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Abstract:
The paper investigates the relationship between human capital characteristics and firm performance in engineering consulting. Because general experience, firm-specific human capital and diversity carry specific costs and benefits we hypothesize curvilinear (taking inverted U-shapes) relations to firm performance. We find little effect of general experience and firm-specific human capital, but the findings give some support for the curvilinear relation between performance and human capital diversity.

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Key words: Educational diversity, human capital, firm performance

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INTRODUCTION

A professional service firm's knowledge embodied in human capital is central for explaining its performance. This paper is concerned with human capital characteristics — in particular with the composition of professionals' educational background — and how such characteristics' affect firms' economic performance in terms of productivity and profitability. Authors increasingly argue that human resources are not only important, but among the strategically most crucial resources (Itami & Roehl, 1987; Castanias & Helfat, 1991; Ulrich & Lake, 1991; Spender, 1993; Lei & Hitt, 1995; Mahoney, 1995; Conner & Prahalad, 1996; Pennings, Lee, & Witteloostuijn, 1998; Hitt, Bierman, Shimizu, & Kochhar, 2001). However, it is not entirely clear *how* human resources matter for firm performance. While the role of heterogeneity of firms' top-management for firm behavior and firm performance has been discussed and studied rather extensively in the existing literature (see for instance, Hambrick & Mason, 1984; Bantel & Jackson, 1989; Murray, 1989; Thomas, Litschert, & Ramaswamy, 1991; Michel & Hambrick, 1992; Hambrick, Seung Cho, & Chen, 1996), very little has been done on the importance of the skill composition in a service firm's knowledge pool.[1] This paper analyzes the importance of educational diversity of professionals for firm performance in a highly knowledge intensive service industry, namely engineering consulting.

We also examine two additional aspects of the relation between human capital and performance. One aspect is the role of the level of a firm's human capital in terms of employee's experience and tenure. The other additional aspect of human capital is how human capital compensation varies with tenure and professional experience. We argue that this aspect is an important explanatory factor in determining firm performance in knowledge-intensive service industries.

In our empirical analysis, we shall make use of a unique dataset, which contains annual, linked data on the total population of employees and establishments in engineering firms in Denmark from 1980 onwards. It includes characteristics of establishments and employees as well as flow data on establishment and employee mobility/turnover on an annual basis. We shall make use of the fact that in the database, employees are characterized by detailed data on formal education.

The remainder of the paper is structured as follows. The next section ("Theory and Hypotheses") contains a theoretical discussion of the issues involved and a formulation of the hypotheses to be tested in the empirical section of the paper. Subsequently, we describe the data, variables, and estimation technique used in the analysis ("Methods"), followed by a section containing the estimation of the empirical model ("Results"). The final section ("Discussion and Conclusion") contains a wider discussion of the results and makes several suggestions for future research.

THEORY AND HYPOTHESES

In choosing our research setting — engineering consulting firms — we follow recent studies (e.g. Pennings et al., 1998; Richard, 2000; Hitt et al., 2001) which utilize the fact that a striking feature of service organizations is their persuasive reliance on knowledge embodied in their human capital. Because there is "…close connection between knowledge possessed by the personnel of the firm and the services obtainable…" (Penrose, 1959: 77), we suggest that an engineering consulting firm's performance is inextricably linked to the properties of its human resource pool.

We pursue two arguments on how human capital characteristics and pay policies co-determine performance in service firms. The first argument relates to the conceptualization and operationalization of a service firm's knowledge stock. In knowledge-intensive service firms, such as engineering consultancies, knowledge is a key resource (e.g. Wernerfelt, 1984; Barney, 1991) and contributes to explaining a firm's rent creation (Nonaka & Takeuchi, 1995; Conner & Prahalad, 1996; Grant, 1996; Quinn & Finkelstein, 1996; Pennings et al., 1998; Hitt et al., 2001). We focus on how levels of human capital experience and educational diversity affect an engineering firm's performance. The second argument deals with the performance implications of service firms' pay policies in terms of the compensation firms pay for their human capital. Because monitoring in knowledge intensive work is notoriously difficult, a service firm's pay policy creates incentives for knowledge workers through rent-sharing arrangements (e.g. Shapiro & Stiglitz, 1984; Lazear, 1991; Yellen, 1995). More precisely, we will discuss reasons to expect higher pay levels and steeper pay profiles across experience and tenure to be positively related to performance.

Experience Levels and Performance

This paper deals with the performance impact of two types of professional experience embodied in human capital – general experience and firm-specific experience. General experience is defined as the professional experience the employees got since entering the labor market, while firm-specific experience refers to experience obtained by the employees within their current firm. Both types of experience-based knowledge is valuable to the extent that it contributes to a firm's competitive advantage by improving efficiency and effectiveness, exploiting opportunities, or neutralizing threats (Barney, 1991; Lado, Boyd, & Wright, 1992). Several studies suggest that firm-specific experience (e.g. Becker, 1962; Pennings et al., 1998) which is by definition not readily available to competitors may provide a potential source of increased performance (Barney, 1991; Snell, Youndt, & Wright, 1996). High levels of general as well as firm-specific experience seem also particularly important in service industries since consulting services are ultimately experience goods, where clients select providers according to personal reputation (Maister, 1993). If clients screen engineering services based on the reputation of the human capital of the firms (Arrow, 1973; Maister, 1993), high levels of experience are clearly an advantage in winning contracts. To the extent that an engineering firm endowed with high levels of experience can produce more consistent, reliable, and high quality services, the likelihood of retaining and winning new clients in the firm's current market is increased (e.g. Pennings et al., 1998).

Development of experience is often path-dependent (Itami & Roehl, 1987), and may require the combination of various sorts of tacit skills, routines, and cultural knowledge in a particular engineering firm's context (Winter, 1987; Galunic & Rjordan, 1998). While high levels of experience-based knowledge can contribute to performance as long as the context remains unchanged, it is also signified by limited options for productive re-utilization in novel contexts. If engineering firms attempt to win new clients outside the firm's core business and try to develop new services, the value of current experiences diminishes. For example, experience acquired in one engineering project, for instance in bridge construction in terms of knowledge of rules of conduct; key players; common sales practices; design challenges etc., might be of limited use — if not misleading — in another project such as port facility design. Likewise, firm-specific experience about a particular client firm's culture and rules might be of limited use — if not harmful — when applied to another client's working context.

Matusik & Hill (1998) further suggest that if general and firm-specific experience becomes obsolete, inflow of external experience may help to update a firm's knowledge stock. Matusik (2002) empirically shows that unique combinations of updated general experience and firm-specific experience may lead to unique firm positioning in novel output markets. However, engineers switching to a new employer often need to go through a firm-specific education process (e.g. concerning work procedures, culture, norms typical to that firm), before they can productively employ their knowledge and professional skills (Penrose, 1959). In addition, as March (1991) suggests, the greater investments in firm-specific experience, the harder assimilation of new knowledge becomes. By implication, experience in firms may enhance an engineering firm's performance, but too much experience may strain such performance. Accordingly, we hypothesize that:

> Hypothesis 1. General experience based human capital and firm-specific human capital are curvilinearly (taking an inverted U-shape) related to firm performance.

Human Capital Diversity and Performance

As pointed out in the introduction the role of diversity of firms' top-management for firm behavior and firm performance has been discussed and empirically investigated extensively in the existing literature. Moreover, Pennings et al. (1998) along with Hitt et al. (2001) suggest that not only levels of human resources might matter, but also their composition with regard to partners and associates. Focusing on an entire workforce rather than on a particular organizational group, Lepak, Takeuchi & Snell (2001) recently found that combinations of alternative types of knowledge work are associated with better firm performance. In a study on racial diversity, Richard (2000) finds that a higher degree of racial diversity, within the proper context, can be conducive to firm performance. We suggest that educational diversity — in terms of the type of employees' educational background — might be most closely related to a service firm's competence and what a firm can achieve in output markets.

Like previous work we suggest that diversity in human resource pools can contribute to explaining firm performance. One key argument of previous studies is that increased human capital diversity provides competitive advantage because specific human resource profiles are hard to imitate due to their social complexity (Lippman & Rumelt, 1982; Barney, 1991). Moreover, research emphasizing the advantages of diversity in human resources, stresses flexible adaptation to changing external contexts (Priem, 1990; Lyles & Schwenk, 1992; O'Reilly, 1993; Sutton & Hargadon, 1997; Galunic & Rjordan, 1998). As Lyles and Schwenk (1992) assert, "diversity may influence a firm's repertoire of the definitions and understandings of how to handle different situations and events." (p.168). A greater breadth of perspectives, skills, and attitudes due to diversity of human capital is beneficial in terms of providing flexibility of strategic adaptation. It may also lead to more comprehensive problem solving and conflict resolution in the face of novel contexts (Priem, 1990; O'Reilly, 1993). Accordingly, diversity can stimulate debate surrounding task related conflicts and eventually result in creative conflict resolution. In addition, several authors (Sutton & Hargadon, 1997; Galunic & Rjordan, 1998) suggest that diversity in human resources can lead to innovative service development through knowledge combination.

While most prior studies have focused on the benefits of diversity, this paper also addresses associated costs. As Grant (1996: 116) asserts: "…if two people have identical knowledge there is no gain from integration, yet, if the individuals have entirely separate knowledge bases, then integration cannot occur beyond the most primitive level." In other words, increasing educational diversity can carry a performance penalty when costs outweigh the benefits of diversity. For example, a highly diverse human resource pool can undermine organizational capabilities if individuals involved in them do not share enough common knowledge (Buckley & Carter, 2002). This can lead to un-coordinated action, delayed decisions, and high communication costs (Hambrick et al., 1996; Casson, 1998). Diversity in perspectives might also create a basis for harmful conflict and misunderstanding, in particular when time pressure exists, conflicting views result in haggling and unconstructive bargaining. Another harmful impact of diversity of employee's educational background might be information overload, which alongside decision delays can prevent the integration of individual skills in the pursuit of organizational efficiency (March, 1991). In sum, positive performance impacts of educational diversity can be expected only as long as advantages gained through it exceed the associated costs.

Based on the forgoing arguments on the performance impact of diversity of employees' educational background, we expect:

> Hypothesis 2. Educational diversity among engineers and among professionals is curvilinearly (taking an inverted U-shape) related to firm performance.

Human Capital Compensation

Besides characteristics of human resources in terms of diversity, experience and tenure, the level and structure of compensation is relevant to explaining productivity and firm performance among service firms. Two interrelated theories are central to explaining pay profiles and show why firms use pay dispersion across experience and tenure, i.e. utilizing rewards for experience gained in the labor market and for tenure within the firm.

Efficiency wages. The first is the theory of efficiency wages (Shapiro & Stiglitz, 1984; Yellen, 1995). Efficiency wages can be regarded as a way to "internalize" labor markets (Cappelli & Cascio, 1991): By paying above market wages, for example to experienced employees, productivity increases, and thus higher pay may be "efficient" in terms of reaching higher profits (e.g. through lower unit labor costs). Four different rationales have been proposed: 1) above market wages discourage shirking due to a high loss in case of dismissal; 2) turnover (quits) will be lower and consequently recruitment and training costs will be lower; 3) additional high productivity employees will be attracted; and 4) high wages when perceived as an equity or fair standard, result in increased effort among employees. Efficiency wages are particularly relevant in firms where metering and monitoring performance is difficult and ambiguous, as is the case in knowledge intensive work. Also, because high wages substitute for direct monitoring, they help reducing costs of supervision.

Deferred payment. The second theory addresses the pay profile across tenure. The theory of deferred payment states that a steep pay profile motivates and retains employees (Salop & Salop, 1976; Lazear, 1991) because starting pay is lower, but employees can expect higher pay in the future, provided they stay within the firm. In addition, shirking will be more expensive in view of higher foregone future earnings. Accordingly, higher individual productivity and lower turnover costs will increase average employee productivity (in terms of value added per employee). As long as average productivity increases more than average pay there will be a net gain from deferred payment. Consequently, lifetime earnings for employees as well as profits increase, provided that the gain is shared between employer and employees (Leonard, Mulkay, & Van Audenrode, 1999).

Pay dispersion. An additional aspect of firms' pay structure is the pay dispersion in general, i.e. pay differentials beyond dispersion related to experience or tenure. No general conclusion can be drawn on the effect of large versus small wage differentials on productivity. However, among theories of motivation, the equity theory (Adams, 1963) says that relative pay should be set in accordance with relative productivity (effort). If one — for example — finds a positive correlation between pay dispersion and productivity, it must be concluded that some firms have smaller pay differentials than what is perceived as fair among employees.

The common prediction of two forms of incentive pay — efficiency wages and deferred pay — is that labor productivity will rise. However, the effect on profits, i.e. after deducting (higher) wages from value added, depends on the relative changes of productivity and average wages. In sum, the theories on human capital compensation lead to our third hypothesis:

> Hypothesis 3. Having higher pay levels and steeper pay profiles across experience and tenure is positively related to employee productivity (value added per employee).

METHODS

Sample and Data

Data on employees (human resources) and on standard economic measures of performance are based on administrative records that are processed and kept by Statistics Denmark. Data on the work force comes from the *IDA-database* (Integrated Database for Labor Market Research). The IDA-database contains annual, linked data on the total population of establishments and employees in Denmark from 1980 onwards. It includes data at a given point in time per year (each November) on the characteristics of establishments and employees. A firm identification number attached to each establishment (i.e. plant) allows one to aggregate data on employee attributes and flows to the firm level. Via "historic" variables information on the year when a employee was hired (i.e. tenure) and the year of completion of formal education (i.e. general experience) is included. The database has up until now been used mainly by labor economists (see for instance, Albæk & Sørensen, 1998), and is largely unexplored when it comes to the analysis of issues related to knowledge and knowledge-creation in service firms. However, we follow Jacobsson & Oskarsson (1995) in arguing that educational categories can be used as proxies for types of bodies of knowledge within firms.

Data on establishments can be aggregated to the firm level at which economic performance data is available. Accordingly, the labor market data are linked with *Firm Statistics*, which comprises standard economic measures based on VAT-records. In addition to revenues and costs of materials and services, the total wage bill at the firm is included. Thus, the level and composition of human capital can be linked with performance of the firms in question. The focus on the engineering consultancy industry, is made for three reasons: First, we are able to obtain an adequate measure of profitability even when lacking information on physical capital assets since physical capital is virtually absent in this service industry. Second, the choice of a specific industry enables one to identify the key type of educational group, in this case engineers and engineers in combination with other graduates or professionals. These advantages are strengthened further by a delimitation of the industry to comprise firms that carry out "pure" consulting and planning only (cf. below). This produces a sample of homogenous firms that validate these properties. Third, we are able to compare some of our results to other studies examining human-capital related issues within similar professional service industries (such as, for instance, Hitt et al., 2001).

The *engineering consultancy industry* is defined as a *subset* of firms belonging to the industry according to the formal industrial classification (NACE). The common attribute is that only firms involved in "pure" consulting and planning are included. Two statistical criteria for the selection of firms are utilized: An upper limit to the share of production workers and a maximum amount of revenues per employed engineer are conditioned. These criteria exclude firms that to a great extent deal with installation of production facilities and with sales, respectively. This yields a sample of homogenous firms within the industry.

Only firms with 15 or more employed persons and with at least 6 engineers are included at the offset. In the present data set, data on firms cover *two years*, 1996 and 1999. This limitation is partly due to the fact that the firm statistics cover only a recent period (from 1995 onwards).[2] The explanatory variables on human resources refer to employee characteristics in these two years. With the exemption of the heterogeneity-index on professionals, variables on human resources are defined for the group of *employee-engineers* only. In this way, human resource attributes are confined to a homogenous group of employees that constitutes the crucial category of human resources in engineering consultancy.

Measures

Dependent variables. The dependent variables are labor productivity and profitability at the firm level. Labor productivity is defined as value added divided by the number of employees (in full-year equivalent), and profitability is measured as gross profits divided by revenues.[3] Gross profits are value added minus total wages.

Independent variables: Human capital characteristics and compensation. Our explanatory variables include measures of human capital levels in terms of general experience and firm-experience, variables reflecting diversity among professionals and engineers, and variables measuring the pay structure across general experience and tenure among engineers.

Human capital experience. General experience and firm-specific experience among engineers is measured by the average employee experience and as the average proportion of total experience spent at the actual firm, respectively. General experience is measured in terms of years since graduation. The reason for choosing the relative measure of proportionate "firm-experience" rather than the absolute measure of tenure is the strong correlation found between average general experience and average tenure at firms. High average experience among employees is accompanied by high average tenure. The proportion of firm experience should be seen in relation to the level of general experience. In other words, given the length of general experience, what then, is the effect of a large or small part spent at the actual firm?

Technically, it should be noted that both general experience and firm experience are truncated variables. The year of graduation is only available for those that graduated after around 1972, i.e. for persons with less than 28 years of experience only (in 1999). A similar condition holds for tenure that can only be measured for those hired after 1980; thus, tenure is available below 18 years only (in 1999). For persons with experience or tenure above these limits an arbitrary number of years are set.

Diversity-indexes. Two separate indexes are used, one for the number of non-engineers seen in relation to the group of engineers, and one for the diversity across types of engineers. Both indexes are measured by the Herfindahl-Hirschman index, which is the opposite of the common concentration index.[4] The first index measures the degree of diversity among the three professional groups of engineers, business economists, and other professionals (natural scientist, social scientist, etc.). The engineer-heterogeneity index is based on the proportions of five types of engineers, i.e. construction-, machinery-, chemistry-, electronics-engineers and engineers not further specified.

Human capital compensation: pay level and pay profile. Estimates on firms' pay policy are based on a first-step OLS-regression of a classical wage function:

$$\text{Log(hourly pay)} = b_1 + b_2\times\text{experience} + b_3\times\text{experience}^2 + b_4\times\text{tenure} + b_5\times\text{tenure}^2 + b_6\times\text{gender} + b_7\times\text{academic level (among engineers)}$$

Coefficients b_1- b_5 are included in the final regression as explanatory variables and are listed in Table 1. A high level of the intercept b_1 corresponds to a high (starting) pay level while high (positive) values of the coefficients to experience and tenure express a steep pay profile across experience or tenure. We term the first variable "pay level". The pay level may serve as a proxy for non-competitive market segments, provided that rents are shared between employer and all employees, irrespective of experience or tenure. Thus the pay level can act as a control for the effect of diversity of skills on productivity (value added per employee) in case of an unobserved association between non-competitive markets and skill heterogeneity. We call the coefficients to experience and tenure for "experience pay" and "tenure pay", respectively. In addition, the value of the Root Mean Square Error (RMSE) by firm is included in the final regression. It measures the part of variation in individuals' pay that is not explained by the wage equation above. Thus, the RMSE measure the "pay dispersion" among similar employees in terms of experience and tenure levels (Leonard et al., 1999).

This interpretation of the RMSE rests on the advantages of register data being that measurement errors and response bias are limited. Some firms (observations) are omitted in the final regression on performance. This is due to instances where a low number of engineers (among smaller firms) coincide with missing wages for some of these employees. This produces indeterminate results or missing values of RMSE. The omission of such firms in the final regression is taken to be random (among smaller firms) and comprises relatively few firms. Of the 152 observations in the sample (Table 1), 132 observations enter the regression (Table 3), i.e. corresponding to a "response rate" of 87 percent.

Control variables. Four control variables are included: the proportion of technicians among employees, the size of firm, a dummy for sub-industry, and a dummy for the year 1999. The proportion of technicians is a proxy of the incidence or weight of standardized consultancy products; as can be seen from Table 2, a large proportion of technicians is strongly correlated with a low diversity of skills (i.e. uniformity) within professionals. The size of firm is measured as the number of employed (a numerical variable), while the sub-industry dummy reflects whether the firm in question is located in "engineering activities and related technical consultancy on machinery and production" as opposed to the "engineering activities and related technical consultancy on construction" sub-industry. Hence the parameter for the dummy expresses whether or not the parameter for "engineering activities … on construction" is different from the benchmark ("engineering activities … on machinery and production"). The dummy for 1999 reflects inflation between the two years 1996 and 1999, in the case of labor productivity, or it may reflect other changes between the two years in both of the two dependent variables.

Statistical Method and Analysis

Since the two performance measures are related in the sense that firm profitability in theory — among other things — is a function of the firm's level of productivity (Milgrom & Roberts, 1995), we apply three-stage least squares (3SLS) estimation of the model. Accordingly, the ordinary least squares (OLS) estimation method is not appropriate because the estimators of the structural coefficients are inconsistent due to simultaneity bias (see for instance, Greene, 1997). Instead, the simultaneous equations models such as two-stage least squares (2SLS) or 3SLS should be used. However, 2SLS is a single equation estimation technique which, unfortunately, does not take account of the fact that in the structural model, the cross-equation error covariances may be non-zero. System methods for the estimation of simultaneous equations models — such as 3SLS — take into account the correlation of disturbances between the interdependent equations. Accordingly, 3SLS is asymptotically efficient relative to 2SLS (Greene, 1997: 754). It should be noted, however, that a disadvantage of system methods, such as 3SLS, is that any specification error in the structure of the model will be propagated throughout the system. In contrast, single equation models, such as 2SLS, will by and large, confine the problem to the particular equation in which it appears (ibid: 760). Nevertheless, due to the efficiency advantages, we present our results using the 3SLS technique. However, the results do not change in any important way, when using the alternative 2SLS procedure.

Table 1 displays descriptive statistics for all our variables. From the table it can be seen that Danish engineering consulting firms are in fact quite different in terms of the diversity of the educational background of the workforce, since some firms have zero educational diversity while others are quite diverse — 25 percent of the firms have HH values higher than 0.24 for the three groups of professionals and HH values of more than 0.42 for the five groups of engineers. The average size of a firm in the industry is 121 employees, but firm size varies a lot in the industry.

[Table 1, just about here]

Table 2 gives partial correlations among our independent variables. In general the correlations are quite low, apart from perhaps the negative correlation between the pay level for engineers and the tenure pay for engineers. Even the positive correlation between educational diversity among five different types of engineers on the one hand, and educational diversity between three broader groups of professionals is not particularly strong (significant at the five percent level only). From the correlation table it is also worth noting that there is a negative — albeit weak — correlation between the length of experience since graduation on the one hand, and the length of tenure divided by the length of experience since graduation, on the other. Our interpretation of this observation is that job-shifts between firms are in fact quite common in the industry.

[Table 2, just about here]

RESULTS

The results of our estimations are shown in Table 3. It can be noted that we have included all independent variables as explanatory variables for labor productivity, while for profits the human capital diversity variables have been excluded. We have followed this procedure for pragmatic reasons, as these variables turned out to be consistently insignificant in explaining profits (directly). Accordingly, it was decided to drop them from this part of the estimation. Moreover, we present three sets of estimations, one for all of the firms in the sample and one set for each of the groups of smaller and larger firms respectively. We split the sample into smaller and larger firms using the firm size median, so that firms with more than 36 employees are labeled "large firms".

[Table 3, just about here]

We do not find much support for Hypothesis 1, since general experience and firm experience are rarely significant in explaining firm performance. In fact, only in the case of the estimations for small firms alone, we find a curvilinear effect on firm profitability from having more firm-specific experience. We are unable to detect any such effect for the entire sample and for large firms – and we never find an impact on productivity.

We find some support for Hypothesis 2, although the relationship appears to be more complicated than as stated in Hypothesis 2. First, we do not find a significant effect on firm productivity in the case of educational diversity of engineers, while we detect an effect in the case of more general diversity among professionals. Second, in a first round of estimations we found a statistically significant U-shaped relationship — rather than an inverted U-shaped relationship — between productivity and diversity among professionals. However, subsequently we tried to include the variable measuring diversity among professionals raised to the power of 3. When included in the regression, this term turns out to be significant as well. For the total sample the regressions result for diversity among professionals is illustrated graphically in Figure 1. Our interpretation of this result is that there are two viable strategies that give rise to better firm performance. One viable strategy has to do with having a very narrow skill-base (zero heterogeneity, high performance), while the other viable strategy has to do with having a heterogeneous skill-base (high diversity, high performance).

However, being "stuck in the middle" in terms of educational diversity is associated with worst firm-performance. Moreover, at very high levels of educational diversity among professionals, decreasing returns set in (top point at HH = 0.38). So for a group of firms over a certain threshold of educational diversity, we do find the curvilinear, inversely U-shaped relationship postulated in Hypothesis 2. Again, it should be noted that the effect of diversity on performance runs through the effect on productivity, which in turn affects profits. We detect no direct effect of educational diversity on firm profits.

[Figure 1, just about here]

When the sample is split into small and large firms we find almost the same pattern among large firms as among the entire sample (see also the Appendix Figure displaying the effect of diversity of professionals on productivity — for large firms only). Marginally more diversity seems "optimal" only among the large firms, when compared to the results for entire sample. For smaller firms, however, we do not detect any effect of educational diversity on performance. In fact for small firms, our ability to explain firm performance is rather poor in general, since the productivity equation in the two-stage least square setting (which is also the first two stages of the 3SLS procedure) is insignificant. When the system R-squared for the 3SLS for large firms is compared to the system R-squared for all firms, it can be seen that the system R-squared is larger only in the case of larger firms, again showing that our model works best for larger firms.

Hypothesis 3, stating that there is a positive effect of the pay level and the rise in pay across experience and tenure on *productivity*, is consistent with our findings. The positive effect of the pay level is significant for both small and large firms, while the positive effect of a steep pay profile is most significant among large firms. That the effect of a steep pay profile is most pronounced among large firms is in accordance with the observation that monitoring should be more difficult in large as opposed to small firms. A steep profile thus seems to have an incentive function at large firms in particular. This is also found by Leonard et al. (1999). There is no significant effect of the dispersion of pay among similar employees on productivity. Thus, from an equity-theory point of view, pay differentials seem to be in accordance with individual differentials in productivity across firms.

However, the overall effect of the pay level and pay profile on *profit* is weak, meaning that higher wage costs tend to counterbalance the productivity gain of higher pay or a steeper pay profile. For small firms none of the coefficients on profit are significant, and for the pay level the sign is positive. For large firms the signs of all coefficients on profit are negative as expected, and some are significant. Regarding the pay level the coefficient is significant at a 10 percent level. Through a joint calculation it turns out that a higher pay level has a positive effect on profits in that the indirect positive effect stemming from higher productivity more than compensates for the direct negative effect on profit. Concerning the pay profile, the coefficients for the steepness across experience on profit are significant. Here it turns out that the direct negative effect on profits is not compensated for by the indirect positive effect through higher productivity. For the individual firm the outcome will depend on the mix of pay level and steepness; from Table 2 it is seen that there is a trade-off between the pay level and the steepness across experience and tenure.

DISCUSSION AND CONCLUSION

Our findings concerning general experience and firm-specific experience strongly indicate that there is no leverage to be gained in terms of firm performance from having higher (or indeed lower) experience within engineering consulting. A reason for general experience not being conducive to firm-level-performance is that it is possible to buy general experience in the factor market (Barney, 1991). Accordingly, no sustained competitive advantage can be achieved following this approach. Moreover, our results indicate that experience is not particularly context-specific, given the fact that the length of employees' firm-specific experience is unrelated to firm-performance as well in the engineering consulting industry. It may of course well be that firm-specific knowledge is still important in achieving competitive advantage, but in that case such knowledge is not related to the length of firm-specific experience. In that sense, our results represents a challenge to future theory development since proponents of tacit knowledge as a key determinant of firm performance (Itami & Roehl, 1987; Winter, 1987; Galunic & Rjordan, 1998) will have to specify more precisely when aspects of firm-specific, tacit knowledge, may give rise to competitive advantage.

Our finding concerning educational diversity among professionals point to a more general conclusion with respect to firm-strategy within the industry — as already hinted — in that there seems to be at least two viable strategies at play within the industry. One strategy has to do with orchestrating a broad set of skills. If firms follow this strategy, it appears that there is a payoff from being heterogeneous only when pursued to a high degree (but still not too much). The other viable strategy has to do with being more focused, implying a homogeneous educational/skill structure within the firm. In other words, it is a kind of an either-or situation – i.e. either pursue educational diversity fully or do not attempt it. It is also interesting to note that "narrow" diversity among engineer types turned out not to be significant while more "broad" diversity among different types of professionals does seem to have implications for firm performance in the engineering consulting industry. In that sense, competitive advantage in the industry seems to be based on combining skills, which are more fundamentally different.

Consistent with prior research on top management teams and other groups (e.g. Hambrick & Mason, 1984; Hambrick et al., 1996), this paper has argued that diversity, experience levels, and compensation of human recourses might influence performance positively. In contrast to prior studies, however, we focused on a sample of the entire workforce in engineering firms rather than on a particular group type in firms only. While upper echelons — be they top management groups or partners — are certainly important, they do not capture the larger human capital pool that ultimately co-determines organizational capabilities and, thus, a firm's performance (Wright & McMahan, 1992; Richard, 2000; Hitt et al., 2001).

Although our study moves beyond many data limitations in prior studies on the human-resource-performance relationship, this study also has clear limitations as well. First, the number of years since graduation and the length of firm tenure might be imperfect representations for experience-based knowledge and firm-specific knowledge respectively. Thus, future research might employ other variables to proximate these constructs. Second, a more comprehensive data set would also include information on the strategy type followed by each individual firm. Third, while we have addressed both human resource experience, diversity, and compensation, future research might combine such data with data on human resource practices and combinations that have been suggested to impact firm performance

(Ichniowski, Shaw, & Prennushi, 1997; Laursen & Mahnke, 2001; Laursen & Foss, 2003) in addition to the human resource pool properties addressed in this study. Moreover, by exploring other service industry settings, future research could investigate the conditions under which human resource pool characteristics such as tacitness, firm-specificity, and diversity impact on competitive advantage and performance among service firms.

ENDNOTES

[1] It should be noted that our analysis does not deny that the composition of the top-management team can be important in shaping firm strategy and performance. In fact, given that the top-management team strongly influences the educational composition of the workforce, the two issues may be closely related, and indeed complementary in nature.

[2] The other limitation has to do with the financial resources required to purchase the data at Statistics Denmark, since a steep fee is charged per year made available. Even two years come at a considerable price.

[3] Notice that descriptive statistics on this rate in Table 1 are for logarithmic values and thus the values are negative.

[4] $HH = 1 - \Sigma p_i^2$, where p_i is the proportion of category *i* (educational group *i*); *p* is on decimal form.

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TABLE 1

Descriptive statistics (n=152)

	Mean	Std Dev	25th Pctl	Median	75th Pctl	Minimum	Maximum
Firm performance (independent variables):							
Value added/Full-year employed (log)	12.98	0.22	12.82	12.96	13.11	12.45	13.72
Gross profits/Revenues (log)	-2.11	0.84	-2.54	-1.90	-1.53	-6.00	-0.94
HR-variables:							
Diversity-index, 3 groups of professionals	0.14	0.14	0.00	0.11	0.24	0.00	0.50
Diversity-index, 5 types of engineers	0.25	0.20	0.00	0.25	0.42	0.00	0.65
Average experience of engineers (general experience)	14.87	3.89	12.58	15.21	17.26	4.00	26.13
Average tenure as a proportion of average experience for engineers (firm experience)	0.33	0.15	0.23	0.32	0.41	0.05	0.87
Wage equation, engineers:							
Pay level	5.06	0.42	4.98	5.07	5.19	0.91	6.47
Experience pay	0.04	0.05	0.02	0.04	0.06	-0.11	0.36
Firm experience pay	0.00	0.17	-0.02	0.00	0.03	-1.12	1.29
Pay dispersion (root mean squared error)	0.16	0.09	0.12	0.15	0.19	0.04	0.88
Other (non-dummy) controls							
Share of technicians	0.22	0.10	0.17	0.21	0.28	0.00	0.57
Size	120.89	295.92	26.00	36.00	62.00	15.00	1765.00

TABLE 2
Correlations among the independent variables (n = 152)

		1	2	3	4	5	6	7	8	9
1	Diversity of professionals									
2	Diversity of engineers	0.185*								
3	General experience	-0.159†	-0.153†							
4	Firm experience	-0.120	-0.339***	-0.145†						
5	Pay level	0.158†	0.027	-0.069	-0.056					
6	Experience pay	0.075	0.010	0.027	-0.053	-0.344***				
7	Tenure pay	-0.163**	-0.020	0.125	0.144†	-0.682***	-0.254**			
8	Pay dispersion	0.144†	0.003	0.085	0.024	-0.071	0.289***	0.010		
9	Share of technicians	-0.483***	-0.051	0.143†	0.029	-0.060	-0.106	0.133	-0.200*	
10	Size	0.322***	0.259**	0.094	-0.164**	0.007	0.054	0.000	0.119	-0.108

† $p < .10$; * $p < .05$; ** $p < .01$; *** $p < .001$

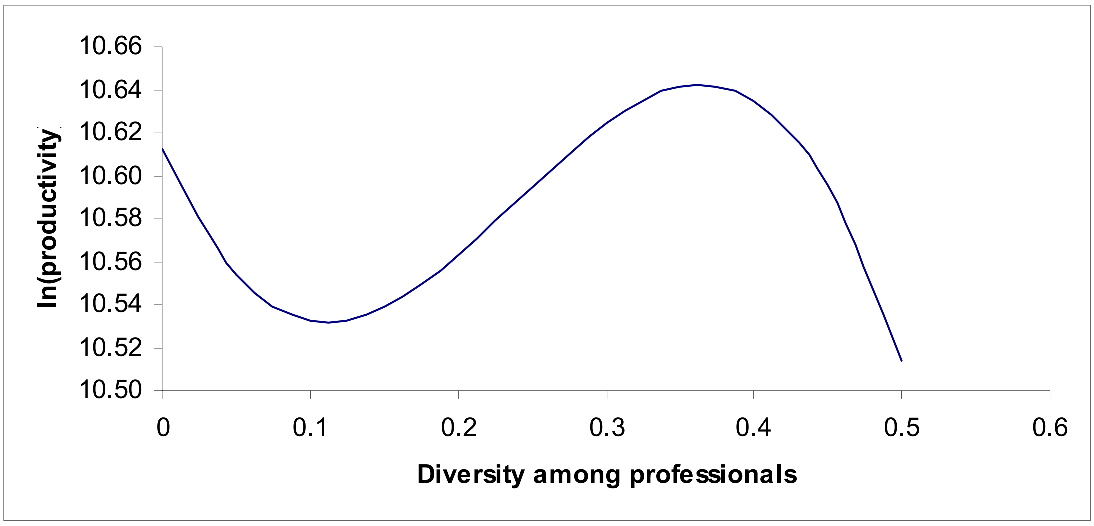
TABLE 3

Regression results explaining firm performance in engineering consultancies by means of human resource characteristics and pay profiles

	3SLS all firms				3SLS small firms				3 SLS large firms			
	Profit		Labor Productivity		Profit		Labor Productivity		Profit		Labor Productivity	
	Coeff.	Std. Error	Coeff.	Std. Error	Coeff.	Std. Error	Coeff.	Std. Error	Coeff.	Std. Error	Coeff.	Std. Error
Productivity	1.222	0.815			1.799	1.313			3.637 ***	0.786		
Diversity of professionals			-1.635 *	0.745			-0.208	1.715			-3.161 **	1.122
Diversity of engineers			-0.945	0.572			-1.073	1.132			-0.417	0.703
Diversity of professionals squared			9.625 *	4.755			-0.496	11.223			18.879 **	6.959
Diversity of engineers squared			4.040	2.450			3.167	5.019			2.723	2.938
Diversity of professionals^3			-13.499 †	7.490			1.217	17.390			-25.230 *	10.912
Diversity of engineers^3			-3.922	2.694			-2.770	5.594			-2.835	3.247
General experience	-0.083	0.085	0.006	0.024	0.058	0.117	0.002	0.041	-0.144	0.165	-0.019	0.049
General experience squared	0.003	0.003	0.000	0.001	-0.002	0.004	0.000	0.001	0.005	0.005	0.000	0.002
Firm experience	1.709	1.364	0.347	0.389	4.858 *	2.258	0.275	0.699	-3.030	2.164	0.710	0.669
Firm experience squared	-1.384	1.671	-0.343	0.478	-4.929 †	2.613	-0.510	0.804	5.515	3.350	-0.956	1.025
Pay level	0.079	0.583	0.455 ***	0.120	0.148	0.816	0.399 *	0.187	-2.053 †	1.089	0.687 *	0.259
Experience pay	-5.208	4.221	2.268 *	1.033	-3.228	5.836	2.162	1.565	-30.219 **	10.837	4.867 †	2.893
Experience pay squared	-114.801 *	50.093	-2.626	13.873	-63.873	61.693	-0.528	20.159	-516.948 *	208.126	37.346	61.121
Tenure pay	-0.373	2.057	1.503 ***	0.439	-0.193	2.736	1.262 †	0.658	-5.638	3.805	2.480 **	0.926
Tenure pay squared	-8.617	5.798	2.217	1.529	-6.760	7.118	1.322	2.228	-22.459	15.450	5.208	4.556
Pay dispersion (RMSE)	-0.142	0.741	0.207	0.205	-0.812	0.990	0.039	0.311	-0.846	1.399	-0.157	0.431
Share of technicians	0.165	0.759	-0.561 **	0.189	-0.610	1.255	-0.740 *	0.347	2.146 *	0.930	-0.142	0.298
Size	0.032 †	0.019	-0.002	0.006	0.575	2.205	-0.546	0.677	0.035 *	0.016	0.007	0.006
Industry dummy	-0.006	0.250	0.009	0.071	-0.183	0.720	0.022	0.241	-0.152	0.235	0.022	0.071
Year 1999	-0.193	0.251	0.053	0.070	-0.327	0.710	0.099	0.230	-0.416 †	0.229	0.045	0.071
Intercept	-18.001 **	8.910	10.613 ***	0.700	-27.140 †	14.564	11.192 ***	1.142	-36.913 ***	8.151	9.529 ***	1.397
No obs		132				59				73		
System R^2		0.26				0.36				0.38		
2SLS *F*-test	2.69 **		3.32 ***		2.18 *		1.37		3.43 ***		3.05 **	

† $p < .10$; * $p < .05$; ** $p < .01$; *** $p < .001$

FIGURE 1
Educational diversity among professionals and productivity. ALL firms



APPENDIX

APPENDIX FIGURE

Educational diversity among professionals and productivity. LARGE firms