Obsolescence, Uncertainty, and Heterogeneity: The European Employment Experience

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Abstract

Before the 1970's, similarly short durations but lower flows into unemployment meant that Europe had lower unemployment rates than the United States. But since 1980, higher durations have kept unemployment rates in Europe persistently higher than in the U.S. A general equilibrium search model with human capital explains how these outcomes arise from the way Europe's higher firing costs and more generous unemployment compensation make its unemployment rate depend on a parameter that determines a worker's loss of valuable skills after an involuntary job loss. An increase in that skill loss parameter after the 70s explains microeconomic findings that indicate that workers experienced more earnings volatility then. Our model also explains why, especially among older workers, hazard rates of gaining employment in Europe fall sharply with increases in the duration of unemployment, and why displaced workers in Europe experience smaller earnings losses and lower re-employment rates than those in the United States. The effects of layoff costs on unemployment rates depend on equilibrium proportions of frictional and structural unemployment that in turn depend on the generosity of unemployment benefits and the skill loss parameter that confronts displaced workers.

Key words: Job, search, skills, obsolescence, turbulence, unemployment, unemployment insurance, employment protection, discouraged worker.

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"A growing body of evidence points to the fact that the world economy is more variable and less predictable today than it was 30 years ago.... [there is] more variability and unpredictability in economic life ..." Heckman (2003)

1 Introduction

Despite institutional differences that endured throughout the post WWII period, unemployment rates that during the 1950s and 1960s were lower in Europe became persistently higher than in the U.S. after the 1970s. This paper explains these outcomes by using a general equilibrium version of a McCall (1970) search model in which frictional unemployment consists of workers who actively search for jobs that they expect to find quickly and structural unemployment consists of discouraged workers who don't search intensively and who don't expect to find jobs soon. Our model tells how Europe's employment protection (EP) measures suppress frictional unemployment by reducing the inflow rate into unemployment and how that effect prevailed during the 1950s and 1960s when there was almost no structural unemployment in Europe. But when the microeconomic environment changed permanently in the late 1970s and confronted displaced workers with greater risks that they would immediately lose valued skills, high unemployment compensation (UI) indexed to a worker's past earnings created a group of long-term unemployed discouraged workers that permanently drove up the European unemployment rate. Its stingy unemployment compensation system prevented structural unemployment from emerging in the U.S.

Section 2 documents the following facts about unemployment in Europe and the U.S. that we use as targets for our quantitative modelling: (1) after being lower in the 1950s and 1960s, unemployment became persistently higher in Europe than in the U.S. in the late 1970s; (2) inflow rates into unemployment were roughly constant over time on both continents, but higher in the U.S. than Europe; (3) the average duration of unemployment was low on both continents in the 50s and 60s, stayed low in the U.S. after the 1970s, but became persistently larger in Europe after the 1970s; (4) after the 1970s, the hazard rate of leaving unemployment declined with the duration of unemployment in Europe; (5) after the 1970s, a substantial group of older workers in Europe became unemployed for long terms; (6) UI benefits were more generous in Europe throughout both periods; (7) EP was stronger in Europe throughout both periods. The task we set for our quantitative model is to take items (6) and (7) as given inputs, then to get items (1)-(5) as outcomes. To achieve this objective we need something that differentiates the 1950s and 1960s from the years after the late 1970s. We take the catalyst of change to be an increase in the risk of skill obsolescence that confronts displaced workers. Workers' skills are not directly observed, but their earnings are. In section 2 we summarize empirical evidence about earnings distributions that lead us to posit an increased risk of skill obsolescence.[1] In addition to motivating our parameterization

[1]The popular book by Friedman (2005) is about this risk. Friedman offers many anecdotes about how reductions in communication costs and lower political barriers, a process that can be called globalization, can lead to rapid depreciation of recently valued human capital. For example, on page 20, Friedman quotes

of skill evolution, in section 5.3, we will use our model's implications about some of that microeconomic evidence to verify our specification.

1.1 Organization

The remainder of this paper is organized as follows. Section 2 summarizes the empirical puzzles about European unemployment and earlier efforts to explain them. We postpone until subsections 6.2 and 8.2 brief discussions of how representative family models without an activity called unemployment have also been used to confront some of the observations about European employment rates. Section 3 describes the tool that we use to explain the puzzles: an equilibrium version of a McCall search model with aging workers; stochastic skill transitions that apply when workers are employed, unemployed, and displaced, respectively; employment protection (EP) in the form of a layoff tax; and unemployment benefits (UI) indexed to earnings on the worker's previous job. Sections 5 and 7 describe quantitative outcomes of our model calibrated for a welfare state (WS) regime with high EP and UI and a laissez faire (LF) regime without EP or UI. Since our model generates earnings outcomes for panels of workers, we can explore the implications of our calibrations for empirical studies of earnings in subsection 5.3, for the issue of duration dependence versus heterogeneity in subsection 5.6, and for the distribution of earnings in Europe in subsection 7.3. Section 8 concludes with a discussion of whether the main forces in our McCall search model would also come through in other models of the labor market. After studying three alternative models in depth, Ljungqvist and Sargent (2005) give an affirmative answer to this robustness question.

2 The problem

This section describes unemployment outcomes in Europe and the U.S. and how economists have tried to explain them.

2.1 Europe as a success story in the 1950s and 1960s

Until the second half of the 1970s, Americans saw Europe's labor market as a success. A Bureau of Labor Statistics report commissioned by President John F. Kennedy (1962) studied unemployment data across countries and concluded that discrepancies in definitions and statistical methods could not explain the lower unemployment rates observed in Europe. That prompted Deputy Commissioner Robert J. Myers (1964, pp. 172–173) at the Bureau of Labor Statistics to write:

David Schlesinger, head of Reuters America, as saying about New London, Connecticut: " . . . Jobs went; jobs were created. Skills went out of use; new skills were required. The region changed; people changed." On page 294, Friedman remarks that workers are paid for "general skills and specific skills" and "when you switch jobs you quickly discover which is which."

"From 1958 to 1962, when joblessness in [France, former West Germany, Great Britain, Italy and Sweden] was hovering around 1, 2, or 3 per cent, [the U.S.] rate never fell below 5 per cent and averaged 6 per cent.

The difference between [the U.S.] unemployment rate and the average for these European countries was only a little more than 3 percentage points. But, if we could wipe out that difference, it would mean 2 million more jobs, and perhaps $40 to $50 billion in Gross National Product. We can surely be excused for looking enviously at our European friends to see how they do it. We have profited much in the past from exchange of ideas with Europe. It would be short-sighted indeed to ignore Europe's recent success in holding down unemployment."

2.2 Discouraged workers in Europe after the 1970s

During the last two and a half decades, Europe has experienced persistently high unemployment (see Table 1 and Figure 1), while the American unemployment rate has continued to fluctuate around it pre 1980 average level. The increase in European unemployment is accounted for by a lengthening of the average duration of unemployment spells and not by a larger flow rate of newly unemployed workers. As noted by Layard et al. (1991, p. 4):

"The rise in European unemployment has been associated with a massive increase in long-term unemployment. In most European countries the proportion of workers entering unemployment is quite small: it is much lower than in the USA and has risen little. The huge difference is in the duration of unemployment: nearly half of Europe's unemployed have now been out of work for over a year."

Table 1 shows that long-term unemployment is the essence of the European unemployment problem. Hazard rates of escaping unemployment in Europe fall sharply with increases in the length of unemployment spells. So although most Europeans leave unemployment relatively quickly, a significant fraction of workers now become trapped in long-term unemployment. In earlier decades, European workers faced a much lower risk of long term unemployment. A study by Sinfield (1968) established that, except for Belgium, long term unemployment was not much of a problem in Europe in the 1960s. Defining 'long-term' as six months and over, Sinfield concluded that long-term unemployment typically affected half a percent of a country's labor force. In countries such as the former West Germany and the Scandinavian countries, it was less than two tenths of a percent.

The population of long-term unemployed workers in Europe today is quite diverse and not easily characterized. Machin and Manning (1999, p. 3093) describe some patterns in the incidence of long-term unemployment (LTU) in various groups of unemployed workers.

"In all countries there is a higher incidence of LTU among older workers and a lower rate among young workers.

> Differences in the incidence of LTU by education are less marked. Most countries seem to have a higher incidence among less-educated but the differences are often small."

During the 1980s, the OECD (1992, p. 67) observed that "former manufacturing workers tend to be overrepresented among the long-term unemployed, reflecting the impact of structural adjustment in industry."

Blanchard (2005, p. 16) posed the problem sharply:

> "Empirically, [the insider-outsider theory] implied that movements in the labor force would not be reflected in employment; but a strongly established fact is that, even in economies with high unemployment, exogenous movements in the labor force – due to demography or repatriation, such as the return of European nationals after the independence of former colonies – translate fairly quickly into movements in employment. Empirically also, why would hysteresis be relevant for Europe from the 1970s on, but not elsewhere and at other times?"

These are two of the major puzzles that we want to address. Why do some (especially older) workers become long-term unemployed while the economy seems to have no problem creating jobs for newcomers? And why did unemployment rates in Europe become persistently higher than in the U.S. after the 1970s when the opposite had been true in earlier decades?

2.3 Other explanations

Blanchard et al. (1986) discussed several potential explanations of high European unemployment. After listing many contributing factors, they stated their "opinion that a sharp decrease in aggregate demand is indeed the proximate cause of the rise in unemployment in the EC [European Communities] since 1980." But because high European unemployment persisted longer than could plausibly be attributed to insufficient demand, most economists began emphasizing mechanisms that could propagate high unemployment. For example, Blanchard and Summers (1986) and Lindbeck and Snower (1988) converted the employed workers into 'insiders' and the unemployed into 'outsiders', modelled an economic shock that increases unemployment as reducing the number of insiders, and assigned to insiders enough bargaining power to force up the real wage after a drop in employment. That higher real wage curtails firms' labor demand and leaves more outsiders unemployed.

2.4 A procession of aggregate shocks

The oil-price increases of 1973 and 1979 are commonly cited as causes of the outbreak of high European unemployment, see e.g. Layard et al. (1991, chap. 8). In the story of (Phelps (1994, chap. 18), these oil price shocks are later supplanted by high real interest rates due to growing world public debt: "by 1986 or 1987 the real price of oil was back to its level of the early 1970s. So it was largely the high real interest rates lasting over most of the decade that account for the high equilibrium unemployment rates in the late 1980s." In addition to high real interest rates, the empirical work of Blanchard and Wolfers (2000) finds that two more aggregate shocks have explanatory power – declining total factor productivity growth in Europe since the early 1970s and a decreasing labor share of output since the 1980s.

2.5 The high safety net in Europe

Layard et al. (1991) emphasized hysteresis and nominal inertia in wage and price setting, but they also argued that the

> "unconditional payment of benefits for an indefinite period is clearly a major cause of high European unemployment."

Martin (1996) supported this characterization of the generosity of European social safety nets. For the average 40-year-old worker with a long period of previous employment, Table 2 describes net welfare benefits after tax and housing benefits. A single-earner household with a dependent spouse in Europe has a replacement rate of approximately 70% five years into an unemployment spell, which contrasts with 14% in the United States. The typical U.S. worker faces a sharp drop in welfare benefits after unemployment compensation expires. The duration of unemployment benefits in the United States is usually restricted to 26 weeks with replacement rates before that ranging from 50 to 70 percent.

2.6 The challenge to imputing high unemployment to the welfare state

A widespread criticism of all attempts to attribute high European unemployment to welfare state institutions is that no major changes in those institutions coincided with the eruption of high European unemployment. As Krugman (1987, p. 68) put it:

> "The main difficulty with the Eurosclerosis hypothesis is one of timing. Although details can be debated, no strong case exists that Europe's welfare states were much more extensive or intrusive in the 1970s than in the 1960s, and no case at all exists that there was more interference in markets in the 1980s than in the 1970s. Why did a social system that seemed to work extremely well in the 1960s work increasingly badly thereafter?"

OECD (1994, chap. 8) pointed out that empirical studies failed to find a positive cross-country correlation between unemployment benefits and aggregate unemployment for data prior to the European unemployment crisis of the 1980s. If anything, there was a negative correlation between benefit levels and unemployment in the 1960s and early 1970s.[2]

[2] Blanchard (2005, pp. 21-23) noted that "[c]hanges in institutions did not appear able however to explain the evolution of unemployment rates *over time*. ... The replacement rates shown in Figure 9 ... no clear trend emerges. ... The indexes of employment protection shown in Figure 10 ... Again, what is striking is the absence of a clear trend ..."

The stability of European labor market institutions transcending these decades of very different unemployment rates leads us to consider an hypothesis about how changes in the economic environment interacted with those institutions to unleash persistently high unemployment in Europe but not in the United States. Thus, we shall pursue a theme of Blanchard and Wolfers (2000) about the *interaction* of shocks and institutions, but with an important difference. Instead of looking for *macroeconomic* shocks, we shall focus on *microeconomic* shocks concealed within slowly moving macroeconomic averages.

2.7 Microeconomic shocks

Both Bertola and Ichino (1995) and Ljungqvist and Sargent (1998) alluded to *microeconomic* evidence of increasing volatility in worker's earnings during and after the 1980's. Gottschalk and Moffitt (1994) provided evidence for growing instability in earnings of U.S. workers over the 1970s and 1980s. They divided data for white males in the Michigan Panel Study of Income Dynamics (PSID) into two nine-year periods, 1970–78 and 1979–87. After adjusting for age-earnings profiles, for each individual within each period they calculated the mean of log earnings over all nine years and the deviation of log earnings from mean in each year. They computed the "permanent variance" of log earnings for each nine-year period as the variance of the means across individuals. They defined the "transitory variance" to be the variance of the nine annual transitory components separately for each individual and by then averaging them across individuals.

Table 3 summarizes Gottschalk and Moffitt's calculations. The first row shows that the permanent and transitory variances of log annual earnings both rose by approximately 40% between the two subperiods. Since the transitory variance is roughly half as large as the permanent variance and the two variances sum to the total cross-sectional variance, the findings indicate that one-third of the widening of the earnings distribution has resulted from a rise in the instability of earnings.[3] To examine whether the rise in transitory variance merely reflected an increase in the instability of employment, the next two rows in Table 3 decompose annual earnings into weekly wages and weeks worked during the year. The calculations show that roughly half of the increase in the variance of transitory annual earnings is a result of an increase in the variance of weekly wages.

Bertola and Ichino (1995) interpreted Gottschalk and Moffitt's findings of greater earnings instability as reflecting more volatile local demand shocks since the 1980s. Given a rigid wage and the high firing costs that prevail in Europe, they showed that a higher likelihood of negative shocks in the near future decreases labor demand by hiring firms. Then so long as the wage rate does not fall, the equilibrium unemployment rate would rise.

Ljungqvist and Sargent (1998) imputed part of the increased earnings variability to shocks to individual workers' human capital. Human capital accumulates when a worker has a job but can be lost during spells of unemployment, and also at the time of an involuntary job loss. According to our 1998 model, generous benefits produce high long-term unemployment

[3]Gottschalk and Moffitt (1994) did the same calculations for different subgroups classified by education and age, and found that the variance of permanent and transitory earnings increased for all subgroups.

in Europe because the last couple of decades saw an increased probability of human capital loss at the time of an involuntary job displacement.[4]

2.8 Increased earnings variability

Their discussants, Dickens (1994) and Katz (1994), both expressed fascination with Gottschalk and Moffitt's documentation of the increased earnings instability, which until then only been speculated about by the public and media, and called for further studies to confirm and extend their finding. Additional research has supported and extended Gottschalk and Moffitt's results. Katz and Autor (1999, p. 1495) summarize the state of knowledge in the Handbook of Labor Economics:

> "A consistent finding across studies and data sets is that large increases in both the permanent and transitory components of earning variation have contributed to the rise in cross-section earnings inequality in the United States from the late 1970s to early 1990s. The increase in the overall permanent component consists of both the sharp rise in returns to education and a large increase in the apparent returns to other persistent (unmeasured) worker attributes. The rise in cross-sectional residual inequality for males (controlling for experience and education) in the 1980s seems to consist of approximately equal increases in the permanent and transitory factors."

For household data on consumption and income from Britain, Blundell and Preston (1998) used the cross-equation restrictions from a permanent income model to infer variations over time in variances of innovations to both permanent and transitory components of earnings. Over the period 1968–1992, they found substantial growth in inequality coming from the transitory part. They also found that at the end of their sample period younger cohorts faced substantially larger permanent innovation variances than older cohorts had at similar ages.

2.9 Personal skill obsolescence versus sectoral reallocation

An aim of this paper is to interpret such findings of increased earnings variability in terms of a parameter that we use to measure turbulence. Our notion of turbulence refers to the instantaneous obsolescence of valued skills confronting a displaced worker. It differs from another notion of turbulence that pertains to reallocations of activity across sectors. Layard et al. (1991, p. 46) had in mind sectoral reallocation when they answered the question: "has turbulence increased since the 1960s in a way that could help to explain increased

[4] For other models of labor market institutions and changing microeconomic environments, see Marimon and Zilibotti (1999) and Hornstein et al. (2003). Marimon and Zilibotti explore how high UI can cause unemployment to rise when there is an increase in the value of forming good matches between heterogeneous workers and firms. Hornstein et al. show that an acceleration of capital-embodied technological change can interact with UI and EP to produce high unemployment.

unemployment? The answer is a clear no." They computed the proportions of jobs in each industry in adjacent years and then took the changes in each proportion. After summing the positive changes to get a measure of the proportion of employment switching industries, they found that turbulence had not increased enough to explain the emergence of high European unemployment.

Individual workers can experience turbulence in our sense without changes in the economy's sectoral composition. As reported by Davis et al. (1996), about one in ten manufacturing jobs disappears in the United States in an average year, and a comparable number of new manufacturing jobs is created. Two-thirds of job creation and job destruction are concentrated at plants that expand or contract by 25 per cent in one year. Workers who are laid off in the process of job destruction might not necessarily qualify for new jobs created in the same industry. A case in point is provided by Shaw (2002) who studies the introduction of new technologies in the U.S. steel industry and their effects on employment. She documents that the restructuring of the steel industry has led to new hiring standards that emphasize independent thinking, ability to solve mechanical problems, and communication skills. As a result, many of the less skilled workers laid off at older, declining steel mills are not candidates for employment at the newer steel mills. We now turn to some evidence about how displaced workers fare in terms of lost earnings.

2.10 Earnings losses of displaced workers

Another type of evidence that reveals the effects of turbulence in labor markets comes from studies of displaced workers, individuals with established work histories who have involuntarily separated from their jobs. Jacobson et al. (1993) studied the earnings lost by displaced workers in Pennsylvania during the early and mid-1980s. From administrative data they identified displaced workers with 6 or more years of tenure on a predisplacement job, and compared their earnings with those of workers who kept their jobs throughout the period 1974–86.

Like earlier researchers, Jacobson et al. found that long-tenured workers incurred large losses at the time of separation, but their data also reveal a consistent intertemporal response to these losses. Displaced workers' relative earnings already begin to decline three years prior to their displacement, drop sharply when they actually lose their jobs, and then rise rapidly during the next six quarters. After that point, however, these workers' earnings recover very slowly, so that five years after separating from their former firms, their losses still amount to 25 percent of their predisplacement earnings. Figure 2 reproduces Jacobson et al.'s figure 1, which dramatically shows the disparate expected earnings patterns of high-tenured workers who were displaced in the first quarter of 1982 compared to workers who remained employed throughout the period. Schoeni and Dardia (1996) found similar long-run earnings losses of 17 to 25 percent for workers separating from declining firms in California in the early 1990s.[5]

[5]For surveys of the evidence about displacement workers in the United States, see Hamermesh (1989), Fallick (1996), Kletzer (1998), and Farber (1997, 2005). Pavoni (2003) reviews a substantial body of evidence bearing witness to the type of human capital loss that we have in mind. We think that the vision and

Studies of displaced European workers have only begun to appear. A common finding seems to be that both earnings losses *and* reemployment probabilities of displaced workers are smaller in Europe than in the United States. For Germany, Burda and Mertens (2001) remark:

> "As only around 80% of all displaced workers [in Germany in 1986] are observed in socially insured employment even 4 years afterwards, it seems that lower displacement wage losses in Germany come at the cost of lower reemployment probabilities."

3 Our model

Ljungqvist and Sargent (1995, 1998) and Ljungqvist (2002) form our starting point. Because our 1998 model assumed that workers do not age, we could not explain why long-term unemployment in Europe is especially high among older workers. Also, the model could not explain why during the 1950s and 1960s Europe's unemployment rates were actually *lower* than those in the U.S. despite Europe also having generous rules then for compensating unemployed workers.

This paper makes three significant modifications to our 1998 model that enable us to understand these features of the data: (a) workers now age stochastically and behave differently at different ages; (b) a job offers a Markov process of wages per unit of human capital; and (c) there is employment protection in form of a tax on all separations except retirements. Feature (a) allows us to study the differential effects of labor market institutions on workers of different ages. Feature (b) endogenizes most separations. At our pre-1980s setting for the key human-capital-loss parameter, features (b) and (c) interact to let high layoff costs push unemployment rates *down* by reducing frictional unemployment, thereby allowing us to explain the lower European unemployment of the 1950s and 1960s. That effect is reversed when the human capital loss parameter is set at its 1980s level. Thus, the effects of layoff costs on the unemployment rate depend on the proportions of frictional and structural unemployment, which differ because they depend on the generosity of the unemployment compensation system.

3.1 The economy

There is a continuum of workers with geometrically distributed life spans, indexed on the unit interval with births equaling deaths. Each worker passes through a finite number of age classes, indexed by $a = 1, 2, \dots, A$, with transition probability from age class a to a' denoted by $\alpha(a, a')$. Aging occurs sequentially, i.e., $\alpha(a, a') = 0$ if $a' \neq a, a+1$; and all workers reach retirement, i.e., $\alpha(a, a) + \alpha(a, a+1) = 1$ for $a = 1, 2, \dots, A-1$. Hence, the probability of retirement from the highest age class A is equal to $1 - \alpha(A, A)$.

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evidence in Heckman (2003) is consistent with the mechanism featured in this paper through which increased turbulence creates bad outcomes when there is a high safety net.

An unemployed worker in period t chooses a search intensity $s_t \geq 0$ at a disutility $c(s_t)$ that is increasing in s_t. Search yields a probability of a job offer in the next period. With probability $\pi(s_t)$, next period the unemployed worker will receive one wage offer from the distribution $F(w) = \text{Prob}(w_{t+1} \leq w)$. With probability $(1-\pi(s_t))$, the worker will receive no offer in period $t+1$. We assume that $\pi(s_t) \in [0,1]$ and that it is increasing in s_t. Accepting a wage offer w_{t+1} means that the worker earns that wage (per unit of skill) in period $t+1$, and thereafter receives a Markov wage process $G(w'|w) = \text{Prob}(w_{t+i+1} \leq w'|w_{t+i} = w)$ for each period he has not retired, has not been laid off, and has not quit his job. The probability of being exogenously laid off at the beginning of a period is $\lambda \in [0,1]$.

Employed and unemployed workers experience stochastic accumulation or deterioration of skills, respectively. There is a finite number of skill levels with transition probabilities from skill level h to h' denoted by $\mu_u(h,h')$ and $\mu_e(h,h')$ for an unemployed and an employed worker, respectively. That is, an unemployed worker with skill level h faces a probability $\mu_u(h,h')$ that his skill level at the beginning of next period is h', contingent on not retiring. Similarly, $\mu_e(h,h')$ is the probability that an employed worker with skill level h sees his skill level change to h' at the beginning of next period, contingent on not being exogenously laid off. In the event of an exogenous layoff, the transition probability is $\mu_l(h,h')$. After this initial period of an exogenous layoff, the stochastic skill level of an unemployed worker is again governed by the transition probability $\mu_u(h,h')$. All newborn workers begin with the lowest skill level.

A worker observes his new age and skill level at the beginning of a period before deciding to accept a new wage offer, choose a search intensity, or quit a job. Each worker maximizes the expected value $E_t \sum_{i=0}^{\infty} \beta^i y_{t+i}$, where E_t is the expectation operator conditioned on information at time t, β is the subjective discount factor, and y_{t+i} is the worker's after-tax income from employment and unemployment compensation at time $t+i$ net of disutility of searching.[6] (The variable y_{t+i} assumes the value zero after retirement.)

Workers who were laid off are entitled to unemployment compensation benefits that depend on their last earnings. Let $b(I)$ be the unemployment compensation to an unemployed worker whose last earnings were I. Unemployment compensation is terminated if the worker turns down a job offer with earnings that are deemed to be 'suitable' by the government in view of the worker's past earnings. Let $I_u(I)$ be the government determined 'suitable earnings' of a laid off worker whose last earnings were I.

A worker quitting his job is entitled to unemployment compensation only if the foregone earnings falls short of a 'suitable earnings' criterion based on the worker's earnings in the previous period. Let $I_e(I)$ be the government determined 'suitable earnings' of an employed worker whose earnings in the previous period were I. A quitter who is entitled to unemployment compensation falls under the same rules as a laid off worker. Newborn workers are not qualified for unemployment compensation.

Income from employment and unemployment compensation are both subject to a flat rate income tax of τ. In equilibrium, the government policy functions $b(I)$, $I_u(I)$ and $I_e(I)$ and the tax parameter τ are set so that income taxes cover the expenditures on unemployment

[6] We defend the linear utility specification in section 3.3.

compensation.

An additional policy instrument is a tax on job destruction. Each worker who is laid off or quits his job has to pay a tax K. It is irrelevant for the analysis of employment whether this tax constitutes a deadweight loss or whether the tax proceeds are handed back lump sum to all workers.

3.2 Workers' decision rules

Let $V(a,h,w,I)$ be the value of the optimization problem for a worker of age a and skill level h, who was employed in the previous period with income I and today has the option to work at the wage w. The value associated with being unemployed and eligible for unemployment compensation benefits is $V_b(a,h,I)$, which is a function of the unemployed worker's age a, skill level h, and last earnings I. In the case of an unemployed worker who is not entitled to unemployment compensation, the corresponding value $V_o(a,h)$ depends only on the worker's age and skill level. The Bellman equations are:[7]

$$(1)\quad V(a,h,w,I) = \max_{\text{accept, reject}} \Big\{ \Omega(a,h,w)\,, \; D(h,w,I)V_b(a,h,I) + \Big[1 - D(h,w,I)\Big] V_o(a,h) - K \Big\},$$

$$(2)\quad V_b(a,h,I) = \max_s \Big\{ -c(s) + (1-\tau)b(I) + \beta \sum_{a'} \alpha(a,a') \sum_{h'} \mu_u(h,h') \cdot \Big[\Big(1-\pi(s)\Big) V_b(a',h',I) + \pi(s) \cdot \Big(\int_{w<I_u(I)/h'} \max_{\text{accept,reject}} \Big\{ \Omega(a',h',w), V_b((a',h',I) \Big\} dF(w) + \int_{w \geq I_u(I)/h'} \max_{\text{accept,reject}} \Big\{ \Omega(a',h',w), V_o((a',h') \Big\} dF(w) \Big) \Big],$$

$$(3)\quad V_o(a,h) = \max_s \Big\{ -c(s) + \beta \sum_{a'} \alpha(a,a') \sum_{h'} \mu_u(h,h') \Big[(1-\pi(s))\, V_o(a',h') + \pi(s) \int \max_{\text{accept,reject}} \Big\{ \Omega(a',h',w), V_o((a',h') \Big\} dF(w) \Big],$$

where

[7] We have left out any lump-sum transfers to workers of the government's proceeds from the tax on job destruction. Such lump-sum transfers would not affect workers' decision rules for reservation wages and search intensities.

$$
\begin{aligned}
\Omega(a,h,w) &\equiv (1-\tau)wh + \beta\sum_{a'}\alpha(a,a')\Big[\lambda\sum_{h'}\mu_l(h,h')V_b(a',h',wh) - \lambda K \\
&\quad +(1-\lambda)\sum_{h'}\mu_e(h,h')\int V(a',h',w',wh)\,dG(w'|w)\Big], \\
D(h,w,I) &= \begin{cases} 1 & \text{if } wh < I_e(I)\,; \\ 0 & \text{if } wh \geq I_e(I)\,. \end{cases}
\end{aligned}
$$

Associated with the solution of equations (1)–(3) are two functions, $\overline{s}_b(a,h,I)$ and $\overline{w}_b(a,h,I)$, giving an optimal search intensity and reservation wage of an unemployed worker of age a and skill level h with last earnings I, who is eligible for unemployment compensation benefits; two functions, $\overline{s}_o(a,h)$ and $\overline{w}_o(a,h)$, giving an optimal search intensity and a reservation wage of an unemployed worker of age a and skill level h, who is not entitled to unemployment compensation; and one function $\overline{w}(a,h,I)$, giving a reservation wage for an employed worker of age a and skill level h with last period's earnings I.

3.3 Linear utility focuses attention on incentives

To focus our analysis on the incentive effects of unemployment compensation on labor supply under different economic environments, we have made the one-period payoff linear in after-tax income. The linear utility specification makes workers choose their labor supplies by comparing the different present values of the after-tax incomes, net of search costs, that are associated with the options confronting them.

Of course, we recognize that the assumption of linearity in after-tax payoffs precludes rationalizing unemployment compensation as a socially desirable insurance program for workers who cannot otherwise insure themselves, either through explicit insurance against job losses or through precautionary savings that sustain some self-insurance. Normative analyses of unemployment insurance, such as Shavell and Weiss (1979) and Hopenhayn and Nicolini (1997), impute concave one-period utility functions to workers and make a worker's consumption both observable and controllable by an insurance agency. To rationalize experience-rated unemployment compensation schemes, those analyses also cut workers off from all other insurance and storage opportunities, and this affects the analysis sensitively. As Werning (2002) emphasizes, if the Shavell-Weiss setting is altered to let workers borrow and lend at a gross risk free rate of interest equal to β^{-1}, then the scope for a social insurance scheme is substantially circumscribed; when they have access to borrowing and lending arrangements, workers' evaluations of the present values of alternative labor-market options become paramount (an insight also present in Allen (1985) and Cole and Kocherlakota (2001)).

Thus, in settings in which workers can save or borrow through market or nonmarket (e.g., family) arrangements, the dominant incentive effects of government supplied unemployment insurance occur through the present values of alternative options. By using linear utility, we intend to spotlight these incentive effects.

In the case of Europe, one could also argue that the focus of our analysis is justified by the very high levels of government provided insurance. Benefits with high replacement rates and indefinite duration drastically reduce the consumption risk faced by individual workers leading us to focus on the incentive effects of those insurance schemes. Therefore, our decision to abstract from risk aversion and not to model private risk sharing arrangements does not seem to be too confining in the European context. Rather, our simpler framework gains in transparency and brings out economic forces that would also be present and drive the results in a richer model with concave utility functions and asset accumulation.[8] In the case of the United States, relaxing our assumption of linear utility would if anything strengthen our result that the U.S. unemployment rate does not rise sharply in turbulent economic times. Risk averse agents faced with stingy government insurance would be compelled to adjust their reservation earnings in response to negative shocks and return to work relatively quickly to earn a living. It should be noted that unemployed workers in the United States seem to achieve substantial consumption smoothing. Gruber (1997) estimates that unemployed workers without unemployment benefits experience consumption declines of 22 percent. Thus, a linear utility specification might not be such a bad approximation even for the kind of labor market outcomes observed in the United States.[9]

3.4 Human capital evaporates after layoffs but not after quits

In our equilibrium version of a McCall search model, workers can be thought of as being self-employed since all endogenous outcomes emanate from the decision rules described in section 3.2.[10] However, we have made precise a distinction between 'being laid off' and 'quitting': the former refers to exogenous layoffs that occur with probability λ and the latter to endogenous separations.

An important aspect of our specification is that workers experience no depreciation of human capital when they *quit*, even in turbulent times; but if they are exogenously *laid off*, they acquire a possibly lower new skill level drawn from the transition probabilities for skills after such layoffs, $\mu_\ell(h, h')$. This specification captures our vision that there are two types of job separations – 'orderly' ones and potentially disruptive ones. Orderly separations include both real-world quitters who are secure in their skills and inspired to change jobs to make better use of their current skills and also workers who are laid off from faltering firms but who can with relative ease find comparable employment opportunities with other firms. In contrast to these orderly separations, all of which we have labelled 'quitters,' the victims of exogenous layoffs are the truly unlucky ones who may experience different amounts of skill obsolescence. Formally, the shocks drawn from $G(w'|w)$ and $\mu_e(h, h')$ that propel quits do not so adversely affect the future earnings of quitting workers as do the events associated with exogenous layoffs.[11]

[8] For a formal analysis that verifies the robustness of our results when risk aversion and precautionary savings are incorporated, see Ljungqvist and Sargent (2005).

[9] We are thankful to Robert Hall for this insight.

[10] Section 7.3 offers an alternative interpretation of our search model where workers are employed by firms rather than being self-employed. The firms pay wages and are liable for layoff costs. Equilibrium outcomes with respect to employment and production are invariant to that alternative interpretation of the model.

[11] Den Haan et al. (2001) make the alternative assumption that quitters are subject to the same risk of

3.5 More general interpretation of immediate skill loss

While we have modelled an increase in turbulence in terms of immediate negative shocks to laid off workers' earning potentials, the multi-dimensional character of employment means that in truth workers' job opportunities can deteriorate in other ways. We think that our specification also captures the situations confronting such workers who have encountered unfavorable labor market conditions in one way or another and who are entitled to generous benefits so long as they remain unemployed.

4 Calibration

We set the model period to be two weeks. We set the discount factor $\beta = 0.9985$, making the annual interest rate 4.0 percent. There are four age classes with probabilities of remaining within an age class equal to 0.9985 for the first age class and 0.992 for each of the other three age classes. The time spent in an age class is then geometrically distributed with an expected duration of 25.6 years in the first age class and 4.8 years in each of the other three age classes. We label the four age classes as age groups '20–45', '45–50', '50–55' and '55–60', respectively.

The probability of being laid off is $\lambda = 0.006$. Given that the worker has not quit or retired, the average time before being laid off is 6.4 years.

There are 11 different skill levels evenly partitioning the interval $[1, 2]$. All newborn workers start with the lowest skill level equal to one. After each period of employment that is not followed by a layoff, with a probability of 0.05 the worker's skills increase by one level (0.1 units of skill), and with probability .95 they remain unchanged. Employed workers who have reached the highest skill level retain those skills until becoming unemployed. As a point of reference, someone who starts working with the lowest skill level will on average reach the highest skill level after seven years and eight months, conditional upon no job loss. The stochastic depreciation of skills during unemployment is twice as fast as the accumulation of skills. That is, after each period of unemployment, there is a probability of 0.1 that the worker's skills decrease by one level; otherwise they remain unchanged.[12] The lowest skill level reached through depreciation is also an absorbing state until the unemployed worker gains employment.

To represent economic turbulence, we use the theoretical construct of Ljungqvist and Sargent (1998) in which a newly involuntarily displaced worker experiences an instantaneous reduction in his human capital modelled as a draw from a truncated left half of a normal

instantaneous skill loss as workers being laid off. With that assumption, they show that in their model, an increase in economic turbulence reduces the unemployment rate because workers fear the potential skill losses that are associated with both voluntary and involuntary job separation, depressing the inflow rate into unemployment.

[12]The assumptions on skill accumulation and skill depreciation are taken from Ljungqvist and Sargent (1998), except that we have here chosen a coarser partition of the skill space in order to economize on the state space. For a motivation of the parameter values, see our earlier argument based on empirical work by Keane and Wolpin (1997).

distribution with specified variance. We use this specification to study six different degrees of economic turbulence (with the variance of the underlying normal distribution in parenthesis): T00 (var. 0), T03 (var. 0.03), T05 (var. 0.05), T10 (var. 0.1), T20 (var. 0.2) and T99 (uniform distribution). Only during tranquil times (T00) can the worker be sure of not experiencing any skill loss when laid off.

The disutility from searching and the function mapping search intensities into probabilities of obtaining a wage offer are assumed to be

$$\begin{aligned} c(s) &= 0.25s\,, \\ \pi(s) &= 0.5s^{0.3}\,, \qquad \text{where } s \in [0,1]\,. \end{aligned}$$

The exogenous wage offer distribution $F(w)$ is assumed to be a normal distribution with a mean of 0.7 and a variance of 0.02 that has been truncated to the unit interval and then normalized to integrate to one. The Markov wage process on the job is as follows. With probability 0.98, the wage will be the same as in the previous period, and with probability 0.02, the wage is drawn from the distribution $F(w)$. The average time between wage draws on the job (given that the worker has not quit or retired) is 1.9 years. Since a worker's earnings are the product of his wage and current skill level, it follows that observed earnings fall in the interval $[0, 2]$.

For purposes of awarding unemployment compensation, the government divides the earnings interval $[0, 2]$ evenly into 20 earnings classes; let the upper limits of these classes be denoted I_i, for $i = 1, 2, ..., 20$. A laid off worker with last earnings belonging to earnings class i receives unemployment compensation of $0.6 \cdot I_i$ in each period of unemployment. However, the benefit is terminated if the worker does not accept a job offer associated with earnings greater than or equal to $0.7 \cdot I_i$. That is, the government policy functions $b(I)$ and $I_u(I)$ are such that a laid off worker faces a 'replacement ratio' equal to 60% and a 'suitable earnings' criterion equal to 70% of the upper limit of the earnings class containing his own last earnings before being laid off. Concerning quitters' entitlement to unemployment compensation, the suitable earnings criterion is the same so that $I_e(I) = I_u(I)$ for all I. Thus, a quitter receives unemployment compensation only if he would have earned less than 70% of the upper limit of the earnings class containing his last earnings before quitting.

We set the layoff tax $K = 10$, making it equivalent to 14 weeks of the average productivity of all employed workers.

5 Model outcomes I

5.1 Tranquil economic times

Table 4 displays the steady states of the WS economy and the LF economy when there is no economic turbulence. The WS economy has significantly lower unemployment than the LF economy because of a lower inflow rate into unemployment while the average duration of unemployment is similar across the two economies. As a result, lower unemployment in the WS economy is accompanied by much longer average job tenures than in the LF economy.

In tranquil times (denoted by an index of turbulence equal to T00), Table 5 shows that the layoff cost in the WS economy is responsible for the lower unemployment rate. If the LF economy were to impose the same layoff cost, it would have an even lower unemployment rate than the WS economy.

Figure 3 depicts reservation wages per unit of skill in the LF economy. In the absence of unemployment compensation and layoff taxes, employed and unemployed workers share the same policy functions for the reservation wage as a function of age and skill level. The U-shaped relationship between the reservation wage and skill level emerges from the technology for accumulation and depreciation of skills. On the one hand, before a worker has reached the highest skill level, the potential for further skill accumulation that can be actualized by accepting a job favors a relatively low reservation wage. But at higher skill levels, the potential for further skill accumulation becomes smaller and emphasis shifts towards searching for higher wages, i.e., the reservation wage curve tends to slope upward. On the other hand, a worker's choice of reservation wage is tempered by the risk of skill depreciation while unemployed. This downward pressure on the reservation wage is smaller at lower skill levels because there are fewer skills to be lost. These forces coalesce to produce a reservation wage policy that is U-shaped in the skill level.

The reservation wages of unemployed workers who are not eligible for unemployment compensation in the WS economy, shown in Figure 4, lie slightly above those in the LF economy. An unemployed worker without benefits in the WS economy takes into account the potential future benefits from the unemployment compensation program. These are an increasing function of the worker's earnings. The optimal search intensity of these workers and the unemployed workers in the LF economy equals the highest value of one.

The reservation wages of *employed* workers yield the lower unemployment rate in the WS economy. Figure 5 depicts the reservation wages of employed workers in age group 20–45 in the WS economy. Because of the layoff tax, employed workers are reluctant to quit their jobs, making reservation wages lower than in the LF economy.

The reservation wages of *unemployed* workers with benefits in age group 20–45 in the WS economy in Figure 6 exhibit some similarities with Figure 5 except that reservation wages are much higher in Figure 6. This is especially apparent for those unemployed workers with low skills who are entitled to high benefits based on their high last earnings. Moreover, because these high reservation wages are hard to find and the generous benefits make it less costly to remain unemployed, Figure 7 shows that an unemployed worker in these circumstances invests less in search by choosing a relatively low search intensity. Figures 8 and 9 show that these adverse incentive effects of generous benefits are accentuated in the highest age group 55–60.

Fortunately, in tranquil economic times there will hardly be any unemployed workers with low skills who are entitled to high benefits based on high last earnings, so the WS economy sustains a low equilibrium unemployment rate in Table 4.

5.2 Economic turbulence

When the economic turbulence parameter is increased in Table 6, the WS economy posts an ever higher unemployment rate while unemployment is practically flat (with some drift downward) in the LF economy. The emergence of high, long-term unemployment in the WS economy is due to both generous unemployment benefits and high layoff costs.

The decision rules of unemployed workers in turbulent economic times are qualitatively the same as in times of tranquility. We can therefore use Figures 6 through 9 to illustrate how the adverse incentive effects of unemployment compensation in the WS economy are exacerbated in turbulent times. Because of turbulence there will be laid off workers who suffer significant amounts of instantaneous skill loss, and they will choose high reservation wages belonging to the "rising slopes" in Figures such as 6 and 8. Since these workers' depreciated skill levels are low relative to their recent earnings history, unemployment benefits based on last earnings look very attractive compared to their current labor market prospects. Therefore, they demand a high wage per unit of remaining skill before giving up those generous benefits. Moreover, such high wages are hard to come by so workers under these circumstances tend to become disillusioned and choose low search intensities, as depicted by the deepest "precipice" in Figures such as 7 and 9. Older laid off workers have a shorter horizon until retirement and therefore less time for any accumulation of new skills, so they are even choosier than younger workers before accepting a job and giving up their benefits. All these adverse incentive dynamics are absent from the LF economy because past earnings are not a state variable for unemployed workers. In other words, any laid off worker in the LF economy who experiences an instantaneous skill loss, will immediately adjust to the new situation and search diligently for a suitable job given the change in circumstances.

We now briefly examine the effects of layoff costs in the WS economy – a discussion that we will pursue more in sections 6.4 and 7.1.

Ljungqvist (2002) showed that in a search model like ours, higher layoff costs lower the unemployment rate by reducing frictional unemployment. However, Table 5 shows that in turbulent times the effect is reversed in the WS economy because in turbulent times unemployment has both frictional and *structural* components. The structural component contains the long-term unemployed who have chosen to become less active in the labor market. In turbulent times, when agents think about withdrawing from the labor market, both the higher turbulence and the higher layoff cost make labor market participation less attractive. But in the absence of generous benefits, not participating in the labor market is not a viable option. Table 5 thus shows how the negative relationship between layoff costs and unemployment is a robust feature in the LF economy even in the face of variations in the degree of economic turbulence (even though it *isn't* such a robust feature of the WS economy).

5.3 Replication of microeconomic empirical studies

We can use our model as a laboratory to replicate aspects of earnings dynamics described by Gottschalk and Moffitt (1994) and Jacobson et al. (1993).

Using the LF economy with economic turbulence indexed by T10 and T20, we generate artificial versions of Gottschalk and Moffitt's PSID panels for 1970–78 and 1979–87, respectively. After applying their method for decomposing each panel's earnings into permanent and transitory components, we arrive at Figures 11a and 11b as our counterparts to their Figures 2 and 4 (reproduced here in our Figures 10a and 10b). Evidently, an increase in our turbulence parameter spreads the distributions of both components of the Gottschalk-Moffitt decomposition in the direction observed. However, there are differences in the ranges of the distributions. The fact that our distribution of permanent earnings in Figure 11a spans a smaller range than the Gottschalk-Moffitt data is not surprising. Our artificial panel contains a group of homogeneous individuals who are *ex ante* identical, while the PSID used by Gottschalk and Moffitt comprises a diverse group of American males with different educational backgrounds. It is also noteworthy that the increased earnings variability in the more turbulent period in our Figure 11b occurs at lower standard deviations than Gottschalk and Moffitt's. In this respect, the increase in economic turbulence in our parameterization for the 1980's falls short of the changes documented for the U.S.

As discussed in the introduction, our Figure 2 reproduces Figure 1 of Jacobson et al. (1993). It shows earnings losses experienced by displaced workers in Pennsylvania in the first quarter of 1982. Using artificial data from the LF economy with economic turbulence indexed by T20, we produce a counterpart of their graph in Figure 12. The surprisingly good fit here is obtained for our subsample of separators who have experienced skill losses of at least 30%. These separators constitute roughly one third of all separators in our artificial data set.

5.4 Displaced workers in the WS economy versus the LF economy

Empirical studies of displaced workers in Europe have started to appear (see for example Burda and Mertens (2001)). A common finding seems to be that European workers experience both smaller earnings losses on average and lower re-employment rates than their American counterparts. We now examine whether there are such differences between our WS economy and LF economy. From hereon, we let economic turbulence be indexed by T20.

We follow two cohorts of workers who were laid off in age groups 45–50 and 55–60, respectively. Prior to the layoffs, these workers were distributed across skills and wages according to the stationary distribution for the employed in each age group. Table 7 reports that these cohorts fare similarly in the LF economy with mean earnings losses of around 15% among the re-employed workers one year after the layoffs, and an unemployment rate of about 4%. In comparison, the re-employed workers in the WS economy suffer smaller earnings losses but have a higher incidence of unemployment. This is especially true for the higher age group 55–60, where the average earnings loss is less than 9% but the unemployment rate exceeds 11% one year after the layoffs. Figure 13a depicts the distribution of those earnings losses in age group 55–60 for both economies.

The lower panel of Table 7 shows how the employment performance of the WS economy further deteriorates when looking at the subgroup of laid-off workers who suffered skill losses of at least 20% at the time of the layoffs. But it remains true that the re-employed workers of the WS economy suffer significantly lower earnings losses than the LF economy. The distribution of those earnings losses in age group 55–60 is depicted in Figure 13b.

5.5 Long-term unemployment in the WS economy

Figure 14 portrays the problem of long-term unemployment in the WS economy by showing hazard rates of gaining employment when economic turbulence is indexed by T20. The hazard rate declines dramatically with the length of an unemployment spell. There are also significant differences across age groups. In particular, the figure shows that the hazard rate of workers in age group 20–45 does not fall off as fast as the one for older workers in age group 55–60. To demonstrate that the disparity is mainly due to the *age effect*, the figure also displays an adjusted hazard rate for age group 20–45 when the cohort entering unemployment has the same distribution of skills and entitlements to unemployment compensation as the one for age group 55–60. Adjusting the hazard rate does little to bridge the difference in hazard rates between the two age groups.

As we would then expect, in Table 8 long-term unemployment is more common among the unemployed in higher age groups. Older workers do have a lower inflow rate into unemployment but it is not sufficient to counter their less favorable hazard rates of accepting jobs so that the unemployment rate is also higher among older workers. The lower inflow rate into unemployment for older workers comes from these workers' greater willingness to hold onto jobs that have suffered poor productivity draws. Older workers have less time left in the labor market, so it makes less sense for them to quit jobs and invest in search for better job opportunities. That is, employed older workers have lower reservation wages than younger employed workers, given the same skill level.

When studying the higher incidence of long-term unemployment among older workers in Table 8, one should keep in mind that labor force participation is not variable in our model. But it is well known that not only early retirement but also enrollments in disability insurance programs have increased dramatically among older workers in several European countries since the 1980s. See the country studies compiled by Gruber and Wise (2004). We conjecture that our analysis also captures the adverse events that have prompted many of these workers to "bail out" into the social safety net.[13] Thus, the unemployment numbers in Table 8 can be thought of as reflecting both open unemployment and hidden unemployment

[13]For example, referring to highly correlated numbers of recipients of disability insurance and unemployment insurance in different geographic regions of Sweden, Edling (2005) concludes that disability insurance is to a large extent used to conceal unemployment, especially among older workers in age group 55-64. Autor and Duggan (2003) argue that adverse demand shifts for the skills of high school dropout in the United States and less stringent screening in the disability insurance program have led to a higher propensity among these workers to exit the labor force and seek disability benefits after adverse shocks. The reasoning is the same in these two studies but the magnitudes are different. According to Autor and Duggan, 3.7% of Americans in ages 25-64 received disability insurance benefits in 2001 while Edling (2005) reports for the Swedish population in ages 20-64 that these benefit recipients comprised 10% in 2004 while another 2.4% had received sick insurance benefits for more than a year in 2003.

in form of ‘excessive’ enrollment in welfare programs such as disability insurance.

5.6 Heterogeneity versus duration dependence

A question that has attracted much attention is whether the negative relationship between hazard rates and the length of unemployment spells is due to *heterogeneity*, in the sense that unemployed workers with high re-employment rates leave unemployment first, or whether it reflects *duration dependence*, in the sense that the passage of time reduces the chances for a particular unemployed worker to secure employment. In our model, sources of duration dependence are the aging and skill level deterioration experienced by each individual worker. The sources of heterogeneity are the cross section distributions of age, skills, and entitlements to unemployment benefits for newly terminated workers. For a stationary equilibrium of our model, we can assess the relative importance of heterogeneity and duration dependence by constructing an adjusted hazard rate that holds fixed the age, skills, and entitlements to unemployment compensation for each worker throughout an unemployment spell, thereby assigning all of the variation in hazard rates to heterogeneity. Figure 15 shows that the adjusted hazard rate is only marginally higher at each point in time, so that we can conclude that in our model under economic turbulence indexed by T20, the falling hazard rate is caused almost entirely by *heterogeneity*. That is, already at the time of quits and layoffs, the unemployed are heterogeneous with respect to reemployment probabilities because of different choices of reservation wages and search intensities that are motivated by a worker’s age, current skill level, and his entitlement to unemployment benefits. In turbulent times, there are laid off workers with large instantaneous skill losses, who with high probability at the very start of their unemployment spells are already destined for long-term unemployment.

It is instructive to present the hazard rate and its adjusted version in tranquil economic times (indexed by T00). Figure 16 shows that the average hazard rate in the economy plummets towards the end of the second year of an unemployment spell, and that the high hazard rate until then explains why the average duration of unemployment spells is only around two months and thus why there is hardly any long-term unemployment in tranquil economic times (see Tables 4 or 6). Moreover, duration dependence is now the sole explanation for why the hazard rate falls over time. Workers age and lose skills during an extended period of unemployment, and both of these factors eventually raise reservation wages per unit of skill and lower search intensities. Recall that skills are assumed to decay gradually during unemployment, and it takes on average three years and ten months for someone to lose all his skills conditional upon having attained the highest skill level prior to the layoff. This slow of rate of skill depreciation in tranquil economic times explains why the adverse incentive effects manifested as a falling average hazard rate does not set in until at least one and one half year into an average unemployment spell. And since there is no instantaneous skill loss at layoffs in tranquil times, the construction of the adjusted hazard rate arrests *all* skill depreciation of workers losing their jobs. The virtually constant adjusted average hazard rate in Figure 16 then implies that all unemployed workers with their earnings potential intact are equally unhappy with a 60% replacement rate and prefer to return to work, i.e., they exhibit similar reemployment probabilities.

6 Comparisons with other models

6.1 Duration dependence in matching models

Our model emphasizes an important feature of the data that many other models ignore, namely, the diversity of unemployment experiences across individuals. Some individuals face very low hazard rates of escaping unemployment, but the reemployment probabilities of other workers appear to be high. A diverse group of unlucky European workers, including disproportionately many older workers, experience protracted spells of long-term unemployment and seem unable to find acceptable jobs. The spells of long-term unemployment frequently end with transitions into disability insurance or early retirement. As noted by Layard et al. (1991) and others, an explosion in these adverse labor market dynamics caused the dramatic increase in European unemployment after 1980. Therefore, we believe that any explanation of the European unemployment problem should confront why hazard rates of gaining employment fall sharply with the length of unemployment spells and should explain the incidence and distribution of long-term unemployment.

However, most macroeconomic models of the European unemployment problem ignore the observed heterogeneity in individuals' labor market experiences.[14] For example, the frequently used matching framework makes the aggregate pool of unemployed workers a critical determinant of the rate at which any particular unemployed worker gets matched with a vacancy, with the implication that hazard rates of escaping unemployment remain constant over the duration of unemployment spells, and that an increase in long-term unemployment amounts to an equal lengthening of the average duration for all unemployment spells. Mortensen and Pissarides (1999b) relax this implication by introducing separate matching functions for unskilled and skilled workers. They attribute the European unemployment problem to skill-biased technological change that causes the unemployment rate to increase for unskilled workers and to fall for skilled workers. In particular, an absolute decline in the productivity of unskilled workers makes the constant value of home production relatively more attractive, so if measures of labor market tightness were to remain unchanged, the unskilled workers would reap a larger share of production when bargaining with employers. That disturbs the equilibrium unemployment rate. In order to restore the profitability of employers, the equilibrium unemployment rate of unskilled workers must increase – both to reduce the average time to fill vacancies and to weaken the bargaining strength of unskilled workers. The implication for skilled workers with increasing productivity is exactly the opposite, and their unemployment rate should fall. While it does introduce some heterogeneity across workers, this theory of the European unemployment problem still predicts constant hazard rates of escaping unemployment for broad groups of workers.

[14]For an analysis of how turbulence, UI, and EP interact in matching, search-islands, and a representative family models, see Ljungqvist and Sargent (2005).

6.2 Heterogeneity versus a representative family

The neoclassical growth model with homogeneous labor and a stand-in household, a.k.a. the real business cycle model, is void of all the individual labor market dynamics that make up the core of our analysis. Prescott (2002) has recently used the growth model to explain among other things the economic performance of the French economy. Prescott argues that "France is depressed by 30 percent relative to the United States because the French labor factor is 30 percent lower. The difference in the labor factors is due to differences in the tax systems." In particular, using estimates of marginal tax rates on labor income and consumption, Prescott shows that the Euler equation of the stand-in household can rationalize that market time is about 30 percent lower in France than it is in the United States. He avoids decomposing the aggregate labor input into employment and average hours of work per employed worker by invoking aggregation results underlying the stand-in household utility function.[15] Specifically, in the presence of indivisibilites in hours of work per employed, Rogerson (1988) and Hansen (1985) have established that employment lotteries are welfare enhancing and would be operational in a complete-market world. Individual households would trade probabilities of working and rely on contingent claim markets to insure away any unwanted consumption risk associated with outcomes of those lotteries.

6.3 Different visions of unemployed workers

Besides downplaying differences among individual workers, the matching and representative family frameworks offer sharply different views than does our McCall search model of the equilibrium forces that sustain high European unemployment. In a matching model, all of the unemployed constitute a "reserve army" whose size adjusts to give firms waiting times that let them break even and just recover the costs of posting vacancies. If unemployment were exogenously perturbed downward, the probability of filling a vacancy would drop and the bargaining strength of employed workers would increase, so that European firms would not be able to recover the expected vacancy costs associated with hiring new workers. Hence, firms would immediately reduce vacancies and thereby hasten the economy's return to its high steady-state unemployment rate.

Alternatively, in a model with employment lotteries, a high unemployment rate in Europe reflects the fact that the populations of Europe have substituted leisure for consumption by engaging in transactions that randomly assign workers to "long-term leisure" while the consumption risks associated with these lottery outcomes are somehow shared collectively, possibly through *private* unemployment compensation schemes. Hence, market forces would undo any exogenous downward perturbation in unemployment by in effect furloughing some workers in order to bring the stand-in household's marginal rate of substitution between leisure and consumption into line with the ratio of the marginal after-tax wage rate to the price of consumption including any consumption tax.

In our search model, there are no such equilibrium forces to cause a rapid reversal of an

[15] See Ljungqvist and Sargent (2004) for a critical account of this theory of aggregation.

exogenous reduction in unemployment. Instead, a temporary exogenous arrival of acceptable job opportunities would have a persistent effect on employment. Europe would enjoy an exogenous downward perturbation in unemployment until idiosyncratic shocks in the future would eventually deteriorate labor market prospects for individual workers and cast them into long-term unemployment, which would eventually return the European unemployment rate to its original high steady-state level.

6.4 Employment effects of layoff costs

The different equilibrating forces in these models lead to different employment effects from layoff costs. Our search model attributes the low European unemployment rate in the 1950s and 1960s to policies that made layoffs very costly. An employment-lottery model has the opposite implication: Hopenhayn and Rogerson (1993) showed that in the lottery model employment falls with higher layoff costs. The explanation for this is that the private economy perceives higher layoff costs as equivalent to a less productive technology, so the stand-in household substitutes away from consumption towards leisure by choosing a lower probability of working in the lotteries over employment.[16] Millard and Mortensen (1997) arrive at the same positive relationship between layoff costs and unemployment in a matching model that they use to study American and British labor market policies. As explained by Ljungqvist (2002), their finding hinges critically upon the assumption that the layoff costs are imposed upon an employer even in its very first encounter with a job seeking worker, regardless of whether the worker is actually hired. As a result, the layoff cost adversely shifts an employer's threat point in wage bargaining and therefore the worker's relative share of the match surplus increases with the layoff cost. To restore the profitability of firms, the equilibrium unemployment rate must increase so that the average time and cost to fill vacancies are reduced and the worker's bargaining strength is thereby weakened. However, if layoff costs are not assumed to affect threat points but only enter negatively in the match surplus, then the matching model with its standard Nash-bargaining formulation produces a negative relationship between layoff costs and unemployment, as demonstrated by Mortensen and Pissarides (1999a,b).[17]

[16]The substitution effect prevails over the income effect because the latter effect is to a large extent neutralized, since layoff costs are assumed to be a layoff tax where the tax revenues are handed back lump-sum to the households.

[17]Despite the theoretical ambiguity regarding the employment effects of layoff costs, Ljungqvist (2002) shows that there is a strong quantitative presumption that layoff costs cause employment to increase in search models and in standard matching models, but to decrease in employment-lottery models and in matching models with the alternative bargaining specification of Millard and Mortensen (1997). Ljungqvist identifies the critical assumptions underlying these outcomes. For example, Blanchard and Portugal (2001) adopt a different matching technology but assume the bargaining specification of Millard and Mortensen (1997) and, in accordance with the presumption, layoff costs are found to increase unemployment. Alvarez and Veracierto (1999) formulate a model that combines features of the search-islands model of Lucas and Prescott (1974) and the employment-lottery model. Their results also confirm the presumption as follows: layoff costs reduce frictional unemployment that arises because of search frictions, but they also reduce labor force participation that is determined through employment lotteries so long as the calibrated labor supply

7 Model outcomes II

7.1 Layoff costs in tranquil versus turbulent times

The negative relationship between layoff costs and unemployment in our search model (and in the standard matching model) confirm the insight related by Deputy Commissioner Myers (1964, pp. 180–181) when answering his own query about what explained the low European unemployment rate in the 1950s and 1960s, as quoted in our introduction. Our analysis also confirms his cautious warning about the efficiency losses of instituting a policy of layoff costs:

> "One of the differences [between the United States and Europe] lies in our attitude toward layoffs. The typical American employer is not indifferent to the welfare of his work force, but his relationship to his workers is often rather impersonal. The interests of his own employers, the stockholders, tend to make him extremely sensitive to profits and to costs. When business falls off, he soon begins to think of reduction in force . . .
>
> In many other industrial countries, specific laws, collective agreements, or vigorous public opinion protect the workers against layoffs except under the most critical circumstances. Despite falling demand, the employer counts on retraining his permanent employees. He is obliged to find work for them to do. . . .
>
> These arrangements are certainly effective in holding down unemployment. But they involve a very heavy cost. They partly explain the traditionally lower productivity and lower income levels in other countries. Here is something we can learn from our neighbors, therefore, but are we quite sure we want to learn it? Are there not better ways to reduce unemployment?"

Something that Myers did not anticipate (and neither did we at the outset of this inquiry) is that the employment effects of layoff costs can be reversed in a welfare state with generous benefits when economic turbulence increases. According to our analysis, Europe has had both frictional unemployment and a substantial amount of *structural* unemployment during the last two decades of economic turbulence. By structural unemployment we refer to those long-term unemployed workers who have to a large degree withdrawn from labor market participation. Layoff costs increase the incidence of such transitions into inactivity because these costs reduce the payoff to work and therefore make labor market participation less attractive. In this respect, in turbulent times our search model with generous benefits becomes similar to the employment-lottery model. As mentioned, the negative employment effects of layoff costs in the latter framework emerge because employment lotteries and complete insurance markets combine to produce a high labor supply elasticity, making employment fall in response to layoff costs because of the implied lower private return to work. In our search model, those workers who experience significant skill losses in turbulent times and

elasticity falls in the range of values commonly assumed in macroeconomics.

who are eligible for generous benefits also consider choosing unemployment. A lower payoff to work tips them toward withdrawing from labor market participation. The fact that layoff costs combined with generous benefits can have different employment effects depending on the degree of economic turbulence adds a dimension of complexity to evaluating labor market policies. Coe and Snower (1997) have emphasized the presence of strong complementarities between different policies. Our analysis suggests that the nature of those complementarities can differ between tranquil and turbulent times.

7.2 The indirect quality of evidence for increased turbulence

Our search model says that the European employment experience has been shaped by two factors – policies that hinder labor mobility and entitle unemployed workers to generous benefits based on past earnings and an economic environment that has changed from a state of tranquility to one of persistent turbulence. European labor market policies are well documented and our characterization of them should not be controversial. But our perspective that there has been a fundamental change in the economic environment is currently a subject of great debate that has received much attention by both macroeconomists and microeconomists in theoretical and empirical studies. To just mention one example, Greenwood and Yorukoglu (1997) used the suggestive title "1974" when attempting to date the start of a new industrial revolution based on the introduction of information technologies. For our purposes, we can be pragmatic about the *sources* of economic turbulence. We only require that the turbulence pertains to individual workers' earnings potentials. Formally, we model turbulence as persistent shocks to workers' human capital, but it could also be other things such as losses of union wage premia. For example, Beeson et al. (2001) report that the restructuring of the U.S. steel industry has been associated with wages for steelworkers falling from a level of approximately 35 percent above the wages of other manufacturing workers in 1979 to just 5 percent higher in 1991. They identify a reduction in the union wage premium as one explanatory factor. In the introduction, we referred to the observation of Shaw (2002) that the restructuring of the steel industry has been accompanied by changing hiring standards that render some workers no longer employable in that industry. From the perspective of our analysis it makes little difference whether a laid off worker faces lower future earnings because of having to change industry or whether the worker still remains employable in his original industry that has now lost its union wage premium. In either case, generous benefits based on past earnings would make the worker reluctant to accept such earnings losses and there would be adverse unemployment dynamics as predicted by our model.

A message of our analysis is that the *aggregate* unemployment rate in Europe can be explained only by focusing on the idiosyncracies of individual workers. Any aggregation of unemployed workers into a stand-in household or a small number of static groupings, for example by educational attainment, misses the kind of individual labor market dynamics that we think is the key to understanding the European employment experience. In our view, it should be of high priority to conduct more empirical work on individual labor market histories. An interesting recent study is by Kambourov and Manovskii (2002) who document a substantial overall increase in occupational and industry mobility in the United States over the period 1968–1993. Our future quest should be to discover the reasons that prompt American workers to undertake more transitions between occupations and industries in the 1980s and 1990s, and that cause individual European workers to enter into long-term unemployment.

7.3 Earnings distribution

As mentioned above, the workers of our model can be thought of as self-employed. The Bellman equations above state that an individual worker receives labor income and bears all layoff costs. As a tool to help interpret observed earnings distributions, we now consider a contractual arrangement that shields the worker both from fluctuations in his productivity arising from the Markov process $G(w'|w)$ and from the payment of the layoff cost K. Let there be financial intermediaries that offer the following contract to a worker of age a and skill level h who has found a job with initial productivity w. In exchange for the production generated by the job, the intermediary promises to pay the worker $\hat{w}(a,h,w)$ per unit of skill until the job is terminated just as it would be under self-employment. That is, job termination is triggered when the productivity per unit of skill falls below the reservation value that solves Bellman equation (1) or when the worker experiences an exogenous layoff or retirement.[18] At the time of a quit or layoff, the financial intermediary absorbs the layoff cost. The worker's obligation under the contract is to stay with the job until it is terminated by one of the stated events.

In a competitive equilibrium with free entry of intermediaries, the equilibrium contract satisfies

$$(4) \qquad \hat{w}(a,h,w) \;=\; \frac{wh + E\Big[\sum_{t=1}^{\infty} D_t^a \beta^t \Big\{ D_t^e w_t h_t + (D_t^e - D_{t-1}^e)K \Big\} \;\Big|\; \Psi_0 \Big]}{h + E\Big[\sum_{t=1}^{\infty} D_t^a \beta^t D_t^e h_t \;\Big|\; \Psi_0 \Big]},$$

where

$$\Psi_0 \equiv \{a_0 = a, h_0 = h, w_0 = w, D_0^e = 1\},$$

$$D_t^a \equiv D^a(a_t) = \begin{cases} 1 & \text{if } a_t \le A; \\ 0 & \text{otherwise;} \end{cases} \qquad \text{for } t \ge 1,$$

$$\begin{aligned} D_t^e &\equiv D^e(a_t, h_t, w_t, w_{t-1}h_{t-1}, D_{t-1}^e) \\ &= \begin{cases} 1 & \text{if } w_t \ge \bar{w}(a_t, h_t, w_{t-1}h_{t-1}) \text{ and } D_{t-1}^e = 1; \\ 0 & \text{otherwise;} \end{cases} \qquad \text{for } t \ge 1. \end{aligned}$$

[18] We assume that workers who enter these contracts would receive the same unemployment benefits as they would in the economy without those contracts, given their state at the time of termination. Thus, workers cannot manipulate benefit levels by entering into contractual arrangements with financial intermediaries.

Job finders and intermediaries are both indifferent between accepting and rejecting the contract; job finders attain the same expected utility as under self-employment and intermediaries break even. The equilibrium contract is sustainable since the intermediary and the worker will never mutually agree to renegotiate a signed contract.

Introducing insurance contracts in an economy with risk-neutral agents cannot change production outcomes. However, these contracts give rise to an alternative measure of labor income, which we denote "adjusted earnings." To compare the equilibrium values of workers' productivities ($w_t h_t$) and their adjusted earnings ($\hat{w}_t h_t$), we follow a cohort of workers that entered the WS economy and the LF economy at some time $t = 0$. Figure 17a and 17b depict the mean and standard deviations of employed workers' productivities. As we would expect, the mean productivity in the WS economy is lower than in the LF economy because it has a less efficient allocation of labor. But in terms of standard deviations there is little difference between the two economies. Figure 19 provides a snap shot of the productivity distribution at the 20-year horizon.

In contrast, Figures 18a and 18b show that the adjusted earnings of employed workers have both a lower mean and a lower standard deviation in the WS economy than in the LF economy. In Figure 20, we see how the adjusted earnings distribution at the 20-year horizon is truncated at the upper end relative to the LF economy. Because job terminations are more efficient, workers who have found good job opportunities in the LF economy are awarded higher adjusted earnings than similar job finders in the WS economy, whose jobs last longer on average but might therefore also entail lower productivities in the future.

Layoff costs can be said to accomplish a lower dispersion of adjusted earnings at the cost of a lower mean.

8 Concluding remarks

8.1 The European employment experience through the camera of the model

To explain differences over time in labor market outcomes in the U.S. and Europe, we have varied a key parameter, T for turbulence. We have denoted alternative values of T by Txx where xx is the variance of a truncated left half of a normal distribution that governs the percentage decrement of a worker's human capital at the time of an involuntary job loss. We have focussed on how variations in T interact with layoff costs and rules for compensating unemployed workers to explain both aggregate and individual workers' labor market outcomes. We calibrated T so that values T00 and T03 approximate outcomes in the 1950s and 1960s, T05 and T10 captures the 1970s, and T20 portrays the 1980s and 1990s. To match outcomes from our model to the data, we think of Europe as having the welfare state (WS) arrangements for compensating unemployed workers and for making layoffs costly, and America as having laissez faire (LF) arrangements.

With little or no turbulence, T00 or T03, the equilibrium of our model mimics the 1950s and 1960s when Europe had significantly lower unemployment than the United States. As with the data, the model attributes the lower European unemployment to lower rates of flow into unemployment in the presence of similar average durations of unemployment spells. The model therefore also implies longer job tenures in Europe. With these parameter settings, long-term unemployment is not a problem in the WS equilibrium, just as it was not a problem in Europe in the 1950s and 1960s.

Model outcomes associated with turbulence T05 remind us of Europe in the 1970s, when unemployment had drifted upwards to reach American levels. The model outcomes for this 1970s parameter setting contain a bad omen about the future: long-term unemployment has reared its head in the WS, as shown by our decomposition of the unemployment rate into a frictional component due to ongoing labor reallocation and a structural component consisting of the long-term unemployed. The similar overall unemployment rates in Europe and the U.S. in the 1970s conceal a long-term unemployment problem that looms on the horizon for Europe.

The problem of long-term European unemployment comes out of hiding in the 1980s in the data and in our model for T20. As with data from Europe since the 1980s, in the model half of all unemployed are long-term unemployed. The model is thus consistent with the observation emphasized by Layard et al. (1991) that the employment problem in Europe is not associated with changes in the inflow into unemployment but rather with a higher average duration of unemployment spells. But the model also reproduces the observation that the length of job tenures does not seem to have changed over time.

Turning to outcomes for individual workers and using values of turbulence of T10 and T20 to represent the 1970s and the 1980s, respectively, the model replicates earnings dynamics documented by Gottschalk and Moffitt (1994), and Jacobson et al. (1993). Further, the WS economy with T20 predicts that long-term unemployment has become a serious problem for older workers, an outcome that agrees with European outcomes summarized by Machin and Manning (1999). The model's hazard rates of gaining employment also resemble estimates reported by Layard et al. (1991). Consistent with observations from Europe, older workers in the model with T20 have lower hazard rates of gaining employment. Moreover, the analysis suggests that the negative relationship between hazard rates and the length of unemployment spells is mainly due to heterogeneity among the unemployed rather than so-called duration dependence.

The model also captures important features documented by recent studies of displaced workers in Europe. In particular, the model predicts that displaced workers in the WS economy suffer smaller earnings losses but also face lower re-employment rates than in the LF economy.

Finally, we constructed a measure of adjusted earnings that we used to think about differences in earnings distributions between the U.S. and Europe. With our measure of earnings, the model with T20 implies that earnings are more equally distributed under WS than with LF, an outcome that matches the compression of Europe's earnings distribution relative to America's.

8.2 Robustness of results

We have chosen to tell our story in the context of an equilibrium version of a McCall search model. Doing that allows us to capture a rich heterogeneity of individuals' labor market experiences. With its risk-neutral McCall workers and exogenous wage distribution, our model ignores features stressed by other models of unemployment, such as the risk-averse consumers, incomplete markets, precautionary savings, and competitive market clearing wage and interest rate captured in the search-islands model of Alvarez and Veracierto (2001); the wage bargaining and congestion effects featured in the matching models of Mortensen and Pissarides (1999a,b); or the indivisibilities, employment lotteries, economy-wide consumption insurance, and high labor supply elasticities emphasized in the representative family employment lottery structures of Rogerson (2005a,b) and Prescott (2002). To evaluate the robustness of the results of this paper to perturbations in the structures of preferences and markets, Ljungqvist and Sargent (2005) analyzes how turbulence interacts with government supplied unemployment compensation and employment protection in extensions of each of those structures that include a simplified version of the human capital dynamics featured here. The search-islands and the matching models convey results much like those in this paper, while the representative family employment lotteries model reproduces our findings about the interaction of turbulence and unemployment compensation, but reverses the direction of the effect of employment protection on equilibrium unemployment rates. As discussed in section 6.4 and by Ljungqvist and Sargent (2005), this difference reflects the fact that there is no frictional unemployment in the representative family employment lotteries model, so that there is no point in using employment protection to suppress it.

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Table 1: Unemployment and long-term unemployment in OECD

	Unemployment (Per cent)			**Long-term unemployment of six months and over** (Per cent of total unemployment)		
	1974–79[a]	1980–89[a]	1995[b]	1979[c]	1989[d]	1995[e]
Belgium	6.3	10.8	13.0	74.9	87.5	77.7
France	4.5	9.0	11.6	55.1	63.7	68.9
Germany[g]	3.2	5.9	9.4	39.9	66.7	65.4
Netherlands	4.9	9.7	7.1	49.3	66.1	74.4
Spain	5.2	17.5	22.9	51.6	72.7	72.2
Sweden	1.9	2.5	7.7	19.6	18.4	35.2
United Kingdom	5.0	10.0	8.2	39.7	57.2	60.7
United States	6.7	7.2	5.6	8.8	9.9	17.3
OECD Europe	4.7	9.2	10.3	...	...	...
Total OECD	4.9	7.3	7.6	...	...	...

[a] Unemployment in 1974–79 and 1980–89 is from OECD, Employment Outlook (1991), Table 2.7.
[b] Unemployment in 1995 is from OECD, Employment Outlook (1996), Table 1.3.
[c] Long-term unemployment in 1979 is from OECD, Employment Outlook (1984), Table H.; except for the OECD aggregate figures that are averages for 1979 and 1980 from OECD, Employment Outlook (1991), Table 2.7.

Table 1 (continued)

	Long-term unemployment of one year and over (Per cent of total unemployment)			
	1970[f]	1979[c]	1989[d]	1995[e]
Belgium	...	58.0	76.3	62.4
France	22.0	30.3	43.9	45.6
Germany	8.8	19.9	49.0	48.3
Netherlands	12.2	27.1	49.9	43.2
Spain	...	27.5	58.5	56.5
Sweden	...	6.8	6.5	15.7
United Kingdom	17.6	24.5	40.8	43.5
United States	...	4.2	5.7	9.7
OECD Europe	...	31.5	52.8	...
Total OECD	...	26.6	33.7	...

[d] Long-term unemployment in 1989 is from OECD, Employment Outlook (1992), Table N.; except for the OECD aggregate figures that are from OECD, Employment Outlook (1991), Table 2.7.
[e] Long-term unemployment in 1995 is from OECD, Employment Outlook (1996), Table Q.
[f] Long-term unemployment in 1970 is from OECD, Employment Outlook (1983), Table 24.
[g] Except for year 1995, data refer to former West Germany only.

Table 2: Net unemployment benefit replacement rates[a] in 1994 for single-earner households by duration categories and family circumstances

	Single earner			**With dependent spouse**		
	First year	Second & third year	Fourth & fifth year	First year year	Second & third year	Fourth & fifth
Belgium	79	55	55	70	64	64
France	79	63	61	80	62	60
Germany	66	63	63	74	72	72
Netherlands	79	78	73	90	88	85
Spain	69	54	32	70	55	39
Sweden[b]	81	76	75	81	100	101
United Kingdom[b]	64	64	64	75	74	74
United States	34	9	9	38	14	14

[a] Benefit entitlement on a net-of-tax and housing benefit basis as a percentage of net-of-tax earnings.
[b] Data for Sweden and the United Kingdom refer to 1995.
Source : Martin (1996), Table 2.

Table 3: Variances of permanent and transitory real annual earnings, real weekly wages and annual weeks worked, United States 1970–89[a] (in logarithms)

	Permanent variance			**Transitory variance**		
	1970–78	*1979–87*	*Change*	*1970–78*	*1979–87*	*Change*
Annual earnings	0.201	0.284	41%	0.104	0.148	42%
Weekly wages	0.171	0.230	35%	0.075	0.101	35%
Weeks worked	0.014	0.020	43%	0.046	0.063	37%

Source: Gottschalk and Moffitt (1994, tables 1 and 2), who base calculations on the PSID from the U.S.

[a] Earnings and wages are deflated to 1988 dollars.

Table 4: Steady state values for the WS economy and the LF economy (under no economic turbulence)

	WS	**LF**
GNP per capita[a]	1.387	1.417
Average productivity of employed[a]	1.442	1.503
Average wage of employed	0.768	0.803
Average skill level in the population	1.874	1.866
Average job tenure[b]	7.26 years	4.53 years
Unemployment rate	3.83 %	5.70 %
Inflow into unemployment per month[c]	2.06 %	3.39 %
Average unemployment duration[d]	7.73 weeks	7.13 weeks
Percentage of unemployed with spells so far $\geq$ 6 months	2.87 %	1.73 %
Percentage of unemployed with spells so far $\geq$ 12 months	0.08 %	0.02 %

[a] GNP and average productivity are computed for the 2-week period.
[b] The average job tenure is computed for all jobs at a point in time, and each job's tenure is the expected duration until termination due to a future layoff, quit or retirement.
[c] The monthly inflow into unemployment is expressed as a percentage of employment.
[d] The average unemployment duration is computed by dividing the unemployment rate by the inflow rate, when both rates are expressed as percentages of the labor force.

Table 5: Unemployment rates (%) in the WS economy and the LF economy with different degrees of economic turbulence and when varying layoff costs

	WS economy			**LF economy**		
Economic	Layoff costs			Layoff costs		
turbulence⋆	0	5	10	0	5	10
T00	5.85	4.77	3.83	5.70	4.43	3.51
T03	5.65	4.74	4.18	5.24	4.14	3.23
T05	5.76	5.03	5.06	5.18	4.06	3.16
T10	6.01	5.92	6.75	5.11	4.03	3.19
T20	6.31	7.00	8.76	5.07	4.00	3.19
T99	6.60	8.08	10.95	5.02	3.98	3.24

⋆ A higher index of economic turbulence is associated with a higher variance of skill losses at layoffs.

Table 6: Steady state values for the WS economy and the LF economy with different degrees of economic turbulence

		Index of economic turbulence*					
		T00	T03	T05	T10	T20	T99
Tax rate (%)	WS	1.46	1.97	2.82	4.42	6.32	8.46
Average productivity of employed[a]	WS	1.442	1.371	1.346	1.317	1.300	1.281
	LF	1.503	1.422	1.395	1.365	1.347	1.327
Average job tenure[b] (in years)	WS	7.26	7.11	7.16	7.22	7.26	7.33
	LF	4.53	4.54	4.56	4.58	4.59	4.61
Unemployment rate (%)	WS	3.83	4.18	5.06	6.75	8.76	10.95
	LF	5.70	5.24	5.18	5.11	5.07	5.02
Inflow into unemployment[c] (% per month)	WS	2.06	2.05	2.03	2.00	1.99	1.97
	LF	3.39	3.33	3.30	3.27	3.25	3.23
Average duration of unempl.[d] (in weeks)	WS	7.73	8.53	10.52	14.47	19.34	25.00
	LF	7.13	6.64	6.63	6.59	6.57	6.56
Percentage of unemployed with spells so far $\geq$ 12 months	WS	0.08	9.67	23.53	41.10	54.14	62.64
	LF	0.02	0.01	0.01	0.01	0.01	0.01

* A higher index of economic turbulence is associated with a higher variance of skill losses at layoffs.
$^{a-d}$ See corresponding footnotes in Table 4.

Table 7: Earnings losses and unemployment in a cohort of workers that were laid off one year ago.[a] (The economic turbulence is indexed by T20.)

	Age group 45–50		Age group 55–60	
	WS	LF	WS	LF
Unconditional of skill loss				
Mean earnings loss[b] (%)	-10.43	-15.10	-8.82	-15.12
Unemployment[c] (%)	5.93	3.84	11.52	3.91
Conditional upon skill loss $\geq 20\%$				
Mean earnings loss[b] (%)	-24.68	-30.96	-21.95	-30.55
Unemployment[c] (%)	10.11	3.34	21.71	3.33

[a] Prior to the layoffs, workers were distributed across skills and wages according to the stationary distribution for the employed in age group 45–50 and 55–60, respectively.
[b] Earnings losses among re-employed workers, one year after the layoffs.
[c] Unemployment rate among non-retired workers, one year after the layoffs.

Table 8: Unemployment by age group in the WS economy (with economic turbulence indexed by T20)

	Age group				
	20–45	45–50	50–55	55–60	All
Unemployment rate[a]	7.29	8.66	10.96	14.55	8.76
Inflow into unemployment per month[b]	2.12	1.86	1.80	1.58	1.99
Percentage of unemployed with spells so far $\geq$ 12 months[c]	43.45	54.59	64.37	74.72	54.14
Distribution of all long-term unemployed across age groups[d]	42.7	11.96	17.85	27.49	100.00

All numbers are expressed in per cent.
[a] Percentage of the labor force in each age group.
[b] Percentage of employment in each age group.
[c] Percentage of unemployed in each age group.
[d] Percentage of all long-term unemployed (one year and over) in the total labor force.

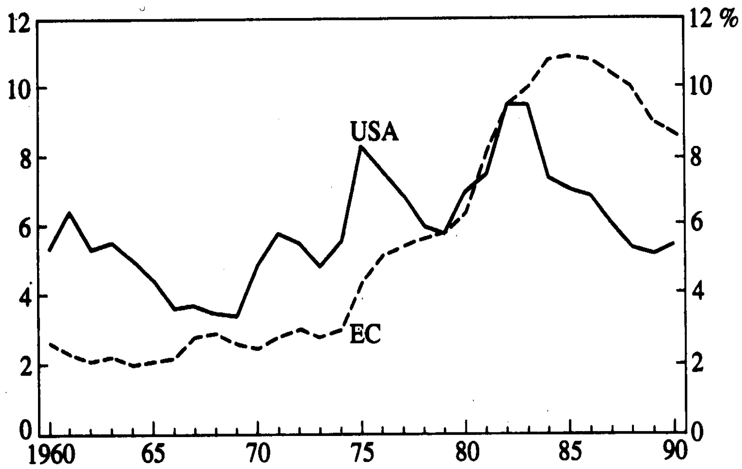


Figure 1: Unemployment rates in the European Community (EC) and in the United States. Reproduction of Layard, Nickell and Jackman's (1991, p. 2) Figure 1a.

Figure 2: Quarterly earnings of high-attachment workers separating in the first quarter of 1982 and workers staying through 1986. The solid line refers to stayers, the dashed line separators. Reproduction of Jacobson et al.'s (1993) Figure 1, omitting their last observation because it was based on an insufficient sample.

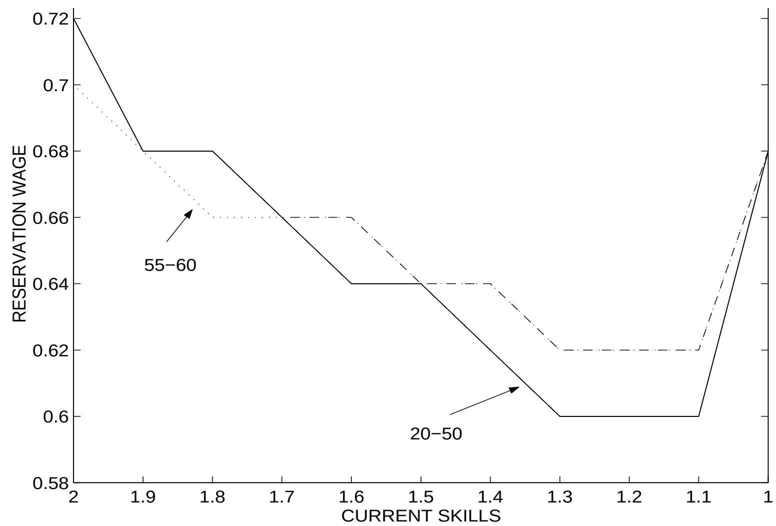


Figure 3: Reservation wage of the employed and the unemployed in the LF economy (under tranquil economic times).

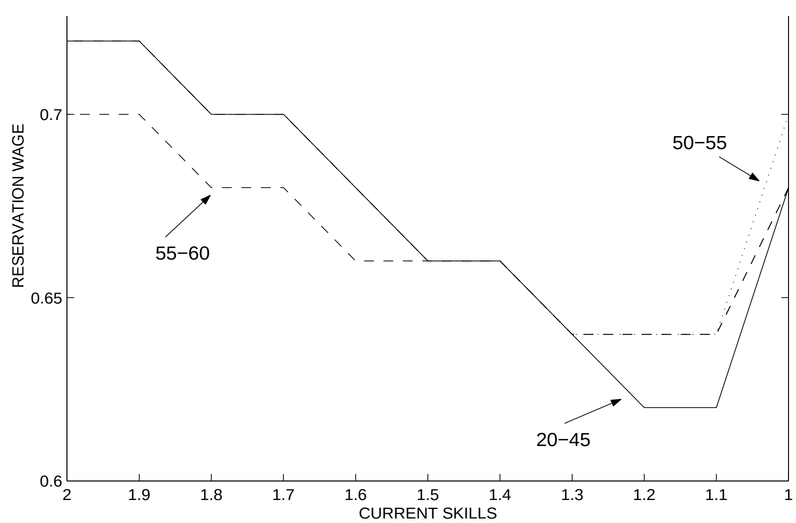


Figure 4: Reservation wage of the unemployed who are not eligible for unemployment compensation in the WS economy (under tranquil economic times).

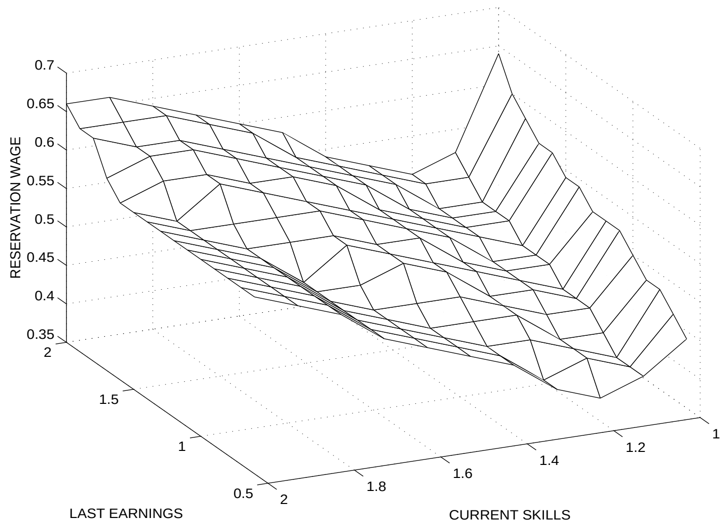


Figure 5: Reservation wage of the employed in age group 20–45 in WS economy (under tranquil economic times).

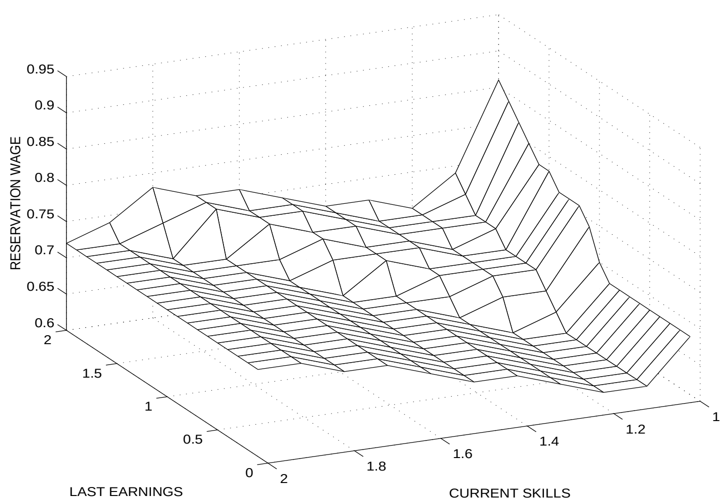


Figure 6: Reservation wage of the unemployed in age group 20–45 who are eligible for unemployment compensation in the WS economy (under tranquil economic times).

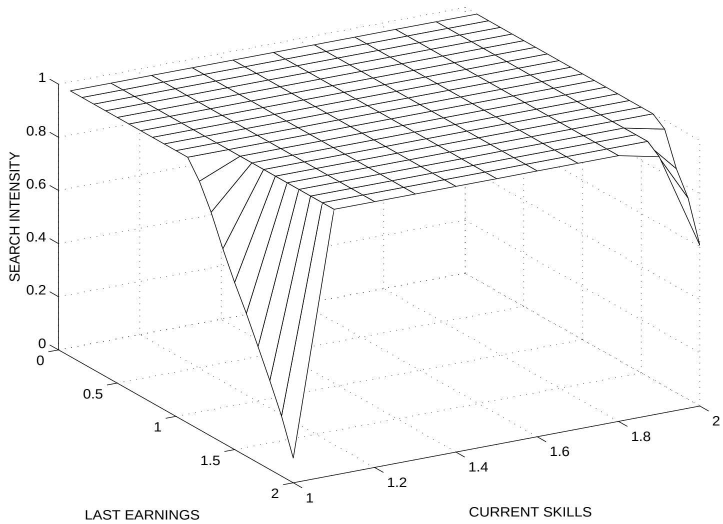


Figure 7: Search intensity of the unemployed in age group 20–45 who are eligible for unemployment compensation in the WS economy (under tranquil economic times)

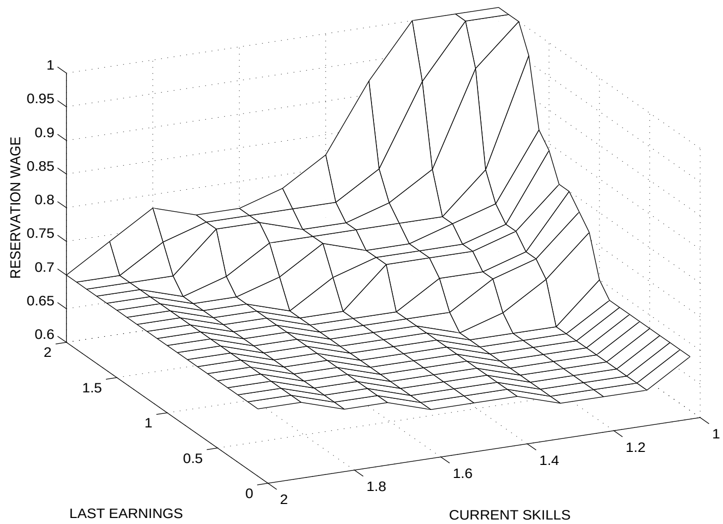


Figure 8: Reservation wage of the unemployed in age group 55–60 who are eligible for unemployment compensation in the WS economy (under tranquil economic times)

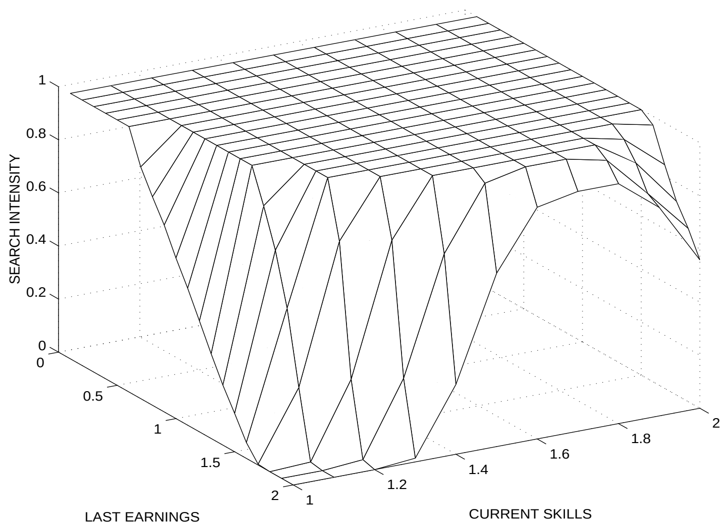
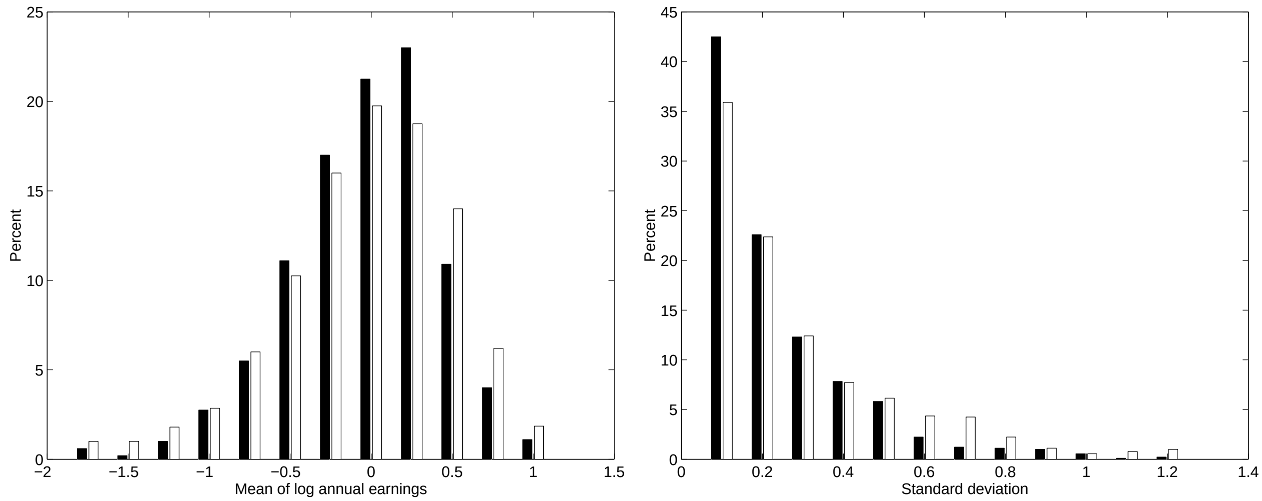


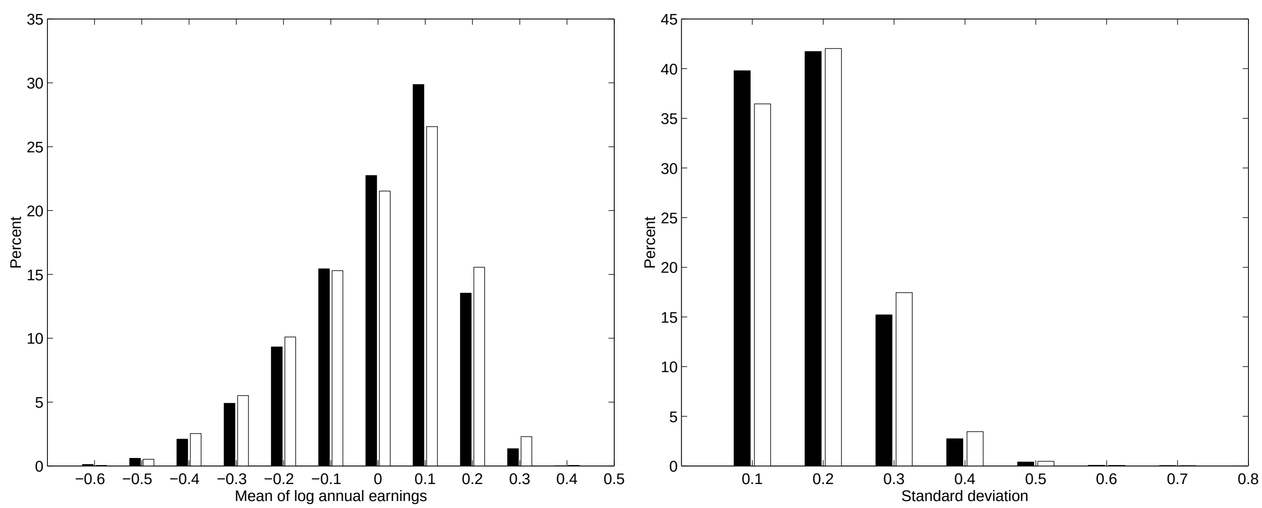
Figure 9: Search intensity of the unemployed in age group 55–60 who are eligible for unemployment compensation in the WS economy (under tranquil economic times)



(a) Distribution of permanent earnings

(b) Distribution of standard deviations of individuals' transitory earnings

Figure 10: Reproduction of Gottschalk and Moffitt's (1994) Figures 2 and 4 in panels (a) and (b), respectively. The black bars correspond to 1970-78, the white bars to 1979-87.



(a) Distribution of permanent earnings

(b) Distribution of standard deviations of individuals' transitory earnings

Figure 11: Laissez-faire economy. The black bars and the white bars correspond to degrees of economic turbulence indexed by T10 and T20, respectively.

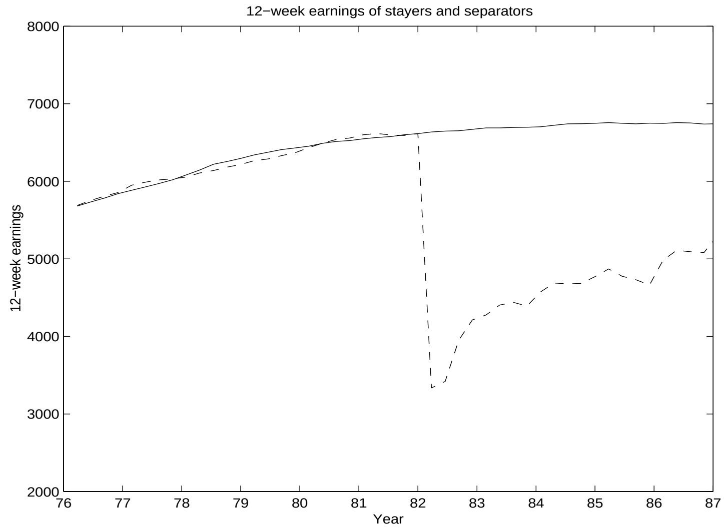


Figure 12: 12-week earnings of high-attachment workers separating in the first 12-week period of 1982 with skill losses exceeding 30% and workers staying through 1986. The solid line refers to stayers, the dashed line separators. The simulation is based on the LF economy with economic turbulence indexed by T20. (The earnings numbers are multiplied by a factor of 700 to facilitate comparison with the empirical study by Jacobson et al. (1993).)

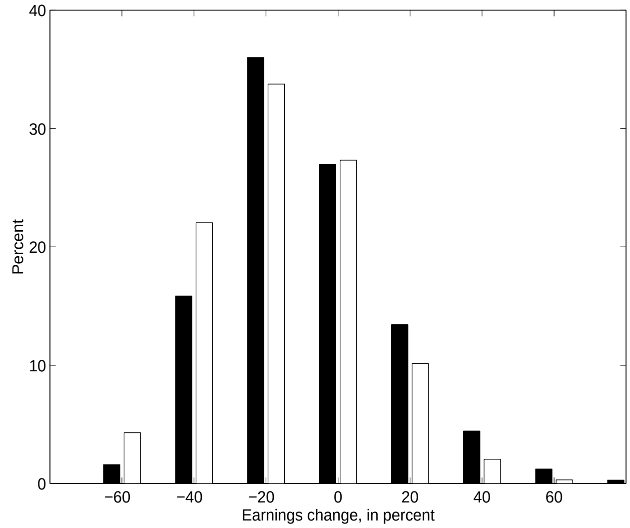


Figure 13a: Earnings losses experienced by re-employed workers one year after being laid off. Prior to the layoffs, the cohort belonged to age group 55–60 and was distributed across skills and wages according to the stationary distribution for that age group. The black bars are the WS economy, and the white bars are the LF economy. (The economic turbulence is indexed by T20.)

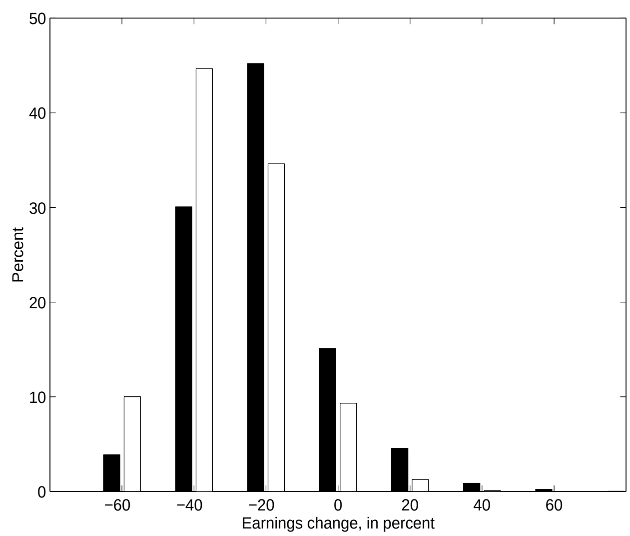


Figure 13b: Earnings losses experienced by re-employed workers one year after being laid off, conditional upon an immediate skill loss of at least 20 % at the time of the layoffs. Prior to the layoffs, the cohort belonged to age group 55–60 and was distributed across skills and wages according to the stationary distribution for that age group. The black bars are the WS economy, and the white bars are the LF economy. (The economic turbulence is indexed by T20.)

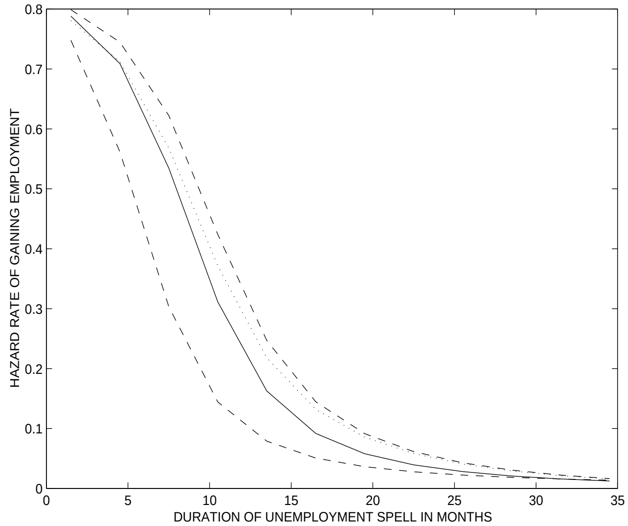


Figure 14: Quarterly hazard rates of gaining employment for all workers (solid line), age group 20–45 (upper dashed line) and age group 55–60 (lower dashed line) in the WS economy. The dotted line is the adjusted hazard rate for age group 20–45 when the cohort entering unemployment has the same distribution of skills and entitlements to unemployment compensation as the one for age group 55–60. (Economic turbulence is indexed by T20.)

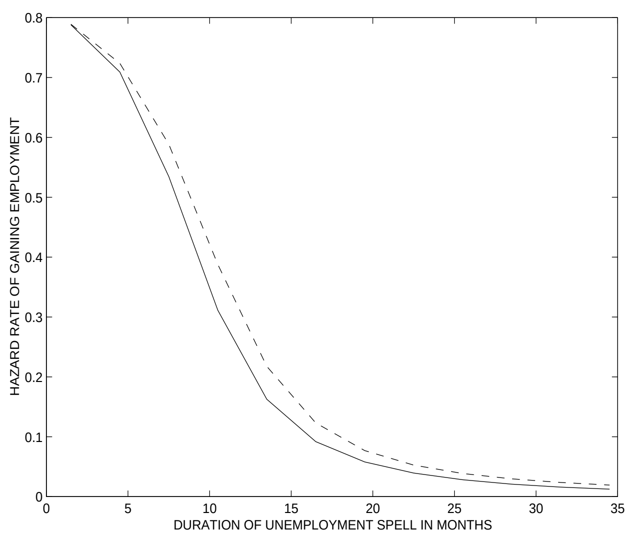


Figure 15: Heterogeneity vs. duration dependence. Quarterly hazard rates of gaining employment for all workers (solid line) in the WS economy. The dashed line is the adjusted hazard rate when age, skills and entitlements to unemployment compensation are held constant during the unemployment spell. (Economic turbulence is indexed by T20.)

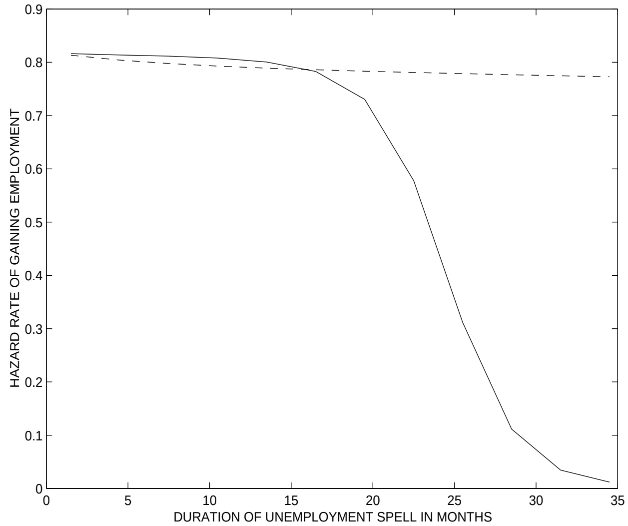
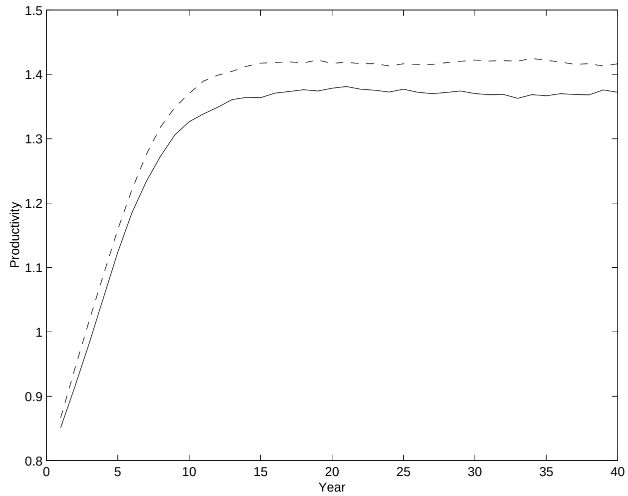
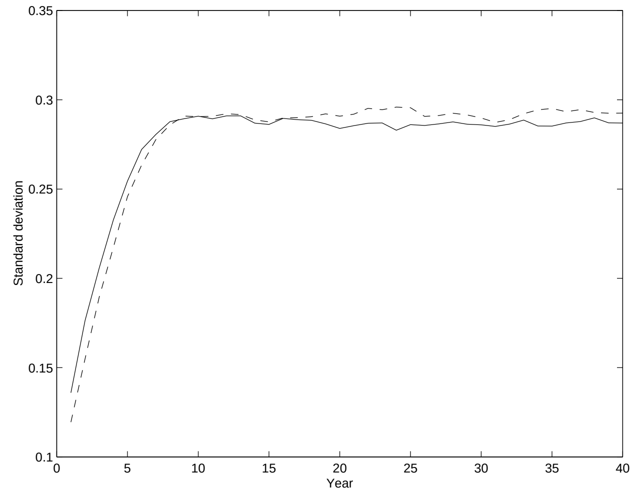


Figure 16: Heterogeneity vs. duration dependence. Quarterly hazard rates of gaining employment for all workers (solid line) in the WS economy. The dashed line is the adjusted hazard rate when age, skills and entitlements to unemployment compensation are held constant during the unemployment spell. (Economic turbulence is indexed by T00.)

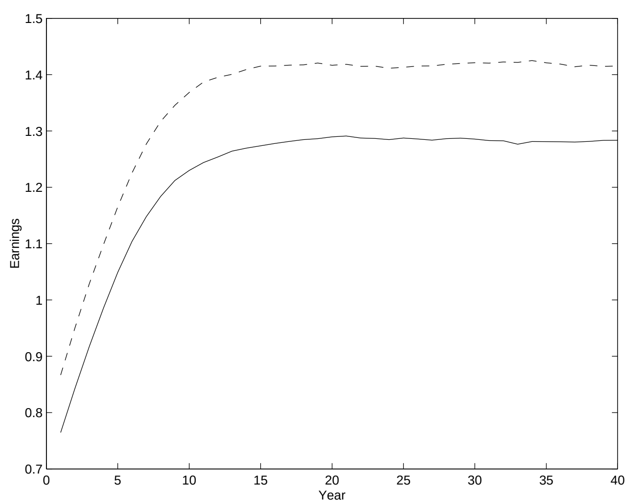


(a) Mean productivity

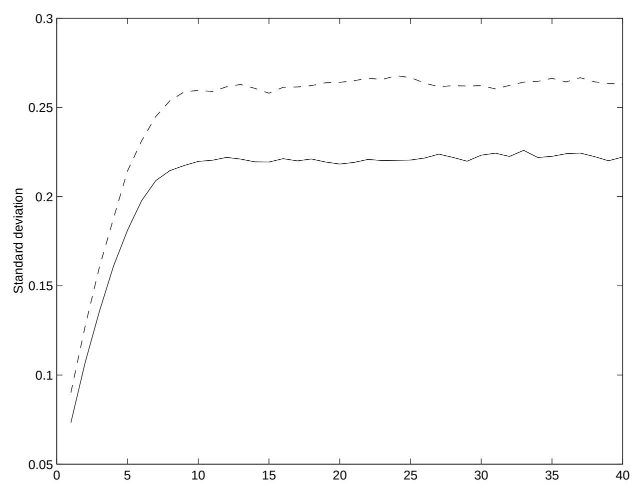


(b) Standard deviation of productivity

Figure 17: Mean and standard deviation of employed workers' productivity in a cohort that entered the labor force in period 0. The solid line is the WS economy, and the dashed line is the LF economy. (The economic turbulence is indexed by T20.)



(a) Mean adjusted earnings



(b) Standard deviation of adjusted earnings

Figure 18: Mean and standard deviation of adjusted earnings of employed workers in a cohort that entered the labor force in period 0. The solid line is the WS economy, and the dashed line is the LF economy. (The economic turbulence is indexed by T20.)

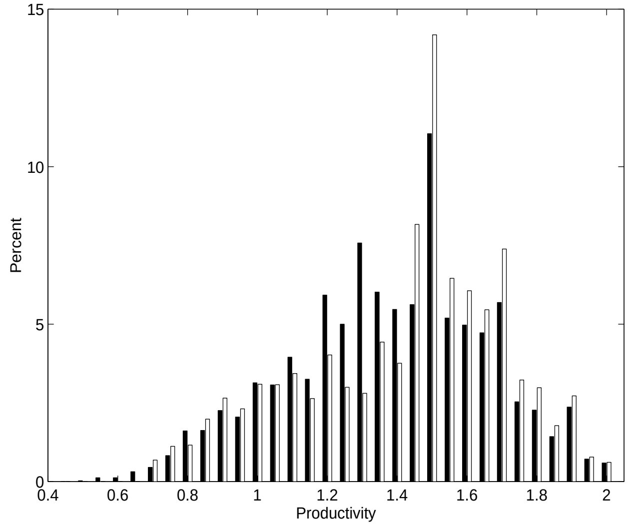


Figure 19: Distribution of productivities of employed workers in a cohort with 20 years in the labor force. The black bars are the WS economy, and the white bars are the LF economy. (The economic turbulence is indexed by T20.)

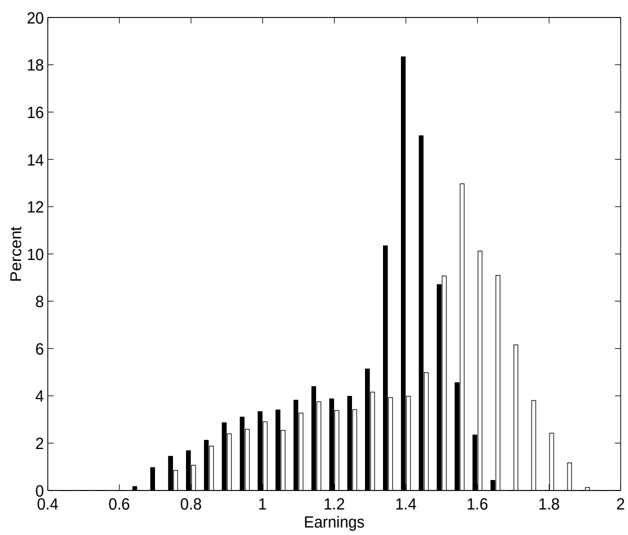


Figure 20: Distribution of adjusted earnings of employed workers in a cohort with 20 years in the labor force. The black bars are the WS economy, and the white bars are the LF economy. (The economic turbulence is indexed by T20.)