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Success in the Academic Labour Market for Economists – The German Experience*

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Abstract

Based on CV information of tenured professors and post-doc researchers in the field of economics at German universities we construct a unique data set. This data set contains detailed information on the career path and on personal characteristics of individuals. Using this data we analyse the determinants of success in the academic labour market. Our notion of success is the (conditional) probability of becoming tenured, i.e. the hazard rate. Estimating a Cox (1972) regression model, we show that the primal determinants of the hazard rate are the publication record and time dummies which control for the decade in which tenure was received. The latter result implies that Germany witnessed a huge structural change in the academic labour within the last 30 years.

Keywords: Academic Labour Market, Duration Analysis, Cox Model
JEL: A11, C41, J44

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1 Introduction

People love to hear gossip about the situation of their peer group. This is not any different with economists. This may be one reason why higher education economics in general and the economics of the academic labour market in particular has become a rapidly expanding field, see for example the symposium of the Journal of Economic Perspectives 1999.

The other reasons why there is growing interest in this field is first that higher education is a key industry in the production of human capital. As such, the organisation of university education is of crucial importance for the future well-being of an economy, see for example Clotfelter (1999). Second, the academic labour market is highly regulated and has features that are uncommon in other labour relations, for example the institutional setting of tenure or the fact that output may be sometimes hard to observe.[1]

Two issues are dominating the literature on the analysis of the academic labour market: the effects of tenure and the changing salaries in private compared to public universities. Concerning the tenure issue, the questions that are addressed span a wide range. There are studies which analyse the impact of the fraction of tenure faculty on the quality of the education of students, see for example McPherson and Schapiro (1999) or Ehrenberg and Zhang (2005). The question whether tenured faculty is substituted by part-time and non-tenure faculty is researched into, see for example Brown (1997). But also how the probability of getting tenure affects faculty salary, see Ehrenberg et al. (1998). This latter issue is related to the question why the salary differential between public and private universities widened over time and what consequences this widening has on the educational quality or the ability of public universities to employ top researchers, see for example Hamermesh (2002), Zoghi (2003) or Ehrenberg (2003).

The majority of the studies focus on the situation of the academic labour market in the US. This is not too surprising since the US American university system is not only very large, but also tremendously successful regardless of the exact measure of success: number of nobel laureates, research output, number of patents. However, the university system (and hence the academic labour market) in the US is characterised by a very different institutional setup compared for example to Continental Europe. The situation in Europe

[1] Larry Summers (2004), former President of Harvard University, once noted that the 12 years work of John Rawls on "Theory of Justice" were observationally equivalent to loafing since there was no output.

is characterised by less heterogeneity within the quality of universities as well as within the salary of university professors. Universities in Europe face higher regulation which is due to the fact that the majority of universities are public and hence professors are civil servants whose salaries are negotiable only to a small extend. Thus, the insights that have been obtained from the US university system may not be applicable to the situation in Europe.

There are only very few studies that analyse the academic labour market in Europe. Sabatier et al. (2006) analyse the career path of individuals working in a group of research laboratories in France. Van der Burg et al. (1998) analyse gender differences in the academic labour market using dutch data. Basically, these are the only studies we are aware of that focus on the situation in the European university system. Our paper adds to this literature by studying the career path and the career opportunities of academic economists in Germany.

The main concern in this study is to disentangle the determinants of success in the academic labour market in Germany where our notion of success is the award of a tenured faculty position. We think this to be an important research question since it allows us to understand whether, for example, the allocation of post-docs to tenured positions is efficient in the sense that it follows generally accepted rules (for example based on publication output). Moreover, we are able to document structural changes in the academic labour market in Germany besides the ones that are based on "anecdotical" evidence. To do this, we need spell data that document the career paths of individuals in the academic labour market in Germany. However, these data do not exists at the individual level. As such, we generated a data-set which contains these spell information. In 2006 (august-october) we downloaded CV information of all economists that have been in the academic labour market in Germany during this time, i.e. tenured university professors and post-docs. Based on this CV information we constructed spell data that document the career path of the individuals until tenure was awarded (or the until the individuals have been right-censored). Besides the career path, the CV data also allowed us to obtain information on individual characteristics which might play a role for the chance of getting a tenured position. Additionally, we matched bibliometric data on research output to the CV data.

Using this unique data set, we estimated the hazard rate unconditional on personal characteristics and, using a Cox (1972) model, conditional on a set of individual covariates. The estimation results show that research out-

put has a strong positive impact on the hazard rate of becoming tenured. However, individuals face a "depreciation" of their research output since the effect is decreasing over time (duration). Moreover, we find that having a (Masters) degree in an area outside of economics increases the tenure probability. However, also this effect is decreasing over time and vanishes eight years after completion of the PhD. Besides this individual covariates, the data also document huge structural changes in the academic labour market in Germany within the last 30 years. Due to an expanding university system in the 1970s, the hazard rate of becoming tenured has been extremely higher compared to all other times. Interestingly enough, however, we do not find a positive effect of the demand shock caused by the reunification of Germany.

The rest of the paper is organised as follows. Section 2 describes the institutional setup of the university system in Germany in general and the academic labour market in particular. Section 3 describes the data generation in more detail and shows the results of the Kaplan-Meier (1958) estimates and the Cox (1972) regression results. Finally, section 4 concludes.

2 Institutional Setup – The situation in the academic labour market in Germany

The academic labour market in Germany is very different from other OECD countries, especially compared to the USA. The main feature is that this labour market is highly regulated. Since the majority of employees at German universities are civil servants, the wage, the contract length, the tasks (teaching load and others) as well as the form of the career path are determined by law.[2] In order to understand the factors which determine success (understood as the probability of becoming tenured) in this market it is crucial to understand these regulations and how a "standard" career path looks like.

A typical career path of a tenured professor in Germany develops as follows. The first degree usually earned is the Diploma-degree or the Magister-degree (depending on the major subject that you study). Students in economics finish with a Diploma-degree. This degree is roughly equivalent to

[2]In Germany, universities are run at the state level ("Bundesländer") which implies that there might be differences in these regulations between the "Länder". In practice this is basically not the case which is sometimes blamed on the fact that some key regulations can only be changed by the federal government.

the Masters degree in the anglo-saxon system.[3] The Diploma, in most cases with imposing a threshold on the Grade Point Average, allows students to earn a doctoral degree. PhD Programms which are standard in the US are the exception rather than the rule in Germany. The standard way is to work at a chair as a research and teaching assistant, giving classes and supporting the research of the professor and writing a PhD thesis. The average time of finishing the PhD thesis is in our sample 4.8 years. This is not too surprising, since the PhD student is typically (full-time or part-time) employed at the university on a non-renewable five years contract. After this period, the majority of PhDs move out of academia and enter the non-academic labour market. Only a small fraction (around 10%) stays at the university and takes up a post-doc position. In our sample around 50% do their post-doc work at the same university where they earned their PhD. The post-doc (which has some similarities to the Associate Professor in the US) again works on the basis of a fixed term contract which usually last six years. During these six years, the post-docs are expected to do research and write a thesis to earn a second advanced degree, the "Habilitation". Although, the "Habilitation" is not a formal prerequisite to become a professor (i.e. to get a tenured position)[4], the majority of tenured professors have this post-doctoral degree. Just until very recently, tenure-track positions did not exist in the academic labour market in Germany. A post-doc whose (fixed) contract ended was effectively forced to apply at another university for a tenured professor position. The reason for this rule was to enforce competition between post-docs and to prevent any unfair advantage for post-docs when applying at their "home" university. The time between earning the "Habilitation" and becoming a tenured professor could be quite long. In our sample, on average 2 years passed from earning the degree until becoming a professor. This could be explained by the frictions in the academic labour market: the process of being tenured is very time consuming, furthermore the flows in the market are rather small. Since the number of professors at existing universities is more or less fixed, job openings only turn up if some incumbent professor moves out of the market, for example working abroad or retiring. The fea-

[3]Very recently, most universities have switched (or will switch) from the Diploma-degree to the Masters-degree. However, since we focus on a group of people that finished their first university degree at least 3-4 years ago, this is only of minor interest.

[4]The law says that to become a professor in Germany you either have to have finished the "Habilitation" or something equivalent which is usually understood as referred publications.

ture of a more or less fixed stock of professorships is not true for two distinct periods of time which brought exogenous demand shocks. The first of these shocks was a series of foundations of new universities in the 1970s. The second was a demand increase (especially in economics) during the aftermath of German reunification in the 1990s.

Some of these rules and regulations have been changed due to reforms in the academic labour market. However, the individuals in our sample face (or faced, for the case of already being tenured) this institutional set-up.

3 Empirical Analysis

The goal of the empirical analysis is to reveal the determinants of success in the academic labour market for economists in Germany. The intuitive approach for the empirical specification would be to follow the individuals on their career path to tenured professorship starting from some distinct point in time, for example from the time of being in a post-doc position since this is (usually) the beginning of the career track. Following these individuals would allow us to observe their (non-)success. With this information it would be possible to run some regression model (for example Probit or Logit) in order to estimate the probability of becoming a tenured professor and its determinants. The major drawback of this specification, however, is that we face a serious lack of (individual) data. It is relatively easy to get information on the career path of the individuals who succeeded in attaining a tenured position. This can be done via CV data which is freely available on the internet. However, getting information on the individuals that tried to become a tenure professor, but did not succeed and dropped out of academia is much more difficult.

As such, we have to stick to another empirical specification. Instead of estimating the (unconditional) probability of becoming a tenured professor, we are going to estimate the hazard rate, i.e. the conditional probability of getting a tenured position. The advantage of this approach is twofold. First, duration data (which we need to estimate the hazard rate) is more or less readily available. Second, this approach allows us to include information on individuals whose (non-)success of getting tenure is a future event, i.e. individuals who are right-censored.

In the following, we will be more precise about the data which we collected and the data set which we constructed, respectively. Moreover, we

will present the foundations for the empirical estimation of hazard rates.

3.1 Data

3.1.1 Data Generation

Only very few individual level data on the participants in the academic labour market exist. However, it has become very common in academia to have a web site and/or publish the CV on the web. Thus, a large data pool on career paths and individual characteristics exists at a decentralised level. In our study we are taking advantage of this fact and collect these CV information and as such gather detailed data on the employment path of the individuals in the sample.[5]

Since we are only interested in information on economists in academic labour market, our first task has been to identify those universities in Germany which offer (tenured) position in economics. Hence, those universities which have economics departments. In sum, 76 of the 88 German universities have economics departments and hence are part of our sample. From August to October 2006, we have collected CV information from all tenured professors plus all individuals having a post-doc position and hence, are on track towards tenure at the 79 universities. As such, we have a stock sample of all individuals who are in the labour market for academic economists. We have downloaded (if available) the CVs of these individuals from their web sites.

In order to generate a basis for the further empirical analysis, we had to code the information which was available in the CVs. Specifically, we focus on two different groups of information. On the one hand we have coded the time at which the individual earned the "Diploma" degree, the PhD and the "Habilitation" and the time at which the individual moved into a tenured position (or the time of censoring). This information puts us in a position to give detailed account of the dynamics of the career path and allows us to derive duration data until the failure event "tenure" occurred. This data is especially important for our empirical analysis. The hazard rate will be estimated using this duration data. The second group of information consists of variables which we think affect the hazard of being tenured. The covariates

[5]Dietz et. al. (2000) demonstrate that despite problems in coding the CV information, this source of data presents valuable information for doing empirical analysis.

Variable	Explanation
sex	
year of birth	
nation	nationality
degree_econ1	Masters degree in economics
degree_math1	Masters degree in maths
degree_misc1	Masters degree other field
phd_econ1	PhD in economics
phd_math1	PhD in maths
phd_misc1	PhD in other field
degree_usa1	Degree obtained in the USA
degree_uk1	Degree obtained in the UK
degree_abroad_rest1	Degree obtained in another country
phd_usa1	PhD obtained in the USA
phd_uk1	PhD obtained in the UK
phd_abroad_rest1	PhD obtained in another country
tenured (yes=1)	
university_degree1	University at which Masters degree was received
university_phd1	University at which PhD was received
university_habil	University at which post-doc degree was received
university_tenure	University at which the first tenured position was obtained

Table 1: List of Covariates

that we derive from the CVs are given in table 1.[6]

As such, the primal information that we were able to derive from coding the CVs is the field in which the various degrees have been obtained and the universities and countries where the individuals have studied. We think these variables to be important in determining the hazard rate for becoming tenured. For example there is anecdotical evidence that having studied maths increases the hazard rate of being tenured. Moreover, one could argue that having studied at a renowned university is a signal of ability and talent and hence also increases the hazard rate.

Without doubt, however, there are additional variables which we also suspect to influence the hazard rate, but which we were not able to code from

[6]Additionally to the covarites mentioned in table 1, we have also information on the details of a second Master's or PhD degree.

the CVs. This is due to the fact that the CV information is characterised by a huge heterogeneity. Thus, for example information on publications, presentations, fellowships, awards etc. obtained from the CVs cannot be used as explanatory variable. Since we think that especially publications have a large impact on the hazard of being tenured, we have to amend the CV information by some bibliometric information on the individuals at the time of being tenured. This bibliometric information should consist of a measure of the number of publications, adjusted for quality, quantity, number of authors and so on. The bibliometric measure which we use is directly taken from Rauber and Ursprung (2006). The idea is that the number of (refereed) publications obtained from the data set EconLit is adjusted for journal quality, the number of pages and the number of authors.[7]

We focus in our study on those individuals from which information on the duration from earning the PhD degree until tenure is available. This restriction is important since we need the duration in order to estimate the hazard rate.[8] We have identified 992 individuals working at the 76 universities as tenured professors or as post-docs being on track to a tenured position. Restricting ourselves to those individuals from which we have the relevant duration information leaves us with 519 individuals. Thus we loose 48% of observations. This is due to the fact that not all individuals that we have identified offer a web based CV or give very few information on their career path. Note that missing information is a standard problem in using publicly available CV data when doing research, see Dietz et al. (2000). To get some leverage on this problem, we started a web based questioning among the 993 individuals concerning their CV information. The response to the survey was quite disappointing. Only 273 (27%) individuals answered the questioning. Moreover, we only obtained additional information on 64 individuals. Thus, our sample expands to 583 individuals.

Having data on only 58% of the population, one might worry whether our data set is a representative sample of the population. Using aggregate data on the characteristics of tenured professors which is provided by the Federal Statistical Office in Germany makes us quite confident that our sample is

[7]We are grateful to Michael Rauber and Heinrich W. Ursprung for providing us with their excellent data set.

[8]We could have also focussed on other durations (time from Master's degree until tenure or time from "Habilitation" until tenure). However, we think the duration from PhD degree to be the relevant one, because with their PhD degree individuals choose to enter/stay in the academic labour market.

	Sample	official Data
male (female)	94%(6%)	87.6%(12.3%)
average age at tenure	37.5	39.5
average age 2005	51.27	54.26

Table 2: Sample vs Population

indeed representative. Table 2 shows the proportion of men (women), the average age when being tenured and the average age in 2005 from our sample and from the official data (which is aggregated over economics and business administration and over all types of universities, for example also Universities of Applied Sciences ("Fachhochschulen")).

The comparison shows that the average tenured professor in our sample is slightly younger in terms of age in 2005 and age at tenure. Note, that this bias might well be due to aggregation. In sum the values of the key characteristics in the sample and in the (aggregate) population data are more or less in the same ballpark.

3.1.2 Data Description

Before we turn to the estimation of the hazard rate of being tenured, let us first of all present some descriptive statistics. Table 3 presents th sample means of covariates that have been directly coded from the CVs or generated using the variables that have been directly coded. We split our sample between those individuals that have already become tenure ("tenured") and those who have a post-doc position and whose failure event "tenure" might occur sometime in the future ("censored"). Moreover, we also show the sample means for the whole sample.

The data reveals that the academic labour market is dominated by men. More than 90% of the tenured individuals in the sample are male compared to only 82% of the censored individuals. Thus, if we assume that there is no gender discrimination, i.e. male and female post-doc have ceteris paribus the same probability of getting tenure, we will witness a substantial increase of the fraction of females in tenured position. Nevertheless, males will remain over-represented in these positions.

91% of the individuals in the sample are of German nationality.[9] This

[9]This figure increases even more when considering Austria and Switzerland. In this

Variable	tenured (n)	censored	all
sex (1=male)	0.9400545	0.8287037	0.8987993
	(n= 367)	(n= 216)	(n= 583)
age	51.26829	36.67133	46.41395
	(n= 287)	(n= 143)	(n= 430)
nation (1=german)	0.9122137	0.9142857	0.9129353
	(n= 262)	(n= 140)	(n= 402)
degree_econ1 (1=yes)	0.8221574	0.8737864	0.8415301
	(n= 343)	(n= 206)	(n= 549)
phd_econ1 (1=yes)	0.941691	0.9620853	0.9494585
	(n= 343)	(n= 211)	(n= 554)
second_degree (1=yes)	0.1362398	0.1435185	0.1389365
	(n= 367)	(n= 216)	(n= 583)
anglo_saxon_degree (1=yes)	0.1152738	0.1268293	0.1195652
	(n= 347)	(n= 205)	(n= 552)
anglo_saxon_phd (1=yes)	0.0895954	0.0528846	0.0758123
	(n= 346)	(n= 208)	(n= 554)
bibscore	20.60592	12.22902	18.82637
	(n= 304)	(n= 82)	(n= 386)

Table 3: Descriptive Statistics

nicely demonstrates that the academic labour is quite closed. This is mainly due to the fact that the main teaching language remains German. This has important implications for the competition in the market: outside competition has only indirect effects and has only become more visible in recent times (for the last 15-20 years or so). Notably, the figures for nationality are more or less the same for tenured as well as for censored individuals. Thus, there has not been a substantial moving in of foreign junior researchers. In that respect an increase in internationality, an often claimed goal in the political arena, has not been achieved.

Besides the personal characteristics of the individuals in the sample, it is also interesting to look at the different qualifications and where they have been obtained. Only 82% of the tenured professors received their first degree in economics.[10] One might be tempted to suspect that there is a trend

case more than 95% of all individuals in the sample are from German speaking countries.

[10]The most prominent non-economics first degree is maths.

of people whose basic academic background is not economics enter the academic labour market for economists. For example one might argue that the increased technical requirements in economics make it relatively easy to move into the economics labour market with a first degree in science (for example maths, physics or the like). However, this suspicion is far from true since the fraction of (first-degree) non-economists is smaller among the censored individuals than among the tenured professors. Note that this is also true for the fraction of first-degree mathematicians. This could be due to the fact that the economics education in Germany changed in the last years so that the comparative advantage in formal maths of holders of a first degree in science is decreasing.

In contrast to the relatively large fraction of individuals holding a first-degree other than economics, this fraction is small when it comes to the PhD degree. Only 6% (4%) of the tenured (censored) individuals hold a non-economics (first) PhD degree. The explanation for this different observation between the "Diploma" degree and the PhD degree reflects the fact that at some point in the academic career some sort of specialisation has to take place. This specialisation makes it very hard to change the career once a PhD in a specific field has been obtained.

A second degree (independent of the field) has been achieved by 13% (14%) of the tenured (censored) individuals in the sample. At first glance this may appear a lot. However, one has to keep in mind that some of these second degrees are for example Economics Masters degrees that have been received while studying abroad and being a regular student in a "Diploma" Program in Germany. The fraction of individuals in the sample that have obtained degrees in different fields is very small.

A substantial fraction of the individuals in our sample have obtained a degree from a university in the UK or the USA (labelled as anglo-saxon in our data). This is not too surprising. First the language barrier is relatively small making it attractive to study there. Second, which is probably more important, the best universities in economics (measured for example in terms of (quality adjusted) research output) are based in the UK and the USA, see Kalaitzidakis et al. (2003). Thus, individuals that decide to participate in the academic labour market might choose to study at a "good" university to increase the probability of success in this market.[11]

[11]Note that nearly 50% of all degrees and PhDs that have been obtained in the UK and the USA are from Top 20 Schools where the ranking is based on the Kalaitzidakis et al.

The last variable for which we show the descriptive statistics is the variable "bibscore". This variable is our bibliometric measure. It measures the number of pages times a quality adjusting factor divided by the number of authors. The quality adjustment factor of the top 5 journals (AER, QJE, JPE, RES, Econometrica) is one. The publication score is recorded until tenure is awarded (or the censoring occurs). Remember that we did not code this variable from the CVs, but amended it from another data source. The average sample "bibscore" is 20.6 among the tenured professors 12.2 among the (censored) post-docs. Thus, tenured professors in Germany publish on average 20 AER pages until they are tenured. Note, however that standard deviation of the bibscore distribution is 20.55 and hence very large. There have been professors that got tenured with 0 top 5 pages, but also those who published more than 90 pages. The large variety of the "bibscore" also holds for the post-docs. This, however is less surprising since the group of (censored) post-docs is very heterogenous. We observe individuals that have just started their career in the academic labour market and we have the matured researchers who are just before being granted tenure.

3.2 Empirical Analysis

After the descriptive results on the data set that we have generated, we turn to the empirical analysis of the data. As already said, we will focus in this paper on the analysis of the duration from the PhD degree until achieving a tenured position. Thus, we analyse the probability of becoming tenured given the time an individual is already in the academic labour market. This conditional probability, the hazard rate, is our measure of success in the academic labour market. Furthermore, we analyse the impact of explanatory variables (the covariates) on the hazard rate.

Let the duration T of the state of being a post-doc researcher until being awarded tenure be a random variable. Denote t a realisation of the random variable. Finally, denote $f(t)$ the density (which has a positive support since the realisations of T can by construction only be positive) and $F(t)$ the cumulative distribution function. The hazard is in this case defined as, see for example Cameron and Trivedi (2005):

$$\lambda(t) = \lim_{\Delta \to 0} \frac{Prob(t \leq T < t + \Delta \mid T \geq t)}{\Delta} = \frac{f(t)}{1 - F(t)}, \tag{3.1}$$

(2003) ranking.

thus the hazard rate is in our case the rate at which tenure (which is the "failure" event) occurs given that the individual has "survived" in the state of post-doc until t. With an assumption on the exact form of the cumulative distribution function we could, using our duration data, estimate the parameters function. Using this we would be able to make statements on the hazard rate. The major drawback of this approach is twofold. First of all, the data are characterised by right-censoring and the existence of ties (i.e. more than one failure event occurs at the same time which is impossible with a continuous function) which imposes additional problems. Second, a problem which is even more serious, we would have to *assume* an exact functional form without knowing the "real" process.

To circumvent these problems in the analysis of the hazard rate, we apply a non-parametric technique which is widely proposed in the literature on survival analysis (see, for example Kalbfleisch and Prentice (2000), Cameron and Trivedi (2005) or Klein and Moeschberger (2005)), the Kaplan-Meier (1958) estimator. The estimator for the hazard rate at some time (duration) t_j is the following (details are found in Kalbfleisch and Prentice (2000)). Let n_j denote the number of those individuals that have not yet failed or censored just until time t_j. Thus n_j is the number of individuals at risk. Let d_j denote the number of those individuals who experience a failure event at t_j. The estimated hazard rate is hence

$$\hat{\lambda}_j = \frac{d_j}{n_j} \tag{3.2}$$

An estimator for the cumulative distribution function could be obtained using the estimated hazard rate.

Figure 1 depicts plots of the Kaplan-Meier (1958) estimates for the survival and the hazard rate function. Note that we are only able to estimate hazard rates. To obtain the hazard rate function, we used a Gaussian Kernel. The plots reveal some interesting properties of the duration until tenure in Germany. First, the hazard rate function is hump shaped, implying that the probability of being tenured is increasing at the beginning of the career, peaks and then decreases. This is not too surprising since this is a standard career pattern. The interesting point, however, is the exact duration of the peak. The hazard rate is increasing until more than ten years after the PhD degree. Thus, until this time it pays (in terms of increasing the probability of being tenured) to stay in the academic labour market. This reveals two problems which are prevalent in the institutional organisation

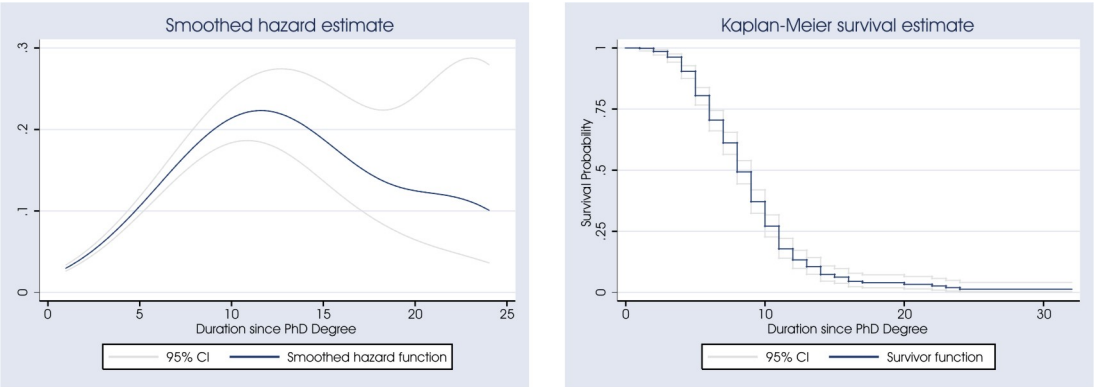

Figure 1: Survival Function and Hazard Rate Function

of the academic labour market in Germany. First, most post-doc positions are on fixed six years contract without possibility of renewal. In light of the evolution of the hazard rate, this may turn out to be too short. These contracts push individuals out of the labour market who would face *increasing* probabilities of getting tenure. Second (which is a related point), one could argue that "waiting" for ten years for the hazard rate to reach its maximum is too long. It makes individuals stay for too long on a track that may turn out unsuccessful.

The survival function shows the probability of surviving (not being tenured) for realisations of the random variable "duration until tenure". Note that opposed to the hazard rate, this is an unconditional probability. The median of the survival function is eight years, i.e. with a probability of 50% an individual has to wait more than eight years before becoming tenured. Note, however that this probability is declining very fast. The probability of waiting more than ten years is slightly more than 25%. Thus, the survival probability nearly halved within two years. Moreover, the survival function shows that between the duration of four to ten years, the probability of leaving the "post-doc" state within the next year are largest (as indicated by the size of steps of the survival function). Thus, these individuals are the primal participants in the academic labour market.

The Kaplan-Meier (1958) estimates show the evolution of the success in the academic labour market as functions of the time already spent on the career path towards tenured professorship. The crucial assumption in this analysis, however, is the heterogeneity among individuals. We did not dif-

ferentiate with respect to personal characteristics or different times of the tenure decision. But what if there exists heterogeneity between individuals? Does your sex or your publication record determine the success in the academic labour? And if so, how strong is this effect? In order to analyse these and related questions concerning the determinants of the hazard rate of becoming tenured (=success in the academic labour market) we have to apply some sort of regression analysis.

Basically, the literature offers two types of regression analysis for failure time data. Either one can choose a parametric approach which again implies assumptions on the exact functional form of the cumulative distribution function. The alternative approach is the semi-parametric Cox (1972) proportional hazard model. In this paper we favour the Cox (1972) model, because it is more flexible than the parametric one and poses less restrictions on the data. Hence, it has become the standard method for the analysis of failure time data, see Cameron and Trivedi (2005).[12]

The idea of the Cox proportional model is that the hazard rate (conditional on the vector of covariates of an individual $\mathbf{X}$) can be separated into the product of the baseline hazard function (which is only a function of duration time) and a function of the covaritates. Assuming the covariates to have an exponential impact on the hazard rate, we get:

$$\lambda(t|\mathbf{X}) = \lambda_0(t) \exp(\mathbf{X}(\mathbf{t})\boldsymbol{\beta}), \tag{3.3}$$

where $\lambda_0(t)$ denotes the baseline hazard function. Due to the semi-parametric nature of the approach, we do not need to specify the functional form of this baseline hazard. So the basic idea of the Cox approach is to estimate the impact of covariates on the hazard rate *relative* to the unspecified baseline hazard rate. Changes in the covariates hence shift the for all individuals common baseline hazard rate. In many applications it is assumed that the covariates do not change over the duration. Thus, their impact is constant over time. Hence, the name proportional hazard models. Kalbfleisch and Prentice (2000), however, note that considering time constant covariates is a unnecessary restriction of the model. Hence, we allow for time varying coefficients. The parameter vector $\boldsymbol{\beta}$ is estimated by maximisation of the partial likelihood function. The partial likelihood function is the product of the failure probability of an individual conditional on the failure probabilities

[12] An overview over the many applications of the Cox model is given in Van den Berg (2000).

of all individuals being at risk at some duration t_j, for details we refer to Kalbfleisch and Prentice (2000) and Cox (1972).

The estimation results of the Cox model are given in table 4. The table shows the results for four different specifications of the Cox model. Note that the different specifications differ in allowing for interaction among covariates and interaction of covariates with duration. Before giving legitimation for the choice of the different specifications, let us first of all comment on the results of the most obvious specification one in which we only allow for direct effects of explanatory variables on the hazard rate.

The first specification shows that the gender of an individual affects the hazard rate of getting tenures. The hazard rate for leaving the post-doc state is larger for males than that for females. The point estimate of this effect is very large and states that the hazard rate for males is 25% (=exp(0.224)) larger than that of females. This effect, however, is not statistically different from zero. Being younger when finishing the PhD also increases the hazard rate. One saved year increases the hazard rate by more than 50%. But again the effect is not significantly different from zero. The bibliometric measure we use is the average bibscore per year in the state of being a post-doc. The regression shows that the point estimate is quite large and statistically significant. A one point higher bibscore (one additional page in a top 5 journal) increases the hazard rate by 24/t%. So publishing in international journals pays in terms of increasing the (probability of) success in the academic labour market. However, the effect of an additional publication is decreasing in t, i.e. in the duration of being a post-doc. So the value of a publication depreciates with the time being on track towards tenure. As such, the academic labour market rewards a flow of publications not necessarily the stock.

It was shown above that a substantial fraction of individuals did not receive their first degree in economics. The Cox regressions shows that these individuals face a higher hazard of becoming tenured. Being a non economist (at least not with the first degree) increases the hazard rate by 6%. The same is true for individuals that hold a foreign degree. Their hazard rate is 20% higher than comparable individuals. This effect, however, is not statistically different from zero.

Besides the non-economics and the foreign degree, we also tested whether it pays to earn a degree (again Masters or PhD degree) in a top school. Using the Kalaitzidakis et. al. (2000) ranking of economics departments in the world, we identified the top 10 economics departments in Germany ("degree_top_germany") and the top 20 economics departments in the world

Variable	Spec. 1	Spec. 2	Spec. 3	Spec. 4
sex (male=1)	0.224	0.217	0.242	0.235
	(0.7)	(0.67)	(-1.38)	(0.73)
age_phd	-0.428	-0.449	-0.045	-0.047
	(-1.31)	(-1.37)	(0.75)	(-1.44)
bibscore $\times$ t^{-1}	**0.214***	**0.223***	**0.219***	**0.228***
	(9.9)	(10.04)	(9.89)	(9.99)
degree_econ1 (yes=1)	-0.059	-0.035	**-2.051***	**-2.019***
	(-0.3)	(-0.18)	(-2.28)	(-2.27)
foreign_degree (yes=1)	0.211	0.217	0.180	0.186
	(0.85)	(0.88)	(0.73)	(0.75)
degree_top_germany (yes=1)	0.126	0.135	0.091	0.100
	(0.79)	(0.84)	(0.56)	(0.62)
degree_top_world (yes=1)	-0.272	0.135	-0.199	0.229
	(-0.74)	(0.27)	(-0.55)	(0.45)
mover (yes=1)	-0.183	-0.214	-0.187	-0.218
	(-1.08)	(-1.24)	(-1.11)	(-1.27)
time70	**2.262***	**2.312***	**2.323***	**2.374***
	(7.54)	(7.68)	(7.71)	(7.84)
time80	**0.748***	**0.784***	**0.737***	**0.775***
	(3.65)	(3.78)	(3.59)	(3.73)
time90	**0.588***	**0.602***	**0.583***	**0.598***
	(2.93)	(3.00)	(2.93)	(2.99)
bibscore $\times$ t^{-1}	–	-0.628	–	-0.066
$\times$ degree_top_world		(-1.12)		(-1.13)
degree_econ1	–	–	**0.998***	**0.995***
$\times$ ln(t)			(2.22)	(2.23)
BIC	820.351	822.418	820.725	822.767
Global Test PH	0.252	0.199	0.676	0.910
n	243	243	243	243

*=Significant at the 95% level

Table 4: Estimation results of the Cox Model for different specifications

("degree_top_world"). The results show that both effects are not statistically significant. Nevertheless, the point estimates reveal an interesting observation. Holding a degree from a top university in Germany increases the hazard rate (13%) whereas a degree a leading international university *decreases* the hazard rate (31%). Even if one considers that holding a top international degree directly implies that one is also holding a foreign degree, the combined effect is smaller, but remains negative.

The last individual characteristic that we included into the regression analysis is the variable "mover" which indicates whether the individual changed during the career path the university, for example whether the PhD degree has been received at another university than the post-doc degree "Habilitation". The point estimate shows that moving decreases the hazard rate (by 20%). This observation could be due to the fact that moving destroys (or at least weakens) the ties in social networks which could turn out important for the tenure decision.

The sample consists of individuals that have been awarded tenure within more than three decades. Assuming the structure of the labour market constant over all these years seems to be flawed to say the least. Especially, since there have been changes in the institutional framework of the academic labour market within the last thirty years. Especially in economics, the academic labour market changed from a very closed and insular market to a more internationally oriented market which uses generally accepted standards. To control for this evolution, we have included time dummies into the regression that indicate in which decade tenure was awarded. The reference group we have chosen consist of those individuals who have been awarded tenure (or being censored) in 2000 or later. The table shows that there has been a substantial change in the academic labour market during the last 30 years. First, the hazard rate has been larger in the past decades. Second, this increase in the hazard rate is decreasing over the decades. The most striking observation is the fact that individuals who received tenure in the 70s faced a 800%(!) larger hazard rate than similar individuals in 2000 (or later). In our view, the reason for this huge effect is twofold. First of all, there was a boom of new universities in the 70s, thus there was a large increase in the demand for tenured professors. This obviously increased the success for getting tenure. Second, it could be that individual characteristics, other than we have controlled for determined success in the academic labour market in the 70s. Thus, all these effects (which vanished over time) would be mirrored in the 70s dummy coefficient.

Another interesting observation is the fact that we do not find a reunification effect. Although, the reunification of Germany implied a demand push in the labour market for academic economists, we do not find an increase in the hazard rate of becoming tenured. It is true that the hazard rate in the 90s is larger than that after 2000, however this increase is smaller than in the 80s. From this we can conclude that the hazard rate of becoming tenured decreased from the 80s to the 90s. Hence, either the reunification effect does not exist or there are negative effects that overcompensated the potentially positive demand push from unification.

In a second specification we have included various interactions among covariates. Based on the Bayesian Information Criterion (BIC), it turned out that specification 2 was the superior one. We have interacted the average bibscore with "degree_top_world" since one might suspect that the effect of a degree which was received at a top university changes with the bibscore that was already achieved. The regression shows that the value of a publication in increasing the hazard rate decreases with a degree from a leading international university. One explanation for this effect could be that the benchmark for these individuals is larger so that they have to publish more to expect the same hazard rate. However, this effect is not significant. The other effects confirm the results of specification 1.

Specification one and two do not consider time varying covariates. By the construction of the Cox Model, this implies that the effect of the covariates is a proportional shift of the baseline hazard rate. As such, the shift of the baseline hazard rate is independent of the duration. If, however, the covariate effect is changing over time, the model would be misspecified. To test the proportionality assumption, we apply a test which is based on Schoenfeld residuals, see Grambsch and Therneau (1994). The residuals are basically the difference between observed and expected values of the covariates for an individual. If the effect of a specific covariate is constant over the duration, this residual should not change, see for example Box-Steffensmeier and Jones (2004). The test statistic which is used is the correlation between the residual and the duration. Global Test PH in table 4 depicts the p value of a statistic that tests the value of this correlation under the Null Hypotheses of zero correlation (i.e. the proportional hazard assumption is true). For Specification 1 (2) the test shows that the Null Hypotheses of zero correlation can be rejected at the 75% (80%) level. Thus, the model suggests that time varying effects play a role. To account for this, we conducted proportionality tests

for every covariate in specification 1 and 2.[13] As such, we identified those covariates for which the test rejects the Null Hypothesis at the 90% level and hence we suspect the impact of these variables to change with the duration.

A way to control for the non-proportionality is to interact the covariate with a function of the failure time. With this, we are able to disentangle the impact of the covariate into a fixed and a time-varying effect, see Kalbfleisch and Prentice (2000).

The covariate which we have identified to have a substantial (in the sense of rejecting the proportionality assumption at the 90% level) non-proportional impact is whether the subject of the first degree is economics. Specification 3 and 4, hence, include interaction between this covariate and the log of duration $\ln(t)$.[14]

Considering the duration interaction modifies the impact of "degree_econ1" on the hazard rate of becoming tenured. In specification 3 and 4 the effect (an economics degree decreases the hazard rate) is significantly negative and quite large (non-economists face a 600% higher hazard rate). However, this effect is declining in duration. After more than seven years in the post-doc state, this effect vanishes completely. After 8 years of duration (which is the median duration in the sample), it is even true that being a non-economist decreases the hazard rate of getting tenure.

The results concerning the effect of the publication output or the time dummies are not affected by the consideration of time variation. Hence, the results turn out to be robust. The proportionality assumption, however, can only be rejected at the 9% level (specification 4). As such, allowing for time variation at least ensures the model fits the assumptions of the Cox (1972) model.

Another crucial assumption of the Cox (1972) model (at least in our application) is that the baseline hazard rate is assumed to be the same for all individuals. The hazard rate of getting tenure is without doubt also driven by some unobserved ability or talent level. Hence, one might worry whether this homogeneity assumption results in a misspecification of the model. In order to account for unobserved heterogeneity we re-estimated specification 4 (our preferred specification) including a random effect, see Cameron and

[13] Note that all these tests are implemented STATA. The results of these tests are available from the authors on request.

[14] We have tried different specifications for the functional form of the duration in the interaction, for example t or $\exp(t)$. The log specification was chosen on the basis of the BIC. Note, however, that the results are robust to these modifications.

Trivedi (2005). Thus, instead of equation (3.3), we estimate

$$\lambda(t|\mathbf{X}, \nu) = \lambda_0(t)\nu \exp(\mathbf{X}(\mathbf{t})\boldsymbol{\beta}), \tag{3.4}$$

where ν is a random variable with $E(\nu) = 1$ and $Var(\nu) = \sigma_\nu$ which reflects the unobserved heterogeneity. Estimation of this model, assuming ν to be Gamma distributed, shows that the estimated variance σ_ν is not significantly different from zero.[15] Thus, we are confident that the results obtained from the model without unobserved heterogeneity are valid.

4 Conclusion

Using a unique data set on the career path of economists in the academic labour market in Germany, we have analysed which variables determine the success in this market. Our notion of success is the hazard rate, i.e. the conditional probability of becoming tenured. The data set that we use was generated on the basis of CV data of tenured economics professors and post-docs in Germany. With the CV information we are able to follow these individuals over their career path and to get data on personal characteristics. Using the duration from first PhD degree until tenure, we apply the non-parametric Kaplan-Meier (1958) estimator to get information on the evolution of the hazard rate. Moreover, we estimate probability of survival in the state of being a post-doc. We find that the hazard rate is hump shaped (as expected) and that it peaks 10 years after the PhD. Moreover, we find large changes of the survival rate between 4 and 10 years after the PhD. As such, post-docs in this state could be seen as the primal participants in the academic.

Additionally to the pure description of the evolution of the hazard rate of becoming tenured over the post-doc state, we analysed which covariates determine this hazard. To minimize the functional assumption posed on the regression model, we applied the semi-parametric Cox (1972) model for our regression analysis. Estimating the Cox (1972) model reveals two significant determinants of the hazard of becoming tenured: the average output of refereed publications and the decade in which tenure was awarded.

The latter fact points to large structural changes which have taken place in the academic labour market in Germany. The most important is the rapid

[15] The results are available upon request from the authors.

expansion of universities in the 70s which has led to a demand push in the market. The second one is Germany unification which, however we find to have no effect on the hazard rate of being tenured.

The effect of the bibliometric measure is not surprising since it could be seen as reflecting talent and productivity (even when considering all shortcomings of the referee process and so on). The strength of the effect is, however, surprising. Publishing a paper in a top 5 Journal (assuming a modest length of 10 pages) increases the hazard rate of becoming tenured by 240%. However, this effect is vanishing at the rate t^{-1} where t is duration in the post-doc state. Thus, two years after publication, a paper in the American Economic Review is only "worth" the same paper published in the Journal of Economic Perspectives.

Furthermore, we performed some robustness checks of the model. First, we tested whether the proportionality assumption of the Cox (1972) model holds for our data. We show this not to be true. Hence, we have to consider time (duration) varying covariates. Doing this makes the effect a the field of the first-degree significant. The hazard rate for non-economists is larger, however this effect is decreasing with duration. 8 years after the PhD degree this effect vanishes. The other effects are robust to the modification of time variation.

Finally, we test whether unobserved heterogeneity plays a role for the hazard of becoming tenured professor. Following the literature, we estimate a random effects Cox (1972) model to account for this heterogeneity. The results of this model show that heterogeneity (at least modelled in this specific form) does not play a role.

The data set is very rich and offers many further avenues of research.

- We would like to amend the data set by more bibliographic data. Up to now, we have missing information on 197 individuals. It would greatly improve the estimation if we were able to include information on these individuals in the data set.

- We would like to use the approach to estimate the effect of covariates on the hazard rate for different failure events. Although we focus our analysis on individuals that have been in the academic labour market in Germany in 2006, we have chosen the failure event to be getting tenured independent of the country where tenure has been received. This begs the question whether the results, for example for the failure event "tenure in Germany" substantially differs and if so in which way.

- The Cox (1972) model offers no estimation of the baseline hazard rate. However, it could be interesting to analyse the evolution (for example over space and time) of this hazard rate which reflects the inherent dynamics of the academic labour market (independent of the personal characteristics).

- Following Dietz et al. (2000), we could also analyse the covariates that determine publication output. With our information on the personal details we are able to analyse what are the characteristics that make individuals publish successfully.

We leave these projects for further research.

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