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Effect of Workforce Age on Quantitative and Qualitative

Organizational Performance:

Conceptual Framework and Case Study Evidence

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Abstract

Field studies linking workforce age to performance tend to treat performance as one-dimensional and often focus on individual, not organizational performance. To analyze the effects of workforce age on organizational performance, we suggest treating performance as multi-dimensional with at least two output dimensions: quantity and quality. We provide a novel conceptual framework that borrows insights from multiple disciplines to better understand ageing phenomena in organizations. In particular, we build on psychological and medical studies showing that individual age has different effects on different cognitive capabilities. As a result we argue that workforce ageing may affect various performance dimensions, such as quantity and quality, in different, often opposite ways. In our empirical part we examine a unique dataset containing detailed court data over a time span of 19 years. We find that average workforce age is linked negatively to *quantitative* organizational performance but positively to *qualitative* organizational performance. Our findings suggest that future organizational studies should decompose performance at least along the quantity-quality dimension. Our theoretical framework helps to understand the different types of ageing effects and to derive itemized implications for changes in organizational performance. It also helps to reconcile contradictory findings of previous studies and to derive important managerial implications for task assignments, career policies, and company strategies in view of upcoming demographic changes in many developed countries.

Keywords: ageing workforce; demographic change; organizational performance; age productivity effects

Introduction

Due to the ageing of societies, workforces in many organizations will change in their age structure and will particularly include a larger share of older workers. Therefore, theoretical models and empirical findings that help to understand how organizational performance is influenced by changes in the age structure of a firm's workforce are of utmost importance to organizational studies.

Research on the effects of ageing on organizational performance, however, is still inconclusive. Numerous case studies on production, sales, and top management teams indicate that team composition, as measured by average age and other demographic variables, may affect team and *organizational* results (Nielsen, 2010; Miller/Triana 2009; Charness/Villeval 2007; Goll, Rasheed, 2005; Jehn/Bezrukova 2004; Hamilton/Nickerson/Owan 2004; Pitcher/Smith 2001; Kilduff/Angelmar/Mehra 2000; Pelled/Eisenhardt/Xin 1999; Milliken/Martins 1996). In these studies, the effect of average age on performance is not consistent (Certo et. al. 2006; Sturman, 2003). Studies on *individual* productivity, in principle, should provide more accurate evidence on ageing and performance. But the results of these studies are also inconclusive. In a meta-analysis involving 380 field studies that examine the effect of ageing on individual productivity, Ng/Feldman (2008: 400) conclude that "… age is largely unrelated to core task performance".

We argue that previous research has remained inconclusive because performance, or productivity, has been conceived as a one-dimensional construct. In this paper, therefore, we provide a novel conceptual framework to understand the effect of ageing on multiple dimensions of organizational performance. In our empirical study, we illustrate our point by de-

composing performance into quantity and quality and by showing how an ageing workforce affects each dimension of performance differently.

Based on a large pool of research results on individual ageing from multiple disciplines, we show that it is important to distinguish two types of capabilities that individuals working in an organization may utilize in the organization's production process. The two types of individual capabilities are *crystalline (pragmatic) intelligence*, also known as experience, knowledge, or wisdom, and *fluid mechanical intelligence*, equivalent to cognitive speed and precision. How the capabilities need to be combined in the quality and quantity dimension influences the way in which ageing affects performance in the two dimensions. In our empirical part, we test our hypotheses for one particular group of professionals, i.e., judges in German courts for labour matters. Based on detailed performance data extending over a 19 year period, we demonstrate that there are two opposing effects of ageing: For "older" courts, quantitative performance decreases, i.e., we observe a lower number of completed cases. At the same time for "older" courts, qualitative performance increases, i.e., we observe a higher accuracy of judicial decision-making as measured by the share of decisions that are not rejected by a higher authority. In other words, a higher workforce age is associated with lower quantity but it is compensated by better quality.

Overall, our study contributes to the organizational literature on ageing in two important ways. Firstly, it uses measures of performance that are immediate outcomes of task performance. By contrast, in previous studies performance was usually measured indirectly by using a monetary measure such as sales or stock market performance. But the link of these monetary measures to actual task performance may be too weak to uncover the effects of an ageing workforce. Secondly, our study treats performance as multi-dimensional. In previous studies, only one single measure of performance was used. Even if multiple measures of performance were introduced, they were considered as alternative measures for the same per-

formance dimension (for example, Levenson, van der Stede, Cohen, 2006; Teitelbaum, 2006). Given that previous studies have not used appropriate direct measures of performance, or have modeled organizational performance as one-dimensional, it is not surprising that their empirical results have been inconclusive (Certo et. al., 2006; Sturman, 2003). We make a step toward resolving this empirical puzzle by showing that multiple performance dimensions – quantity and quality – need to be considered and studied separately to draw a clearer picture of how an ageing workforce affects organizational performance.

Our research is important for researchers and practitioners alike. In terms of future research directions, our paper presents a conceptual framework that allows researchers to investigate the multi-dimensionality of performance and to revisit previous studies and reconcile their partly contradictory findings. For practitioners in professional organizations, especially those who focus on complex professional services such as consulting, teaching, or research, our results may offer helpful data that can guide organizational policies concerning workforce ageing. Our results, for example, suggest that the age structure of a firm's workforce and its product market or service strategies should always be jointly determined to make sure that market strategies are matched with the advantages resulting from the age composition of a company's actual and future workforce.

Our paper is structured as follows. The second section contains a review of the psychological and medical literature on ageing and data regarding its effects on various cognitive capabilities. In the third section, our analytical framework is used to derive hypotheses concerning the impact of age on both quantitative and qualitative performance in the courts we study, namely the German Labour Courts of Appeal. In the fourth and fifth sections, we present our data and findings from regression analyses. In the concluding section, we discuss our managerial and research implications. We also assess how this approach may be extended to other, related field settings.

Literature on Individual Ageing Effects

There is a long tradition of laboratory studies in the psychological, gerontological, and medical disciplines that examine how various abilities change over an individual's lifetime. The results of these studies offer largely consistent evidence (Posner, 1995; Skirbekk, 2005). Three components of productivity should be distinguished: physical productivity, fluid mechanical intelligence, and crystalline pragmatic intelligence. Physical productivity, after an early peak, starts declining at the age of 30. Therefore, for jobs where physical strength is important, performance starts declining rather early. However, for the type of jobs we analyze, i.e., professional, high-skill white collar jobs, physical strength is almost negligible; therefore we will not go into more detail here but will instead concentrate on fluid mechanical and crystalline pragmatic intelligence.

Fluid (mechanical) intelligence: cognitive speed and precision

Fluid intelligence refers to mechanical cognitive skills such as comprehension, abstraction, and especially the ability to process information quickly and accurately. This can be compared to the hardware of a computer, with the key component of fluid intelligence being the speed and accuracy of information processing. These abilities start declining relatively early, at the age of about 35, and continue to do so on account of biological brain ageing (Baltes, Freund&Li, 2005; Baltes et al., 2004; Compton et al., 2003; Sternberg, Grigorenko, 2005). As processing speed declines, older people tend to comprehend matters more slowly and to reason less precisely (Baltes, Freund, Li, 2005; Skirbekk, 2005). From the age of 55 onwards, information processing speed is significantly impaired, leading to a 20 to 40 percent slower velocity of comprehension, allocation, and classification of information, as well as to inferior consequential decision-making (Compton et al., 2003; Koustaal, 2003; Rabbitt,

2005). Besides cognitive speed, accuracy also tends to decline as the brain's structure changes with age. Additionally, inhibition, i.e., the suppression of non-relevant information, weakens and, as a result, the robustness and accuracy of information processing are reduced, particularly when people are under tight time constraints (Baltes, Freund, Li, 2005; Baltes et al., 2004).

Overall, biological brain ageing leads to a decrease in fluid-mechanical cognitive capacity with age. Cognitive speed and precision significantly decline from the age of 50, although inter-individual variation is significant (Baltes, Freund, Li, 2005; Fair, 2004; Lindenberger, Mariske, Baltes, 2000; Rabbitt, Chetwynd, McInnes, 2003; Skirbekk, 2005; Sternberg, Grigorenko, 2005).

Crystalline (pragmatic) intelligence: knowledge, experience, and wisdom

Crystalline intelligence, by contrast, does not necessarily decrease with age. It can be compared to a computer's software and it may include capabilities that require general knowledge, know-how, or vocabulary. These capabilities can be expanded substantially through work and life experience and may therefore increase with age. Crystalline intelligence also includes what is colloquially termed wisdom (Baltes, Freund, Li 2005; Sternberg, Grigorenko, 2005).

Since crystalline intelligence is based on accumulated socio-cultural knowledge; it may be expanded through experience, education, and training. In particular, crystalline pragmatics consist of general human capital and know-how, orthographic and language skills, thinking strategies and practically generated intelligence, as well as social competence and the ability of ambivalence. Besides social-biographical factors, experience and age contribute to crystalline intelligence. On average, this form of cognitive ability continuously increases until

the age of 50 and remains stable until about the age of 70 to 75. Only after this age does it start declining (Baltes, Freund, Li, 2005; Baltes et al., 2004; Rabbitt, Chetwynd, McInnes, 2003; Skirbekk, 2005; Sternberg, Grigorenko, 2005).

Crystalline intelligence is to a large extent made up of general human capital and knowledge, forming the foundation for wisdom. Wisdom describes knowledge and integrity in the context of the fundamental mechanisms of life and human relationships (Baltes, Freund, Li, 2005), including facts and knowledge of the processes and diversity of life, especially as regards context and lifetime progression, knowledge of the relativism of values, goals and priorities, and awareness of life's uncertainty (Sternberg, Grigorenko, 2005). Wise individuals are better able to abstract themselves from their own situation and keep a distance from their own mental state when analyzing a situation. On account of their superior emotional regulation, they are better able to handle difficult situations, and because they are superior in terms of distance, reflection, and ambivalence skills, they are generally better suited to conduct judgment-related operations (Baltes, Freund, Li, 2005).

To a great extent, wisdom is founded on task-related and contextual life experiences and is tacit, since it cannot be communicated or taught (Posner 1995). On average, elderly people perform better than younger individuals on tests measuring wisdom, since they make more realistic judgments about situations and scenarios than do younger people (Charness, Villeval, 2007). In sum, crystalline pragmatic intelligence and especially wisdom may develop with age and experience and are a strength of older people.

Figure 1 summarizes the findings from the literature by depicting the typical average evolution of the different components of individual capability across an individual's lifetime.

Insert Figure 1 about here

Thus, ageing negatively impacts cognitive speed but positively influences experience and wisdom (Baltes, Freund, Li, 2005;Baltes et al., 2004; Compton et al., 2003; Rabbit, 2005; Sternberg, Grigorenko, 2005).

Literature on Ageing at the Workplace

What the results on individual ageing effects imply for field settings and concrete ageing effects at the workplace or in organizations has rarely been studied. Only a few papers have used the results to examine age-productivity profiles according to type of job in real work-places (Posner, 1995; Spitz-Oener, 2006;Veen, 2008; Warr, 1994). In these papers, results show that for a particular type of job either old or young workers have a comparative advantage (for the most recent evidence cf. Veen, 2008: 36ff.). Our approach is more fine-tuned because it implies that age affects various dimensions of performance differently even within the same job. Accordingly, if in a particular organization one dimension of performance is dominant, workers of a certain age may be most productive for that particular organization. But if in another organization both dimensions of performance are of similar importance, a more balanced age structure would be optimal for that particular organization. Hence, our approach offers an analytical framework to link workforce age structure to organizational performance in a new and important manner.

Most previous field studies concentrate on those types of workers for whom output measures are simple and readily available: teams in production or sales and top management teams (e.g., Charness, Villeval, 2007; Hamilton, Nickerson, Owan, 2004; Jehn, Bezrukova, 2004; Kilduff, Angelmar, Mehra, 2000; Milliken, Martins, 1996; Pelled, Eisenhardt, Xin, 1999; Pitcher, Smith, 2001). But most jobs today involve complex professional tasks. Here, per-

formance needs to be measured based on multiple and mostly non-financial dimensions. These dimensions are much more difficult to operationalize, the resulting measures are usually not readily available, and, therefore, the age-performance link is rarely examined with non-financial performance measures.

There are a few exceptions, however. Some studies have examined the impact of age on scientific performance (Jones, 2005; Simonton, 2004) and artistic performance (Simonton, 1991). Furthermore, a number of studies have looked at the performance of judges, the profession on which we also focus. Kosma (1998) found a positive impact of the judges' age on the citation of decisions by the US Supreme Court. Posner (1995) did not find an influence of age on citiations among judges at US courts of appeal. Bhattacharya, Smith (2001) und Smyth, Bhattacharya (2003) showed that age and citations are linked in a non-linear way to citations for Australian courts. Finally, Teitelbaum (2006) found that for the US Supreme Courts the number of cases decreases with age but that the number of opinions increases with age.

Our empirical study is most closely related to the study by Teitelbaum (2006) because we also focus on court performance not individual judges' performance. Unlike Teitelbaum, however, we conceive performance as a multi-dimensional concept and explicitly refer to the results from the medical and psychological literatures to derive our hypotheses on how ageing may affect performance dimensions differently.

Age and Organizational Performance in Courts: Research Setting and Hypotheses

Why a case study and why judges?

Since each dimension of organizational performance involves a specific mixture of individual cognitive capabilities, each task and within each task each dimension of performance may be influenced differently by workforce age. Therefore, the link between ageing and organizational performance has to be examined in narrowly-defined field settings. Then the appropriate empirical design lies not in broad surveys but, rather, in detailed quantitative case studies.

The case study we present refers to the German Labour Courts of Appeal. They form the second tier in the German employment judiciary, a specialized court system that deals with various matters related to both labour law and individual employment law (Weiss, Simitis, Rydzy, 1989). The bulk of all cases seen by these courts involve claims of unfair termination. Legal decisions by the Labour Courts of Appeal can be appealed through the Federal Labour Court (Bundesarbeitsgericht), the highest tier of the judiciary with respect to employment and labour law.

The Labour Courts of Appeal provide an almost ideal empirical setting for a test of our theoretical framework for a number of reasons. Firstly, the judges' work is a task for which multiple performance dimensions are discernible. The professional judges conduct a hearing according to civil-law procedures. They then extract the relevant facts, and assign the dispute to an existing legal norm as derived from statute law and case law; this is what Mintzberg (1979) has termed "pigeonholing". If the conflicting parties cannot agree on a settlement, a decision becomes necessary. Judges must write that decision in an appropriately short time period to avoid case backlogs. If the decisions are appealed they are reviewed by the Federal

Labour Court. Hence, judges' decisions may be reversed if they do not meet the prevailing quality standards for decisions. In particular, the Federal Labour Court will require a sound research of facts in each individual case and a knowledge of the correct legal interpretation of the case, which may be controversial in some cases. Overall, the judges' task involves multiple performance dimensions, including the speed of decision-making and case processing, the procedural fairness of the hearing, and the quality of the judgment.

Secondly, performance on the various dimensions can be measured because detailed performance data is available referring to the number of finished cases, the backlog of cases, the share of cases finished after a certain time period, the settlement rate, and the share of decisions confirmed by the higher court level. We will focus on two key measures of organizational performance termed "quantity" and "quality". "Quantity" refers to the number of cases that the court completes during a given year. "Quality" refers to the share of the court's judgments that are confirmed in subsequent judicial review by the Federal Labour Court. Of course, two measures still cannot capture true performance of courts or of any other organization in a balanced way (Meyer, 2003). But our measures are more accurate than those available for most private companies. Furthermore the measures are related to many of the other dimensions of performance mentioned above, such as the speed of decision making. Finally, the quantity and the quality measure differ markedly in terms of the cognitive capabilities needed. Hence, the itemized effects of workforce age that we expect are likely to be visible when examining the number of completed cases and the confirmation rate.

There is a third reason why our empirical context is most appropriate. A judge's job is typical for a broad range of other tasks that are often termed "professional" – they are complex, may involve trade-offs between quantity and quality, and are mostly conducted in knowledge-intensive firm (e.g. Robertson, Scarboroush, Swan, 2005). Examples include highly-skilled workers in research and development, consulting, teaching, and the health services.

To these professional settings, the theoretical framework and the empirical strategy that we suggest (though not our particular empirical findings) may be generalized in a theoretical way.

Finally, by studying courts, we focus on organizations that actually do employ older workers. The average age of judges in the Labour Courts of Appeal is around 50, and the judges work until the mandatory retirement age of 65. In many private sector organizations, by contrast, retirement age is more scattered. Often the number of older workers in employment is low and the workers who do continue working until retirement age may differ systematically from the ones who retire early. In particular, older workers who retire may be less productive or less motivated than other workers. Such a self selection effect, however, does not hamper our findings because judges in labour courts do work until mandatory retirement age, so with our sample we can measure the effect of workforce age in an unbiased way.

Hypotheses on ageing of judges and performance of courts

Posner (1995: 197) states that "[w]isdom, and by implication judicial capability, do not decline with age". In typologies of occupation, the judicial task is also usually considered as a job in which older workers generally have a comparative advantage over younger workers (Spitz-Oener, 2006; Warr, 1994). In contrast, based on our theoretical framework we argue that older workers in general and judges in particular can develop *advantages* in one aspect and *at the same time* develop *disadvantages* in other aspects of their job. Therefore, we study age-specific effects using two dimensions of judicial performance, namely quantity and quality. We further argue that fluid mechanical intelligence is the key capability favoring *quantitative* performance of judges, while crystalline pragmatic intelligence is the key capability favoring *qualitative* performance of judges. Thus, quantitative performance and quali-

tative performance are each influenced by a different type of underlying ability. These different abilities in turn produce age-specific performance profiles. Figure 2 summarizes our theoretical framework to explain how ageing affects different types of performance.

Insert Figure 2 about here

Quantitative performance as defined by the number of legal cases processed by the court during the year, either through settlement or through trial, should be negatively correlated with average age of judges in a court. To be productive in this dimension, a judge must assign the particular conflict to a certain legal case constellation. This involves rapid comprehension, abstract reasoning, and cognitive speed. Furthermore, a judge is assigned to more than one case at a time, so the capacity to gather and process large sets of information is important, not only in conducting the hearing, but also in writing the decision. Overall, we suggest that a judge's quantitative performance may be strongly influenced by his or her fluid mechanical intelligence. As was demonstrated in the second section, this type of intelligence declines with age starting around the age of 40. Therefore, we conjecture a negative link between age and quantitative performance of judges. We expect that the average age of judges employed within a court will be *negatively* associated with quantitative court performance (Hypothesis 1).

Qualitative performance as defined by the accuracy of the judgment, which is measured by the share of decisions confirmed by a higher authority. Qualitative performance should be positively correlated with average age of judges in a court. In any judiciary, only a fraction of decisions will be reviewed, but these include the most complex ones. Pigeonholing these

cases is often difficult or impossible, because the individual conflict does not directly map to existing cases. In this situation, experience can help with accurate decision-making. Experienced judges oversee a large number of such complex cases, they can draw on a richer stock of analogies, and they may anticipate more accurately which type of decision will convince the higher authorities. It is not the speed of information processing but rather the tacit knowledge one has accumulated through life and one's job experience that favor accuracy in this context. Furthermore, as Posner (1995) emphasizes, the rhetorical qualities of a decision also influence whether the decision will be considered convincing within the legal community. Since rhetorical abilities and the tacit knowledge acquired through experience are the key components of crystalline pragmatic intelligence, we expect this type of intelligence to strongly influence the accuracy of judicial decisions. Because this type of intelligence typically increases with age, a positive link between age and quality is conjectured. Therefore, the average age of judges employed within a court will be *positively* associated with qualitative court performance (Hypothesis 2).

Data and Methods

Sample

For our empirical analysis, we assembled a unique dataset consisting of data from various, partly non-public sources (see footnotes for Table 1). The data refer to nine of the 19 Labour Courts of Appeal and include detailed performance and personnel data for 230 judges across the period from 1980 to 1998. All judges included in our data hold a degree in law and must have been in office as professional judges for at least five years before their present position. Most judges start their employment with a Labour Court of Appeal between the age of 40 and 50. Among all judges, 46 percent of judges hold a Ph.D., and 15 percent are female.

Since judges are career civil servants in terms of their employment status, they are all of German nationality. Overall, the employees in our sample are unusually homogeneous in terms of educational background and nationality, and they have all gathered considerable experience in the judicial task before they entered the court.

Insert Table 1 about here

Dependent variables

To test our hypotheses, we use multivariate statistical methodology. A measure of quantitative performance and a measure of qualitative performance were each regressed on measures of workforce age and a number of important control variables.

As a measure of quantitative performance, we used the number of "processed cases" (natural log). This is defined as the number of conflicts resolved by the court during the year of observation. The number of cases processed ranged from 141 to 3,204, depending on the size of the court in terms of the number of judges employed. (To control for size, we included the number of judges in our regressions; see below.)

As a measure of qualitative performance, we used the "confirmation rate" (natural log), which captures the accuracy of decision-making. This is defined as the fraction of decisions subsequently confirmed by the Federal Labour Court on appeal. The conflicting parties can appeal an unfavorable decision by the Labour Courts of Appeal at the next tier of the judiciary, the Federal Labour Court in Erfurt. The number of decisions confirmed refers to opinions that are not rejected by the Federal Labour Court. A confirmation indicates that the original decision stands up to the formal quality standards and decision-making "policy" of the Federal Labour Court, i.e., the more confirmations, the higher is the quality of the origi-

nal decisions. Our figures for published and confirmed decisions were computed based on a content analysis of data from JURIS, the most comprehensive electronic database for legal decisions in Germany.

The indicator also shows large differences between the courts and over time. It ranges from 17 percent to 100 percent in our data and provides enough variation to be able to test our hypotheses.

Although the confirmation rate is a very good measure of quality, as explained above, one could argue that it still suffers from certain limitations. Unlike the number of processed cases (our quantity indicator) it is not an official performance figure but has been defined and computed by ourselves for the purpose of this study. Furthermore, one could argue that judges may be confirmed or rejected not on the basis of quality but because of political differences in interpreting the law. Though this may occur occasionally, our measure is based on a large number of decisions most of which will not be politically loaded. Perhaps the strongest potential limitation of our measure refers to the sampling of decisions. Not all decisions by the Labour Courts of Appeal are appealed and are thereby subjected to the quality control by the Federal Labour Court.

However, in favor of our measure is that the decisions that proceed to the third level are the most important ones: decisions concerning the most controversial cases and those cases that involve intricate, new legal problems. Furthermore, since the cases that underlie our quality measures are extremely important, the decisions of the Federal Labour Court are often cited in legal journals and will therefore have a large impact on the reputation of the respective Labour Court of Appeal. The decisions will also influence the way in which lower-level courts will decide similar cases in the future, so they also exert a strong influence on the labour market and society at large. Therefore, we rely on a biased sample of decisions but the bias is an advantage rather than a disadvantage for our quality measure – it comprises the

decisions that are particularly important for society and for the Labour Court of Appeal. Thus, our quality measure gets at the core of the courts' mission as an organization. Deciding such cases requests an unusually high degree of wisdom or crystalline intelligence in which older employees should have advantages over younger employees. Hence, the confirmation rate is an ideal measure to illustrate our contextual framework. Despite some potential limitations, the confirmation rate is a very good measure of quality in our context.

Independent variables and estimation techniques

The first independent variable is "average age", defined as the mean of the judges' ages. Average age ranges from 45 to 62 years, with a mean of 52 years. Average age is only a crude measure, since different age distributions may lead to the same mean. Therefore, we constructed an alternative set of independent variables (see Teitelbaum, 2006) that capture whether performance is affected asymmetrically by the share of younger and older judges. The mean share of younger judges (below 50 years of age) is 35 percent, and the mean share of older judges (above 59 years of age) is 16 percent.

We estimated cross-section time-series regressions, i.e., observations for the nine courts over the 19-year period were pooled in a regression model. For such samples, the panel-corrected standard errors (pcse) model has been suggested (Beck, Katz, 1995). It accounts for non-constant variance of the error term (heteroskedasticity) and serial error term correlation. Also, for this small sample, the pcse model does not rely on overconfident estimates of the significance levels generated by the feasible generalized least square (fgls) estimators. Instead, the pcse model transforms the data to account for the serial correlation of the error term, as suggested by the Prais-Winsten estimator. In addition, we inserted dummies for the courts to account for unmeasured differences between the courts.

A number of additional controls were considered. The number of "judges employed" refers to the full-time equivalent of judges employed by the court during the whole year (natural

log). This measures the quantitative input in the production process. (As a result, our regressions may be considered production functions.) Furthermore, the demand for judicial services was captured by the "case backlog" (natural log). This is defined as the sum of newly filed and pending cases per judge employed. The acquisition of organization-specific skills was controlled for by "average tenure", defined as the mean number of years for which a judge has been in office. After controlling for mean tenure, the age variables include the effects of age on performance net of the impact of organization-specific skills. In other words, the age measures include wisdom and life experience but not actual job experience.

Findings

Table 2 lists the results of our regression analyses in the context of quantitative performance. The baseline regression (1) only contains control variables. As expected, both the number of judges employed and the case backlog influence the number of processed cases positively and in a statistically significant way ($p < 0.01$). Some of the court dummy variables are also highly statistically significant, so some courts are more productive than others. Surprisingly, neither the number of judges with fewer than three years of tenure nor average tenure is related in a statistically significant way to quantitative performance. Thus, the acquisition of court-specific skills does not appear to be important in the present context, which may be explained by the hiring standards. Judges in the observed courts need to have had at least five years of experience serving as professional judges in lower-level courts. Thus, beyond this threshold, job experience does not seem to play an important role with regard to quantitative performance.

We proposed in Hypothesis 1 that quantitative performance should decline with average age. Evidence for this is provided by regressions (2) and (3) in Table 2. In regression (2), as ex-

pected, the average age of the judges is negatively linked to the number of processed cases in a statistically significant way ($p < 0.05$). An increase of one standard deviation (2.89) is estimated to lead to a 5.17 percent reduction in processed cases, which is equivalent to a reduction of 66 processed cases for the average court that completes around 1280 cases per year. This finding supports Hypothesis 1. Furthermore, the findings in regression (3) suggest that the negative average age effect for quantity is primarily driven by the share of older judges. The percentage of judges younger than 50 does not influence the number of processed cases, but the proportion of judges older than 59 has a statistically significant ($p < 0.10$) and negative effect on the quantitative performance measure. An increase of one standard deviation (18.4) is estimated to lead to a reduction in processed cases of 2.76 percent, which is equivalent to a reduction of 35 processed cases for the average court. Hence, a higher share of older judges affects quantitative performance negatively, which implies a negative link between workforce age and quantitative performance.

Insert Table 2 about here

Insert Table 3 about here

Table 3 lists the regression results with the confirmation rate as the dependent variable. Again, baseline regression (1) only contains the control variables. We proposed in Hypothesis 2 that qualitative performance increases with average age and find supporting evidence for this in regressions (2) and (3) in Table 3. Regression (2) shows that the average age of judges is linked positively to the confirmation rate in a statistically significant way ($p <$

0.05). An increase in average age by one standard deviation (2.89) is estimated to lead to an increase in the confirmation rate of 10.9 percent. This is equivalent to an increase from 88 percent confirmation (the average) to 97 percent confirmations. When considering the age shares in regression (3), one can see that the share of judges with age above 59 does not influence the confirmation rate. However, the share of judges younger than 50 is negatively linked to the confirmation rate in a statistically significant way ($p < 0.05$). An increase in that figure by one standard deviation (19.7) is estimated to lead to a 9.76 percent reduction in the confirmation rate. This is equivalent to a reduction from 88 percent confirmations (the average) to 79 percent confirmations. Hence, a higher share of younger judges affects qualitative performance negatively, which implies a positive link between age and qualitative performance.

In sum, we find opposing effect of workforce age on quantity and quality. Average age exerts a negative effect on quantitative performance but a positive effect on qualitative performance. An increase in average age of one standard deviation is estimated to lead to a reduction in processed cases of about 5 percent but to an increase of the confirmation rate by about 10 percent.

Robustness checks

As an alternative estimator, we used an OLS model with panel-corrected standard errors including the lagged dependent variable and a seemingly unrelated regression model (Zellner, 1962). The OLS model with panel-corrected standard errors including the lagged dependent variable has been recommended as an alternative to the Prais-Winsten model by Beck and Katz (1995). This also accounts for forms of serial correlation of the errors without transforming the data. Its disadvantage is the loss of the first year of observation data, which is the reason why we only use it as a robustness check. Also, the seemingly unrelated regression model has been recommended for jointly analyzing multiple productivity measures

whose error terms may be linked (Martin, Smith, 2005). In essence, the error terms of the two equations are transformed such that they have the same variance and are uncorrelated. Then, the other variables are transformed accordingly, and OLS regressions are run using the transformed data. Applying both alternative estimators left the results for the age variables essentially unchanged.

We also tested our hypotheses with additional independent variables. We first checked whether any other performance dimensions systematically influenced the dependent variables. In particular, a high settlement rate may allow courts to process more cases. Therefore, one regression for processed cases included the settlement rate. Since it may be endogenous, this variable was lagged by one year. Likewise, it is conceivable that some courts try to avoid appeals to the Federal Labour Court, which in turn may lead to a higher confirmation rate. We therefore included in one regression the lagged appeal rate, defined as the share of decisions that are subject to judicial review by the Federal Labour Court.

Also included in the regressions were additional demographic variables. Though performance is unlikely to be affected by age heterogeneity in this context because of low task interdependence, the standard deviation of age as one heterogeneity measure was also included along with average age. Including age heterogeneity along with 18 year dummy variables also controls for possible cohort effects – different generation of judges may possibly interpret their task in systematically different ways. Finally, to account for possible non-linear effects, we also included average age squared in the regressions including average age.

Finally, one could argue that career incentives may bias the findings. Younger judges are usually more concerned about future promotions than are older judges. Judges at the Labour Courts of Appeal may be promoted to the position of President or Vice President of their own court, and to positions within the Federal Labour Court system. In order to control for such an effect, a priori promotion probabilities were computed for the judges and included in

our regressions. Promotion probabilities were calculated by regressing the judges' subsequent career success on their age, tenure, the entry cohort, scientific output, and on whether or not they held a doctoral degree in law. Summing the promotion probabilities across judges produced a measure of promotion probabilities for all the judges employed by a court in a given year. That variable was also included in our regressions.

Including the additional variables in our regression analyses did not change our main results. The age effects on quantity and quality remained stable across all the operations. Thus, adding new variables did not affect the conclusions drawn from our preferred regressions in the main part of the paper.

Discussion

Theoretical and Managerial Implications

The aim of our paper was to examine how workforce age affects organizational performance on different dimensions of organizational performance. We suggested the decomposition of organizational performance at least into a quantity and a quality dimension. We drew on numerous psychological, gerontological, and medical studies that show how individual age-productivity profiles range widely for different types of productivity components. In particular, they are negative for cognitive speed but positive for wisdom. Thus, depending on the type of work, we expected the quantity and quality of organizational performance to be affected differently. We provided an in-depth analysis involving the legal profession, and we reported empirical evidence that average age of judges is negatively linked to quantitative performance but positively linked to qualitative performance.

Since courts can be seen as typical for a broad range of complex professional services with multiple performance dimensions, our results extend far beyond our example. They help us

to reconcile the often contradictory findings of previous studies and can be used to derive fine-grained managerial implications for task assignments and career policies, which in turn may help organizations to adjust to an ageing workforce and increase organizational performance in ageing societies.

Our approach helps to understand why empirical findings regarding the age-performance link have been inconclusive to date – because performance was not considered as a multidimensional concept. For example, although Teitelbaum (2006) used two performance proxies for courts, namely the number of accepted cases and the number of judicial decisions, he did not explain why his measures were affected by age in opposite directions. Given our theoretical framework, these results are not surprising because one measure of performance is more related to wisdom and quality and one is more connected with cognitive speed and quantity. To see this, however, organizational performance has to be conceptualized as genuinely multi-dimensional.

Our approach may help to formulate importance policy conclusions that go beyond those of previous studies. Previous studies may also account for the inconclusive or contradictory effects of firm demographics on organizational performance mentioned above. They do so by categorizing jobs or occupations by age-specific comparative advantage (Spitz-Oener, 2006; Veen, 2008). Our approach, however, delivers more fine-grained performance information than does the categorization approach. Going beyond overall performance helps us to understand how age can differentially affect multiple aspects of performance. From this, managers can derive implications for task assignments and career promotion frameworks.

For example, our case study evidence implies that younger judges are better able to cope with a large caseload, while older workers are better able to evaluate complex legal cases. The judicial employment system acknowledges this. The German labour judiciary consists of three levels (of which we have analyzed the second) and operates as its own internal la-

bour market. Judges are promoted within that judiciary to higher offices. In the most junior court, judges work on many cases; at the highest level of the court, judges hear only a few cases, all of which are complex. Relevant career policies imply that tasks are assigned in a manner that is compatible with the age-specific comparative advantages that we have uncovered. Younger judges, who excel in quantity, are employed in the lower-level courts; older judges, who excel in quality, are employed only in higher-level courts. Similar conclusions may be drawn for many other organizations employing highly-skilled professionals.

Though the particular empirical results for the labour judiciary cannot be generalized to other organizations, we believe that the general approach of decomposing performance does have a general applicability. Differential effects of ageing are likely to occur in many organizations where professionals perform complex tasks and where performance cannot be captured easily using just one dimension. Examples include banks, consulting firms, universities, and research laboratories. An important practical implication of our result is that neither a younger nor an older workforce will always be better. There may be organizations that achieve strong performance by attracting younger employees with their particular HRM strategies and who follow a business strategy based on physically strong and/or mentally fast employees. On the other hand there may be organizations that achieve strong performance by attracting more experienced and older employees with their particular HRM strategy, but they have to make sure their business builds on experience and quality and not on speed or quantity. And there may be companies with a mix thereof in workforce age and business strategy. Thus, given foreseeable demographic changes, the challenge for companies will be to adjust their business and HRM strategies to changes in the available workforce.

Implications for Future Research

Our empirical findings were derived from a specific empirical context. The employees included in our study were extremely homogeneous (male, German lawyers), they did not work in teams, and the measures of organizational performance were highly context-specific. While the specific context allowed us to pinpoint the effects of workforce age on performance, it limits the generalizability of our findings. Hence, a number of interesting issues could not be addressed in our study; they deserve attention in future research.

Firstly, teamwork effects may alter the findings in a significant way. In our case, task interdependencies were negligible because all judges perform identical tasks and because each professional judge is responsible for his or her cases. As a result, our performance measures were not blurred by potential complementarity or team effects and age heterogeneity did not influence performance. In contexts in which task interdependencies are strong, however, age heterogeneity influences team or organizational performance as numerous studies have indicated (e.g. Charness, Villeval, 2007; Hamilton, Nickerson, Owan, 2004; Jehn, Bezrukova, 2004; Kilduff, Angelmar, Mehra 2000; Milliken, Martins, 1996; Pelled, Eisenhardt, Xin, 1999; Pitcher, Smith, 2001; Backes-Gellner, Veen, 2009). The influence of teamwork relies on a number of causal mechanisms. For example, Pattriotta and Spedale (2009) have shown that sense-giving mechanisms such as leadership can provide a common set of expectations and stimulate group-based interaction. Ageing may have a similar effect as leadership. Furthermore, through influencing a common identity and cohesion, workforce age may influence knowledge sharing (Cabrera, Cabrera 2002) and co-worker assistance (Frenkel, Sanders, 2007).

Similarly, workforce diversity may give rise to more complex links between age and organizational performance. Typically, organizations are more diverse in terms of gender, ethnicity, and educational background than the courts we studied. This may affect the findings in a

number of ways. For example, the individual effect of ageing on performance may differ between men and women. More importantly, workforce age heterogeneity may interact with other types of diversity and give rise to splits or fault lines in work groups (Lau, Murnighan, 1998, 2005). Fault lines may create subgroup identities and influence the effectiveness of communication within teams, with controversial effects on performance (Bezrukova et al. 2009; Gibson, Vermeulen, 2003).

Third, the role of motivation and incentives deserves further analysis. In field settings, age may affect performance because of changes in both ability and motivation. In our study, we have controlled for possible promotion probabilities, which is the only type of monetary incentive that may motivate judges in our context. Nevertheless, in other contexts, a broader range of incentives may be at work. Lazega (2000), for example, showed that partners in corporate law firms have developed a lateral control regime and we would assume that such peer incentives are also affected by workforce age.

Finally, the impact of workforce age needs to be examined with a broad range of other measures of organizational performance. Our study focused on very specific measures of performance, and the confirmation rate created a proxy for quality in the form of accuracy of decision-making. Other quality variants that may be of interest in future studies include risk-taking effectiveness, artistic creativity, and knowledge creation (Jones, 2005; Simonton, 1988, 1997; Robertson, Scarborough, Swan, 2005). Furthermore, interesting issues arise when the impact of workforce age on organizational performance is studied in private companies. A straightforward question would be whether workforce age influences the various performance indicators in a balanced scorecard differentially as argued in our paper. But serious problems of measuring company performance accurately need to be kept in mind (Meyer, 2003). In particular, performance measures used in organizations are controversial and subject to politics (Lowe, Jones, 2004; Itter, Larcker, Meyer, 2003). Then, depending on

the indicators that evolve out of the controversy, an ageing workforce age may appear more

or less favorable for overall organizational performance.

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Figure 1: Age-capability profiles: typical evolution of various capabilities over the courseof an individual's lifetime
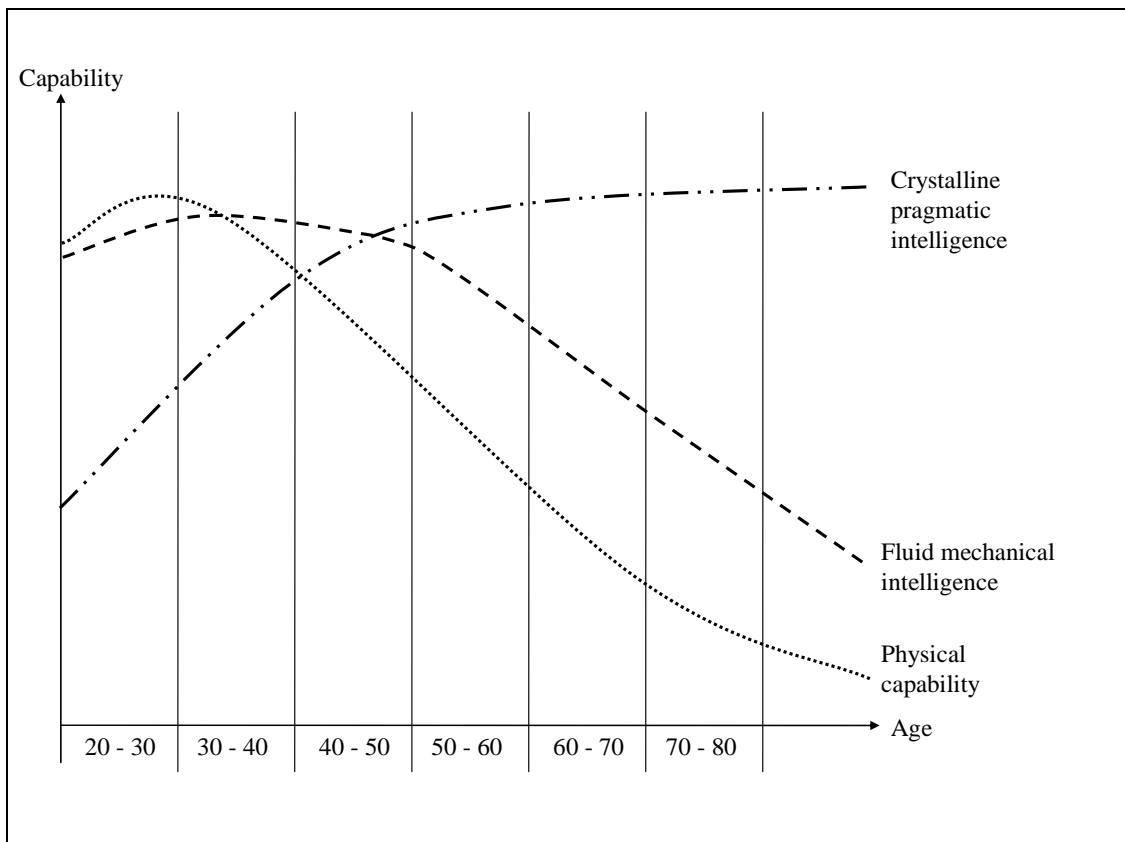
Source: own illustration following Baltes et al. (2004)

Figure 2: Theoretical framework and hypotheses

Explanans	**Dimension of court performance** *Explanandum*	
	<u>**Quantitative performance**</u> (number of processed cases)	<u>**Qualitative performance**</u> (share of decisions confirmed in judicial review)
Predominant cognitive ability that affects performance dimension:	fluid mechanical intelligence	crystalline pragmatic intelligence
Causal Factor	Age	Age
Relationships between age and relevant cognitive ability	Negative	Positive
Hypotheses: Effect of age on dimensions of court performance	(1) Average age will be **negatively** linked to quantitative court performance.	(2) Average age will be **positively** linked to qualitative court performance.

Table 1: Descriptive statistics

Variable	Mean	Std. Dev.	Min.	Max.
1) Processed cases	1279.51	761.20	141.00	3208.00
2) Confirmation rate (*100)	87.62	16.69	16.67	100.00
3) Judges employed	9.51	5.09	1.92	18.67
4) Cases per judge	199.29	45.51	106.22	378.23
5) Judges with < 3 yrs tenure	1.94	1.60	0.00	8.00
6) Average tenure	7.15	2.13	1.00	14.50
7) Average age	52.38	2.89	44.67	62.00
8) Proportion of judges < 50 yrs	0.353	0.197	0.00	1.00
9) Proportion of judges > 59 yrs	0.161	0.184	0.00	1.00
10) Standard deviation of tenure	4.01	1.74	0.00	8.00
11) Standard deviation of age	5.32	2.17	0.00	9.46
12) Settlement rate	30.68	6.82	18.27	52.61
13) Appeals rate	0.04	0.02	0.00	0.10
14) Likelihood of promotion	0.25	0.10	0.08	0.44

Data sources:

1), 4), 12), 13) calculated from statistics issued by the Federal Ministry of Labour, published annually in the journal *Bundesarbeitsblatt* and from unpublished statistics compiled annually by the Bavarian Ministry of Labour ("*Bayernstatistik*"), various issues.

2) calculated from analyzing decisions published in JURIS Arbeitsrecht.

3) taken from unpublished statistics compiled annually by the Bavarian Ministry of Labour ("*Bayernstatistik*"), various issues.

6), 7), 8), 9), 10), 11) calculated from HandbuchderJustiz (various issues), a biannual compilation of judges employed in German courts, issued by the DeutscherRichterbund, the most important professional organization of judges

14) Average of ex ante promotion probabilities of judges employed at a court. Authors' calculations; see Appendix 1.

Table 2: Workforce age and processed cases (quantitative performance) in the German Labour Courts of Appeal: results from pooled cross-section time-series regressions

Quantity:	Dependent variable: Processed cases (logs)		
	(1)	(2)	(3)
Control variables			
Judges employed (logs)	0.9532	0.9156	0.9211
	(10.31)***	(10.84)***	(10.64)***
Case backlog (logs)	0.8605	0.8552	0.8564
	(14.04)***	(14.98)***	(14.97)***
Judges with < 3 yrs tenure	0.0009	-0.0010	0.0005
	(0.12)	(0.15)	(0.07)
Average tenure	0.0030	0.0151	0.0114
	(0.36)	(1.50)	(1.26)
Fixed effects for nine courts	Included	Included	Included
Age measures			
Average age		-0.0175	
		(2.19)**	
Proportion of judges < 50 yrs * 10			0.0096
			(1.09)
Proportion of judges > 59 yrs * 10			-0.0172
			(1.93)*
Wald-Chi2	34600.37***	32556.18***	20663.60***
Rho	0.34	0.27	0.29

N=171; Panel-corrected z-statistics in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%
pcse estimator: Prais-Winsten regression with panel-corrected standard errors
(Beck, Katz, 1995)

Table 3: Workforce age and confirmation rate (qualitative performance) in the German Labour Courts of Appeal: pooled cross-section time-series regressions

Quality	Dependent variable: Confirmation rate (logs)		
	(1)	(2)	(3)
Control variables			
Judges employed (logs)	0.3047	0.2822	0.2441
	(2.39)**	(2.16)**	(1.88)*
Case backlog (logs)	0.0601	0.0751	0.0510
	(0.87)	(1.02)	(0.71)
Judges with < 3 yrs tenure	0.0130	0.0180	0.0186
	(1.22)	(1.65)*	(1.80)*
Average tenure	0.0100	-0.0027	0.0034
	(1.18)	(0.22)	(0.36)
Fixed effects for nine courts	Included	Included	Included
Age measures			
Average age		0.0226	
		(2.33)**	
Proportion of judges < 49 yrs			-0.0313
			(2.55)**
Proportion of judges > 59 yrs			0.0009
			(0.13)
Wald-Chi2	187.80***	160.35***	173.12***
Rho	0.09	0.19	0.15

N=171; Panel-corrected z-statistics in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%
pcse estimator: Prais-Winsten regression with panel-corrected standard errors
(Beck, Katz, 1995)