

# Retraining the Unemployed in a Matching Model with Turbulence \*

Felix Reichling  
Stanford University

First Version: February 7, 2005

This Version: March 24, 2005

## Abstract

I investigate to what degree differences in retraining opportunities are responsible for the divergence of unemployment rates between the U.S. and Europe since the early 1980s. I provide some evidence for higher retraining rates in the U.S. as compared to Europe and further show that there is tremendous heterogeneity across OECD countries with respect to retraining. In my model, unemployed workers not only search for jobs but also for suitable retraining programs. I find that when it becomes more difficult to find suitable retraining programs, enrollment rates, productivity and the unemployment rate decline. Furthermore, this paper is the first attempt to investigate the role of retraining in economies that are subject to economic turbulences as described by Ljungqvist and Sargent (1998, 2004). Using a similar parametrization as Ljungqvist and Sargent (2004), I find that the generosity of unemployment benefits, the main driving force in their model, is not an important determinant of unemployment, even during tumultuous economic times, if sufficiently good retraining institutions are available. Economies with more flexible retraining institutions adjust better to economic turbulence, and as a result, feature lower unemployment rates and higher productivity and output. My results suggest that differences in retraining opportunities play an important role in explaining cross-country differences in unemployment rates.

---

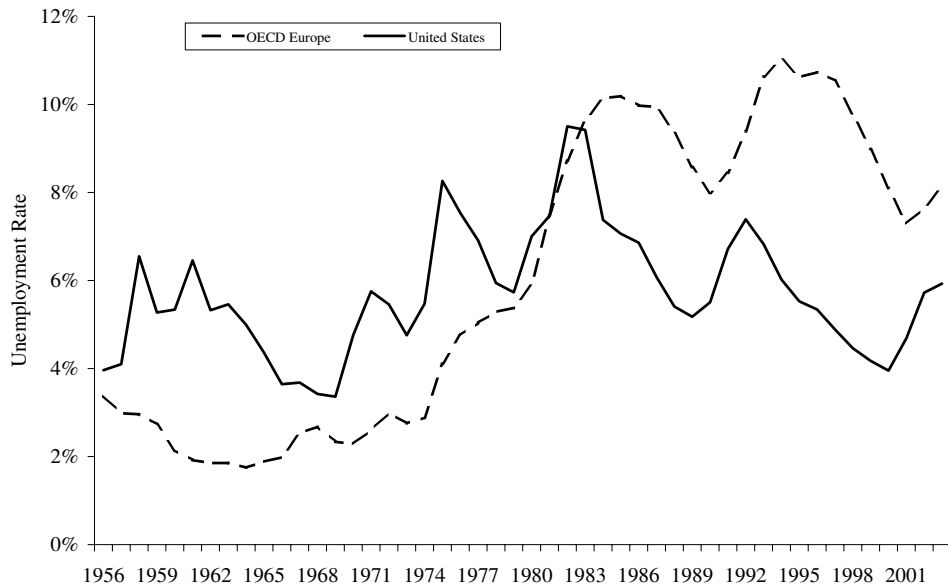
\*I thank Robert E. Hall for his generous support and outstanding advice and guidance throughout this project. I further thank Ute Breden, Pete Klenow, Narayana Kocherlakota, Masaki Nakabayashi, and Michèle Tertilt for helpful discussions.

## 1 Introduction

Unemployment in Europe started to emerge as a problem in the early 1980s. For the prior three decades, the unemployment rate in Europe was considerably lower than that in the United States. Since 1983, however, Europe has had consistently higher unemployment rates than the U.S., reaching levels as high as 11 percent in the early 1990s (see Figure 1). The timing and magnitude of this increase, however, varies greatly across countries. While some countries experienced a sharp increase in unemployment from the 1970s to the 1980s, others experienced similar increases only one decade later. Some of the countries that experienced increasing unemployment rates from the 1970s to the 1980s were able to decrease their rates significantly by the 1990s, while others have not seen any significant changes in their unemployment rates over the last 40 years.

In attempting to explain Europe's unemployment experience since the 1970s researchers have focused on three different approaches: the effects of adverse economic shocks, the role of labor market institutions, and the interaction between them (see Bean, 1994, for a survey). Early work using adverse shocks as an explanation includes Blanchard et al. (1986). The authors argue that, among other factors, a sharp decrease in aggregate demand caused the increase in European unemployment. However, the strong persistence of the unemployment rates suggests that this explanation is not sufficient. Other shocks considered in the literature include technological change, decreasing TFP growth, an increase in the real interest rate, a shift in labor demand, and oil price shocks (see Blanchard and Wolfers, 2000, for a discussion). While adverse economic shocks are able to explain increases in unemployment rates, most of them affected not only European countries, but the U.S. as well. The question remains why these shocks would lead to such different outcomes in the U.S. and Europe.

Another approach focuses on differences in institutions. The main argument is that European welfare institutions and labor market rigidities are responsible for creating higher unemployment in Europe by distorting the wage structure, incentives to work and the propensity of firms to hire workers (see Nickell, 1997, and Siebert, 1997). Institutions often held responsible for these labor market rigidities include high levels of employment protection, generous unemployment benefits combined with long entitlement durations, high tax rates, and extensive union powers. There are several problems with this approach. Schettkat (2003), for example, compares the very different experiences of Germany and the Netherlands. Despite the fact that welfare state institutions in the Netherlands are more generous than in Germany, the Netherlands, unlike Germany, has experienced a declining unemployment rate since the early 1980s. Schettkat concludes that "differences in the incentive structures between the two economies cannot explain the differences in



Source: OECD Annual Labor Force Statistics, Part II, own calculations.

Figure 1: Unemployment Rates, 1956-2003

employment success” (p. 771).

Another problem with the institutions approach is that of timing. While most European welfare states have become less generous since the 1970s, unemployment rates have increased over the same period. It is not obvious why institutions that once produced very low levels of unemployment now produce so much higher levels in some countries. Thus, differences in institutions alone cannot explain unemployment differences between Europe and the U.S. (also see Blanchard, 1999).

The shortcomings of the previous two approaches prompted many researchers to consider the interaction of economic shocks with institutions. This approach is attractive because shocks can potentially explain the general increase in unemployment, while differences in institutions can potentially explain differences in outcomes across countries. Blanchard and Wolfers (2000) and Nunziata (2002) explore the interaction of institutions with macroeconomic shocks such as a decrease in TFP growth, an increase in the real interest rate, and a shift in labor demand. The institutions they consider include unemployment insurance, employment protection, tax rates, and unionization. Both find that these interactions are able to explain much of the evolution of unemployment across countries and times. However, their estimated effects do not appear to be very robust (Nunziata, p. 37).

Ljungqvist and Sargent (1998), on the other hand, explore the interaction between microeconomic shocks and European welfare state institutions. They argue that the oil price shocks of the 1970s, a shift from manufacturing to services, the spread of new information technologies, and a decrease in government regulations, among other factors, have made the economic environment more turbulent since the 1970s. They focus on the interaction between generous European unemployment benefits and an increase in economic turbulence, arguing that the European problem is the result of a supply side response to an increase in economic turbulence. In their model, workers' wages are determined by their level of human capital and productivity draws from a common distribution. They model an increase in economic turbulence as an increase in the probability of skill loss upon layoff. Since workers have no ability to retrain in their economy but receive unemployment compensation that depends on their last earnings, workers who lose enough human capital are very unlikely to ever accept another job. The treatment of human capital is central to their mechanism. While this paper explains the evolution of unemployment differences between Europe and the U.S. extremely well, the authors use several questionable assumptions. Section 5 revisits Ljungqvist and Sargent's model and shows how changes in their key assumptions would alter their results.

My own research adds another, so far little explored, dimension to this literature. I investigate to what degree differences in retraining opportunities are responsible for the divergence of unemployment rates between the U.S. and Europe. In my model, unemployed workers search for jobs as well as suitable retraining programs. I find that when it becomes more difficult to locate suitable retraining programs, enrollment rates, productivity and the unemployment rate decline. As it becomes harder to find suitable training programs, the value of remaining unemployed decreases, prompting unemployed workers to accept jobs at higher rates. Productivity declines as fewer low-skilled workers enroll in training programs and upgrade their skill to the higher skill level.

Furthermore, this paper is the first attempt to investigate the role of retraining in economies that are subject to economic turbulences as described by Ljungqvist and Sargent (1998, 2004). Using a similar parametrization as Ljungqvist and Sargent (2004), I find that the generosity of unemployment benefits, the main driving force in their model, is not an important determinant of unemployment, even during tumultuous economic times, if sufficiently good retraining institutions are available. Economies with more flexible retraining institutions adjust better to economic turbulence, and as a result, feature lower unemployment rates and higher productivity and output. An increase in economic turbulence leads to a decrease in unemployment rates a model calibrated to the European economy, while it leads to a very slight increase in unemployment in the U.S. economy. Economies in which unem-

ployed workers have the ability to retrain feature lower unemployment rates than similar non-training economies. As economic turbulence increases, retraining becomes less attractive and the probability of finding a suitable training opportunity decreases, leading to a decline in the value of being unemployed. As a result, the job finding rate in the training economies increases with turbulence, leading to a lower unemployment rate than in non-training economies.

These results suggest that differences in retraining institutions might play an important role in explaining cross-country differences in unemployment rates. Countries with more widely available retraining opportunities should have adjusted better to turbulence and feature lower unemployment rates. My results also suggest that economic turbulence as modeled by Ljungqvist and Sargent cannot fully explain the divergence of unemployment rates between the U.S. and Europe.

## **2 Retraining**

In this section, I present different proxies for retraining in OECD countries and review the existing literature. Unfortunately, there is no internationally comparable data on retraining. I define a worker who receives retraining as someone above the age of 30 years who is enrolled in an educational program. My assumption is that somebody who is at least 30 years old is not obtaining her first qualification, but is enrolled in educational courses for retraining purposes. The data I use was extracted from the OECD Online Education Database and does not include “courses or classes for adults that are primarily for general interest or personal enrichment and or for leisure or recreation” (OECD, 2004; p.15). I only use data for the years 1998 to 2002 because earlier data is not comparable. For the remainder of the section, all data I present are for workers 30 years and older. In all my data, the United Kingdom is an extreme outlier. Therefore I also report data for OECD Europe excluding the U.K., which I will simply refer to as OECD Europe in what follows.

### **2.1 Some Facts**

There is tremendous heterogeneity across OECD countries with respect to retraining. Table 1 shows total enrollment in retraining programs as a fraction of the labor force for 18 European countries, as well as Australia, New Zealand, Japan, and the United States. This fraction ranges from 0.1 percent for Japan to 12.8 percent for the U.K. Using this proxy, enrollment rates in the U.S. are more than twice as high as in OECD Europe. Within Europe, Nordic countries have the highest enrollment rates, while southern European countries have among the lowest. Japan

Country	Enrollment as % of total Labor Force	Full-time enrollment as % of unemployment	Full-time enrollment as % of unemployment (excluding Tertiary A)	Fraction of full-time students
Austria	1.9	31.3	6.1	90.8
Belgium	3.8	4.9	1.3	7.4
Denmark	3.1	44.2	30.5	100.0
Finland	5.5	42.4	25.4	100.0
France	0.6	6.9	1.4	100.0
Germany	1.5	14.9	2.0	97.2
Greece	0.0	0.2	0.1	100.0
Iceland	4.4	55.9	36.4	48.3
Ireland	0.2	2.9	2.9	72.2
Italy	1.1	14.6	0.9	98.8
Luxembourg	0.2	1.3	1.3	13.8
Netherlands	2.0	20.7	15.4	34.9
Norway	3.8	53.4	26.6	63.7
Portugal	1.6	5.9	2.2	88.4
Spain	1.6	6.6	0.3	47.5
Sweden	7.5	32.0	20.4	31.8
Switzerland	1.4	24.1	8.8	54.5
United Kingdom	12.8	28.5	22.4	13.0
OECD Europe	3.5	15.6	5.7	35.8
OECD Europe (no UK)	1.7	13.9	3.3	68.9
Australia	6.8	17.8	7.5	11.4
New Zealand	5.3	28.9	15.0	34.3
Japan	0.1	0.0	0.0	0.0
United States	3.9	27.9	14.9	33.7

Source: OECD Education database; OECD Annual Labour Force Statistics, Part III; own calculations.

Table 1: Different Proxies for Retraining (Averages for 1998-2002)

has virtually no workers above the age of 30 enrolled in formal training programs, which suggests that training might be organized within firms. Enrollment rates in Australia and New Zealand, on the other hand, are extremely high, ranging from 5.3 percent in New Zealand to 6.8 percent in Australia. An alternative proxy for retraining presented in Table 1 is full-time enrollment of workers as a fraction of unemployment. According to this proxy, the U.S. has enrollment rates that are approximately twice as high as those in Europe. Again, Nordic countries have the highest enrollment rates, while southern European countries have among the lowest. One drawback of this proxy is that in some countries full-time enrollment consists to a large degree of enrollment in Tertiary A courses, the equivalent of college in the U.S. (see Appendix for definitions and details). A high fraction of

enrollment in Tertiary A courses might indicate that many of these students are still in the process of finishing their first university degree.

To correct for this potential shortcoming, I also present a third proxy of retraining. Table 1 also shows full-time enrollment, excluding Tertiary A enrollment, as a fraction of unemployment. According to this proxy, enrollment for some European countries such as Austria, France, Germany, Italy, and Spain is reduced by up to 96 percent. Without Tertiary A participants, the enrollment rate in the U.S. is about five times higher than in Europe.

The United States and Europe not only differ in enrollment rates, but also in the intensity of retraining programs. As Table 1 shows, U.S. workers enroll in part-time programs at a much higher rate than European workers do. Some countries, such as France, Germany, and Italy, seem to only have full-time programs for adults.

Table 2 points out potentially important differences in the types of retraining programs between the two continents. While in Europe and the U.S. the fraction of total enrolled workers who participate in Tertiary A programs is approximately equal, the United States enrolls a significantly higher fraction in Tertiary B and post-secondary non-tertiary programs. Europe, on the other hand, has much higher enrollment in upper secondary programs. In the U.S. 15.9 percent of enrolled workers above the age of 30 participate in post-secondary programs, as compared to only 2 percent in Europe. There are also tremendous differences within Europe. Belgium, Denmark, Finland, Iceland, Ireland, the Netherlands, Sweden, and the U.K. enroll more than 30 percent of students in upper secondary programs, while France, Germany, and Italy only enroll between 0.1 and 7.4 percent in these programs. The data suggest that France, Germany, and Italy do not have very good infrastructures for continuing training. Almost 70 percent of all European students above the age of 30 years enroll in tertiary A courses, of which the majority are probably still working on their first degree.

To get an idea of whether countries that have high retraining rates are also those with low unemployment rates, I calculated correlations between the aggregate unemployment rates and the proxies for retraining discussed above. The results are presented in Table 3. For each proxy, aggregate unemployment rates are negatively correlated with retraining; that is, more retraining is associated with lower unemployment rates. The correlations between unemployment rates and some of these proxies are quite high, ranging from -0.06 to -0.60. Although these correlations do not imply causality, they do suggest that retraining may have a positive effect on the aggregate unemployment rate. The presented evidence suggests that retraining institutions in the U.S. are more flexible than in Europe. The data show that there are large differences in enrollment rates, which might also imply that the variety of retraining programs, and the associated career paths, is much larger in the U.S. The higher enrollment rate in part-time programs suggests that U.S. workers have

Country	Tertiary		Upper Secondary	Post-secondary non-tertiary
	Tertiary A	Tertiary B		
Austria	78.6	4.7	11.7	5.0
Belgium	7.3	12.2	80.0	0.5
Denmark	43.5	22.4	32.7	1.4
Finland	53.6	5.4	36.3	4.8
France	81.4	10.0	3.8	4.8
Germany	85.6	13.1	0.1	1.1
Greece	10.7	80.9	2.4	5.9
Iceland	46.3	7.1	43.2	3.3
Ireland	0.0	0.0	38.9	61.1
Italy	85.3	0.7	7.4	6.6
Luxembourg	0.0	9.6	9.3	81.1
Netherlands	55.2	1.7	37.6	5.5
Norway	73.8	4.0	19.7	2.5
Portugal	76.3	7.9	15.8	0.0
Spain	82.4	0.4	17.0	0.1
Sweden	36.7	1.6	60.2	1.5
Switzerland	50.0	28.9	11.0	10.1
United Kingdom	11.2	12.6	76.1	0.0
OECD Europe	34.0	10.5	54.6	0.8
OECD Europe (no UK)	67.2	7.4	23.4	2.0
Australia	22.2	10.8	53.8	13.2
New Zealand	28.9	17.0	36.4	17.7
Japan	77.0	6.0	17.1	0.0
United States	65.0	16.0	3.1	15.9

Source: OECD Education database; OECD Annual Labour Force Statistics, Part III;  
own calculations. Note: Fractions of Total Enrollment, full and part time.

Table 2: Level of Education (Averages for 1998-2002)



Type of Enrollment		Unemployment Rate
Total Enrollment, 30+	Full- & Part-Time (as % of LFS)	-0.16
	Full-Time (as % of unempl.)	-0.44
Tertiary A enrollment, 30+	Full- & Part-Time (as % of LFS)	-0.28
	Full-Time (as % of unempl.)	-0.60
Tertiary B, 30+	Full- & Part-Time (as % of LFS)	-0.21
	Full-Time (as % of unempl.)	-0.41
Post-sec. non-tert. Enrollment, 30+	Full- & Part-Time (as % of LFS)	-0.23
	Full-Time (as % of unempl.)	-0.40
Total Upper secondary	Full- & Part-Time (as % of LFS)	-0.06
	Full-Time (as % of unempl.)	-0.41
Total Enrollment w/o Tertiary A, 30+	Full- & Part-Time (as % of LFS)	-0.13
	Full-Time (as % of unempl.)	-0.47

Table 3: Correlations between Enrollment and Unemployment for 1998-2002

more flexibility of when to attend training classes. Furthermore, there are also large differences in retraining across European countries, suggesting that differences in retraining opportunities might help explain cross-country differences in unemployment rates.

## 2.2 Literature

Much of the literature on retraining the unemployed has concentrated on evaluating active labor market programs (ALMP) in which unemployed workers participate in government-provided training programs, often as a condition for the renewal of entitlements to unemployment benefits (e.g. see Calmfors, 1995, p. 590). For survey articles see Calmfors et al. (2002) and Martin (1998). The results of these studies vary greatly. While some programs seem to be very successful, others seem to make matters worse. In my model, I assume that retraining is not provided by the government but instead through private institutions. Therefore, I will not further discuss this line of research.

Coles and Masters (2000) analyze the effects of skill depreciation on the equilibrium level and composition of unemployment and retraining. They develop a continuous-time, Pissarides style matching model with a continuum of workers and free entry of firms. Each period, a fraction of workers retires and an equal fraction newly enters the unemployment pool. All new workers are identical and are initially endowed with the highest possible skill level. If workers remain unemployed, their skills lose relevance over time, which is modeled as a depreciation at a fixed rate. Workers do not lose skills while being employed. Furthermore,

each employer has access to a retraining technology and can retrain a worker at some cost. When an active job seeker and a firm with a vacancy meet, they both observe the job seeker's current skill level. Either the firm or the worker may reject the potential match and continue search. If they desire to form a match, the worker and firm negotiate over the wage, the amount of training and the worker's contribution to training costs. Upon reaching an agreement, both parties leave the market for good. In equilibrium, workers whose skills are below a certain cut-off will never be hired and are unemployable. They stop looking for work. All other workers reach immediate agreement with employers and get trained to the highest level of skill. Coles and Masters suggest that governments should offer positive unemployment benefits to ensure that very low-skilled workers do not search for jobs and thus do not generate negative congestion externalities on the matching rates of higher skilled workers. The positive depreciation of skills implies that governments should subsidize vacancy creation. However, because of the lack of externalities associated with retraining, governments should not subsidize training.

These conclusions heavily depend on how the authors model retraining. If workers could retrain prior to meeting a firm in the matching market, as they can in my model, all three conclusions would probably be overturned. In that case, very low-skilled workers would receive retraining until they were employable. Furthermore, governments should probably subsidize retraining to some extent, since it would increase the rate at which workers find new jobs. The case for subsidizing vacancy creation over retraining might be further weakened if low and high-skilled workers were in different labor markets and would not compete for the same jobs. My model differs from Coles and Masters in two ways. Firstly, I consider retraining of the unemployed explicitly in an economy which is subjected to the kind of economic turbulence proposed by Ljungqvist and Sargent (2004). Secondly, in my model unemployed workers have a choice of whether to retrain prior to meeting a firm. Workers who upgrade their skills do not only increase their earnings potential, but also increase their chance of finding employment.

Masters (2000) develops a model based on Pissarides (1985) that incorporates labor market training. In his model, workers enter the market trained to do two different jobs. After receiving offers they accept jobs that require only one of their skills. Masters assumes that workers instantaneously forget the skill they do not utilize in their current job. As a consequence, a worker who becomes unemployed is only available for employment in the area of his previous employment. Workers can retrain at some cost, which allows them to re-enter the labor market with the same options as a new entrant. Masters shows that if vacancy creation is perfectly elastic, employment necessarily increases with training. If efficiency is desired, the government should not subsidize retraining. If the number of jobs in the economy is fixed, multiple equilibria may exist, providing a role for government interven-

tion.

Krueger and Kumar (2004) analyze the effect of education policy on economic growth. Their claim is that Europe's focus on specific skill acquisition worked well during the 1960s and 1970s when technological progress was relatively slow. However, starting in the 1980s, technological change accelerated and countries that put a greater emphasis on general skill acquisition, such as the U.S., experienced higher growth rates. The key assumption in their model is that only workers with general education are able to operate new production technologies, whereas vocationally trained workers are more efficient in operating established technologies but are unable to operate new ones. In their model, newly born workers make an irreversible choice about what kind of education to receive. Acquiring general education is more costly than acquiring specific skills, but operating newer, more productive technologies is also associated with higher wages. Firms may choose to operate using a well-understood, commonly available technology for which they can hire workers with specific skills. Alternatively, firms may decide to adopt cutting edge technologies at some cost but have to employ workers with general skills. Krueger and Kumar show that as the rate of newly available technologies increases, countries that emphasize vocational training could experience slower growth rates. Although their paper is not directly related to my work, one could reinterpret the idea that vocationally educated workers cannot operate new machinery as the absence of retraining opportunities. In this case, rapid technological progress, which in my model is equivalent to an increase in economic turbulence, could lead to a decrease in growth rates because workers are unable to keep up with technological advances.

### 3 Model

I adopt a standard Diamond (1982), Mortensen (1982) and Pissarides (1985) matching model and extend it to allow for worker heterogeneity and retraining of the unemployed. The basic set-up is similar to Den Haan, Haefke, and Ramey (2004) and Ljungqvist and Sargent (2004). In this environment, time is discrete and the economy is populated by a constant measure one of risk-neutral workers who can obtain two different skill levels  $k$ , where  $k = h$  denotes high skills and  $k = l$  low skills. Each period a measure of  $\rho$  workers retires and a measure of  $\rho$  workers enters the work force with low skills. Workers have two options to upgrade their skills: (1) they can become employed and face a probability  $\gamma^U$  of an upgrade to the high skill level or (2) they can enroll in training programs at per period cost  $\tau$  while being unemployed and face a probability  $\gamma^T$  of upgrading their skill. Employment relationships break up exogenously with probability  $s$ . Upon separation, high-skilled

workers lose their skills with probability  $\gamma^D$ . In every period, unemployed workers are eligible for unemployment benefits  $b_j$ , where the level of benefits depends on the workers' last earnings so that  $j$  denotes the skill level before entering the unemployment pool. Workers must spend a minimum of one period in a high skilled-job in order to be eligible for high unemployment benefits. There are four groups of workers, each one characterized by its skill level and benefit entitlement,  $(k, j)$ : (1) low-skilled workers entitled to low unemployment benefits ( $(l, l)$  workers), (2) formerly high-skilled workers who experienced a skill downgrade upon lay-off and are entitled to high benefits ( $(l, h)$  workers), (3) formerly low-skilled workers who just upgraded to the high skill level and are entitled to low benefits ( $(h, l)$  workers), and (4) high-skilled workers entitled to high benefits ( $(h, h)$  workers).

Production requires an employment relationship between one worker and one firm who produce output  $z$  per period. After meeting in the matching market, new worker-firm pairs choose to accept or reject their matches after observing their initial productivity draw  $z$  from a c.d.f.  $G_k(z)$ , where  $G_h(z)$  first order stochastically dominates  $G_l(z)$ . Bargaining is efficient, so that workers and firms aim to maximize their joint surplus. The division of match surplus is determined by Nash bargain, where the workers' bargaining weight is  $\phi$ .

### 3.1 Matching Market

New matches are formed according to a standard Cobb-Douglas matching function with

$$M(u_{k,j}, v_{k,j}) = A (u_{k,j})^\alpha (v_{k,j})^{1-\alpha}$$

where  $M(u_{k,j}, v_{k,j})$  is the measure of successful matches per period,  $u_{k,j}$  denotes the measure of unemployed workers with skill level  $k$  and benefit entitlements  $b_j$ , and  $v_{k,j}$  is the measure of firms posting vacancies for skill  $k$  workers with benefits  $b_j$ . There are four matching markets, one for each worker group, that use the same technology, with  $A > 0$  and  $\alpha \in (0, 1)$ . A firm's probability of matching with a worker is given by

$$\lambda^f(x_{k,j}) = \frac{M(u_{k,j}, v_{k,j})}{v_{k,j}} = A (x_{k,j})^{-\alpha}$$

where  $x_{k,j} = v_{k,j}/u_{k,j}$  is the vacancy-unemployment ratio. The probability that an unemployed worker matches with a firm is

$$\lambda^w(x_{k,j}) = \frac{M(u_{k,j}, v_{k,j})}{u_{k,j}} = A (x_{k,j})^{1-\alpha}$$

After a match is formed, the initial productivity draw  $z$  is observed. Any draw above the cut-off level  $z_{k,j}^*$ , i.e.  $z \geq z_{k,j}^*$ , is acceptable, and an employment relationship is formed. For draws below the cut-off it is in the mutual interest of both parties to continue searching for a better match. The measure of acceptable jobs is

$$\Pr [z_{k,j} \geq z_{k,j}^*] = \int_{z_{k,j}^*}^{\infty} dG_k(z) = 1 - G_k(z_{k,j}^*)$$

A firm successfully hires a skill  $k$  worker if it matched with a worker and the productivity draw is sufficiently high. The probability of hiring a worker is thus given by

$$h(x_{k,j}) = [1 - G_k(z_{k,j}^*)] \lambda^f(x_{k,j})$$

Workers find new jobs at rate

$$f(x_{k,j}) = [1 - G_k(z_{k,j}^*)] \lambda^w(x_{k,j})$$

The job finding rate could potentially be greater than one, which would be a problem in this model. However, in my numerical simulations, the job finding rate is always within the interval  $[0, 1]$ .

### 3.2 Joint Surplus

Let  $E_{k,j}(z)$  denote the value a  $\{k, j\}$  worker receives from being employed,  $U_{k,j}$  the worker's value of being unemployed, and  $J_{k,j}(z)$  a firm's value of a filled job. The joint surplus from an employment relationship is the sum of the worker's surplus,  $E_{k,j}(z) - U_{k,j}$ , and the firm's surplus,  $J_{k,j}(z)$ . For a  $\{k, j\}$  worker, the joint surplus is thus

$$S_{k,j}(z) = E_{k,j}(z) - U_{k,j} + J_{k,j}(z) \tag{1}$$

I assume that firms can freely enter this economy so that the value of a vacancy is zero in equilibrium. The cut-off  $z_{k,j}^*$  is the level of productivity at which the joint surplus of an employment relationship is zero. Since bargaining results in an efficient allocation, workers and firms aim to maximize the joint surplus and would reject any productivity that would result in negative surplus. The reservation productivity  $z_{k,j}^*$  is the solution to

$$S_k(z_{k,j}^*) = 0$$

### 3.3 Firms

A firm's value of a filled job  $J_{k,j}$  is given by the produced output  $z$  and the expected present value of continuing the employment relationship less the wage  $w_{k,j}(z)$  it has to pay the worker. For a  $\{l, j\}$  firm, a firm that hires low skilled workers who are entitled to either low ( $j = l$ ) or high ( $j = h$ ) unemployment benefits, this value is given by

$$J_{l,j}(z) = z_{l,j} - w_{l,j}(z) + \beta(1-s)[(1-\gamma^U)J_{l,j}(z) + \gamma^U \bar{J}_{h,l}] \quad (2)$$

where  $\bar{J}_{h,l} = \int_{z_{h,l}^*}^{\infty} J_{h,l}(z|z \geq z_{h,l}^*)g_h(z)dz$  is the conditional expectation of  $J_{h,l}(z)$  given that  $z \geq z_{h,l}^*$ . For the remainder of the paper I will denote  $\bar{J}_{k,j}$  and  $\bar{E}_{k,j}$  as the conditional expectations of  $J_{k,j}(z)$  and  $E_{k,j}(z)$ , respectively, given that  $z \geq z_{h,l}^*$ . The time discount factor  $\beta = (1-\rho)/(1+r)$  includes the probability of surviving to the next period,  $(1-\rho)$ . A filled job turns into a vacancy with probability  $s$ . If the employment relationship continues, the worker either receives a skill upgrade with probability  $\gamma^U$  or remains at the current low skill level with probability  $1-\gamma^U$ . After a skill upgrade a worker receives a new productivity draw from the distribution  $G_h(z)$ . An assumption I maintain throughout this paper is that upgraded workers always receive productivity draws above the new cut-off level. This assumption ensures that upgraded workers are not at risk of becoming unemployed. Even after a skill upgrade the worker-firm relationship is maintained. The firm thus expects to receive  $\bar{J}_{h,l}$  with probability  $\gamma^U$  instead of its current value  $J_{l,j}(z)$ . Similarly, the value of a filled job for a  $\{h, j\}$  firm is given by

$$J_{h,j}(z) = z_{h,j} - w_{h,j}(z) + \beta(1-s)J_{h,j}(z) \quad (3)$$

Before a firm can hire any worker, it is required to post a vacancy at cost  $c_{k,j}$ . The assumption that firms can enter freely implies that firms expect to earn zero profits from posting a vacancy in equilibrium. The associate equilibrium condition is given by

$$\beta h(x_{k,j}) \bar{J}_{k,j} = c_{k,j} \quad (4)$$

This equilibrium condition states that the expected benefit of a vacancy, given by  $\beta h(x_{k,j}) \bar{J}_{k,j}$ , equals the cost of posting it,  $c_{k,j}$ .

### 3.4 Workers

A  $\{k, j\}$  worker can either be employed and receive a value of  $E_{k,j}(z)$  or be unemployed and receive  $U_{k,j}$ . In addition, low-skilled unemployed workers may enroll

in retraining programs, receiving a value of  $R_j$ . A  $\{l, j\}$  worker's value of being employed is given by

$$E_{l,j}(z) = w_{l,j}(z) + \beta[sU_{l,l} + (1-s)(\gamma^u \bar{E}_{h,l} + (1-\gamma^u)E_{l,j}(z))] \quad (5)$$

Both types of low-skilled workers have similar continuation values because  $\{l, h\}$  workers lose their entitlements to high unemployment benefits after working one period as low skilled workers. For  $\{h, j\}$  workers, the value of being employed is

$$E_{h,j}(z) = w_{h,j}(z) + \beta[s(\gamma^d U_{l,h} + (1-\gamma^d)U_{h,h}) + (1-s)E_{h,j}(z)] \quad (6)$$

Again, the continuation value for both types of high skilled workers are similar because  $\{h, l\}$  workers become eligible for high benefits after one period of employment.

Unemployed workers receive unemployment benefits  $b_j$  and search for new jobs. Benefits depend on the workers' last earnings. As a simplification I take  $b_j = \delta \bar{w}_{j,j}$ , where  $\delta \in (0, 1)$  is the replacement ratio and  $\bar{w}_{j,j}$  denotes the average wage of a  $(j, j) = \{(l, l), (h, h)\}$  worker. Low-skilled unemployed workers also search for suitable training programs that allow them to upgrade their skills. Unemployed workers always take acceptable job offers. Only when they have not receive any acceptable job offers will they consider enrolling in training programs. The value of a  $\{l, j\}$  worker of being unemployed is given by

$$U_{l,j} = b_j + \beta[f(x_{l,j}) \bar{E}_{l,j} + (1-f(x_{l,j}))\{(1-F(o_j^*))\bar{R}_j + F(o_j^*)U_{l,j}\}] \quad (7)$$

where  $o_j \in [0, 1]$  represents the quality of the training opportunity. With probability  $1 - F(o_j^*)$  this opportunity is better than the threshold  $o_j^*$  and the worker enrolls in the training program and expects to receive  $\bar{R}_j$ , where  $\bar{R}_j$  is the conditional expectation of  $R_j(o_j)$  given that  $o_j \geq o_j^*$ .

The value of a  $\{h, j\}$  worker of being unemployed is given by

$$U_{h,j} = b_j + \beta[f(x_{h,j}) \bar{E}_{h,j} + (1-f(x_{h,j}))U_{h,j}] \quad (8)$$

### 3.5 Training

As mentioned above, low-skilled unemployed workers may choose to enroll in training programs at a per period cost  $\tau$  to upgrade from low to high skill levels. Every period, unemployed workers learn about training opportunities. The quality of this opportunity, denoted by  $o_j$ , may depend on several factors. For example, workers might have very specific preferences over future career paths. Training opportunities that provide skills for less preferable careers might then be regarded as low quality opportunities. Other factors may include the reputation of the training

institution, admissions standards, and the distance to the training facility. Every period  $o_j$  is drawn from a c.d.f.  $F(o)$ .

Once an acceptable opportunity is found and a worker enrolls in the training program, there is a probability  $\gamma^T$  that her efforts will be successful. With probability  $1 - \gamma^T$  retraining will be unsuccessful and the worker will remain low-skilled. A worker's value of retraining,  $R_j(o_j)$ , is given by

$$R_j(o_j) = b_j + \gamma^T [U_{h,j} - b_j] + (1 - \gamma^T)\beta[f(x_{l,j})\bar{E}_{l,j} + (1 - f(x_{l,j}))((1 - F(o_j^*))R_j(o_j) + F(o_j^*)U_{l,j})] - \frac{\tau}{o_j} \quad (9)$$

I assume that enrolled workers continue to receive unemployment benefits. When a worker successfully upgrades her skill, she receives the continuation value of a high skilled unemployed worker,  $U_{h,j} - b_j$ , in the next period. If the retraining is unsuccessful, the worker receives the continuation value of a low-skilled worker in the next period, with one difference. I interpret a draw of  $o_j \geq o_j^*$  by an enrolled worker as remaining in the current training program. In this case, the worker will receive exactly the same value, e.g.  $R_j(o_j)$  and not  $\bar{R}_j$ . Hence, workers search for employment while being enrolled and decide whether to drop out or not, i.e. they do not necessarily have to spend time being unemployed in order to find a job. The total cost of retraining is  $\tau/o_j$ , where  $\tau$  can be interpreted as a tuition cost. Total cost is inversely related to the quality of the training opportunity. If  $o_j = 1$ , the education program is a perfect fit for the worker and the only remaining cost is  $\tau$ . If  $o_j < 1$ , the opportunity is a less than perfect fit and implies a worker's lower willingness to take up retraining. In the model, this lower willingness is equivalent to a higher cost of retraining.

The expected surplus from enrolling in a retraining program is given by

$$S^T(o_j) = R_j(o_j) - U_{l,j} \quad (10)$$

Workers enroll in retraining courses if they expect to receive a higher value from enrolling than from remaining unemployed, i.e. if  $S^T(o_j) \geq 0$ . The cut-off level  $o_j^*$  of acceptable retraining opportunities is then defined as the solution to

$$S^T(o_j^*) = 0$$

### 3.6 Transition Equations

In this section I present the steady-state equations for the different groups of unemployed, employed, and enrolled workers. There are four unemployment groups, four employment groups, and two enrollment groups, which are denoted by  $u_{l,l}$ ,



$u_{l,h}$ ,  $u_{h,l}$ ,  $u_{h,h}$ ,  $e_{l,l}$ ,  $e_{l,h}$ ,  $e_{h,l}$ ,  $e_{h,h}$ ,  $r_{l,l}$ , and  $r_{l,h}$ . Just like above, the first subscript indicates the skill level and the second the level of unemployment benefits. For the computation of average productivity levels I would principally also have to keep track of workers who started employment in  $e_{l,h}$  or  $e_{h,l}$  and transitioned into the  $e_{l,l}$  or  $e_{h,h}$  groups. These workers have different productivities than workers entering the  $e_{l,l}$  or  $e_{h,h}$  groups directly. The differences in productivity arise from differences in acceptance rates, i.e. these workers require higher (or lower) productivity draws in order to accept job offers. However, for the sake of simplicity I abstract from these differences as the flow of these workers is very small so that the results would not be affected. The main points of the following exercises would be unchanged. Each of the following steady-state equations has the same format, with inflows on the left and outflows on the right.

The  $u_{l,l}$  state:

$$\begin{aligned} & \rho + (1 - \rho)\{s(e_{l,l} + e_{l,h}) + (1 - \gamma^T)(1 - f(x_{l,l}))F(o_l^*)r_l\} \\ & = \{\rho + (1 - \rho)(f(x_{l,l}) + (1 - f(x_{l,l}))(1 - F(o_l^*)))\}u_{l,l} \quad (11) \end{aligned}$$

The flow into the  $u_{l,l}$  state consists of two groups. The first one includes low-skilled employed workers who lost their jobs, while the second group consists of workers in retraining who did not upgrade to the high skill level, did not find jobs as low-skilled workers and were unable to find other suitable training opportunities. I make the assumption that enrolled workers search for jobs and new retraining opportunities in every period. If they do not upgrade to the higher skill level, but instead find an acceptable job, they take it over any retraining opportunity<sup>1</sup>. This assumption is also reflected on the right side of the equation. Only workers who do not find suitable jobs consider enrolling in retraining. The flow out of the  $u_{l,l}$  state consists of three groups: retirees, unemployed workers who find jobs, and unemployed workers who enroll in retraining programs. The transition equation for the  $u_{l,h}$  state is very similar.

The  $u_{l,h}$  state:

$$\begin{aligned} & (1 - \rho)\{s\gamma^D(e_{h,h} + e_{h,l}) + (1 - \gamma^T)(1 - f(x_{l,h}))F(o_h^*)r_h\} \\ & = \{\rho + (1 - \rho)(f(x_{l,h}) + (1 - f(x_{l,h}))(1 - F(o_h^*)))\}u_{l,h} \quad (12) \end{aligned}$$

The  $u_{h,l}$  state:

$$(1 - \rho)\gamma^T(1 - f(x_{h,l}))r_l = \{\rho + (1 - \rho)f(x_{h,l})\}u_{h,l} \quad (13)$$

---

<sup>1</sup>In steady-state, the average value of being employed as a low-skilled worker is higher than the average value of being in retraining.

The  $u_{h,h}$  state:

$$(1 - \rho) \{s(1 - \gamma^D)(e_{h,h} + e_{h,l}) + (1 - f(x_{h,h}))\gamma^T r_h\} \\ = \{\rho + (1 - \rho)f(x_{h,h})\} u_{h,h} \quad (14)$$

The  $e_{l,l}$  state:

$$(1 - \rho) \{f(x_{l,l}) u_{l,l} + (1 - \gamma^T)f(x_{l,l}) r_l + (1 - s)(1 - \gamma^U)e_{l,h}\} \\ = \{\rho + (1 - \rho)(s + (1 - s)\gamma^U)\} e_{l,l} \quad (15)$$

The  $e_{l,h}$  state:

$$(1 - \rho) \{f(x_{l,h}) u_{l,h} + (1 - \gamma^T)f(x_{l,h}) r_h\} = e_{l,h} \quad (16)$$

Note that workers can spend at most one period in the  $e_{l,h}$  or  $e_{h,l}$  state. After one period they either retire, lose their job, or transition into the  $e_{l,l}$  or  $e_{h,h}$  groups, respectively.

The  $e_{h,l}$  state:

$$(1 - \rho) \{(1 - s)\gamma^U(e_{l,l} + e_{l,h}) + f(x_{h,l}) u_{h,l} + \gamma^T f(x_{h,l}) r_l\} = e_{h,l} \quad (17)$$

The  $e_{h,h}$  state:

$$(1 - \rho) \{f(x_{h,h}) u_{h,h} + (1 - s)e_{h,l} + \gamma^T f(x_{h,h}) r_h\} = \{\rho + (1 - \rho)s\} e_{h,h} \quad (18)$$

The  $r_l$  state:

$$(1 - \rho)(1 - f(x_{l,l}))(1 - F(o_l^*))u_{l,l} = \{\rho + (1 - \rho)(\gamma^T \\ + (1 - \gamma^T)(f(x_{l,l}) + (1 - f(x_{l,l}))F(o_l^*)))\} r_l \quad (19)$$

The  $r_h$  state:

$$(1 - \rho)(1 - f(x_{l,h}))(1 - F(o_h^*))u_{l,h} = \{\rho + (1 - \rho)(\gamma^T \\ + (1 - \gamma^T)(f(x_{l,h}) + (1 - f(x_{l,h}))F(o_h^*)))\} r_h \quad (20)$$

## 4 Calibration

In this section I calibrate my model in two different ways. One resembles the U.S. economy while the other mimics a typical European economy. Both economies share a set of common parameters, which I take to a large degree from Ljungqvist

and Sargent (2004) in order to compare my results better with theirs. Both economies differ, however, in three important ways: (1) separation rates, (2) unemployment benefit replacement ratios, and (3) retraining enrollment rates. In my model these differences are captured by the parameters  $s$ ,  $\delta$ , and  $\tau$ , respectively, and imply, together with restrictions on  $\lambda^w$ , differences in the matching efficiency parameter  $A$  and the vacancy creation costs  $c$ . Before I discuss the country-specific parameters I present parameters common to both economies.

#### 4.1 Common Parameters

I set the model period to be one month and assume an annual interest rate of 5.0 percent, or  $r = 0.004074$ . Workers' life spans are geometrically distributed with an expected duration of 50 years, implying  $\rho = 0.001667$ . These two parameters determine the monthly discount factor  $\beta = 0.9942$ . Following Ljungqvist and Sargent (2004), I set the workers' bargaining power to  $\phi = 0.50$  and choose a monthly probability of skill upgrade of  $\gamma^U = 0.01$ , so that it takes on average 8 years and 4 months, conditional on no job loss, to move from the low skill level to the high skill level. Both skill groups draw productivities from uniform distributions with identical standard deviations of  $1/\sqrt{12}$  but different means. The mean productivity for low-skilled workers is 1, while that of high-skilled workers is twice as high. I set the monthly probability of skill loss to  $\gamma^D = 0.10$ , which is the same as the 10 percent per quarter used by Den Haan, Haefke, and Ramey (2004). Following Shimer (2005), I set the elasticity of the matching function to  $\alpha = 0.72$  which is also well within the range of estimates for European economies. Burda and Wyplosz (1994) report estimates for France, Germany, Spain, and the U.K. between 0.70 and 0.80 when imposing constant returns. The survey by Petrongolo and Pissarides (2001) shows that these estimates lie at the upper end of estimates for the elasticity of matching with respect to unemployment. Finally, I set  $\gamma^T = 0.04$  and the distribution of training opportunities to be uniformly distributed over the unit interval. Conditional on not leaving the training program, it takes on average 25 months to upgrade to the higher skill level. This is four times faster than upgrading on the job. A summary of these parameters can be found in Table 4.

#### 4.2 Country Specific Parameters

In Ljungqvist and Sargent (1998) the U.S. "laissez-faire" economy and the European "welfare state" differ only in the level of the unemployment benefit replacement ratio. They pick replacement ratios of 50 percent for the U.S. and 70 percent for the European economy. While certain groups of unemployed workers face very high replacement ratios in Europe, they are usually old workers who had relatively

<b>Parameter (monthly rates)</b>	<b>Value</b>
Interest rate, $r$	0.00407
Retirement probability, $\rho$	0.00167
Worker's bargaining weight, $\phi$	0.5
Probability of skill upgrade, $\gamma^U$	0.01
Probability of skill downgrade, $\gamma^D$	0.1
Probability of training success, $\gamma^T$	0.04
Uniform productivity distribution	
mean for low-skill workers, $E(z_l)$	1.0
mean for high-skill workers, $E(z_h)$	2.0
standard deviation, $\sigma^z$	$12^{-(1/2)}$
Elasticity of the matching function, $\alpha$	0.72

Table 4: Common Parameter Values

low earnings prior to getting laid-off. Martin (1996) presents data for gross replacement rates that are considerably lower than the replacement rates used by Ljungqvist and Sargent. Martin also reports an estimate of the average unweighted net replacement ratio of 50 percent for OECD countries in 1994/95. Despite the evidence for lower replacement ratios, I use the same values Ljungqvist and Sargent proposed for better comparability.

The separation rate is another important difference between the two economies. Table 5 suggests that the monthly U.S. separation rate lies between 2.3 and 3.2 percent, while Shimer (2005) reports an average separation rate of 3.4 percent per month using data from 1951 to 2003. Abowd and Zellner (1985) find a separation rate of 3.42 percent for the period between 1972 and 1982. In light of this evidence, I set the monthly separation rate for my U.S. calibration to be 3.4 percent. This number is considerably higher than the 1.8 percent used by Ljungqvist and Sargent (1998). Table 5 also suggests that separation rates in Europe are considerably lower than those in the U.S. Sweden had rates below 1 percent in the 1970s and 1980s, while Finland and Norway had rates around 1 percent. France and Spain had separation rates between 1 percent and 1.6 percent. The unweighted OECD average between 1970 and 2003 was 1.4 percent and that of the G7 countries was 1.8 percent. Zimmermann (1998) reports values for Germany ranging from 0.58 percent in 1991 to 0.88 percent in 1981. In light of this evidence I set the separation rate to  $s = 0.01$  for the European economy.

Evidence presented earlier suggests that both economies also differ in the number of workers enrolled in retraining programs. I calibrate the parameter  $\tau$  such that

	1970s	1980s	1990s	2000-2003	1970-2003
Australia	2.1	1.7	1.7	1.3	1.7
Canada	3.5	3.7	3.3	3.0	3.4
Czech Republic			0.7	0.7	0.7
Finland		1.1		1.3	1.8
France		1.0	1.5	1.2	1.3
G7 countries	1.9	2.0	1.7	1.6	1.8
Hungary				0.6	0.6
Mexico			2.5	1.7	2.2
North America	3.0	3.2	2.4	2.1	2.8
Norway			1.0	1.2	1.1
Oceania	0.7	0.5	0.4	0.7	0.5
OECD countries	1.7	1.5	1.1	1.0	1.4
Poland			1.8	2.4	2.0
Slovak Republic			1.5	2.2	1.8
Spain	1.0	1.5	1.6	1.0	1.5
Sweden	0.2	0.2			0.2
United States	3.0	3.2	2.4	2.3	2.8

Source: OECD, own calculations.

Table 5: Average Job Losing Rates in Percent of Employed

the total enrollment equals 3 percent of the labor force in the U.S. economy and 1 percent of the labor force in Europe.

There are five parameters left to calibrate: The efficiency of the matching function,  $A$ , and the four recruiting costs  $c_{j,k}$ . For each economy, I restrict all four worker matching probabilities  $\lambda^w$  to be the same at the calibration point. Unfortunately, I am unable to use the same matching probabilities for all four economies. The model including retraining is very tightly parameterized, so that I simply pick values that work. The probability of matching is not very important to show the qualitative effects retraining has on my economies. I take  $\lambda^w = 0.40$  for the U.S. and  $\lambda^w = 0.50$  for the European training economy. These values are considerably higher than the 30 percent used by Ljungqvist and Sargent (2004). Furthermore I restrict the (unweighted) mean of the recruiting costs to 7 percent of the average annual wages, a number used by Joseph et al. (2004) and similar to Mortensen and Pissarides (1999). The resulting parameters of this calibration can be found in Table 6.

In order to compare the training and non-training economies, I calibrate a version of my model without retraining in the same way described above. However, calibrating the training and non-training economies to the same unemployment

<b>Parameter (monthly rates)</b>	<b>U.S. with retraining</b>	<b>U.S. without retraining</b>	<b>Europe with retraining</b>	<b>Europe without retraining</b>
Separation rate, $s$	3.4%	3.4%	1.0%	1.0%
Benefit replacement rate, $\delta$	50%	50%	70%	70%
Tuition cost, $\tau$	0.65		1.46	
Worker matching probability, $\lambda^w$	0.40	0.37	0.50	0.26
Efficiency of matching, $A$	0.52	0.43	0.68	0.33
<i>Recruiting costs</i>				
$c_{l,l}$	1.10	1.60	1.71	2.09
$c_{l,h}$	0.09	0.72	0.01	0.44
$c_{h,l}$	3.07	2.15	3.67	2.91
$c_{h,h}$	1.98	1.26	1.72	1.25

Table 6: Country Specific Parameter Values

rates requires different matching probabilities for the non-training economies. I set the workers' matching probabilities to 37 percent (U.S.) and 26 percent (Europe). The resulting parameters of this calibration can also be found in Table 6.

## 5 Ljungqvist and Sargent Revisited

Before presenting the results of my model I discuss the robustness of Ljungqvist and Sargent's approach. Two assumptions drive the result of their paper: (1) very high unemployment benefits in their welfare economy, and (2) exogenous breaks in employment relationships. In regards to the first assumption, it is unrealistic to assume a replacement rate of 70 percent in an economy where unemployment benefits run forever. The second assumption can be criticized along two lines. While it is not unusual to model separations as determined by an exogenously given parameter, it could be a confounding assumption. With an increase in the probability of skill loss upon separation, separating becomes more costly for workers. In this case we would expect that workers would try harder to avoid separations by accepting wage cuts, working extended hours, and increasing their efforts. Den Haan et al. (2004) show that allowing for endogenous separations reverses Ljungqvist and Sargent's result. As economic turbulence increases, high-skilled workers become so afraid of skill loss upon quitting their jobs that they choose to stay with the same firm for longer, actually causing a decrease in the unemployment rate. In

Den Haan et al.'s model an increase in turbulence implies that employed workers who receive a productivity switch are more likely to accept low productivity draws. Their results hold even if high-skilled workers who voluntarily quit their jobs face skill loss probabilities as low as 0.3 percent. With exogenous separations the effect of Ljungqvist and Sargent's mechanism is larger the greater the difference in mean productivities between the two skill groups. A greater difference in productivity implies a greater difference in average wages. However, a greater difference in average wages implies a greater disincentive for low-skilled unemployed workers with high benefits to find new jobs (see Ljungqvist and Sargent, 2004). With endogenous separations, on the other hand, a greater difference in productivity implies a greater disincentive for high-skilled workers to voluntarily quit their jobs.

However, even if one only allows for exogenous separations, Ljungqvist and Sargent's result is not very robust with respect to changes in the separation rate. In their economy, 1.8 percent of employed workers lose their jobs every month, which is almost half the 3.4 percent average for the U.S. between 1951 and 2001 and about twice as high as the 1 percent suggested by Table 5 for the 1970s and 1980s in Europe. The choice of the separation rate is not benign, however. The interaction between the separation rate  $s$  and the skill loss probability  $\gamma^D$  is essential in Ljungqvist and Sargent's model. Each month, employed high-skilled workers face a probability of  $s\gamma^D$  of becoming unemployed and losing their skills. When turbulence increases from  $\gamma^D = 0.1$  to  $\gamma^D = 0.5$ , as Ljungqvist and Sargent (2004) suggest in their paper, the probability of skill loss faced by high-skilled workers increases from 0.18 to 0.9 percent. With a separation rate of 1 percent this probability increase from 0.1 percent to 0.5 percent. With a separation rate of 3.5 percent, the rate at which high-skilled workers are laid-off and lose their skills increases from 0.35 percent to 1.75 percent. Thus, in economies with higher separation rates, a larger proportion of high-skilled workers suffers from skill loss as economic turbulence increases.

Tables 7 shows how different assumptions about parameter values change Ljungqvist and Sargent's predictions. I calibrate a version of my model without retraining to an unemployment rate of 5.0 percent and separation rates ranging from 0.5 percent to 4 percent with benefit replacement rates of 50, 60, and 70 percent. The gray shaded fields in the table mark the different calibration points. Increasing turbulence does not matter much in an economy with a replacement ratio of only 50 percent. With a separation rate of 1 percent, unemployment increases from 5 percent to 5.17 percent when increasing turbulence from 10 to 50 percent. With a separation rate of 0.5 percent, unemployment slightly decreases with an increase in turbulence. In the model with a 3.5 percent separation rate, the unemployment rate increases to 5.7 percent. Even when increasing the benefit replacement rate to 60 percent, an increase in turbulence has hardly any effect on the unemployment

		<b>Pannel A: Unemployment Rates with <math>\delta = 50\%</math></b>							
		<i>seperation rate, s</i>							
		<b>0.50%</b>	<b>1.00%</b>	<b>1.50%</b>	<b>2.00%</b>	<b>2.50%</b>	<b>3.00%</b>	<b>3.50%</b>	<b>4.00%</b>
Probability of skill downgrade, $\gamma^D$	<b>0%</b>	5.01%	4.94%	4.89%	4.83%	4.76%	4.71%	4.66%	4.61%
	<b>10%</b>	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%
	<b>20%</b>	4.98%	5.04%	5.10%	5.14%	5.18%	5.22%	5.26%	5.27%
	<b>30%</b>	4.98%	5.09%	5.19%	5.27%	5.35%	5.39%	5.44%	5.47%
	<b>40%</b>	4.97%	5.13%	5.27%	5.38%	5.47%	5.53%	5.59%	5.62%
	<b>50%</b>	4.96%	5.17%	5.34%	5.47%	5.57%	5.65%	5.70%	5.75%
	<b>60%</b>	4.95%	5.20%	5.40%	5.54%	5.66%	5.74%	5.81%	5.85%
	<b>70%</b>	4.94%	5.23%	5.45%	5.62%	5.73%	5.82%	5.88%	5.92%
	<b>80%</b>	4.93%	5.26%	5.50%	5.68%	5.79%	5.89%	5.95%	5.99%
	<b>90%</b>	4.92%	5.28%	5.55%	5.73%	5.85%	5.94%	6.00%	6.04%
<b>100%</b>	4.91%	5.31%	5.58%	5.77%	5.90%	5.99%	6.04%	6.09%	

		<b>Pannel B: Unemployment Rates with <math>\delta = 60\%</math></b>							
		<i>seperation rate, s</i>							
		<b>0.50%</b>	<b>1.00%</b>	<b>1.50%</b>	<b>2.00%</b>	<b>2.50%</b>	<b>3.00%</b>	<b>3.50%</b>	<b>4.00%</b>
Probability of skill downgrade, $\gamma^D$	<b>0%</b>	4.98%	4.91%	4.83%	4.75%	4.69%	4.63%	4.57%	4.51%
	<b>10%</b>	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%
	<b>20%</b>	5.02%	5.10%	5.16%	5.22%	5.27%	5.31%	5.35%	5.38%
	<b>30%</b>	5.04%	5.19%	5.31%	5.41%	5.51%	5.58%	5.66%	5.71%
	<b>40%</b>	5.06%	5.27%	5.46%	5.60%	5.72%	5.84%	5.92%	6.00%
	<b>50%</b>	5.08%	5.37%	5.59%	5.79%	5.93%	6.06%	6.17%	6.27%
	<b>60%</b>	5.11%	5.45%	5.72%	5.94%	6.13%	6.28%	6.42%	6.53%
	<b>70%</b>	5.13%	5.53%	5.86%	6.11%	6.32%	6.50%	6.66%	6.79%
	<b>80%</b>	5.16%	5.62%	5.98%	6.27%	6.51%	6.72%	6.90%	7.09%
	<b>90%</b>	5.18%	5.70%	6.11%	6.43%	6.70%	6.94%	7.18%	7.39%
<b>100%</b>	5.21%	5.78%	6.23%	6.59%	6.90%	7.18%	7.47%	7.75%	

		<b>Pannel C: Unemployment Rates with <math>\delta = 70\%</math></b>							
		<i>seperation rate, s</i>							
		<b>0.50%</b>	<b>1.00%</b>	<b>1.50%</b>	<b>2.00%</b>	<b>2.50%</b>	<b>3.00%</b>	<b>3.50%</b>	<b>4.00%</b>
Probability of skill downgrade, $\gamma^D$	<b>0%</b>	4.91%	4.81%	4.71%	4.62%	4.52%	4.44%	4.36%	4.28%
	<b>10%</b>	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%
	<b>20%</b>	5.09%	5.21%	5.32%	5.42%	5.52%	5.64%	5.74%	5.86%
	<b>30%</b>	5.20%	5.45%	5.68%	5.92%	6.18%	6.50%	6.94%	7.66%
	<b>40%</b>	5.31%	5.70%	6.11%	6.57%	7.20%	8.30%	12.10%	63.51%
	<b>50%</b>	5.42%	6.00%	6.64%	7.53%	9.36%	26.24%	63.33%	63.53%
	<b>60%</b>	5.57%	6.35%	7.35%	9.27%	23.28%	70.23%	63.34%	
	<b>70%</b>	5.72%	6.75%	8.38%	13.90%	71.48%			
	<b>80%</b>	5.88%	7.25%	10.01%	71.78%				
	<b>90%</b>	6.06%	7.87%	13.14%	77.55%				
<b>100%</b>	6.26%	8.67%	21.65%						

Table 7: Unemployment Rates with Different Parameter Assumptions



rate.

The effects become considerably larger when using a 70 percent replacement ratio. With a 2 percent separation rate, an increase in the turbulence from 10 percent to 50 percent increases the unemployment rate to 7.53 percent. This is an increase comparable to that in Ljungqvist and Sargent (1998). However, when taking a separation rate of 1 percent the unemployment rate increases to only 6.00 percent. This compares to an increase to 5.70 percent for a separation rate of 3.5 percent and a replacement ratio of 50 percent.

This exercise shows that an increase in turbulence as modeled by Ljungqvist and Sargent (1998, 2004) might have a more adverse effect on the U.S. economy than on the European economy because job churning is much higher in the U.S. In fact, the tables suggest that under reasonable assumptions for the European economy, such as a replacement ratio of 50 or 60 percent and separation rates between 0.5 and 1.5 percent, the effect of an increase in economic turbulence on unemployment rates is negligible. Even for replacement rates of 70 percent, the effect of turbulence is very small for separation rates below 2 percent and skill loss probabilities below 50 percent.

## **6 Retraining the Unemployed**

To shed light on the effects of retraining I contrast the steady states of the U.S. and European economies with and without training in Table 8. It should not come as a surprise that the measure of high-skilled workers in the training economies is between 1.4 percent (Europe) and 11.0 percent (U.S.) larger than in the non-training economies. At the same time, the measure of low-skilled workers in the training economies is between 8.8 percent (Europe) and 27.7 percent (U.S.) smaller than in the non-training economies. It follows that the ratio of high-skilled to low-skilled workers is between 11.1 percent (Europe) and 53.5 percent higher in the training economies. Also note that the European non-training economy features a higher skill-ratio than the U.S. training economy, a result of differences in the separation rate and replacement ratio. While the average job tenure in the U.S. economy is only about 2 years and 5 months, it is 8 years and 4 months in the European economy. Since it takes workers on average 8 years and 4 months to upgrade their skills to the higher level, conditional on not being laid-off, there are relatively more high-skilled workers in Europe. In addition, due to the higher unemployment benefit replacement ratio, European workers are more selective about which jobs to accept, which translates into higher productivity.

In my model, high-skilled workers' productivity draws are on average twice as high as those for low-skilled workers. As a result of differences in the skill compo-

	<b>U.S. with retraining</b>	<b>U.S. without retraining</b>	<b>Europe with retraining</b>	<b>Europe without retraining</b>
Fraction of low-skilled workers	26.2%	36.3%	21.3%	23.4%
Employed	21.6%	30.6%	16.4%	20.0%
Unemployed	4.7%	5.7%	4.9%	3.4%
Fraction of high-skilled workers	70.8%	63.7%	77.7%	76.7%
Employed	61.9%	55.5%	72.7%	70.0%
Unemployed	8.9%	8.2%	5.1%	6.7%
<i>Ratio of high to low skilled workers</i>	2.70	1.76	3.65	3.28
Employed only	2.87	1.82	4.43	3.50
Unemployed only	1.91	1.44	1.03	2.00
<i>Average Productivity of employed</i>	1.98	1.84	2.18	2.07
Low-skill workers	1.27	1.15	1.33	1.21
High-skill workers	2.22	2.22	2.37	2.32
<i>GDP</i>	1.65	1.59	1.94	1.87
<i>Unemployment Rate</i>	13.9%	13.9%	10.0%	10.0%
Low-skill workers	17.7%	15.8%	23.0%	14.3%
High-skill workers	12.5%	12.9%	6.5%	8.7%
<i>Average duration of unemployment (weeks)</i>	5.2	4.5	10.2	9.6
<i>Acceptance rate of job offers</i>				
low skills, low benefits	46%	70%	34%	59%
low skills, high benefits	13%	47%	2%	27%
high skills, low benefits	69%	72%	39%	54%
high skills, high benefits	55%	55%	27%	35%
<i>Job finding rate</i>				
low skills, low benefits	18%	26%	17%	15%
low skills, high benefits	5%	17%	1%	7%
high skills, low benefits	28%	27%	20%	14%
high skills, high benefits	22%	21%	13%	9%
<i>Enrollment in training programs</i>				
Total as % of the labor force	3.0%		1.0%	
<i>Public Finance</i>				
Gross wage income	1.55	1.47	1.88	1.79
Cost of unemployment insurance	0.13	0.12	0.15	0.14
Cost of retraining	0.03		0.02	
Net wage income	1.39	1.35	1.72	1.65

Table 8: Steady-State Values at Calibration Point

sition, average productivity is between 4.8 percent (Europe) and 7.4 percent (U.S.) higher in the training economies. Since productivity and wages are directly linked, average wages are also higher in the training economies. The higher average productivity results in higher GDP, despite the fact that overall employment is lower in the training economies.

All workers have lower job acceptance rates in the training economies. The availability of training programs for low-skilled unemployed workers increases the value of being unemployed just like an increase in unemployment benefits. An increase in the value of being unemployed induces workers to be more selective about which job offers to accept, leading to a decline in the acceptance rate and job finding rate, but an increase in productivity. A decrease in the acceptance rate implies a decrease in the job finding rate, given that the matching probability remains unchanged. In my calibration exercise I had to choose different matching probabilities for the different economies. While the acceptance rate of job offers is lower in the training economies, some of the job finding rates are actually higher due to differences in the matching probabilities. Given the change in incentives for low-skilled workers to accept jobs, it is not surprising that their unemployment rates are higher in the training economies with an increase from 14.3 to 23.0 percent in Europe and an increase from 15.8 to 17.7 percent in the U.S.

The unemployment rates for high-skilled workers decreases from 8.7 percent in the European non-training economy to 6.5 percent in the training economy. In the U.S. the high-skilled unemployment rate hardly changes, decreasing from 12.9 to 12.5 percent. These decreases are the result of the higher matching rate in the training economy.

A crude measure of welfare in my economy is total net wage income. I calculate this measure as gross wage income, i.e. the sum of all wages workers receive, less total retraining costs and government expenditures for unemployment benefits. In this calculation, I implicitly assume that the expenditures are financed through lump sum taxation and are thus not distortionary. Since the parameter  $\tau$  is for calibration purposes only, I use data from the U.S. Department of Education and the Census Bureau to estimate the average cost of retraining. According to the Department of Education, the average per student cost of attending a two year institution, including tuition, room and board, was \$6,238 for the academic year 2002-2003. The Census Bureau reports mean income for men of approximately \$30,000 in 2003. Hence, one year of retraining costs roughly 20 percent of the average annual income per worker. Total net wage income is larger in the training economies than in the non-training economies due to higher wages associated with higher productivity.

## 7 Results

In this section I present some results comparing the training and non-training economies as well as the U.S. economy and my European calibrated version. I first investigate the effects that changes in enrollment have on my economies, and then analyze how these economies are affected by an increase in economic turbulence.

### 7.1 Changes in Enrollment

To illustrate the effects a change in enrollment has on my economies, I use the calibrated values reported in Tables 4 and 6 and calculate steady-states for different levels of the calibrated tuition cost  $\tau$ . Increasing  $\tau$  makes retraining more expensive and thus increases the cutoff value  $o_j^*$ . With a lower percentage of unemployed workers finding suitable training programs, enrollment rates decrease.

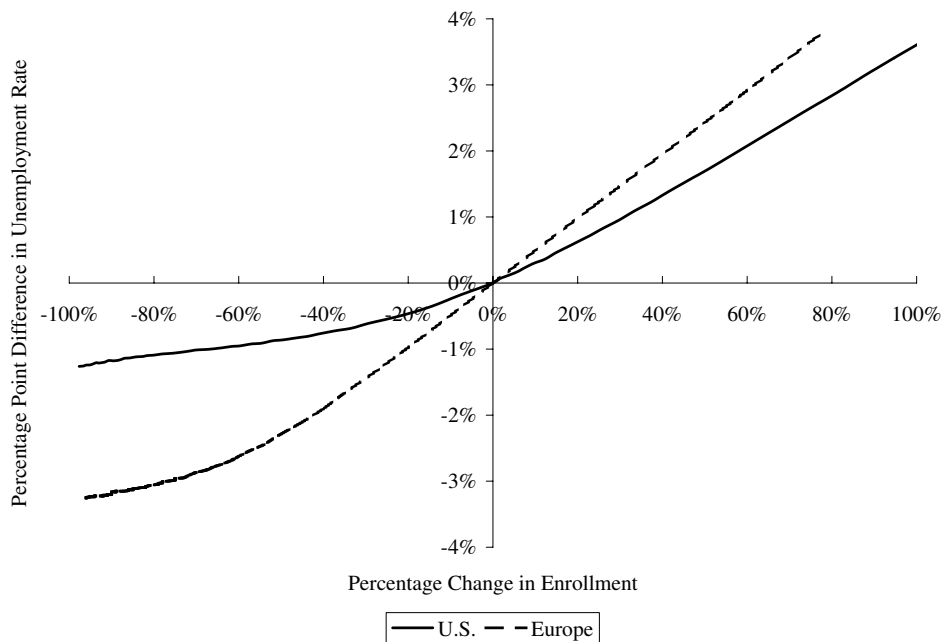


Figure 2: Unemployment Rate and Changes in Enrollment

Figures 2 and 3 show how changes in enrollment, induced by changes in  $\tau$ , affect the unemployment rate and productivity. Figure 2 exhibits an important feature of the way I model retraining: it affects the incentives of low-skilled workers in the

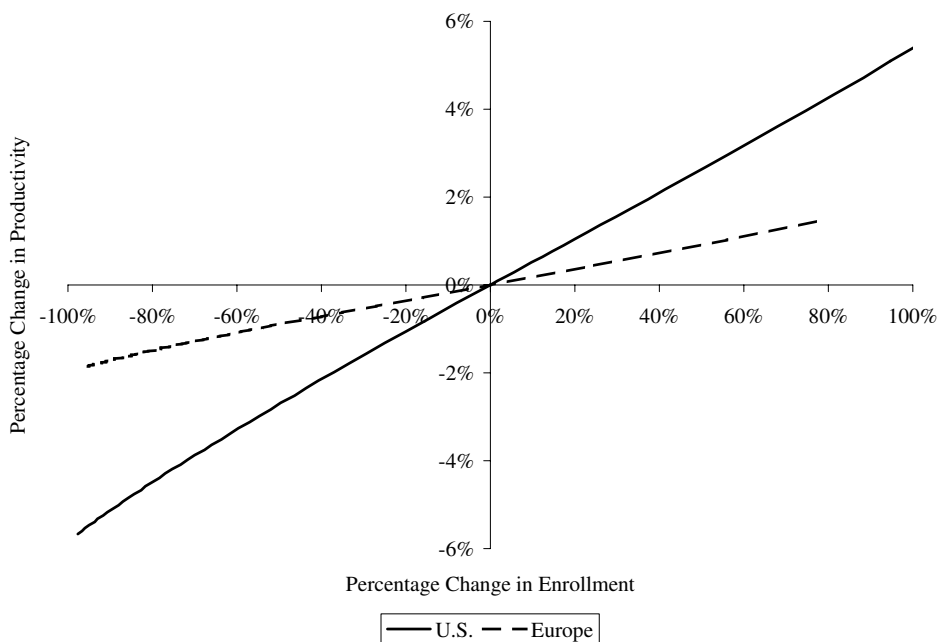


Figure 3: Productivity and Changes in Enrollment

same way unemployment insurance does. An increase in enrollment is associated with a higher probability of finding a suitable retraining program. However, as the chance of enrolling in retraining and potentially upgrading to the higher skill level increases, so does the value of remaining unemployed. The tremendous difference in wages between low and high skill level makes it worthwhile for workers to spend more time in the unemployment pool to search for retraining opportunities. Similarly, a lower probability of finding good training opportunities decreases enrollment and the unemployment rate.

Note that the European unemployment rate is much more sensitive to changes in enrollment than in the U.S. A replacement ratio of 70 percent and total enrollment of 1 percent of the labor force provide as much disincentives to unemployed workers in Europe as a replacement ratio of roughly 80 percent without retraining. It is then not surprising that changes in enrollment have a much stronger incentive effect in the European economy than in the U.S. economy. A 20 percent increase in enrollment increases unemployment by 0.6 percentage points in the U.S., but by roughly 1.2 percentage point in Europe.

Figure 3 shows the positive relationship between enrollment and productivity. Productivity increases with enrollment for two reasons. With more workers

enrolled in retraining, more low-skilled workers upgrade to the higher skill level, which is associated with an increase in average productivity of 70 to 80 percent. Furthermore, while the productivity of high-skilled workers is not affected, low-skilled productivity increases. An increase in enrollment increases the value of being unemployed so that low-skilled workers become more selective about what jobs to accept. A 20 percent increase in enrollment increases productivity between 0.4 percent (Europe) and 1 percent (U.S.). The increase in U.S. productivity is larger because retraining is a much more important channel for skill upgrade in the U.S. due to its higher separation rate. Few workers are employed long enough to upgrade to the higher skill level on the job.

With higher enrollment, employment decreases in both economies. A 20 percent increase in enrollment decreases employment by 1.3 percent in the U.S. and 1.5 percent in Europe. Given that the population is fixed at unity, higher enrollment and unemployment implies lower employment. As a result, GDP decreases between 0.3 percent (U.S.) and 1.1 percent (Europe). The composition of the workforce in both economies also changes considerably with changes in enrollment. Low-skilled employment decreases between 6.3 percent (Europe) and 9.3 percent (U.S.). High-skilled employment changes little in the European economy by increases by 1.4 percent in the U.S. economy.

With increases in enrollment, total net wage income decreases in both economies for the same reasons as GDP. With changes in the composition and rate of unemployment, the cost of providing unemployment benefits increase between 5.1 percent (U.S.) and 12.5 percent (Europe). Higher enrollment rates increase the cost of providing retraining between 24 percent (U.S.) and 27 percent (Europe). As a result, total net wage income decreases between 1.4 percent (U.S.) and 2.6 percent (Europe).

This analysis points out an important feature of how I model retraining. My model introduces an additional search friction: workers not only search for jobs but also for suitable retraining opportunities. Changes in the availability of these opportunities have strong effects on workers' incentives, very similar to changes in unemployment benefits. My results would change if workers could find suitable training programs instantaneously without having to search for them. In that case, the presence of retraining opportunities would not change incentives for low-skilled workers to find employment.

## **7.2 Changes in Economic Turbulence**

An increase in economic turbulence has a devastating effect on the welfare state in Ljungqvist and Sargent's (1998) model. I showed in Section 5 that their result is not very robust to different calibrations of a DMP matching model. In this section

I show that the generosity of unemployment benefits does not matter much, even during tumultuous economic times, if sufficiently good retraining institutions are available.

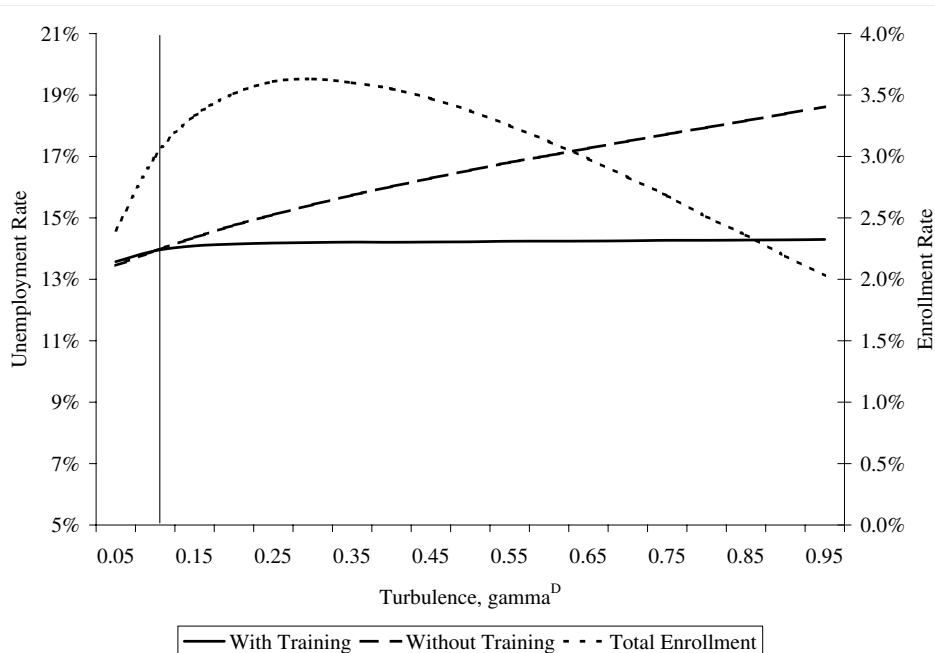


Figure 4: Changes in Unemployment Rates and Enrollment, U.S.

Figures 4 and 5 show the impact of an increase in the turbulence parameter  $\gamma^D$  on the enrollment and unemployment rates. The vertical line at  $\gamma^D = 0.10$  marks the calibration point. The non-training economies respond to increases in turbulence similarly to the economy described in Ljungqvist and Sargent: unemployment increases more in the European economy than in the U.S. economy. In the training economies, however, unemployment in the U.S. is essentially flat and that of the European economy decreases slightly. Enrollment in training programs initially increases in both economies. As  $\gamma^D$  increases, the benefit of being a high-skilled worker declines because of the greater likelihood of skill loss, decreasing the value of retraining. However, the large increase in the measure of low-skilled unemployed workers associated with the increase in turbulence increases the pool of potential enrollees. The measure of low-skilled workers initially increases faster than the probability of finding a suitable training opportunity declines. Consequently, enrollment increases at first, but decreases at higher levels of turbulence.

If Ljungqvist and Sargent's mechanism were correct, we should have, accord-

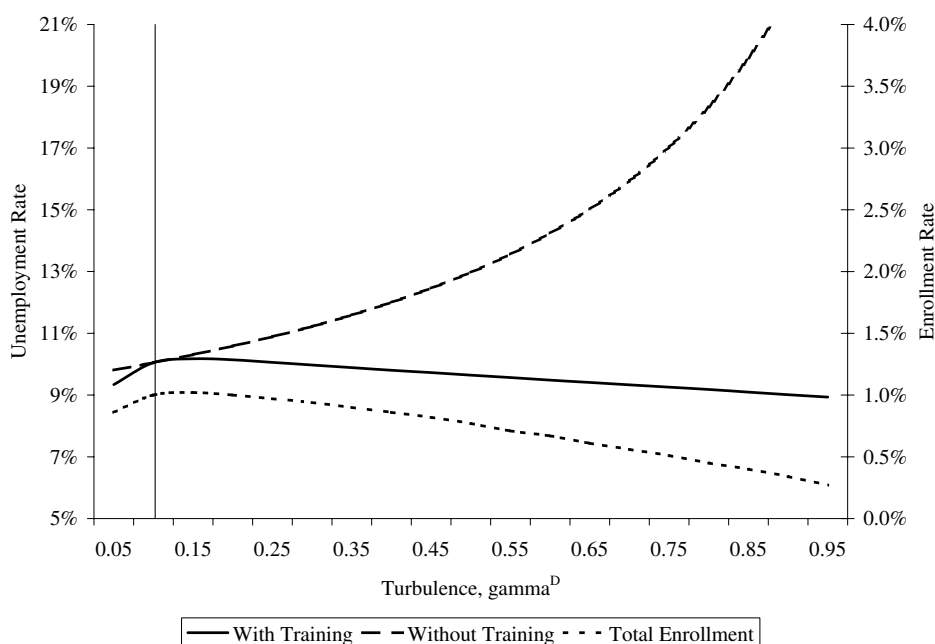


Figure 5: Changes in Unemployment Rates and Enrollment, Europe

ing to my model, observed an increase in enrollment in retraining programs in the U.S. and Europe since the 1970s. Indeed, there is some evidence that U.S. enrollment increased tremendously during the last three decades. See table 9 for data from the National Center for Education Statistics. Note that this data includes all levels of education. Also note that there are other factors that could increase enrollment in my model. These are: (1) an increase in the separation rate  $s$ , (2) an increase in the replacement ratio  $\delta$ , and (3) an increase in the difference between high and low-skill productivity. While there is little evidence that separation rates have increased since the 1970s or that the U.S. unemployment insurance system has become more generous since then, there is reason to believe that productivity differences have been increasing. I was not able to find comparable data for European economies.

In the training economies, an increase in turbulence results in an increase in the job finding rates of low-skilled workers. In Ljungqvist and Sargent, on the other hand, an increase in turbulence induced low-skilled workers to decrease their search efforts. In fact, those entitled to high benefits almost completely stopped looking for new jobs. This is true in my non-training economies as well, although to a much lesser degree because of the different calibration. However, in the train-



	1970	1980	1990	2000
Labor force, 30+	48,807,000	66,239,000	85,672,000	104,261,000
Enrollment, 30+	1,310,000	2,664,000	3,805,327	4,014,000
As % of total enrollment	15.3%	22.0%	27.5%	26.2%
As % of the labor force	2.7%	4.0%	4.4%	3.8%

Source: National Center for Education Statistics, BLS, own calculations.

Table 9: U.S. Enrollment In Education Programs, 1970 - 2000

ing economies, this effect is reversed. The intuition is that unemployment benefits represent only one part of the value of being unemployed. Another important part is the opportunity of finding a suitable training program and potentially upgrading to the higher skill level. With an increase in economic turbulence, the value of retraining decreases and hence the value of being unemployed. As a result, low-skilled workers are more eager to find employment. On the other hand, high-skilled workers' incentives to find work decrease with more economic turbulence. A decline in the job finding rate in both the training and non-training economies is the result.

Average productivity at the calibration point is between 4.8 (Europe) and 7.3 percent (U.S.) higher in the training economies than in the non-training economies (see Figures 6 and 7). As economic turbulence increases, the difference in productivity also increases at first, but decreasing at higher levels of turbulence. Note that the difference in productivity between the training and non-training economies is closely related to the evolution of enrollment rates.

In the European economy, an increase in turbulence has almost no effect on the difference in average productivity. Due to the lower separation rate, most of the skills are acquired on-the-job and the number of workers who upgrade through training is very small. As turbulence increases, enrollment decreases, but this does not significantly affect the skill ratio of the training economy. As a result, the difference in average productivity is very small.

Due to the decline in unemployment and enrollment, GDP and after tax wage income decrease more slowly in the European training economy than in the non-training economy. An increase in turbulence from  $\gamma^D = 0.10$  to  $\gamma^D = 0.50$  decreases GDP by 8.7 percent in the European training economy, but by 12 percent in the non-training economy. In the U.S., GDP and after tax wage income also decline faster in the non-training economies. This is due to an increase in the unemployment rate between the training and the non-training economy.

In my model, an increase in economic turbulence has a much different effect on a European calibrated economy than in Ljungqvist and Sargent (1998, 2004).

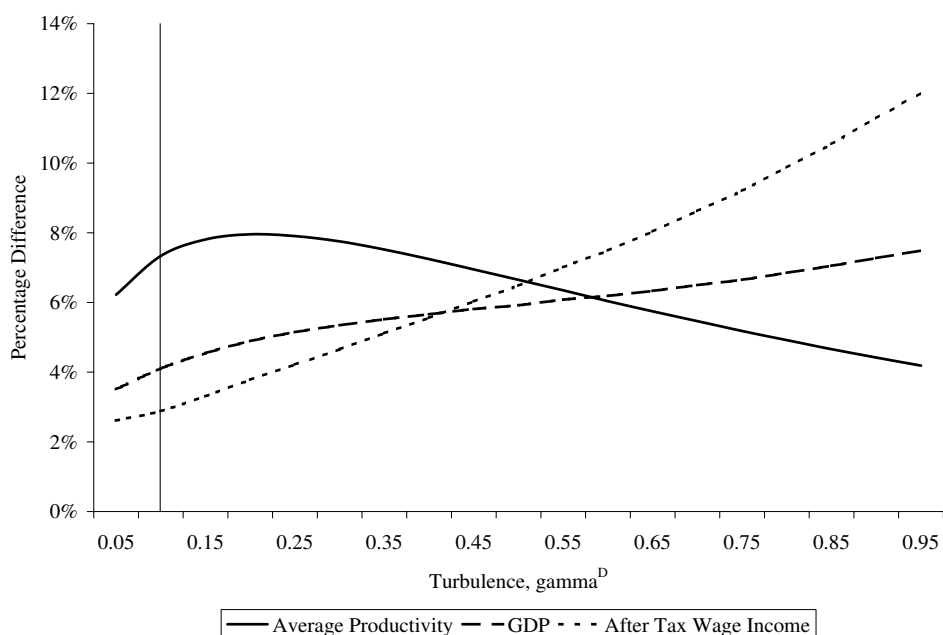


Figure 6: Differences in Average Productivity, GDP and Net Wage Income (Training vs. Non-Training Economy), U.S.

While the European unemployment rate in their model increases significantly with an increase in turbulence, the unemployment rate in my model declines slightly. While in Ljungqvist and Sargent the incentives of unemployed workers were only influenced by the unemployment replacement ratio and the degree of turbulence, the incentive of workers in my model are also influenced by the availability of retraining opportunities. As turbulence increases, the probability of finding a suitable training opportunity decreases and with it the incentive to remain unemployed. As a result, job finding rates for low-skilled workers increase with increases in turbulence - very much the opposite from the model without retraining. An increase in job finding rates, however, implies a decrease in the unemployment rate.

Figures 4 and 5 show the response of unemployment to increases in turbulence in economies with and without retraining. In my model, every low-skilled worker has a chance to find a suitable retraining opportunity. This would be an example of an economy with extremely flexible training institutions. However, it is not hard to imagine that there are no retaining opportunities for some workers. There could be several reasons for this, some of which include geography and previous education and work experience. In the case were retraining is only possible for a subset of

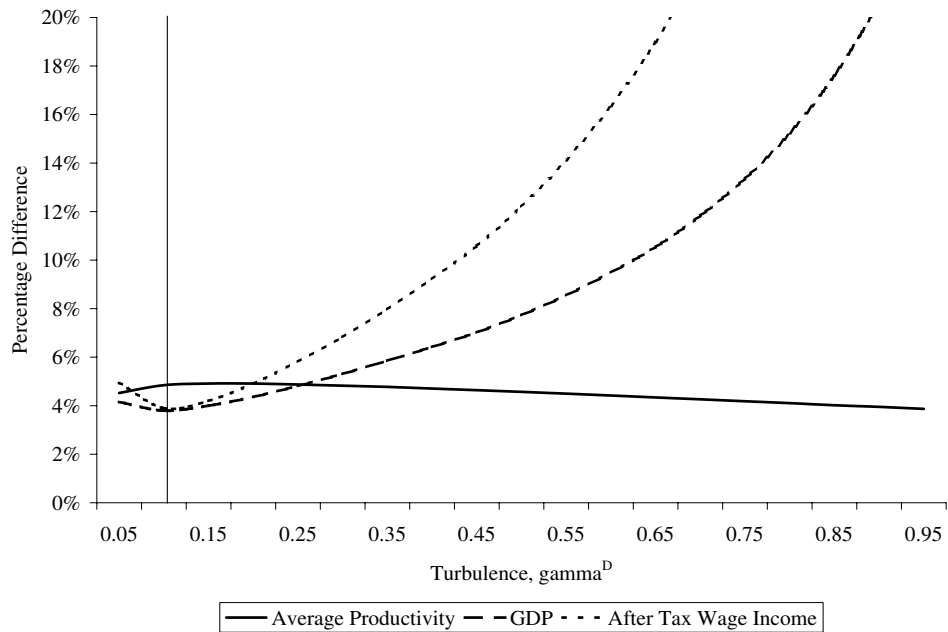


Figure 7: Differences in Average Productivity, GDP and Net Wage Income (Training vs. Non-Training Economy), Europe

workers, the response of unemployment to economic turbulence would be worse than in my model with retraining, but better than in my model without retraining. In this sense, economies with more flexible training institutions perform better in the presence of economic turbulence than economies with no training opportunities.

## 8 Conclusion

In this paper I explored to what degree differences in retraining opportunities are responsible for the divergence of unemployment rates between the U.S. and Europe. In my model, an increase in training opportunities for low-skilled workers increases productivity, but it also increases unemployment. The reason is that workers have to search for suitable training programs. Increasing the probability of finding retraining opportunities increases the value of remaining unemployed and thus reduces the job finding rate, which leads to an increase in the unemployment rate.

Economic turbulence decreases the value of retraining and thus the value of being unemployed. The result is a decrease in the unemployment rate. Ljungqvist

and Sargent pointed out a promising channel to explain the divergence of unemployment rates between Europe and the U.S. since the early 1980s. As I showed in Section 5, their result is not very robust to changes in their parametrization. Furthermore, I show that the generosity of unemployment benefits, the main driving force in their model, is not an important determinant of unemployment, even during tumultuous economic times, if sufficiently good retraining institutions are available.

My results suggest that retraining might be important in two ways. Giving unemployed workers the opportunity to upgrade their skills increases productivity, but also changes their incentive structure. Of course, my result depend much on the fact that only unemployed workers are allow to retrain. Allowing low-skilled employed workers to retrain as well might alter my results.

Further research should investigate the importance of general versus specific training. As Krueger and Kumar (2004) argue, European economies rely much more heavily on vocational, or specific skill education, while the U.S. economy relies more on general skill acquisition. This might play an important role in explaining the different evolution of unemployment rates between the U.S. and Europe.

## References

- ABOWD, J., AND A. ZELLNER (1985): "Estimating Gross Labor-Force Flows," *Journal of Business and Economic Statistics*, 3(3), 254–283.
- BEAN, C. R. (1994): "European Unemployment: A Survey," *Journal of Economic Literature*, 32(2), 573–619.
- BLANCHARD, O. (1999): "European Unemployment: the role of shocks and institutions," Baffi Lecture.
- BLANCHARD, O., R. DORNBUSCH, J. DREZE, H. GIERSCH, R. LAYARD, AND M. MONTI (1986): "Employment Growth in Europe: A Two-Handed Approach," in *Restoring Europe's Prosperity: Macroeconomic Papers from the Centre for European Policy Studies*, ed. by O. Blanchard, R. Dornbusch, and R. Layard, Cambridge, MA. MIT Press.
- BLANCHARD, O., AND J. WOLFERS (2000): "The Role of Shocks and Institutions in the Rise of European Unemployment: The Aggregate Evidence," *The Economic Journal*, 110.
- BURDA, M., AND C. WYPLOSZ (1994): "Gross worker and job flows in Europe," *European Economic Review*, 38, 1287–1315.
- CALMFORS, L. (1995): "Labour market policy and unemployment," *European Economic Review*, 39, 583–592.
- CALMFORS, L., A. FORSLUND, AND M. HEMSTROEM (2002): "Does Active Labour Market Policy Work? Lessons from the Swedish experiments," CESinfo Working Paper No. 675.
- COLES, M., AND A. MASTERS (2000): "Retraining and long-term unemployment in a model of unlearning by not doing," *European Economic Review*, 44, 1801–1822.
- DEN HAAN, W. J., C. HAEFKE, AND G. RAMEY (2004): "Turbulence and Unemployment in a Job Matching Model," IZA Discussion Paper No. 1403.
- DIAMOND, P. A. (1982): "Aggregate Demand Management in Search Equilibrium," *Journal of Political Economy*, 90(5), 881–894.
- JOSEPH, G., O. PIERRARD, AND H. R. SNEESSENS (2004): "Job turnover, unemployment and labor market institutions," *Labor Economics*, 11, 451–468.

- KRUEGER, D., AND K. B. KUMAR (2004): "Skill-Specific rather than General Education: A Reason for US–Europe Growth Differences?," *Journal of Economic Growth*, 9(2), 167–204.
- LJUNGQVIST, L., AND T. J. SARGENT (1998): "The European Unemployment Dilemma," *Journal of Political Economy*, 106(3), 514–550.
- (2004): "European Unemployment and Turbulence Revisited in a Matching Model," *Journal of the European Economic Association*, 2(2-3), 456–468.
- MARTIN, J. P. (1996): "Measures of Replacement Rates for the Purpose of International Comparisons: A Note," *Economic Studies* 26, OECD.
- (1998): "What Works among Active Labour Market Policies: Evidence from OECD Countries' Experiences," in *Unemployment and the Australian Labour Market*, ed. by G. Debelle, and J. Borland, pp. 276–302, Sydney. Reserve Bank of Australia.
- MASTERS, A. (2000): "Retraining the unemployed in a model of equilibrium employment," *Bulletin of Economic Research*, 52(4), 323–340.
- MORTENSEN, D. T. (1982): "Property Rights and Efficiency in Mating, Racing, and Related Games," *American Economic Review*, 72(968-979).
- MORTENSEN, D. T., AND C. A. PISSARIDES (1999): "Job reallocation, employment fluctuations and unemployment," in *Handbook of Macroeconomics*, ed. by J. B. Taylor, and M. Woodford, vol. 1, pp. 1171–1228, Amsterdam. North-Holland.
- NICKELL, S. (1997): "Unemployment and Labor Market Rigidities: Europe versus North America," *Journal of Economic Perspectives*, 11(3), 55–74.
- NUNZIATA, L. (2002): "Unemployment, Labour Market Institutions and Shocks," Nuffield College Working Papers in Economics, 2002-W16.
- OECD (2004): *UOE data collection manual*.
- PETRONGOLO, B., AND C. A. PISSARIDES (2001): "Looking into the Black Box: A Survey of the Matching Function," *Journal of Economic Literature*, 34(2), 390–431.
- PISSARIDES, C. A. (1985): "Short-Run Equilibrium Dynamics of Unemployment, Vacancies, and Real Wages," *American Economic Review*, 75(4), 676–690.

- SCHETTKAT, R. (2003): "Are institutional rigidities at the root of European unemployment?," *Cambridge Journal of Economics*, 27, 771–787.
- SHIMER, R. (2005): "The Cyclical Behavior of Equilibrium Unemployment and Vacancies," *American Economic Review*, 95(1), 25–49.
- SIEBERT, H. (1997): "Labor Market Rigidities: At the Root of Unemployment in Europe," *Journal of Economic Perspectives*, 11(3), 37–54.
- ZIMMERMANN, K. F. (1998): "German Job Mobility and Wages," IZA Discussion Paper No. 4.

## A Appendix

In this appendix, I will explain how I calculated the separation rates from the OECD data and provide definitions for the OECD classification of education levels.

### A.1 Calculating Separation Rates

I calculated the job-finding and separation rates from OECD data on average unemployment durations. Using average duration data might introduce two biases if the average is calculated using interrupted unemployment spells. These biases stem from (1) counting unemployment spells not yet completed and (2) undersampling short completed unemployment spells. While these are well-known problems with the U.S. duration data, it is not clear that the same issues apply to data from other countries presented in the table. I disregard these differences and adjust all data for these biases by calculating the job finding rate as  $2/(\text{average duration of unemployment})$ . I then assume that the economies were in a steady-state in which the aggregate unemployment rate is given by

$$u = \frac{s}{s + f}$$

Knowing  $f$ , the job finding rate, and  $u$ , the aggregate unemployment rate, I can calculate the separation rate  $s$  as

$$s = \frac{u}{1 - u} f$$

While this yields a relative accurate estimate for the U.S., it is probably an upper bound for all other countries.

### A.2 OECD Education Categories

**Upper Secondary:** Upper secondary education may either be preparatory, i.e. preparing students for tertiary education or terminal, i.e. preparing the students for entry directly into working life .

**Post-Secondary Non-Tertiary:** Post-secondary non-tertiary educational programmes straddle the boundary between upper secondary and post-secondary education from an international point of view, even though they might clearly be considered upper secondary or post-secondary programmes in a national context. Although their content may not be significantly more advanced than upper secondary programmes, they serve to broaden the knowledge of participants who have already gained an upper secondary qualification. The students tend to be older than those enrolled at the upper secondary level.



**Tertiary A:** Tertiary-type A programmes are largely theory-based and are designed to provide sufficient qualifications for entry to advanced research programmes and professions with high skill requirements, such as medicine, dentistry or architecture. Tertiary-type A programmes have a minimum cumulative theoretical duration (at tertiary level) of three years' full-time equivalent, although they typically last four or more years. These programmes are not exclusively offered at universities. Conversely, not all programmes nationally recognized as university programmes fulfil the criteria to be classified as tertiary-type A. Tertiary-type A programmes include second degree programmes like the American Master. First and second programmes are sub-classified by the cumulative duration of the programmes, i.e. the total study time needed at the tertiary level to complete the degree.

**Tertiary B:** Tertiary-type B programmes are typically shorter than those of tertiary-type A and focus on practical, technical or occupational skills for direct entry into the labour market, although some theoretical foundations may be covered in the respective programmes. They have a minimum duration of two years full-time equivalent at the tertiary level.

*Source: OECD*