for these kinds of governmental programmes within the data.

We also have to address the robustness and the reliability of the Dip-test in identifying multiple equilibria. First, note that the Dip-test by its construction is very conservative, i.e. biased in favour of the null-hypothesis. As Cheng and Hall (1998) state, the use of the uniform distribution as a benchmark for the worst uni-modal distribution is responsible for this distortion. Inspecting the density plots makes us feel comfortable concerning the multimodality results.<sup>20</sup> The Dip-test, however, might be misleading in cases where regional labour markets are characterised by multiple equilibria, but the difference between these equilibria is very small, or in cases where the majority of regions are determined by one equilibrium and only a few regions are from another one. In this case the Dip-test would indicate unimodality since it is not sensitive enough.

## 4 Summary and Conclusion

Labour market models which incorporate preference based social interaction are often characterised by multiple equilibria. This is due to the fact that individual behaviour is influenced by the behaviour of others, giving rise to an externality. The consequence of this interdependence may be a coordination failure. Thus, two identical agent would behave differently depending on the environment they live in. Models with social interaction can in principle explain disparities in regional unemployment rates. In this paper, however, we present a Pissarides (2000) type search model in which we incorporate social interaction. Our notion of social interaction is modelled as a leisure externality. Unemployed agents have to invest time in the search process of finding a new job. The value of this time depends on the time other individuals spend on job search since agents are social individuals who would like to spend their time together. Despite this interaction, the economy is characterised by a unique (stable) labour market equilibrium. This uniqueness result is due to the existence of a "no action" equilibrium, i.e. if firms expect that agents do not invest time they will not offer any jobs. If on the other hand agents expect firms not to offer jobs, they will not invest time into the

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<sup>20</sup>One could also apply other tests for multi-modality, e.g. the excess mass test by Müller and Sawitzki (1991) or the bandwidth test by Silverman (1981). However, according to Cheng and Hall (1998), these may also lead to considerable distortions.

search process.

Whether social interaction leads to multiple equilibria or not has important policy implications since the existence of multiple equilibria will broaden the scope for public regional policies. This begs the question whether we observe multiple equilibria in real world labour markets. Using a micro-level data set on the duration of unemployment in Germany we analyse whether regions are characterised by multiple equilibria. We apply survival analysis to estimate the individual hazard rate of leaving unemployment controlling for structural individual and regional variables.

We find that the overwhelming majority of differences in the hazard rate between individuals can be explained by structural individual characteristics. Structural regional heterogeneity has surprisingly little effect on the duration of unemployment. From this, we conclude that to leave unemployment it does not matter where you are, but who you are. Moreover, we find that the hazard rate controlling for structural variables basically does not differ between regions. This indicates that regional disparities in the unemployment rate cannot be explained by social interaction as sometime suggested in the literature, see Kolm (2005) for example.

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## 5 The Appendix

### 5.1 Wage Bargaining

The first order condition for the bargaining wage  $w_i$  (using equations (3) and (10)) reads:

$$\varphi J(w_i) - (1 - \varphi)(W(w_i) - U) = 0. \quad (22)$$

This simple structure of the wage setting rule is only due to the fact that the value of being employed is linear in the wage, i.e. that workers are risk-neutral. We can rewrite this equation and get a relation between the value of a filled job (which is given by the free entry condition) and the (optimal) net value of being employed:  $W(w_i) - U = \frac{\varphi}{1-\varphi}J(w_i)$ .

Using (22) we can also derive an explicit solution for the bargained wage. Plugging the expressions for  $W_i$  and  $J$  from the Bellman equations, (3) and (10), into the rent splitting rule we get:

$$\frac{w_i}{r+\lambda} - \frac{r}{r+\lambda}U_i = \varphi \frac{p-w_i}{r+\lambda} + \varphi \frac{w_i}{r+\lambda} - \frac{r}{r+\lambda}\varphi U_i, \quad (23)$$

which may be simplified to

$$w_i = \varphi p + (1-\varphi)rU_i. \quad (24)$$

By the first order condition of the Nash bargaining solution  $W_i - U$  is given by  $\frac{\varphi}{1-\varphi}J(w_i)$  so that we can simplify equation (4) to:

$$rU_i = b + l_i^\mu l^\chi + s_i \theta^\alpha \frac{\varphi}{1-\varphi} J. \quad (25)$$

Plugging equation (9) into this equation gives

$$rU_i = b + l_i^\mu l^\chi + s_i \theta^\alpha \frac{\varphi}{1-\varphi} cps^{-1} \theta^{1-\alpha}. \quad (26)$$

Plugging (26) into (24) gives the wage equation (13) stated in the text.

## 5.2 Empirical Results

|   | Germany   |           |           | West Germany |           |          | East Germany |           |           |
|---|-----------|-----------|-----------|--------------|-----------|----------|--------------|-----------|-----------|
| Year  | 1999      | 2000      | 2001      | 1999         | 2000      | 2001     | 1999         | 2000      | 2001      |
| <i>No. of individuals in a region</i>                             |           |           |           |              |           |          |              |           |           |
| Mean  | 1771,6280 | 1801,5290 | 1790,7240 | 1851,31      | 1887,544  | 1883,508 | 1508,147     | 1517,107  | 1483,92   |
| Std. Deviation  | 2,1334    | 2,1376    | 2,1371    | 2183,929     | 2226,613  | 2220,516 | 761,7294     | 775,7916  | 771,5965  |
| Min   | 424       | 421       | 427       | 424          | 421       | 427      | 786          | 793       | 767       |
| Max   | 23142     | 23490     | 23301     | 23142        | 23490     | 23301    | 5074         | 5187      | 5137      |
| <i>Average age in a region</i>                                    |           |           |           |              |           |          |              |           |           |
| Mean  | 37,9039   | 38,2494   | 38,5860   | 37,64938     | 37,95497  | 38,2944  | 38,74546     | 39,22284  | 39,55024  |
| Std. Deviation  | 0,9829    | 0,9875    | 0,9852    | 0,739586     | 0,7244424 | 0,704467 | 0,5647247    | 0,6156947 | 0,5892435 |
| Min   | 35,22882  | 35,44238  | 35,9124   | 35,22882     | 35,44238  | 35,91235 | 37,31902     | 37,59844  | 37,99664  |
| Max   | 40,02752  | 40,32589  | 40,7744   | 39,70466     | 39,96109  | 40,04436 | 40,02752     | 40,32589  | 40,77441  |
| <i>No. of individuals with no professional training</i>           |           |           |           |              |           |          |              |           |           |
| Mean  | 272,6811  | 295,3467  | 308,9690  | 320,3871     | 344,254   | 357,3387 | 114,9333     | 133,6267  | 149,0267  |
| Std. Deviation  | 1,7675    | 1,7779    | 1,7826    | 323,1454     | 343,1382  | 353,2058 | 62,82028     | 74,34993  | 81,17931  |
| Min   | 52        | 58        | 65        | 71           | 77        | 75       | 52           | 58        | 65        |
| Max   | 3580      | 3 811     | 3969      | 3580         | 3811      | 3969     | 402          | 481       | 534       |
| <i>No. of individuals with secondary education</i>                |           |           |           |              |           |          |              |           |           |
| Mean  | 1193,3930 | 1187,4890 | 1157,3190 | 1202,048     | 1197,492  | 1172,149 | 1164,773     | 1154,413  | 1108,28   |
| Std. Deviation  | 2,0222    | 2,0208    | 2,0152    | 1275,048     | 1265,981  | 1231,07  | 512,6318     | 510,436   | 497,6756  |
| Min   | 289       | 293       | 294       | 289          | 293       | 294      | 638          | 633       | 613       |
| Max   | 13909     | 13752     | 13289     | 13909        | 13752     | 13289    | 3350         | 3336      | 3244      |
| <i>No. of individuals with university-entrance diploma</i>        |           |           |           |              |           |          |              |           |           |
| Mean  | 124,3406  | 132,8204  | 137,2539  | 140,5202     | 150,8548  | 156,4274 | 70,84        | 73,18667  | 73,85333  |
| Std. Deviation  | 1,7146    | 1,7284    | 1,7377    | 246,6044     | 266,9359  | 281,6229 | 56,41378     | 60,79311  | 65,43239  |
| Min   | 13        | 8         | 12        | 13           | 8         | 12       | 27           | 24        | 19        |
| Max   | 2076      | 2263      | 2357      | 2076         | 2263      | 2357     | 355          | 394       | 414       |
| <i>No. of individuals with university diploma</i>                 |           |           |           |              |           |          |              |           |           |
| Mean  | 181,2136  | 185,8731  | 187,1827  | 188,3548     | 194,9435  | 197,5927 | 157,6        | 155,88    | 152,76    |
| Std. Deviation  | 1,7879    | 1,7939    | 1,7968    | 371,9121     | 385,1015  | 391,7146 | 148,5809     | 149,5441  | 146,4626  |
| Min   | 21        | 23        | 23        | 21           | 23        | 23       | 49           | 50        | 49        |
| Max   | 3577      | 3664      | 3686      | 3577         | 3664      | 3686     | 978          | 1005      | 975       |
| <i>No. of individuals working in the agricultural sector</i>      |           |           |           |              |           |          |              |           |           |
| Mean  | 49,2260   | 46,9350   | 43,8855   | 43,53629     | 41,55242  | 38,67339 | 437          | 411,76    | 385,7067  |
| Std. Deviation  | 1,4852    | 1,4740    | 1,4501    | 56,43568     | 52,0941   | 43,55761 | 168,2661     | 162,6139  | 158,1445  |
| Min   | 4         | 5         | 5         | 4            | 5         | 5        | 165          | 154       | 129       |
| Max   | 526       | 448       | 415       | 526          | 448       | 415      | 1048         | 993       | 947       |
| <i>No. of individuals working in the production sector</i>        |           |           |           |              |           |          |              |           |           |
| Mean  | 592,1641  | 582,1517  | 568,1269  | 639,0887     | 633,6815  | 623,2944 | 838,2267     | 815,4133  | 808,3067  |
| Std. Deviation  | 1,8436    | 1,8401    | 1,8363    | 500,1462     | 488,7661  | 476,4859 | 551,7198     | 545,9234  | 552,9705  |
| Min   | 111       | 109       | 115       | 111          | 109       | 115      | 355          | 355       | 349       |
| Max   | 4453      | 4116      | 3797      | 4453         | 4116      | 3797     | 3509         | 3489      | 3479      |
| <i>No. of individuals working in the trade and service sector</i> |           |           |           |              |           |          |              |           |           |
| Mean  | 1027,5760 | 1036,1240 | 1042,9720 | 1084,839     | 1102,871  | 1113,94  | 68,04        | 64,73333  | 61,12     |
| Std. Deviation  | 2,0640    | 2,0675    | 2,0693    | 1569,119     | 1595,385  | 1608,449 | 27,63685     | 26,94857  | 25,08147  |
| Min   | 219       | 213       | 227       | 219          | 213       | 227      | 15           | 17        | 14        |
| Max   | 16101     | 16219     | 16284     | 16101        | 16219     | 16284    | 136          | 133       | 133       |
| <i>Number of in-flows into unemployment</i>                       |           |           |           |              |           |          |              |           |           |
| Mean  | 148,4985  | 139,2724  | 111,0000  | 124,1653     | 116,871   | 94,09274 | 228,96       | 213,3467  | 166,9067  |
| Std. Deviation  | 1,6504    | 1,6453    | 1,5950    | 155,0126     | 151,9071  | 109,7136 | 95,28456     | 87,61872  | 71,52739  |
| Min   | 26        | 22        | 14        | 26           | 22        | 14       | 119          | 106       | 85        |
| Max   | 2118      | 2089      | 1474      | 2118         | 2089      | 1474     | 608          | 589       | 479       |

Table 1: Descriptive summary for the used covariates.



**Germany 1999-2001**

| Distribution of unemployment durations |                | Log-Normal     |  |
|--|----------------|----------------|--|
| <i>Individual Characteristics</i>      | NE             | UBJ            |  |
| Age                                    | 0.0126601 ***  | 0.0288007 ***  |  |
| No professional training               | 0.6861099 ***  | 0.7024939 ***  |  |
| University-entrance diploma            | 0.0178518      | -0.0245373     |  |
| University diploma                     | -0.0788928 **  | -0.2070774 *** |  |
| Agricultural sector                    | -0.0114872     | -0.053354 *    |  |
| Trade and services sector              | 0.253012 ***   | 0.2445984 ***  |  |
| <i>Regional Characteristics</i>        |                |                |  |
| Average age                            | 0.0813232      | 0.0140666      |  |
| Number of individuals with/working in  |                |                |  |
| No professional training               | -0.0003816     | -0.0012692 *   |  |
| Secondary education                    | -0.0000443     | 0.00129 **     |  |
| University-entrance diploma            | 0.0010618      | -0.0005825     |  |
| University diploma                     | -6.09E-06      | 0.0024291 ***  |  |
| Agricultural sector                    | -0.0002963     | -0.0000418     |  |
| Industrial sector                      | -0.0004269     | -0.0010302 **  |  |
| Trade and services sector              | -0.0006407     | -0.0006703     |  |
| Number of inflows into unemployment    | 0.0001522      | -0.0001823     |  |
| Constant                               | 5.499339 ***   | 5.304817 ***   |  |
| Number of regional dummies             | 322            | 322            |  |
| min                                    | -1.767465 ***  | -4.423586      |  |
| max                                    | 10.77954 *     | 0.8396235      |  |
| <i>Ancillary parameter</i>             |                |                |  |
| Constant                               | 0.3913959 ***  | 0.5078563 ***  |  |
| Number of regional dummies             | 322            | 322            |  |
| min                                    | -0.6220613 *** | -0.5932685 *** |  |
| max                                    | 0.242695 ***   | 0.1423117 ***  |  |
| Number of individuals                  | 45697          | 55799          |  |
| Number of unemployment spells          | 60810          | 77080          |  |
| Number of failures                     | 37295          | 49059          |  |
| Number of regions                      | 323            | 323            |  |
| Log-pseudo-likelihood                  | -79670.746     | -107136.42     |  |

significance levels: \* 90% \*\* 95% \*\*\* 99%

standard errors are adjusted for clustering on regional level

reference categories: secondary education, industry; city of Kiel

Table 2:

**West Germany 1999-2001**

| Distribution of unemployment durations |                | Log-Normal     |  |
|--|----------------|----------------|--|
| <i>Individual Characteristics</i>      | NE             | UBJ            |  |
| Age                                    | 0,0120409 ***  | 0,0320974 ***  |  |
| No professional training               | 0,6313369 ***  | 0,6865765 ***  |  |
| University-entrance diploma            | 0,0121847      | -0,0175913     |  |
| University diploma                     | -0,096417 ***  | -0,2397993 *** |  |
| Agricultural sector                    | -0,1058374 **  | -0,1849751 *** |  |
| Trade and services sector              | 0,2069265 ***  | 0,1883735 ***  |  |
| <i>Regional Characteristics</i>        |                |                |  |
| Average age                            | 0,0256515      | 0,0541618      |  |
| Number of individuals with/working in  |                |                |  |
| No professional training               | -0,0004922     | -0,0008509     |  |
| Secondary education                    | -0,0003226     | 0,0023811 ***  |  |
| University-entrance diploma            | 0,0010758      | -0,0000445     |  |
| University diploma                     | -0,0005994     | 0,0038507 ***  |  |
| Agricultural sector                    | 0,0001124      | -0,0002464     |  |
| Industrial sector                      | -0,000046      | -0,0012849 *** |  |
| Trade and services sector              | 0,0002137      | -0,002166 ***  |  |
| Number of inflows into unemployment    | 0,0002891      | -0,0009186 *   |  |
| Constant                               | 5,251585 ***   | 5,701283 ***   |  |
| Number of regional dummies             | 247            | 247            |  |
| min                                    | -1,061929      | -1,471566 ***  |  |
| max                                    | 2,288278       | 1,015783       |  |
| <i>Ancillary parameter</i>             |                |                |  |
| Constant                               | 0,3905041 ***  | 0,5004467 ***  |  |
| Number of regional dummies             | 247            | 247            |  |
| min                                    | -0,6049604 *** | -0,5808263 *** |  |
| max                                    | 0,2377412 ***  | 0,1453234 ***  |  |
| Number of individuals                  | 30859          | 38171          |  |
| Number of unemployment spells          | 39671          | 51148          |  |
| Number of failures                     | 24023          | 31513          |  |
| Number of regions                      | 248            | 248            |  |
| Log-pseudo-likelihood                  | -51056,353     | -69445,049     |  |

significance levels: \* 90% \*\* 95% \*\*\* 99%

standard errors are adjusted for clustering on regional level

reference categories: secondary education, industry, city of Kiel

Table 3:

**East Germany 1999-2001**

| Distribution of unemployment durations |                | Log-Normal     |  |
|--|----------------|----------------|--|
| <i>Individual Characteristics</i>      | NE             | UBJ            |  |
| Age                                    | 0,0146014 ***  | 0,023792 ***   |  |
| No professional training               | 0,9998454 ***  | 0,7878115 ***  |  |
| University-entrance diploma            | 0,0484634      | -0,0681372     |  |
| University diploma                     | -0,0174711     | -0,115908 *    |  |
| Agricultural sector                    | 0,0994111 **   | 0,1084606 ***  |  |
| Trade and services sector              | 0,3361455 ***  | 0,3440026 ***  |  |
| <i>Regional Characteristics</i>        |                |                |  |
| Average age                            | -0,00502       | 0,1331422      |  |
| Number of individuals with/working in  |                |                |  |
| No professional training               | 0,0002197      | -0,0011305     |  |
| Secondary education                    | 0,0000782      | 0,0006828      |  |
| University-entrance diploma            | -0,004057      | 0,0052194 *    |  |
| University diploma                     | -0,0019        | 0,0015145      |  |
| Agricultural sector                    | -0,0030291     | -0,0033742     |  |
| Industrial sector                      | -0,0026427 *** | 0,0012121      |  |
| Trade and services sector              | -0,0016216 **  | 0,0006043      |  |
| Number of inflows into unemployment    | 0,0001393      | 0,0018192 **   |  |
| Constant                               | 3,691068 ***   | 6,191037 ***   |  |
| Number of regional dummies             | 74             | 74             |  |
| min                                    | -1,374436 ***  | -7,233703 ***  |  |
| max                                    | 8,981759 ***   | 0,4450857      |  |
| <i>Ancillary parameter</i>             |                |                |  |
| Constant                               | 0,3347184 ***  | 0,4571515 ***  |  |
| Number of regional dummies             | 74             | 74             |  |
| min                                    | -0,2100894 *** | -0,2438343 *** |  |
| max                                    | 0,225218 ***   | 0,0615879 ***  |  |
| Number of individuals                  | 15486          | 18358          |  |
| Number of unemployment spells          | 21046          | 25765          |  |
| Number of failures                     | 13226          | 17441          |  |
| Number of regions                      | 75             | 75             |  |
| Log-pseudo-likelihood                  | -28407,996     | -37344,327     |  |

significance levels: \* 90% \*\* 95% \*\*\* 99%

standard errors are adjusted for clustering on regional level

reference categories: secondary education, industry, city of Cottbus

Table 4:

**Germany - NE Proxy**

| Duration           | 30         | 60         | 90         | 180        | 270        | 365        | 455        |
|--------------------|------------|------------|------------|------------|------------|------------|------------|
| Mean               | 0,0048156  | 0,0047335  | 0,0043738  | 0,0034694  | 0,002893   | 0,0024823  | 0,0022007  |
| Std. Deviation     | 0,0019927  | 0,0017796  | 0,0015952  | 0,0012301  | 0,001015   | 0,0008649  | 0,0007631  |
| Coef. of Variation | 0,41380098 | 0,37595859 | 0,36471718 | 0,35455698 | 0,35084687 | 0,34842686 | 0,34675331 |
| Min                | 0,0008819  | 0,0014295  | 0,0016202  | 0,0015504  | 0,0013371  | 0,0011749  | 0,0010591  |
| Max                | 0,0105059  | 0,0107484  | 0,010181   | 0,0090795  | 0,0078722  | 0,0068795  | 0,0061568  |
| Duration           | 545        | 635        | 730        | 820        | 910        | 1000       | 1095       |
| Mean               | 0,0019845  | 0,0018125  | 0,0016647  | 0,0015483  | 0,0014492  | 0,0013638  | 0,0012853  |
| Std. Deviation     | 0,0006855  | 0,0006241  | 0,0005716  | 0,0005304  | 0,0004955  | 0,0004654  | 0,0004378  |
| Coef. of Variation | 0,34542706 | 0,34433103 | 0,34336517 | 0,34256927 | 0,34191278 | 0,34125238 | 0,34062087 |
| Min                | 0,0009675  | 0,0008931  | 0,000828   | 0,0007759  | 0,000731   | 0,0006919  | 0,0006557  |
| Max                | 0,0055843  | 0,0051198  | 0,0047155  | 0,004394   | 0,0041186  | 0,0038797  | 0,0036594  |

**West Germany - NE Proxy**

| Duration           | 30         | 60         | 90         | 180        | 270        | 365        | 455        |
|--------------------|------------|------------|------------|------------|------------|------------|------------|
| Mean               | 0,0058003  | 0,005604   | 0,0051172  | 0,0039796  | 0,0032842  | 0,0027984  | 0,0024694  |
| Std. Deviation     | 0,0019166  | 0,0018629  | 0,001739   | 0,0013926  | 0,0011595  | 0,0009914  | 0,0008757  |
| Coef. of Variation | 0,33043118 | 0,33242327 | 0,33983428 | 0,34993467 | 0,35305402 | 0,35427387 | 0,35462056 |
| Min                | 0,0003051  | 0,0004252  | 0,0004772  | 0,000513   | 0,0005006  | 0,0004778  | 0,0004552  |
| Max                | 0,0115233  | 0,0129833  | 0,0126697  | 0,0106249  | 0,0089416  | 0,0076806  | 0,0068015  |
| Duration           | 545        | 635        | 730        | 820        | 910        | 1000       | 1095       |
| Mean               | 0,0022188  | 0,0020207  | 0,0018514  | 0,0017185  | 0,0016058  | 0,0015089  | 0,0014201  |
| Std. Deviation     | 0,000787   | 0,0007166  | 0,0006562  | 0,0006088  | 0,0005685  | 0,0005338  | 0,000502   |
| Coef. of Variation | 0,35469623 | 0,35462958 | 0,35443448 | 0,35426244 | 0,35402914 | 0,35376765 | 0,35349623 |
| Min                | 0,0004339  | 0,0004143  | 0,0003956  | 0,0003795  | 0,0003648  | 0,0003515  | 0,0003385  |
| Max                | 0,0061224  | 0,0055807  | 0,0051153  | 0,0047486  | 0,004437   | 0,0041684  | 0,0039221  |

**East Germany - NE Proxy**

| Duration           | 30          | 60          | 90          | 180         | 270         | 365         | 455         |
|--------------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| Mean               | 0,0162612   | 0,0117357   | 0,0094032   | 0,0061727   | 0,0047279   | 0,0038457   | 0,0032936   |
| Std. Deviation     | 0,009635    | 0,006242    | 0,004713    | 0,002818    | 0,002053    | 0,001613    | 0,001349    |
| Coef. of Variation | 0,59251470  | 0,53185579  | 0,50122299  | 0,45646152  | 0,43425199  | 0,41945550  | 0,40949113  |
| Min                | 0,00000001  | 0,00000004  | 0,00000010  | 0,00000071  | 0,00000108  | 0,00000303  | 0,00000500  |
| Max                | 0,0438819   | 0,0293966   | 0,0226497   | 0,0140201   | 0,0104231   | 0,0083091   | 0,0070193   |
| Duration           | 545         | 635         | 730         | 820         | 910         | 1000        | 1095        |
| Mean               | 0,0028943   | 0,0025903   | 0,0023383   | 0,0021452   | 0,0019847   | 0,0018488   | 0,0017261   |
| Std. Deviation     | 0,001163    | 0,001025    | 0,000913    | 0,000828    | 0,000759    | 0,000701    | 0,000649    |
| Coef. of Variation | 0,40185883  | 0,39570706  | 0,39036907  | 0,38607123  | 0,38237517  | 0,37911077  | 0,37610799  |
| Min                | 0,000000700 | 0,000000901 | 0,000001015 | 0,000001039 | 0,000001064 | 0,000001090 | 0,000002017 |
| Max                | 0,0061032   | 0,0054154   | 0,0048518   | 0,0044242   | 0,0040716   | 0,0037752   | 0,0035094   |

Table 5: Descriptive Statistics for the Regional Baseline Hazard Rates – NE Definition

**Germany - UBJ Proxy**

| Duration           | 30         | 60         | 90         | 180        | 270        | 365        | 455        |
|--------------------|------------|------------|------------|------------|------------|------------|------------|
| Mean               | 0,0063741  | 0,0055514  | 0,0048645  | 0,0036068  | 0,0029215  | 0,0024625  | 0,0021587  |
| Std. Deviation     | 0,0035841  | 0,0022783  | 0,0017619  | 0,001147   | 0,0008901  | 0,0007338  | 0,0006352  |
| Coef. of Variation | 0,56229115 | 0,41040098 | 0,36219550 | 0,31801042 | 0,30467226 | 0,29798985 | 0,29425117 |
| Min                | 0,0022403  | 0,0021305  | 0,0019588  | 0,0015664  | 0,0013203  | 0,0011438  | 0,0010084  |
| Max                | 0,040733   | 0,0256023  | 0,0192436  | 0,0115326  | 0,0084493  | 0,0066731  | 0,0056028  |
| Duration           | 545        | 635        | 730        | 820        | 910        | 1000       | 1095       |
| Mean               | 0,0019305  | 0,0017518  | 0,0016002  | 0,001482   | 0,0013822  | 0,0012966  | 0,0012185  |
| Std. Deviation     | 0,0005632  | 0,0005079  | 0,0004616  | 0,0004259  | 0,000396   | 0,0003705  | 0,0003473  |
| Coef. of Variation | 0,29173789 | 0,28993036 | 0,28846394 | 0,28738192 | 0,28649978 | 0,28574734 | 0,28502257 |
| Min                | 0,0009037  | 0,0008217  | 0,0007521  | 0,0006978  | 0,0006518  | 0,0006124  | 0,0005764  |
| Max                | 0,0048491  | 0,0042869  | 0,0038285  | 0,0034824  | 0,0031979  | 0,0029595  | 0,0027635  |

**West Germany - UBJ Proxy**

| Duration           | 30         | 60         | 90         | 180        | 270        | 365        | 455        |
|--------------------|------------|------------|------------|------------|------------|------------|------------|
| Mean               | 0,0063741  | 0,0055514  | 0,0048645  | 0,0036068  | 0,0029215  | 0,0024625  | 0,0021587  |
| Std. Deviation     | 0,0035841  | 0,0022783  | 0,0017619  | 0,001147   | 0,0008901  | 0,0007338  | 0,0006352  |
| Coef. of Variation | 0,56229115 | 0,41040098 | 0,36219550 | 0,31801042 | 0,30467226 | 0,29798985 | 0,29425117 |
| Min                | 0,0022403  | 0,0021305  | 0,0019588  | 0,0015664  | 0,0013203  | 0,0011438  | 0,0010084  |
| Max                | 0,040733   | 0,0256023  | 0,0192436  | 0,0115326  | 0,0084493  | 0,0066731  | 0,0056028  |
| Duration           | 545        | 635        | 730        | 820        | 910        | 1000       | 1095       |
| Mean               | 0,0019305  | 0,0017518  | 0,0016002  | 0,001482   | 0,0013822  | 0,0012966  | 0,0012185  |
| Std. Deviation     | 0,0005632  | 0,0005079  | 0,0004616  | 0,0004259  | 0,000396   | 0,0003705  | 0,0003473  |
| Coef. of Variation | 0,29173789 | 0,28993036 | 0,28846394 | 0,28738192 | 0,28649978 | 0,28574734 | 0,28502257 |
| Min                | 0,0009037  | 0,0008217  | 0,0007521  | 0,0006978  | 0,0006518  | 0,0006124  | 0,0005764  |
| Max                | 0,0048491  | 0,0042869  | 0,0038285  | 0,0034824  | 0,0031979  | 0,0029595  | 0,0027635  |

**East Germany - UBJ Proxy**

| Duration           | 30         | 60         | 90         | 180        | 270        | 365        | 455        |
|--------------------|------------|------------|------------|------------|------------|------------|------------|
| Mean               | 0,0062765  | 0,0054201  | 0,0047312  | 0,0034932  | 0,0028256  | 0,0023802  | 0,0020859  |
| Std. Deviation     | 0,002898   | 0,001882   | 0,001423   | 0,000860   | 0,000635   | 0,000505   | 0,000427   |
| Coef. of Variation | 0,46178603 | 0,34717072 | 0,30081163 | 0,24616398 | 0,22455408 | 0,21204100 | 0,20446810 |
| Min                | 0,0028953  | 0,0031049  | 0,0028682  | 0,0022378  | 0,0018595  | 0,0015944  | 0,0014139  |
| Max                | 0,0189759  | 0,0125719  | 0,0096717  | 0,0062297  | 0,0048314  | 0,0039588  | 0,0034059  |
| Duration           | 545        | 635        | 730        | 820        | 910        | 1000       | 1095       |
| Mean               | 0,0018651  | 0,0016922  | 0,0015457  | 0,0014314  | 0,001335   | 0,0012523  | 0,0011769  |
| Std. Deviation     | 0,000371   | 0,000330   | 0,000296   | 0,000271   | 0,000250   | 0,000232   | 0,000216   |
| Coef. of Variation | 0,19907780 | 0,19501241 | 0,19162839 | 0,18904569 | 0,18689139 | 0,18509942 | 0,18344804 |
| Min                | 0,0012758  | 0,0011661  | 0,0010719  | 0,0009976  | 0,0009345  | 0,00088    | 0,0008299  |
| Max                | 0,0030029  | 0,0026942  | 0,0024372  | 0,0022395  | 0,0020747  | 0,0019349  | 0,0018085  |

Table 6: Descriptive Statistics for the Regional Baseline Hazard Rates – UBJ Definition

## Regional Baseline Hazard Rates - Germany NE - Proxy

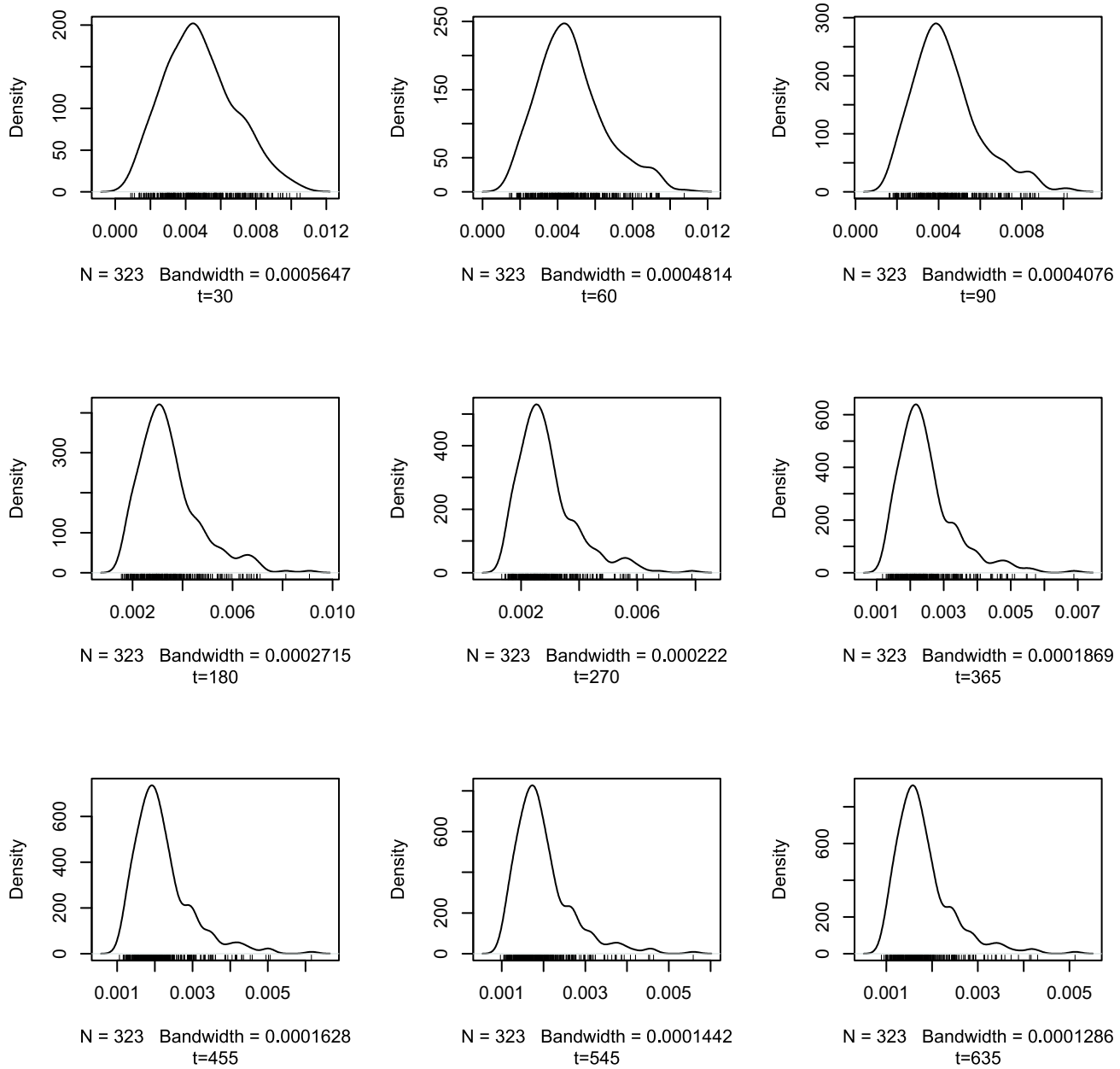
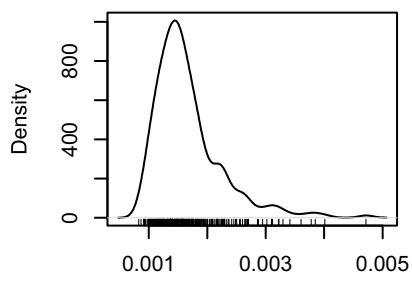
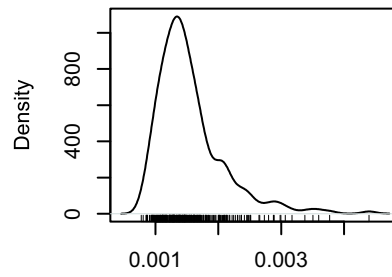


Figure 2:

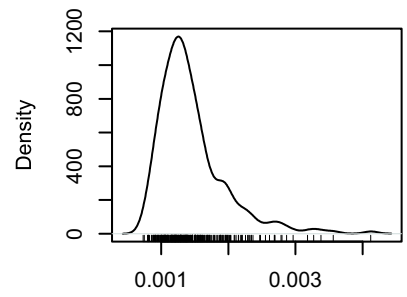
### Regional Baseline Hazard Rates - Germany NE - Proxy



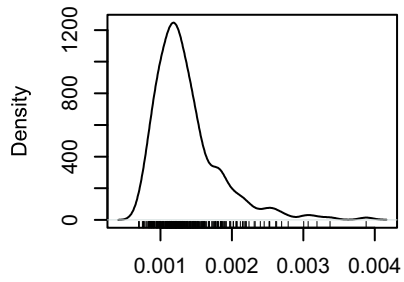
N = 323 Bandwidth = 0.0001165  
t=730



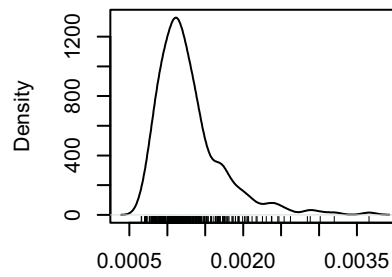
N = 323 Bandwidth = 0.0001072  
t=820



N = 323 Bandwidth = 0.0001004  
t=910



N = 323 Bandwidth = 9.462e-05  
t=1000



N = 323 Bandwidth = 8.865e-05  
t=1095

Figure 3:

### Regional Baseline Hazard Rates - Germany UBJ - Proxy

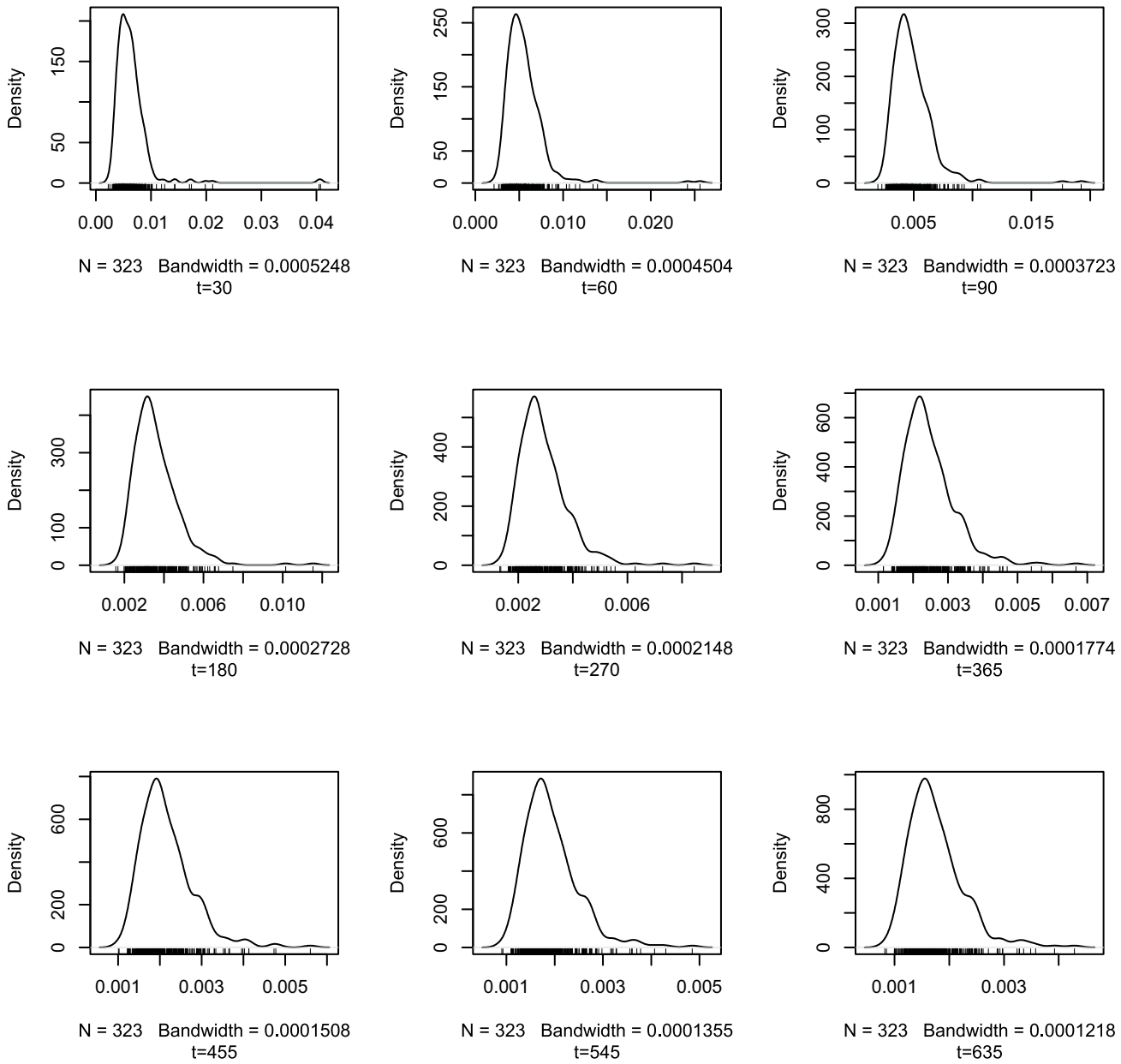


Figure 4:



**Regional Baseline Hazard Rates - Germany**  
**UBJ - Proxy**

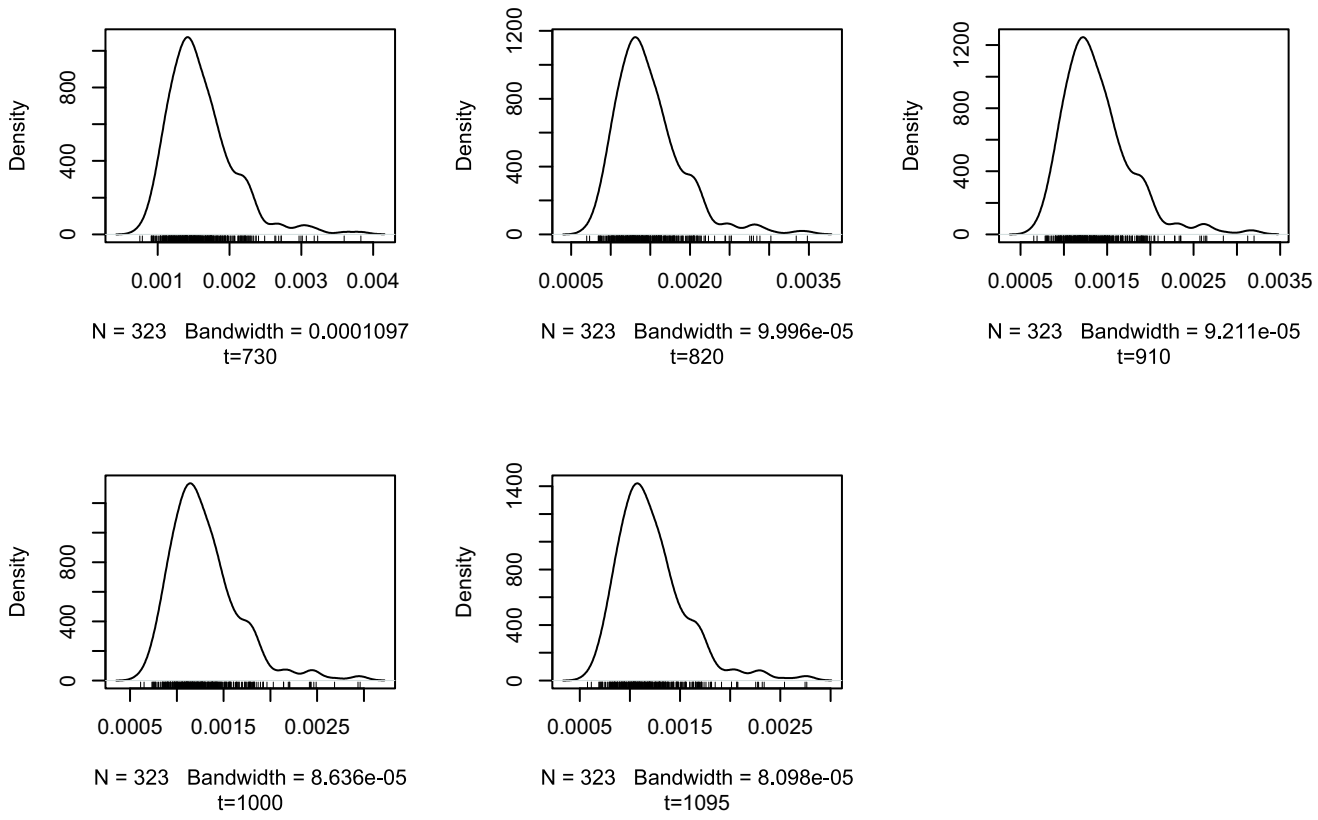


Figure 5:

| <b>NE Proxy</b>  |                |           |                    |                     |           |                     |           |
|------------------|----------------|-----------|--------------------|---------------------|-----------|---------------------|-----------|
| Duration         | <b>Germany</b> |           |                    | <b>West Germany</b> |           | <b>East Germany</b> |           |
|                  | Dip            | Uni-modal | Significance = 99% | Dip                 | Uni-modal | Dip                 | Uni-modal |
| 30               | 0,0151052      | yes       |                    | 0,0147519           | yes       | 0,02937652          | yes       |
| 60               | 0,01790928     | yes       |                    | 0,01300539          | yes       | 0,02672174          | yes       |
| 90               | 0,01289873     | yes       |                    | 0,01375341          | yes       | 0,02512945          | yes       |
| 180              | 0,01385845     | yes       |                    | 0,01571918          | yes       | 0,02720139          | yes       |
| 270              | 0,01151076     | yes       |                    | 0,0189356           | yes       | 0,0242116           | yes       |
| 365              | 0,01258255     | yes       |                    | 0,01439373          | yes       | 0,02523247          | yes       |
| 455              | 0,01366336     | yes       |                    | 0,01578179          | yes       | 0,02886098          | yes       |
| 544              | 0,01751526     | yes       |                    | 0,01535741          | yes       | 0,02725137          | yes       |
| 635              | 0,01531989     | yes       |                    | 0,01528028          | yes       | 0,02642542          | yes       |
| 730              | 0,01362229     | yes       |                    | 0,01378019          | yes       | 0,02677622          | yes       |
| 810              | 0,01261178     | yes       |                    | 0,01354609          | yes       | 0,02704961          | yes       |
| 920              | 0,01302154     | yes       |                    | 0,01514897          | yes       | 0,02704961          | yes       |
| 1000             | 0,01195623     | yes       |                    | 0,01668281          | yes       | 0,02955739          | yes       |
| 1095             | 0,01136926     | yes       |                    | 0,01602339          | yes       | 0,03002688          | yes       |
| <b>UBJ Proxy</b> |                |           |                    |                     |           |                     |           |
| Duration         | <b>Germany</b> |           |                    | <b>West Germany</b> |           | <b>East Germany</b> |           |
|                  | Dip            | Uni-modal | Significance = 99% | Dip                 | Uni-modal | Dip                 | Uni-modal |
| 30               | 0,01541311     | yes       |                    | 0,02170949          | yes       | 0,03622034          | yes       |
| 60               | 0,01587238     | yes       |                    | 0,02091254          | yes       | 0,03393956          | yes       |
| 90               | 0,01258815     | yes       |                    | 0,02010958          | yes       | 0,0255199           | yes       |
| 180              | 0,01120743     | yes       |                    | 0,01468738          | yes       | 0,03038955          | yes       |
| 270              | 0,01347011     | yes       |                    | 0,02155366          | yes       | 0,03271841          | yes       |
| 365              | 0,01317735     | yes       |                    | 0,02023775          | yes       | 0,03288518          | yes       |
| 455              | 0,01508845     | yes       |                    | 0,01972749          | yes       | 0,03096421          | yes       |
| 544              | 0,01413378     | yes       |                    | 0,0208734           | yes       | 0,03113122          | yes       |
| 635              | 0,01193083     | yes       |                    | 0,01934339          | yes       | 0,02993426          | yes       |
| 730              | 0,01027185     | yes       |                    | 0,01649127          | yes       | 0,02673475          | yes       |
| 810              | 0,0115521      | yes       |                    | 0,01636888          | yes       | 0,02727477          | yes       |
| 920              | 0,01195591     | yes       |                    | 0,01717514          | yes       | 0,02566191          | yes       |
| 1000             | 0,01053407     | yes       |                    | 0,01642772          | yes       | 0,02944302          | yes       |
| 1095             | 0,01134372     | yes       |                    | 0,0165334           | yes       | 0,02709677          | yes       |

Table 7: Results of the Dip-test for Unimodality. The critical values for determining the level of significance have been calculated for  $n = 323$  and using the methodology of Hartigan (1985).

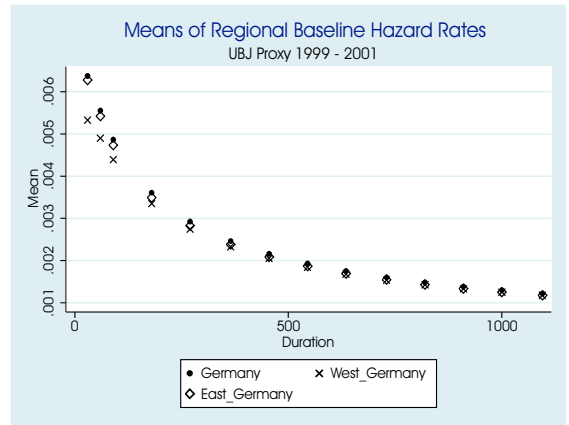
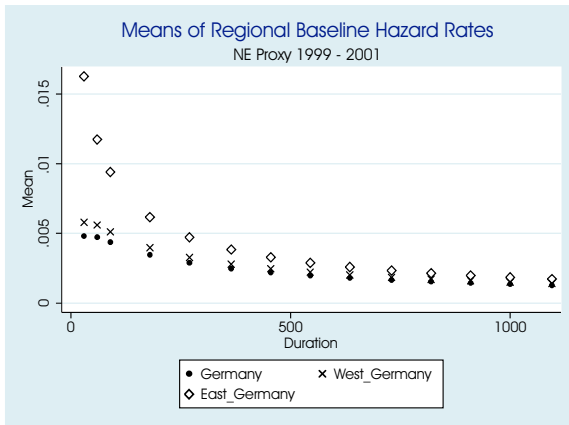


Figure 6: Comparison of the Means