Age Effects on Equilibrium Unemployment

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Abstract

This paper analyzes how the demographic changes in the age composition of the labor force affect unemployment through shifts in labor turnover and job creation. A theoretical model of equilibrium unemployment is used to study the effects of age-related changes in the mean value of a job-worker match and in average separation risks. The analysis produces four regimes with different effects on unemployment and vacancies. We then examine empirically for a set of 12 OECD economies which country relates to which regime. According to the estimates we can identify all four possible outcomes. We find, for example, that the ongoing aging of the working force will cause an increase in unemployment in Australia, France and Germany but a decrease in Sweden and North America.

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

Labor markets in developed countries face an increasing challenge from the demographic change, in particular from population aging. Although population forecasts are quite distinct in predicting an increasing share of older people and older workers, the effects of aging on labor market issues such as employment are not fully discovered. This paper sheds light on the impact of an aging working force on job creation, the job-worker matching and the implications for the equilibrium unemployment rate.

The end of the baby boom and the persistent low fertility rates fundamentally changed the age composition of the labor force in many developed countries. During the 1980s and 90s, the ratio of young workers to old ones (here between 15 and 39 years old to those between 40 and 64 years old) declined from 1.7 to 1.0 in Canada, from 1.2 to 0.8 in Germany, from 1.3 to 0.9 in Japan and from 1.5 to 1.0 in the USA.

These demographic changes are already changing the labor markets of the affected economies and even more profound consequences will arise in coming years. One important effect is the increasing appearance of older job seekers and job candidates. However, it is not evident which implications this may have for the job-worker matching in the labor market and, ultimately, for unemployment. The answer to this question may depend on various factors, such as: Are firms equally willing to create jobs for old workers? Do firms see age-related productivity effects or does age discrimination play a role? Which are the aggregate effects on matching if the average job separation rate changes, for example because older workers tend to have a higher job loyalty?

To a certain extent, age-related impacts on employment and job-worker matching are documented in the economic but also in the psychological literature. Pissarides and Wadsworth (1994) and Burgess (1993) find evidence for Great Britain that rates of job separation are higher for young workers because a higher proportion undertakes on-the-job search. Hence, the demographic change may reduce flows in the labor market as Coles and Smith (1996) argue in their study for England and Wales, saying that job-worker matching decreases with an older working population. Job separations and low hiring rates for older workers can be the result of age-discrimination (Johnson and Neumark, 1997; Büsch et al. 2004, Charness and Villeval, 2007) and pretended or actual productivity differentials (Haltiwanger et al. 1999, Daniel and Heywood, 2007). Productivity may increase with age if job experience is important (Autor et al., 2003) or decline if human capital depreciates over life time, in particular due to technological change or a loss of manual abilities (Bartel and Sicherman 1993, Hellerstein et al. 1999, Börsch-Supan 2003, Ahituv and Zeira 2005). Concerning cognitive abilities, the age effect is more complex. The ability of information processing is lower for senior workers (Baltes and Lindenberger, 1997) which makes it difficult to employ older workers in some challenging jobs such as, for example, in flight control. Employment effects may also stem from differences between the age-earning profile and the age-productivity profile, for which Lazear (1979), Hutchens (1987, 1989) provide empirical evidence. According to these findings, earnings increase with age more than productivity grows. Firms receive benefits from this productivity-wage differential if employees are young, but the benefits reduce with their age and might become even negative. As a consequence, firms may intend to get rid of their older employees and aging of the labor force may be the reason for an increase in the total number of dismissals. However, psychological research indicates that aging does not induce a general decline in individual productivity because other capabilities can compensate for the deficits. Instead, tests of the effectiveness of training measures imply that older adults show only a larger variance in their results (see e.g. Kubeck et al. 1996).

While age effects on the matching equilibrium are noticeable, they do not allow a definite conclusion for a change in unemployment in an aging labor force. This is because different effects occur, such as, for example, the assumed higher productivity but lower job loyalty of younger employees, which affect the matching equilibrium in opposite ways. One simple way to estimate the effects of the age structure on unemployment is the shift-share approach. An example is Shimer (1998), who attributes changes in US unemployment to variations in the population shares of age groups with low and high age-specific unemployment rates. However, this approach does not consider age-related changes in labor demand. The papers most closely related to ours are Shimer (2001) and Nordström Skans (2005), who estimate the impact of changes in the population share of the young (age 16 to 24) on unemployment. In their analysis of U.S. and Swedish local labor markets respectively, they find that unemployment tends to be lower if many young people supply labor. Shimer (2001) argues that a high proportion of young workers is an incentive for firms to create new jobs because younger workers undertake more search activities which reduce the recruitment costs for the firms.[1]

However, some aspects of the relationship between aging and employment may be country specific so that an empirical analysis of one or two countries cannot display the whole picture. For example, age discrimination or age-related productivity differentials can be subject to national labor market institutions and business cycle effects. Therefore, the comparison of different economies should bring new insights into the understanding of

[1] There are more demographic impacts on the labor market discussed in the literature. Important examples are: labor supply and the role of the social security systems (Breyer and Stolte, 2001; Ehrlich and Kim 2005), employment effects of changes in consumption (Batey and Madden, 1999), and growth effects (Miles, 1999; Bloom and Canning 2004). For an overview and more effects see Börsch-Supan, 2003 and Johnson and Zimmermann, 1993.

employment effects of an aging labor force. Moreover, more attention should be given to the labor-demand side, i.e. the willingness of firms to open vacancies, and to differences between young and experienced, not necessarily old workers. The willingness to create new jobs is expected to change not only because of variations in the cohort sizes but also because of expected changes in job mobility and average labor productivity in an aging labor force. Furthermore, many employment-relevant attributes change neither just after the career start nor some years before retirement but in the middle of the working life. Examples would be: seniority effects on productivity lose significance after some years, job mobility is different before and after starting a family and the risk of a job-worker mismatch and job separation is particularly high in the worker's early career.

The following analysis undertaken to identify the demographic effects on equilibrium unemployment, provides theoretical implications and empirical findings to the problem. First, we extend the standard Pissarides (2000) model of equilibrium unemployment by two age groups. Then age-related effects are introduced with the consideration of an assumed productivity differential between the two groups and with age-specific separation risks. The new matching equilibrium results in four different labor-market regimes of an aging labor force with different combinations of changes in the Beveridge curve and job creation. Only in two regimes the demographic impact on unemployment is clear-cut. To capture the demographic effects empirically, this paper is the first approach, to our best knowledge, to estimate both the Beveridge curve and the job creation curve. The estimates with macro data for 12 OECD countries re-produce the four regimes. Hence, strong evidence for changes in unemployment caused by an aging labor force can be found only in some countries. Our results suggest that some countries are better prepared to deal with the demographic challenges. For example: Canada, Sweden and the USA are expected to experience positive employment effects from an increase in the share of workers of age 40 and older. In contrast to this, aging of the labor force may cause a rise in unemployment in Australia, France, and Germany.

The remainder of the paper is organized as follows. In section 2 we model equilibrium unemployment under the assumption of age-related heterogeneity in the labor force. Section 3 presents the econometric model and reports the estimation results. Finally, we summarize our results in section 4.

2 The Theoretical Model

Our modeling extends the original framework of search and equilibrium unemployment (see Pissarides, 2000) with the distinction between younger and older workers and age-related effects of job creation and job destruction.[2] The standard model implies that countries with an older labor force will have lower unemployment rates. This is due to the simple assumption that young workers are born into unemployment. In contrast to this, we ignore "births" and "deaths" in the labor market but analyze the effects on equilibrium unemployment if younger and older workers differ in some individual characteristics. From this it follows that changes in the age structure can have ambiguous effects on unemployment.

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 younger and older workers who may generate different levels of surplus for firms if they fill a vacancy. We consider age-sensitive differentials in labor productivity, wages, and separation risks. The purpose of the setting is to be general enough to catch the different ways of how shifts in the age composition can affect equilibrium unemployment via job creation and job destruction. Due to the generality we can apply our theoretical results to a macroeconometric model in section 3 to analyze how the demographic change influences unemployment.

2.1 Matching and Equilibrium Worker Flows

There are two types of agents, workers and firms. All agents are risk neutral and discount the future at rate r. From the individual attributes i of workers we consider age as the only relevant factor here. Hence the labor force is divided into two age groups which have a share of p and $1-p$ respectively. Later in the empirical part we cut the labor force within the group of prime age workers. Therefore, we henceforth denote the two groups as the younger workers, y, and the older workers, o. Workers are either employed or unemployed which means that they seek for a new job. The average rate of unemployment in a continuum of workers, normalized to 1, is then composed of the age-specific rates weighted at the relevant population share, $u = (1-p)\, u_o + p u_y$. The share of younger workers in the unemployment pool is $p\widetilde{u}_y$ and the one of older workers is $(1-p)\, \widetilde{u}_o$, with $\widetilde{u}_i = u_i/u$ denoting the relative unemployment risk at age $i = [y, o]$. Hence, the age composition of the unemployed has a demographic and an economic element as the relative unemployment risk can be different from unity.

A firm can be in one of the three states: It is inactive at zero return, it seeks for a worker at search costs, or it hires one worker, starts production and earns profits. Vacancies are equally open to younger and older workers.

[2] We analyze the effects of aging of the labor force but ignore effects from a population decline. The reason for this is that most empirical studies find constant returns to scale of matching functions. Petrongolo and Pissarides (2001) provide an overview of the related literature. Therefore, the pure population size has no effect on matching and search equilibrium in the labor market.

We show later that we receive a pooling equilibrium indeed if search costs are equal to the benefits from waiting for a better performing younger or older worker.

Search frictions limit the matching of unemployed and vacancies. New employment relations are created through a standard matching technology which forms the number of matches from the number of unemployed workers and the number of vacancies. Hence, $m = m(u, v)$ is the flow rate of matches formed, with v denoting the vacancy rate. As standard, $m(u, v)$ exhibits constant returns to scale in its two arguments, is continuous and differentiable, and $m(u, v) < \infty$. Equilibrium in search models usually critically depends on a measure of the tightness of the labor market defined as $\theta = v/u$. This is because θ determines how successful search is. A firm with a vacancy meets a job seeker at a rate $q(\theta) = m(u, v)/v$, decreasing in the vacancy-unemployment ratio. We assume that the matching technology is random in the sense that if the proportion of younger workers in the unemployment pool is $\widetilde{pu_y}$, then the conditional probability that a vacancy is filled with a younger worker is $\widetilde{pu_y}$, too. Equivalently, a job seeker finds a new employment at rate $\theta q(\theta)$ which is identical for both age groups as vacancies do not differentiate between younger and older candidates.

Job-worker matches have a finite time horizon. Once formed, matches have a constant risk to come to an end and the state of a firm changes to new search or inactivity. Separation takes place because of idiosyncratic shocks which hit all matches at the same probability s. In addition to this, age-related shocks are possible. Let τ_o and τ_y denote the rates which indicate the added risk that the match ends as the worker is older or younger. The rates may also include different quitting rates, for example because of family moves etc. The age-related separation rates are added to s to define the risk of losing the joint surplus of a job-worker match.

Unemployment rates of younger and older workers evolve according to job creation and job destruction. Age-related separations risks and employment rates give the flow into unemployment, the matching rate yields the transition probability for the unemployed:

$$\dot{u}_i = (s + \tau_i)(1 - u_i) - \theta q(\theta) u_i. \tag{1}$$

From $\dot{u}_i = 0$ it follows that the age-specific rate of equilibrium unemployment is $u_i = (s + \tau_i) / (s + \tau_i + \theta q(\theta))$, with $i = [y, o]$. The summation of the two unemployment rates weighted at the respective population proportions then yields the Beveridge curve (BC):

$$u = \frac{s + \tau_o}{s + \tau_o + \theta q(\theta)} + p(u_y - u_o). \tag{2}$$

This is the standard BC plus an age-related effect which disappears if the separation rate is identical for younger and older workers. Otherwise, an increasing proportion of that age group with the higher separation rate increases job destruction and unemployment. Furthermore, the unknown θ in BC determines equilibrium unemployment and is explained by the willingness by the firms to create vacancies. Firms employ younger and older workers but the surplus from a match can be different. Hence, we analyze next how job creation, and therefore θ, depend on the age structure.

2.2 Firms

Whether firms create new jobs or remain inactive is subject to the benefits they receive and the costs they have to pay during their market activities. The benefits and costs include the (present discounted) value of the states: Match with an older worker J_o, match with a younger worker J_y, and unfilled vacancy V. The values satisfy the Bellman equations

$$rJ_o = \mu - w_o - (s + \tau_o)(J_o - V), \tag{3}$$

$$rJ_y = \mu + \delta - w_y - (s + \tau_y)(J_y - V), \tag{4}$$

$$rV = -\gamma + q(\theta)(J - V). \tag{5}$$

Firms receive revenues μ from selling the output if an older worker is employed, while they pay the wage w_o as compensation. Equivalently, a younger worker produces the value $\mu + \delta$ and earns w_y. Experience and lower training costs favor older workers but a lower depreciation of human capital is an argument for a higher productivity of younger workers. As it is not clear which effect dominates, we do not fix the sign of the output differential so that $\delta \gtreqless 0$.[3] The job-worker match ends at the probability $s + \tau_i$, in which case the value of the match is replaced by the value of an unfilled vacancy. The vacant job costs γ per unit time and changes state according to the Poisson Process at rate $q(\theta)$. The change of state yields net return $J - V$ with J denoting the expected value of a filled vacancy. As the firm can meet two types of workers, we consider that the worker is younger at the probability $p\widetilde{u}_y$ and he is older at the probability $(1-p)\,\widetilde{u}_o$. The probabilities are equal to the relative shares of younger and older workers in the unemployment pool. Therefore, the expected value of filling the vacancy is:

$$J = p\widetilde{u}_y J_y + (1-p)\,\widetilde{u}_o J_o. \tag{6}$$

As revenues exceed costs in any case, a job-worker match is always more profitable than a vacant job.

[3] See Börsch-Supan (2003) and Hutchins (2001) on the difficulty of the measurement of individual age-related productivity.

2.3 Workers

Workers have an impact on the equilibrium outcome through their role in wage determination. The employment of an older or a younger worker provides different returns to the firms. For this reason, a job should bring a different income also for the two types of workers. Consequently, older workers earn w_o and younger ones w_y when employed and they receive some real return b during job search. Typically the major component of b are unemployment insurance benefits. As these payments have only little age-sensitive elements, we assume the same rate b for older and younger job seekers. Let U and W denote the present-discounted value of the expected income stream of an unemployed and an employed worker, respectively. The unemployed get benefits b and in unit time they can expect to move into employment at the probability $\theta q(\theta)$. In this case they gain W but lose U. The chance to find an employment is equal for older and younger workers as firms do not advertise age-segregated vacant jobs. The permanent income of employed workers is different from the constant wage as the match ends for an individual at probability $s + \tau_i$ and the status changes from W to U. Hence, individuals at age $i = [o, y]$ can expect benefits from labor supply which satisfy

$$rU_i = b + \theta q(\theta) \left(W_i - U_i\right) \tag{7}$$

during job search and

$$rW_i = w_i + (s + \tau_i) \left(U_i - W_i\right) \tag{8}$$

if they are employed. Though workers of any age can fill the same vacancy, a wage differential between w_o and w_y reflects that older and younger workers can be of different value for a firm. The separation risk also varies with age $\left(\tau_o \lesseqgtr \tau_y\right)$. This affects the probability of a change of state towards unemployment and consequently affects the expected values of W_i and U_i. As usual we assume that $w_i > b$ and workers do not give up their jobs due to a higher alternative income.

2.4 Equilibrium

The final determination of the market tightness and, hence, equilibrium job creation demands two things. First, wage determination has to specify the labor costs so that firms can evaluate the actual value of filling a vacancy. And second, the age-related job-worker matches have to satisfy the pooling condition,[4] which leads to vacant jobs that do not distinguish between older

[4] A separating equilibrium either means the exclusion of one age group or the exclusion of age effects. Both results contradict the purpose of our analysis. Moreover, only few advertisements of vacancies have information about a minimum or a maximum age of successful candidates.

and younger workers. From this it follows how job creation complements the BC to establish equilibrium with w^*, u^*, θ^*.

Wages are derived from the Nash bargaining solution. The wage for older and younger workers is the rate w_o and w_y respectively that maximizes the weighted product of the worker's and the firm's net return from an employment. While the worker gains W_i but loses U_i if she starts a new job, the firm gives up V for J. The share of the total benefits that each party receives depends on a measure β which is usually interpreted as the bargaining power of the workers. As shown in Appendix, the bargaining outcome yields the age-sensitive wages:

$$w_o = \frac{(1-\beta)\,b + \beta\mu\left[1 + \frac{\theta q(\theta)}{r+s+\tau_o}\right]}{1 + \beta\frac{\theta q(\theta)}{r+s+\tau_o}}, \tag{9}$$

$$w_y = \frac{(1-\beta)\,b + \beta\,(\mu+\delta)\left[1 + \frac{\theta q(\theta)}{r+s+\tau_y}\right]}{1 + \beta\frac{\theta q(\theta)}{r+s+\tau_y}}. \tag{10}$$

Employed workers receive a pay between income during job search (b) if $\beta = 0$ and the total revenues generated by the employment ($\mu, \mu+\delta$) if $\beta = 1$. Values of β between zero and unity consider a twofold effect of a higher probability of reemployment $\theta q\,(\theta)$. First, the lower bound of bargaining outcome increases with $\theta q\,(\theta)$ because it is easier to find another vacant job and the threat level is lower that the application for a job is rejected. Second, the upper bound decreases with $\theta q\,(\theta)$ because firms have to wait longer until they can fill a vacant job. This reduces the total benefits from market activities which can be shared among firms and workers.

Productivity and wages of the workers differ with age. While a vacant job generates zero revenues ($V = 0$), otherwise firms would create an infinite number of jobs, the filled vacancy has a positive value for a firm. In consideration of the age-related wages, it then follows from eq. (3) and eq. (4) that the value of employing an older worker is

$$J_o = \frac{(1-\beta)\,\mu + (\beta-1)\,b}{r+s+\tau_o+q\theta\beta}, \tag{11}$$

whereas the younger worker generates a value of

$$J_y = \frac{(1-\beta)\,(\mu+\delta) + (\beta-1)\,b}{r+s+\tau_y+q\theta\beta}. \tag{12}$$

The dissimilarity in the equations implies that firms may prefer to meet a younger or an older job seeker if they have a vacant job. One age group can have a higher productivity-wage ratio or a lower quitting rate so that it is more valuable to hire workers from this age group. However, firms also know that search will continue and cause further costs if they refuse a job candidate. The candidates are stochastically drawn from the pool of unemployed and are younger at the probability $p\widetilde{u}_y$ and older at the probability $(1-p)\,\widetilde{u}_o$. If the drawing brings the inferior candidate and the firm rejects an employment, the firm expects to pay γ over an additional $q(\theta)$ period. Therefore, firms will accept the first applicant for work as long as extra costs of rejection are equal to the extra gain through employing a superior worker. In this case the expected value of a vacancy is zero because waiting is worthless. This holds true if $J = \gamma/q(\theta)$ and with eq. (6), the equation for the expected J, we have:

$$J_o = \frac{1}{1-p}\left(\frac{\gamma}{q(\theta)\widetilde{u}_o} - p\frac{u_y}{u_o}J^y\right). \tag{13}$$

This is the condition for a pooling equilibrium in which vacancies are open for both age groups. Only the market tightness is variable and guarantees the identity of eq. (13). Rearranging yields the job creation condition:

$$\frac{1}{q(\theta)} = \frac{(1-p)\,\widetilde{u}_o}{\gamma}\frac{\mu - w_o}{r+s+\tau_o} + \frac{p\widetilde{u}_y}{\gamma}\frac{\mu+\delta-w_y}{r+s+\tau_y} \tag{14}$$

The vacancy-matching ratio $1/q(\theta)$ is an indicator for job creation. Firms open more vacancies for a given number of job seekers if $1/q(\theta)$ increases. It is obvious that easy search and high profits foster job creation.

Steady state equilibrium $(\theta^*, u^*, w_o^*, w_y^*)$ satisfies the flow equilibrium (2), the job creation condition (14), and the two wage equations (9) and (10). Job creation and the wage equations yield the market tightness. Together with the BC equilibrium unemployment is fixed.

2.5 The Effects of the Age Structure

A change in the age structure, for example less younger workers due to persistent low fertility rates or baby boomers who grow old, will affect equilibrium unemployment if older and younger workers differ in the considered attributes. Hence, we analyze next the comparative static effects of a change in the share of younger workers (p) on equilibrium.

From the job creation condition it follows that the market tightness responds to a change in p according to:

$$\frac{\partial\left(\frac{1}{q(\theta)}\right)}{\partial p} = \frac{1}{\gamma}\left(\widetilde{u}_y J_y - \widetilde{u}_o J_o\right). \tag{15}$$

The willingness to create a vacancy, $1/q(\theta)$, decreases (increases) due to a fall in p if $\widetilde{u}_y J_y > \widetilde{u}_o J_o$ ($\widetilde{u}_y J_y < \widetilde{u}_o J_o$). The age structure has no effect on job creation under the assumption that $J_y/J_o = \widetilde{u}_o/\widetilde{u}_y$. This means that different age-related effects, such as the separation risk and the productivity differential, cancel out each other. The condition for this is:

$$\delta = \underbrace{(\mu - b)\left(\frac{u_o}{u_y}\frac{r+s+\tau_y+\beta q(\theta)\theta}{r+s+\tau_o+\beta q(\theta)\theta} - 1\right)}_{=:\eta}. \tag{16}$$

However, it is more gainful to employ a younger than an older worker if δ is larger than the right-hand side of the equation. Meeting a younger worker is less likely for a firm with a vacant job as soon as their share p decreases. Consequently, fewer firms seek for new employees if $\delta > \eta$ as the firms now expect lower returns to an advertised vacancy. Hence, θ declines and $1/q(\theta)$ declines. The opposite holds true if $\delta < \eta$ and θ increases because firms prefer older workers and their share in the labor force $(1-p)$ grows.

As individuals of different age may have different separation rates, the flow equilibrium changes if p varies. The age proportion of younger workers changes the BC of equation (2) in case of differences in the relative unemployment rates due to age-related separation risks, and we have:

$$\left.\frac{\partial u}{\partial p}\right|_{\partial\theta=0} = (\tau_y - \tau_o)\frac{\theta q(\theta)}{[s+\theta q(\theta)][s+\theta q(\theta)+\tau_y+\tau_o]+\tau_y\tau_o}. \tag{17}$$

The second term is always positive and therefore a decline in p reduces the average flows in the labor market if younger workers separate more often from jobs. A higher proportion of older workers then reduces the labor turnover and less job-worker pairs have to be matched. It follows from the standard matching technology that, given a constant job creation, a lower total separation risk correspond to less equilibrium unemployment.

Figure 1 shows equilibrium in the vacancy-unemployment space and illustrates the effects which can arise if the age structure influences flows in the labor market and job creation. The steady state condition for unemployment is the BC which is convex to the origin by the properties of the matching technology. As usual, the BC is downward sloping. Unemployment is low if the vacancy rate is high because job seekers find easily new employments. The JC is the curve that maps the job creation condition. Firms prefer a large pool of unemployed because then they find easily appropriate candidates for their vacancies and save search costs. Hence, firms create more jobs if unemployment is high and the JC slopes upwards.

Taking the old equilibrium as a starting point, four different outcomes may occur if the ratio of younger to older workers decreases.[5] The results are denoted as regime (1) to (4) henceforth. In regime (1) older workers increase the mean separation risk and due to an unfavorable productivity-wage ratio they are the less preferred by the firms. A growing share of older workers

[5] We analyze the case of a decrease in p because this will take place in the coming years in nearly all developed countries.

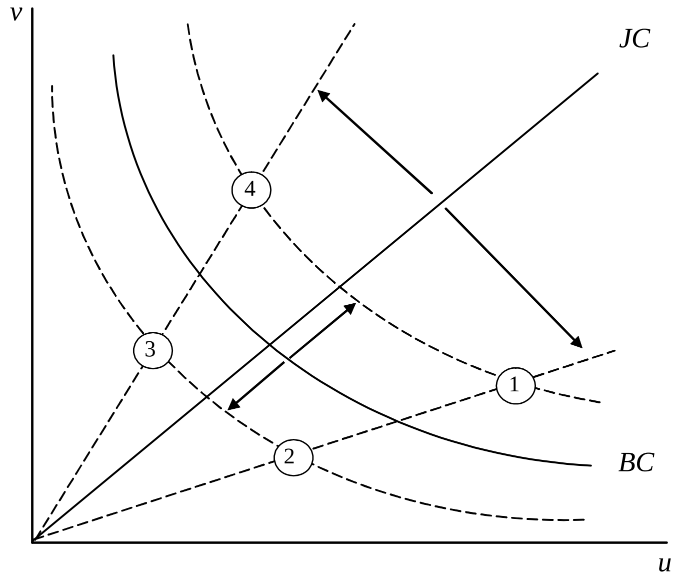

Figure 1: The effects of aging on the search equilibrium

then implies that the BC shifts outwards and the JC rotates clockwise. The result is that unemployment increases clearly but the effect on the vacancy rate is ambiguous. Regime (2) implies that firms still prefer younger workers who become fewer. However, older workers reduce the labor turnover and the BC consequently shifts inwards. From this it follows that less vacant jobs are available, but it is not clear-cut whether this leads to higher unemployment as also fewer job-worker matches get terminated and less people look for a reemployment. Unemployment decreases if the reduced labor turnover is combined with a favorable productivity-wage ratio of older workers. This takes place in regime (3). Finally, firms can intensify job creation because older employees are a superior workers, but it is not clear whether this reduces unemployment if older workers have a high separation risk. The resulting increase in labor turnover is accompanied by more vacancies but the total employment effect in regime (4) is ambiguous.

The four results are also summarized in Table 1. Note that if more older workers in the labor force imply negative (or positive) employment effects, this applies not only to the older but also to the younger workers. The increase or decline in job creation has the same consequence for all job seekers, which can be either higher or lower chances for filling a vacant job. Regime 1 is less advantageous than the others because it implies that the demographic change is followed by a rise in unemployment. This poor result can arise because of misleading policy interventions but also as a consequence of individual behavior and preferences. Examples would be public early retirement schemes, higher employment protection for older workers, age discrimination as well as lower regional and occupational mobility of older workers. Improvements in these fields could move a labor market towards the superior regimes and prepare it for the demographic change.

Table 1: The effects of a decline in p

regime		BC	JC	u	v
(1)	$\tau_y < \tau_o,\ \ \delta > \eta$	o	r	$+$	$\sim$
(2)	$\tau_y > \tau_o,\ \ \delta > \eta$	i	r	$\sim$	$-$
(3)	$\tau_y > \tau_o,\ \ \delta < \eta$	i	l	$-$	$\sim$
(4)	$\tau_y < \tau_o,\ \ \delta < \eta$	o	l	$\sim$	$+$

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

For the sake of simplicity we assumed in the model that only a productivity differential and age-related separation risks distinguish younger from older workers. However, no general effect is lost by this simplification. This is because other age-related heterogeneity also affects equilibrium either through changes in labor turnover or through changes in the value of a job-worker match. For example one could think of age-related search intensities which affect reemployment probabilities and age-specific unemployment rates. Other examples would be firm specific human capital or seniority which could give older workers higher bargaining power, or differences in the discount rates if younger workers value career progression in a job higher than the current salary. Moreover, one could argue that δ is a discrimination factor, which is positive if firms discriminate against older workers. In the case that employers prefer younger workers, because of prejudices or bad experiences with older employees, they may add an extra value to the observable productivity of the young.

The consequences of these examples would be a differential between J_o and J_y which results in more or less job creation if the age structure alters. Hence, more age-related heterogeneity could be captured but the considered effects represent the general impact of the age-structure and the distinction between the four regimes remains untouched by different extensions of the model.

3 Empirical Analysis

This section investigates empirically whether population aging really affects unemployment differently in different countries as the theoretical model suggests. Hence, based on the model's mechanism, we present an empirical analysis of the possible aging-effects on unemployment in 12 OECD countries. Age-related changes in job destruction and job creation consider dynamics ignored by the simple shift-share approach, which uses the general fact that young workers have higher unemployment rates than old workers.[6]

In order to capture changes in the age-composition of job-candidates and job-seekers, we divide the group of unemployed (analogous to the theoretical model) into young, $p\tilde{u}_y$, and old, $(1-p)\,\tilde{u}_o$, but henceforth with $\tilde{p} \equiv p\tilde{u}_y$ as the share of the young unemployed and $1-\tilde{p} \equiv (1-p)\,\tilde{u}_o$ as the share of old unemployed respectively. We use a broader definition of young and old workers than most other studies do because we believe that many individual characteristics relevant for job creation and job destruction, such as quit rates and productivity changes, have a break in the middle age of workers.[7] Moreover, narrow definitions critically depend on behavioral and institutional changes such as age-specific employment programs, early retirement schemes and extended education. Hence, we label workers as young when they are between 15 and 39 years old, and they are called old when their age is between 40 and 64 years.[8] Exceptions are Australia, Finland, Norway and Sweden, in which the cut is 35 years due to data availability.

In each of our 12 countries, the age composition of the unemployment pool changed notably. Figures 2 and 3 show these changes independent of whether the age 40 or 35 is the cut between the young and the old. Periods of quasi full employment have high and non-systematic variations in the age-composition,[9] but in times with high unemployment even business cycles effects do not alter significantly the distribution of unemployment by age.

At the latest from the mid 1980s, the unemployment pool is continuously aging and the share of young unemployed decreased in all considered countries. In Japan, this development has already started in the late 1960s. Although the trend is the same, the relative share of young unemployed varies from country to country. Unemployed are particularly young in Australia, Norway, and Spain but relatively old in Germany, Sweden and Finland.

3.1 Identification

To identify the effect of the distribution of unemployment by age on job creation and job destruction and, hence, on the corresponding regime shifts (1) to (4) we provide our identification strategy in the next subsection. The core equations in section 2 are the BC and the JC. While the BC is

[6] See various issues of the OECD Employment Outlook. An exception to this rule is Germany in the 1990s. However, this has much to do with the unification of two different labor markets in East and West Germany.

[7] For example, Börsch-Supan (2003) shows that the typical age-productivity profile peaks when workers are in their 40s or 50s.

[8] We tried other cut-off points, but with no relevant changes in the estimation results.

[9] Quasi full employment existed in Germany until the mid 1970s, in Norway until the late 1980s, and in Sweden until the early 1990s.

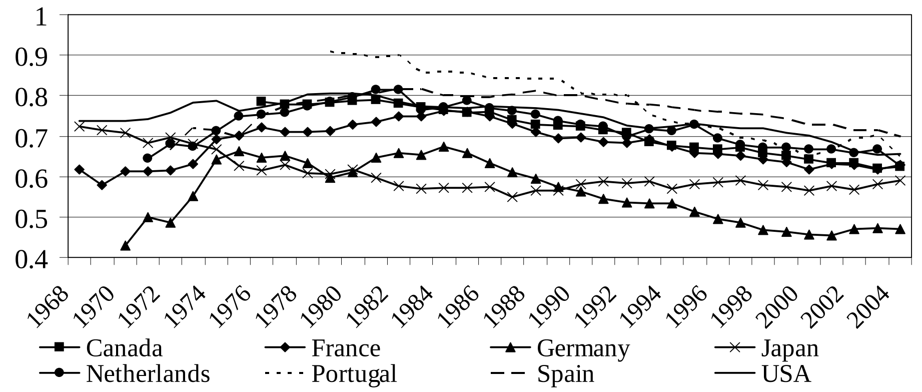

Figure 2: Share of the unemployed younger than 40 years old

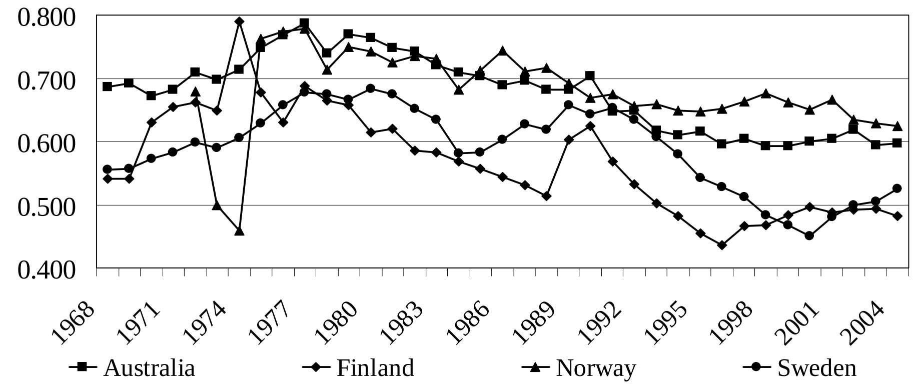

Figure 3: Share of the unemployed younger than 35 years old

estimated several times in the literature, the JC is exceedingly difficult to identify. Our approach to generalize job creation is given in equation (14), which indicates that the vacancy-matching ratio, $1/q(\theta)$, is an indicator for job creation. An increase in this ratio means that firms open more vacancies for a given number of job seekers. Hence, we chose $\theta = v/u$ as a proxy for job creation. This approximation of job creation is similar to that in Marimon and Zilibotti (1999).

In the BC the unemployment rate (u) is a function of the vacancy rate (v), the idiosyncratic (s) and conditional (τ_y, τ_o) separation rates, the age structure of the unemployed ($\tilde{p}$), and the matching efficiency (m). JC, approximated by the market tightness (θ), is a function of income during unemployment (b), bargaining power (β), productivity (μ, δ), interest rate (r), search costs (γ), and the parameters that define the matching rate according to the BC:

$$u = f(v, s, \tau_y, \tau_o, \tilde{p}, m)$$

$$\theta = g(b, \beta, \mu, \delta, r, \gamma, s, \tau_y, \tau_o, \tilde{p}, m)$$

Our proxy for $\tilde{p}$ is the share of unemployed between 15 and 39 years old. In principle, this variable should capture the differences of a value of a match with a young or an older worker that arise from a change in the age composition. In the first instance this refers to τ_y, τ_o and δ.[10] However, if trade unions have different bargaining strategies with respect to the age groups or the discount rate is different for the two age groups, this will be captured by $\tilde{p}$, too. Furthermore, income during unemployment can have components in addition to insurance benefits, which may be different for younger and older job seekers. This means that $\tilde{p}$ controls for unobserved heterogeneity in the econometric model which comes from a changed proportion of young workers. To make sure that $\tilde{p}$ does not capture effects from a changed (effective) participation of older workers for a given age structure, we additionally control for this effect by considering the employment population ratio of the age group 40 to 64 years (*epro*) in the estimates. A larger *epro* indicates a lower separation rate as workers remain employed when they grow older. Hence, we expect that the BC then shifts inwards and the JC rotates counterclockwise.

The idiosyncratic shock rate in the BC will be approximated by the real interest rate (r) and the GDP growth rate (*gdp*).[11] In contrast to the BC the shock rate in the JC is approximated by r and the real import prize for oil in national currencies (*oil*). Since the substitutability for energy in the production process is practically zero in the short run, idiosyncratic shocks increase with the oil price. The GDP comprises demand and cyclical components, in contrast to the oil prize, which is not a crucial factor for job creation. In addition, the GDP reacts with a log on changes in the oil price.

We proxy μ not only by the real labor productivity but also by labor costs in real productivity units (*cp*). The reason for doing so is that the wage rate w does not appear in the solution of the theoretical model because it is fully explained by b and β. From an empirical perspective this approximation is insufficient and may cause a bias especially on the parameters that measure the effect of $\tilde{p}$. However, we consider the bargaining power of

[10] An aging labor force and an age-related (assumed) productivity differential or a different separation risk, as modeled in the previous section, may lead not only to a change in average job creation but also to a change in the overall matching efficiency. This effect appears when differences in the job-finding rates between young and old workers mean that vacancies remain unfilled for a longer period of search if there is a high number of older job seeker.

[11] Shimer (2005) argues that the standard textbook model cannot generate shocks of a plausible magnitude. Hence, we choose the GDP and the interest rate as proxy variables for shocks to account for the business-cycle fluctuation.

workers approximated by union density (ud) and bargaining coverage (bc) to map effects beyond current wage determination. Generally speaking, we expect negative effects on JC from high (ud) and (bc). Nevertheless, positive effects are possible if unions negotiate more for the unemployed than for insiders and if bargaining coverage stabilizes wages at the firm level. However, due to the explicit consideration of the wage-productivity ratio, the parameters for bargaining power reflect rather expectations on future wages and bargaining shocks than bargaining as a whole.

The vacancy rate and the benefit replacement rate are directly observable. Furthermore, our proxy for r is the real short term interest rate. The search costs are expected to be constant to a greater or lesser extent but different across countries. Therefore, the constant and the country fixed effects take them into account.

In addition to the variables that explained BC so far, we control for institutional effects on job destruction and therefore on additional shifts of the BC. The labor market institutions that are expected to influence job destruction are union density, bargaining coverage, and employment protection. Union density and bargaining coverage reduce the flexibility of firms to react to changes in the economic environment and, consequently, they are expected to increase job destruction. Employment protection increases firing costs, but it is expected to decrease job destruction.

Finally, the reduced form of the BC and the JC are:

$$u = f(v, b, ep, ud, bc, r, gdp, epro, \tilde{p})$$

$$\theta = g(b, ep, ud, bc, r, cp, oil, epro, \tilde{p})$$

3.2 Data

The empirical analysis comprises data on 12 OECD Countries: Australia, Canada, Finland, France, Germany, Japan, the Netherlands, Norway, Portugal, Spain, Sweden, and the USA. The period is 1977 to 1999 for the BC and 1978 to 1999 for the JC. The selected periods yield a balanced panel and include the turning point during the mid 70s and early 80s when the ratio of younger to older job seekers began to decrease substantially in most considered countries.

From OECD online database we take the standardized unemployment rate, the GDP, and data on unemployment, employment, and population for different age groups. The data on labor market institutions and vacancies[12] are taken from Nickell and Nunciata (2002) and Baker et al. (2002). The institutions include benefit replacement rate, employment protection, bargaining coverage, and net union density. For the construction of theses data

[12] It is worth noting that the national official statistics report only a fraction of vacancies. However, it is not possible to account for this problem for each country. Therefore, estimates have to be interpreted carefully.

we refer to Nickell and Nuniciata (2002). Data on the real short term interest rate and labor costs are also taken from Nickell and Nuniciata (2002) and the OECD online database. The data on labor productivity are taken from the online service of the US department of Labor, bureau of labor statistics. Finally, the time series on exchange rates yield from the US board of governors of the Federal Reserve System and data on the actual paid oil price for imported oil into the US are taken from the Energy Information Administration of the US government.

3.3 Econometric Model

The econometric specification of the BC and the JC is basically that of the reduced form. Since institutions typically have low variation and are highly correlated within a country, each equation will be estimated as panel model.[13] In contrast to this, the effects of the age structure are estimated country specific because we can distinguish between four regimes of different effects of $\tilde{p}$ and there is no reason that all countries share the same regime. The lagged dependent variable is also considered on the right hand side to focus on the short run effects of the exogenous variables. Furthermore, we choose the park estimator to control for country specific heteroskedasticity and contemporaneous correlation across the countries. In this case only country fixed effects are allowed. The time fixed effects are approximated by a linear time trend in each equation.

The econometric equations are:[14]

$$\begin{aligned}\log(u_{it}) &= \beta_0 + \beta_1 \log(u_{it-1}) + \beta_2 \log(v_{it}) + \beta_3 b_{it} \\ &\quad + \beta_4 ep_{it} + \beta_5 ud_{it} + \beta_6 bc_{it} + \beta_7 r_{it} + \beta_8 gdp_{it} \\ &\quad + \beta_9 epro_{it} + \beta_{10} trend_t + \kappa_i \tilde{p}_{it} + \varphi_i + \epsilon_{1it}\end{aligned} \tag{18}$$

$$\begin{aligned}\log(\theta_{it}) &= \alpha_0 + \alpha_1 \log(\theta_{it-1}) + \alpha_2 b_{it} + \alpha_3 ep_{it} \\ &\quad + \alpha_4 ud_{it} + \alpha_5 bc_{it} + \alpha_6 r_{it} + \alpha_7 cp_{it} + \alpha_8 oil_{it} \\ &\quad + \alpha_9 epro_{it} + \alpha_{10} trend_t + \lambda_i \tilde{p}_{it} + \psi_i + \epsilon_{2it}\end{aligned} \tag{19}$$

The estimated effects of the age composition, κ_i and λ_i, reveal how unemployment changes due to shifts of and moves on the BC. Furthermore, they identify the regime according to Table 1.

The share of the young unemployed, $\tilde{p}$, depends not only on the number of young unemployed, but also on the number of older unemployed. For

[13] A seemingly unrelated regression estimator produced similar results to the OLS estimates and we therfore use the panel approach.

[14] The use of the logarithm of $\tilde{p}$ 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.

example, $\tilde{p}$ increases without a change in the number of young unemployed if the number of old unemployed decreases due to early retirement. Hence, it is likely that $\tilde{p}$ is endogenous and suffers from a negative bias. To solve this problem we estimate both equations with an instrumental variable (IV) estimator, too. We consider as instruments the working-age population-share of the young and the employment population share of the young.[15] These instruments control for the general participation as well as for long run shifts, e.g. due to a change in educational attainment.

3.4 Results

Table 2 shows the estimation results for the panel estimates with and without instruments. The dependent variables are the standardized unemployment rate in eq. (18) and the market tightness in eq. (19). We can conclude on the basis of two unit root tests (Levin, Lin & Chu and ADF-Fischer) that the residuals exhibit neither a common nor an individual unit root process. With respect to the IV models we apply two overidentifying restriction tests (Sargan test and J-Statistic). In all cases the instruments are exogenous. In addition to this, the R2 of the first stage signalize that the instruments are relevant. Concerning the Sargan test, we can carefully conclude that the non-instrumented covariates are not correlated with the residuals. This is an important information concerning the identification of job creation. Rightward the model parameters, we provide robust standard errors in parenthesis. Probability values are provided in parenthesis for the unit root tests.

First we discuss the cross country effects for the variables that are not directly related to aging. With respect to the labor market institutions the estimated effects might differ from those in Nickell et al. (2005) because they estimate a reduced form of our specification. In addition, their period and set of considered countries differ from our sample, too. The lagged dependent variables and the vacancy rate have the expected effects. Concerning the BC, the negative effect of employment protection (*ep*) has two possible explanations. First, firms are more reluctant to fire someone if firing costs are high. Or second, the matching efficiency increases with higher employment protection. This effect applies to search at the firm side, since the parameter for *ep* reflects the net effect of a change in the matching efficiency and job destruction.[16] On the other hand, we find that job destruction in-

[15] We have used the GDP growth rate as a third instrument. This instrument should consider the different firing experiences of the young because this group is particularly affected by dismissals during a recession. However, it turns out that this instrument is weak.

[16] A change in employment protection may affect the search behavior of the firms. First, since the costs of dismissals increase, firms intend to reduce dismissals and select candidates more cautiously. In total, the matching efficiency increases if the resulting lower separation rate effect exceeds the effect of extended duration of search. The opposite

creases with trade union power, whereas the level of wage bargaining has a significant effect in the IV model only. Regarding the proxies for a productivity shock it is the GDP growth that is significant.[17] The real interest rate does not significantly affect unemployment at given GDP. Finally, unemployment reduces if the employment population ratio of older workers (*epro*) is higher. This is as expected because we see *epro* as an indicator for the job duration of older workers. In contrast to Nickell et al. (2005) the effect of the replacement rate (b) is not significant in our specifications. However, if we run the regression without controlling for country specific aging (see Appendix) the replacement rate has a significant positive effect. Hence, the shift in the age distribution induces a positive bias. In other words, benefits are more important for older worker.

TABLE 2 ABOUT HERE

Employment protection leads to a positive effect on JC through a decrease in the quit rates, whereas the effect of unemployment benefits is not significant. The labor costs in productivity units have no significant effect across all considered countries. This is in line with Shimer (2005) who points out that labor productivity shocks have much smaller fluctuations than θ. An alternative interpretation is that, on average, wages increased moderately compared to productivity. However, the variables that capture bargaining indicate that more flexibility in negotiations would increase JC. As expected, a rise in the interest rate and in the oil prize lowers JC. The interest rate is significant in the JC, since it has a direct and an indirect effect that are expected to have the same direction. The significant positive effect of the employment population ratio of older workers (*epro*) means that the average duration of matches is extended.[18] In the specification without controlling for the shift in the age structure of the unemployed two effects are different (see Appendix): First, labor costs in productivity units are significantly negative as expected. Second, employment protection is not significantly positive, which can be expected, too. Hence, both effects suffer from a negative omitted variable bias if we neglect the age structure of the unemployed.

The trend variables can be interpreted as an autonomous increase in job destruction in the BC and a rise in search costs for firms in the JC. That is, search costs differ across countries and change over time. Likewise it is

occurs in the second case and the matching efficiency decreases.

[17] Variables that act twice but unidirectional as proxy are expected to be significant for both channels by definition.

[18] The estimated institutional effects differ from those of Nickell et al. (2005) because they estimate a reduced form of our specification. In addition, their period and set of considered countries differ from our sample, too.

possible that both trends reflect an autonomous decrease in the matching efficiency.

The age structure has effects on flows in the labor market and the expected value of a match between jobs and workers if the effects measured by $\tilde{p}$ are different from zero. Changes in the age structure with an increasing share of older workers results in an increase (reduction) in unemployment if $\kappa_i < 0$ and $\lambda_i > 0$ (if $\kappa_i > 0$ and $\lambda_i < 0$), with ambiguous effects on the vacancy rate. This corresponds to the first (third) regime[19] which implies an outward (inward) shift of the BC and a clockwise (counterclockwise) rotation of the JC. In the other two regimes, changes in BC and JC have opposite effects on unemployment. The total effect depends not only on the magnitude of the two effects, but also on the curvature of the BC and the locus of the initial equilibrium point on the BC.

The results with respect to $\tilde{p}$ are the following: In the panel specification, job destruction changes significantly in all considered countries if the age structure changes. With respect to the panel IV estimates the effects are qualitatively unchanged and in most cases significant. "Aging friendly" shifts of the BC are estimated for Canada, Finland, Spain, Sweden, and the USA. Regarding the other countries, we expect that flows in the labor market produce higher unemployment in the future due to the ongoing age composition effects. Concerning job creation we find that Finland, Germany, the Netherlands, Norway, Spain, and Sweden may experience positive effects because of future changes in the age composition that we expect from the demographic change, whereas the others will have rather less job creation. If we merge the results, we identify regime (1) for Australia, France, Japan, and Portugal. Workers will experience increasing unemployment spells in these countries. Regime (3) is identified for Finland, Spain, and Sweden. Unemployed workers will have a better chance to get reemployed in these countries. For the remaining countries in the regimes (2) and (4), we first have to calculate the net effects before we can conclude whether workers win or lose in terms of reemployment risks as soon as there is a higher proportion of older workers.

We find that, in principle, the IV estimates are similar to those of the usual panel estimates. The general conclusions with respect to the effects of p do not change if we consider the IV estimates. As pointed out above, the estimated age effects in the usual panel model are likely to suffer from a negative bias. In the panel IV estimates, most of the parameters have gone up, which reflects the supposed negative bias due to early retirement.

Our findings for the USA are consistent with those of Bleakley and Fuhrer (1997), Katz and Krueger (1999), Haltiwanger et al. (1999), and Sneddon and Triest (2002). But they contradict those of Shimer (2001) who finds that a fall in the share of the young increased total unemployment.

[19] See figure 1 and table 1.

However, our model differs in two aspects from the approach by Shimer (2001). First, in his analysis the young age group is defined as those who are between 15 to 24 years old. However, many talented young people are still in education at this age. As a consequence, levels of formal education are lower in this cohort than in older age groups. For example, in the period 1997 to 2002, the average share of Americans with maximum secondary education was 92% for the age group 15 to 24 years, but only 62% for the age group 25 to 34 years. This is not a general decline in formal education but reflects non-completed schooling. In contrast to Shimer (2001), we account for this effect using the age group 15 to 39 years. Second, Shimer uses population shares and does not control for labor market participation rates of different age groups. However, in the USA, for example, the correlation coefficient between the labor market participation rate for the age group 15 to 64 years and the rate for the age group 15 to 24 years is -0.19 for the period 1975 to 2002. One main reason for this non-conform trend in labor market participation is that the average duration of young people's education has steadily increased in the last decades. Hence, labor supply of the young relatively decreased over time for a given population. This is not a US-specific trend, but it is a trend in all industrialized countries. To control for this outcome, we focus on the group of unemployed and use instruments to mitigate the problem of changing participation rates.

3.5 Unemployment Rates and Net Effects

The following exercise intends to disentangle the different effects on unemployment in order to reveal the final impact of aging. Based on the results of the panel IV model, we estimate the country-specific unemployment rates and the rates, which would apply for a constant age composition. The results are shown in figure 4. The standardized unemployment rate is denoted by "u", the estimated BC by "*BC estimated*", while "*BC no aging*" means that the age composition of 1977 is kept constant. "*BC & JC estimated*" and "*BC & JC no aging*" include additionally the estimated effects on unemployment via job creation. All country figures feature precise estimates of the BC. The preciseness of the estimates declines slightly for "BC & JC estimated". Hence, it is not surprising that the divergence between "BC no aging" and "BC & JC no aging" is relatively large. However, it is the difference between "*BC & JC estimated*" and "*BC & JC no aging*" that really matters.

According to these estimates, the unemployment rate would have been higher in the 1990s in Canada, Finland, the Netherlands, Sweden, USA, and Spain (from the mid-1990s) if the age composition of the unemployed had not changed since the late 1970s. For Australia, Germany, Japan, Norway, Portugal, and France (from the late 1980s) it is the other way around. In Japan and the Netherlands the effects of aging were quite small and negligible. Moreover, the two countries are the only ones, in which the job creation effect dominates the job destruction effect. With reference to our four regimes, we can conclude that "aging friendly" effects are found in regime (3) countries as well as in regime (2) or (4) countries. Recall that in the regimes (2) and (4) the effects of BC and JC on the unemployment rate are opposing.

FIGURE 4 ABOUT HERE

To give precise information about the regimes, we calculate in a next step the single and net effects on the equilibrium unemployment rate for a rising share of the older unemployed. With respect to the two estimated equations, BC and JC, we distinguish between a direct and an indirect effect. The direct effect κ_i shifts the BC and the indirect effect λ_i leads to moves along the BC. In some of the cases, which reflect regime (2) and (4), we found opposing effects that result in ambiguous changes in unemployment as a consequence of the observed changes in the age structure. Table 3 shows the different effects of an increasing share of the older unemployed on the overall unemployment rate for the panel and the panel IV approach, respectively. A negative (positive) sign denotes that unemployment reduces (increases). The total effect depends on the direction of the direct and the indirect effect and, if opposing, on their relative magnitude, the curvature of the BC, and the locus of the initial equilibrium point on the BC.

The direct effect is the relevant one in all countries of regime (2) and (3). This means that in an aging labor force, the reduction in job destruction dominates the possibly lower job-creation rate. Hence, unemployment falls if demographic aging implies lower job destruction as it applies to the regimes (2) and (3). In contrast to this, unemployment increases in all countries of regime (1) and (4) with the Netherlands as the only exception. Here, aging leads to higher rates of job destruction, which are more significant than higher rates of job creation in regime (4).

TABLE 3 ABOUT HERE

It is necessary to interpret cross country differences carefully. First, the results do not allow to conclude that, for example, older worker have a lower productivity in France than in Germany. The results reveal merely differences within the countries. Second, the indirect effect may be underestimated in some cases. The vacancy rate is always measured based on national definition and represent only a fraction of the total number of vacancies. Third, the estimated slope of the Beveridge curve is the same for all countries. This parameter is of importance for the calculation of the indirect effect. Although the low standard error in the estimates is an indicator of a good approximation across the countries, differences can not be excluded.

3.6 Policy Implications

In order to prepare their labor markets for the demographic change, countries can and should undertake different policy measures. The regime to which a country belongs can be a first indicator for the direction of necessary measures. However, an effective policy needs a deeper understanding of the underlying mechanisms. For example: Although our estimations imply that young workers in the USA and Canada have high separation rates and therefore induce high search costs for firms, employers respond with lower job creation to a fall in the ratio of young to old job candidates. As firms seem to favor young employees for any reason, on should expect that demographic aging then means higher unemployment rates. The way policy should deal with this outcome, though, is not clear-cut. Higher average education can explain the advantage of young workers in the past. Alternatively, a poor productivity-wage ratio due to seniority-wages or age discrimination can also be the cause. In the first case, the effect of aging will disappear because future older workers, i.e. those in their middle age now, will be equivalently educated. If seniority-wages are the reason, only changes in the wage profile can stimulate job creation in an aging labor force. Instead, a better information policy is necessary to reduce age discrimination.[20]

Another example would be Germany, the Netherlands, and Norway, where we find that the average separation risk increases when the share of old workers increases. However, job creation responds positively to the demographic aging. In this case one could argue that policy makers are not obliged to initiate fundamental changes in their labor market policies. However, this conclusion can be wrong. The opposing effects of aging on job creation and job destruction might be explained by the ambiguous outcome of early retirement schemes. On the one hand, there is more labor reallocation and job destruction. On the other hand, firms have the possibility to dismiss unproductive old workers and to keep the highly productive ones. The early retired workers are removed from the group of job candidates. This raises the search productivity and firms are willing to create new jobs. But job creation only artificially benefits from aging and the positive effect will disappear as soon as early retirement programs phase-out.

As politics turns away from early retirement schemes and increases in the retirement age are implemented, future job destruction and job creation will critically depend on the wage-productivity ratio of old workers. But severe wage-cuts for old workers would concern an increasing share of the aging labor force. Hence, further qualification and lifelong learning are of growing importance for employment levels and the quality of job-worker matching.

All in all these examples show that our estimations can forecast future

[20] Indeed, age discrimination seems to play some role in the dismissals and the (re)employment of old workers. Johnson and Neumark (1997) provide evidence for the USA and Charness and Villeval (2007) find age discrimination in France.

developments of unemployment only if the general framework remains the same. However, more research is needed to find the country specific causes of why a country refers to a certain regime. Only then we can give profound policy recommendations to avoid negative employment effects as a consequence of the demographic change.

4 Conclusions

In this paper, we examined the relationship between the change in the age structure according to the demographic change, and unemployment by means of both a theoretical and an empirical model. The modeling relates to the literature on search and matching in the labor market with equilibrium unemployment. We extended the standard framework by age-specific effects which lead to age-related job creation and job destruction. From a theoretical perspective, the effect of an increasing share of older unemployed on total unemployment is ambiguous and divides into four possible regimes. In the case that older workers bring more profits to the firms, either because of a higher productivity or a lower separation risk, the firms will respond to an increase in the relative share of this age groups with a permanent increase in the number of vacancies. Unemployment will strictly decrease if this effect on job creation goes in the same direction as the effect of aging on job destruction. However, unemployment goes up with a higher proportion of older job seekers if firms prefer younger workers who also reduce average job destruction. In contrast to this, the total outcome is ambiguous if the effects of job creation and job destruction are opposing. The net effect on employment then depends on the magnitude of the changes.

The empirical part of the analysis revealed that demographic aging has indeed different effects on unemployment in different countries. To discover the effects, we estimated two equations: The Beveridge curve and the job creation curve. Based on our proxy for aging, which is the share of younger unemployed, we were able to identify the effects of the age structure on unemployment in 12 OECD countries. This approach allowed to calculate the net effect in the ambiguous cases. We found all four regimes in the data, which were derived in the theoretical model. Taking all estimation results into account, we suppose that an increase in the share of the older unemployed reduced unemployment in Canada, Finland, the Netherlands, Spain, Sweden, and the USA. As the demographic change is ongoing, these countries can expect lower unemployment rates in the future if age-related effects remain the same. On the other hand, policy makers in Australia, France, Germany, Japan, Norway, and Portugal should be less optimistic. The results for these countries imply that unemployment tends to further increase when the share of the younger job seekers continuously decreases.

Appendix

Wage Determination: Individual with attribute i can be younger $i = y$ or older $i = o$. Firms have information about the worker's age but wages follow from identical bargaining rules. Workers receive $W_i - U_i$ from a new employment, whereas the firm gets J_i. According to Nash bargaining the wage satisfies:

$$w_i = \arg\max \left(W_i - U_i\right)^{\beta} J_i^{1-\beta}. \tag{20}$$

The first order condition is

$$0 = \beta \left(W_i - U_i\right)^{\beta-1} J_i^{1-\beta} \frac{\partial W_i}{\partial w_i} + (1-\beta) J^{-\beta} \left(W_i - U_i\right) \frac{\partial J_i}{\partial w_i}. \tag{21}$$

Solving eq. (8) for W_i and differentiation with respect to wages gives:

$$\frac{\partial W_i}{\partial w_i} = -\frac{\partial J_i}{\partial w_i} = \frac{1}{r + s + \tau_i}. \tag{22}$$

We use the equation in eq. (21) and have:

$$\beta \frac{J_i}{r + s + \tau_i} = (1-\beta) \frac{W_i - U_i}{r + s + \tau_i}. \tag{23}$$

From this we see that the extra value received by a worker is a factor $\beta/(1-\beta)$ of the value which remains in the firm:

$$W_i - U_i = \frac{\beta}{1-\beta} J_i. \tag{24}$$

Using the equation in (8), and substituting J_i for (11) and (12), yields:

$$w_o = (1-\beta) rU_o + \beta\mu, \tag{25}$$

$$w_y = (1-\beta) rU_y + \beta \left(\mu + \delta\right). \tag{26}$$

Employed workers receive an income that lays between their reservation wage indicated by rU_i and the full surplus that an employment generates. Both boundary values can be different for older and younger workers.

From eq. (3) and eq. (4) we can see that firms evaluate an employment according to $J_o = \left(\mu - w_o\right) / \left(r + s + \tau_o\right)$ and $J_y = \left(\mu + \delta - w_y\right) / \left(r + s + \tau_y\right)$. This and (24) yields:

$$W_o - U_o = \frac{\beta}{1-\beta} \frac{\mu - w_o}{r + s + \tau_o}, \tag{27}$$

$$W_y - U_y = \frac{\beta}{1-\beta} \frac{\mu + \delta - w_y}{r + s + \tau_y}. \tag{28}$$

Finally, with (7) we have:

$$rU_o = b + \theta q(\theta)\frac{\beta}{1-\beta}\frac{\mu - w_o}{r+s+\tau_o}, \tag{29}$$

$$rU_y = b + \theta q(\theta)\frac{\beta}{1-\beta}\frac{\mu + \delta - w_y}{r+s+\tau_y}. \tag{30}$$

From plugging eq. (29) into eq. (25) and eq. (30) into eq. (26) we get the wage equation presented in the text:

$$w_o = \frac{(1-\beta)\,b + \beta\mu\left[1 + \frac{\theta q(\theta)}{r+s+\tau_o}\right]}{1 + \beta\frac{\theta q(\theta)}{r+s+\tau_o}},$$

$$w_y = \frac{(1-\beta)\,b + \beta\,(\mu+\delta)\left[1 + \frac{\theta q(\theta)}{r+s+\tau_y}\right]}{1 + \beta\frac{\theta q(\theta)}{r+s+\tau_y}}.$$

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Table 2: Estimation results for the Beveridge curve and job creation curve

	BC				JC			
	Panel		Panel IV		Panel		Panel IV	
constant	1.578‡	(0.288)	0.211	(0.419)	-3.945‡	(1.079)	-4.737‡	(1.343)
$\log(u_{it-1})$	0.583‡	(0.026)	0.550‡	(0.032)				
$\log(\theta_{it-1})$					0.593‡	(0.044)	0.536‡	(0.050)
$\log(v_{it})$	-0.216‡	(0.010)	-0.231‡	(0.013)				
b_{it}	-0.087	(0.078)	-0.036	(0.110)	0.272	(0.289)	0.223	(0.344)
ud_{it}	1.243‡	(0.169)	1.793‡	(0.213)	-0.025	(0.503)	-0.921$^{\sharp}$	(0.563)
bc_{it}	0.025	(0.017)	0.063‡	(0.022)	-0.106†	(0.053)	-0.070	(0.059)
ep_{it}	-0.290‡	(0.080)	-0.256†	(0.107)	1.966‡	(0.290)	2.017‡	(0.333)
r_{it}	-0.095	(0.144)	0.174	(0.162)	-1.551†	(0.660)	-0.485	(0.699)
gdp_{it}	-1.615‡	(0.121)	-1.293‡	(0.143)				
oil_{it}					-0.112‡	(0.023)	-0.135‡	(0.025)
cp_{it}					-0.017	(0.225)	-0.093	(0.257)
$epro_{it}$	-2.250‡	(0.272)	-2.160‡	(0.304)	4.499‡	(0.911)	5.932‡	(1.045)
$trend_t$	0.014‡	(0.272)	0.022‡	(0.002)	-0.019‡	(0.006)	-0.025‡	(0.007)
$\tilde{p}_{aus,t}$	-0.562‡	(0.208)	-0.448$^{\sharp}$	(0.250)	0.663	(1.093)	0.920	(1.191)
$\tilde{p}_{can,t}$	2.057‡	(0.269)	3.233‡	(0.435)	2.468†	(1.112)	3.615‡	(1.326)
$\tilde{p}_{fin,t}$	0.696†	(0.341)	1.472‡	(0.542)	-1.830†	(0.906)	-2.948‡	(1.098)
$\tilde{p}_{fra,t}$	-1.373‡	(0.308)	-1.319‡	(0.443)	3.024‡	(1.252)	3.123†	(1.461)
$\tilde{p}_{ger,t}$	-0.703‡	(0.262)	-0.925‡	(0.383)	-4.797‡	(0.689)	-3.436‡	(1.081)
$\tilde{p}_{jap,t}$	-2.247‡	(0.467)	-0.104	(0.825)	1.197	(1.775)	14.930‡	(3.369)
$\tilde{p}_{net,t}$	-1.144‡	(0.441)	-0.135	(0.707)	-7.015‡	(1.673)	-4.110$^{\sharp}$	(2.256)
$\tilde{p}_{nor,t}$	-2.678‡	(0.670)	-1.134	(1.317)	-1.434	(2.156)	-5.211	(3.314)
$\tilde{p}_{por,t}$	-1.186‡	(0.304)	-1.103‡	(0.438)	0.364	(1.024)	1.930	(1.404)
$\tilde{p}_{spa,t}$	3.581‡	(0.916)	8.089‡	(1.661)	-17.811‡	(4.206)	-34.486‡	(5.437)
$\tilde{p}_{swe,t}$	0.905‡	(0.281)	1.280‡	(0.383)	-4.672‡	(0.700)	-3.126‡	(0.814)
$\tilde{p}_{usa,t}$	1.972‡	(0.408)	3.464‡	(0.870)	2.021	(1.478)	4.215†	(1.827)
adj. R^2	0.993		0.993		0.977		0.977	
LLC	-9.725	(0.000)	-9.706	(0.000)	-12.105	(0.000)	-12.271	(0.000)
ADF-Fischer	125.246	(0.000)	124.995	(0.000)	162.407	(0.000)	169.945	(0.000)
Sargan Test			15.869$^{\flat}$				30.960$^{\flat}$	
J-Statistic			13.640$^{\flat}$				25.143$^{\flat}$	
R^2 1. stage			0.908				0.962	

Notes: All regressions with fixed effects, observations: BC = 276 (period 1977-1999) and JC = 264 (period 1978-1999), $\ddagger$, $\dagger$, $\sharp$ = 1%, 5%, 10% significance level, $\flat$ = null hypothesis of exogeneity is not rejected, for unit root tests probability of unit root are provided in parenthesis, LLC = Levin Lin and Chu t-test, instruments: working-age population-share of the young and employment population share of the young.

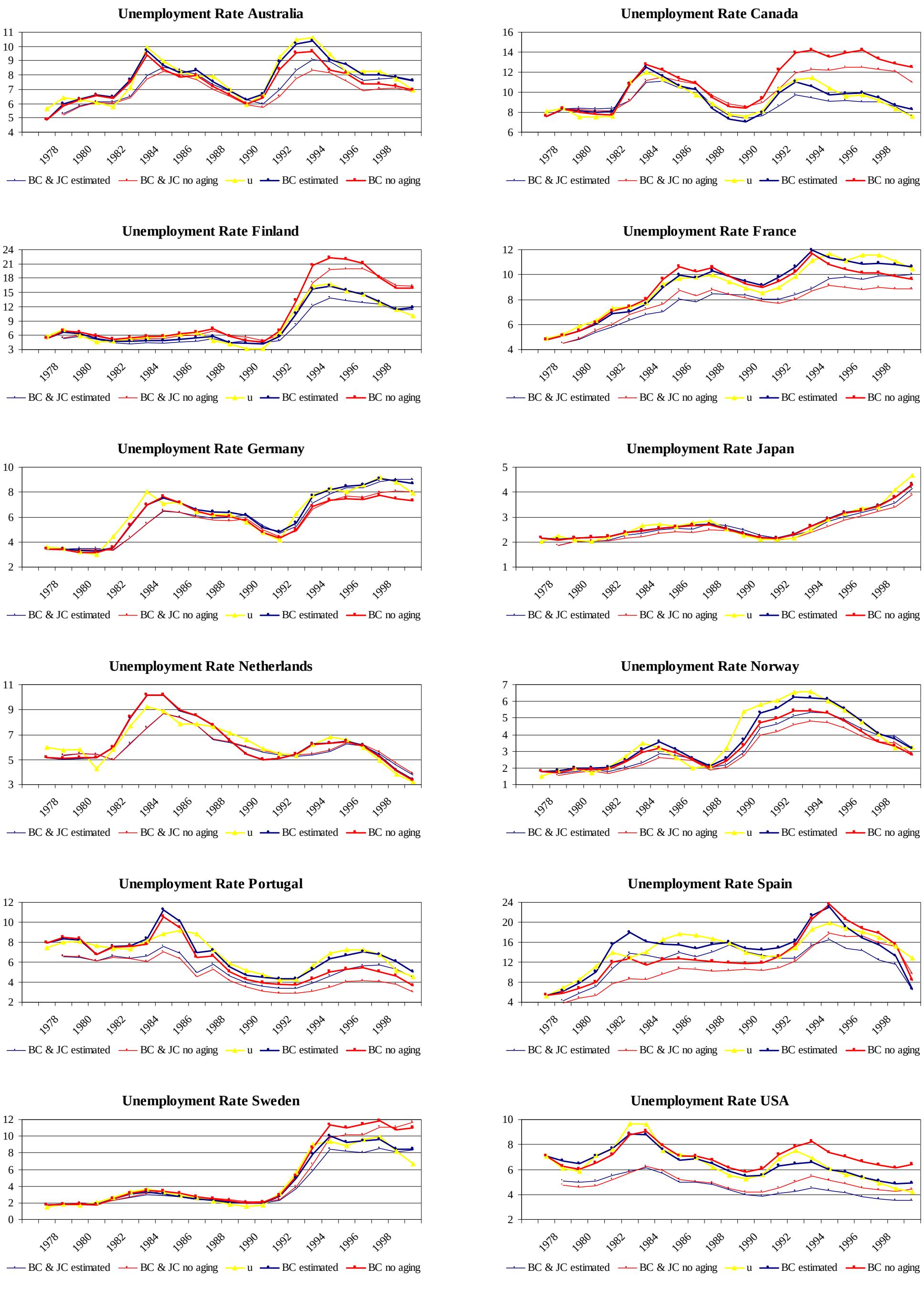

Figure 4: Unemployment rates with and without aging

Table 3: Changes in the equilibrium unemployment rate due to aging

	direct (BC)		indirect (JC)	total	regime
Australia	$+^{\sharp}$	>	$+$	$+$	1
Canada	$-^{\ddagger}$	>	$+^{\ddagger}$	$-$	2
Finaland	$-^{\ddagger}$	>	$-^{\ddagger}$	$-$	3
France	$+^{\ddagger}$	>	$+^{\dagger}$	$+$	1
Germany	$+^{\ddagger}$	>	$-^{\ddagger}$	$+$	4
Japan	$+$	<	$+^{\ddagger}$	$+$	1
Netherlands	$+$	<	$-^{\sharp}$	$-$	4
Norway	$+$	>	$-$	$+$	4
Portugal	$+^{\ddagger}$	>	$+$	$+$	1
Spain	$-^{\ddagger}$	>	$-^{\ddagger}$	$-$	3
Sweden	$-^{\ddagger}$	>	$-^{\ddagger}$	$-$	3
USA	$-^{\ddagger}$	>	$+^{\dagger}$	$-$	2

Notes: ‡, †, $^{\sharp}$ = 1%, 5%, 10% significance level.

Table 4: Estimation results for BC and JC without age effects

	BC		JC	
constant	1.606‡	(0.250)	-2.770‡	(0.752)
$\log(u_{it-1})$	0.671‡	(0.026)		
$\log(\theta_{it-1})$			0.669‡	(0.042)
$\log(v_{it})$	-0.164‡	(0.011)		
b_{it}	0.126†	(0.061)	0.178	(0.178)
ud_{it}	0.444‡	(0.128)	-0.202	(0.284)
bc_{it}	0.024	(0.016)	-0.027	(0.038)
ep_{it}	-0.236‡	(0.064)	0.288	(0.219)
r_{it}	-0.071	(0.162)	-2.564‡	(0.565)
gdp_{it}	-1.854‡	(0.148)		
oil_{it}			-0.098‡	(0.020)
cp_{it}			-0.387‡	(0.181)
$epro_{it}$	-1.979‡	(0.255)	3.902‡	(0.818)
$trend_t$	0.008‡	(0.001)	-0.011‡	(0.004)
adj. R^2	0.991		0.970	

Notes: All regressions with fixed effects, observations: BC = 276 (period 1977-1999) and JC = 264 (period 1978-1999), ‡, †, $^{\sharp}$ = 1%, 5%, 10% significance level.