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MPIDR WORKING PAPER WP 2003-028
AUGUST 2003

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Age and Individual Productivity:

A Literature Survey

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The support of the International Institute for Applied Systems Analysis (IIASA), the Max Planck Institute for Demographic Research and the Norwegian Research Council is gratefully acknowledged. The author values the help of David Horlacher, Landis MacKellar, Heiner Maier, Alexia Prskawetz as well as comments from Wenke Apt, Sara Grainger, Karsten Hank, Torbjørn Hægeland, Puja Jawahar, James Raymer, Dorothea Rieck, Pertti Saariluoma and Ingrid Teply.

Abstract

This article surveys supervisors' ratings, work-sample tests, analyzes of employer-employee datasets and other approaches used to estimate how individual productivity varies by age. The causes of productivity variations over the life cycle are addressed with an emphasis on how cognitive abilities affect labor market performance. Individual job performance is found to decrease from around 50 years of age, which contrasts almost life-long increases in wages. Productivity reductions at older ages are particularly strong for work tasks where problem solving, learning and speed are needed, while in jobs where experience and verbal abilities are important, older individuals' maintain a relatively high productivity level.

1. *Introduction*

Understanding age-productivity profiles is of vital importance in several areas of economic research. Given that older individuals are less productive, an aging working population can lower economic growth and decrease fiscal sustainability. If senior workers' wages exceed their productivity levels, their wages may have to be reduced to increase their employability. Thus, the removal of seniority-wage systems may be a condition that is required to allow the political attempts to increase the retirement age to be successful.

The current article focuses on how individual productivity varies by age, as well as the causal factors of these productivity differentials. Figure 1 outlines how physical abilities, mental abilities, education and job experience form an individual's productivity potential. Combined with the firm's characteristics, these factors determines job performance. The weight of the different causal factors in determining individual productivity is steadily changing, where mental abilities and education have long been growing in importance, while physical abilities have become less important. Continuously changing types of work can imply that that the ability to absorb new information is becoming increasingly important relative to having long experience.

This paper is organized as follows: Research on age-variation in mental abilities is presented in section 2, the role of experience and learning is discussed in section 3, while section 4 debates how mental abilities relate to productivity. Section 5 reviews the evidence on productivity variation between the age groups, section 6 presents data on age-earnings profiles, followed by section 7, which discusses the problems of wage-productivity differentials at higher ages, and section 8 concludes.

2. Age, Cognitive Abilities and Interrelations with Training

A large body of evidence supports the notion that cognitive abilities[2] decline from some stage in adulthood. Verhaegen and Salthouse (1997) present a meta-analysis of 91 studies, which investigate how mental abilities develop over the life span. On the basis of these studies, they conclude that the cognitive abilities reasoning, speed and episodic memory declines significantly before 50 years of age and more thereafter.

The ability levels of employed white men and women up to the age of 65, using data from the *General Aptitude Test Battery* collected in the U.S. from 1970-1984, is shown in Figure 2. These findings suggest a relatively sharp decline in most abilities, after maximum values are reached in the 20s and early 30s (Avolio and Waldman 1994).

The decline of mental abilities from early adulthood is a universal phenomenon. The age-induced changes in cognitive abilities are similar across countries and within population subgroups, such as between men and women (Park et al. 1999, Maitland et al. 2000). Further individuals with high and low ability levels are subject to the same age-induced changes in cognitive functioning (Deary et al. 2000). Even among non-human species, ranging from fruit flies to primates, age-reductions in memory and learning capabilities have been observed (Minois and Bourg 1997, Bunk 2000).

In spite of the seemingly unavoidable reductions in cognitive abilities, targeted training programs seem effective in softening, or halting age-related decline. Schaie and Willis (1986a, 1986b) conclude that such programs can stabilize or even reverse age-specific declines in inductive reasoning and spatial orientation among many individuals. Ball et al. (2002) find that exercising speed, reasoning and memory abilities enhance the functional level of those who undergo training relative to those who do not.

The different cognitive abilities tend to follow relatively independent slopes over the life cycle (Schaie 1994). A division can be drawn between the fluid abilities, mental abilities that are strongly reduced at older ages and crystallized abilities, which remain at a high functional level until a late age in life (Horn and Cattell 1966, 1967). Fluid abilities concern the performance and speed of solving tasks related to new material, and they include perceptual speed and reasoning. The second group, crystallized abilities, measures abilities that improve with accumulated knowledge, such as verbal meaning and word fluency.

The distinction between fluid and crystallized abilities is supported by empirical findings, such as Schwartzman et al. (1987), who studies psychometric test results of young and older men. They find that verbal abilities remains virtually unchanged, while reasoning and speed abilities decline with age. Blum et al. (1970) provide similar findings, in a test-retest study of twins, where vocabulary size is

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[2] “Cognitive” or “mental abilities” refer to broad aspects of intellectual functioning. These include reasoning, spatial orientation, numerical capabilities, verbal abilities and problem solving. The most commonly used measurement of cognitive abilities is the IQ score.

observed not to differ at older and younger ages, despite a general reduction in other cognitive abilities.

Further, the relative demand for work tasks that involve certain cognitive abilities have shifted asymmetrically over recent decades. The demand for interactive skills, which are abilities that are relatively stable over the life cycle, has increased more than the demand for mathematical aptitude, which declines substantially by age (Autor et al. 2003). This could suggest that older workers are getting relatively more productive over time. However, any decreases in the labour market value of long experience, is likely to have an even stronger importance on the relative performance of older and younger workers.

Studies on age and mental functioning are either based on cross-sectional data, which describe the population’s current abilities, or longitudinal data sets, which follow the ability levels of one or more cohorts. Cross-sectional analyzes typically find a younger ability peak, as shown in the “Seattle Longitudinal Study” where age-differences are examined both by longitudinal and cross sectional approaches (Schaie 1996). The longitudinal data suggest that for example verbal abilities peak as late as age 53, while according to the cross-sectional data, the ability peaks take place at younger ages.

Longitudinal studies tend to suffer from non-random attrition. In the Seattle Longitudinal Study, more than half of the initial sample was lost by the time of the third wave (Schaie 1994). This loss of respondents is likely to create an upward bias in the age-ability estimates, since the remaining sample is likely to be positively selected. A second source of error stems from test practice, meaning that individuals in subsequent waves perform better simply because they have more exercise in taking these type of tests. Thus, ability decrements found in longitudinal data will most likely underestimate the true cognitive declines (Willis and Baltes 1980).

Cross-sectional data may also produce biased results, since ability levels can vary between cohorts. Willis and Schaie (1998), analyze primary mental ability test results for 1924, 1945, 1952 and 1959 cohorts, and find increasing test performance in reasoning and verbal memory, but decreasing results in tests of vocabulary and numerical ability. Tuddenham (1948) and Flynn (1987) find increases in military cognitive test results over time, though Rodgers (1999) argue that these findings are at least partly a result of methodological errors. Further, the fact that mental ability levels rise may be due to the educational expansion, as well as that they have become more common in candidate-selection processes (Jenkins 2001). This means that individuals from more recent cohorts will be better prepared and more motivated at taking these tests.

3. Experience and Learning

The decreased cognitive abilities of older workers can lead to lower productivity, unless their longer experience and higher levels of job knowledge outweighs the declines in mental abilities. Warr (1994) suggest a categorization of professions according to whether age boosts or reduces performance. Here, jobs are distinguished according to whether reduced cognitive performance and/or long experience affects job performance. Salthouse (1984) gives an example of a profession where experience can alleviate the impact of cognitive reductions. He shows that older typewriters work as effectively as their younger counterparts, despite lower speed, since they use more efficient work strategies.

The productivity profile may change over time given structural changes in the labor market. Accelerating technological progress can increase the importance of being able to learn and to adjust to new ways of working, while a long work experience may become less important. This is particularly problematic for older employees, due to age-related declines in the processing speed and in learning capacities (Baltes and Lindenberger 1997, Hoyer and Lincourt 1998).

The elderly learn at a slower pace than younger individuals especially if what they learn is qualitatively different from what they already have mastered. Rybash et al. (1986) argue that as people grow older, they undergo an *encapsulation* of job know-how, implying that the individuals' skills are attached to certain work domains, and are increasingly less transferable. In some occupations, the cognitive abilities that remain stable are the ones most closely correlated with job success. Senior employees can remain highly productive within a field that they know well and where long experience is beneficial. An example of an age-robust ability is *tacit knowledge*, procedural knowledge used to solve everyday problems, which can explain why many older managers perform as good as younger ones (Colonia-Willner 1998). However, when they perform unfamiliar work, they have to rely on the ability to learn and adjust, skills where younger individuals tend to be better endowed. Senior individuals are less able than young individuals to reorient themselves to new task requirements and to solve novel problems (Smith 1996) and age-induced productivity reductions may increase with the complexity of the work task (Myerson et al. 1990).

Job experience improves productivity for several years, but there does come a point at which further experience no longer has an effect. Ilmakunnas et al. (1999) assess a broad sample of Finnish manufacturing employees, and find that job duration improves job performance for up to 3.8 years. Ericsson and Lehmann (1996) argue that it takes roughly 10 years to achieve expert competence in games where strategic and analytic competence is important, such as chess. In summary, experience increases individual productivity up to a given duration, and thereafter, cognitive declines can decrease performance on the job.

4. Cognitive Abilities, Productivity and Wages

Age-variation in mental abilities are likely to affect productivity levels, because they are one of the most important determinants of success in education and on the job (see for example Barrett and Depinet 1991). Altonji and Blank (1999) show how group differences in wages are reflected in test-scores, after adjusting for schooling, industry, region and experience levels. Currie and Thomas (1999) and Tyler et al. (2000) find close relations between mental abilities at a young age and adult income, holding income and family status constant. Currie and Thomas examine scores from a general mental ability test at the age of 7, while Tyler and colleagues analyze the test results of high school drop-outs in math, writing, reading, science and social studies.

Schmidt and Hunter (1998) provide a meta-analysis of how individual characteristics relates to job performance such as education, work experience and general mental abilities. They find that mental ability test scores represent the best predictors of individual job performance. Additional studies showing the importance of intellectual abilities in determining wage levels include Bishop (1991), Grogger and Eide (1993) and Murnane et al. (2000).

Boissiere et al. (1985), using evidence from developing countries find that some cognitive abilities seem to be more important to wage premiums than others.

The performance on the reasoning ability is found to have little influence on wages, while literacy and numerical abilities has the highest impact. The number of years in school has only a moderate effect on earnings. Dolton and Vignoles (2000) examine the pay off to advanced mathematics in a British study of secondary school mathematics specialists, and find that advanced math competence was positively linked to adult earnings.

Murnane et al. (1995) find an increasingly strong correlation between test scores and wages. They study the relationship between mathematics test performance at the end of high school and hourly wages in the U.S. The analysis shows that math scores predicts wage levels in the 1980s better than in the 1970s, and that the relationship between wages and test scores was stronger six years after graduation than two years after graduation. Control variables includes the number of siblings, parental education, race, work experience, and whether the individuals were full-time employed or raised in a single parent household. Other evidence suggesting an increase in the payoff to mental abilities over time include Juhn et al. (1993). They find empirical support for the ability payoff increasing within narrowly defined school and occupational groups.

5. Measuring Productivity of individuals at different ages

This section survey the main approaches used to measure job performance differences by age. The approaches assessed are supervisors’ ratings, piece-rate samples, employer-employee matched data sets and age-earnings data, as employment structure.

Studies based on supervisors' ratings tend not to find any clear systematic relationship between the employee's age and his/her productivity. A meta-analysis by Waldman and Avolio (1986), based on 18 supervisor assessment samples, found a slight negative impact of age on job performance. Accordingly, they argue that only a small part of the productivity variation could be attributed to age. In 96 studies McEvoy and Cascio (1989) review the impact of the employee's age on supervisors' assessment and sales records. Age productivity coefficients were found to range from -.44 to .66. Medoff and Abraham (1980, 1981) examine white-collar employees in large American corporations and find that seniority was either unrelated to or negatively associated with performance evaluations. Remery et al. (2003), analyze a survey of 1007 Dutch business leaders and personnel managers. They find that older individuals are more likely to be perceived as less productive when the share of senior employees is higher, which are the workplaces who should have the highest knowledge on this issue.

A general disadvantage with the use of supervisors' ratings' to rank individuals by age and productivity is that managers may wish to reward older employees for their loyalty and past achievements. This can inflate the evaluations of senior employees, and bias the results (Salthouse and Maurer 1996). In a study of firms undergoing rapid technological change, Dalton and Thompson (1971) investigate performance evaluations from not only supervisors, but also employees, in 6 large firms. The ratings from the engineers and their managers suggested that employees in their 30s put in the most effort and perform the most sophisticated technical work, and that productivity falls as the engineers move into their 40s and beyond.

A second approach to measuring the impact of age on job performance is based on *work-samples*, which generally find lower productivity levels among the oldest employees. Mark (1957) and Kutscher and Walker (1960) provide some evidence that mail sorters and office workers kept productivity quite stable at higher ages, while factory workers' productivity fell after the age of 55. A study by the U.S. Department of Labor (1957), based on a broad selection of industries, compares output between individuals of different ages. Job performance increases until the age of 35, before steadily declining thereafter. However, the slope of the decline was not steep: productivity declined by only 14% in the men's footwear industry, and 17% in the household furniture industry.

These task-quality/speed tests, although potentially more objective, do not necessarily reflect the true productivity of individuals. The workers analyzed are likely to be selected in terms of age groups and occupations (Kate and Perloff 1992). Further, the time-limit in such samples may give age-biased results. Older employees may not be able to uphold a high work speed longer than the short period studied (Salthouse and Maurer 1996).

The productivity of individuals doing "creative" jobs, such as researchers, authors and artists, is measured by the quantity and sometimes the quality of their output. Stephan and Levin (1988) study the performance of researchers within Physics, Geology, Physiology and Biochemistry. The number of publications and the standard of the journals they appear in, is found to be negatively associated with the researchers' age. Similar evidence is found in the field of economics, where Oster and Hamermesh (1998) conclude that older economists publish less than younger ones in leading journals, and that the rate of decline is the same for top researchers as among others. Further evidence on that older researchers have decreased research output is found in Bayer (1977) and Bratsberg et al. (2003).

Miller (1999) describe how the output of artists vary across their life span. Miller analyzes the number of paintings, albums and books produced by 739 painters, 719 musicians and 229 writers. The peak ages for creative output seem to be in the 30s and 40s, the only exception being female authors who write most in their 50s. Galenson and Weinberg (2000) take a measure of quality into account, namely the price of artists' paintings, and find that market demand can have a strong influence on peak productivity age. They investigate 51 modern American painters' quality adjusted output, and find that for artists born prior to 1920, 50.6 years was the peak productivity age, while for cohorts born after 1920 the peak age was 28.8 years.

A third way of measuring productivity by age is based on the analysis of *employer-employee matched data-sets*[3], where individual productivity is measured as the workers' marginal impact on the firm's value-added. These studies are likely to be less subjective than those based on supervisors' ratings, and there are fewer sample selection problems than studies on work-samples. However, the main challenge to this approach is to isolate the effect of the employees' age from all the other factors that affect the firm's value-added.

Given the absence of surveys that focus on how age differences in productivity are estimated by employer-employee studies, an overview is presented in Table 1. For 5 out of the 7 employer-employee studies, an inverted U-shaped work performance profile is found, where individuals in their 30s and 40s have the highest productivity

[3] A survey of matched employer-employee data analyses is found in Abowd and Kramarz (1999).

levels. Employees above the age of 50 are found to have lower productivity than younger individuals, in spite of their higher wage levels.

Exceptions to the notion of decreasing productivity is a notion by Hellerstein and Neumark et al. (1995) who suggest that productivity increase over the life span in a study of Israeli manufacturing firms. However, the authors stress that their study does not allow conclusions about age and productivity to be drawn, due to the high inflow of young immigrants as well as the poor data quality. Similarly, in a study of American firms, Hellerstein et al. (1999) suggest that those above 55 contribute the most to output levels. However, Hellerstein et al. (1999) find that the peak productivity shifts to 35-54-year-olds workers when they use the firms' value-added instead of output levels as an indicator of productivity. Further, previous analysis based on the same dataset concluded older workers contributing the least to the firm's output (Hellerstein et al. 1996).

Most studies on age-productivity differences are based on cross-sectional evidence. A problem with this approach is that cross sectional samples do not take into account that seniority leads to occupational shifts; good workers get promoted, while inefficient workers lose their jobs or are demoted. This can bias age-productivity estimates based on within-occupation measurements. Employer-employee datasets also have the same problem: Firms' success may increase the number of new employees and lead to a younger age-structure, rather than a young age-structure causing firm success. Andersson et al. (2002) use lagged measures of the worker's age to overcome this problem in their analysis of employer-employee data. Their results confirm earlier findings that older workers with primary and secondary education are less productive than younger individuals, while tertiary non-technical workers tend to have a positive effect on productivity until a later age.

Age-earnings profiles can provide information on productivity profiles in settings where wages reflect current productivity. One example is a study by Lazear and Moore (1984), who examine the difference between earnings profiles of the self-employed and salary workers. They find that the self-employed tend to have little wage variation over the life cycle, while salary workers have increasing wages throughout their career. This suggests that productivity remains stable over the life cycle. A study by Boot (1995), describe age-earnings profiles for British workers in the first half of the 19th century, when there were few regulations in the labor market. For the physically demanding work that is analyzed, men reach their peak earnings in the beginning of their 30s, and wages decrease substantially from around 40 years of age.

Labor market participation rates can provide information on age-differences in work performance if low employment rates imply decreased productivity. In 1995, 54.3% of the 55-64-year-olds participated in the labor force, compared to 89.8% for 35-44-year-olds in OECD countries (OECD 1998). Further, the labor force attachment of older individuals' decreased in the period 1950-1995[4]. The unemployment rates of

[4] For most OECD countries the approximate retirement age, or the "average age of transition to inactivity", was found to lie between 57.6 to 63.6 years for men in 1995, except Japan and Iceland, where men retired at ages 66.5 and 69.5 years, respectively. For women, the retirement age was for most countries in the range of 54.1 to 62.1 years. Exceptions are Turkey and Japan, where women retired at ages 66.6 and 63.7 years, respectively (Blöndal and Scarpetta 1999).

In almost all OECD countries, the retirement ages decreased substantially in the period 1950-95. Men retired from a 2.7 to a 7.3 year older age. Exceptions are Japan and Iceland, where the male retirement age decreased 0.7 and increased 0.7 years, respectively. Women delayed the age at retirement with 2.6 to 8.4 years in this period, except for Irish women, who retired at a 10.7 years younger age, the Japanese who retire at a 0.9 years earlier, and the Swedes, where the retirement age fell by 1.3 years.

55-64-year-olds were 5.5% in 1996, which was lower than unemployment among younger individuals. However, the share who were long term unemployed was higher among the elderly, and it has increased over time (Baumol and Wolff 1996).

Rodriguez and Zavodny (2003) find that the risk of losing their jobs increased in particular for middle-aged and older workers between the periods 1983-1987 and 1993-1997 relative to younger workers. Bartel and Sicherman (1993) argue that older workers' risk of being excluded from the labor market rise with the rate of technological change, which is consistent with Ahituv and Zeira (2000), who investigate industry sectors differences, and Clark et al. (1999), who examine cross-country evidence.

6. Age-earnings Profiles

A wage analysis provided by the OECD shows that for 17 out of the 19 countries observed[5], gross wages peak for the 45-54 year old age group (OECD 1998). The age-earnings profile is characterized by a relatively steep increase in wage levels until the peak is reached followed by a mild reduction in earnings the last years before retirement. The 25-29-year-olds earn on average 0.72 of what the 45-54-year-olds earn, while the 55-64-year-olds earn 0.91 of what the 44-54-year-olds do[6].

Age-differences in wages increase with educational level (OECD 1998). For individuals with less than an upper secondary education, 25-29-year-olds earned 0.81

[5] The countries in the study were Australia, Canada, Denmark, Finland, France, Germany, Ireland, Italy, Japan, Mexico, the Netherlands, New Zealand, Norway, Portugal, Sweden, Switzerland and the U.S.. For the Czech Republic and the UK, the wages peak for the 35-44-year-olds.

[6] These percentages represent unweighted averages for the countries in the study.

times of what the 45-54-year-olds earned, while for those with a university education, 25-29-year-olds earned only 0.53 times of what the 45-54-year-olds earned. Generally, wages increase from the age at labor market entrance until a peak around 50 years of age is reached, followed by a modest decrease.

7. A wage-productivity discrepancy

Based on micro and macro evidence presented in previous sections, the wage increases that last almost throughout a workers life seem to be determined by other factors than the workers' current productivity. Although productivity may fall in the latter half of the working life, wages continue to rise. This creates a discrepancy between productivity and wages, where younger workers are underpaid and older workers are overpaid relative to their productivity.

In the stylized situation in figure 3, wages are lower than productivity levels at young ages and higher at older ages. This leads to a situation where firms will lose from hiring older workers, and profit from employing the young. When the labor force is aging, the firms' profit levels decrease and eventually turn negative. Therefore, when older workers' wages exceed their productivity levels, their employment opportunities are reduced. It generates pressure to exclude older workers from the labor market, since they cost more than they produce. This is a particular problem when the share of the firms' older workers is growing, which is the case in industrialized countries.

Several theories have emerged to explain why the age earnings profile differs from the age productivity profile. Important reasons include employers' initial uncertainty concerning new employees' (Harris and Holmstrom 1982). Older workers are paid above their marginal productivity, since upwards sloping wage profiles strengthen the employees' work effort by raising their shirking costs (Lazear 1979) and lowers the firms' need to train new workers. Further, when older workers receive higher wages as a reward for past productivity, junior workers' loyalty rise. Hutchens (1989) argue that this type of incentive systems, *delayed payment contracts*, is most commonly found for work tasks, which are difficult to observe or measure.

Delayed payment contracts implicitly assume that individuals have either life long contracts in a firm or that any job switches are done between firms with similar wage systems. However, when a worker could choose whether to work in firm A, where the wages peak early in life and firm B, where the wages peak late in life delayed payment contracts would break down. The rational worker would then spend his/her younger years in firm A, with high initial salaries, and then switch to firm B, with high seniority-wages, in the middle of his/her career. Consequently, firm B will lose young workers who otherwise would bear the costs of seniority wages and their wage systems would be left unsustainable. The average worker does in fact change employer several times during his/her working life, and the frequency of job shifts has increased over time (Bergmann and Mertens 2002, Burgess and Rees 1996).

An important reason why having a high age wage peak has been in firms' interest was the existence of a young age structure of the labor force. Firms gain from having a delayed payment contract as long as most workers are paid below their marginal productivity. However, as Lazear (1988) contests, population aging can challenge the financing of such systems, and increase firms' incentives to either decrease older individuals' wages or to lay them off.

8. Conclusion

Studies that estimate the influence of age on individual productivity are based on different indices, including supervisors' evaluations, work-sample tests and analyses of employer-employee datasets. A general problem with estimates of age and productivity is that older individuals who remain in the workforce are likely to be positively selected and have a higher productivity than those who leave the workforce, which could create an upwards bias in the estimates. And although supervisor's evaluations do on average show little or no relationship between the assessment score and the age of the employee, managers may inflate opinions of older employees due to loyalty reasons. Both work-sample tests, measuring the quantity and quality of the workers' output, and analyzes of employer-employee datasets, where the firms' productivity is measured, are more objective approaches. Nevertheless, identification and selection problems can still constitute some validity problems in these approaches. In general, the evidence suggest that productivity tend to follow an inverted U-shaped profile, where significant decreases take place from around 50 years of age.

An important cause of these age-related productivity declines is likely to be reductions in cognitive abilities across the life span. Some abilities, such as perceptual speed, show relatively large decrements from a young age, while others, like verbal abilities, show only small changes throughout the working life. Although older individuals have longer experience, they learn at a slower pace and have reductions in their memory and reasoning abilities. In particular are senior workers likely to have difficulties in adjusting to new ways of working.

'Active aging' policies, intended at increasing labor market participation of older individuals, are encouraged by authorities in most aging economies. The productivity loss associated with early retirement indicates that this emphasis is entirely justified. However, active aging policy programs should take into account that older workers' compensation tends to exceed their productivity levels, due to seniority-based wage systems. The likelihood that active aging policies will be successful increases with awareness of these issues.

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Table 1. Overview of Employer-Employee Datasets

Authors	**Region/ Country**	**Sample Size**	**Individual Variables**	**Age Categories**	**Control Variables**	**Productivity Measurement. Individuals' influence on:**	**Age-Productivity Profile**	**Remarks**
Ilmakunnas et al. (1999)	Finland	3,882> Firms, 279,181 Employees	Education, Experience, No. of hours worked	Average employee age at each firm examined	Firm's Age, Capital	Firm's Value-Added	40 year olds peak. Declining thereafter	Manufacturing
Crépon et al. (2002)	France	77,868 Firms, 3,000,000< Employees	Gender, Occupation, No. of hours worked	<25, 25-34, 35-49, 49<	Firms' Age and Size, Industry Type, Capital	Output	25-34 Year-peak. Lowest for those over the age of 50	Manufacturing and non-manufacturing
Hægeland and Klette (1999)	Norway	7,122 Firms, 270,636 Employees	Education, Experience, No. of hours worked	Dependent on Length of Education and Length of Experience	Firms' Age, Industry Type, Regrion, Public Ownership, Foreign Ownership	Firm's Value-Added	Decline for those with more than 15 Years of experience (Late 30s and older)	Manufacturing
Hellerstein et al. (1999)	U.S.	3,102 Firms, 128,460 Employees	Gender, Race, Occupation, Whether Married, Education	<35, 35-54, 54<	No. of Employees, Region, Type of Establishment, Type of Industry	Firm's Output or Value-Added	Increase/Decrease over life cycle according to model specification	Manufacturing
Hellerstein and Neumark (1995)	Israel	933 Firms	Occupation	<35, 35-55, 55<	Industry Type No. of Employees, Firms's capital and Input factors R&D Spending	Firm's Output	Increase over life cycle	Poor quality of data, and high age-biased inflow of immigrants lower validity of the study

Table 1. Overview of Employer-Employee Datasets (Continued)

Authors	Region/ Country	Sample Size	Individual Variables	Age Categories	Control Variables	Productivity Measurement. Individuals' influence on:	Age-Productivity Profile	Remarks
Haltiwanger et al. (1999)	Maryland/ U.S.	Lacking Information (All firms in Maryland 1984-1997)	Gender, Education, Immigrant status	<30, 30-55, 55<	Firm s Age and Size, Industry Type, Period-Effects	Sales per employee	55< year old workers lower	All industries
Andersson et al. (2002)	Sweden	2,874 Firms	Education	16-29, 30-39, 40-49, 50-59, 60-64, 64<	Period-, Plant- and Industry-Effects	Firms' Value-Added	50 years old with primary and secondary education lower, tertiary educated more	Manufacturing and mining industries. Longitudinal analysis confirm findings.

Figure 1.) Outline of key factors affecting job performance

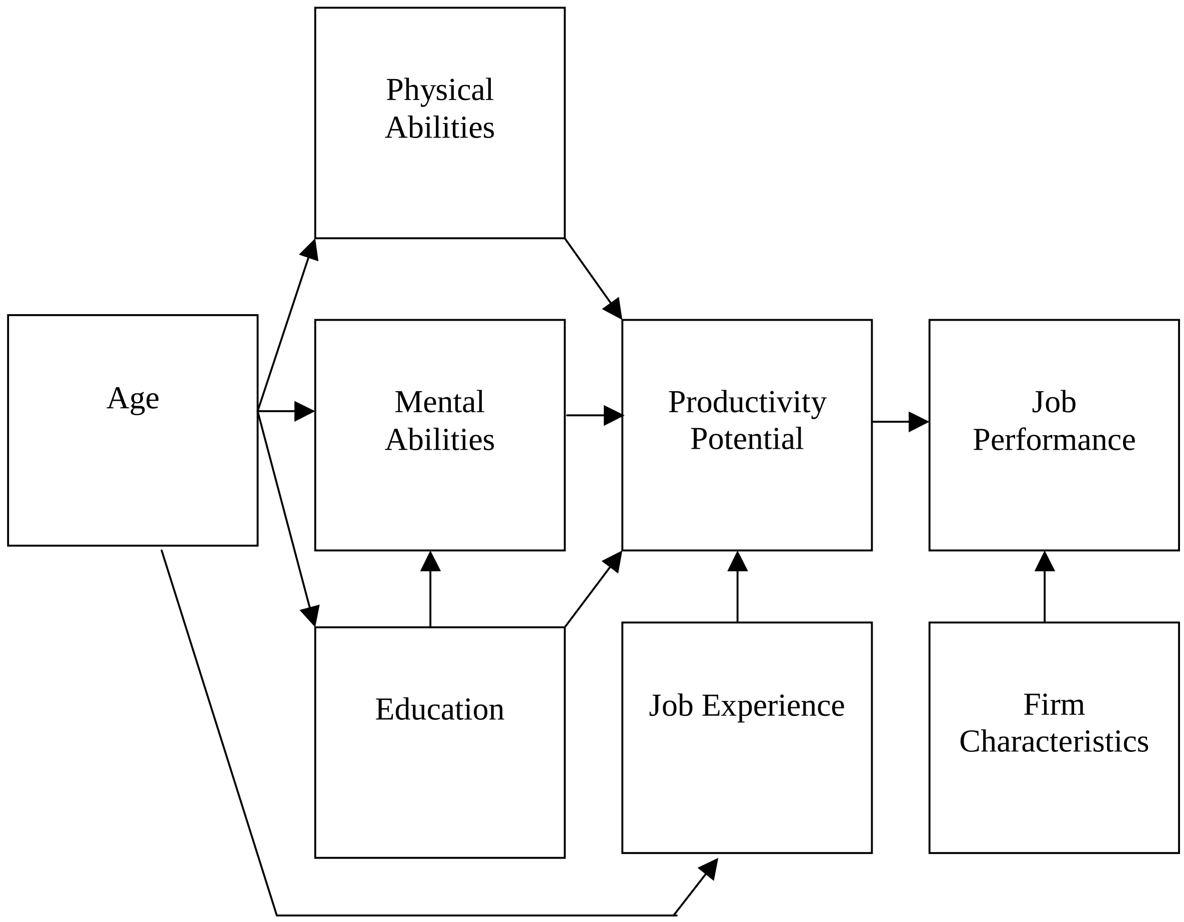

Figure 2.) Ability Levels relative to 25-34-Year-Olds Average of White Employees (measured in percentage of 25-34-Year-Old's Standard Deviation).
Source: General Aptitude Test Battery (Avolio and Waldman 1994).

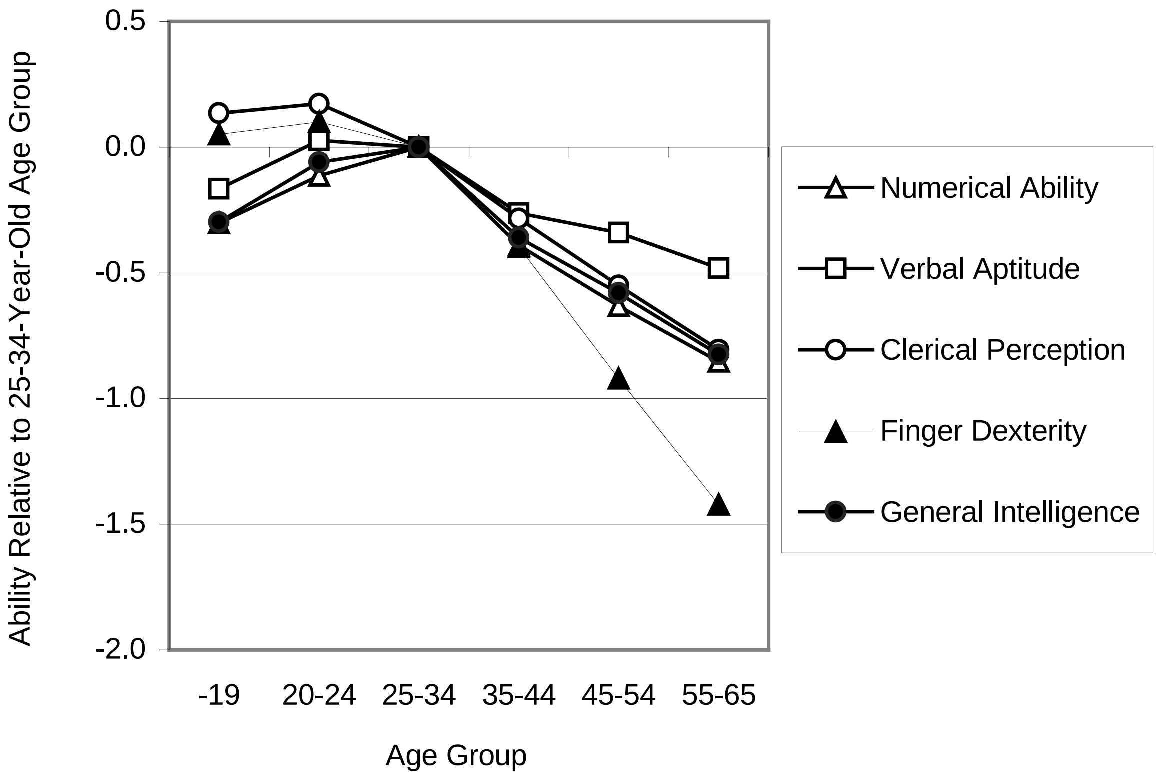

Figure 3.) Stylized Presentation of Productivity- and Wage-Variation across the life span, based on Lazear (1979) and Jackson (1998).