6. Cox Regression Models for Unemployment Duration in Romania, Austria, Slovenia, Croatia, and Macedonia[1]

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Abstract

This paper applies the semi-parametric Cox regression approach to model unemployment duration in five Central and Eastern European countries. The Cox proportional hazards models and the Cox regression models with a time-dependent

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covariate are developed, and the results are interpreted and compared. The impact of the variables age, gender, education level, and region on the hazard ratio is discussed. The results for the time-dependent variable age imply that the longer the unemployment spell lasts, the less pronounced the differences between various age groups are.

Keywords: survival analysis, Cox proportional hazards model, Cox regression model with a time-dependent covariate, unemployment duration.

JEL Classification: C14, C24, J60, J64

1. Introduction

This paper analyzes the impact of the variables age, gender, education level, and region on the duration of unemployment spells in Romania, Austria, Slovenia, Croatia, and Macedonia. The well-known Cox proportional hazards models and Cox regression models with a time-dependent covariate are applied, and the results are interpreted and compared. The parameters of the models are estimated from large datasets that consist of all registered unemployment spells of several years. The conclusions are relevant for the development of the labour markets in the countries observed.

In recent years, various survival analysis and duration techniques for modelling the length of unemployment spells and strike duration have gained popularity in the social sciences. New developments in econometric methods for labour market analysis are presented in Moffitt (1999). Using nonparametric and parametric estimation methods and controlling for unobserved heterogeneity, Tansel and Tasci (2005) analyzed the determinants of the probability of exiting unemployment in Turkey. Age has a negative effect on the hazard rate. Nivorozhkin (2006) employed a competing risk duration model to distinguish between exits to a previous employer and exits to a new job. His model, which includes the interaction of age and tenure, suggests that, despite being protected by legislation, older workers in Sweden remain unemployed longer conditioned on the same tenure. A negative association between age and probability of reemployment was also established by Kupets (2006) for Ukraine. D'Agostino and Mealli (2000), on the other hand, developed Cox proportional hazards models to study unemployment duration in several European countries, with mixed results. In Portugal, France, and Denmark, difficulties in leaving unemployment are encountered mainly by older people, whereas the young and the old have fewer chances for reemployment in Italy, the UK, and Spain.

Using a dependent competing risk model with nonparametric specification, van den Berg *et al*. (2008) simultaneously analyzed transitions from unemployment to employment and to nonparticipation based on French registered unemployed data. Stratification for gender yielded different results for unemployed men and women. Convergence and determinants of non-employment durations in Eastern and Western Germany were examined by Hunt (2004), who argued that the gender gap in Eastern Germany non-employment duration cannot be characterized as a skills gap. Gonzalo and Saarela (2000) discussed gender disparities in unemployment duration in Finland.

Substantial differences in the exit rates from unemployment were found for individuals under 30. Estimation results from the Cox proportional hazards models show that in Belgium, Greece, France, Spain, Denmark, and Portugal women have lower chances of leaving unemployment (D'Agostino and Mealli, 2000). Similar conclusions were reached by Tansel and Tasci (2005) for Turkey and by Stetsenko (2003) for Kyiv.

Many authors have studied the impact of education level on the duration of unemployment. In a study by Ollikainen (2003) on Finland, education appears as a highly positive factor in reducing the duration of unemployment, particularly for women. Kettunen (1997), on the other hand, argued that for the lowest levels additional education increases the probability of re-employment, but at the highest levels the relationship turns negative. Finnish unemployed workers with 13 to 14 years of education have the highest re-employment probability. A higher educational level shortens unemployment duration in the UK, Belgium, and Ireland, whereas in Greece and Spain educational level does not seem to have a strong effect on the expected duration (D'Agostino and Mealli, 2000). Using a multinomial logit model, Domadenik and Pastore (2004) found that tertiary educational attainment works as a buffer against unemployment, especially for young adults. Van Ours and Ridder (1995) looked at the increase in unemployment in the Netherlands during the cyclical downturn of the 1980s, when unemployment rates of less-educated workers increased more than those of more-educated workers. This phenomenon could be explained by job competition between workers of different levels of education or by employers dismissing replaceable less-educated workers before irreplaceable more-educated workers. According to Tansel and Tasci (2005), Kupets (2006), and Nivorozhkin (2006), more-educated individuals are more likely to find a new job in Turkey, Ukraine, and Sweden, respectively. McKenna (1996) suggested that education confers two related benefits to workers: broader access to jobs and higher lifetime earnings. A study by Stetsenko (2003), on the other hand, indicated a negative effect of education on the re-employment probability in Kyiv. Löfmark (2008) examined unemployment duration in Taganrog, Russia, and argued that possessing a medium education improves one's position in the labour market only slightly, whereas holding a high education has no effect at all. Such conclusions agree with the findings of Cheidvasser and Benitez-Silva (2007) that educational changes have no impact. The authors suggest that job destruction in the Russian Federation during transition principally involved highly skilled jobs, whereas job creation mainly involved jobs demanding lower educational attainment.

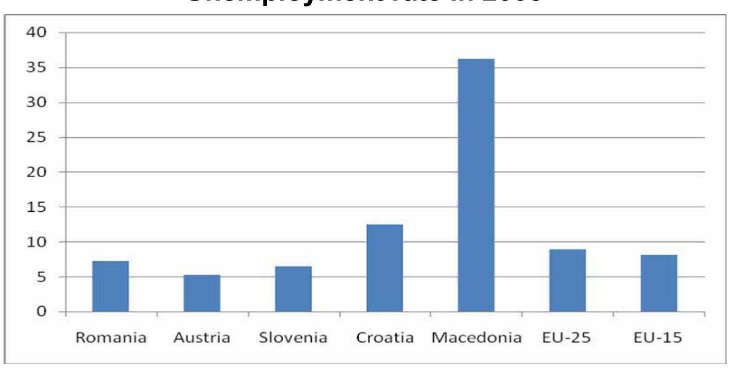
Similar studies of labour markets in Romania, Austria, Slovenia, Croatia, and Macedonia are rare or non-existent. This paper therefore seeks to fill a gap in the empirical literature. We believe this is the first attempt to apply the survival analysis techniques developed by Cox to model and compare the length of unemployment spells in these five countries. The rest of this paper is organized as follows. A short overview of the current unemployment trends in the labour markets observed is given in section 2. Section 3 presents the basic notion and describes the methodological approach of the Cox regression models. The proportional hazards assumption is discussed and different approaches to testing whether such an assumption holds are stated. Section 4 addresses the major question on the effects of age, gender, educational level, and region on the length of unemployment spells using the Cox proportional hazards model. The models for all five countries are estimated and the results are interpreted and compared. The Cox regression models with the time-dependent variable age are specified only for Romania, Slovenia, and Croatia, for which the proportional hazards assumption is rejected.

2. Short overview of unemployment trends

Among the criteria used to compare the economic performance of countries in terms of conditions prevailing on labour markets, the unemployment rate is usually of great interest. The registered unemployment rate and ILO unemployment rate are usually referred to in practice. The ILO unemployment rate is based on Labour Force Surveys conducted according to the International Labour Office (ILO) instructions. It is internationally comparable. The ILO counts as unemployed those that meet the following criteria: not working for pay, not employed or self-employed, actively seeking employment, and willing to accept work immediately or within two weeks (Kajzer, 2007a). A significant discrepancy between these two measures of unemployment in some countries may be due to a high level of informal work and/or a generous unemployment insurance system. Löfmark (2008) emphasizes that discouraged workers (i.e., those that give up searching for a job) are not included in the ILO definition, which could be problematic.

Figura 1

Unemployment rate in 2005



Source: Eurostat.

Unemployment registration in Romania was introduced in 1991, and the first study to evaluate unemployment by ILO standards was conducted in 1994 (Bădulescu, 2006). Similar to other transition countries, unemployment in Romania emerged inevitably as a result of enterprise restructuring and output contraction. Romania was among the few former communist economies to experience relatively low unemployment. Even after a rise due to rapid and sustained GDP expansion in the recent years, the ILO unemployment rate has stabilized at 7 to 8% (Kotzeva and Păuna, 2006). The unemployment rate of 7.2% in 2005 places Romania at the middle of the countries observed. Figure 1 presents a bar chart of the ILO unemployment rates in 2005. Using the Dobrescu macromodel of the Romanian market economy, Păuna *et al*. (2008) forecast the unemployment rate for 2008 at 5.3%.

It is quite common for Austria's labour market to be considered rather unproblematic by the international labour market experts. However, the general economic tendencies shared among almost all the European countries have also left their mark on the Austrian labour market and with it a major task for the economic policy to counteract the undesirable tendencies. The OECD survey on Austria (OECD, 2005) recommends adaptation of the tax and transfer system to reduce disincentives to both labour supply and demand. Abolishing the remaining incentives for effective early retirement at old age, such as disability pension schemes and income support targeted at older employees that reduce their working time, is also required. If calculated by the method favoured by the European Union, Austria's unemployment rate was 5.2% in 2005. This ranks it fifth within the European Union, after Ireland (4.4%), the UK (4.7%), the Netherlands (4.7%), and Denmark (4.8%). In 2005, according to calculations the unemployment rate stood at 8.9% for the EU-25 and at 8.1% for the EU-15. The fact that unemployment benefits in Austria are not seen as very generous could also be regarded as an element contributing to the consolidated labour market performance.

The system in the former Yugoslavia provided stability in the labour market by striving to achieve full employment and equal wealth distribution. It required radical regulation of the labour market to provide jobs for practically everyone. The unlimited guarantee of employment was even a constitutionally guaranteed right (Vodopivec, 1995). Transition brought about significant changes in the labour demand and, consequently, a dramatically high increase in the unemployment rate at the beginning of the 1990s. In Slovenia, the registered unemployment rate peaked in 1993, when it reached almost 15%, and started to decrease only in 1998. In 2006, the registered unemployment rate dropped below 10% for the first time after the beginning of transition. According to Eurostat, the internationally comparable ILO unemployment rate in Slovenia was lower, reaching 6.5% in 2005, which is below the EU-15 and EU-25 averages. The labour market situation in Slovenia has improved in the last 10 years and is now relatively favourable. However, several problems persist: the proportion of long-term unemployed and unskilled unemployed persons remains large, and the employment rate for elderly workers is low (Kajzer, 2007b).

Unemployment in Croatia rose throughout most of the last two decades and reached its highest level in 2002, when the registered unemployment rate was 21%. The increase in unemployment was the greatest during two different periods. The first was the early period of transformation (1990–1991), and the second in 1996 after the military downsizing following the Croatian War of Independence. In 2005 and 2006 unemployment briefly fell to 17%, but has since generally remained at around 19%. The ILO methodology indicated a significantly lower unemployment rate, of 12.7% in 2005. Registered unemployment in Croatia diverges systematically from the ILO figures, giving unemployment rates up to 50% higher and indicating the existence of a significant informal sector. According to the European policy review (International Labour Office and Council of Europe, 2006), estimates of the magnitude of the informal sector in Croatia ranged from 7% to 33% of GDP in 2000. The main problem regarding employment and unemployment in Croatia concerns jobless growth. Like other transformation economies, relatively high growth rates are achieved with modest increases in employment. The solution to this problem is at the core of the future economic success of the Croatian economy.

Macedonia has one of the highest unemployment rates in Europe. The country's structural inadequacy and weak economic growth in the last two decades have been the main reasons for high unemployment. Sharp contractions in economic activities during the transition period have increased the level of informal employment. The central problem that persists is the lack of labour demand in the formal sector. The unemployment rate fluctuated between 21.5% and 23.9% in the 1980s and was significantly higher than in other ex-Yugoslav republics. In the 1990s, the unemployment rate rose dramatically and reached its highest level of 39.1% in 1995. The lowest level was reached in 2001 (30.52%) after economic reforms were successfully implemented. The military conflict in 2001 and 2002 suppressed economic activity and the unemployment rate again surpassed 35% in the following years. The constantly high unemployment level in this period is primarily not the result of the layoffs, but rather the result of the extreme inflexibility of the labour market and rigid labour-force protection laws. As Riboud and Jauregui (2002) have calculated, the index of rigidity of the labour-force protection laws in Macedonia was 4.2 at the end of the 1990s. This index assigns a value between 0 and 6 (6 being the most rigid labour-law regulation); given the average index value for EU countries at 2.4, Macedonia's rigidity is obvious.

3. Methodology

3.1 Basic notions

Survival analysis and duration models originate in biostatistics, in which the survival time is the time until death or until the relapse of an illness. In recent years, these techniques have also gained popularity in social sciences to model the length of unemployment spells and strike duration. A comprehensive overview of the methods and models used in survival analysis is given by Therneau and Grambsch (2001) and by Klein and Moeschberger (2005).

Let the random variable T denote the *survival time*. The distribution function of T is defined by the equation

$$F(t) = P\left(T < t\right) \tag{1}$$

and measures the probability of survival up to time t. Because T is a continuous random variable, its density function $f(t)$ can be computed as the first derivative of the distribution function.

The *survival function S(t)* denotes the probability of surviving until time t or longer and is given by

$$S(t) = P(T \geq t) = 1 - F(t)\,. \tag{2}$$

The limit

$$\lambda(t) = \lim_{\delta \to 0} \frac{P\left(t \leq T < t + \delta \mid T \geq t\right)}{\delta} \tag{3}$$

represents the risk or proneness to death at time *t*. The function $\lambda(t)$ is usually called the *(instantaneous) hazard function* or the *failure rate* and measures the instantaneous death rate given survival until time *t*. Greater values of the hazard function can also be interpreted as higher potential for the event to occur. By integrating the hazard function over the interval $\left[0,t\right]$ one obtains the *cumulative hazard function*

$$\Lambda(t) = \int_0^t \lambda(u)du\,. \tag{4}$$

It is easy to see that $-\log S(t) = \int_0^t \lambda(u)du$, and, therefore, $S(t) = e^{-\int_0^t \lambda(u)du}$.

Because any of the functions *F(t)*, *S(t)*, *f(t),* and $\lambda(t)$ may be expressed with the help of any of the remaining three functions, one may decide to model any one of them and estimate the others from the derived equations.

3.2 Cox proportional hazards model

The *Cox proportional hazards model* is a semi-parametric method of analyzing the effects of different covariates on the hazard function. A detailed discussion of the Cox models can be found in Kleinbaum (2005) and in Hosmer and Lemeshow (2003). Assuming n individuals under observation, the Cox proportional hazards model is of the form

$$\lambda_i(t) = e^{x_i'\beta} \cdot \lambda_0(t) = c_i \cdot \lambda_0(t), \quad i = 1,2,\ldots,n\,, \tag{5}$$

in which $x_i = \left(x_{i1}, x_{i2}, \ldots, x_{ik}\right)'$ is the vector of k covariate values for individual i, $\beta = \left(\beta_1, \beta_2, \ldots, \beta_k\right)'$ is the vector of regression coefficients, $\lambda_i(t)$ is the hazard function of individual i, and $\lambda_0(t)$ is the *baseline hazard*. Thus, the baseline hazard corresponds to an observation with $x_i = 0$. The effect of the covariates on the hazard function in the Cox proportional hazards model does not depend on time because the ratio $\frac{\lambda_i(t)}{\lambda_0(t)}$ is equal to the constant c_i. Consequently, the baseline hazard determines the shape of the hazard function.

The ratio of the hazard functions of individuals i and j, namely $\frac{\lambda_i(t)}{\lambda_j(t)}$, is called the *hazard ratio*. This quotient is equal to

$$\frac{\lambda_i(t)}{\lambda_j(t)} = \frac{e^{x_i'\beta} \cdot \lambda_0(t)}{e^{x_j'\beta} \cdot \lambda_0(t)} = e^{(x_i - x_j)'\beta}\,. \tag{6}$$

The hazard ratio is the ratio of covariate effects for both individuals and is thus independent of time. This is called the *proportional hazards assumption*. The interpretation of the hazard ratio is similar to the odds ratio interpretation for logistic regression. A hazard ratio lower than 1 indicates decreased risk, whereas a ratio higher than 1 signals increased risk. Suppose that the vectors of covariates x_i and x_j differ only in the value of the *p*-th covariate and only for one unit. In this case, the hazard ratio

$$\frac{\lambda_i(t)}{\lambda_j(t)} = e^{\beta_p} \qquad (7)$$

measures the change of the hazard function for a unit change in the *p*-th covariate (if the covariate is a numerical variable). The hazard ratio is said to be statistically significant at the given level, when its confidence interval excludes 1. In this case, the null hypothesis that the variable is not related to survival can be rejected. This is the basis for the interpretation of the Cox regression results. By using *Cox's partial likelihood estimator*, it is possible to estimate the parameter vector *β* without specifying and estimating the baseline hazard (see Greene (2003) for details).

3.3 Proportional hazards assumption

The proportional hazards assumption is unrealistic in some cases. For example, the hazard ratio may change over time. In addition, it follows from equation (7) that the hazard ratio should be the same for the unit change in the given covariate, independently of the initial covariate value. The variable age, which is frequently used in Cox regression models, often violates the proportional hazards assumption. Namely, the ratio of the hazards should be the same for all age intervals (e.g., the quotient of the hazard functions for the 40- and 20-year-olds should be the same as the quotient for the 60- and 40-year-olds). This is often not the case.

The proportional hazards assumption can be checked in several ways, either graphically or more formally with statistical tests. Graphic examination can be carried out with a *log-minus-log (LML) plot* or with the help of *partial (Schönfeld) residuals.* A detailed discussion on how to test the proportional hazards assumption can be found in Therneau and Grambsch (2001).

One commonly used statistical test for proportional hazards is performed in a time-dependent covariates setting. An auxiliary model is fitted that includes an interaction term between time and the covariate under inspection (e.g., product of the covariate with time). If the proportional hazards assumption holds, the estimated coefficient of the interaction term in the model obtained with a time-dependent covariate should not be significantly different from zero. When a covariate fails a test for proportional hazards, non-proportional hazards can be built into the model by specifying interactions between covariates and time. One of the most often used interactions in practice is the product of a covariate and the time variable. Such a model is called the *Cox regression model with a time-dependent covariate*.

4. Empirical analysis

4.1 Data

The data for our empirical investigation were obtained from the national employment offices and from the Austrian National Statistical Office. The databases consist of all registered unemployment spells completed between the start date and the end date (as given in the fifth column of Table below) and all ongoing spells at the end date. The time span between 2002 and 2005 is covered in every country. For each of the unemployment spells, unemployment duration and the variables gender, age, and education level are given. In addition, information about the statistical region is included in the databases for Slovenia, Croatia, and Macedonia. In the case of Romania, we were only able to obtain the dataset for the Gorj County.[2] Because national employment offices are not allowed to disclose personal data about unemployed persons, only a personal identification number was added to enable identification of repeated spells. Information about registered unemployed persons in Austria was not available and two subsets of the micro-census database of the Austrian Statistical Office were used instead.[3] Due to the relatively small amount of data, this attempt to estimate the Cox proportional hazards model can only be considered a tentative exploratory study. For the rest of the countries under observation, on the other hand, relevant conclusions can be drawn owing to comprehensive datasets.

The percentage of censored observations is given in the sixth column of Table 1.

Table 1

Dataset description

	Number of observations	Mean duration	Factors	Period	Censored	Source
Romania*	80,961	264 days	Gender, age, education level	1 Jan 02 to 31 Aug 06	76.1%	National employment office
Austria	398 (sample 1) 686 (sample 2)	255 days 344 days	Gender, age, education level	2000–03, 2004–05	44.0% 68.2%	National statistical office
Slovenia	442,703	478 days	Gender, age, education level, region	1 Jan. 02 to 18 Nov. 05	21.3%	National employment office
Croatia	1,408,596	455 days	Gender, age, education level, region	2002–05	22.5%	National employment office
Macedonia	422,527	353 days	Gender, age, education level, region	2002–05	48.0%	National employment office

*Notes: * Gorj County only.*

[2] *Although a request was submitted to the Romanian Employment Office to obtain the dataset for the entire country, we only received the data for the Gorj County.*

[3] *The databank of the Austrian Employment Office contains individual data on all unemployment spells in Austria, but it is not publicly available, not even for research. The samples were not pooled due to a change in the design of the survey.*

This kind of censoring is called *right censoring*. Because the event under observation (i.e., the end of the unemployment spell) had not occurred by the end of the study, it is only possible to estimate the lower bound of survival time. The mean duration of completed (uncensored) unemployment spells is presented in the third column. One should note that the mean length of unemployment spells in Slovenia (478 days) is 81% higher than in Romania (264 days). These numbers should be interpreted in connection with the percentage of censored data. 76.1% of the unemployment spells in Romania had not been terminated by the end of our study, as compared to only 21.3% in Slovenia, and, therefore, the exit rate from unemployment is significantly higher in Slovenia than in Romania.

4.2 Cox proportional hazards models

The factors age, gender, education, and region (the last for Slovenia, Croatia, and Macedonia only) are employed as explanatory variables in the Cox proportional hazards models. We wished to estimate the impact of these variables on the length of unemployment spells in the period observed, primarily from 2002 to 2005. The categories of the variables education and region used in our empirical examination are given in Tables A1 to A5 in the Appendix. Because the education systems in the five countries are often not directly comparable and because we are limited by the availability of the official data, a different number of categories was employed in different countries to represent the variable education. Slovenia is divided into 12 statistical regions, Croatia into 20 counties plus one city district, and Macedonia into 30 regions.

The results of the Cox regression analysis are presented in Tables A1 to A5. The estimate of the regression coefficients vector β is denoted by B. As already explained (see equation (7)), Exp(B_p) is an estimate of the change of the hazard function for a unit increase in the p-th covariate when the covariate is a numerical variable. Only the variable age is numerical in our case. For the categorical variables gender, region, and education, Exp(B_p) measures the hazard ratio of a given category with the reference category. In our analysis, female gender (with the exception of Austria, for where male gender was used) and elementary school or no education were chosen for the reference categories for the variables gender and education. The reference regions are Coastal-Karst, Vukovar-Srijem, and Stip for Slovenia, Croatia, and Macedonia, respectively.

As already mentioned, the expression “hazard” originates in biostatistics, in which it is usually used to denote the risk of death. When applying survival analysis techniques to model unemployment duration, the hazard function measures the instantaneous rate of employment given unemployment up to the present moment or, in other words, instantaneous exit rate from unemployment to employment. Therefore, it would be better to use the expression “ratio of employment chances” instead of “hazard ratio”.

Table presents an overview of the main results for each of the countries and variables. With the exception of the Austrian sample from 2000 to 2003, the hazard for the unemployment spell to end is higher for unemployed men than for unemployed women. The gender gap is the most pronounced in Croatia, where the exit rate from unemployment to employment is 32% higher for men than for women, followed by Austria (29.9% for the sample from 2004 to 2005), Slovenia (20.8%), and Romania (16.3%). Gender differences seem to be negligible only in Macedonia, for which the hazard ratio is equal to 1.03. Löfmark (2008) emphasizes that the difficulties women face in the labour market may be due to discrimination, fiscal cuts in childcare, substitution of household production for previously free/subsidised services, and/or gender differences in degrees of risk aversion.

It is interesting that women in Slovenia had no disadvantages in the labour market during transition, which was not the case in other transition economies. Vodopivec (1995) stated that women represented a higher share in the two highest vocational classes (managers and head clerks) in comparison to men. The situation was reversed in Macedonia, as illustrated by Kjosev (2007). Women were more likely to be unemployed than men during the transition period. However, the gender gap has been decreasing over time and was even reversed in 2003, when male unemployment, at 37.0%, marginally surpassed the female rate of 36.3%. The share of unemployed women in Romania started to fall in 1997 as a result of collective dismissals mainly involving constructions, mining, and metallurgy – industries with preponderantly male employees. Another factor that contributed to the unemployment decrease among women was represented by the growth of the confectionery, clothing, and footwear industries, in which the labour force mostly consists of women (Dănăcică and Babucea, 2007).

Table 2

Overview of comparative results by country

Country		Age	Gender	Education	Region
Romania	+	−0.2%*	Men (+16.3%)	University-level	…
	−		Women	Elementary school or none	…
Austria 2000–03	+	−3.2%	Women (+33.7%)	Vocational high school, university-level	…
	−		Men	Elementary school or none	…
Austria 2004–05	+	−2.4%	Men (+29.9%)	Vocational high school, general high school,* university-level	…
	−		Women	Elementary school or none	…
Slovenia	+	−2.4%	Men (+20.8%)	Doctorate, bachelor's degree, higher professional	Upper Carniola, Coastal-Karst
	−		Women	Elementary school or none, middle vocational	Savinja, Mura, Central Sava, Drava
Croatia	+	−2.4%	Men (+32.0%)	Doctorate, bachelor's degree, master's degree	Istria, Međimurje, Požega-Slavonia
	−		Women	Elementary school, 3-year vocational	Karlovac, Split-Dalmatia
Macedonia	+	−1.0%	Men (+3.0%)	Doctorate, bachelor's degree	Bitola, Sv. Nikole, Radovis, Vinica
	−		Women	Elementary school or none, 1 or 2 years of secondary school	Gostivar, Tetovo

Notes: * *Variable not significant at the 5% level.*

Regarding the variable age, similar results were obtained for Austria (sample from 2004 to 2005), Slovenia, and Croatia, for which an additional year of age decreases the chances for employment by 2.4%. As pointed out by Kupets (2006), the difficulties that older workers face in finding work could be attributed to the restrictive hiring standards of employers due to objective and discriminatory factors, such as obsolete skills, health problems, loss of motivation, and discouragement. All these factors may in turn lead to fewer job offers. Austria, Slovenia, and Croatia have also been facing unfavourable demographic trends, especially population aging and stagnant aggregate population. In Slovenia and Croatia, these unfavourable demographic developments were coupled during transition with the extensive use of early retirement as a means of solving the unemployment prospects for many older workers. As a consequence, the share of retired persons below the age of 65 increased substantially. The awareness of the non-sustainability of such policies led to change in pension rules and considerably slowed the inflow of new persons into retirement (Babić, 2003).

The impact of the variable age is less pronounced in Macedonia and even insignificant in Romania, which could be due to high youth unemployment rates in both countries. Kjosev (2007) argues that the deterioration in the youth job market has contributed to large increases in enrolment rates in higher education and to the “brain-drain” process of the highly qualified young work force.

Regional distribution of the duration of unemployment in Slovenia highlights the differences between the highly developed central part (the Upper Carniola Region) and the coastal area (the Coastal-Karst Region) on the one hand, and the underdeveloped North-Eastern part (the Savinja, Mura, and Drava regions) on the other hand. In Croatia, the best chances of employment are given to unemployed persons from Istria County, where the hazard for the unemployment spell to end is a full 121% higher than in Karlovac County on the other side of the spectrum. All the other Croatian regions lag behind Istria County regarding the chances of employment. The regions in Eastern Macedonia are more advantageous in the labour market than the regions in the western part. Unemployed persons from Tetovo and Gostivar are in the worst position, with approximately 50% lower chances of finding a job in comparison to Bitola. One of the main reasons for such results could be the significant grey economy in the Western Macedonia. The regional differences in Macedonia seem to be more pronounced than in Slovenia and Croatia (with the exception of Istria County). Recall that, in the case of Austria, the information about the regional affiliation of unemployed persons is not at our disposal, and only the data for Gorj County are available for Romania. According to Florescu *et al*. (2007), the distribution of the unemployment rate in Romania reveals large regional disparities: 2.0 to 4.7% (15 counties), 5.1 to 5.9% (7 counties), 6.0 to 6.9% (10 counties), and 7.0 to 11.2% (10 counties).

In Romania (Gorj County), Slovenia, and Macedonia, the hazard ratio generally increases with increasing education level. Kupets (2006) argues that higher exit rates among educated people can be explained by their more effective ability to search for a job due to better access to information, higher opportunity costs of unemployment, greater flexibility, and a wider range of alternatives for future employment. Whereas more educated persons are able to compete for jobs that require fewer years of schooling, the reverse is not generally the case. There is one notable exception to the increasing hazard ratios rule in the models for Slovenia and Macedonia. Surprisingly, unemployed persons with a master's degree have lower chances of employment than unemployed persons with a bachelor's degree. The disadvantaged position of a master's degree is also revealed by the mean length of unemployment, which is 70 days or 32 days longer for a master's degree than for the bachelor's degree in Slovenia and Macedonia, respectively. The appropriateness of an education system that does not guarantee a better position in the labour market for higher educational levels is questionable. In addition, the comparison between unemployed persons with a bachelor's degree and with a doctorate in Slovenia reveals only a slight advantage of the highest education level. There is a striking difference in this regard among these three ex-Yugoslav republics because the doctorate seems to be very appreciated in the labour markets of Croatia and, especially, Macedonia. We could not examine the status of the two highest levels of education in Romania and Austria because of the aggregation in the data. For these two countries, a bachelor's degree, master's degree, and doctorate are coded as one category termed "university-level education".

In Austria, there does not seem to be a distinct relation between education level and chances of employment, but this may be due to the small sample size. Croatia, on the other hand, is an exception among the countries observed. The lowest education level in the other four countries (elementary school or no education) is divided into five categories. The exit rates to employment first decrease with increasing education level. The relationship is then reversed after completion of elementary school. Kjosev (2007) offers an explanation for such results. He argues that relatively lower unemployment figures for workers that have not completed elementary school can be explained by the fact that they are less reluctant to accept low-qualified jobs, mainly in the agricultural sector.

Vulnerable groups in the labour force, some of which have already been mentioned (young workers, older workers, women with small children, unskilled workers, migrant workers, etc.), can benefit from flexible forms of employment. Nesporova (2008) discussed evidence of labour market flexibilization, which has been on the increase in Southeast Europe during the transition period. Unfortunately, such a course of development also deepened labour market segmentation. Core workers of prime age are relatively well protected, whereas peripheral workers have less secure contracts or limited contracts, sometimes even without social security benefits. Labour market segmentation in Croatia was examined by Račić, Babić, and Najla (2005). The authors claim that, due to the institutional insufficiency of the judicial system, segmentation largely results from the patterns of unionization and collective bargaining.

4.3 Cox regression models with a time-dependent covariate

In order to test the proportional hazards assumption for the variable age, a model that includes the interaction term between time and age (Age · T) is fitted. Due to the small size of the Austrian sample, no attempt was made to fit the augmented model. In the case of Macedonia, the proportional hazards assumption was not rejected, and therefore the Cox regression models with the time-dependent covariate age were estimated only for Romania (Gorj County), Slovenia, and Croatia. The Cox proportional hazards models are not well suited for these three countries because the interaction terms are highly significant. The estimates in Tables A3, A5, and A6 show that the hazard ratios for the variables gender, education, and region mostly change only slightly when compared to those from the proportional hazards model. There are two changes that should be noted. The first appears in the model for Romania, in which the hazard ratio for unemployed men compared to unemployed women increased from 1.163 to 1.248. Regarding the second change (for the variable education in the model for Slovenia), one may observe that the hazard ratios for lower levels of education slightly decreased and, for higher levels of education, the hazard ratios increased. Thus, the more appropriate model with a time-dependent covariate places more emphasis on higher levels of education that on the average guarantee shorter unemployment spells.

The interpretation of results for the time-dependent variable age is different in this setting. If age of individual i is 1 year higher than for individual j while the values of the covariates gender, region, and education are the same for both individuals, then the hazard ratio is equal to

$$\frac{\lambda_i(t)}{\lambda_j(t)} = \frac{e^{x_i'\beta} \cdot \lambda_0(t)}{e^{x_j'\beta} \cdot \lambda_0(t)} = e^{b_1 + b_2 \cdot T}. \qquad (11)$$

In the case of Slovenia, $b_1 = -0.0342$ and $b_2 = 0.0000212$. This means that after 1 year of unemployment ($T = 365$) the hazard ratio is equal to

$$\frac{\lambda_i(t)}{\lambda_j(t)} = e^{-0.0342+0.0000212 \cdot 365} = 0.974$$

and after 2 years of unemployment ($T = 2 \cdot 365 = 730$)

$$\frac{\lambda_i(t)}{\lambda_j(t)} = e^{-0.0342+0.0000212 \cdot 730} = 0.981.$$

Thus, the hazard ratio is time-dependent because it increases with time. After 1 year of unemployment, the hazard is reduced with increasing age of the unemployed by 2.6% each year and, after 2 years of unemployment, by 1.9% each year. In other words, the longer the unemployment spell lasts, the less pronounced are the differences between different age groups. Similar results are obtained for Croatia and Romania. Such results are also confirmed by the actual circumstances in the labour markets in Slovenia, Romania, and Croatia and are more realistic than the proportional hazards assumption.

5. Conclusion

The results of the Cox proportional hazards regression modelling with respect to the factors age, gender, education, and region reveal several differences among the countries observed. The gender gap is most pronounced in Croatia, whereas gender disparities seem to be negligible in Macedonia. The impact of the variable age is similar in Austria, Slovenia, and Croatia, where older workers are at a disadvantage in the labour market. Macedonia and Romania, on the other hand, face a higher youth unemployment rate.

In general, unemployed persons with higher levels of education are in a better position in the labour market. Only one surprising conclusion has to be drawn; namely, that unemployed persons with a master's degree in Slovenia and Macedonia have lower chances of finding a job than the unemployed persons with a bachelor's degree. The disadvantaged position of a master's degree is also revealed by the substantially longer mean length of unemployment.

The comparison of the Cox regression models with a time-dependent covariate and the Cox proportional hazards models reveals that the hazard ratios for the variables gender, education, and region mostly change only slightly. The results for the time-dependent variable age, on the other hand, imply that the longer the unemployment spell lasts, the less pronounced the differences between different age groups are. Such results are also confirmed by the actual circumstances in the labour markets and are more realistic than the proportional hazards assumption.

Our findings have important implications for policymakers because they indicate the target groups for the policy tools. Nevertheless, the countries in question are obliged to follow the objectives of the Lisbon Strategy[3] and achieve higher overall employment rates, and within this higher employment rates of women and older workers. The analysis has proven that the characteristics of duration of unemployment in these five countries observed are specific. The results can help identify potential target groups of unemployed persons in order to improve the effectiveness of active employment policy in individual countries, which can contribute to achieve the Lisbon objectives in the near future from the point of view of promoting the re-employment of women and older workers.

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[3] *More specifically, one of the Lisbon targets is a 70% employment rate in the EU by 2010. Because the structure of employment is of crucial importance, the Lisbon strategy also foresees achieving a 60% employment rate for women and a 50% employment rate among older people in the same period. Among the economies observed, only Austria has already fulfilled two of these three targets (overall and women's employment rates).*

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Appendix

In the tables below, the abbreviation *SE* stands for *standard error* and *Sig.* for significance (p-value).

Table A1

Cox proportional hazards model and Cox regression model with a time-dependent covariate for Romania (Gorj County)

	ROMANIA (Gorj County)							
	Cox proportional hazards model				Cox regression model with time-dependent covariate			
	B	SE	Sig.	Exp(B)	B	SE	Sig.	Exp(B)
Age	−0.002	0.009	0.840	0.998	−0.007	0.001	0.431	0.993
Age · T					0.001	0.000	0.000	1.001
Gender			0.000				0.000	
Male	0.151	0.021	0.000	1.163	0.221	0.021	0.000	1.248
Female	**Reference category**				**Reference category**			
Education			0.000				0.000	
Elementary school or none	**Reference category**				**Reference category**			
Apprenticeship, vocational school, finished or unfinished secondary school	0.539	0.139	0.000	1.715	0.438	0.140	0.002	1.549
High school	0.536	0.140	0.000	1.709	0.577	0.140	0.000	1.780
Foreman school or post high school	0.583	0.143	0.000	1.791	0.536	0.144	0.000	1.709
University-level	1.284	0.143	0.000	3.611	1.103	0.143	0.000	3.012

Notes: Time and duration of unemployment in the model for Romania are measured in months and not in days, as for other countries.

Table A2

Cox proportional hazards models for Austria

	AUSTRIA							
	Cox proportional hazards model 2002–2003				Cox proportional hazards model 2004–2005			
	B	SE	Sig.	Exp(B)	B	SE	Sig.	Exp(B)
Age	−0.032	0.007	0.000	0.968	−0.024	0.007	0.000	0.976
Gender			0.039				0.060	
Female	0.290	0.141	0.039	1.337	−0.261	0.139	0.060	0.770
Male	**Reference category**				**Reference category**			
Education								

	AUSTRIA							
	Cox proportional hazards model 2002–2003				Cox proportional hazards model 2004–2005			
	B	SE	Sig.	Exp(B)	B	SE	Sig.	Exp(B)
Elementary school or none	Reference category				Reference category			
Apprenticeship	0.391	0.182	0.032	1.479	0.427	0.187	0.022	1.533
Vocational middle school	0.524	0.277	0.059	1.689	0.365	0.235	0.121	1.440
General high school	0.301	0.279	0.280	1.351	0.512	0.280	0.067	1.669
Vocational high school	0.837	0.274	0.002	2.309	0.549	0.255	0.031	1.732
University-level	0.611	0.258	0.018	1.843	0.505	0.253	0.046	1.657

Table A3

Cox proportional hazards model and Cox regression model with a time-dependent covariate for Slovenia

	SLOVENIA							
	Cox proportional hazards model				Cox regression model with a time-dependent covariate			
	B	SE	Sig.	Exp(B)	B	SE	Sig.	Exp(B)
Age	−0.025	0.000	0.000	0.976	−0.034	0.000	0.000	0.966
Age · T					0.0000212	0.000	0.000	1.0000212
Gender			0.000				0.000	
Male	0.189	0.003	0.000	1.208	0.171	0.007	0.000	1.187
Female	Reference category				Reference category			
Education			0.000				0.000	
Elementary school or none	Reference category				Reference category			
2-year lower vocational	0.172	0.008	0.000	1.187	0.153	0.015	0.000	1.165
3-year lower vocational	0.122	0.016	0.000	1.130	0.162	0.033	0.000	1.176
Middle vocational	0.286	0.005	0.000	1.331	0.264	0.009	0.000	1.302
Secondary	0.260	0.005	0.000	1.296	0.248	0.009	0.000	1.282
Post-secondary vocational	0.322	0.011	0.000	1.379	0.341	0.023	0.000	1.407
Higher professional	0.534	0.012	0.000	1.706	0.524	0.023	0.000	1.688
Bachelor's degree	0.572	0.008	0.000	1.772	0.588	0.017	0.000	1.800

	SLOVENIA							
	Cox proportional hazards model				Cox regression model with a time-dependent covariate			
	B	SE	Sig.	Exp(B)	B	SE	Sig.	Exp(B)
Master's degree	0.459	0.042	0.000	1.583	0.474	0.084	0.000	1.606
Doctorate	0.584	0.070	0.000	1.793	0.595	0.149	0.000	1.813
Region			0.000				0.000	
Mura	−0.288	0.010	0.000	0.750	−0.256	0.019	0.000	0.774
Drava	−0.238	0.009	0.000	0.788	−0.211	0.017	0.000	0.809
Carinthia	−0.155	0.012	0.000	0.857	−0.128	0.023	0.000	0.880
Savinja	−0.283	0.009	0.000	0.753	−0.284	0.018	0.000	0.753
Central Sava	−0.225	0.013	0.000	0.799	−0.214	0.026	0.000	0.808
Lower Sava	−0.162	0.011	0.000	0.850	−0.142	0.023	0.000	0.867
Southeast Slovenia	−0.224	0.011	0.000	0.799	−0.193	0.021	0.000	0.825
Central Slovenia	−0.118	0.009	0.000	0.889	−0.107	0.018	0.000	0.899
Upper Carniola	0.157	0.009	0.000	1.170	0.182	0.019	0.000	1.199
Inner Carniola-Karst	−0.095	0.014	0.000	0.910	−0.063	0.027	0.022	0.939
Gorizia	−0.096	0.012	0.000	0.908	−0.106	0.024	0.000	0.900
Coastal-Karst	**Reference category**				**Reference category**			

Table A4

Cox proportional hazards model and Cox regression model with a time-dependent covariate for Croatia

	CROATIA							
	Cox proportional hazards model				Cox regression model with a time-dependent covariate			
	B	SE	Sig.	Exp(B)	B	SE	Sig.	Exp(B)
Age	−0.024	0.000	0.000	0.976	−0.027	0.000	0.000	0.973
Age · T					0.0000071	0.000	0.000	1.0000071
Gender			0.000				0.000	
Male	0.277	0.002	0.000	1.320	0.268	0.006	0.000	1.307
Female	**Reference category**				**Reference category**			
Education			0.000				0.000	
None	**Reference category**				**Reference category**			
Up to 4th grade	−0.088	0.056	0.116	0.916	−0.015	0.171	0.932	0.985
5th to 7th grade	−0.173	0.051	0.001	0.841	−0.138	0.152	0.362	0.871
6 months training without elementary school	−0.495	0.056	0.000	0.610	−0.392	0.169	0.020	0.676
Elementary school	−0.555	0.047	0.000	0.574	−0.562	0.139	0.000	0.570
3-year vocational	−0.538	0.047	0.000	0.584	−0.558	0.139	0.000	0.572

	CROATIA							
	Cox proportional hazards model				Cox regression model with a time-dependent covariate			
	B	SE	Sig.	Exp(B)	B	SE	Sig.	Exp(B)
Vocational secondary school	−0.393	0.047	0.000	0.675	−0.401	0.139	0.004	0.670
Training after secondary school	−0.371	0.048	0.000	0.690	−0.345	0.141	0.014	0.708
Secondary school of more than 4 years	−0.352	0.047	0.000	0.703	−0.353	0.139	0.011	0.702
Upper secondary school	−0.466	0.047	0.000	0.628	−0.464	0.140	0.001	0.629
Higher professional	−0.102	0.047	0.031	0.903	−0.118	0.140	0.397	0.889
Bachelor’s degree	0.068	0.047	0.146	1.071	0.051	0.139	0.715	1.052
Master’s degree	0.033	0.061	0.583	1.034	0.092	0.180	0.609	1.097
Doctorate	0.865	0.254	0.001	2.376	0.617	1.010	0.541	1.854
County			0.000				0.000	
Zagreb	0.201	0.006	0.000	1.223	0.190	0.018	0.000	1.209
Krapinja-Zagorje	0.242	0.007	0.000	1.274	0.225	0.023	0.000	1.252
Sisak-Moslavina	0.008	0.006	0.168	1.008	0.034	0.019	0.070	1.035
Karlovac	−0.087	0.007	0.000	0.917	−0.116	0.021	0.000	0.890
Varaždin	0.224	0.006	0.000	1.251	0.219	0.020	0.000	1.245
Koprivnica-Križevci	0.124	0.007	0.000	1.132	0.130	0.024	0.000	1.139
Bjelovar-Bilogora	0.060	0.006	0.000	1.062	0.059	0.020	0.004	1.061
Primorje-Gorski Kotar	0.226	0.006	0.000	1.254	0.200	0.018	0.000	1.222
Lika-Senj	0.136	0.010	0.000	1.146	0.125	0.032	0.000	1.133
Virovica-Podravina	0.069	0.007	0.000	1.071	0.066	0.023	0.003	1.068
Požega-Slavonia	0.243	0.008	0.000	1.274	0.268	0.024	0.000	1.307
Brod-Posavina	0.024	0.006	0.000	1.024	0.024	0.019	0.204	1.025
Zadar	0.181	0.006	0.000	1.198	0.155	0.020	0.000	1.168
Osijek-Baranja	0.027	0.005	0.000	1.027	0.015	0.016	0.346	1.016
Šibenik-Knin	0.121	0.007	0.000	1.128	0.116	0.021	0.000	1.123
Split-Dalmatia	−0.021	0.005	0.000	0.979	−0.034	0.016	0.032	0.967
Istria	0.670	0.006	0.000	1.954	0.666	0.020	0.000	1.946
Dubrovnik-Neretva	0.207	0.007	0.000	1.230	0.182	0.021	0.000	1.200
Međimurje	0.264	0.007	0.000	1.303	0.275	0.023	0.000	1.317
City of Zagreb	0.165	0.005	0.000	1.179	0.162	0.015	0.000	1.176
Vukovar-Srijem	Reference category				Reference category			

Table A5

Cox proportional hazards model for Macedonia

	MACEDONIA			
	Cox proportional hazards model			
	B	SE	Sig.	Exp(B)
Age	−0.010	0.000	0.000	0.990
Gender			0.000	
Male	0.030	0.004	0.000	1.030
Female	**Reference category**			
Education			0.000	
Elementary school or none	**Reference category**			
1 year of secondary school	0.148	0.023	0.000	1.159
2 years of secondary school	0.153	0.017	0.000	1.166
3 years of secondary school	0.206	0.006	0.000	1.229
4 years of secondary school	0.310	0.005	0.000	1.363
Advanced training or specialization	0.369	0.014	0.000	1.446
Bachelor's degree	0.609	0.008	0.000	1.839
Master's degree	0.344	0.083	0.000	1.411
Doctorate	1.306	0.122	0.000	3.690
Region			0.000	
Berovo	−0.003	0.021	0.870	0.997
Bitola	0.103	0.012	0.000	1.108
Debar	−0.263	0.023	0.000	0.769
Delcevo	−0.295	0.019	0.000	0.745
Demir Hisar	−0.178	0.029	0.000	0.837
Gevgelija	0.001	0.017	0.970	1.001
Gostivar	−0.708	0.016	0.000	0.493
Kavadarci	−0.322	0.017	0.000	0.725
Kicevo	−0.287	0.018	0.000	0.751
Kocani	−0.200	0.015	0.000	0.819
Kratovo	−0.415	0.029	0.000	0.660
Kriva Palanka	−0.449	0.019	0.000	0.638
Krusevo	−0.264	0.030	0.000	0.768
Kumanovo	−0.383	0.013	0.000	0.682
Makedonski Brod	−0.434	0.032	0.000	0.648
Negotino	−0.074	0.019	0.000	0.928
Ohrid	−0.056	0.014	0.000	0.945
Prilep	−0.329	0.013	0.000	0.720
Probistip	−0.108	0.019	0.000	0.898
Radovis	0.071	0.016	0.000	1.073
Resen	−0.400	0.028	0.000	0.670
Skopje	−0.264	0.010	0.000	0.768
Struga	−0.249	0.017	0.000	0.779
Strumica	−0.307	0.014	0.000	0.736

	MACEDONIA			
	Cox proportional hazards model			
	B	SE	Sig.	Exp(B)
Sveti Nikole	0.089	0.016	0.000	1.093
Tetovo	−0.544	0.013	0.000	0.580
Valandovo	−0.382	0.027	0.000	0.683
Vinica	0.061	0.018	0.001	1.063
Veles	−0.461	0.015	0.000	0.630
Stip	Reference category			