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Working Paper No. 57

How Aging of the Labor Force Affects
Equilibrium Unemployment

by

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How Aging of the Labor Force Affects Equilibrium Unemployment*

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Abstract

This paper argues that aging of the labor force affects job creation and job destruction. To analyze this, we extend a standard model of equilibrium unemployment and search in the labor market by the distinction between age specific separation risks and a productivity differential between young and elderly workers. Based on the theoretical model, we identify four regimes of changes in the Beveridge Curve and job creation which can occur if the age structure varies. We also present an econometric model to find out which country relates to which regime. According to the estimates we can identify all four cases. For example, Spain and the US may experience positive effects on employment when the labor force grows older. In contrast to this, the unemployment rate in Germany and Japan will rise as a consequence of the increase in the share of elderly workers.

Keywords: Vacancies and Separations, Unemployment, Job Creation, Aging of the Labor Force, Demographic Change

JEL classification: J63, J64, J23, J21, J10

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1 Introduction

With more and more elderly workers being employed, the labor markets of nearly all developed economies will go through deep changes. The share of the age group 55 to 64 years in the US is increasing by one third over the next twenty years. Europe and Japan will experience an even more considerable development. Besides other effects, the altered age composition is supposed to affect the labor market via changes in job and labor turnover, namely job creation, job destruction and job-search behavior. Young job seekers may be different from old ones in their incorporated skills and the different time horizon, for example the remaining time until retirement, which affects the separation risk of a job-worker match. We therefore expect effects of the aging working population on unemployment and vacancies.

Recent papers on aging deal in particular with the change in consumption, savings and growth, and the impact on the pension systems.¹ Labor market consequences of population aging are discussed in terms of reduced total labor supply including feedbacks of capital intensity, the effects of the age structure on labor productivity, shifts in the aggregate or cohort wage level, and changes in goods demand which affect labor mobility (see Börsch-Supan, 2003; Johnson and Zimmermann, 1993). This paper analyzes another aspect of aging and the labor markets, which is widely ignored in the literature to date: The impact of the age structure on the search equilibrium on the labor market and equilibrium unemployment. Some parts of the empirical literature on search and the matching function include demographic variables but only as a sideline of the analysis. Coles and Smith (1996) find that matching decreases with an older working population for England and Wales. Other authors argue that separation rates are higher for younger workers as they are more likely to undertake on-the-job search. Pissarides and Wadsworth (1994) and Burgess (1993) find evidence for Great Britain. However, the existent theoretical and empirical literature does not allow drawing any conclusions with regard to demographic effects on variations in unemployment if e.g. job separation and matching decline in equal size. Hence, the question of how aging affects search and matching on the labor market and thereby equilibrium unemployment has not been answered yet. To our knowledge, this paper is the first contribution to the literature which deals with this issue.

The aim of this paper is to identify and estimate the effects of aging on unemployment via changes in the flows on the labor market related to the

¹See, for example, Batey and Madden (1999), Bloom and Canning (2004), Bloom et al. (2003), Breyer and Stolte (2001), Butrica et al. (2004), Ehrlich and Kim (2005), Sneddon and Triest (2001, 2002), Miles (1999) and Sellon (2004).

matching function and changes in job creation. For this, we develop a model of equilibrium unemployment which follows the standard search models of Diamond-Mortensen-Pissarides. The results will depend on the assumption on relative separation rates and relative productivity between young and elderly workers. We identify four regimes with different changes in the Beveridge Curve and job creation which can occur if the age structure varies. Only in two out of the four cases the theoretical outcome for changes in unemployment as the job seekers get older is clear-cut. This makes econometric estimations necessary, which we undertake for nine countries (the US and Japan in addition to selected European economies). We find all four cases in our empirical results. For example, Spain and the US may experience positive effects on employment when the labor force grows older. In contrast to this, unemployment in Germany and Japan will rise as a consequence of the increase in the share of elderly workers. In some countries the results depend on whether we consider the aging of the employed workers, which includes the effects of on-the-job search, or take the unemployed as the only job seekers.

The remainder of the paper is organized as follows. In section 2 we extend the standard model of search and equilibrium unemployment by age effects. Section 3 presents the econometric model and reports the estimation results. Finally, we summarize our results in section 4.

2 The Model

Our modeling is a simple extension of the standard framework of search and equilibrium unemployment (see Pissarides, 2000). The search equilibrium of the labor market is given by the extent of job creation subject to the optimal job posting of firms, job destruction and the matching technology, manifested in the Beveridge Curve. We examine the effects of aging on the search equilibrium which arise from a change in the age structure of the labor force but we ignore size effects.² The way we introduce heterogeneity into the labor force follows Acemoglu (1997), who distinguished between high-skilled and low-skilled workers. In contrast to this, we differentiate between young and elderly workers who may be different not only in productivity but also in their separation risk. Two effects apply: (1) old workers separate because they retire before the match gets unproductive. (2) Young workers bring the

²Most of the existing empirical studies suggest constant returns to scale of matching function (see Petrongolo and Pissarides, 2001 for an overview). Therefore, no size effects on search in the labor market are expected when the population declines due to demographic change.

current match to an end because they leave for better jobs, whereas older ones stay because of tenure rents. In the model we will allow for both cases, as well as for relative high or low productivity of elderly workers.

2.1 Trade in the Labor Market

There is a continuum of workers normalized to 1 and a larger continuum of firms. Each firm can decide to be inactive at zero return or can open a vacancy at flow cost γ . Each vacancy can employ only one worker. The total labor supply is divided into two age groups. Workers are young at a share p , henceforth symbolized with superscript y , and elderly at a fraction $1 - p$, identified by superscript e . The elderly and the younger workers are identical in all respects apart from a productivity differential δ and a different expected duration as part of a job-worker match. The formed matches come to an end because of exogenous technological shocks, but young workers may leave a current match also because on-the-job search resulted in a better alternative match. Hence, the period probability to separate with the job is s^y for the young worker. For the elderly one we assume that on-the-job search is not profitable anymore, but they end a match when they retire³, which results in a separation rate s^e . The difference in the two separation rates is given by a positive value of τ :

$$s^y = \tau s^e. \tag{1}$$

Therefore, the expected duration of a match is of equal length for young and elderly workers if $\tau = 1$, but it may be larger or smaller than unity, too. This means that the separation risk may be larger in the case of on-the-job search or in the case of near retirement. The average separation rate then comes from the shares of young and old according to

$$s = (p\tau + (1 - p)) s^e. \tag{2}$$

New employment relations are formed through a standard matching technology which forms the number of matches from the number of unemployed workers and the number of vacancies. With a population normalized to unity the matching rate is given by:

$$m_t = M(u_t, v_t), \tag{3}$$

where u_t is the unemployment rate, v_t is the vacancy rate and $M(u_t, v_t)$ is the flow rate of matches formed at time t . As standard, $M(u_t, v_t)$ exhibits

³For simplicity suppose that retirement does not change the total population because the influx of young workers exactly replaces the retired workers.

constant returns to scale in its two arguments⁴, is continuous and differentiable, and $M(u_t, v_t) < \infty$. Define $\theta = v/u$ as a measure of the tightness of the labor market. Then the flow rate of matches for an unfilled vacancy, $q(\theta_t)$, is equal to:

$$q(\theta_t) = \frac{M(u_t, v_t)}{v_t}, \text{ with } q'(\theta_t) < 0. \quad (4)$$

The share of workers who enter unemployment⁵ during a small time interval is $s(1 - u_t)$, while $\theta_t q(\theta_t)$ is the transition probability for u_t unemployed. The evaluation of unemployment is given by the difference between the two flows,

$$\dot{u}_t = s(1 - u_t) - \theta_t q(\theta_t) u_t. \quad (5)$$

We can rewrite eq. (5) as an equation determining unemployment in terms of the two transition rates:

$$u = \frac{p\tau + (1 - p)s^e}{[p\tau + 1 - p]s^e + \theta_t q(\theta_t)} \quad (\text{BC}). \quad (6)$$

By the properties of the matching function, equation (6) represents the so-called Beveridge Curve (BC), a convex and downward-sloping curve in the θ, u space. For constant parameters of the model, in particular a stable age distribution $p/1-p$, the value of the market tightness fixes the unemployment rate. The unknown θ is explained by the willingness to create vacancies by the firms, put down in the next section.

2.2 Job Creation

The following equilibrium of job creation will be characterized through a set of Bellman equations, which define the values of vacancies and jobs. Search models generally assume foresighted firms, especially when they optimize their job posting. Compared with the standard analysis, the following equations consider the probabilities of matching the vacancy with a young and an old worker respectively. Age affects the revenues of a match via its separation risk and its profit per period. Old-age retirement and on-the-job-search argue for the separation risk, while the profits depend on the productivity differential between young and old workers. Let J^y denote the net present

⁴Most of the empirical papers find constant returns to scale. See, for example, Blanchard and Diamond (1989, 1990), Burda (1993), Coles and Smith (1996), Layard et al. (1991), Pissarides (1986), and van Ours (1991, 1995).

⁵Unemployed are always young in this model as young workers who are looking for a match replace retired workers.

discounted value of a firm that employs a young worker when the job is filled, and V when the state of the vacancy is unfilled. The discount rate which values future income streams is r . Similarly, for a firm which employs an elderly worker we use J^e and again V .

$$rJ^e = \mu - w^e + s^e (V - J^e) \quad (7)$$

$$rJ^y = \mu + \delta - w^y + s^y (V - J^y) \quad (8)$$

$$rV = -\gamma + q(\theta_t) [p(J^y - V^y) + (1 - p)(J^e - V^e)] \quad (9)$$

Eq. (7) says that the gain from a job filled with an elderly worker is the output of the worker μ less its wage cost w^e plus the expected value of the capital loss. The probability of this loss is the separation risk and the value of the filled vacancy is then replaced by the value of an unfilled vacancy. From similar arguments in eq. (8) follows in the value of a job filled with a young worker, who differs in his/her productivity from the old one by $\delta \gtrless 0$, so that young workers can be equal, more or less productive than their older colleagues.⁶ Assessing the value of a vacancy in eq. (9) has to consider the flow costs of the job posting γ faced by the possible additional value of the asset when the state of the vacancy changes with probability $q(\theta_t)$ from unfilled to filled. In this case p is the chance to fill it with a young worker and $1 - p$ is the chance to employ an elderly one.

When a vacancy is filled, workers and firms share the value of the match and the wage is given by the fraction λ of the output levels,

$$w^y = \lambda (\mu + \delta), \quad (10)$$

and

$$w^e = \lambda \mu. \quad (11)$$

Equilibrium requires that the value of a vacancy is zero, otherwise firms would open an infinite number of v . Hence, $V = 0$ and from (8) and (10) then follows that

$$J^y = \frac{1 - \lambda}{r + s^y} (\mu + \delta), \quad (12)$$

and (7) together with (11) implies that

$$J^e = \frac{1 - \lambda}{r + s^e} \mu. \quad (13)$$

⁶See Börsch-Supan et al. (2005) on the difficulty of the measurement of individual productivity. Hence, even if we would apply a micro econometric approach in section 3, it seems not to be advisable to use a proxy for productivity.

Whether it is more profitable for a firm to employ a young or an elderly worker depends on the productivity differential δ and the differential in the separation rates τ . For example, the expectation of a relative longer match duration in the case of employing elderly workers could compensate their lower productivity, and the other way around. The comparison between the values of J^y and J^e yields that:

$$J^y \begin{matrix} \geq \\ < \end{matrix} J^e \quad \text{if } \tau \begin{matrix} \leq \\ \geq \end{matrix} 1 + \delta \frac{r+s}{s} \quad (14)$$

Using (9) produces the expression for the value of a match between an elderly worker and a job that balances the values of J^e and J^y for a given age distribution so that a firm is indifferent between employing a young or elderly worker when she faces the open vacancy:

$$J^e = \frac{1}{1-p} \left(\frac{\gamma}{q(\theta_t)} - pJ^y \right). \quad (15)$$

The next step is to substitute (12) and (13) into (15). This yields the job creation curve (JC) which has only one value of θ to solve the equation.

$$(1-\lambda) \left(\frac{\mu}{r+s^e} + \frac{p}{1-p} \frac{\mu+\delta}{r+\tau s^e} \right) - \frac{\gamma}{(1-p)q(\theta_t)} = 0 \quad \text{(JC)} \quad (16)$$

Therefore JC determines the market tightness and establishes together with the BC the search equilibrium with the equilibrium values θ^*, u^* .

2.3 The Effects of Aging

A change in the age distribution $p/(1-p)$ has effects on the search equilibrium θ^*, u^* if young workers differ from their elderly colleagues with respect to productivity and separation risk. The relative size of the age groups affects the amount of job creation through the willingness of firms to open vacancies which depends on the age specific value of a match. From (16) we get:

$$Q(\theta_t) = \frac{1}{q(\theta_t)} = \frac{1-\lambda}{\gamma} (1-p) \left[\frac{\mu}{r+s^e} + \frac{p(\mu+\delta)}{(1-p)(r+\tau s^e)} \right]. \quad (17)$$

Some comparative statics tells us that an increase in the age productivity differential shifts the JC-curve to the left: $\frac{\partial Q(\theta_t)}{\partial \delta} > 0 \Rightarrow \theta_t \uparrow$. This is the effect of extra productivity which also increases the average productivity and the expected output of a firm with an open vacancy. Higher expected profits means more vacancies and less unemployment. Given the separation risk of

the elderly, the increase in τ raises the mean separation rate. Accordingly, this effect shifts the JC-curve to the right: $\frac{\partial Q(\theta_t)}{\partial \tau} < 0 \Rightarrow \theta_t \downarrow$.

However, the most interesting results come from the effects of a labor force that is growing old. The effect on job creation yields:

$$\frac{\partial Q(\theta_t)}{\partial p} = \frac{\mu + \delta}{r + \tau s^e} - \frac{\mu}{r + s^e} = J^y - J^e. \quad (18)$$

The increase in the fraction of elderly workers $1 - p$ shifts the JC to the right, namely $\frac{\partial Q(\theta_t)}{\partial p} > 0$ if $J^y > J^e$, respectively if $\tau < 1 + \delta \frac{r+s}{s}$. In this case the aging working force tends to reduce the market tightness because matches with young workers are more gainful. With the rise in the probability to fill a vacancy with an elderly worker, the firms reduce their number of vacancies. In contrast to this, the number of job posting will increase with the rise in the mean age of a worker if elderly employees are more productive or stay longer in the firm. That is, JC shifts to the left, $\frac{\partial Q(\theta_t)}{\partial p} < 0$, if $J^y < J^e$ because $\tau > 1 + \delta \frac{r+s}{s}$.

Aging does not affect only job creation but has its effects also on job destruction. As separation rates differ between young and elderly employees, aging will change the average duration of a match. Obviously the change in the BC with respect to the fraction of younger workers,

$$\frac{\partial u}{\partial p} = (\tau - 1) s^e \left[\frac{\theta_t q(\theta_t)}{[(p\tau + 1 - p) s^e + \theta_t q(\theta_t)]^2} \right], \quad (19)$$

depends on whether the young or the elderly workers have a lower probability of bringing the match to an end. Hence, aging shifts the BC inwards $\frac{\partial u}{\partial p} > 0$ if $\tau > 1$. The increase in the mean age of the workers tends to lower unemployment if job destruction is reduced via the low separation rate of elderly workers. In contrast to this, if retirement is a considerable risk for the firms to end a productive match, more elderly workers lead to more job destruction and flows on the labor market. The BC shifts outwards, $\frac{\partial u}{\partial p} < 0$, in case of $\tau < 1$.

Figure 1 reveals the possible outcomes that arise from considering jointly changes in BC and JC. The results are also summarized in Table 1. Solving the model produces either more or less job creation and job destruction for a labor force which grows old. Different combinations of the effects of aging on unemployment are possible. For example, more old-age retirement reduces the mean duration of a match in regime (1). This shifts the BC outwards. In case of $\delta > 0$ this effect is not compensated by a higher productivity of the elderly and the average value of a match reduces. Hence less jobs are created and the JC-curve shifts to the right. Both effects imply an increase

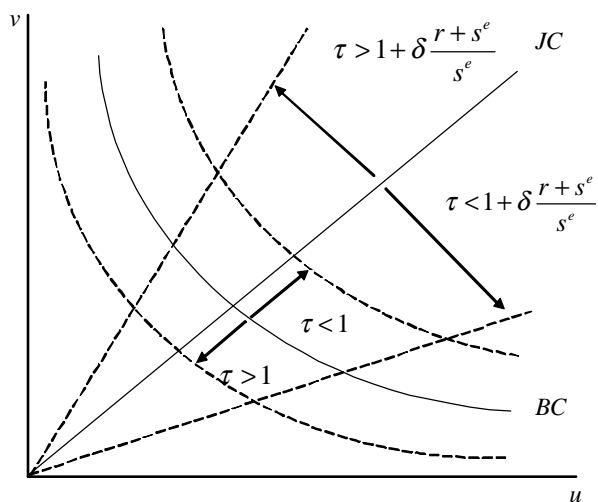


Figure 1: The effects of aging on the search equilibrium

in the unemployment rate due to the demographic change, but the change in vacancies is not clear-cut. Another case says that if $1 < \tau < 1 + \delta \frac{r+s^e}{s^e}$ less jobs are destroyed if the mean age of the working force goes up. But as elderly workers are less productive the average value of a match still decreases and reduces the number of jobs posted. The two effects work in different directions and in this case the effect on unemployment is ambiguous, while the vacancy rate decreases. The third case of $\tau > 1 + \delta \frac{r+s^e}{s^e}$ yields a clear reduction of unemployment as soon as the population grows old because elderly workers have a so much lower probability to separate that this advantage outweighs their productivity disadvantage. The value of an average match thus increases and results in more job creation when the rate of job destruction falls coincidentally. So far, we assumed that $\delta > 0$. However, if the elderly are more productive than the younger workers, aging means that more jobs are created on average to benefit from the high productivity of the elderly. If the retirement risk is high at the same time, job creation increases, but job destruction rises as well. The overall effect on unemployment is ambiguous, although the economy will create more vacancies.

Table 1: The effects of aging

regime		BC	JC	u	v	
(1)	$\delta > 0$	$\tau < 1$	o	r	$+$	\sim
(2)		$1 < \tau < 1 + \delta \frac{r+s^e}{s^e}$	i	r	\sim	$-$
(3)		$\tau > 1 + \delta \frac{r+s^e}{s^e}$	i	l	$-$	\sim
(4)	$\delta < 0$	$1 > \tau > 1 + \delta \frac{r+s^e}{s^e}$	o	l	\sim	$+$

o =outward, i =inward, l =left, r =right, $+$ =increase, $-$ =decrease, \sim =ambiguous effect

3 Estimation and Results

Even with micro data it is difficult to estimate the model discussed in section 2. Since our concern is to compare different economies, we decided to use macro data and reduce the econometric model to the essential elements. Our main objective is to use the estimation results in order to differentiate between the four regimes in Table 1.

There are several possibilities for constructing a proxy variable for the aging of the labor force. We decide to use the ratio of young (age cohort 16 to under 30) to old (age cohort 50 to 64). Furthermore, we use this proxy for two different groups, employed and unemployed. Let ϕ denote this proxy in either case. Since individuals from both groups may look for a new job, one should analyze whether firms react differently or similarly on the age structure of the employed and the unemployed.⁷

Figure 2 shows the different developments of the aging proxy of the employed for the countries we are going to analyze in this section. Unfortunately, the data is not available for the whole period between 1960 and 1999 for all considered countries. We see as a common pattern that aging starts somewhere in the 80s or early 90s when the ratio young to old fell considerably. Before that time, the working force got rather younger on average. The exception to this observation is Japan, where the aging process is ongoing since the late 60s and Spain where the pattern is not fully definite. According to the proxy variable the Canadian employees are the youngest among the selected group of countries, whereas Japan experiences the strongest aging process of all mapped countries. It is interesting to see that the Nordic countries had a comparatively high average age of the employees already in the

⁷Burgess (1994) allows in his theoretical model for job search of both employed and unemployed, which has significant effects on the unemployment dynamics. Van Ours (1995) differentiates between the two groups and estimates higher flow elasticities for the unemployed.

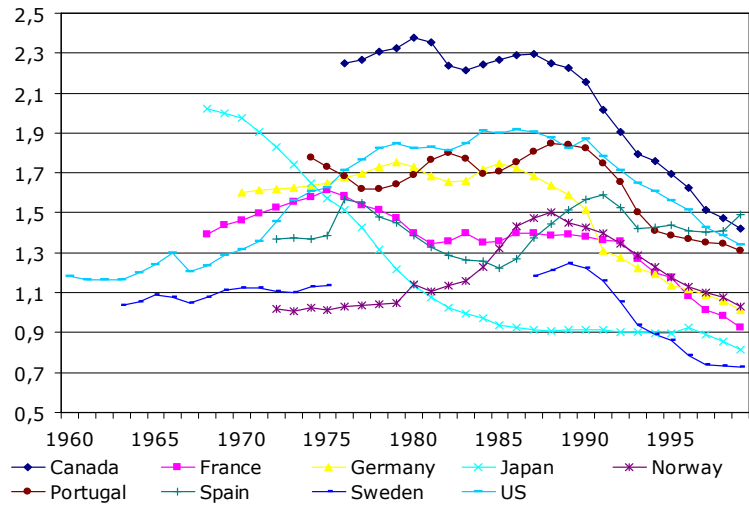


Figure 2: Employed with age under 30 / Employed with age 50 to 64

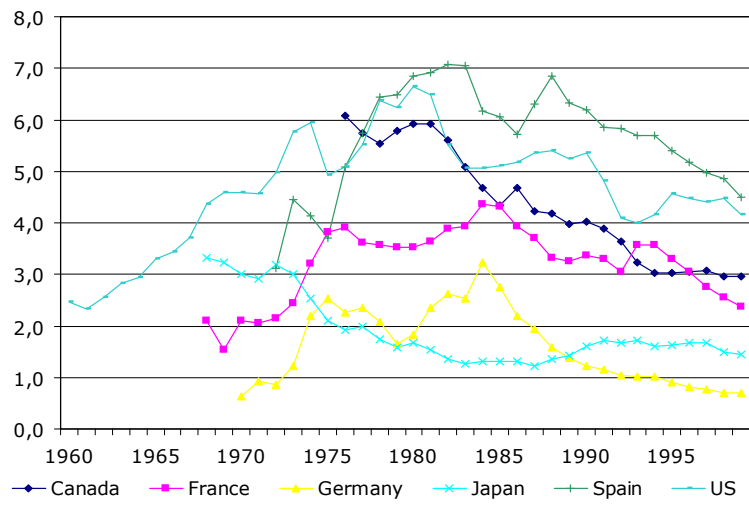


Figure 3: Unemployed with age under 30 / Unemployed with age 50 to 64

sixties and early seventies. This can be explained by the typical high labor market participation in these countries.

Comparing the values of Figure 3 with 2 reveals that the unemployed are on average younger than the employed workers. The only exception is Germany up to 1974 and since 1988. Furthermore, Germany and Japan have the lowest proportion of young to elderly unemployed since the middle of the seventies. A considerably decline in this number is found for Canada, Spain, and the US with the beginning of the 80s. The data is not available for Portugal, Norway, and Sweden.

3.1 Econometric Model and Data

We have to estimate two equations to differentiate between the four regimes. Aging affects the locus of the BC and the JC-curve as pointed out in section 2.3. Hence, the first equation to be estimated is the BC. In the second case we estimate the vacancy equation (VE) because we are interested in the effects of aging on the vacancy rate. If aging rotates the JC-curve anticlockwise, the vacancy rate increases and vice versa. Therefore, we regress the unemployment rate and the vacancy rate on the proxy variable for aging ϕ according to:⁸

$$\log(u_t) = \beta_0 + \beta_1 \log(v_t) + \beta_2 \phi_t + \sum_{i=3}^I \beta_i X_{it} + \varepsilon_{1t}, \quad (20)$$

$$\log(v_t) = \alpha_0 + \alpha_1 \phi_t + \sum_{i=2}^I \alpha_i X_{it} + \varepsilon_{2t}. \quad (21)$$

The estimated effects of aging, β_2 and α_1 , reveal the moves of the BC and identify the regime according to Table 1. The set of control variables X comprises benefit replacement rate, benefit duration, employment population ratio, union density, labor costs, and the real interest rate.

Because of other effects which are not considered here, it is possible that the error terms ε_1 and ε_2 may be correlated across the equations of the system. To allow for this possible outcome, we use the following assumption on the error terms in the system:

$$E(\varepsilon_{1t}\varepsilon_{2t}) = \sigma_{12} \quad E(\varepsilon_{1t}\varepsilon_{2t}) = 0 \quad \text{with } t \neq s. \quad (22)$$

⁸The use of the logarithm of the proxy for aging would estimate the wrong functional form if the parameter is positive but less than one. In this case the relationship between unemployment and aging is a monotonic increasing concave function. This would be contradictory to the theoretical model with a monotonic increasing convex function.

That is, the error terms are homoskedastic and independent across t , but may be correlated across the equations. Therefore, we estimate a seemingly unrelated regression (SUR) model with unknown covariance matrix.

We estimate several specifications for each country to control for the effects of multicollinearity.⁹ In all cases we start with the full set of variables. We then sequentially remove a variable based on the information of the correlation matrix of the variables, and estimate the system again. We repeat this process until the remaining simple correlations are below 0.8. To improve the significance of the remaining parameters, we finally remove variables from the system which are insignificant in both equations. This procedure has been carried out for both proxies of aging.

The data for the unemployment rate, the vacancy rate, and the control variables is taken from Nickell and Nuncita (2002).¹⁰ For aging we use two different proxies. First, we use the ratio of the employees under 30 years old to those 50-64 years old. Secondly, we do the same with the unemployed. These time series are taken from the OECD online database. We undertake the investigation for Canada, France, Germany, Japan, Norway, Portugal, Spain, Sweden, and the US over the period from 1960 to 1995. Due to data availability the actual period starts after 1960 for most countries.

3.2 Results

We estimated almost 40 specifications of the system for the nine countries. To make sure that the illustration remains clear, we focus on the two relevant parameters β_2 and α_1 only, which represent semi-elasticities. For the complete results see appendix.

First, we discuss the results for the ratio of young to old employees as the proxy for aging. Interestingly enough, we find only two regimes. Table 2 summarizes all countries for which we identified the first regime, namely an outward shift of the BC and a clockwise rotation of the JC-curve. This means that unemployment will rise as a consequence of an aging labor force with ambiguous effects on the vacancies. The negative effect of aging in the BC equations implies that unemployment increases for a given number of vacancies. The coefficients for Japan and France are below unity. However, according to the used proxy, these are the countries with the longest aging

⁹In particular the considered labor market institutions have a low volatility and are highly correlated among each other.

¹⁰It should be mentioned that the official vacancy statistics report only a fraction of unfilled jobs in the economies. However, it is not possible to account for this problem for each country. Therefore, the interpretation of the estimates has to be done carefully and standardised vacancy rates are badly needed.

Table 2: First regime based on the employment proxy

	(1)	(2)	(3)	(4)	(5)
	<i>BC</i>				
France	-0.170 (-1.942)	-0.186 (-1.979)	-0.211 (-2.219)	1.042 (2.065)	
Germany	-1.858 (-4.894)	-0.875 (-4.676)	-1.097 (-2.596)	-1.272 (-1.894)	-1.245 (-1.851)
Japan	-0.475 (-2.962)	-0.509 (-3.270)	-0.588 (-3.706)	-0.588 (-3.712)	
Portugal	-1.212 (-3.163)	-0.930 (-2.511)	-0.897 (-2.099)		
Sweden	-1.874 (-1.304)	-1.836 (-1.282)	-1.460 (-2.589)	-1.505 (-2.686)	
	<i>VE</i>				
France	0.855 (0.857)	0.841 (0.845)	0.901 (0.925)	1.946 (2.207)	
Germany	2.282 (5.969)	0.638 (1.821)	2.161 (4.578)	2.207 (4.601)	2.199 (4.585)
Japan	0.354 (1.445)	0.369 (1.573)	0.640 (2.775)	0.645 (2.801)	
Portugal	2.450 (2.845)	1.969 (2.018)	2.653 (2.366)		
Sweden	9.453 (3.179)	10.910 (3.714)	3.903 (2.653)	4.447 (3.100)	

The Table contains the estimates for β_2 and α_1 . For each country different system specifications are estimated. T-statistics are in parentheses. For complete results see appendix.

process.¹¹ The proxy ϕ declined between 1968 and 1999 from 2.02 to 0.81 in Japan and it fell from 1.75 in 1979 to 1.01 in 1999 in Germany. Therefore, the average annual growth rate of ϕ is nearly the same for these countries (-2.6% for Japan and -2.8% for Germany).¹² However, the impact of aging on unemployment is much higher in Germany as we will see later on. From clockwise rotation of the JC-curve follows that vacancies decrease and unemployment increases. Again, the estimated effects of aging are low in France and Japan and high in Germany, Portugal, and in Sweden. The total effect of the change in vacancies depends on the curvature of the BC estimated in

¹¹The positive value for France in (4) bases on a specification error. Labor costs have a strong positive effect on unemployment. If we remove this variable due to a high negative correlation with the employment-population ratio, the coefficient for aging changes the sign.

¹²The average yearly growth rate is calculated from the peak point when the aging process started, which is not necessarily the first observation.

Table 3: Second regime based on the employment proxy

	(1)	(2)	(3)	(4)	(5)
	<i>BC</i>				
Canada	-0.004 (-0.035)	0.360 (2.625)	0.359 (2.628)		
Norway	2.831 (5.367)	2.617 (7.405)	1.912 (4.238)	1.362 (2.095)	1.842 (3.545)
Spain	0.703 (2.420)	0.668 (2.445)	-1.713 (-15.251)	-1.755 (-16.638)	0.938 (2.923)
US	0.943 (9.952)	0.945 (10.031)	0.929 (10.134)	0.965 (11.676)	
	<i>VE</i>				
Canada	1.053 (2.723)	1.210 (8.188)	1.208 (8.215)		
Norway	1.639 (3.024)	0.812 (1.829)	1.314 (2.832)	1.357 (3.062)	0.979 (2.623)
Spain	11.687 (6.301)	11.684 (7.956)	0.374 (0.314)	0.878 (0.794)	11.338 (8.440)
US	0.589 (2.069)	0.715 (2.465)	0.629 (2.098)	0.654 (2.497)	

The Table contains the estimates for β_2 and α_1 . For each country different system specifications are estimated. T-statistics are in parentheses. For Complete results see appendix.

the first equation.

Table 3 reveals the main results for the second regime, in which the BC shifts inwards and the JC-curve again rotates clockwise. The outcome is ambiguous in terms of the expected change in unemployment but the vacancy rate will definitely decrease. The positive coefficient for aging indicates the inward shifts of the BC.¹³ The effect on the unemployment rate is very low for Spain because the aging proxy undulates and decreases only since the beginning of the 1990s. The average annual growth rate of the employment proxy for Canada and the US is 2.8% and for Norway 3.5%. Since we found the highest estimated effect for Norway, it does not surprise that the total effect on unemployment is higher in Norway than in the other countries. The positive effect of aging in the vacancy equation is the same as in the group of the first regime. We cannot conclude on the basis of the two equations whether the overall effect of aging on unemployment is positive or negative

¹³The two negative parameters for Spain are the result of a specification bias. In this case the employment population ratio is removed and a strong negative bias changes the sign of aging.

because the BC shifts inwards and the JC-curve rotates clockwise. For this reason, we calculate the net effect in the next section.

To sum up, the use of the employment proxy identifies only the first and the second regime with a negative effect of aging on job creation but different shifts of the BC. According to the model of section 2 this implies a productivity disadvantage of the elderly workers, namely δ has a positive sign. Sneddon and Triest (2002) find a significant negative effect of the growth rate of the working age population on average productivity in the US. This coincides with our findings because a fall in the share of the young increases their relative productivity. Beside this age composition effect of the work force we control for the labor force participation rate. In this case the ratio of civilian employed to working age population (15-64 years) has a significant negative effect on unemployment in most considered countries. Since the participation rate is lower for the elderly, a fall in the share of the young increases total unemployment. This coincides with the finding by Bloom and Canning (2004).

Up to now we analyzed the effects of aging in the segment of on-the-job searchers. In the remainder of the section, we look at the segment of unemployed job searchers. Unfortunately, the corresponding data is not available for Portugal, Norway, and Sweden. If we take the ratio of young to elderly unemployed as the proxy for aging, we find all possible regimes of Table 1. Again, we identify for Japan the first regime and for Canada and the US the second regime, just as with the employment proxy. However, with respect to Germany, France, and Spain, we now find a positive effect on vacancies. That is, in Spain aging of the unemployed unambiguously reduces unemployment because the BC shifts inwards and the JC-curve rotates counterclockwise (third regime). In contrast to this, for Germany and France the BC shifts outwards as before but the JC-curve now rotates counterclockwise. This represents the fourth regime and results in an ambiguous effect on unemployment because of the opposing effects of the changes in the BC and the JC-curve when the age composition alters.¹⁴

The previous results imply that the effects of aging on search unemployment depend in some countries on whether we consider on-the-job search or job search of the unemployed. To be more precisely: While the effects on the BC do not change in the two scenarios, the response of firms to aging with more or less vacancies can be different for employed or unemployed job-seekers. Why do firms create more jobs when the job-seekers grow old if they decide to hire former unemployed workers but decrease job openings

¹⁴See footnotes 11 and 13 for the explanation of the positive effect for France and the two negative effects for Spain in the BC.

Table 4: Regime based on the unemployment proxy

	(1)	(2)	(3)	(4)	(5)
	<i>BC</i>				
Japan	-0.180 (-1.986)	-0.159 (-2.487)	-0.180 (-2.611)	-0.179 (-2.598)	
Canada	-0.004 (-0.035)	0.360 (2.625)	0.359 (2.628)		
US	0.135 (4.079)	0.114 (3.855)	0.109 (3.577)	0.128 (4.853)	
Spain	0.038 (1.896)	0.030 (1.541)	-0.227 (-1.832)	-0.294 (-2.590)	0.038 (1.494)
France	-0.014 (-0.617)	-0.030 (-1.334)	-0.039 (-1.830)	0.316 (5.592)	
Germany	-0.025 (-0.283)	-0.083 (-0.871)	-0.019 (-0.203)	-0.273 (-3.629)	-0.271 (-3.594)
	<i>VE</i>				
Japan	0.309 (2.885)	0.201 (2.490)	0.283 (3.459)	0.284 (3.452)	
Canada	1.053 (2.723)	1.210 (8.188)	1.208 (8.215)		
US	0.195 (4.144)	0.192 (4.990)	0.197 (5.243)	0.171 (5.235)	
Spain	-0.389 (-1.085)	-0.736 (-2.182)	-0.751 (-2.562)	-0.553 (-1.779)	-0.761 (-2.131)
France	-0.494 (-2.334)	-0.435 (-2.189)	-0.362 (-1.873)	0.137 (0.899)	
Germany	-0.228 (-1.646)	-0.243 (-1.838)	-0.274 (-1.888)	-0.201 (-2.101)	-0.201 (-2.100)

The table contains the estimates for β_2 and α_1 . For each country different system specifications are estimated. T-statistics are in parentheses. For complete results see appendix.

if they face on-the-job searchers? And why is this true in France, Germany, and Spain but not in Canada, Japan, and the US? Aging could not be the reason because the share of the elderly increases within the employed as well as within the unemployed. Following the arguments of the model in section 2, we argue that relative productivity differences can explain the story. One indication for this can be found in Börsch-Supan et al. (2005) and Yashiro (2001). Early retirement of the age cohort 50 to 64 years has been comparatively high in Southern Europe (Spain) as well as in France and Germany. More precisely, early retirement plays an important role for men and women in France and Germany, whereas in Spain the women's share of home-makers is nearly as high as the group of early retired man. This low participation,

in turn, tends to increase the average productivity of the elderly unemployed because it is reasonable to say that the low skilled leave the labor force by a majority. In contrast to this, the low skilled remain in the labor force within the group of the young unemployed. Putting things together we arrive to the conclusion that the average productivity of the elderly unemployed may be higher than (may be nearly equal to) the average productivity of the young unemployed in France and Germany (in Spain). That is, δ from the theoretical model is smaller if we look at unemployed instead of employed job-seekers and gets even negative in France and Germany.

An alternative explanation for Spain (switch from the second to the third regime) is that the relative separation risk τ is higher if we take only the job search of unemployed into account. Due to their high rate of unemployment the young unemployed are apt to accept the first best job offer. The experience has shown that these matches have a comparatively shorter duration. That is, the separation rate of the young unemployed is higher than the rate of the young on-the-job searchers.

3.3 Calculation of Net Effects

In this section we summarize the estimates and, additionally, we want to find out what are the total effects of the estimates on unemployment. With respect to the two estimated equations we distinguish between a direct and an indirect effect. The direct effect β_2 shifts the BC and the indirect effect α_1 leads to moves on the BC. In some of the cases, regime two and four precisely, we get opposing effects that result in ambiguous changes in unemployment as a consequence of the aging of the labor force. However, even if both effects have the same direction it is interesting to know which of the effects dominates the other. Table 5 shows the different effects of aging on the unemployment rate. A negative (positive) sign denotes that aging decreases (increases) search unemployment. The total effect depends on the direction of the direct and indirect effects and, if they are opposing, on their relative magnitude.

If we consider the aging of the employed, we see the rise in unemployment as expected in regime 1. However, in some cases the direct effect dominates in other cases it is the other way around. The total effect of regime 2 is negative in all four countries. That is, the shift of the BC dominates the move along the curve and unemployment decreases. The picture is a good deal more mixed if we consider the age structure of the unemployed. Only in Japan and the US the identified regimes and net effects are the same as before. For Canada the identified regime remains the same but the net effect on unemployment is now positive. The effect for Spain is negative as

Table 5: Effects of Aging on Unemployment

	aging of employed				aging of unemployed					
	direct	indirect	total	regime	direct	indirect	total	regime		
Canada	-	>	+	-	2	-	<	+	+	2
France	+	<	+	+	1	+	<	-	-	4
Germany	+	<	+	+	1	+	>	-	+	4
Japan	+	>	+	+	1	+	>	+	+	1
Norway	-	>	+	-	2					
Portugal	+	<	+	+	1					
Spain	-	>	+	-	2	-	<	-	-	3
Sweden	+	>	+	+	1					
US	-	>	+	-	2	-	>	+	-	2

predicted for the third regime. In France and Germany the fourth regime has different total effects because once the direct once the indirect effect dominates. While in France this means that unemployment decreases with aging, unemployment increases in Germany.

Taking all results into consideration, we can conclude that no negative consequences for unemployment are expected for Spain and the US when the mean age of the labor force is going to increase continuously. With respect to the US, the results coincide with those of Bleakley and Fuhrer (1997) and Katz and Krueger (1999). On the other hand, the results for Germany and Japan showed for either measure that these countries have to prepare for a further increase in unemployment when the labor force grows older.

4 Conclusions

In this paper, we examined the relationship between the aging of the labor force, according to the demographic change, and unemployment by means of both a theoretical and an empirical model. The modeling applies to the literature on search in the labor market and matching with equilibrium unemployment. We extended the standard framework by age-specific variables which consider different separations risks and a different productivity/wage. From a theoretical perspective, the effect of aging on unemployment is ambiguous and divides into four possible regimes. In the case that one age group brings strictly more profits to the firms in terms of productivity and separation risk, the firms will respond to a change in the relative share of the age groups with a variation in the number of offered vacancies. If this effect on

job creation goes in the same direction as the effect of aging on job destruction, unemployment will either strictly increase or decrease. Unemployment goes up (down), when the labor force grows older, if firms prefer younger (elderly) job seekers. In contrast to this, the total outcome is ambiguous if the two effects are opposing. The net effect on employment then depends on the magnitude of the changes in job creation and job destruction.

In the empirical part of the analysis we estimate jointly two equations: The Beveridge Curve and the vacancy equation. Based on our proxy for aging, we are able to identify which of the regimes dominates in the considered nine OECD countries. Furthermore, this approach allows to calculate the net effect in the theoretical ambiguous cases. Therefore, we can say what is the expected change in search unemployment when the share of elderly workers grows continuously as a consequence of the demographic change.

Taking all employed as job seekers, aging of the employed labor force leads to less job creation in terms of a reduced vacancy rate in all considered economies. This strictly means a higher unemployment rate for France, Germany, Japan, Portugal, and Sweden because in these countries the effect which follows from changes in the Beveridge Curve is of the same kind. In contrast to this, we find that aging causes a fall in the unemployment rate in Canada, Norway, Spain, and the US. This is an interesting result because it means that less job destruction - the Beveridge Curve shifts inwards - outweighs the loss of job creation. Furthermore, we obtain all four regimes, which are theoretically possible if we take the age of the unemployed as a proxy, instead of only two in case of taking the employed as an explanatory. The investigation yields that aging of the unemployed increases (decreases) the unemployment rate in Canada, Germany, and Japan (France, Spain, and the US). Taking all estimation results into account, we suppose that aging of the labor force reduces search unemployment in Spain and the US, whereas the opposite is true for Germany and Japan.

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Appendix

Table 6a: Canada: Estimates with Aging of Employed

	BC			JC		
	(1)	(2)	(3)	(1)	(2)	(3)
LOG(v)	-0.240 (-4.791)	-0.395 (-3.973)	-0.394 (-3.972)			
AGING	-0.004 (-0.035)	0.360 (2.625)	0.359 (2.628)	1.053 (2.723)	1.210 (8.188)	1.208 (8.215)
BD	4.872 (8.269)			-3.420 (-1.362)		
BRR	-3.558 (-5.543)	0.075 (0.072)		3.475 (1.262)	0.360 (0.153)	
UDNET	-3.173 (-2.361)	-1.662 (-0.653)	-1.717 (-0.708)	-12.144 (-2.275)	-13.152 (-2.675)	-13.434 (-2.944)
EPOP	-0.042 (-7.385)	-0.014 (-1.729)	-0.014 (-1.809)	0.071 (3.582)	0.044 (2.944)	0.043 (3.026)
LABC	1.001 (3.335)			-1.894 (-1.493)		
RIRL	0.958 (1.773)	3.705 (3.928)	3.738 (4.522)	-0.215 (-0.089)	-3.074 (-1.530)	-2.920 (-1.675)
R^2	0.980	0.907	0.907	0.912	0.894	0.894
DW	2.595	1.529	1.538	1.360	1.423	1.415

BC and JC are estimated simultaneously with the SUR method. T-statistics are in parentheses. v: vacancy rate; AGING: ratio of young to old; BD: benefit duration; BRR: benefit replacement rate; UDNET: net union density; EPOP: employment population ratio; LABC: labor costs; RIRL: real interest rate; DW: Durbin-Watson statistic.

Table 6b: Canada: Estimates with Aging of Unemployed

	BC			JC		
	(1)	(2)	(3)	(1)	(2)	(3)
LOG(v)	-0.239 (-6.873)	-0.151 (-1.813)	-0.151 (-1.815)			
AGING	-0.049 (-3.219)	-0.009 (-0.242)	-0.008 (-0.228)	0.009 (0.087)	0.321 (5.050)	0.321 (5.077)
BD	4.882 (12.547)			0.175 (0.070)		
BRR	-3.400 (-6.744)	-0.178 (-0.147)		2.289 (0.715)	0.293 (0.090)	
UDNET	-2.884 (-2.641)	2.378 (0.808)	2.506 (0.891)	-17.972 (-3.124)	-16.074 (-2.280)	-16.291 (-2.459)
EPOP	-0.044 (-9.420)	-0.024 (-2.206)	-0.024 (-2.238)	0.092 (4.196)	0.092 (4.295)	0.092 (4.509)
LABC	0.493 (1.829)			-4.422 (-3.107)		
RIRL	0.349 (0.738)	3.865 (3.220)	3.796 (3.430)	-1.456 (-0.482)	0.564 (0.175)	0.677 (0.228)
R^2	0.987	0.876	0.875	0.879	0.798	0.798
DW	2.190	1.564	1.554	1.824	1.012	1.007

BC and JC are estimated simultaneously with the SUR method. T-statistics are in parentheses. v: vacancy rate; AGING: ratio of young to old; BD: benefit duration; BRR: benefit replacement rate; UDNET: net union density; EPOP: employment population ratio; LABC: labor costs; RIRL: real interest rate; DW: Durbin-Watson statistic.

Table 7a: France: Estimates with Aging of Employed

	BC				JC			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
LOG(v)	-0.178 (-10.878)	-0.177 (-10.072)	-0.179 (-9.845)	0.019 (0.191)				
AGING	-0.170 (-1.942)	-0.186 (-1.979)	-0.211 (-2.219)	1.042 (2.065)	0.855 (0.857)	0.841 (0.845)	0.901 (0.925)	1.946 (2.207)
BD	0.559 (2.068)				0.558 (0.179)			
BRR	-1.142 (-5.057)	-1.021 (-4.361)	-0.973 (-4.072)	3.551 (3.211)	-4.163 (-1.680)	-4.047 (-1.690)	-4.172 (-1.768)	-1.471 (-0.709)
UDNET	4.878 (5.591)	3.258 (7.892)	3.079 (7.630)	-2.768 (-1.322)	3.018 (0.301)	1.402 (0.317)	1.824 (0.435)	-2.182 (-0.554)
EPOP	-0.069 (-10.443)	-0.074 (-11.201)	-0.076 (-11.444)	-0.127 (-3.352)	0.134 (1.874)	0.130 (1.948)	0.135 (2.094)	0.117 (1.717)
LABC	2.255 (29.109)	2.165 (31.394)	2.149 (30.681)		1.416 (1.663)	1.328 (1.906)	1.371 (2.011)	
RIRL	0.675 (1.704)	0.571 (1.353)			-1.218 (-0.267)	-1.323 (-0.292)		
R^2	0.998	0.998	0.998	0.924	0.601	0.601	0.600	0.542
DW	1.834	1.843	1.779	0.485	0.825	0.835	0.813	0.745

BC and JC are estimated simultaneously with the SUR method. T-statistics are in parentheses. v: vacancy rate; AGING: ratio of young to old; BD: benefit duration; BRR: benefit replacement rate; UDNET: net union density; EPOP: employment population ratio; LABC: labor costs; RIRL: real interest rate; DW: Durbin-Watson statistic.

Table 7b: France: Estimates with Aging of Unemployed

	BC				JC			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
LOG(v)	-0.188 (-10.049)	-0.193 (-9.896)	-0.197 (-10.160)	0.034 (0.491)				
AGING	-0.014 (-0.617)	-0.030 (-1.334)	-0.039 (-1.830)	0.316 (5.592)	-0.494 (-2.334)	-0.435 (-2.189)	-0.362 (-1.873)	0.137 (0.899)
BD	0.528 (1.703)				-2.344 (-0.757)			
BRR	-1.071 (-4.168)	-0.910 (-3.625)	-0.841 (-3.384)	0.533 (0.524)	-1.585 (-0.616)	-2.348 (-0.981)	-3.180 (-1.358)	-2.004 (-0.725)
UDNET	4.833 (5.231)	3.562 (6.228)	3.554 (6.082)	-5.843 (-3.501)	4.104 (0.442)	9.946 (1.905)	10.519 (1.976)	-2.300 (-0.505)
EPOP	-0.071 (-8.176)	-0.078 (-9.926)	-0.082 (-10.823)	-0.054 (-1.728)	-0.002 (-0.019)	0.032 (0.417)	0.066 (0.920)	0.145 (1.767)
LABC	2.251 (22.957)	2.215 (22.019)	2.226 (21.781)		2.639 (3.090)	2.856 (3.513)	2.874 (3.452)	
RIRL	0.714 (1.572)	0.512 (1.111)			-5.911 (-1.330)	-5.115 (-1.173)		
R^2	0.998	0.998	0.998	0.959	0.658	0.650	0.633	0.477
DW	1.691	1.750	1.776	1.004	0.932	0.890	0.741	0.757

BC and JC are estimated simultaneously with the SUR method. T-statistics are in parentheses. v: vacancy rate; AGING: ratio of young to old; BD: benefit duration; BRR: benefit replacement rate; UDNET: net union density; EPOP: employment population ratio; LABC: labor costs; RIRL: real interest rate; DW: Durbin-Watson statistic.

Table 8a: Germany: Estimates with Aging of Employed

	BC					JC				
	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
LOG(v)	0.254 (2.009)	-0.012 (-0.121)	-0.050 (-0.380)	0.115 (0.567)	0.110 (0.537)					
AGING	-1.858 (-4.894)	-0.875 (-4.676)	-1.097 (-2.596)	-1.272 (-1.894)	-1.245 (-1.851)	2.282 (5.969)	0.638 (1.821)	2.161 (4.578)	2.207 (4.601)	2.199 (4.585)
BD	8.763 (5.163)	11.887 (7.961)	11.307 (5.603)	19.899 (8.375)	20.249 (8.877)	1.507 (0.577)	-10.395 (-4.822)	-2.171 (-0.723)	-0.093 (-0.041)	-0.286 (-0.131)
BRR	-12.772 (-4.065)	-6.305 (-2.512)				14.666 (3.732)	3.454 (0.699)			
UDNET	10.710 (2.868)		-0.187 (-0.056)	-5.891 (-1.155)	-6.253 (-1.233)	-21.645 (-5.498)		-14.022 (-3.362)	-16.046 (-4.261)	-15.897 (-4.256)
EPOP	-0.290 (-7.698)	-0.219 (-6.716)	-0.225 (-5.157)	-0.326 (-5.044)	-0.330 (-5.105)	0.278 (13.110)	0.291 (9.392)	0.312 (13.154)	0.299 (14.367)	0.302 (16.572)
LABC	1.691 (6.970)	1.675 (6.018)	1.912 (6.322)			0.555 (1.542)	1.272 (2.577)	0.463 (1.041)		
RIRL	-1.891 (-1.323)	-2.110 (-1.288)	-2.044 (-1.119)	1.391 (0.501)		-1.195 (-0.542)	-1.627 (-0.502)	-1.564 (-0.574)	-0.763 (-0.286)	
R^2	0.993	0.991	0.989	0.973	0.973	0.972	0.939	0.957	0.955	0.955
DW	2.058	2.163	1.816	1.375	1.408	1.153	0.985	0.962	0.905	0.884

BC and JC are estimated simultaneously with the SUR method. T-statistics are in parentheses. v: vacancy rate; AGING: ratio of young to old; BD: benefit duration; BRR: benefit replacement rate; UDNET: net union density; EPOP: employment population ratio; LABC: labor costs; RIRL: real interest rate; DW: Durbin-Watson statistic.

Table 8b: Germany: Estimates with Aging of Unemployed

	BC					JC				
	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
LOG(v)	-0.227 (-1.900)	-0.206 (-1.560)	-0.284 (-2.447)	-0.340 (-2.389)	-0.339 (-2.371)					
AGING	-0.025 (-0.283)	-0.083 (-0.871)	-0.019 (-0.203)	-0.273 (-3.629)	-0.271 (-3.594)	-0.228 (-1.646)	-0.243 (-1.838)	-0.274 (-1.888)	-0.201 (-2.101)	-0.201 (-2.100)
BD	12.826 (4.874)	10.645 (3.878)	13.285 (4.911)	21.683 (11.990)	21.963 (12.643)	-2.280 (-0.531)	-2.830 (-0.701)	-3.683 (-0.817)	-6.322 (-2.922)	-6.284 (-3.081)
BRR	-5.239 (-1.383)	-11.852 (-4.038)				10.968 (1.881)	9.394 (2.380)			
UDNET	-5.623 (-2.442)		-7.902 (-4.738)	-9.420 (-4.720)	-9.598 (-4.855)	-1.380 (-0.366)		3.851 (1.420)	4.382 (1.676)	4.358 (1.693)
EPOP	-0.148 (-4.182)	-0.140 (-3.591)	-0.144 (-3.945)	-0.227 (-6.401)	-0.232 (-6.770)	0.169 (3.533)	0.171 (3.627)	0.182 (3.632)	0.211 (8.074)	0.210 (9.273)
LABC	1.783 (3.577)	1.861 (3.374)	1.886 (3.693)			-0.286 (-0.350)	-0.268 (-0.328)	-0.569 (-0.665)		
RIRL	-2.356 (-1.119)	-2.238 (-0.959)	-2.343 (-1.074)	1.264 (0.525)		1.137 (0.330)	1.172 (0.339)	1.261 (0.343)	0.176 (0.053)	
R^2	0.987	0.985	0.987	0.979	0.979	0.940	0.939	0.931	0.930	0.930
DW	1.969	1.480	1.982	1.916	1.972	0.930	0.976	1.128	1.091	1.093

BC and JC are estimated simultaneously with the SUR method. T-statistics are in parentheses. v: vacancy rate; AGING: ratio of young to old; BD: benefit duration; BRR: benefit replacement rate; UDNET: net union density; EPOP: employment population ratio; LABC: labor costs; RIRL: real interest rate; DW: Durbin-Watson statistic.

Table 9a: Japan: Estimates with Aging of Employed

	BC				JC			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
LOG(v)	-0.471 (-3.948)	-0.474 (-3.937)	-0.569 (-4.952)	-0.569 (-4.956)				
AGING	-0.475 (-2.962)	-0.509 (-3.270)	-0.588 (-3.706)	-0.588 (-3.712)	0.354 (1.445)	0.369 (1.573)	0.640 (2.775)	0.645 (2.801)
BD								
BRR	1.167 (2.081)	1.113 (1.980)	0.689 (1.270)	0.689 (1.305)	0.524 (0.593)	0.546 (0.623)	1.684 (2.021)	1.733 (2.156)
UDNET	1.671 (0.690)	2.247 (0.965)	-1.036 (-0.655)	-1.036 (-0.656)	-12.363 (-4.056)	-12.610 (-4.551)	-7.631 (-3.532)	-7.633 (-3.530)
EPOP	-0.010 (-0.769)				0.004 (0.194)			
LABC	0.467 (1.870)	0.463 (1.838)			-0.903 (-2.530)	-0.903 (-2.528)		
RIRL	0.864 (1.344)	0.740 (1.177)	0.002 (0.004)		-1.638 (-1.686)	-1.590 (-1.691)	-0.187 (-0.222)	
R^2	0.953	0.952	0.947	0.947	0.728	0.728	0.666	0.665
DW	1.204	1.215	1.227	1.227	1.538	1.547	1.085	1.095

BC and JC are estimated simultaneously with the SUR method. T-statistics are in parentheses. v: vacancy rate; AGING: ratio of young to old; BD: benefit duration (zero by definition for Japan); BRR: benefit replacement rate; UDNET: net union density; EPOP: employment population ratio; LABC: labor costs; RIRL: real interest rate; DW: Durbin-Watson statistic.

Table 9b: Japan: Estimates with Aging of Unemployed

	BC				JC			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
LOG(v)	-0.430 (-3.060)	-0.443 (-3.261)	-0.577 (-4.331)	-0.580 (-4.365)				
AGING	-0.180 (-1.986)	-0.159 (-2.487)	-0.180 (-2.611)	-0.179 (-2.598)	0.309 (2.885)	0.201 (2.490)	0.283 (3.459)	0.284 (3.452)
BD								
BRR	1.168 (1.898)	1.151 (1.874)	0.541 (0.898)	0.494 (0.850)	0.030 (0.036)	0.135 (0.157)	1.215 (1.475)	1.328 (1.686)
UDNET	0.866 (0.332)	0.479 (0.205)	-4.448 (-4.510)	-4.493 (-4.608)	-12.236 (-4.627)	-10.768 (-4.238)	-4.784 (-4.479)	-4.718 (-4.444)
EPOP	0.006 (0.329)				-0.035 (-1.469)			
LABC	0.591 (2.268)	0.596 (2.286)			-0.744 (-2.319)	-0.833 (-2.545)		
RIRL	1.015 (1.472)	1.087 (1.661)	0.162 (0.289)		-1.049 (-1.159)	-1.581 (-1.835)	-0.355 (-0.448)	
R^2	0.946	0.946	0.936	0.936	0.775	0.758	0.702	0.699
DW	1.151	1.130	1.221	1.252	1.591	1.466	1.009	1.021

BC and JC are estimated simultaneously with the SUR method. T-statistics are in parentheses. v: vacancy rate; AGING: ratio of young to old; BD: benefit duration; BRR: benefit replacement rate; UDNET: net union density; EPOP: employment population ratio; LABC: labor costs; RIRL: real interest rate; DW: Durbin-Watson statistic.

Table10: Norway: Estimates with Aging of Employed

	BC					JC				
	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
LOG(v)	-0.630 (-3.609)	-0.588 (-3.720)	-0.125 (-0.726)	-0.183 (-0.721)	-0.267 (-1.068)					
AGING	2.831 (5.367)	2.617 (7.405)	1.912 (4.238)	1.362 (2.095)	1.842 (3.545)	1.639 (3.024)	0.812 (1.829)	1.314 (2.832)	1.357 (3.062)	0.979 (2.623)
BD	5.612 (3.166)	5.270 (3.159)	7.899 (5.346)			-2.724 (-1.305)	-5.284 (-2.714)	-0.545 (-0.311)		
BRR	-0.665 (-0.544)					-3.042 (-2.261)				
UDNET	-0.900 (-0.195)	-2.149 (-0.533)	6.859 (1.782)	15.894 (3.104)	15.442 (2.942)	-10.167 (-1.951)	-19.576 (-5.615)	-13.136 (-3.548)	-13.816 (-4.609)	-14.553 (-4.725)
EPOP	-0.146 (-7.630)	-0.151 (-9.190)	-0.175 (-8.539)	-0.113 (-4.518)	-0.109 (-4.285)	0.058 (2.940)	0.041 (2.031)	0.010 (0.395)	0.005 (0.266)	0.002 (0.096)
LABC	1.223 (1.052)	0.928 (0.896)				3.991 (3.508)	3.257 (2.690)			
RIRL	-0.176 (-0.172)	-0.182 (-0.176)	1.734 (1.302)	2.306 (1.173)		-2.702 (-2.420)	-3.362 (-2.810)	-2.142 (-1.410)	-2.191 (-1.446)	
R^2	0.948	0.947	0.891	0.762	0.748	0.802	0.755	0.545	0.543	0.503
DW	1.468	1.479	1.109	0.738	0.702	1.939	1.922	1.174	1.229	1.295

BC and JC are estimated simultaneously with the SUR method. T-statistics are in parentheses. v: vacancy rate; AGING: ratio of young to old; BD: benefit duration; BRR: benefit replacement rate; UDNET: net union density; EPOP: employment population ratio; LABC: labor costs; RIRL: real interest rate; DW: Durbin-Watson statistic.

Table 11: Portugal: Estimates with Aging of Employed

	BC			JC		
	(1)	(2)	(3)	(1)	(2)	(3)
LOG(v)	0.267 (3.122)	0.193 (2.447)	0.086 (1.117)			
AGING	-1.212 (-3.163)	-0.930 (-2.511)	-0.897 (-2.099)	2.450 (2.845)	1.969 (2.018)	2.653 (2.366)
BD	1.435 (1.695)			-5.027 (-2.569)		
BRR	0.711 (1.891)	0.946 (2.521)		-1.078 (-1.102)	-2.560 (-2.792)	
UDNET	3.890 (2.589)	1.685 (2.089)	0.131 (0.218)	-10.081 (-3.053)	-3.176 (-1.427)	1.456 (0.826)
EPOP	-0.013 (-0.515)	-0.046 (-2.363)	-0.066 (-3.217)	-0.147 (-2.372)	-0.045 (-0.820)	0.012 (0.201)
LABC	-0.460 (-1.013)	-0.655 (-1.389)	-1.274 (-2.735)	-0.586 (-0.483)	0.131 (0.096)	2.546 (2.019)
RIRL	-0.137 (-0.160)	-0.280 (-0.307)	1.481 (2.184)	3.444 (1.600)	5.315 (2.260)	0.772 (0.383)
R^2	0.883	0.866	0.821	0.648	0.526	0.331
DW	1.977	2.047	1.882	1.837	1.376	0.601

BC and JC are estimated simultaneously with the SUR method. T-statistics are in parentheses. v: vacancy rate; AGING: ratio of young to old; BD: benefit duration; BRR: benefit replacement rate; UDNET: net union density; EPOP: employment population ratio; LABC: labor costs; RIRL: real interest rate; DW: Durbin-Watson statistic.

Table 12a: Spain: Estimates with Aging of Employed

	BC					JC				
	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
LOG(v)	0.016 (0.790)	0.016 (0.788)	0.177 (8.209)	0.173 (8.017)	0.008 (0.313)					
AGING	0.703 (2.420)	0.668 (2.445)	-1.713 (-15.251)	-1.755 (-16.638)	0.938 (2.923)	11.687 (6.301)	11.684 (7.956)	0.374 (0.314)	0.878 (0.794)	11.338 (8.440)
BD	-0.083 (-0.347)					-0.008 (-0.003)				
BRR	0.303 (2.164)	0.327 (2.702)	0.558 (2.083)	0.404 (1.854)	0.496 (3.694)	-1.910 (-1.267)	-1.907 (-1.488)	-3.631 (-1.333)	-2.056 (-0.903)	-2.276 (-2.052)
UDNET	-2.090 (-2.069)	-2.026 (-2.033)	1.912 (0.946)		0.329 (0.401)	-23.697 (-2.382)	-23.690 (-2.435)	-20.864 (-0.996)		-28.772 (-8.147)
EPOP	-0.113 (-8.013)	-0.110 (-8.860)			-0.120 (-8.008)	-0.537 (-5.480)	-0.537 (-8.313)			-0.527 (-8.413)
LABC	1.205 (3.186)	1.203 (3.170)	2.005 (2.402)	2.779 (16.508)		-2.357 (-0.560)	-2.357 (-0.560)	7.195 (0.825)	-1.324 (-0.749)	
RIRL	1.144 (3.763)	1.079 (4.493)	1.884 (3.742)	1.582 (3.974)	1.520 (6.282)	-2.803 (-0.837)	-2.809 (-1.077)	5.172 (0.991)	8.918 (2.399)	-3.734 (-1.836)
R^2	0.998	0.998	0.992	0.991	0.998	0.872	0.872	0.408	0.377	0.870
DW	2.760	2.715	3.105	3.286	2.526	2.298	2.298	0.557	0.607	2.119

BC and JC are estimated simultaneously with the SUR method. T-statistics are in parentheses. v: vacancy rate; AGING: ratio of young to old; BD: benefit duration; BRR: benefit replacement rate; UDNET: net union density; EPOP: employment population ratio; LABC: labor costs; RIRL: real interest rate; DW: Durbin-Watson statistic.

Table 12b: Spain: Estimates with Aging of Unemployed

	BC					JC				
	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
LOG(v)	0.063 (4.980)	0.068 (5.738)	0.076 (0.905)	0.032 (0.419)	0.083 (5.659)					
AGING	0.038 (1.896)	0.030 (1.541)	-0.227 (-1.832)	-0.294 (-2.590)	0.038 (1.494)	-0.389 (-1.085)	-0.736 (-2.182)	-0.751 (-2.562)	-0.553 (-1.779)	-0.761 (-2.131)
BD	0.289 (1.144)					8.036 (1.902)				
BRR	0.365 (2.573)	0.303 (2.236)	2.633 (3.346)	2.244 (3.046)	0.527 (3.343)	-0.699 (-0.270)	-2.874 (-1.136)	-2.743 (-1.330)	-1.198 (-0.554)	-1.298 (-0.529)
UDNET	-0.483 (-0.474)	-0.662 (-0.636)	8.151 (1.160)		2.992 (8.327)	-26.805 (-1.528)	-37.856 (-2.095)	-37.374 (-2.168)		-10.991 (-2.182)
EPOP	-0.080 (-25.538)	-0.082 (-30.330)			-0.079 (-23.567)	0.051 (0.912)	-0.005 (-0.089)			0.021 (0.403)
LABC	1.348 (3.496)	1.427 (3.640)	-2.243 (-0.856)	0.681 (0.912)		7.007 (1.023)	10.969 (1.541)	10.766 (1.596)	-3.290 (-1.586)	
RIRL	0.722 (1.852)	1.038 (3.648)	6.275 (3.947)	5.686 (3.647)	1.648 (5.498)	-3.695 (-0.523)	6.056 (1.143)	6.355 (1.548)	11.294 (2.962)	12.085 (3.186)
R^2	0.998	0.998	0.907	0.901	0.997	0.629	0.558	0.558	0.448	0.503
DW	3.159	3.364	1.304	1.198	2.523	1.025	0.822	0.831	0.746	0.899

BC and JC are estimated simultaneously with the SUR method. T-statistics are in parentheses. v: vacancy rate; AGING: ratio of young to old; BD: benefit duration; BRR: benefit replacement rate; UDNET: net union density; EPOP: employment population ratio; LABC: labor costs; RIRL: real interest rate; DW: Durbin-Watson statistic.

Table 13: Sweden: Estimates with Aging of Employed

	BC				JC			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
LOG(v)	-0.407 (-4.776)	-0.400 (-4.910)	-0.412 (-5.791)	-0.421 (-6.053)				
AGING	-1.874 (-1.304)	-1.836 (-1.282)	-1.460 (-2.589)	-1.505 (-2.686)	9.453 (3.179)	10.910 (3.714)	3.903 (2.653)	4.447 (3.100)
BD								
BRR	-0.124 (-0.275)				-1.582 (-1.471)			
UDNET	-0.162 (-0.093)	-0.421 (-0.286)			11.386 (3.143)	8.880 (2.650)		
EPOP	-0.039 (-1.090)	-0.043 (-1.352)	-0.051 (-3.637)	-0.050 (-3.579)	-0.111 (-1.286)	-0.183 (-2.465)	-0.012 (-0.290)	-0.022 (-0.514)
LABC	1.377 (3.310)	1.375 (3.299)	1.268 (6.943)	1.274 (6.948)	-3.058 (-3.774)	-3.389 (-4.153)	-1.487 (-3.331)	-1.618 (-3.642)
RIRL	0.422 (0.401)	0.556 (0.597)	0.418 (0.524)		-6.224 (-2.743)	-4.948 (-2.252)	-2.671 (-1.149)	
R^2	0.977	0.977	0.977	0.977	0.864	0.850	0.802	0.790
DW	1.542	1.515	1.529	1.529	1.466	1.276	0.931	0.849

BC and JC are estimated simultaneously with the SUR method. T-statistics are in parentheses. v: vacancy rate; AGING: ratio of young to old; BD: benefit duration; BRR: benefit replacement rate; UDNET: net union density; EPOP: employment population ratio; LABC: labor costs; RIRL: real interest rate; DW: Durbin-Watson statistic.

Table 14a: USA: Estimates with Aging of Employed

	BC				JC			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
LOG(v)	-0.774 (-14.770)	-0.773 (-15.431)	-0.763 (-15.864)	-0.762 (-15.685)				
AGING	0.943 (9.952)	0.945 (10.031)	0.929 (10.134)	0.965 (11.676)	0.589 (2.069)	0.715 (2.465)	0.629 (2.098)	0.654 (2.497)
BD	0.094 (0.235)	0.083 (0.214)	0.251 (0.861)		-0.715 (-0.566)	-1.373 (-1.081)	0.168 (0.166)	
BRR	0.940 (1.911)	0.935 (1.909)	1.151 (3.164)	1.046 (3.022)	-2.878 (-1.934)	-3.457 (-2.267)	-1.641 (-1.333)	-1.712 (-1.485)
UDNET	0.132 (0.112)				6.692 (1.868)			
EPOP	-0.030 (-2.324)	-0.031 (-4.241)	-0.027 (-7.211)	-0.027 (-7.088)	0.015 (0.373)	-0.050 (-2.136)	-0.013 (-0.992)	-0.013 (-0.980)
LABC	0.150 (0.665)	0.146 (0.656)			1.407 (2.076)	1.323 (1.869)		
RIRL	0.502 (0.650)	0.441 (0.803)	0.402 (0.732)	0.186 (0.377)	0.604 (0.246)	-2.703 (-1.524)	-3.352 (-1.840)	-3.499 (-2.198)
R^2	0.953	0.953	0.952	0.951	0.361	0.299	0.231	0.230
DW	1.271	1.261	1.303	1.289	0.757	0.952	0.746	0.741

BC and JC are estimated simultaneously with the SUR method. T-statistics are in parentheses. v: vacancy rate; AGING: ratio of young to old; BD: benefit duration; BRR: benefit replacement rate; UDNET: net union density; EPOP: employment population ratio; LABC: labor costs; RIRL: real interest rate; DW: Durbin-Watson statistic.

Table 14b: USA: Estimates with Aging of Unemployed

	BC				JC			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
LOG(v)	-0.828 (-8.580)	-0.825 (-8.358)	-0.841 (-8.276)	-0.867 (-8.563)				
AGING	0.135 (4.079)	0.114 (3.855)	0.109 (3.577)	0.128 (4.853)	0.195 (4.144)	0.192 (4.990)	0.197 (5.243)	0.171 (5.235)
BD	0.800 (1.256)	1.134 (1.900)	0.612 (1.184)		-1.467 (-1.368)	-1.408 (-1.438)	-1.084 (-1.308)	
BRR	2.537 (3.503)	2.857 (4.097)	2.284 (3.689)	1.991 (3.441)	-3.332 (-2.973)	-3.276 (-3.142)	-2.938 (-3.304)	-2.535 (-2.970)
UDNET	-2.810 (-1.304)				-0.499 (-0.134)			
EPOP	-0.024 (-1.093)	0.001 (0.113)	-0.013 (-2.349)	-0.012 (-2.129)	-0.026 (-0.696)	-0.022 (-1.234)	-0.012 (-1.371)	-0.015 (-1.698)
LABC	-0.696 (-1.929)	-0.569 (-1.599)			0.343 (0.553)	0.366 (0.613)		
RIRL	1.336 (1.086)	2.497 (2.871)	2.745 (3.100)	2.511 (2.854)	-0.482 (-0.227)	-0.276 (-0.188)	-0.441 (-0.304)	-0.028 (-0.019)
R^2	0.879	0.873	0.864	0.859	0.516	0.515	0.510	0.487
DW	0.983	1.091	0.893	0.893	1.033	1.007	0.948	0.938

BC and JC are estimated simultaneously with the SUR method. T-statistics are in parentheses. v: vacancy rate; AGING: ratio of young to old; BD: benefit duration; BRR: benefit replacement rate; UDNET: net union density; EPOP: employment population ratio; LABC: labor costs; RIRL: real interest rate; DW: Durbin-Watson statistic.