Does the welfare state make older workers unemployable?

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1 Introduction

Why should the labor market for older workers be of special interest? The answer lies with the aging problem with which most advanced economies are faced. Regardless of the way the pension system is administered, people must eventually work longer as the duration of human life lengthens. But this means that the labor market for older workers must work well enough to absorb this increase in the supply.

One characteristic of European labor markets (as opposed to "Anglo-Saxon" ones) is that they are heavily regulated. Historically, most of these regulations arose to protect some archetypal "insider" workers, with little concern for how they would affect the market for "outsiders". Older workers were not highly represented among the "insiders", which means that the impact of regulations on their employability had little weight in the design of those regulations. Furthermore, the problem was aggravated by ill-conceived attempts to "make room" for younger workers by inducing older workers to retire earlier, which were due to collide with the increased labor participation of the latter required by the aging problem. As a result of those developments, a culture has arisen where the older workers are assumed to be unemployable. Accordingly, some specific provisions that made it harder to fire them have been implemented in some countries, like the French "Delalande" contribution discussed below.

This paper discusses the specificities of the labor market for older workers and how it is affected by labor market regulation. I argue that most, but not all, of the employability problems of older workers are the result of labor market rigidities. In particular, early retirement, the backward indexation of unemployment benefits on wages, and age-specific layoff taxes tend to depress the market for older workers. And this is true more generally of any policy that (i) gives entitlements to workers indexed on their past incomes, (ii) reduces the expected remaining employment spells of older workers, (iii) increases non-wage labor costs on older workers but not on substitutable categories, and (iv) generally increases hiring and training costs. By contrast, the analysis suggests that uniform increases in employment protection harm

older workers less than younger ones.

Sections 2 and 3 discuss these issues from a theoretical point of view. Section 4 compares labor market outcomes for older workers in two countries: a rigid one (France), and a flexible one (the US). It then discusses the role of rigidities by relating the empirical findings to the preceding analytical discussion. Section 5 draws the policy lessons from our exercise.

2 Why is the labor market for older workers specific?

There are three characteristics of older workers that presumably have an impact on their labor market.

The most important one is that their remaining career time is small: they are expected to leave their job and retire fairly soon. This is in contrast to a younger worker who can be expected to remain with the firm for more than a decade. As we will see, this obvious fact has profound implications for the employment of older workers.

The second characteristic is that their productivity is (likely) falling. While this is plausible it is not obvious, but has been documented by a number of studies. In particular, Kotlikoff and Ghokale (1992) estimate an age-productivity profile for various categories of workers by disentangling a worker's wage from his marginal productivity – the idea is that deferred payments for incentive reasons create such a wedge. In such a world, a worker's marginal productivity profile over time is different from his wage profile. The former can nevertheless be estimated by using the fact that under competition, no net profits should be generated by hiring an additional worker. Hence, the present discounted value of the worker's marginal product should be equal to that of his wages, and Kotlikoff finds that under some conditions this can be used to recover the age-productivity profile. His results are striking. They imply that for most categories of workers, productivity peaks at around age 45, then falls to levels that are estimated to a third of that peak at age 65. Since it is typically found that compensation rises with age throughout the life cycle, these findings imply that relative to their productiv-

ity, older workers are "overpaid", while they were "underpaid" during their prime age. This finding is consistent with the theoretical literature which argues that firms use deferred compensation as an incentive device (Lazear, 1990). Other studies (surveyed in e.g. Skirbekk (2003)) rely on direct measuring of how ability evolves with age. They confirm the findings of Kotlikoff and Ghokale, although by design they cannot express them as a monetary equivalent. Figure 1, taken from Avolio and Waldman (1994), shows how different measures of ability evolve with age. They all peak around 20-25, suggesting that if productivity increases from 25 to 45, it is due to experience rather than ability.

Third, relative to younger workers, older workers have a human capital which is more specific to their current job/firm, and less general, i.e. less transferable to other firms and other sectors. This is because they have spent a greater fraction of their life acquiring those specific skills through learning-by doing relative to acquiring more general ones in the educational system. Empirically, one way to measure that effect is to look at the wage loss of displaced workers in their future jobs, which should be greater, the greater the specific component of their human capital in the job they lost. Indeed, existing studies (Ruhm (1991), Jacobson et al (1993) Cohen et al (1997) Rosolia and Saint-Paul (1998)) often find a large loss for older workers. However, such a loss may also reflect greater rents rather than greater specific skills, especially in light of the above argument that deferred compensation generates such rents for older workers for incentive reasons. We return to that issue in our empirical study below.

These three key characteristics of older workers have a number of implications for the working of the labor market and especially for how the impact of labor market institutions, such as those which prevail in Europe, on those workers. Let us discuss these implications.

If workers were offering their services in a pure spot market, they would be paid their marginal product at each point in time. We would then observe wages peaking at around 45 and then falling to reach possibly much lower levels toward the end of one's career. However, as pointed above, this is not what we see, since wages go up with age. If we assume that this discrepancy is

due to incentive problems, we see that older workers who lose their job lose an important rent. That is, while deferred payments are not directly allocative at the level of the firm/worker pair (the timing of payments is disconnected from that of the worker's marginal product), they are not neutral when one considers mobility to another position, which is more costly and therefore more deterred, the greater the worker's wage relative to his productivity– and therefore the greater his age.

This is compounded by the loss of specific human capital, and also by a third effect, which is that given the short expected tenure in any position that they will find, there is little room for engaging in deferred compensation. In some sense, that is fortunate, because it makes it less likely that the employer lowers the wage upon hiring to increase it later. At the same time, it also means that the older workers are more likely to end up in jobs where incentive problems are less important. This is true not only because deferred compensation is more difficult but more generally because it is more difficult to use pay to elicit incentives for workers with short expected tenure[1]. Overall, this means that older workers, unless they are still employed at a "lifelong" position, are more likely to be employed in the "secondary" sector of jobs that are easily monitored and thus typically involve less autonomy and responsibility, and also lower wages[2].

A second implication is that unemployment benefits are likely to be more damaging to the employment rate of older workers that to that of younger workers. Ljunqvist and Sargent (1998) have analysed the consequences for aggregate unemployment of the fact that unemployment benefits are indexed *backward* on wages. This backward indexation implies that the unemployed will be especially picky if the distribution of job offers is associated with lower wages than the preceding one. They show that at times of "turbulence", i.e. intense sectoral reallocation, job losses are associated with losses of firm- and sector-specific human capital, so that the wages that the unemployed can get in the new sector of the economy, where they are yet to learn the trade, are

[1] This is a general prediction of the "shirking" model of efficiency wages (see Shapiro and Stiglitz (1984)).

[2] See Saint-Paul (1996).

low compared to their previous ones, and therefore low compared to their unemployent benefits. This is why "turbulence" has a large adverse impact on unemployment in countries with generous, backward-indexed, unemployment benefits; on the other hand, the effect is much smaller in countries where such benefits are not generous. Their argument is especially salient for the older workers. Our discussion above implies that even in the absence of "turbulence", the wages they can claim after having lost a job are likely to be substantially smaller, because of the deferred compensation effect, the loss of specific human capital effect, and the greater likelihood of working in the secondary sector. Furthermore, as their productivity falls with age, the wedge between their reservation wage – as determined by their benefit level – and the offers they get is likely to grow. Thus we not only expect a lower exit rate from unemployment, but also a stronger "duration dependence" – the phenomenon by which exit rates from unemployment tend to fall with the length of the unemployment spell[3]. We will refer below to this effect – the fact that unemployment benefits push the resevration wage of older workers up relative to the wages they can expect on their future offers – as the *entitlement effect.*

Third, hiring and firing costs will affect the employability of older workers differently from younger workers. This is an important question because a large fraction of those costs are regulatory – especially the firing costs that are created by employent protection legislation. Furthemore, employment protection is paid special attention in the debate over the market for older workers. Some countries (e.g. France, as discussed below) have special provisions that increase employment protection beyond a certain age. Furthermore, in most cases entitlements are increasing with tenure, which automatically benefits older workers.

If we first consider firing costs, we see that their deterrent effect on employability is lower for older workers. The reason is that, should the firm consider laying off the worker, it can wait for his retirement instead of paying the firing cost. That value of waiting is obviously much higher if the

[3]Unfortunately, my own attempts to find such a statistically significant effect in the French case failed.

worker is young. So, somewhat paradoxically, a firing cost that would be imposed uniformly on all workers would make older workers more employable relative to the younger ones.

Of course, the story is entirely different if firing costs go up with age. Indeed, most European countries have employment protection legislations that become more stringent as the tenure of the worker increases. This is likely to be correlated with age. Furthermore, a number of countries impose additional taxes on layoffs for older workers. A notable provision, for example, is the French so-called "Delalande " contribution, which imposes an additional firing tax on workers who are older than 50. Following standard economics, we expect such a tax to reduce both the hiring rates and the firing rates of this category of workers. Furthermore, it is also likely that the expectation of the tax will reduce the hiring rate for workers younger than 50, and is also likely to increase their layoff rate as firms may want to anticipate on a future layoff decision concerning those workers to avoid paying the additional tax. Behagel et al. (2008) use changes in the Delalande tax to estimate its effect on the hiring rate of older workers.

In particular, in 1992 the system was changed so as to exempt firms from paying the tax whenever workers were older than 50 at the time they were hired. Clearly, this was meant to offset the negative effects of the tax upon hiring; but at the same time it meant that those hired after 50 lacked the extra protection of the others. This would imply that workers hired after 50 would be laid off before workers of the same age hired prior to that age, thus reinforcing the dual nature of the labor market. In any case, the estimates of Behagel et al based on that natural experiment confirm the presumption that imposing extra protection on a selected group of workers has a substantial negative impact on their hiring rate. They find that the reform increased the job finding rate of the 50+ group, relative to younger workers, by 0.5 percentage points on a monthly basis. This is a large effect. For example, with a monthly job loss rate of 0.1 % and job finding rate of 1.5 %, we get an unemployment rate in steady state equal to $0.1/1.6 = 6.25$ %. If we now reduce the monthly job finding rate by 0.5 %, the unemployment rate jumps to 10 %. The effect is a compound of "direct" effects – the return from hiring

somebody is lower if there are greater firing costs – and substitution effects – I prefer the low firing cost applicant the high one. While it is difficult to disentangle the two kinds of effects, the authors' results suggest that strong substitution is at work: the reform not only reduced the gap in hiring rate between th 50- and the 50+ age groups, it inverted its sign: after the reform, it was *easier* to find a job for a worker aged 51 than a worker aged 49.

Finally, the authors are also able to estimate the effect of the Delalande tax on layoffs; they find that it reduces the layoff rate. They also find a slight positive effect on the layoff rate before age 50 butit is very small and statistically insignificant.

Turning now to hiring costs, we see that they have a stronger effect on a worker's employability, the older that worker. This is because the hiring cost is less damaging to the firm, the longer the duration of the job over which the firm can recoup it. Clearly, that duration is lower for older workers. Thus a uniform hiring costs reduced the demand for older workers relative to younger ones. The lower expected duration of the job reduces the total (discounted) value to the firm of employing the worker: this is what we will call the *endgame effect.* As a result the firm is willing to pay less to employ the worker, implying that older workers are going to find jobs in sectors where training and recruitment costs are low. Below, I will document the endgame effect both in the context of a small theoretical model and of an empirical comparison between France and the United States. This is in accordance with the rest of the literature. For example, in a recent paper, Hairault et al. (2008) capture the effects of hiring costs in a search-matching model, and they document a positive relationship between the age of retirement and the employment rate of older workers. This positive relationship is depicted on Figure 2. They supplement this with econometric evidence by constructing a worker-specific variable which measures the distance to retirement and show that this variable has a positive effect on the probability of being employed in a French data set, controlling for the usual variables.

3 Lessons from a simple model

While some of the aspects discussed above are easy to grasp, a formal model may be useful in order to understand the interplay between hiring and firing costs and the endgame effect. In this section, I consider such a model.

Assume time is continuous and that the duration of human life is T. When hired, workers are in a high productivity state and produce a flow of output $y = y_H$. Let s denote the worker's age. With probability $p(s)$ per unit of time, the workers falls into a low productivity state such that $y = y_L < y_H$. The worker remains in that state until he leaves the job or retires. In principle $p(s)$ can vary with age, and could reflect the hump-shaped dependence of productivity with respect to age documented by Kotlikoff and Ghokale and others. Wages are fixed and equal to w. To hire a worker a firm must pay a hiring cost H. Furthermore, a firing cost F must be paid and we allow it to be time-dependent. More specifically, the firing cost is assumed to be equal to F_0 for $s < s^*$ and $F_1 \geq F_0$ for $s \geq s^*$. If $F_1 = F_0$ we are in the special case of a firing cost which is independent of age.

Firms maximize the present discounted value of profits, under a constant real interest rate equal to r. They have workers of different ages arriving randomly, and for each worker decide whether or not to hire him. Clearly given the constant returns to scale implicit in our assumptions regarding the process for productivity, all these hiring decisions are independent from one another.

We want to characterize the hiring and dismissal decisions of firms depending on the age of the worker. For the problem to be interesting, it must be that

$$y_L < w < y_H.$$

Otherwise, one would either not hire anybody or not fire anybody. Let us then assume that this inequality holds. We first characterize the dismissal decision. For a worker of age $s > s^*$ such that $y = y_L$, the firm can keep him

until retirement which yields a (negative) present discounted profit equal to

$$\begin{aligned}\pi_K(s) &= \int_s^T (y_L - w)\mathrm{e}^{-r(t-s)}\mathrm{d}y \\ &= \frac{y_L - w}{r}\left(1 - \mathrm{e}^{-r(T-s)}\right). \qquad (1)\end{aligned}$$

On the other hand, the firm can get rid of the worker right away, which involves an immediate cost equal to F_1 and thus a net profit equal to

$$\pi_F(s) = -F_1.$$

Thus the firm will keep the worker if and only if

$$\frac{w - y_L}{r}\left(1 - \mathrm{e}^{-r(T-s)}\right) < F_1.$$

For a worker in the low state with age $s < s^*$, the two options are the same: keep the worker until retirement and get a profit $\pi_K(s)$ given by the RHS of (1), vs. fire the worker right away and have a profit $\pi_F(s) = -F_0$. The intermediary option of keeping the worker to get rid of him immediately prior to the rise of the firing cost at age s^* cannot be optimal. It would yield a net profit equal to

$$\begin{aligned}\pi_W(s) &= \int_s^{s^*} (y_L - w)\mathrm{e}^{-r(t-s)}\mathrm{d}y - F_0 e^{-r(s^*-s)} \\ &= \frac{y_L - w}{r}\left(1 - \mathrm{e}^{-r(s^*-s)}\right) - F_0 e^{-r(s^*-s)} \\ &= -F_0 + \left(F_0 + \frac{y_L - w}{r}\right)\left(1 - \mathrm{e}^{-r(s^*-s)}\right). \qquad (2)\end{aligned}$$

Clearly, for that option to dominate immediate dismissal, we would need that $\pi_W(s) > -F_0$, implying, by virtue of (2), that $F_0 > \frac{w-y_L}{r}$. But since $\frac{w-y_L}{r}$ is the present discounted value of losses for a low productivity worker that would stay forever, this latter inequality in turn implies that the firm will be better-off keeping the worker at age s^* rather than get rid of him. In short, if the flow equivalent of losses is greater than the firing cost, then immediate dismissal is optimal; otherwise, waiting until the worker retires is optimal. The intermediate option cannot be optimal unless the losses themselves are time-varying which we have ruled out in our model for simplicity.

Figure 3 plots the "dismissal" frontier FF in the (s, y_L) plane: it gives the lowest value of y_L such that the firm prefers to keep the worker, as a function of age. It is downard sloping and has a vertical asymptote at $s = T$ and $y_L = -\infty$, reflecting the fact that firms are more likely to wait, the older the worker. The step at $s = s^*$ reflects the increase in firing costs when one passes that age threshold.

The intersection of this frontier with a horizontal line at the actual value of y_L determines a critical age, $\tilde{s}$, after which the worker will not be fired if he falls in the low productivity state. Conversely, all workers younger than that will be fired if they fall in the low productivity state. The critical age may be larger than, equal to, or smaller than, the regulatory threshold s^*. It will be exactly equal to it for a whole range of low productivity levels, due to the vertical portion of FF at $s = s^*$. Tightening employment protection legislation – increasing F_0,F_1, or both — shifts the dismissal frontier down and lowers the critical age. This is illustrated on Figure 4.

While the model rules out any "preventive" dismissal in anticipation of the threshold for low-productivity workers, this may happen for high-productivity workers. In Appendix 1 I solve for the firm's maximum expected discounted profit in the case where p is constant and in the regime where $\tilde{s} > s^*$. It is shown that for F_0 small enough and F_1 and w large enough within the parameter zone compatible with this regime, it is indeed optimal to fire high productivity workers immediately before they reach the critical age s^*.

The next step is to characterize the hiring decision. To do so, I need to compute $J_H(s)$, the value to the firm of employing a worker of age s in the high productivity state. This in turn gives us the "employabililty" of a worker of age s. If it is greater than the hiring cost H, then an applicant of age s will be hired, otherwise the applicant will be turned down. Therefore, the greater the value of the worker $J_H(s)$, the more the worker is employable.

The variation of $J_H(s)$ with s is analysed in the Appendix, and there are three possibilities:

1. The simplest case is when $J_H(s)$ falls with s along the life cycle. This

is the case depicted on Figure 5[4]. Workers are always less employable when they get older. Typically, this is more likely to old when p is small, y_H is large, F_1 is small, and $w - y_L$ is small. Firing costs then do not play a big role in the firm's hiring decisions: one is not very likely to fall into the low productivity state, the losses made in that state are not very large, the profits made in the high productivity state are large, and the level of the firing cost is low. The profile of employability then resembles the one that we would get in the absence of employment protection; it is decreasing simply because when the worker is older the firm expects to reap profits from the worker over a shorter period of time.

2. In the situation shown on Figure 6[5], employability goes up until it reaches a maximum age $\hat{s}$, which is greater than $\tilde{s}$, meaning that the most employable workers are not fired when they fall into the low productivity state. This situation prevails if firing costs are important, thus if p is large, F_1 large, y_H small and $w - y_L$ large, and also if the incremental firing cost for older workers, $F_1 - F_0$, is small. In such a situation the possibility of having to inefficiently retain the worker, or get rid of him and pay the firing tax, should productivity fall, plays an important role. This gives a premium to older workers who are not expected to stay long, and this in turn, through forward-looking expectations, generates an upward-sloping pattern of employability up to age $\hat{s}$. The process has limits, though, since high productivity workers who are too old stay too little time in the firm to generate a large NPV: the value of the job eventually falls to zero as s increases beyond $\hat{s}$.

3. In the situation depicted on Figure 7, employability is M-shaped[6]. That is, it falls until one reaches the threshold age s^*, then goes up until age $\hat{s}$, and then falls again. This situation prevails in the same circumstances as the preceding one, except that the gap $F_1 - F_0$ is now large. This means that workers get less and less employable when they approach the threshold.

[4]This figure has been drawn for $T = 50$, $s^* = 35$, $w = 1$, $y_H = 2$, $y_L = 0.5$, $F_0 = 0.5$, $F_1 = 1.5$, $r = 0.05$, $p = 0.1$.

[5]This figure has been drawn for $T = 50$, $s^* = 35$, $w = 0.8$, $y_H = 1.5$, $y_L = 0.5$, $F_0 = 2.8$, $F_1 = 3$, $r = 0.05$, $p = 0.1$.

[6]This figure has been drawn for $T = 50$, $s^* = 35$, $w = 0.8$, $y_H = 1.5$, $y_L = 0.5$, $F_0 = 0.5$, $F_1 = 3$, $r = 0.05$, $p = 0.1$.

However, after that, age is again a positive factor since it reduces the likelihood of having to pay the firing cost. But this is again eventually defeated by the vanishing of the individual's remaining professional life.

Finally, it is also useful to compare the profile of employability for different levels of employment protection. This is what is done on Figure 8, where three situations are compared: a "flexible" one with no firing cost, a "rigid" one with a uniform firing cost equal to 150 % of the annual wage, and an asymetrical one with a firing cost equal to 100 % of the wage before $s = 35$ and to 200 % of the wage therafter. The graph confirms that rigidities reduce employability mostly for young and prime-age workers rather than older workers, and that the step reduces employability, relative to a uniform system, ahead of the date the step takes place (by some five years in this simulation).

4 How do older workers fare in a flexible vs. a rigid labor market? An empirical comparison between France and the US.

In this section I perform an empirical comparison of the relative employability of older workers in a "flexible" labor market (the United States) and a "rigid" one (France). To keep the discussion short, I only consider those dimensions where the two countries are significantly different. However, a complete set of graphs and tables is available in the working paper version of this article.

4.1 Employment rates: the endgame effect

The first variable I look at is the employment rate. This variable reflects both labor supply and labor demand, and therefore captures different forces from indicators like unemployment or unemployment duration, which tell us something about the functioning of the labor market. An employment rate can be low either because unemployment is high or because labor supply is low, and the latter can be low either because of distortions or because of taxes. On the other hand, it is often argued that the incentives to register

as unemployed are low if unemployment benefits are not generous enough, which blurs the distinction between being unemployed vs. out of the labor force. We cannot solve these issues here but we can look at both indicators.

Cohen et al. (1997) have shown that for sufficiently narrowly defined (by sex and education) cells, employment rates are paradoxically slightly higher in France than in the US for prime-age workers. Thus, most of the lower performance of France overall comes from (i) non prime-age workers (ii) the composition effect due to lower educational levels in France. More recent data from the 2005 US CPS and the 2005 French labor force survey confirms those findigs: employment rates are marginally higher in France for prime-aged men. But for older workers, the picture is reversed. While employment rates are understandably much lower in the 60-65 age range – since the official retirement age in France is 60 – they are also lower in the 55-60 range[7]. This is reported in Table 1: employment rates for those catgories of workers are all lower in France than in the US 1, and the categories where the older workers are least employed in France relative to the US, are low and medium-skilled men.

To have some clue about how to interpret these findings, we can refer to the model above. It implies that employability falls sharply as one nears retirement age (see for example figure 8). Thus the lower employability of the 56-60 age group in France compared to the US is probably due to the earlier retirement age in France. When that age was brought down to 60 the effect on employment for people immediately below that age was not taken into account–these numbers suggest it is substantial. We have also seen that employment protection legislation runs in the opposite direction, by making the older workers relatively more employable. Thus the numbers suggest that this effect is not strong enough to offset the endgame effect.

[7]For women, the picture is more complex. For high-school drop-outs, employment rates are substantially higher in France, implying that even the 55-60 range has a higher employment rate than its Us counterpart. The same is true for college graduates, but that is now due to the fact that employment rates are virtually identical across all actegories, except of course the 60-65 age range. For high school graduates and college dropouts, the pattern is the same as for men: higher employment rates for prime-age workers in France, but much lower ones for the 55-60 range.

4.2 Unemployment: the mid-life discount

We now turn to unemployment rates (Table 2). These figures are fairly low for older workers; for workers older than 60 in France, very few are actively looking for a job and unemployment rates (not reported) are very low. The most striking feature here is associated with mature rather than older workers: There is a sharp rise in unemployment rate for men with at least a high school degree in France during their forties. We will refer to this as the *mid-life discount.* This phenomenon does not take place in the United States. It is most salient for the intermediate skills group, kicking in at 41 for high school graduates and 46 for workers with some college. It is milder and chiefly limited to the 41-46 age group for college graduates and virtually non-existent for high school drop outs.

Since the midlife discount occurs in France and not in the US, it is natural to assume that it is due to labor market rigidities. While institutions such as the increase in employment protection with tenure and the existence of a step at a certain age may play a role, a bigger role can presumably be ascribed to the entitlement effect, as we have discussed above. At 45 workers enjoy their peak productivity, which includes a great deal of job-specific human capital, and in addition derive large rents from deferred compensation. Thus the entitlement effect is likely to be large for this group. This hypothesis is somewhat confirmed by the fact that the phenomenon is absent for high-school dropouts. They are more likely to work in easily monitored routine or non cognitive tasks, which reduces the role for incentive payment schemes, including deferred compensation. And the scope for learning by doing in those jobs is lower, which suggests a flatter evolution of productivity during one's career. Therefore, at mid-life these workers' wages are likely to be less different from their marginal product (in both their current and future jobs) than for other workers, which makes the entitlement effect of backward indexation of unemployment benefits less salient.

Interestingly, the mid-life discount does not seem to affect women. Instead. they experience abnormally high unemployment rate in France compared to the US during their fertile years, between 25 and 45. This is presum-

ably the result of generous provisions for maternity leave in France, which reduces the demand for women in those ages. The effect may be so strong as to dwarf the mid-life discount. But the mid-life discount is also likely to be smaller for women on average, since they are both less likely to engage in continuous careers (thus acquiring less specific human capital) and more likely to work in the "secondary" sector.

4.3 Labor market transitions

The preceding data gives us a static picture of the labor market. We also want to know how the older workers fare in a dynamic sense. For this we compare the transition rates between France and the US.

A stylised representation of these two economies holds that because of rigidities, both the job loss and the job finding rates are lower in France than in the US. This is indeed what the earlier literature found, e.g. Cohen et al. However it also found that some groups, like the young, were used as a buffer of flexibility and that their job loss rates, in particular, were more similar to the US. We want to know if this stylized vision holds for more recent data, and in particular how the older workers fare: are they used in a "flexible" or in a "rigid" way.

One issue is that labor market flows are quite sensitive to the business cycle. And the business cycle was not the same in 2005 in France and the US. While unemployment was falling in the US, it was still rising in France; it started to fall in 2006. Therefore, we perform the comparison of transition rates for two more similar years, keeping 2005 for France but using 2002 for the United States.

I first discuss aggregate transition rates by age and then disaggegate them by sex and education.

I start with the job loss rate. In relation to the above discussion about the measurement of employment and unemployment, there are two ways to measure it: one can use the flow from employment to unemployment, or alternatively the flow from employment to non-employment (the sum of unemployment and non participation). Ideally, the first one should capture

involuntary job losses, and the second one adds voluntary ones. In practice, the distinction is blurred by the high incentives to register as unemployed in France (even in the case of a voluntary quits), and the low ones in the US. So I look at both measures.

Figure 9 depicts the employment-to-unemployment flow in both countries. A striking fact is that this measure of the job loss rate is not larger in the US. The measures are similar for prime-age, higher in France for the young, and lower for the older workers. This suggests that older workers, despite reforms like the 1992 adjustment to the Delalande contribution mentioned above, firmly remain in the protected sector. In contrast, the young now have a job loss rate even higher than in the United States. Figure 10 shows the job loss rate, including the employment-to-nonparticipation flow. The picture is somewhat more consistent with conventional wisdom: the job loss rate is higher in the US for prime-age workers; it is similar in both countries for the young; and it is now higher in France for older workers. This is clearly due to the flow to non participation, and thereforer mostly captures the role of retirement and early retirement schemes. This is not surprising, but the numbers are telling: they suggest that for the 56-60 age groups, who have not reached the official retirement age yet, these schemes account for some 15 % of the relevant workforce retiring each year, as compared to 10 % in the United States.

I now turn on the job finding rates, that are reported on Figure 11. The data are striking. Overall, job finding rates are twenty percentage points greater in the United States than in France, say 50 % vs. 30 % yearly. And the gap widens as the workers get older, rising to thirty percentage points for the 51-55 age group, while the job finding rate falls to a very small 5 % per year for the 56-60 age group in France.

This leads us to reconsider somewhat the existence of the mid-life discount: it does not show up as large unemployment for older workers because the incidence of unemployment (the employment-unemployment transition rate) among those workers, is low. But if we look at the duration of unemployment (the inverse of the job finding rate), we find it is extremely low for those workers; and we also have seen that the incidence is somewhat

artifically low because of the large rate at which they withdraw from the workforce.

Both the supply side and the demand side conspire in generating a low job finding rate for older workers: on the supply side, there is the entitlement effect. On the demand side, we have the endgame effect. Note however that if we use the job finding rate of the 60-65 age group in the United States as a measure of the endgame effect in a flexible economy, we do find that it exists, however it accounts for say a reduction in job finding rates from 55 % a year to 40 % a year. This is substantial, but not comparable to the massive collapse in job finding rate experienced by French workers as they reach 55. The gap is not likely to be explained by the entitlement effect alone: it is probably as large for the 46-50 group (otherwise the mid-life discount would not arise), and yet this group has a much higher job finding rate. An additional factor probably comes from the minimum wage. One could try to test for this by looking at more disaggregated data, however that is difficult for the job finding rate since there are very view unemployed workers in many sex x age cells. But the scant evidence that we have suggests that the job finding rates are especially low for the older, low skilled workers. Indeed, in the French labor force survey, the vast majority of the unemployed above 50 are high-school dropouts. For the small number of older unemployed workers with greater skills, the job finding rates are typically substantially higher, although there are so few observations that we should be cautious in drawing any conclusion.

Overall, these data give a picture of a substantial excess protection for job loss in France for older workers, with the counterpart of extremely low job finding rates compared to other groups.

4.4 Wages

We now turn to the analysis of wages, starting with the evolution of wages over the life cycle in both countries.

Figure 12 depicts the time profile of wages, for each educational group,

in France[8]. We find a typical pattern of wages rising with age, and the rate of increase shows no sign of slowing down. One exception is high school dropouts, who have a pretty flat profile and experience a slight fall toward the end of their career (consistent with my argument above regarding the entitlement effect being weaker for those workers).

Figure 13 shows the wage profile for each educational category for the "flexible" US. We see that there is a hump-shaped pattern and that it is typically more pronounced, the more educated the worker. In fact, for high-school dropouts, wages are essentially flat over time: there seems to be no human capital accumulation, and no depreciation thereof.

This sharp contrast between the two countries suggest that wage-setting institutions in France lead to returns to age that are substantially too high relative to the market outcome: wages should eventually be falling, despite the tendencies to deferred compensation and human capital accumulation, and in accordance with the direct evidence on productivity. The fall should start at around 50 (which is precisely the age where the Delalande contribution kicks in). But in France the increase continues. For example, in the US, male college graduates aged 61-65 earn 10 % less than those aged 45-50. In France they earn 33 % more. Taken at face value, this suggests they are 43 % overpaid. Consequently, one needs a very large incremental firing cost to offset the high incentives of firm to fire them, and one would need a sharp reduction in their unemployment benefit replacement ratio to bring their reservation wage in line with what they could earn in a future job.

4.5 Wage losses

A lot of the discussion above around the effects of unemployment benefits and their retrospective indexation on wages revolves around the existence of high rents for older workers. We have argued that those rents may originate in their disproportionate accumulation of job-specific human capital as well as the use by firms of deferred compensation in order to elicit incentives. There are other sources of rents as well: They may originate in a collective

[8]For space reason the data are again confined to men. A similar pattern arises for women.

bargaining structure that would impose an age profile for earnings disconnected from market forces. Or, it may be that older workers have had more time to acquire rents, for example by investing in securing a job in the unionized sector. In this section I provide some evidence by looking at the wage losses of displaced workers.

In theory, the rent of a worker should be defined as the (expected) present discounted value of his income stream under his current job, minus his expected present discounted value of income should he become unemployed. Under a competitive labor market, the difference between the two should be zero. In practice, to measure that we would need to know the details of the processes governing income both under employment and under unemployment. While this is not in principle unfeasible, it is replete with problems, so we use instead the difference between the age earned following an unemployment spell and the wage of similar workers who have not experienced that spell. This is only an imperfect measure of the rent because it rests on the wages of those workers who *do* find jobs. This tends to reduce the wage loss as compared to the rent, since wage offers that are below the reservation wage are rejected, which tends to increase the duration of unemployment, thus depressing the value of being unemployed. Thus the true rent materializes not only in the future wage but also in the duration of unemployment, and that part – which clearly is affected by labor market institutions – is not reflected in our measure of wage loss. Nevertheless, if anything this leads our measure to under-estimate the rent in the "rigid" (= high unemployment duration) country compared to the flexible (=low unemployment duration) country. Thus if we find a substantial wage loss for older workers in the rigid country, this is an understatement of the problem generated for those workers by the backward indexation of unemployment benefits.

To estimate the effect of age, I estimate an earnings function to which I add age dummies crossed with a dummy equal to 1 if the worker has experienced an unemployment spell in the preceding year. Two comments are in order: First, this approach constrains the estimated wage loss to be the same across educational categories; this is a drawback but it saves on degrees of freedom. Second, the estimates may be biased if there is a correlation be-

tween unobserved ability and the likelihood of losing one's job; to correct for this the literature has usually limited the analysis to job losses that are supposedly exogenous to the workers' unobserved ability, such as those drven by plant closing. Here, however, this would substantially reduce the number of available observations. Note however that my comparison between two countries remains valid as long as the biases induced by unobserved heterogeneity are assumed to be the same; furthermore, the estimates are quite similar to those of the literature, suggesting the bias is small[9].

Table 3 reports the results for men and women. In both France and the United States, the estimated wage loss is substantial and of the same order of magnitude as found by the earlier literature. The loss is significantly higher in the United States than in France, which is at variance with some of the earlier findings[10]. Finally, the rent seems increasing with age in France, but in the US it is highest for the 41-50 age group. In a nutshell, Table 3 tells us that rents (as measured by wage losses) are greater in the US than in France, and that theyr are hump-shaped with age in the US but increasing with age in France.

How can we make sense of those results? In both countries, rents are greater for older workers overall. This is consistent with our discussion above as both the effect of deferred compensation and that of specific human capital accumulation tend to generate an upward profile of rents. The differences between the US and France are more difficult to understand. If only these two market forces were present, we would expect to get the same results in the two countries. Rigidities obviously introduce differences between the two countries, but it is not straightforward to predict their effect[11]. One

[9]It should be added that the plant closing approach has problems of its own: To the extent that wages have a plant specific component (which would be true if wage formation obeyed some rent-sharing logic), they are likely to be correlated with the likelihood of plant closing. And such a correlation will also arise if workers of similar unobservable ability tend to work in the same plants, as the theory of assignment predicts under complementarity between worker quality.

[10]Notably, Cohen et al. (1997).

[11]Note that the theoretical prediction regarding the comparison of wage losses between rigid and flexible countries is ambiguous. On the one hand, greater generosity of unemployment benefits pushed the reservation wage up: this tends to reduce the wage loss from displacement, and at the same time to lengthen the duration of the unemployment spell.

interpretation is that in the US, where wages are more influenced by market forces and wage inequality is greater, the return to specific human capital is greater, implying greater effects on wages when such human capital is lost or depreciated[12]. At the same time, collective bargaining in France forces an upward profile of rents with age. On net, this generates greater rents in the US except for the age category where the latter effect is stronger, i.e. the older workers.

5 Conclusion and policy perspectives

Above I have argued that a number of features of European labor market institutions are particularly harmful for the elderly. This brings the key question: how should policy handle these issues?

A tempting answer would be to increase employment protection for the elderly, which has indeed often been done. Why is that tempting? Because the endgame effect is a fundamental characteristic of the labor market for the elderly. One can reduce its strength by eliminating regulatory components of hiring costs — whatever the justification for such costs, the existence of the endgame effect tells us that they particularly harm older workers and suggests such regulations should be alleviated for them. But the bulk of hiring costs are intrinsic and not generated by regulation. Thus it is tempting to say that no deregulation of hiring costs will work and that the only thing one can do is to have higher employment protection for older workers.

Yet this is far from satisfactory, for at least three reasons. First, we have seen above that there are reasons to believe that differential employment protection provisions generate strong substitutions effects. Second, this would

On the other hand (this would be apparent from a dynamic search model), the probability of finding a job is lower in a rigid country, which makes it more costly for the worker to turn down an offer; this pushes the reservation wage down. Some simulations reported in Saint-Paul (2000) suggest that the two effects could easly cancel each other, delivering a similar wage discount in a flexible and a rigid country.

[12]Note that the hump-shaped pattern of wage losses in the US mimicks that of wages. This is consistent with our interpretation provided that (i) a substantial fraction of the evolution of wages over the life cycle is accounted for by specific human capital, and (ii) a substantial fraction of that specific human capital is lost when the worker loses is job and/or during the subsequent unemployment spell.

lead to locking older workers in their jobs for a long time, which is probably udesirable from the viewpoint of allocative efficiency. Third, no matter how high employment protection is, there will always be a mass of unemployed older workers, if anything because their employer went bankrupt or because they had to resign due to some adverse personal shock such as having to move. Clearly, these would be particularly harmed by differential firing costs for older workers. This is indeed the rationale for the waiving of the Delalande contribution for workers hired after 50 discussed above, but it begs the question of how to handle the endgame effect.

To resolve this tension, it is useful to start recognizing that the endgame effect is genuine in that it is simply socially inefficient to pay high hiring costs for a worker who will retire four years after being hired. This should rule out policies that subsidize the hiring of older workers; if older workers have to change jobs, it must be in activities where hiring costs are not too high.

To get a grasp of how an efficient policy would look like, we may speculate on how the labor market for older workers would operate in a world of perfectly competitive labor markets. In such a world, older workers would be more likely to stick to their current job because of the endgame problem. This means that they would have to bear with wage cuts in response to productivity falling with age and in response to negative shocks to that productivity. But some of them would nevertheless lose their jobs and they might either work in sectors with low hiring costs, that are probably not paying much, or decide to use their accumulated wealth to retire. Thus we will see (i) declining wages with age, (ii) a susbstantial wage loss upon unemployment (reflecting the devaluation of specific human capital associated with job loss), (iii) lower job loss rates, (iv) use of personal savings to make up for wage losses, and finally (v) retirement contingent on having an adverse labor market shock.

Ironically, we could make the point that, to the extent that the wages of older workers are "too high" relative to that benchmark in Europe, institutions like additional employment protection and pre-retirement are exactly what is needed to replicate the competitive outcome in terms of employment

patterns despite that wages give the wrong signals. However, this administrative solution does not guarantee that the right people are allocated to the situations of continuing in their job and retiring, and, more worryingly, the third tier of older workers – those who move to low-productivity jobs – is eliminated altogether, being pushed into pre-retirement schemes or other welfare programs.

One way to improve on that would be to move to a system of more flexible wages and less generous unemployment benefits (and in particular reconsider their backward indexation on wages), while introducing a compensation system that allows older workers to supplement their labor income. An attractive solution is to let them free to choose their retirement age in an actuarially fair way, while disconnecting entirely the payment of pensions from labor market participation. Thus, those who see their wage falling at say 58, could start drawing their pension, either in part or fully, and cumulate it with their labor income. Another approach would be to replace generous unemployment benefits by a "wage insurance" scheme that would supplement the income of older workers if they have lost their job and end up in a low-paying job. This would not be of great help to the unemployed, but evidence from anglo-saxon countries suggests that at low benefit levels, unemployment duration is low, so that substantial insurance is derived from high job finding rate. Furthermore, a system of unemployment support account could be introduced, which would amount to easing the credit constraint on the unemployed.

One common worry is that increasing the retirement age does not work, because older workers have a very low job finding rate and are thus "unemployable". To the extent that this is due to the endgame effect, our analysis suggests that the mere fact of raising the retirement age will increase the job finding rate for workers in a given age category. On the other hand, the endgame effect cannot be eliminated and it will now apply to the older workers who are at the same distance from retirement; since those are even less productive, the effect will be even stronger, which reinforces my claim that cumulating pensions with work must be an important feature of any workable pension reform.

Should the employment of the older workers be subsidized, as is the case in the Netherlands? Euwals et al. (2008), in an extensive discussion of the Dutch system and its reform prospects, argue that this is probably counterproductive. In addition to the ethical problems of tax treatments linked to individual characteristics, in a pure market outcome the employment rate of older workers would naturally be lower than for prime-age ones. The only distortion that exacerbates that is the backward-indexed unemployment benefit, but then it makes sense to reconsider the design of unemployment benefits. And there is some contradiction between the attempt to improve the financing of public pensions by working longer, and at the same time introducing another redistributive scheme in favor of the elderly.

The wage insurance system proposed above is not as perversely redistributive as the Dutch subsidy, especially since it may benefit younger workers and older ones alike (but the latter would benefit more), and would be compensated by lower unemployent benefits (which would also be better in budgetary terms). And allowing to cumulate pensions is even simpler and financially and distributively neutral – overall, the goals of those systems is to allow consumption smoothing along the life cycle and across states of nature, in the face of financial market imperfections, and that is what unemployment support accounts and actuarially fair access to pensions provide. Euwals et al. agree with this but seem more cautious about such unemployment support accounts, based on the view that credit constrains are not so important in the Netherlands. If this is true, then unemployment support accounts are of little value, but, a shown by Hassler and Rodriguez-Mora (1998), so is unemployment insurance: given the relatively low duration of unemployment spells in a flexible labor market, borrowing and lending allow workers to achieve a great deal of insurance on their own in the absence of unemployment benefits.

Few countries would consider reducing employment protection for older workers. Yet Euwals et al. (2009) point to a Dutch study which shows that this could reduce unemployment duration for older workers considerably. Furthermore, the economic case for increasing employment protection with age/tenure is not strong. Current systems of additional employment

protection for older workers are a very imperfect attempt at providing consumption smoothing in light of lower re-employment probabilities for older workers. But once more efficient instruments such as those suggested above are put in place, the merit of employment protection rests at best on whether there is a discrepancy between the private cost of labor as perceived by the firm and the true social opportunity cost of labor. The greater the former relative to the latter, the greater the incentives to inefficiently dismiss the worker. Employment protection is often understood as a tax to correct such a discrepancy (See for example Blanchard and Tirole (2006)). Above we have discussed three sources of high wages for older workers. One is specific human capital accumulation; it increases wages because its return are typically shared between the worker and the firm, not the because the firm's perceived cost of employing the worker has increased. Another is a collective bargaining structure which is more binding for older workers. It may indeed increase the wedge between the private and social opportunity cost of labor, but then one may equally consider a change in collective bargaining. Finally, there is the effect of deferred payments. But such payments are not allocative: In Lazear's (1990) model, for example, their timing is determined by incentive considerations, while the separation decision is determined by a comparison of the worker's productivity and the private opportunity cost of work. Therefore, in that setting, greater wages for the elderly per se do not generate excesssive incentives for dismissals relative to other workers. Hence there is no compelling reason to argue for additional employment protection for older workers.

REFERENCES

Avolio, B. J. and D. A. Waldman (1994). "Variations in Cognitive, Perceptual, and Psychomotor Abilities Across the Working Life Span: Examining the Effects of Race, Sex, Experience, Education, and Occupational Type.", *Psychology and Aging*, Vol. 9, No. 3, pp. 430-442.

Behaghel, Luc, Bruno Crépon and Béatrice Sédillot (2008), "The perverse effects of partial employment protection reform: The case of French older workers", *Journal of Public Economics* 92, 696–721

Blanchard, Olivier Jean and Jean Tirole, "The Optimal Design of Unem-

ployment Insurance and Employment Protection: A First Pass", *Journal of the European Economic Association*, vol. 6, n°1, 2007, p. 45-77.

Cohen, Daniel, Arnaud Lefranc and Gilles Saint-Paul (1997), "French Unemployment: A transatlantic perspective", *Economic Policy*

Euwals Rob , Ruud de Mooij, and Daniel van Vuuren (2009), "Rethinking Retirement: From participation towards allocation", CPB working paper n° 80, Den Haag.

Hairault, Jean-Olivier, François Langot and Thepthida Sopraseuth, (2008) "Distance to Retirement and Older Workers' Employment: The Case For Delaying the Retirement Age", mimeo, University of Paris I

Jacobson, Louis, LaLonde, Robert, and Sullivan, Daniel G, (1993). "Earnings Losses of Displaced Workers," *American Economic Review*, 83(4), 685-709.

Kotlikoff, Lawrence and J. Gokhale (1992), "Estimating The Age-Productivity Profile Using the Present Value of Lifetime Earnings", *Quarterly Journal of Economics*

Lazear, Edward, "Job Security Provisions and Employment," *Quarterly Journal of Economics* 105:3 (August 1990): 699-726.

Ljunqvist, Lars and Thomas Sargent (1998), "The European Unemployment Dilemma", Journal of Political Economy,106, 3, 514-550

Rosolia, Alfonso and Saint-Paul, Gilles (1998), "The effect of unemployment spells on subsequent wages in Spain", working paper, Universitat Pompeu Fabra and CEPR.

Ruhm, Christopher (1991), "Are Workers Permanently Scarred by Job Displacements" American Economic Review, Vol.

81, No. 1, 319-24.

Saint-Paul, Gilles (1996), *Dual Labor Markets.* Cambridge MA: MIT Press

———————- (2000), "L'anatomie du chômage en Espagne; une comparaison avec la France et les Etats Unis", Economie et Statistique, 332/333,159-167

Shapiro, Carl, and Stiglitz, Joseph E. (1984). "Equilibrium unemployment as worker discipline device". *American Economic Review* 74:433-44.

Skirbekk, Vegard (2003), "Age and individual productivity: a literature survey", Max Planck Institute working paper.

APPENDIX

In this Appendix, we solve for the value of the firm under a constant p. We already know that in the low productivity state, the value of the job to the firm is equal to

$$J_L(s) = \frac{y_L - w}{r}(1 - \mathrm{e}^{-r(T-s)})$$

for $s > \tilde{s}$, and to $J_L(s) = -F(s)$ for $s < \tilde{s}$, with $F(s) = F_0$ if $s < s^*$ and $F(s) = F_1$ if $s > s^*$. Let us focus on the regime where $\tilde{s} > s^*$. We then have that

$$F_1 = \frac{w - y_L}{r}(1 - \mathrm{e}^{-r(T-\tilde{s})}). \tag{3}$$

Consider now $J_H(s)$, the value of employing a worker of age s in the high productivity state. The Bellman equation for $s > \tilde{s}$ is

$$(r+p)J_H(s) = y_H - w + p\frac{y_L - w}{r}(1 - \mathrm{e}^{-r(T-s)}) + \frac{\mathrm{d}J_H(s)}{\mathrm{d}s}. \tag{4}$$

The solution of this differential equation, whose terminal condition is $J_H(T) = 0$, is

$$J_H(s) = \frac{y_H - y_L}{r+p}\left(1 - \mathrm{e}^{-(r+p)(T-s)}\right) + \frac{y_L - w}{r}(1 - \mathrm{e}^{-r(T-s)}). \tag{5}$$

The last term is simply $J_L(s)$; the first term is the expected present discounted value of the additional profits made relative to the low productivity state as long as the worker remains in a high productivity one. Note also that this equation along with (3) implies that

$$J_H(\tilde{s}) = \frac{y_H - y_L}{r+p}\left(1 - \mathrm{e}^{-(r+p)(T-\tilde{s})}\right) - F_1. \tag{6}$$

For $s^* < s < \tilde{s}$, the Bellman equation is

$$(r+p)J_H(s) = y_H - w - pF_1 + \frac{\mathrm{d}J_H(s)}{\mathrm{d}s}.$$

The terminal solution of this differential equation is given by (6). Consequently, the solution is

$$J_H(s) = \frac{y_H - y_L}{r+p}\left(1 - \mathrm{e}^{-(r+p)(T-s)}\right) + \frac{y_L - w}{r+p}(1 - \mathrm{e}^{-r(T-s)}\mathrm{e}^{-p(\tilde{s}-s)}) - \frac{pF_1}{r+p}. \tag{7}$$

Consider the decision to fire a highly productive worker just before age s^*.This will be optimal provided $J_H(s^*) < -F_0$. This is more likely to hold, the lower F_0 and the greater F_1. The smallest possible value of F_0 is zero, and the largest one compatible with this regime is the one such that $\tilde{s} = s^*$, i.e. $F_1 = \frac{w-y_L}{r}(1 - \mathrm{e}^{-r(T-s^*)})$. Substituting into (7), we see that in such a case the inequality $J_H(s^*) < -F_0 = 0$ holds provided

$$\frac{y_H - y_L}{r+p}\left(1 - \mathrm{e}^{-(r+p)(T-s^*)}\right) < \frac{w - y_L}{r}(1 - \mathrm{e}^{-r(T-s^*)}).$$

The maximum admissible value of w is $w = y_H$, and it can be checked that at this point this inequality holds, since for any $a > 0$ the expression $\frac{1-\mathrm{e}^{-az}}{z}$ falls with z.

Finally, for $s < s^*$ the Bellman equation is

$$(r+p)J_H(s) = y_H - w - pF_0 + \frac{\mathrm{d}J_H(s)}{\mathrm{d}s}, \tag{8}$$

and the terminal condition is a value-matching condition with (7) at $s = s^*$. We get the following solution:

$$\begin{aligned} J_H(s) &= \frac{y_H - y_L}{r+p}\left(1 - \mathrm{e}^{-(r+p)(T-s)}\right) + \frac{y_L - w}{r+p}(1 - \mathrm{e}^{-r(T-s)}\mathrm{e}^{-p(\tilde{s}-s)}) \\ &\quad - \frac{pF_0}{r+p} - \frac{p(F_1 - F_0)}{r+p}\mathrm{e}^{-(r+p)(s^*-s)} \end{aligned} \tag{9}$$

Equations (5), (7) and (9) define the age-profile of the firm's net expected profits from employing a worker in the high productivity state. If $J_H(s) > H$, then any worker of age s would be hired. If that inequality fails, then the worker would not be hired. These formulas are valid in the parameter zone where $\tilde{s} > s^*$, or equivalently $F_1 < \frac{w-y_L}{r}(1 - \mathrm{e}^{-r(T-s^*)})$.

Differentiating the relevant formula for $J_H(.)$ in the three zones, we get the following:

1. If $s > \tilde{s}$, we have that $J'_H(s) \propto (w - y_L) - (y_H - y_L)e^{-p(T-s)}$.

2. If $s^* < s < \tilde{s}$, then $J'_H(s) \propto (w - y_L) - (y_H - y_L)e^{-p(T-\tilde{s})}$.

3. Finally, if $s < s^*$, then $J'_H(s) \propto (w - y_L) - (y_H - y_L)e^{-p(T-\tilde{s})} - \mathrm{e}^{r(T-s^*)}\mathrm{e}^{p(\tilde{s}-s^*)}p(F_1 - F_0)$

Consequently, if $(w - y_L) < (y_H - y_L)e^{-p(T-\tilde{s})}$, or equivalently

$$w - y_L < (y_H - y_L)\left(1 - \frac{rF_1}{w - y_L}\right)^{p/r}$$

then $J'_H < 0$ throughout.

If this inequality does not hold, then there are two possibilities:

-If $(w - y_L) - (y_H - y_L)e^{-p(T-\tilde{s})} > \mathrm{e}^{r(T-s^*)}\mathrm{e}^{p(\tilde{s}-s^*)}p(F_1 - F_0)$, then $H' > 0$ for $s < \hat{s} = T + \frac{1}{p}\ln\frac{w-y_L}{y_H-y_L}$ and $H' > 0$ for $s > \hat{s}$.

-If $(w - y_L) - (y_H - y_L)e^{-p(T-\tilde{s})} < \mathrm{e}^{r(T-s^*)}\mathrm{e}^{p(\tilde{s}-s^*)}p(F_1 - F_0)$, then $H' < 0$ for $s < s^*$, $H' > 0$ for $s^* < s < \hat{s}$, and $H' > 0$ for $s > \hat{s}$.

For the sake of completeness, let us also describe the solution if $F_1 > \frac{w-y_L}{r}(1 - \mathrm{e}^{-r(T-s^*)})$. In this case, workers such that $s > s^*$ are not fired when falling into the low productivity state, and we have two further possibilities:

A. If $F_0 < \frac{w-y_L}{r}(1 - \mathrm{e}^{-r(T-s^*)})$, then all workers such that $s < s^*$ lose their job when their productivity falls. Then J_H is given by (5) for all $s > s^*$. For $s < s^*$, it follows the Bellman equation (8) with the terminal condition

$$J_H(s^*) = \frac{y_H - y_L}{r+p}\left(1 - \mathrm{e}^{-(r+p)(T-s^*)}\right) + \frac{y_L - w}{r}(1 - \mathrm{e}^{-r(T-s^*)}).$$

The solution is

$$\begin{aligned} J_H(s) &= \frac{y_H - y_L}{r+p}\left(1 - \mathrm{e}^{-(r+p)(T-s)}\right) - \frac{pF_0}{r+p}\left(1 - \mathrm{e}^{-(r+p)(s^*-s)}\right) \\ &\quad + \frac{y_L - w}{r}\left(\frac{r}{r+p} + \frac{p}{r+p}\mathrm{e}^{-(r+p)(s^*-s)} - \mathrm{e}^{-r(T-s)}\mathrm{e}^{-p(s^*-s)}\right). \end{aligned}$$

B. If $F_0 > \frac{w-y_L}{r}(1 - \mathrm{e}^{-r(T-s^*)})$, then workers who fall into the low state are retained iff $s > \tilde{s}$, with $\tilde{s}$ now solution to

$$F_0 = \frac{w - y_L}{r}(1 - \mathrm{e}^{-r(T-\tilde{s})}), \tag{10}$$

and $\tilde{s} < s^*$. For all $s > \tilde{s}$, $J_H(s)$ satisfies the Bellman equation (4) with the terminal condition $J_H(T) = 0$. Hence it is again given by (5). For all $s < \tilde{s}$, it satisfies (8) with terminal condition

$$J_H(\tilde{s}) = \frac{y_H - y_L}{r+p}\left(1 - \mathrm{e}^{-(r+p)(T-\tilde{s})}\right) - F_0.$$

The solution is

$$\begin{aligned} J_H(s) &= \frac{y_H - y_L}{r+p}\left(1 - \mathrm{e}^{-(r+p)(T-s)}\right) - \frac{F_0}{r+p}\left(p + r\mathrm{e}^{-(r+p)(\tilde{s}-s)}\right) \\ &\quad + \frac{y_L - w}{r+p}\left(1 - \mathrm{e}^{-(r+p)(\tilde{s}-s)}\right). \end{aligned}$$

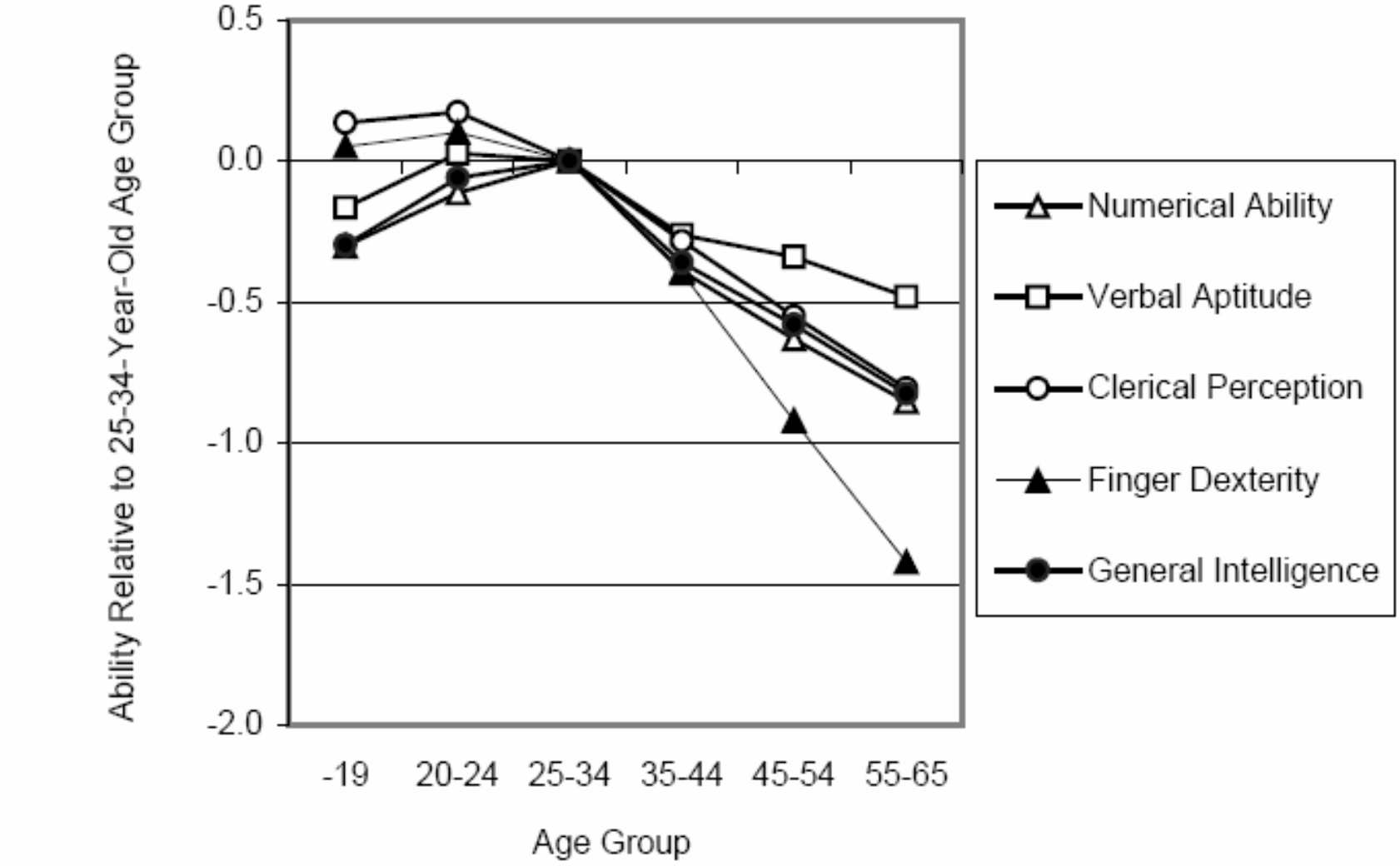


Figure 1: the evolution of skills over the life cyle; source: Avolio and Waldman (1994)

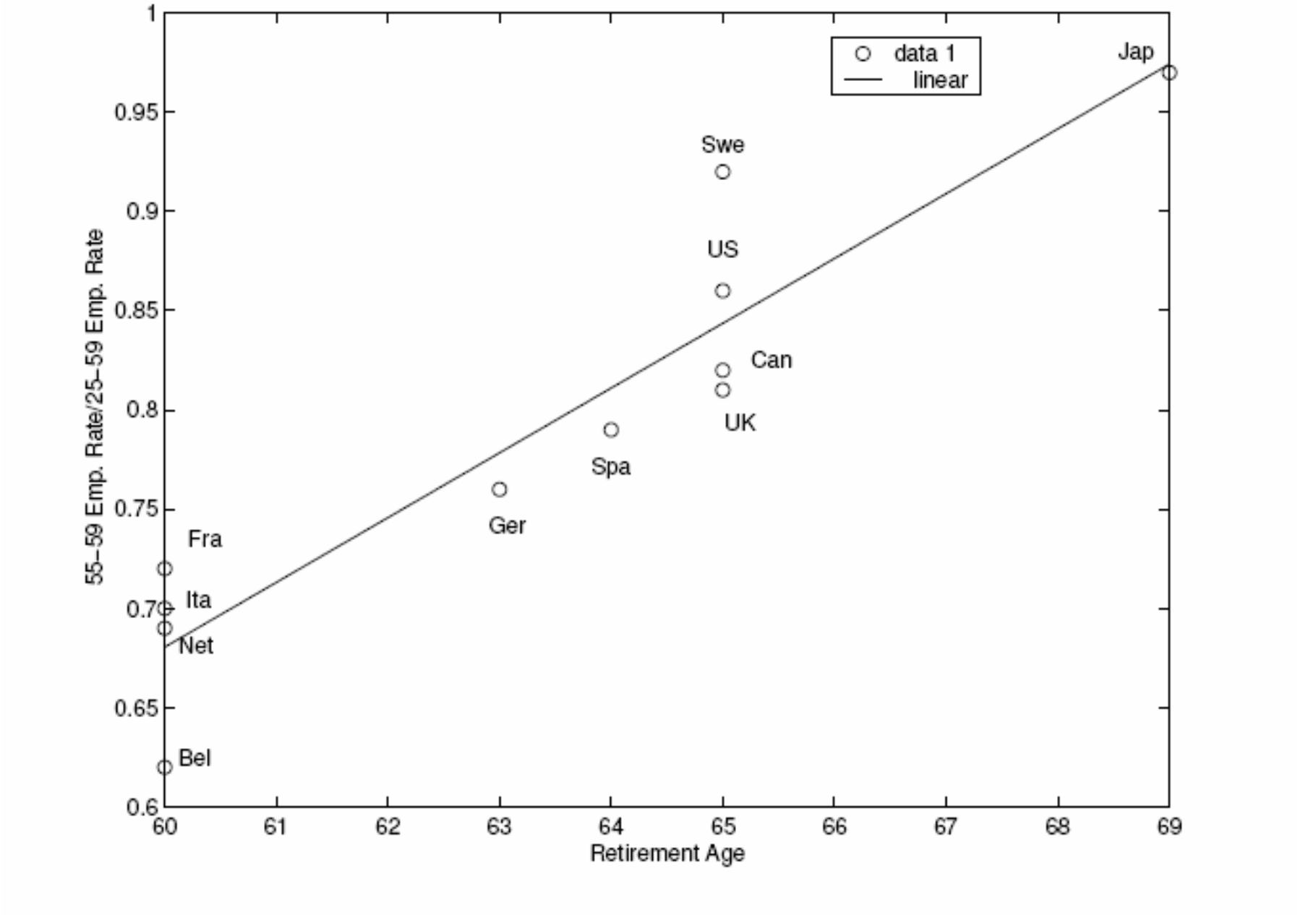


Figure 2: employment of older workers across countries. Source: Hairault et al. (2008)

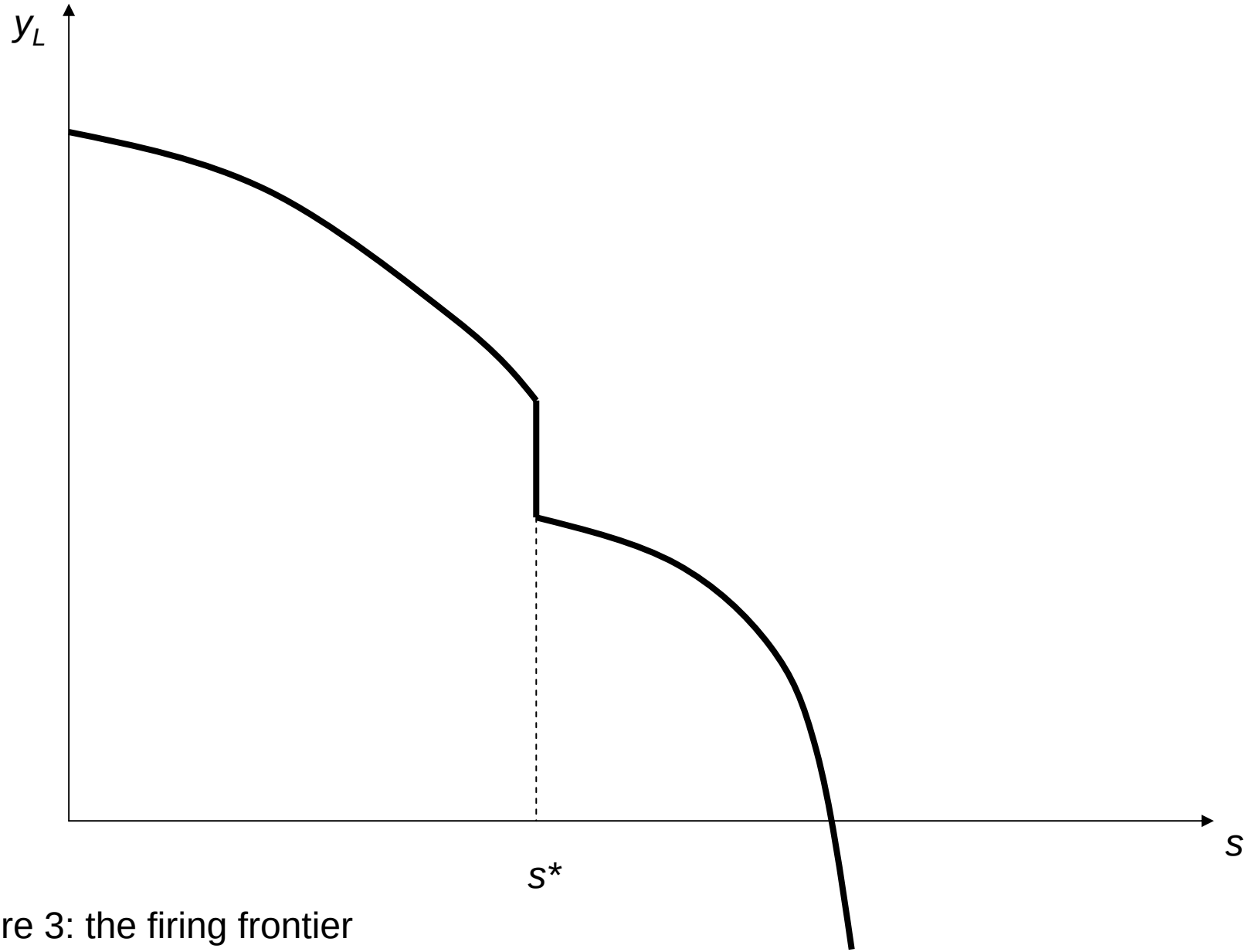


Figure 3: the firing frontier

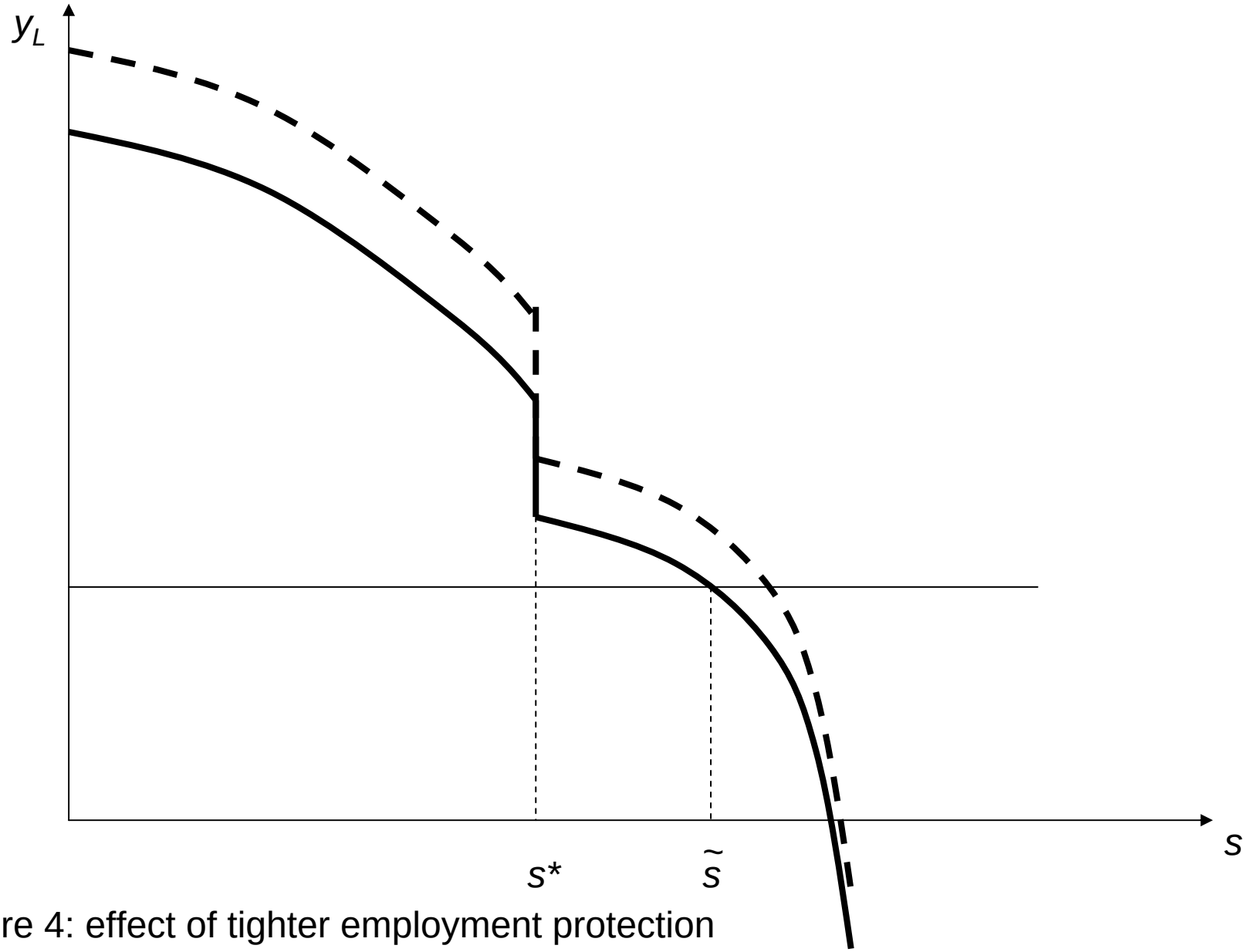
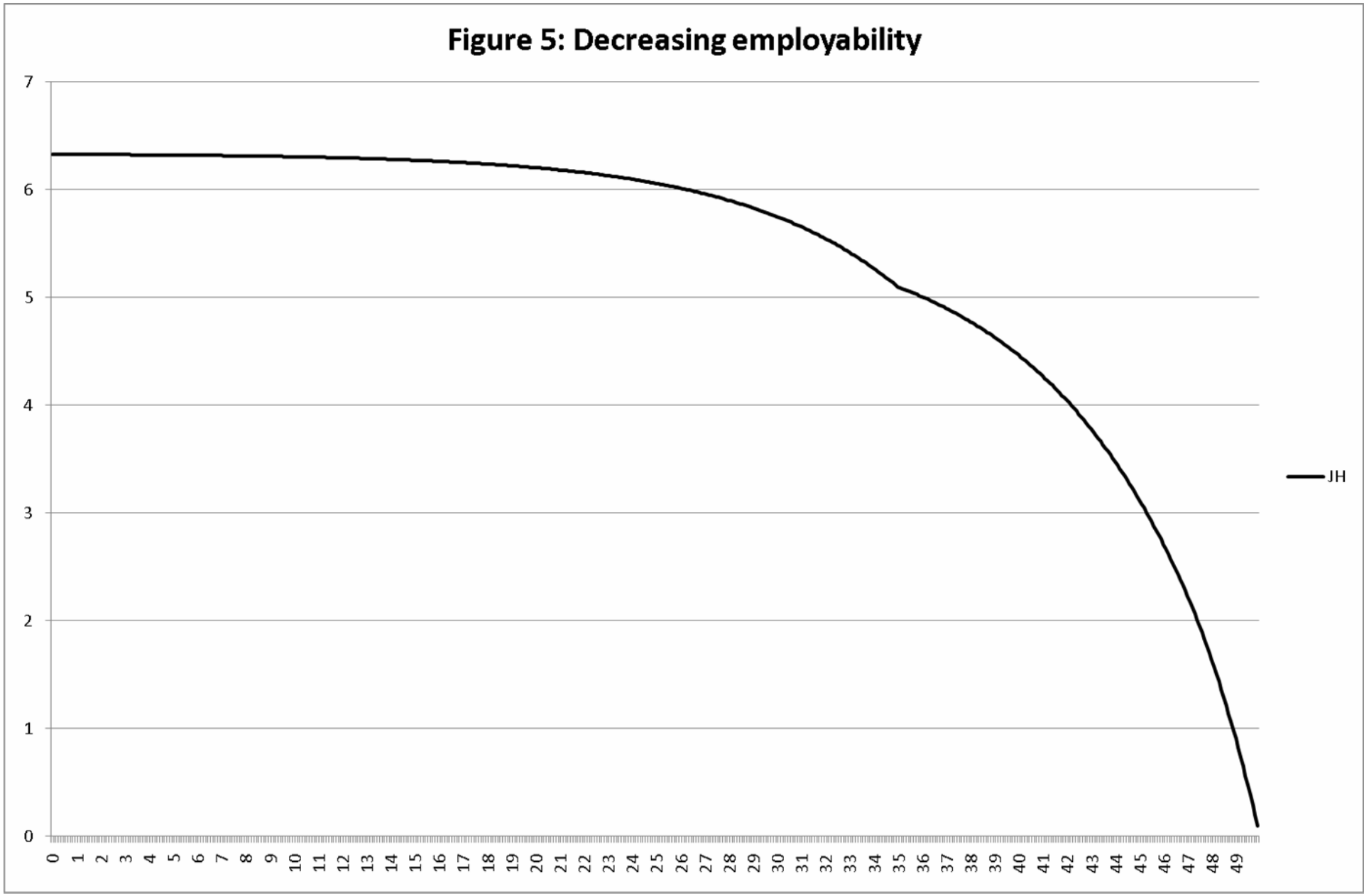


Figure 4: effect of tighter employment protection

Figure 5: Decreasing employability



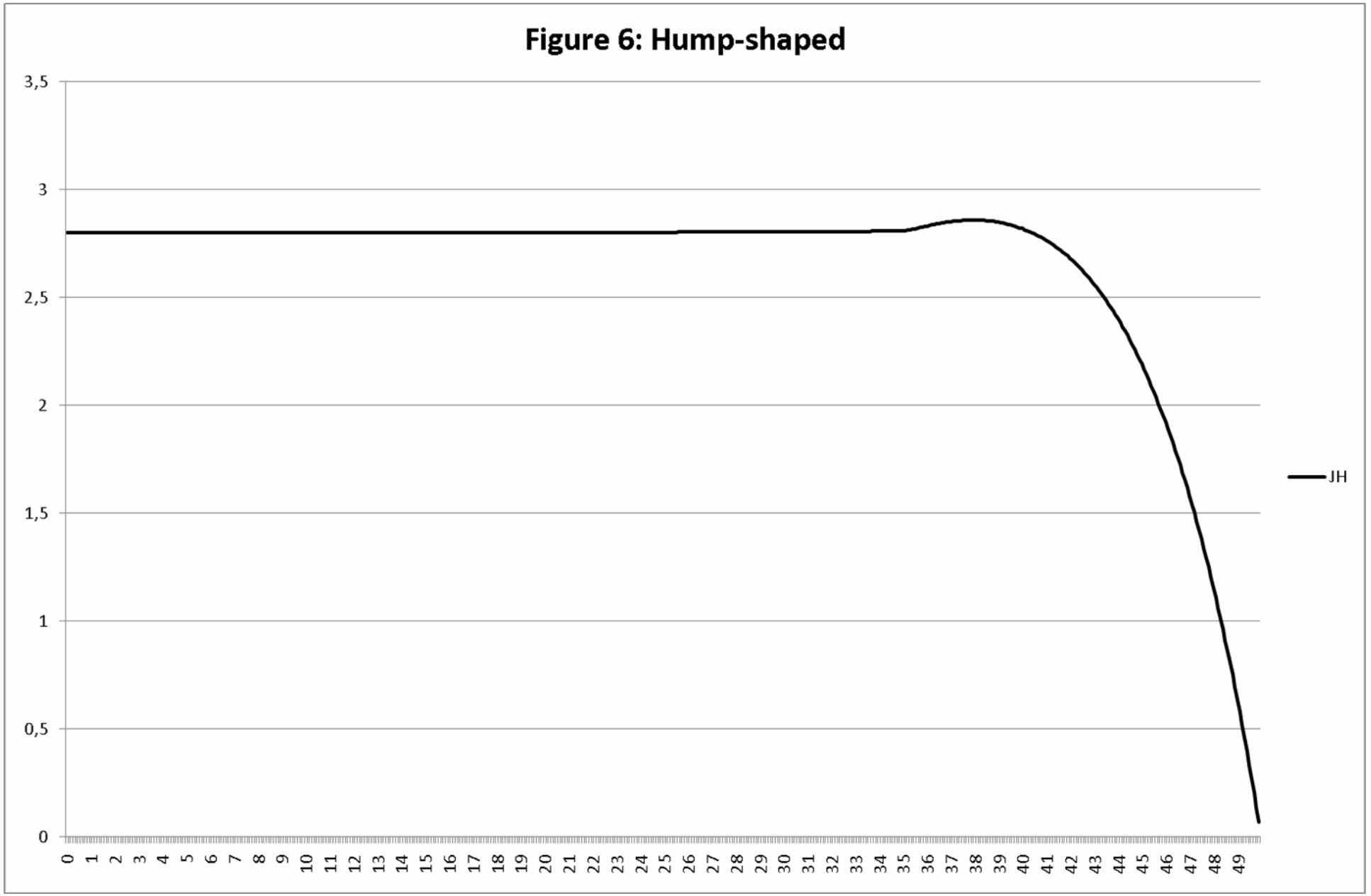


Figure 6: Hump-shaped
3,5
3
2,5
2
1,5
1
0,5
0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49
JH


Figure 7:M-shaped
5
4,5
4
3,5
3
2,5
2
1,5
1
0,5
0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49
JH

Figure 8

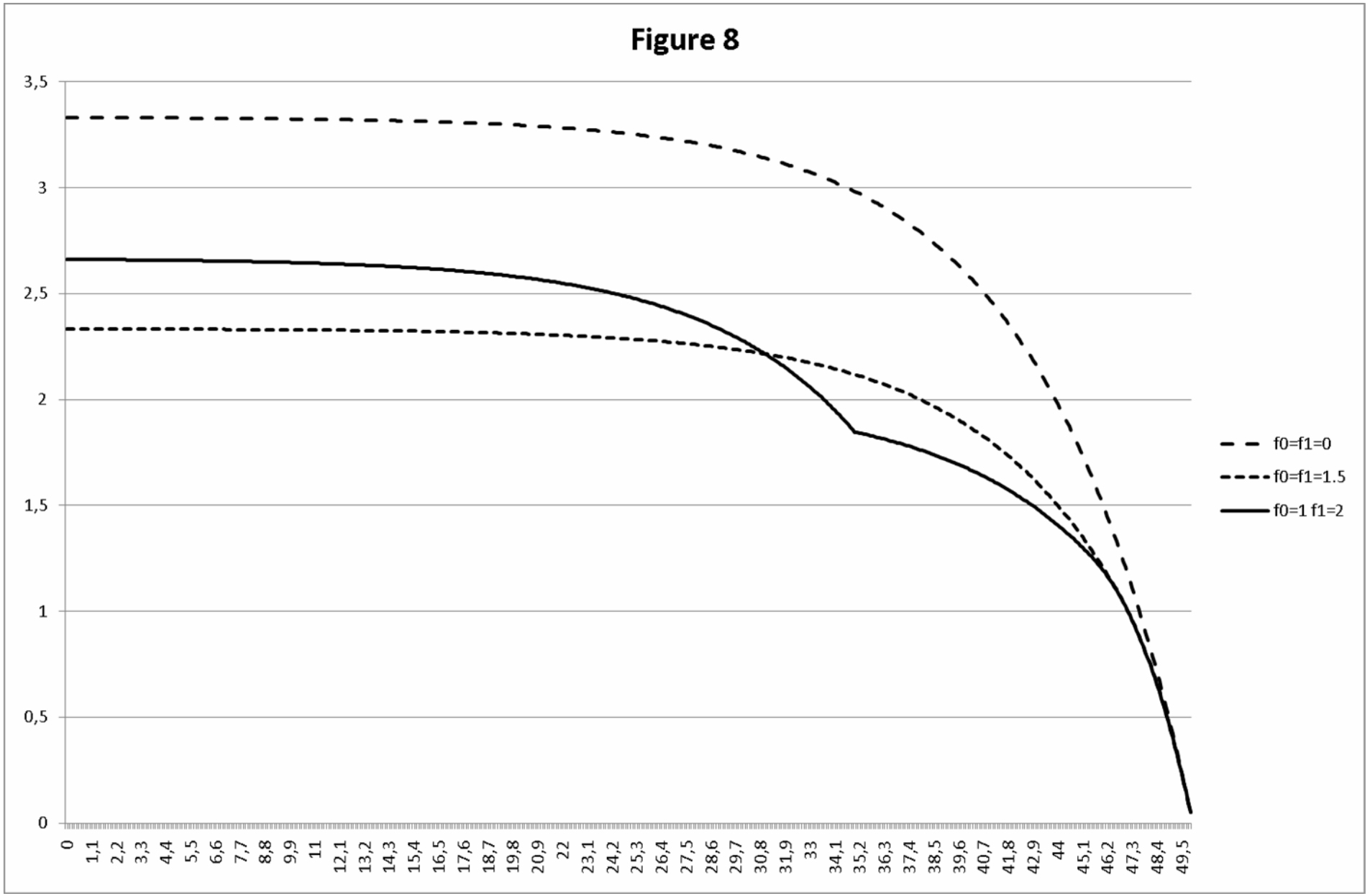

3,5
3
2,5
2
1,5
1
0,5
0
0
1,1
2,2
3,3
4,4
5,5
6,6
7,7
8,8
9,9
11
12,1
13,2
14,3
15,4
16,5
17,6
18,7
19,8
20,9
22
23,1
24,2
25,3
26,4
27,5
28,6
29,7
30,8
31,9
33
34,1
35,2
36,3
37,4
38,5
39,6
40,7
41,8
42,9
44
45,1
46,2
47,3
48,4
49,5
f0=f1=0
f0=f1=1.5
f0=1 f1=2

Figure 9: E->U transitions

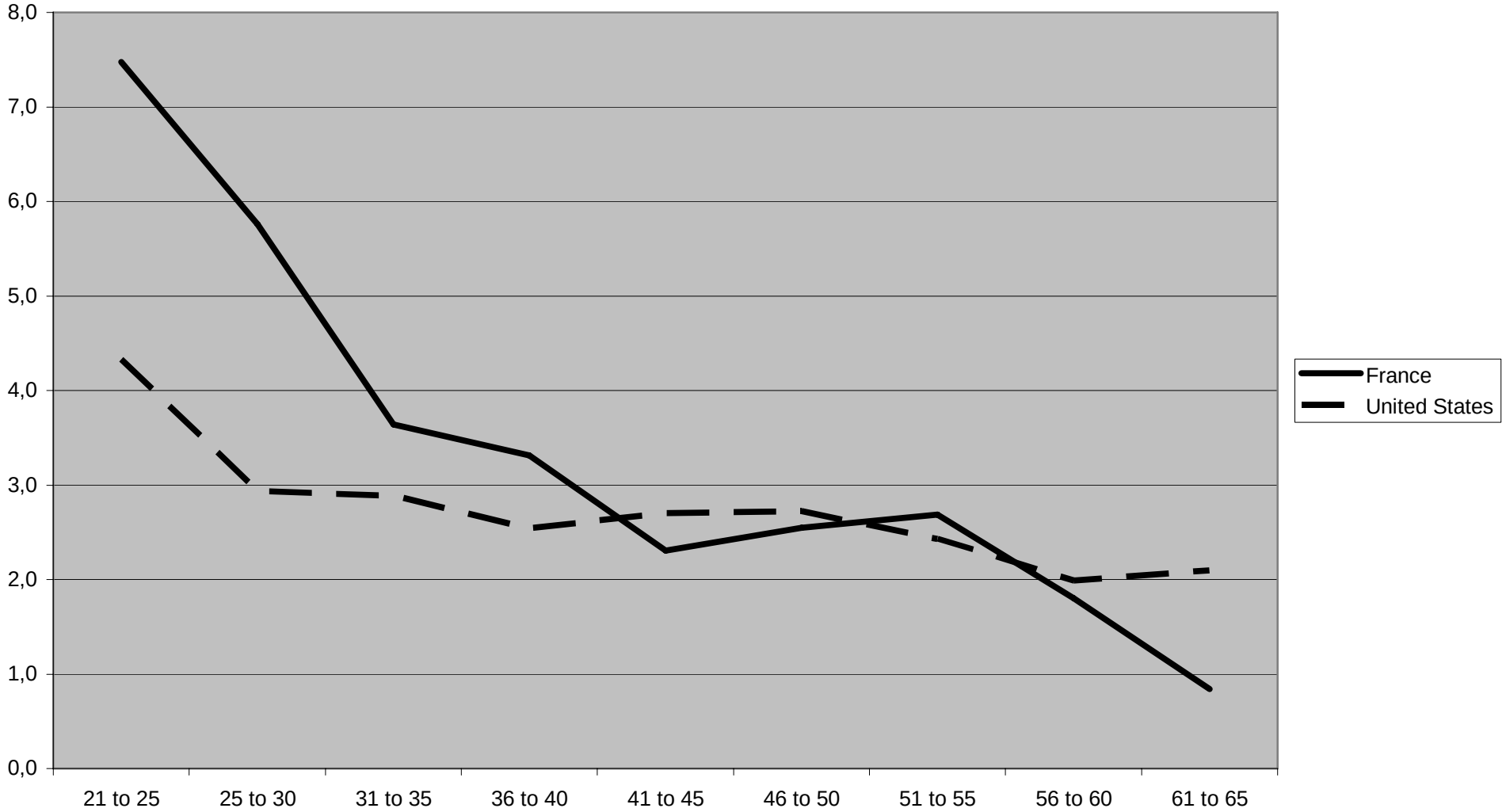


Figure 10: E-->non E transition

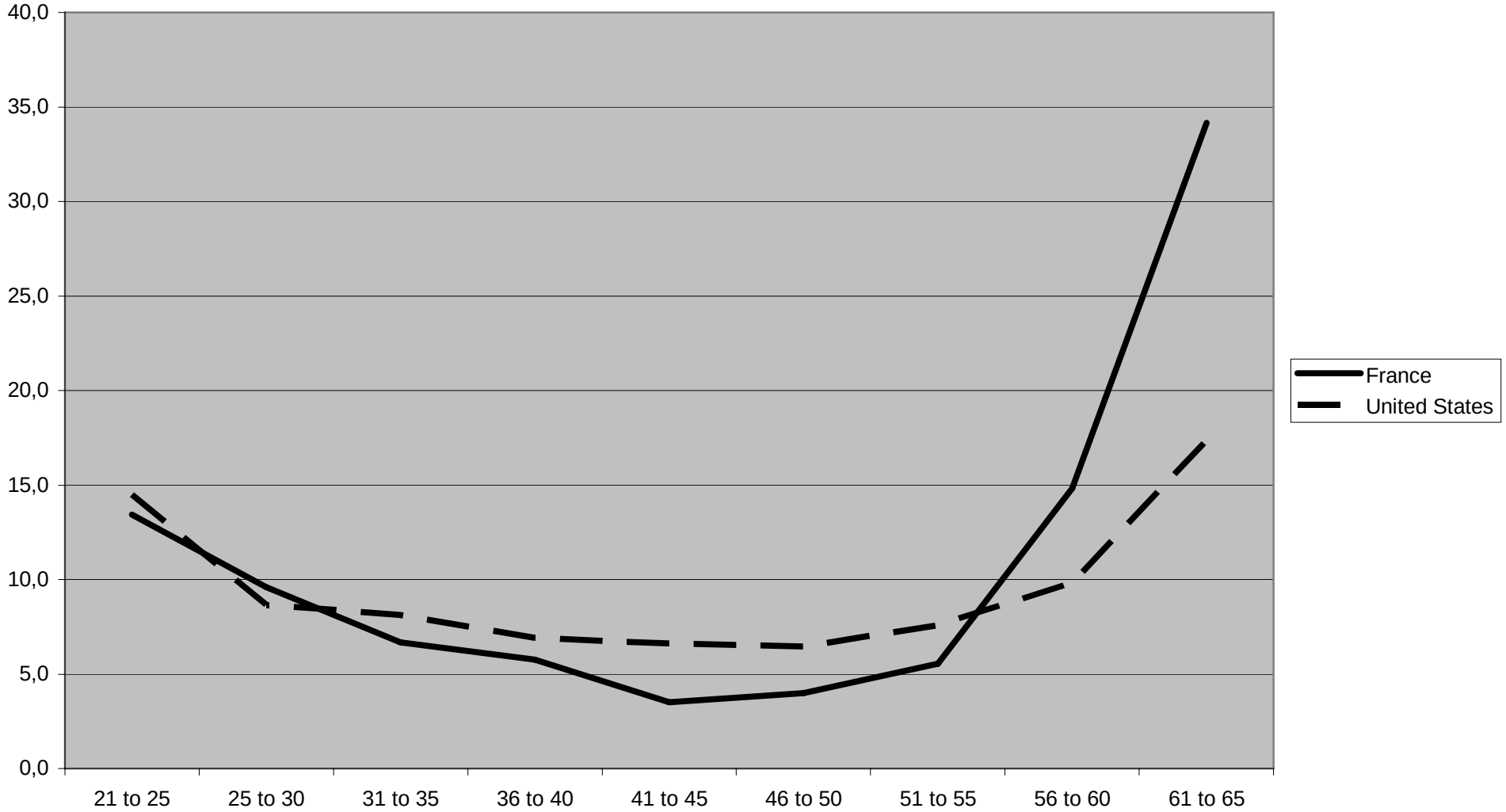


Figure 11: job finding rate

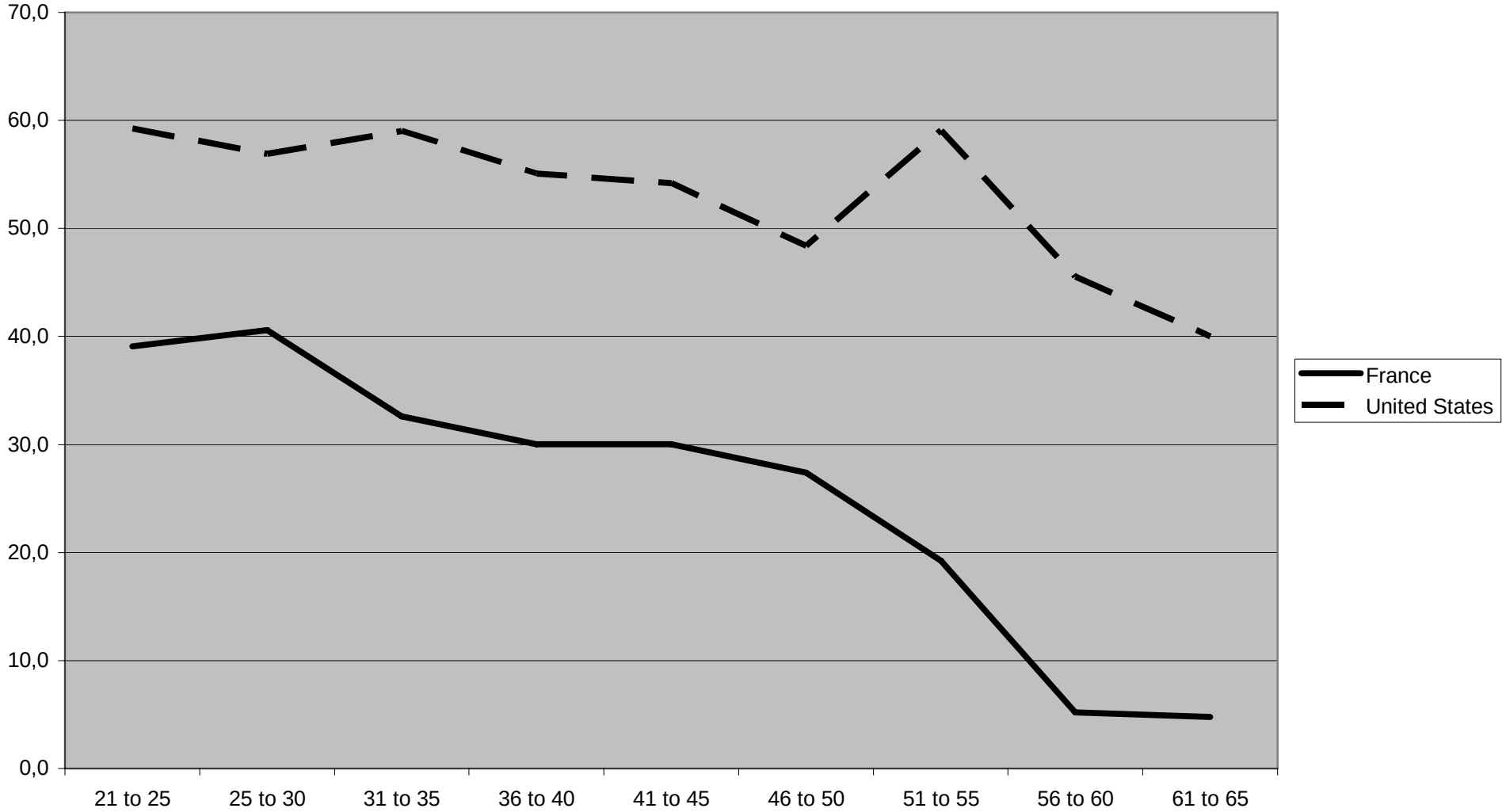


Figure 12: median wage, France, men

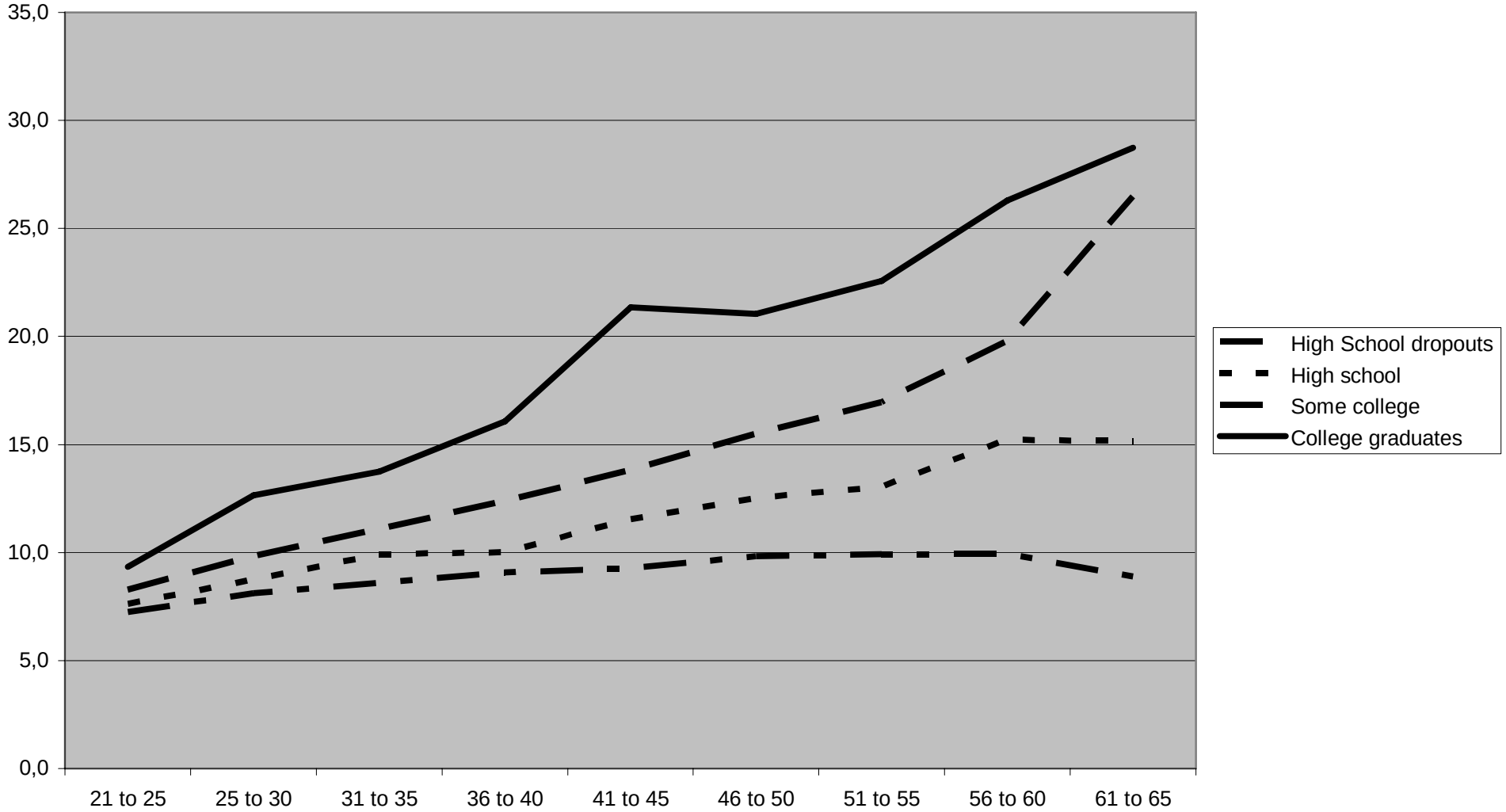
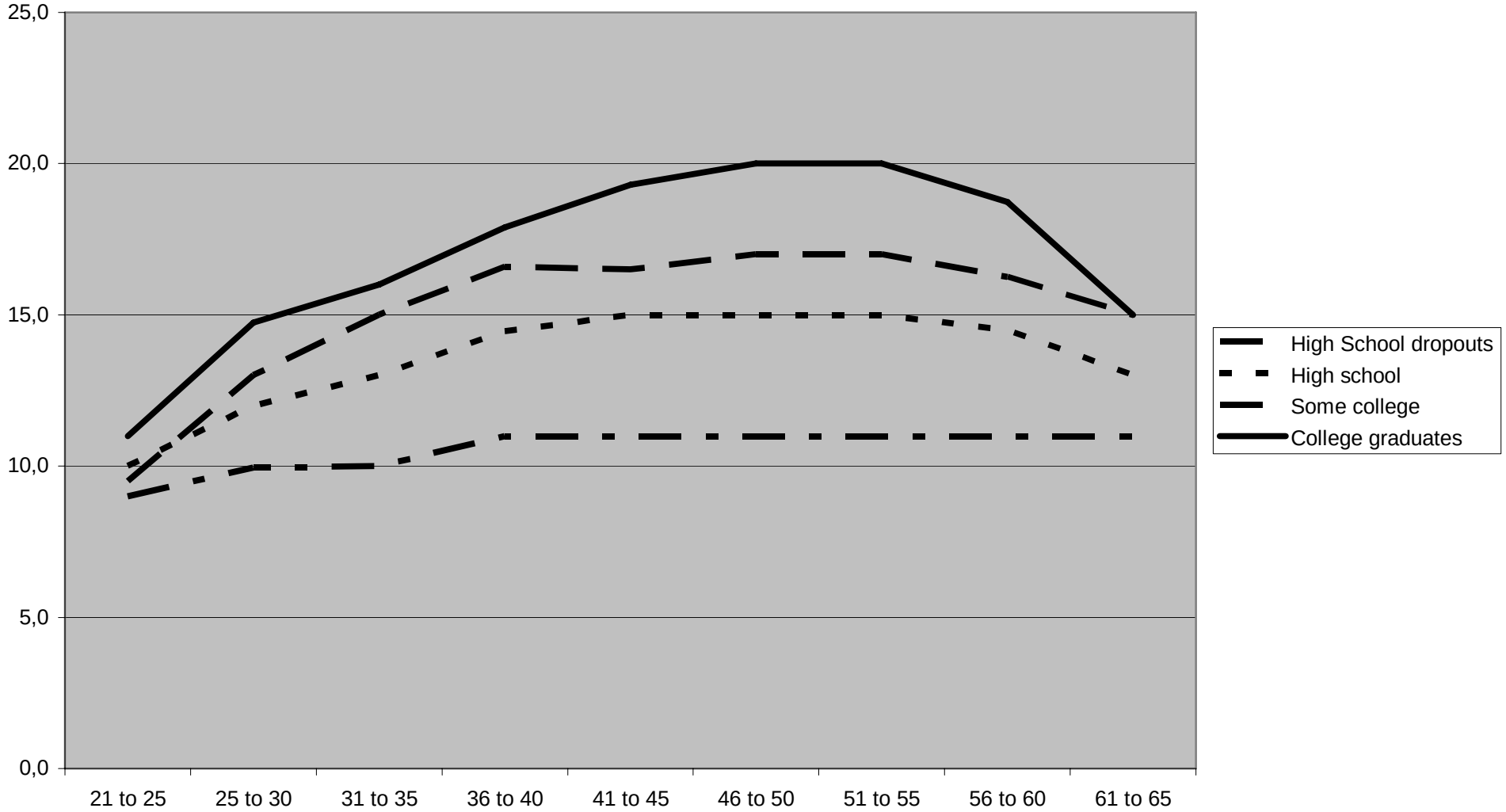


Figure 13: median wage, USA, men



Education level	High school dropout		High school		Some college		College degree	
Country	France	USA	France	USA	France	USA	France	USA
56-60	47.9 (1.5)	53.9 (2.3)	58.2 (3.6)	69.7 (1.5)	55.4 (4.6)	73.9 (1.5)	79.9 (3.4)	83.6 (1.1)
61-65	8.6 (1.1)	35.4 (2.2)	16.0 (3.6)	44.9 (1.7)	17.3 (4.5)	53.1 (22)	31.9 (5.1)	63.5 (1.8)

Table 1 – Employment rates of older workers by educational levels, men, US and France.

Education level	High school dropout		High school		Some college		College degree	
Country	France	USA	France	USA	France	USA	France	USA
31-35	11.6 (1.1)	7.8 (1.1)	6.0 (1.4)	6.0 (0.6)	6.2 (1.4)	3.9 (0.6)	5.6 (1.6)	2.4 (0.4)
36-40	7.3 (0.8)	7.2 (1.0)	5.5 (1.5)	5.3 (0.6)	3.7 (1.2)	3.7 (0.6)	5.6 (1.6)	1.5 (0.3)
41-45	5.9 (0.7)	4.6 (0.8)	8.1 (2.0)	5.2 (0.5)	3.0 (1.2)	3.7 (0.6)	8.3 (2.3)	2.2 (0.4)
46-50	6.2 (0.7)	5.0 (0.8)	8.2 (2.2)	3.9 (0.5)	7.6 (2.3)	3.6 (0.6)	5.9 (1.9)	2.5 (0.6)
51-55	6.3 (0.7)	4.5 (0.9)	7.7 (2.0)	4.7 (0.6)	9.5 (2.9)	2.5 (0.4)	4.3 (1.8)	2.2 (0.4)
56-60	3.4 (0.6)	4.4 (0.9)	4.2 (1.4)	3.5 (0.5)	8.8 (2.9)	2.9 (0.6)	5.2 (2.0)	2.5 (0.5)

Table 2 – Unemployment rates, men, France and USA

	France	USA
16-30	-0.041 (0.015)	-0.063 (0.016)
31-40	-0.128 (0.021)	-0.215 (0.021)
41-50	-0.199 (0.026)	-0.369 (0.022)
51-65	-0.201 (0.039)	-0.225 (0.03)

Table 3 – Wage losses of displaced workers, men and women, France and USA.