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Are older workers overpaid? A literature review

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## **Abstract in English**

It is widely believed that wage and productivity profiles of individual workers do not coincide at all ages. We give an overview of the theories which provide a rationale for this, and discuss the empirical literature. Human capital theories typically imply that wages rise with tenure, so that job reallocation at old age would imply a wage cut. Incentive theories typically imply that wages exceed productivity at the end of a worker's career. Bargaining power of unions may also lead to 'overpayment' of older workers. Some general conclusions regarding the wages of older workers are formulated on basis of the authors' reading of the empirical literature.

*Key words: age, wage, productivity*

*JEL code: J24, J31, J33, J51, J62*

## **Abstract in Dutch**

De gedachte dat loon en productiviteit van individuele werknemers niet voor alle leeftijden gelijk zijn, is wijdverspreid. We geven een overzicht van economische theorieën die verschillen tussen loon en productiviteit rechtvaardigen. Voorts bespreken we de empirische literatuur. Theorieën die de opbouw van menselijk kapitaal centraal stellen, impliceren in de regel dat individuele lonen stijgen met de duur van het dienstverband. Daardoor zien oudere werknemers een loondaling tegemoet indien zij overwegen om van baan te veranderen. Theorieën die de prestatieprikkel voor werknemers centraal stellen, impliceren meestal dat de lonen van oudere werknemers hun productiviteit overstijgen. Onderhandelingsmacht van vakbonden kan eveneens leiden tot relatief hoge lonen van oudere werknemers. Op basis van lezing van de empirische literatuur formuleren de auteurs enkele algemene conclusies.

*Steekwoorden: leeftijd, loon, productiviteit*



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## Summary

The labour market is not a spot market. Instead, supply, demand and price may be the result of complex contracts that seek to deal with various market imperfections. An important implication is that the productivity and wage of an individual worker's do not necessarily coincide at all ages. This has important implications. First, discrepancies between wage and productivity over the life cycle cause redistribution between generations through implicit pay-as-you-go transfers. This may be unsustainable in light of the ageing population (Lazear, 1988). Second, discrepancies affect the labour-market position at different ages. For instance, current payment schemes may hamper the hiring of older workers to the extent that they are overpaid compared to their productivity (Hutchens, 1986; Daniel and Heywood, 2007; Heywood et al., 2010). Third, while payment schemes may be based on optimal private decisions of workers and employers, they are not necessarily socially optimal due to external effects that they create.

To understand the possible discrepancies between productivity and wages, this paper offers a survey of the literature aimed at explaining them. Thereby, we focus on older workers. We discuss several theories, including incentive theories, human capital theory, and imperfect labour market theories. Most of these theories have been developed during the 1970s and 1980s. In recent decades, researchers have started to test these theories. We summarize the consensus results that can be derived from this empirical literature. Early empirical studies use individual cross-section and longitudinal data, without making a direct link to firm productivity. Later studies have started to make use of matched employer-employee data to relate firm productivity and wages to the firm's worker-age composition. Moreover, empirical studies have started to perform experiments and surveys to complement other empirical methods. Overall, we collected 70 studies, primarily from the US and Europe. While they do not allow deriving conclusions for individual countries, sectors, firms, or individuals, they do offer insights that justify some general conclusions.

Theories emphasizing specific human capital are able to explain why firms employ older workers but hardly ever hire them. The evidence grants support to this theory and it seems particularly important at the early stages of careers. However, its precise relevance is still subject to debate. In the empirical literature, there are strong indications that this theory alone cannot explain the wage patterns of older workers, and that at least one other theory should be added to allow for proper explanations of wage profiles. For instance, studies allowing for both specific human capital and deferred payment schemes gain some support. Moreover, theories that emphasize insurance, collective bargaining, and workers' preferences also receive some support from the data. Hence, it is unlikely that just one theory explains the wage-productivity gap for all older workers.

Different theories arrive at different outcomes regarding the optimality of wage profiles. In some theories, a wage-productivity gap is socially desirable, especially when firms and workers find it optimal to conclude such a payment scheme without imposing external costs on others.

In principle, this is the case in, for instance, Lazear style implicit contracts, worker preferences theory, and insurance theories. However, deferred compensation schemes may be inefficient if they aggravate problems of liquidity constrained young households or discourage job-to-job mobility at old age. Moreover, wage bargaining theories emphasize inefficiencies of wage contracts due to monopsony power of trade unions. As a result, the normative implications of the different theories may differ importantly.

# 1 Introduction

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The rest of this paper is organized as follows. Section 2 discusses theories providing explanations for wages being unequal to productivity. Section 3 discusses the main empirical findings. Section 4 concludes.



## 2 Theories explaining wages of older workers

We discuss theories which predict deviations from wages that would be realised in a spot market. First, we focus on human capital theory, which generally predicts that wages are above the spot market wage but below the worker's value to the firm. Second, we discuss deferred compensation schemes, which often imply that older workers are paid above their productivity within the firm. We also discuss three alternative theories. Collective bargaining and worker preferences may lead to wages rising with seniority, implying that wages exceed productivity as workers near the end of their careers. Insurance may lead employers to offer stable wage profiles. At times, this may imply that wages deviate from worker productivity. The effect may go both ways, so that according to these theories older workers could be either under- or overpaid compared to their productivity.

### 2.1 Human capital investment in long-term employment relationships

#### 2.1.1 General and specific capital investment

Investments in human capital increase the individual worker's productivity, and most usually also his earnings. After completion of schooling, formal or informal on-the-job training is the major productivity-enhancing investment. Human capital theory distinguishes between investments in general and specific skills (Becker, 1964). General skills are equally valuable in any employee-firm match, whereas specific skills are valuable only for a particular match. In a competitive labour market, employers share the returns and the costs of investments in firm-specific skills with their employees. Moreover, firms do not invest in general skills of their employees. Employees capture all the returns to their general human capital, and as a result make this investment themselves. Mincer (1970; 1997) summarizes the empirical evidence, and finds that earnings depend positively on the stock of human capital; the age-earnings profile is at least for a long time upward sloping, at a decreasing rate; and the age-earnings profile becomes steeper and has its maximum later if investment in human capital increases.

Another approach to human capital investment assumes that investment levels are not contractible and that post-training wages are determined by bargaining. This strand of the literature recognizes that there are problems in writing contracts contingent on future events that are important for the employment relationship, including investments. With specific investments (in human and/or physical capital) demand and supply conditions do not determine a unique equilibrium wage, but instead determine the lowest wage for which an employee is willing to work and the highest wage the employer is willing to pay. In the absence of an explicit contract, bargaining determines where between those two the wage lies, and thus how the rents to continued employment are divided. If the size or division of the rents depends on the return to an investment undertaken by a firm, ex-post bargaining may result in the employee capturing some of that return. This is called hold-up. As a result, the firm will under-invest in

specific capital (Grout, 1984). Similarly, the employee will under-invest in his specific (human) capital if part of the return to that investment is captured by the firm. This constitutes a market failure: hold-up implies underinvestment in human capital, leading to lower levels of employment.

Replacing an employee with someone equally good may involve hiring costs. Similarly, moving to another comparable job often involves search and relocation costs for the employee. With hiring costs, the impact of any investment, specific or general, on the alternative wage of the employee is always less than its impact on the firm's net revenue. This provides the firm with an incentive to invest in general skills. The similarity with specific capital is evident. Turnover costs can be seen as a rent which can be shared between the worker and the firm. Thus, underinvestment is not only a problem with specific human capital, but also with general human capital (Shaked and Sutton, 1984; Stevens, 1994; Acemoglu and Pischke, 1999).<sup>1</sup>

In the following, we first discuss contracts that may (to a certain extent) protect investments from hold-up. Second, we examine the consequences of these contracts for the wage profiles of individual workers.

### **2.1.2 Contracts to induce investment in general and specific capital**

Employee wages often rise with tenure as a result of such contracts which induce human capital investment by the firm and/or employee. The main results are summarised in table 1. A "firm sets wage" contract implies that the wage equals the outside option of the employee. Because the wage is independent from specific investments and fully reflects general investments, the firm invests efficiently in specific skills and the employee invests efficiently in general skills. As a result, wages do not rise with tenure. An "employee sets wage" contract, on the contrary, implies that the wage equals the outside option of the firm. Because the wage fully reflects both general and specific investments, the employee invests efficiently in both general and specific skills, and the tenure effect is positive. In a "fixed wage" contract, the wage rate is fixed, and the firm has an incentive to invest in general and specific skills. However, it will not invest efficiently due to the probability of renegotiation. At times of renegotiation the employee may capture (a part of) the returns on the investment. It is precisely this prospect of wage adjustment that provides an incentive for the employee to invest positively in general and specific skills. Whereas the investments in general skills raise the outside opportunities for the employee, and – with high enough investments – will likely lead to renegotiation, investments in specific skills will only pay off in times of downward renegotiations. As downward wage adjustments are unlikely, the investment in specific skills by the employee and the accompanying tenure effect are small.

A "firm sets wage" contract results in no specific investments by the employee, while the firm invests efficiently. Conversely, an "employee sets wage" contract implies efficient

<sup>1</sup> Alternatively, complementarities between general and specific capital may also lead to firm investments in general capital (see, e.g., Franz and Soskice, 1995).

investments by the employee, but results in no investments by the firm. That is, either the firm or the employee invests efficiently while the other invests not at all. In some circumstances, it may however be more efficient to have both parties invest some positive amount than for one to invest efficiently and the other not at all. This is the case if both parties have access to different investment opportunities (with diminishing returns). This may e.g. be the case if an investment requires effort from the employee. A firm will not invest in a training course if the employee does not provide effort. A fixed wage contract can typically induce both to make some specific investment. In this way, a fixed wage contract can be an improvement over other types of contracts.

**Table 2.1 Investment in human capital, and tenure effect on wages**

Type of contract	Type of investment	Investment by <sup>a</sup>		Tenure effect
		Firm	Employee	
no contract	general	0	efficient	
	specific	+	+	+
no contract, turnover costs	general	+	+	
	specific	+	+	+
firm sets wage	general	0	efficient	
	specific	efficient	0	0
Employee sets wage	general	0	efficient	
	specific	0	efficient	+
Fixed wage	general	+	+	
	specific	+	+	+ <sup>b</sup>

<sup>a</sup> A '+' indicates a generally lower than efficient investment.

<sup>b</sup> A fixed wage contract implies only a small positive tenure effect when downward renegotiation occurs.

### 2.1.3 Implications for wage profiles

General human capital is expected to accumulate with total job market experience, and fall in later stages as depreciation dominates investments in skills. Wages initially increase with experience to the extent that the employee is able to capture the return to these investments. As a result, differences in individual wages reflect differences in productivity. Specific human capital can be expected to accumulate with tenure with a given employer. Wages then increase with tenure to the extent that an employee is able to capture some of the return to this capital. Or, in other words, wages grow during periods in which on-the-job training occurs. If specific human capital is an important factor in wage growth, firms will be less inclined to hire older workers (who lack those specific skills). For instance, Acemoglu and Pischke (1999) predict both an experience premium – as wages are higher during the later career of workers because of the investments in skills during the early years – and a tenure premium – because market frictions make these skills partly specific.

In a frictional labour market with on-the-job search, in which firms can post general contracts, firms may use contracts in which the value to the worker increases with tenure (Burdett and Coles, 2003; Stevens, 2004). This may happen either instantaneously, by means of

an entrance fee, or slowly if entrance fees are not possible, by means of a rising wage. Such contracts increase the retention of existing workers (and hence reduce labour market turnover), and allow the firm to extract rents. The firm's benefits of retention are even higher in the case of specific capital investments – to the extent that the firm captures the returns on these investments. Firms may actually choose increasing wage-tenure contracts, such as back-loaded compensation and generous pensions, so as to invest in specific capital and retain their workers at the firm.

Two implications of these human capital explanations for the wage-seniority relationship deserve emphasis. First, wages grow with seniority *because* productivity grows with seniority (experience and/or tenure). Second, at least for older (trained) workers, the spot wage is always less than or equal to the spot value of the marginal product within the firm.

## **2.2 Incentive contracts**

Employers may stimulate the individual worker's productivity by offering him a deferred compensation scheme. That is, the worker earns a relatively high wage compared to his productivity near retirement. In this section we first briefly discuss the problem of verifiability of worker productivity. Next, we discuss how worker effort can be stimulated in this case. The typical solution is an implicit contract between the firm and the worker where worker effort – as subjectively assessed by the firm – is rewarded by some form of deferred compensation. This may imply wages exceeding productivity for older workers.

### **2.2.1 Individual productivity and the implicit contract**

If the productivity of an individual worker can be observed without much cost, then commission or piece-rate schemes directly based on output can be used in order to stimulate effort. However, such explicit labour contracts are rare. According to Milgrom and Roberts (1992; p. 329), an employment contract : “is typically quite imprecise. The employees agree that within limits that are rarely completely described and only partly understood they will use their minds and muscles to undertake the tasks that the employer directs them to do. The employer agrees to pay the employees. The range of actions that might be requested or required is unclear.” This implicit nature of labour contracts is a consequence of several practical issues. First, workers typically perform multiple tasks. Inducing the right amount of effort for each task would require an intricate explicit labour contract, and high monitoring costs for the firm. Second, it is hard to imagine a contract which adequately defines the amount of effort to be dedicated to each task. Output-based contracts are in practice typically focused on tasks which are easiest or cheapest to measure, and this induces employees to reallocate their activities precisely towards these tasks (Holmstrom and Milgrom, 1990; Baker, 1992). Third, it is practically impossible to foresee all the events that might possibly arise over time, and unambiguously describe these events and the actions that should be taken in the explicit labour



contract. A fourth fundamental problem with output-based payment schemes is that third parties may not be able to verify the performance of individual workers, so that such schemes cannot be enforced by legal courts. That is, even if worker output is observable by the firm, then output-based payment schemes may be infeasible because of this non-verifiability problem. Apart from these practical reasons, implicit labour contracts facilitate dynamic wage incentives in order to stimulate worker productivity.

### **2.2.2 Early incentive theories**

In order to stimulate worker effort, the employer could offer a higher wage than the worker's alternative source of income and at the same time threaten him with dismissal in case he does not meet performance conditions set by the employer (Shapiro and Stiglitz, 1984). While wages are above the market clearing level, there is involuntary unemployment. The relatively high wage combined with the threat of unemployment stimulates the worker to maximize his output. Some empirical support for this theory of efficiency wages can be found in, amongst others, Krueger and Summers (1988) and Krueger (1991). However, a problem with efficiency wages is that the incentive to perform becomes smaller as the worker becomes older. From a career perspective, it is therefore more attractive for the employer to allocate the wage premium in later periods. Such a wage premium may come in several forms, e.g. occupational pension schemes, early retirement schemes, or simply a relatively high wage during the final periods prior to retirement. In a stylized model, Becker and Stigler (1974) demonstrate that a wage premium in the last period, combined with the threat of dismissal in case of detected malfeasance, is sufficient to motivate the worker over his entire career with the firm.

Such a payment scheme however only works if the employee trusts the employer that the firm's assessment takes place under fair conditions, and that the outcome is in accordance with that assessment. Legal enforcement of the payment scheme is in general not possible, because worker effort is not verifiable by third parties. In principle, the firm could thus be tempted to cheat on the worker in the last period by claiming that he has not shown enough effort, firing the worker, and keeping the wage premium for itself. Therefore, the worker will only trust the firm if it has a good reputation. In fact, in the absence of third parties, firm reputation is necessary in order to make deferred compensation schemes feasible (Bull, 1987). Next, the question arises why the firm would care about its reputation. The answer is that this can only be the case if the firm earns quasi-rents from being in business, i.e. there must be costs attached to going out of business, moving the firm's capital elsewhere, and attracting new workers (Klein and Leffler, 1981; Shapiro, 1983). The assumption that the firm cares about its reputation is a crucial element in all deferred compensation schemes. A firm with a harmed reputation will not be able to motivate its employees anymore nor attract new workers.

A deferred compensation scheme may imply that the worker is disciplined through the concept of equilibrium unemployment (as with efficiency wages). It is however often possible to construct a wage profile with a more efficient outcome. If workers earn relatively high

wages, then at least some of the unemployed are willing to pay an entrance fee in order to obtain a job. On the other hand, the firm may demand entrance fees from newly hired workers in order to cut its labour costs. It may do so without demoralizing its workers, as wages in the first period do not affect worker effort. If the probability of being caught shirking is small or if the worker's valuation of shirking is large, then paying an entrance fee may imply a net transfer from the worker to the firm during the first period. In that case, the scheme resembles a 'bonding scheme', in which the worker is required to post a 'performance bond' before work begins. Wages equal the worker's alternative plus interest on the bond. Deferred pay at the end of the contract equals the bond itself. In fact, the incentive to perform is then derived from the threat that the firm does not pay off the implicit bond to the worker. Thus, a bonding scheme does in principle not require wage premiums to stimulate worker effort.

Explicit entrance fees and performance bonds are however rarely observed in practice. The possible absence of entrance fees and performance bonds cannot be explained by liquidity constraints of workers as a result of imperfect capital markets. The argument is that whenever demanding the perfect entrance fee is not possible, the firm could still ask whatever up-front payments workers can make. It is unlikely that workers can make no payment at all, and in fact it is very simple to prove that some of them are willing to do so (Carmichael, 1985). The possibility of firm cheating – the firm may falsely claim that the worker shirks and keep the entrance fee for itself – can also not explain the lack of entrance fees, as it is assumed that firms are concerned about their reputations. This argument will however most likely imply lower entrance fees (Dickens et al., 1989). In conclusion, it appears that no convincing arguments exist for why firms should not raise entrance fees to newly hired workers. In the next subsection, we consider a wage profile with an integrated entrance fee, i.e. one which is deducted from the wages during the first years of employment.

### **2.2.3 Lazear style implicit contracts**

While the theory just discussed may e.g. explain the existence of pensions, it does not give a clear answer on what the typical wage profile would look like. We consider three issues in order to link the theory with some stylized empirical facts. First, as was already mentioned in the previous subsection, entrance fees (or performance bonds) for newly hired workers are hardly observed in practice. While it was argued that there are no sound theoretical reasons for the non-existence of entrance fees, it may be the case that entrance fees are somehow integrated into the wage profiles of workers. That is, workers are paid less during their first years of employment and their implicit performance bond is potentially paid back near the end of their careers. Second, several studies have found that relative earnings increase in time although relative performance does not. This suggests an increasing wage profile over the life-cycle. Third, it has been noted that employers often stimulate their older workers to retire. Lazear (1979) specifically pointed at mandatory retirement, which was prevalent in many sectors at that time, and to the fact that many pension schemes were actuarially unfair – that is, a financial

penalty was imposed on extending the working life once a certain age was reached. This third point suggests that older workers are paid above their productivity level.

Lazear (1979, 1981, 1983) proposed a payment scheme which connects the theory described in the previous section with these empirical facts. Lazear focuses on potential dispersions between wages and productivity, rather than between wages and alternatives (as e.g. in efficiency wage theory). In fact, he assumes that the worker's alternative is strictly less than his productivity level (prior to retirement). In the general scheme proposed by Lazear, the worker implicitly posts a performance bond in the early years of his career by accepting wages below his productivity level. Then, wages typically show an increasing pattern during the worker's career, and finally the performance bond is paid out to the worker, for instance in the form of a pension. As older workers become relatively expensive in such a payment scheme the firm needs to get rid of these older workers in order to sustain the payment scheme. This can e.g. be achieved through mandatory retirement or through a (properly devised) defined benefit pension plan. The steepness of the payment scheme is closely linked to the probability that the worker is caught shirking. A low probability typically implies a steep wage profile (relative to the productivity profile), as workers can only be deterred from shirking by the threat of losing future payments. An example of the resulting life-cycle wage profile is given in figure 2 in Lazear's article in this special issue.

A criticism on such Lazear style implicit contracts (LSICs) is that the implicit bonding solution is imperfect because young workers do not have the full incentive to perform (Akerlof and Katz, 1989). A worker who has just started his career with a firm and did not post the full bond yet may find it optimal to shirk, as he does not have that much to lose in case he is caught. A counter-argument is that LSICs may imply equilibrium unemployment similar to what was theorized in the case of efficiency wages. Another argument in favour of LSICs is that firms may offer 'entry level jobs' to young workers in order to assess their productivity. These young workers are paid below their productivity until they have posted the implicit bond, and at that point the worker can be promoted to a job where effort and output are more difficult to observe (Neal and Rosen, 2000). It has further been noted that young workers are nowadays less willing to post implicit bonds, because lifetime jobs are now quite uncommon. In that case, it will be harder for firms to offer LSICs. Finally, LSICs in an ageing workforce may imply more redistribution from young workers to old workers. We will come back to these last two issues in the concluding section of this paper.

#### **2.2.4 Tournaments**

The wage growth of workers is for an important part caused by jumps associated with promotions. For the U.S., McCue (1996) estimates that between 9 and 18% of the average within-firm wage growth over the life cycle is due to promotions. As the worker's inherent skills are likely to remain more or less constant in the short run, it is unlikely that his productivity really jumps up on promotion day with a jump equal to that in his wage (Neal and

Rosen, 2000). A possible explanation is derived from tournament theory. In a setting where the relative productivity of employees is observable, the employer may reward the worker with the highest productivity score with a bonus or promotion to a higher function, and reward the second most productive worker with the second highest bonus or promotion, etc. The number of bonuses and promotions is fixed beforehand in order to prevent the employer from cheating.

Contrary to piece rate schemes, tournament compensation schemes offer a practical solution to stimulating worker effort when individual output is non-verifiable (Malcomson, 1984; 1986). Based on the worker's relative performance the firm may rank workers on the basis of their productivity scores, and assign bonuses accordingly. Workers maximize expected utility by choosing the effort level which equates the marginal cost of effort with its marginal benefit. The marginal benefit of effort depends on (i) the marginal probability of winning, and (ii) the size of the bonus. A firm may thus stimulate effort by increasing either of the two. Most of the theoretical literature on tournaments focuses on the determination of the optimal size of the bonus (leaving the probability of winning the tournament fixed). If workers are risk-neutral, then a tournament may give the optimal incentive to perform (Lazear and Rosen, 1981). However, in the more relevant case of risk averse workers, the optimal incentive cannot be obtained by a tournament (Mookherjee, 1984). Tournaments may also serve as an incentive mechanism for workers to acquire specific capital. The firm may attach relatively high wages to jobs which require relatively much specific capital, such that workers face a bonus if they develop the appropriate skills (Prendergast, 1993).

While it is obvious that tournaments affect the wage curves of individual workers, it is difficult to predict what their precise implications are. As was argued at the beginning of this subsection, it is quite certain that promotions cause differences between wage and productivity. If a tournament consists of multiple rounds, say over  $n$  periods, then it may be optimal to keep the bonus constant at a relatively low level in the first  $n-1$  rounds and at a relatively high level in the last round (Rosen, 1986). This offers an explanation for why promotions to top ranks in firms are associated with relatively large wage increases (see Baker et al., 1994a, for some empirical evidence). Second, it may also explain why older workers have on average relatively high wages.

A drawback of tournaments compared to other payment schemes is that it can be equally rewarding for workers to sabotage the output of co-workers rather than to increase their own effort. Lazear (1989) demonstrates that the optimal bonus should be lower in that case. It is however questionable whether tournaments work if sabotage is a serious problem in the firm. A second drawback mentioned in the literature is that too large a wage dispersion within firms may be discouraging for employees. If workers perceive to be paid unfairly, they may start exerting less effort than they would otherwise (Akerlof and Yellen, 1990).

## 2.3 Alternative theories

Human capital investment and incentive contracts are not the only concepts that try to explain the relationship between life-cycle wage profiles and productivity profiles. In this section we review some alternative theories presented in the literature that can account for wage-productivity gaps of individual workers.

### 2.3.1 Collective bargaining

Trade unions are traditionally associated with the standardization of pay-setting procedures, and incremental, seniority-based wage scales in particular. This raises the question why unions often adopt seniority scales.

One strand of the literature on unions shows that unions' distributional preferences – unions pay more attention to "senior" workers' preferences – can explain various union practices, including rising seniority-wage profiles. For example, Weiss (1985) and Tracey (1986) explain the presence of rising seniority-wage profiles by assuming that "incumbents" (the older members of the union) control the union at the expense of newcomers. In such a setting, seniority wage increases are found to serve as implicit initiation fees and thus serve as one means of appropriating rents from future union members. Alternatively, union preferences may reflect the preferences of the representative worker, who simply prefers increasing wage profiles (as found by Loewenstein and Sicherman, 1991; see subsection 2.3.3).

Another strand of the literature shows that seniority rules for employment and rising seniority-wage profiles are optimal for the union, even when it is indifferent to distribution (Frank, 1985; Kuhn, 1988; Kuhn and Robert, 1989, Frank and Malcomson, 1994). This is the so-called *discriminating monopoly* approach that employs a non-uniform pricing model of union wages. With a last-in, first-out (LIFO) layoff rule, the firm cannot easily replace high-wage senior workers with low-wage junior workers. As a result, the marginal employment decision involves the low-wage junior workers. A new worker is taken on if the present discounted value of the lifetime marginal product exceeds the discounted lifetime income stream. Hiring a worker at the bottom of a steep scale is more profitable for the firm than at the constant average wage (or the wage that would prevail without a wage scale), since the firm pays the higher wage rates in the discounted future. In this way the union can extract (part of) the surplus from the firm, without distorting employment so much, as would be the case with a uniform wage. Thus, a seniority wage scale can achieve greater employment efficiency, and thereby increase the total surplus to be divided between the firm and the workers.<sup>2</sup> And, for given bargaining power, the union can achieve greater total income for the workers (Booth and Frank, 1996).

<sup>2</sup> If the union opts for greater employment efficiency with scales than in the case without scales, the present discounted value of a new worker actually decreases – as only then the firm employs more workers. The rationale for this behaviour is that the union maximizes total earnings over the working life, that is, without discounting. Or, in a static sense, it maximizes total earnings of its current members, if its members are equally distributed among seniority levels.

In both situations, with distributional preferences or with discriminating monopoly, the process of collective bargaining between the firm and its workers, as represented by the trade union, induces a shift towards a steeper wage profile. This may result in a situation in which younger workers are paid less than their productivity and older workers more than their productivity.

### **2.3.2 Insurance**

Risk averse agents derive utility from insurance against fluctuations in consumption. If financial markets cannot provide this insurance, then firms may provide it to their workers instead. For that purpose employers may offer employees a (relatively) stable wage profile. This can be efficient if the employer disposes of relevant information that an independent insurer does not (Malcomson, 1999). In addition, contracts that specify a stable wage profile shift risk from the employee to the employer. That is efficient if employers are less risk averse than employees or are better able to shift some of these risks to the capital market (Bovenberg and Teulings, 2008).

In general, a contract that is not legally enforceable will only be adhered to if it is in the interest of both parties, that is, if it is self-enforcing. In such a setting both the firm and the employee are bounded by their outside option constraints, which define their alternative opportunities in the market. A self-enforcing contract consists of a sequence of wages (and possibly a sequence of hours) such that neither party prefers to take their outside option as long as it is efficient for employment to continue. The result is that the firm provides insurance to the employee in the form of a constant real wage until the wage is either too low to prevent the employee quitting (in which case it is increased by just enough to ensure the employee stays) or it is too high to prevent the firm laying off the employee (in which case it is reduced by just enough to avoid layoff).

Contracts to insure employees' earnings have a number of characteristics that are consistent with the empirical evidence (Malcomson, 1999). For example, such contracts are consistent with earnings fluctuating less than spot market earnings of employees with identical characteristics. In addition, employees hired at different dates under different labour market conditions also have different earnings.

### **2.3.3 Worker preferences**

Many workers prefer increasing wage profiles over flat or decreasing wage profiles (Loewenstein and Sicherman, 1991; Frank and Hutchens, 1993; Neumark, 1995). Loewenstein and Sicherman (1991) offer four possible explanations for this finding. First, workers may associate wages with productivity and derive utility from a feeling of mastery when wages increase. Second, workers could anticipate a need for increased future expenditures but could experience difficulty controlling spending in early periods – a problem of self-control. Third, a preference for increasing wages (or payments) could be explained by a self-control problem combined with a utility function that depends positively on both changes in consumption and its absolute level. The fourth reason is that workers may derive utility in the present from

anticipating future consumption, again combined with the problem of self-control. Notice that the first reason implies a direct preference for wage increases, whereas the other three reasons are based upon a preference for increasing consumption. The latter explanations therefore assume that workers have a self-control problem that prevents easy transformation of decreasing payments into an increasing consumption pattern.





### 3 Empirical evidence

We present an overview of the empirical literature testing the different theories discussed in the previous section. These tests are mostly indirect, as identification problems are the rule rather than the exception. An obvious problem is that individual productivity is never observed, so that e.g. the wage-productivity gap implied by Lazear style implicit contracts (LSICs) cannot be assessed directly. Moreover, it is not straightforward to estimate life-cycle profiles of both the individual's wage and his productivity. The time span covered by longitudinal data sets is usually shorter than a life-cycle, so that profiles of different cohorts have to be compared in order to derive complete life-cycle profiles. Such comparison requires a correction for cohort effects, which can be hardly done without making some model assumptions. Another problem is endogenous selection. Workers who expect to earn low wages at old age are inclined to retire earlier than workers with a high earnings potential.<sup>3</sup> Similarly, firms wish to keep workers with high productivity, and stimulate lowly productive workers to retire. As a result, both the estimated wages and productivity of older workers are biased upward if the endogeneity is not properly taken into account. The recent development of matched employer-employee datasets has substantially increased possibilities for empirical research. Studies based on such data typically estimate production and wage equations for firms, and derive the impact of the firm's age composition on both production and the firm's wage bill. This approach can be used to test for LSICs and/or seniority wages in highly unionized sectors of industry. Studies making use of experiments have also become more popular lately. Such studies have been used to test tournament theory and the preferences of both employers and employees for non-decreasing wages.

#### 3.1 The empirical literature

An individual's productivity potential consists of his/her physical abilities, mental abilities, education, and job experience. Combined with the characteristics of the firm, these factors determine the individual's job performance or productivity. Studies in occupational medicine, cognitive psychology, and gerontology find that physical and mental fitness are deteriorating from the age of 25 onwards. Fitness indicators used in these studies include muscle strength, sight, retentiveness, cognitive ability, and other measurable indicators (for an excellent survey, see Skirbekk, 2004). Different abilities tend to follow relatively independent paths over the life cycle. Some abilities, like the performance and speed of solving new tasks, are strongly reduced at older ages, while other abilities, like verbal capacities and word fluency, remain at a high

<sup>3</sup> The income effect, according to which high income individuals are inclined to retire earlier than low income individuals, works the other way (see, e.g., Johnson and Neumark, 1996). The problem of endogenous selection stays in place in case the income effect would dominate the substitution effect.

functional level until late in life. Furthermore, training and experience can stabilize or even reverse age-specific declines in abilities.

Ideally, the individual productivity level can be observed and compared with individual wages. Accurate measurement of individual output is however only possible for a small number of professions. Examples are the quantity and quality of publications in academic research, the output of artists (measured by number of paintings, albums, books), and performance in sports activities. For instance, Oster and Hamermesh (1984) find a declining age-productivity relationship for economists at 17 American top-universities. Fair (1998) finds that running times of athletes increase almost logarithmically between the ages of 35 and 75. The author is surprised about the “slow” rate of deterioration. For instance, a man aged 85 only needs about 50% more time than a man aged 45 for running distances between 400 meters and a half marathon. Van Ours (2009) finds that running performance declines after age 40, but that the productivity of academic researchers remains quite constant at high age.

In some occupations wages do reflect productivity. Lazear and Moore (1984) compare earnings profiles between self-employed and salary workers. They find that the self-employed tend to have little earnings variation over the life cycle, suggesting that the productivity profile is relatively flat. This contrasts the increasing wages of salary workers throughout their careers. Boot (1995) studies age-earnings profiles of British workers in physically demanding jobs during the first half of the 19th century. Men reach their peak earnings in their early 30s, and wages decrease substantially from around 40 years of age. As there were few regulations in the labour market at that time, the productivity profile likely resembles this wage profile.

Such kind of studies are however rare. Most studies are not able to explicitly test for differences between wage and productivity level, simply because productivity cannot be observed. Some studies measure productivity for groups of workers or for firms as a whole. Typically, subjective assessments (Medoff and Abraham, 1980; 1981) or imperfect productivity indicators (Flabbi and Ichino, 2001) are used.

Since the 1990s many studies have used matched employer-employee data sets, including Hellerstein and Neumark (1995, 2004), Hellerstein et al. (1999), Crepon et al. (2003), Ilmakunnas and Maliranta (2005), Dostie (2006), Lallemand and Rycx (2009), and van Ours and Stoeldraijer (2010). In these studies, the impact of the firm’s worker composition on production is estimated, and this gives correlations between the firm’s age composition and its production. The same is done for the firm’s wage bill. Most studies find an inverted U-shaped work performance profile. Workers in their 30s and 40s have the highest productivity levels, while workers above the age of 50 have lower productivity levels than their younger colleagues in spite of their higher wage level. A drawback of this approach is the relatively high level of aggregation. To address this issue, Börsch-Supan et al. (2006) estimate the relation between the age structure of work teams and their productivity for a car manufacturing plant, which is approximated by the number of errors made in the production process. They find an essentially flat age-productivity profile. Overall, the evidence from this literature is mixed. Most studies

find that the firm's average productivity does not increase as much as with age as wages do. A sizeable minority of studies however does not find proof for a wage-productivity gap of older workers.

**Table 3.1 Testable implications of different theories**

Testable implication	Main finding literature
<b>Incentive theory (LSIC)</b>	
The life-cycle wage profile is steeper than the life-cycle productivity profile.	(+)
Self-employed workers have less steep wage profiles than employees.	+
The difference between pay and productivity is highest in those functions where it is difficult to observe/verify worker productivity.	+
Pensions and/or mandatory retirement are most common for those functions where it is difficult to observe/verify worker productivity.	lack of results
Mandatory retirement is related to pension provision by the firm.	lack of results
Firms are less inclined to hire older workers.	++
An unexpected takeover of the firm reduces employment of older workers.	+
The profitability of a firm is negatively related to the share of older workers in its workforce.	(+)
Individual wages rise less with tenure, the more they are based on individual output.	+
<b>Tournament theory</b>	
Promotions bring about discrete wage jumps.	+
Workers' incentives to perform result from wage differentials (not levels) between different ranks within the firm.	+
The set of promotions or bonuses is fixed beforehand.	+
Positive relation between firm productivity and within-firm wage dispersion.	+
<b>Theory on general human capital</b>	
More general human capital leads to higher wages	++
Individual wage differentials reflect productivity differentials.	(-)
Wages rise with total job market experience, but not with tenure	(-)
<b>Theory on specific human capital</b>	
Wages rise with firm tenure.	+
The individual wage profile is less steep than the productivity profile.	--
Firms provide incentives to keep workers attached, such as backloaded compensation and generous pensions.	lack of results
Firms are less inclined to hire older workers.	++
<b>Theory on collective wage bargaining</b>	
Returns to tenure larger in unionized sectors	+
Displaced workers in unionized sectors experience relatively large wage losses	(+)

A '(+)' indicates that although the literature does not provide unambiguous results, a majority of studies is in accordance with the testable implication; a '+' indicates that the literature is largely consistent with the testable implication; and a '++' indicates that the effect is well-established in the literature. The number of empirical studies is taken into account when scoring the testable implication. Similar notations are used for negative outcomes, with '(-)', '-' and '--'.

In most studies, it is not possible to determine the precise cause of divergence between wages and productivity. The sign of a divergence may obviously rule out the relevance of some theories, but it is typical that no strong conclusions can be drawn on the prevalence of e.g. incentive theory because other theories may lead to similar shapes of wage and productivity profiles.

In total, we have found about 70 empirical papers focusing on the discussed theories (see the appendix). About half of the studies focuses on the US, more than a third on European countries, and the rest on other countries (Australia, Canada, Ghana, Israel, and Japan). Empirical studies typically test one or more implications of a theory. Table 2 offers a list of the implications that have been tested most often in the empirical literature. Although there is still discussion about some of the testable implications, and some have not yet been studied well enough, the literature has already established some important results. Two of the most convincing findings are that firms are reluctant to hire older workers, and that the wage profile of workers is not less steep than the productivity profile. In the following subsection we formulate more general conclusions on the basis of these findings in the literature.

### **3.2 Main implications**

*The theory of general human capital does mostly not suffice to explain observed wage profiles.* This result was established empirically by Medoff and Abraham (1980, 1981) on the basis of personnel data from large U.S. manufacturing firms. The authors use job performance ratings done by immediate supervisors to measure the relative productivity of managerial and professional employees engaged in comparable work. They find no association (or even a negative one) between experience and relative performance, and a strong positive association between experience and relative earnings. Flabbi and Ichino (2001) confirmed Medoff and Abraham's conclusion on a sample of non-managerial employees of a large Italian bank, extending the analysis by considering alternative measures of productivity. Other studies confirming that wages do not necessarily reflect productivity are Bishop (1987) and Kotlikoff and Gokhale (1992).

Of course, general human capital still remains an important factor. Many empirical studies do find a positive effect of general labour market experience on individual wages, which is an important indication for the relevance of general human capital. Results from three important studies even imply that most wage variation can be attributed to differences in general human capital (Altonji and Shakotko, 1987; Abraham and Farber, 1987; Hellerstein et al., 1999). Although Altonji and Shakotko (1987) do find a small positive tenure effect on individual wages, their main conclusion is that "general labor market experience accounts for the lion's share of wage growth during a career". In addition, Yamaguchi (2007) finds that the wage growth of American higher educated workers (college graduates) is primarily driven by general skills, and that firm-specific human capital does not play an important role for this category.

The reverse is found for high school graduates. However, Beffy et al. (2006) establish precisely the opposite result for French data.

Practically all studies which have been published during the 1990s and 2000s – typically using better data and/or better estimation techniques than the early studies by Altonji and Shakotko (1987) and Abraham and Farber (1987) – agree that individual wages are simultaneously driven by other factors than general human capital.<sup>4</sup> Thus, at present there does not seem to be much controversy over our first conclusion: besides the theory of general human capital, at least one other theory is relevant in explaining individual wage profiles.

*Tenure with the firm affects the wage rate, but there is controversy over the magnitude of this effect.* A large body of empirical research has focused on obtaining estimates for the returns to experience (time spent in the labour market) and tenure (time spent in the firm). It is often thought that the return to labour market experience is closely related to the return to general human capital, and the return to tenure is closely related to specific human capital. As was mentioned in the previous conclusion, some authors – in particular Altonji and Shakotko (1987) and Altonji and Williams (1997) – believe that the returns to firm tenure are only modest. On the contrary, a number of other studies, such as Topel (1991), find a strong positive relationship between wages and tenure.

Using longitudinal matched employer-employee data for France, Abowd et al. (2006) find that the average structural returns to tenure are close to zero. However, this masks an enormous amount of heterogeneity in firm compensation, promotion and retention policies adopted by firms. The main contrast is between high-wage, low-mobility firms where returns to tenure are low (even negative) and low-wage, high-mobility firms where returns to tenure are relatively high. Beffy et al. (2006) also find different results for subgroups, ranging from no returns to tenure for high school drop-outs to very high returns to tenure for college graduates. The authors also find higher tenure effects for the US than for France. The rationale is that US firms aim to reduce their relatively mobile workers, while French firms do not need to reward tenure in order to keep their (relatively immobile) workers at the firm.

It should be noted that tenure effects do not necessarily imply that specific human capital is relevant. Other theories, such as Lazear's agency theory do also imply that individual wages rise with firm tenure. For instance, Abowd et al. (1999) find that their (positive) returns to tenure are negatively correlated with firm-specific intercepts in the compensation relation, which is consistent with Lazear's theory rather than the theory of specific capital. One should thus take care not to confuse a significant tenure effect with 'proof' of the relevance of specific human capital.

*The accumulation of firm-specific capital is important in some firms and at certain education levels.* Firm-specific capital is never directly observed, and is not necessarily a part of the

<sup>4</sup> This includes the studies by Altonji and Williams (1997) and Hellerstein and Neumark (2004).

workers' wages. This severely hampers the task of testing the specific capital model. In addition, while the specific-capital model is able to explain a core set of facts about worker mobility, it also appears that worker heterogeneity can account for much of what we observe in the mobility data. These results and considerations induce Farber (1999) to conclude that, while deriving convincing direct evidence for the specific capital model is difficult, it appears that specific capital is a useful construct for understanding wage dynamics and worker mobility. In addition, Malcomson (1999) concludes that "models of hold-up look promising candidates for providing rigorous theoretical foundations for at least some of the observed behaviour of wages. These models are, however, too new for the empirical studies drawn on in the discussion to have been designed with them in mind and so those empirical studies have not tested their predictions at all rigorously." Almost a decade ahead since Malcomson's conclusion, it still looks early to draw a final conclusion on the precise relevance of specific human capital and its impact on individual wages.

This is not to say however that empirical research has halted since, on the contrary. Recently, a number of studies have made use of the large administrative French panel data set 'DADS', and linked these individual employee records to employer data. On the basis of these data, Beffy et al. (2006) interpret their significant tenure effects as an indication for the relevance of firm-specific capital. In addition, the authors find much heterogeneity among different educational categories.<sup>5</sup> They find that in particular university graduates have very high returns to tenure. On the other hand, only small tenure effects are found for high school drop-outs. Thus, following the authors' reasoning, there is substantial heterogeneity among educational categories concerning the relevance of specific human capital. Using the same data set, Dostie (2005) however concludes that "[f]irm-specific capital does not seem to be important, and human capital would be easily transferable from firm to firm." He bases this conclusion on the finding that the average tenure effect can entirely be related to selection on the basis of unobserved characteristics of both workers and firms. The author does however not allow for heterogeneous tenure effects for different levels of education.

Similar to Beffy et al. (2006), Dustmann and Meghir (2005) also find substantial heterogeneity among different educational groups in Germany, but reach an opposite conclusion, viz. that firm-specific human capital is more relevant for unskilled workers (including high school drop-outs) than for skilled workers. Similar results are found for the US. In a recent study, Buchinsky et al. (2005) find large returns to tenure for all education groups. They find that the cumulative return to tenure is relatively high for the least educated, which leads the authors to conclude that a larger share of their human capital is firm-specific. Using

<sup>5</sup> In an earlier study based on the same data set, Abowd et al. (1999) also find substantial heterogeneity in the returns to tenure, although not necessarily related to education.

another data set, Yamaguchi (2007) also finds significant returns to tenure for lower educated workers, but none for college graduates.

There also appears to be considerable variation in the return to tenure across firms (Abowd et al., 1999; 2006). This suggests that firm-specific human capital may be relevant in some firms and irrelevant in others.

Many authors seem to agree that the relation between tenure effects and specific capital is more relevant in the US than in France – or continental Europe in general – as American workers are more mobile, and thus need to be stimulated to stay with the firm for a longer period in order to generate returns to specific capital investments made by the employer (Buchinsky et al., 2005; Beffy et al., 2006).

*A majority of papers supports the relevance of Lazear style implicit contracts.* For countries other than the US, results in 18 out of 21 studies are consistent with implications from the theory of Lazear style implicit contracts (LSICs). For the US this holds in 8 out of 15 studies. Thus, there appears to be more controversy in the US than in other countries over the prevalence of LSICs. From a theoretical point of view this can be considered quite remarkable, as Employment Protection Legislation (EPL) in the US is generally less strict than in European countries. It was seen in the previous section that the threat of dismissal is an essential element in LSICs: deferred compensation can only function as an incentive for the individual worker if he runs the risk of missing out on it in case he is detected shirking. Theory thus predicts that LSICs are likely to be less relevant in countries with strict EPL.

It is virtually impossible to test Lazear's theory directly. As was expounded in the previous section, deferred compensation schemes can only be optimal in cases where worker effort is not verifiable by third parties. This means that researchers also have a hard time observing worker effort and productivity. In fact, the more precise the data on individual worker effort or productivity, the less likely it is that Lazear style implicit contracts (LSICs) play a role. Therefore, most papers rely on indirect evidence. In particular, many studies have tested whether individual wage profiles are steeper than productivity profiles (a.o. Lazear and Moore, 1984; Hutchens, 1987; Abowd et al., 1999; Lazear, 2000). Other authors have focused on the issue of mandatory retirement (Lazear, 1979; Clark and Ogawa, 1992). Both papers examine whether an early mandatory retirement age is associated with a steep earnings profile (and vice versa), and indeed find that this is the case. This is in accordance with Lazear's theory.

Some of the best-known studies producing favourable results for LSICs are Lazear and Moore (1984), Hutchens (1987), Kotlikoff and Gokhale (1992), and Hellerstein and Neumark (2004) for the US; Crepon et al. (2003) for France; and Dostie (2006) for Canada. In addition, Huck et al. (2004) provide some experimental evidence on the link between deferred compensation schemes and worker effort by performing tests on a sample of 60 British university students. They propose a three-period compensation scheme based on the Lazear

model, and find that this scheme indeed stimulates life-time worker effort in 70 percent of cases.

Some of the more critical studies – both on data from the US – are Brown (1989), who finds that virtually all within-firm wage growth can be attributed to productivity growth, and Hellerstein et al. (1999), who find that interpersonal wage differentials do generally reflect productivity differentials.

*The observed wage profiles of individual workers cannot be fully explained by either deferred compensation or specific human capital theory.* The relevance of the different theories clearly depends on the setting. LSICs are more likely to be relevant in jobs where worker output is difficult to verify, and the accumulation of specific capital is obviously more relevant in jobs which require specific skills. On the other hand, several authors have shown that even within a given firm multiple theories are needed in order to understand the observed individual wages. According to Baker et al. (1994b), wage changes cannot be entirely explained by either incentive theory, on-the-job-training (specific capital), or firm learning about the employee's innate ability. Seltzer and Merrett (2000) find that both incentive theory and the theory of specific human capital are the cause of tenure effects in individual wages. We therefore postulate that it is the rule rather than the exception that the wage formation of individual workers involves at least two different theories.

The accumulation of specific human capital may be most relevant for younger workers, and LSICs may be most relevant for older workers. This proposition is confirmed in the case studies by Seltzer and Merrett (2000), who use a long panel data set of white collar workers at an Australian bank, and Shaw and Lazear (2007), who use a panel of workers in an American windshield installation firm. In addition to these studies, many other findings are implicitly consistent with this complementary role for specific human capital and incentive theories. For instance, in studying the growth of wages of young workers (up to the age of 35) in Germany, Dustmann and Meghir (2005) find that returns to (firm) tenure during the initial five-year period at the firm equal 4% per year for unskilled workers and 2% for skilled workers. However, no additional returns to tenure are found after these five years.

*Tournament theory is relevant.* Of those empirical studies focusing on the relevance of tournament theory, not one single study was able to reject any implication by this theory. The influential studies by Baker et al. (1994a; 1994b) conclude that none of the major theories alone can explain the wage policy of a certain medium sized US firm in the service industry. In the second place, many of the firm's wage policies turn out to be consistent with tournament theory. Amongst others, the authors find that promotions bring discrete salary premiums, and that these are especially high for the highest job levels; and that the firm a priori determines a set of rewards that the workers have to compete for. It should however be mentioned that most empirical evidence is derived from US data from the 1970s and 1980s. Moreover, this research



typically focuses on the wage policy of one single firm, which of course needs not be representative for other firms. It is very likely that tournament theory is more relevant in one firm than in the other, in particular it should be relevant in those firms where the relative productivity of individual workers can be observed (and not the absolute productivity level). Experimental evidence shows that bonuses outperform piece-rate schemes in case productivity is multi-dimensional (Fehr and Schmidt, 2004), and that effort increases with the prize spread (Harbring and Irlenbusch, 2003). An early experimental study by Bull et al. (1987) concludes that although results are on average supportive of tournament theory, there is much heterogeneity in individual behaviour. Additional experimental evidence concludes that tournaments may attract specific types of workers, in particular over-confident, selfish, and less risk averse workers compared to other payment schemes (Dohmen and Falk, 2006). Firms may either stimulate or curb such self-selection through their tournament design.

*Wages rise more with seniority in unionized sectors.* In a study of British panel data, Booth and Frank (1996) find that, for unions with seniority scales, the union wage differential is increasing with seniority. This is not the case for unions without seniority scales. Using an extended British panel data set, Zangelidis (2008) reports that seniority-earnings profiles appear to be steeper in the union sector, while occupational expertise (as opposed to mere tenure) is estimated to have a more significant role in non-union jobs. The results in Abraham and Farber (1988), Kuhn and Sweetman (1999), Ballou and Podgursky (2002), and Williams (2009) also support this conclusion.

*Workers prefer stable wages, and this may lead to a wage-productivity gap at old age.* Many workers derive positive utility from receiving an increasing sequence of payments, and negative utility from a decline in payments. This preference appears to be independent of the consumption levels that could be attained through this stream of income (Loewenstein and Sicherman, 1991). According to managers, one of the main reasons for avoiding pay cuts is morale damage. In Kaufman (1984), firms were asked if they could find qualified personnel at less than current wages, and if so, what prevents the firm from cutting wages. The most common response to the last question was that wage reductions would upset workers and reduce their work effort. According to Bewley (1999), wage cuts affect worker morale, whereas wage increases do not. The reason for this dissimilarity is that workers quickly get used to increases, and grow to believe they have a right to them. The past wage is used as a reference wage from which the 'fairness' of the current wage is inferred. Many studies indeed find that workers' concerns about fairness and relative wages partly explain why firms prefer not to cut wages during recessions. For instance, the experimental evidence in Fehr and Falk (1999) shows that employers refuse to offer low wages to their workers. A lower wage would damage work effort. Blinder and Choi (1990) report that 53% of the personnel managers found the idea of an implicit insurance through stable wages 'somewhat plausible' or 'relevant'.



## 4 Conclusion

This paper reviews theory and empirical evidence on the discrepancies between wage and productivity profiles, with a focus on older workers. One major conclusion is that considerable heterogeneity among firms and workers renders it impossible to derive general conclusions on the appropriate theory to explain such discrepancies. Indeed, the relevance of theories may differ across countries, sectors, firms and individuals and may depend on various factors, such as education, mobility, age, and the institutional environment. Despite these differences, we draw some lessons from the literature.

Theories emphasizing specific human capital are able to explain why firms employ older workers but hardly ever hire them. The evidence grants support to this theory and it seems particularly important at the early stages of careers. However, its precise relevance is still subject to debate. In the empirical literature, there are strong indications that this theory alone cannot explain the wage patterns of older workers, and that at least one other theory should be added to allow for proper explanations of wage profiles. For instance, studies allowing for both specific human capital and deferred payment schemes gain some support. Moreover, theories that emphasize insurance, collective bargaining, and workers' preferences also receive some support from the data. Hence, it is unlikely that just one theory explains the wage-productivity gap for all older workers.

Different theories arrive at different outcomes regarding the optimality of wage profiles. In some theories, a wage-productivity gap is socially desirable, especially when firms and workers find it optimal to conclude such a payment scheme without imposing external costs on others. In principle, this is the case in, for instance, Lazear style implicit contracts, worker preferences theory, and insurance theories. However, deferred compensation schemes may be inefficient if they aggravate problems of liquidity constrained young households or discourage job-to-job mobility at old age. Moreover, wage bargaining theories emphasize inefficiencies of wage contracts due to monopsony power of trade unions. As a result, the normative implications of the different theories may differ importantly.

In the coming years, we will see how various trends will affect wage profiles for elderly workers. For instance, an ageing population may induce pressure on too large discrepancies that involve an implicit transfer between generations. Moreover, technological shocks or dynamic adjustment due to globalization can make it more costly to have large discrepancies between wage and productivity at old age.

The empirical literature has quickly grown in size recently, but there still remain some important questions. First, there is still some controversy over the precise shape of the life-cycle wage profiles of individual workers. Most data sets are simply too short to cover an entire life-cycle, and therefore most studies have had to make identifying assumptions on cohort effects in order to determine the wage profile of an individual worker. It will become possible in the near future to estimate more precise life-cycle wage profiles as longer data sets become available. A

second line of future research could link employer-employee matched data sets to subjective employer assessments as a proxy for individual productivity. Current studies often link workers' wages to average firm productivity, which is in fact quite a crude way to assess wage-productivity gaps for workers within specific age groups. A more disaggregated approach partly based on subjective data could yield more precise knowledge, and would in any case learn something on deviations between wages and the employer's perceived productivity. Finally, some more research is needed on the complementarities of different theories. Much empirical research still shows a tendency to focus on one particular theory, whereas the interplay between the different theories appears quite important. For instance, deferred compensation schemes may be less attractive for the employer if employment protection of older workers is relatively strong. Once we know more on such interactions, the relative importance of the different theories discussed in this article will be better understood.

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**Appendix A Overview of empirical studies**

No.	Study	Country	Data
1	Tsuru (2007)	Jap	large Japanese auto sale firm, 1995-2004, reform in 2000
2	Fukao et al. (2006)	Jap	panel of 36,905 manufacturing firms with matched workers, 1993-2003, Census of Manufacture (CM) and BSWS
3	Tanaka (2001)	Jap	repeated cross-section of male employees from all sectors, 1980-1994 (BSWS)
4	Ohkusa (1997)	Jap	cross-section of 30,413 employees and 4679 self-employed workers, 1992 (BSES)
5	Clark and Ogawa (1992)	Jap	repeated cross-section of about 6,000 firms, with matched male workers, 1981 and 1986 (Survey on Employment Management and BSWS)
6	Hashimoto and Raisian (1985)	US and Jap	cross-section of male workers in nonagricultural private industries, cell means for Japan, 1980 (BSWS), individual observations for US, 1979 (CPS)
7	Levine (1993b)	US and Jap	cross-section of 3,529 male workers from 80 manufacturing plants, 1982-1983
8	Shaw and Lazear (2007)	US	panel of 3,707 workers in 1 firm (windshield installation), 1994-1995
9	Yamaguchi (2007)	US	panel of white males aged 17-35, 593 high school graduates, and 478 college graduates, 1979-2004 (NLSY79)
10	Montizaan et al. (2007)	US	panel of 4,549 men, 1966-1983 (NLSOM)
11	Buchinsky et al. (2005)	US	panel of about 4,000 heads of households, aged 18-65, 1975-1992 (PSID)
12	Hellerstein and Neumark (2004)	US	cross-section of 20,056 manufacturing plants, and 522,802 matched workers, 1990 (DEED)
13	Balan (2003)	US	panel of male heads of households, full-time non-union workers employed in private sector firms, aged 25-54, 1981-1992 (PSID)
14	Hu (2003)	US	repeated cross-section of 11,113 workers aged 20-65, 1979-1993 (CPS)
15	Grant (2003)	US	panel of 23,132 private sector workers, 1966-1998 (NLS)
16	Kawaguchi (2003)	US	panel of 2,715 white men, 1985-1998 (NLSY79)

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**Appendix A Overview of empirical studies (continued)**

No.	Main finding(s)	Rationale or implication
1	shift from a tenure-oriented payment scheme towards a performance-oriented scheme brought a slight improvement in individual productivity	the incentive effect of a performance oriented scheme is more important than human capital theories
2	the wage-tenure profile is steeper than the productivity-tenure profile	consistent with (implicit) incentive theory
3	positive tenure effect on wages; effect is however becoming less important in later years	investments in specific human capital
4	productivity profiles are less steep for self-employed than for employed workers; but no difference for small firms	LSIC rejected; accumulation of firm-specific human capital seems to be important
5	an increase in the age of mandatory retirement reduces the rate of growth of earnings with job tenure	incentive theory is more relevant than human capital theory
6	both earnings-tenure and earnings-experience profiles are more steeply sloped in Japan than in the US	consistent with (a.o.) the theory of specific human capital and incentive theory; not clear which theory is more important
7	plants with high returns to tenure do not provide above-average levels of training, and do not face lower turnover; high levels of on-the-job training do not imply lower turnover	at odds with human capital theory
8	during two initial years on the job, the pay profile is flatter than the output profile; wages rise faster than productivity as workers get older	evidence supports both firm-specific investments (when young) and incentive pay (when older)
9	returns to tenure very low for college graduates, and relatively high for high school graduates; significant returns to general experience	specific human capital seems to be relevant for high school graduates, not for college graduates
10	workers with firm-specific training retire at an earlier age than workers with a general training background	indication that firms using much specific capital bond their workers by offering deferred compensation
11	returns to tenure are even larger than in Topel (1991); returns to experience are much higher for college graduates than for lower levels of education	specific human capital is an important factor
12	wage and productivity profiles are rising and concave; estimated relative wage profile is steeper than relative productivity profile	consistent with (implicit) incentive theory
13	some evidence that the formation of LSIC's between firms and new entrants into the labour market has declined (or ceased)	the costs associated with LSIC's have increased (which is related to the ban on mandatory retirement), while benefits have decreased
14	sizeable tenure effects, ranging from 20 to 40% per 20 years, for small and large firms, respectively	specific capital seems to be important
15	both the contemporaneous unemployment rate and the lowest unemployment rate since being hired affect wages	partial wage insurance against negative labour demand shocks, partial wage responsiveness to current labour market conditions
16	self-employed wages are closer to productivity levels; they have a higher level of initial human capital, and invest less in human capital	in accordance with findings of Lazear (1984), but lower human capital investments by self-employed explain results (rather than LSIC)

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**Appendix A Overview of empirical studies (continued)**

No.	Study	Country	Data
17	von Wachter (2002)	US	cross-sections of male employees aged 55-75, 1968-2000 (CPS), data on mandatory retirement imputed from RHS and NLS
18	Stern and Todd (2000)	US	panel of 2,497 men, 1966-1983 (NLS)
19	Hellerstein et al. (1999b)	US	cross-section of 3,102 plants (WECD), and 128,460 matched workers (LRD)
20	Parent (1999)	US	panel of 5,649 young workers, 1979-91 (NLSY)
21	Loewenstein, Spletzer (1999)	US	panel of 4,814 individuals, 1993-1994 (NLSY) and a survey of 1,527 employers, 1982 (EOPP), data are not matched
22	Altonji and Williams (1997)	US	panel containing about 10,000 observations (depending on sample selection), 1968-1991 (PSID)
23	Johnson and Neumark (1996)	US	panel of 2,767 male employees aged 45 and over, 1966-1983 (NLSOM)
24	Gokhale et al. (1995)	US	panel of 133 employers, 1980-1991 (Community Salary Survey)
25	Knoeber and Thurman (1994)	US	panel of 75 broiler chicken growers, 1981-1985
26	Baker et al. (1994a)	US	panel of over 5,000 employees in a medium-sized firm in a service industry, 1969-1988
27	Baker et al. (1994b)	US	panel of over 5,000 employees in a medium-sized firm in a service industry, 1969-1988
28	Kaestner and Solnick (1992)	US	cross-section of 13,566 white male employees from a large manufacturing company, 1980-1983
29	Kotlikoff and Gokhale (1992)	US	panel of 5,598 workers in one (anonymous) large firm, 1969-1983
30	Topel (1991)	US	panel of 1,540 white male employees, aged 18-60, 1968-1983 (PSID)
31	Brown (1989)	US	panel of 995 heads of households, 1976-1984 (PSID)
32	Abraham and Farber (1987)	US	panel of 1,537 male heads of households with non-union jobs, aged 18-60, 1968-1981 (PSID)
33	Altonji and Shakotko (1987)	US	panel of 2,163 white male heads of households, aged 18-60, 1968-1980 (PSID)



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**Appendix A Overview of empirical studies (continued)**

No.	Main finding(s)	Rationale or implication
17	mandatory retirement does not affect wage profiles, it also does not affect job tenure	seems at odds with Lazear's theory on implicit contracts and mandatory retirement
18	positive correlation between mandatory retirement and pension provision; however, employees retire earlier under a mandatory retirement scheme	the second finding is not consistent with Lazear's theory on mandatory retirement
19	wage differentials between different types of workers generally reflect productivity differentials	not in accordance with LSIC; consistent with the general human capital model
20	substantial returns to on-the-job training; general training is fully reflected in higher wages; however, returns on specific investments are fully captured by the firm; workers do not appear to bear the costs of general investments through lower (initial) wages	consistent with human capital theory; may seem surprising that workers do not capture any of the returns on firm-specific capital
21	most employer-provided training is general; employers often extract some of the returns to general training	role of specific human capital seems to be limited
22	returns to tenure are modest, around 1% per year	modest role for specific capital accumulation
23	some wage decline is found for workers aged 63 and above, but this appears to be largely related to the Social Security system	seems inconsistent with general human capital theory; alternative theories seem to play a role
24	hostile takeovers reduce the relative employment of older workers, and reduce the steepness of wage-seniority profiles	consistent with (implicit) incentive theory
25	growers respond to prize differentials, not prize levels; less able growers adopt riskier behaviour	consistent with tournament theory
26	promotions bring discrete salary premiums; these premiums are especially high for the highest job levels; in explaining wage variance, job levels have much more explanatory power than human capital variables	consistent with tournament theory
27	the firm determines a set of nominal rewards that employees have to compete for; individual rewards are based on recent (not past) performance	consistent with tournament theory
28	promotions have as much impact on wage growth as seniority; returns to seniority increase with firm position (rank); however, relative returns do not increase	consistent with incentive theory; inconsistent with human capital theory
29	productivity falls with age; compensation first lies below and then exceeds productivity; discrepancy between compensation and productivity is highest for functions where it is difficult to observe productivity	consistent with incentive theory
30	returns to tenure are substantial, 10 years of job seniority raises the wage by more than 25 percent	specific human capital is an important factor
31	firm-specific wage growth occurs almost exclusively during periods of on-the-job training	within-firm wage growth is mainly determined by productivity growth, no evidence that (implicit) contractual considerations imply wage growth
32	small return to seniority, about 0.25% (blue collar jobs) or 0.5% (white collar jobs) per year; positive correlation between job duration and earnings	the role of incentive theory seems to be limited; results are consistent with efficiency wage models
33	wages increase with total job market experience, but are only weakly positively related to tenure on the current job	general human capital accumulation is important determinant of wage growth; specific capital does not seem to be important

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**Appendix A Overview of empirical studies (continued)**

No.	Study	Country	Data
34	Hutchens (1987b)	US	cross-section of 2,852 older men, 1971 (NLS and DOT)
35	Rumberger (1987)	US	survey of ~1,500 workers (1969 Survey of Working Conditions; 1973 and 1977 Quality of Employment Surveys)
36	Murphy (1986)	US	panel of 1,488 CEO's in 992 firms, 1974-1985 (Forbes magazine)
37	Lazear and Moore (1984)	US	cross-section of 11,987 male nongovernment workers, of which 15% self-employed, 1977 (CPS)
38	Leigh (1984)	US	panel of men aged 45 and older, 1966-1981 (NLS)
39	Medoff and Abraham (1980)	US	panel of 7,606 full-time employed, white, male, managerial and professional employees at two large manufacturing companies, 1971-1977
40	Medoff and Abraham (1981)	US	panel of 7,547 full-time employed, white, male, managerial and professional employees at a large manufacturing corporation, 1972-1977
41	Bull et al (1987)	US	experiments using 24 students (economics) per treatment
42	Abraham and Farber (1988)	US	panel of 1,382 male heads of households, unionized and non-unionized, aged 18-60, 1968-1980 (PSID)
43	Ballou and Podgursky (2002)	US	panel of 502,000 teachers, 1986-1998 (DOD)
44	Kuhn and Sweetman (1999)	US	4 samples (USDWS, CDWS, COEP, OML) of men, aged 20-64, not self-employed, in different years (resp. 1994 and 1996, 1986, 1993, 1982)
45	Dustmann and Meghir (2005)	Ger	panel of 32,913 young male workers (age 15-35), German Social Security Records, 1975-1995 (IAB)
46	Harbring and Irlenbusch (2003)	Ger	experiments using 36 students (different disciplines) per treatment
47	Dohmen and Falk (2006)	Ger	experiments, total of 240 students
48	Williams (2009)	UK	panel of male employees aged 18-60, 1991-2001 (BHPS)
49	Sessions and Theodoropoulos (2008)	UK	repeated cross-section of 30,848 British workplaces, 1998 and 2004 (WERS)
50	Daniel and Heywood (2007)	UK	survey of 900+ British workplaces with at least 10 employees, and matched employee data, 1998 (WERS)

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**Appendix A Overview of empirical studies (continued)**

No	Main finding(s)	Rationale or implication
34	jobs with repetitive tasks (easy to monitor) have relatively low wages, short job tenures, lack of pensions, and less mandatory retirement	consistent with Lazear style implicit contracts
35	schooling in excess of that required in the job is rewarded at a lower rate than required schooling	human capital is not fully reflected in wages
36	upward sloping experience-earnings profiles are found; relation between pay and performance is strongest during initial years as CEO and during early years with the firm	the last two findings are inconsistent with incentive theory; the authors favour theory that ceo ability is initially unknown, but revealed over time
37	wage growth for hired workers exceeds that for self-employed workers	incentive theory can explain the steeper profile, under the assumption that human capital accumulation is equal for both categories
38	both specific training and vested pension benefits are directly related to mandatory retirement; unionisation has also a strong impact on mandatory retirement	the prevalence of mandatory retirement can for a large part be explained by the theory of specific human capital (in addition to incentive theory)
39	there is a strong positive association between relative earnings and experience, and no association or even a negative association between experience and relative performance	results are at odds with human capital interpretation of experience-earnings profile
40	the earnings rise with experience cannot be explained by higher productivity; the relative performance of more experienced workers even deteriorates	results are at odds with human capital interpretation of experience-earnings profile
41	theory explains average behavior in tournaments reasonably well; however there is a large variance of behavior across identical tournaments	evidence supports tournament theory
42	the return to seniority in the union sector is larger than in the nonunion sector	evidence supports collective bargaining theory
43	unions raise the returns to tenure	evidence supports collective bargaining theory
44	unionized workers experience much greater wage losses than other displaced workers	evidence supports collective bargaining theory
45	wages of skilled workers grow with experience, in particular during the first three years; modest return to tenure during the first 5 years; wages of unskilled workers grow with experience during the first two years, and returns to firm tenure during the first 5 years are large	specific human capital theory is relatively more important for unskilled workers; skilled workers' human capital is largely transferable
46	effort increases with the prize spread; variability of behavior decreases with the number of winner prizes	evidence supports tournament theory
47	output is much higher in the variable pay schemes (piece rate, tournament) compared to the fixed payment scheme; this difference is largely driven by productivity sorting	evidence supports incentive theories
48	tenure plays a modest role; heterogeneity is very important; tenure effect seems to be related to union coverage	evidence supports collective bargaining theory; specific human capital seems to be of minor importance
49	increased worker monitoring is negatively related to the slope of the wage-tenure profile	incentive theory drives the wage-tenure profile rather than human capital considerations
50	firms which defer compensation are less inclined to hire older workers; firms requiring specialised training are somewhat less inclined to hire older workers	robust evidence in favour of strategic compensation back-loading; weak evidence for the role of training

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**Appendix A Overview of empirical studies (continued)**

No.	Study	Country	Data
51	Devereux and Hart (2007)	UK	panel of about 180,000 full-time workers (NESPDP)
52	Beffy et al. (2006)	Fra	panel of 86,651 employees, 1976-1995 (EDP/DADS)
53	Dostie (2005)	Fra	panel of 989,215 employment spells in full-time jobs in the goods and services sector, 1978-1996 (EAE/DADS)
54	Dygalo and Abowd (2005)	Fra	panel of 332,246 private sector firms, and 813,633 matched workers, 1976-1996 (DADS)
55	Crepon et al. (2003)	Fra	panel of 77,868 firms, and over 3 million matched workers, 1994-1997 (BRN/DADS)
56	Cingano (2003)	Italy	repeated cross-section of 1,320 workers in the manufacturing sector, maximum age 37, 1975-1997 (INPS)
57	Flabbi and Ichino (2001)	Italy	panel of 10,809 employees from a large bank, 1989-1995
58	Lallemand et al. (2007)	Bel	cross-section of 34,969 workers and 1,498 firms, 1995 (SES and SBS)
59	Gelderblom et al. (2006)	Neth	cross-section of 3,223 firms, 2000 (OSA)
60	Dohmen (2004)	Neth	panel of (all) 17,610 workers at an aircraft manufacturer (Fokker), 1987-1996
61	van Ours, Stoeldraijer (2010)	Neth	panel of almost 13,941 firms with more than 4 employees, 2001-2005 (SSB, GBA, ABR, PS)
62	Bayo-Moriones et al. (2004)	Esp	interview with 734 plant managers in the manufacturing industry, concerning blue-collar workers, 1997
63	Haegeland and Klette (1999)	Nor	panel of 7,122 manufacturing plants with at least 5 employees, with matched worker data, 1986-1993
64	Barth (1997)	Nor	cross-section of 2,321 workers in 549 private-sector firms, 1989
65	Daveri and Maliranta (2007)	Fin	panel of 1,104 manufacturing plants from the forest, industrial machinery, and electronics sectors, with matched workers, 1995-2002 (FLEED)
66	Ilmakunnas, Maliranta (2007)	Fin	panel of 18,848 firms with 405,000 matched employees, 1995-2003 (FLEED)
67	Dostie (2006)	Can	panel of 5,500 Canadian firms, and 78,864 matched workers, 1999-2002 (WES)

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**Appendix A Overview of empirical studies (continued)**

No.	Main finding(s)	Rationale or implication
51	the spot market has a predominant influence on wages, i.e. wage rigidity seems to be limited	relevance of implicit contracts seems to be limited
52	returns to tenure range from close to zero (high school dropouts) to substantial (2.5% a year for college graduates); returns are significantly lower than in the US	returns to tenure are used as an incentive device to keep immobile workers at the firm; specific human capital is thus an important factor
53	returns to tenure are very small, and even negative for first few years	supports job search and job matching as determinants of wage level and wage growth; firm-specific capital seems to be unimportant
54	productivity rises faster than earnings during the initial years of an employment spell; however, the earnings profile is steeper in the longer run, and slopes upward even when productivity declines	authors regard results supportive of theory that workers prefer increasing earnings profiles; not human capital or incentive theories
55	wage profile steeper than productivity profile; productivity and experience are not related above age 35	human capital theory of little use in explaining wage formation above age 35; incentive theory might be
56	high returns to tenure	supports human capital theory
57	productivity is not the driving force of the observed upward sloping wage/seniority profiles; however it might be for low level jobs	incentive theory might be (part of) the reason
58	positive relationship between within-firm wage dispersion and firm productivity; stronger effect for firms with (i) many blue-collar workers and (ii) high degree of monitoring	in line with the 'tournament' models
59	wages do not follow the sharp drop in relative productivity after age 55; young workers are paid more than their productivity	incentive theory; stimulate firm-specific capital accumulation by young workers
60	performance determines the steepness of individual wage-tenure profiles	upward-sloping tenure profiles reflect both deferred compensation and improvements in productivity
61	small wage-productivity gap for older workers	incentive theory might be (part of) the reason
62	firms that offer seniority-based pay are less likely to employ piece rates, less likely to invest in monitoring devices, more engaged in long relationships	support to (implicit) incentive theory
63	experienced workers are paid more than their relative productivity; workers with less than 15 years of experience are underpaid	support to (implicit) incentive theory
64	support for tenure effect, but it is however negligible for piece-rate workers; employees with much firm-specific human capital have less steep wage profiles	support to (implicit) incentive theory; no support for the (specific) human capital explanation of seniority wages
65	productivity and wage profiles differ in the electronics sector; the discrepancy is mainly by tenure; in 'average' industries both productivity and wages keep rising, either with tenure (forest) or with experience (industrial machinery)	consistent with the deferred compensation hypothesis for high-tech plants but not for the other industries; inconsistent with human capital theories
66	unlike other labour flows, separations of older workers (50+) has a strong positive impact on profitability, in particular in the manufacturing ICT industry	consistent with the deferred compensation hypothesis, and with older workers having more bargaining power than others (e.g. as result of EPL)
67	productivity is diminishing faster than wages for workers aged 55 and over; in particular for men with at least an undergraduate degree	incentive theory might be (part of) the reason

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**Appendix A Overview of empirical studies (continued)**

No.	Study	Country	Data
68	Seltzer and Merrett (2000)	Aus	panel of 950 white-collar workers at a bank (Union Bank of Australia), 1850s-1940s
69	Serneels (2005)	Ghana	cross-section of 666 workers and 82 firms, 2000 (Ghana Manufacturing Enterprise Survey)
70	Hellerstein and Neumark (1995)	Israel	cross-section of 933 firms, 1988 (Industrial Survey and Survey of the Labor Force in Industry)

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**Appendix A Overview of empirical studies (continued)**

No.	Main finding(s)	Rationale or implication
68	wage grows with tenure; important late-career wage growth, and mandatory retirement	evidence supports both firm-specific investments (when young) and incentive pay (when older)
69	wage and productivity profiles are similar in small and non-unionized firms; wage profile steeper in large and unionized firms	human capital theory important in small firms; contract theory more relevant in institutionalized environments
70	both earnings and productivity profiles upward sloping; they are statistically indistinguishable	most consistent with the general human capital model; however other theories cannot be rejected

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