Human capital revisited: the role of experience and education when controlling for performance and cognitive skills

Pieter Serneels
University of East Anglia

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Abstract[1]

Human capital theory predicts that differences in wages arise because of differences in human capital. The latter can be accumulated in two ways: through experience and education. Using matched firm - worker data for the Ghanaian Manufacturing sector we test whether changes in wages over the life cycle reflect changes in performance, following the methodology of Medoff and Abraham (1980, 1981), and find that they are independent, which contradicts human capital theory. This result holds when controlling for firm fixed effects, and is confirmed by further analysis. When we include a control for on-the-job-training in the wage equation, it does not attenuate the seniority profile, which is also at odds with human capital theory. We do find however that firm characteristics play an important role. Wage-seniority profiles are steeper in large firms, but performance profiles are not, suggesting that while human capital theory may have limited explanatory power in large firms, as shown by Medoff and Abraham, it may have more explanatory power for small firms. We then assess the role of education and find, using data on cognitive ability, that the effect of education on wages is at least partially because it signals cognitive ability, and that the returns to education are not related to performance, while the returns to cognitive ability are. Education is, however, important for the allocation to job levels.

Key words: wage profile, individual productivity, performance appraisal
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1. Introduction

Human capital theory argues that changes in wages arise because of differences in human capital. Assuming that changes in wages reflect changes in productivity, it claims that accumulation of human capital increases productivity, and thus wages. Human capital is accumulated in two ways: through experience and education. More experienced and more educated workers are therefore expected to earn more (see for example Becker 1964, Mincer 1974).

Empirical evidence confirms that there is a positive relationship between wages and experience, and between wages and education[2], but, as is well known, these may by explained by alternative theories.[3] Regarding the positive relationship between wages and experience, an alternative view is that changes in earnings are unrelated to changes in productivity, but arise from institutional factors, like explicit or implicit contracts (see for example Lazear 1979, Doeringer and Piore 1971, Azariadis 1979). In the case of education, an alternative view is that schooling does not necessarily increase human capital but that it works as a signalling device, implying that students with higher cognitive ability reach higher levels of education (Spence 1973).

How to test between human capital theory and these alternative views? Regarding the effect of experience, to test accurately whether changes in wages reflect changes in

[2] Some authors doubt that the positive relationship between wages and experience has been shown beyond reasonable doubt (see for instance Felli and Harris 1996), while others argue that the relationship is spurious (see for example Abraham & Farber, 1987 and Altonji and Shakoto 1987). However, as underlined by Flabbi and Ichino (2001), even in the most conservative case, the 'true' effect of experience on wages is estimated to be 11% per year. In this paper we therefore accept that the positive relationship holds, as this is also the case for our data. Similarly, we accept that there are positive returns to education, as this is well illustrated to hold in many settings (see Psacharapoulos and Patrinos 2004), including in most African countries (see for instance Appleton, Hoddinot and Krishnan 1999), and it is also confirmed for our data.

[3] For clarity of exposure, we present polarized views, considering only the two 'extremes'.

productivity over the life cycle, one needs data on earnings and performance at the individual level. Data on individual productivity is, however, still uncommon, as a measure of individual output is costly to collect and also difficult to apply to most production processes.[4] However, an alternative approach, often used in personnel psychology, is to measure individual performance through the assessment of the worker's supervisor (see Sacket et al, 1988). This is the approach followed by Medoff and Abraham (henceforth MA) in their seminal papers in the Quarterly Journal of Economics (1980) and the Journal of Human Resources (1981). MA argue that, if human capital theory holds, including performance evaluation in the wage equation should reduce the effect of seniority on wages. They find that it does not.

Two recent papers have sought to reproduce these results. Flabbi and Ichino (2001) complement supervisor's evaluation with 'more objective' measures like recorded absenteeism and misconduct, and reach a similar conclusion. Dohmen (2004) shows, using data for a large Dutch firm, that seniority-wage profiles are largely independent

[4] Although there is some innovative work trying to measure output at the individual level - see for instance Bandiera, Barankay and Rasul 2005, who analyse the effect of incentives schemes on individual output for fruit pickers - most studies analyse productivity profiles on a more aggregate level, namely for groups of workers or indeed for the firm's entire workforce. A common approach is to predict productivity for each worker using a firm level production function [see for example Hellerstein and Neumark (1993), Hellerstein, Neumark and Troske (1993), Bigsten et al (2000), Jones (2001)], but the obtained variable is the average for a group of workers. Because one can only enter a limited number of categories in the production function it becomes also complicated to simultaneously analyse the effect for different - overlapping - characteristics. While taking the average may reduce the measurement error, it also suppresses heterogeneity, reducing variation across firms and potentially leading to results that are wrongly significant in a second stage regression of productivity on individual characteristics. A second method often used in the absence of a direct measure of individual productivity is to include the average of individual workers' characteristics in a log linear firm level production function [see Hall and Jones (1999), Bils and Klenow (2000), Bigsten et al (2000), Soderbom et al (2003), for example for years of schooling.] However, the obtained results reflect the effect of the mean years of schooling on firm level productivity, and to compare this with the effect of schooling on wages is ambiguous. The first reflects the average effect of a characteristic of the *entire labour force*, while the second reflects the average effect of an *individual* characteristic. The two are not necessarily the same as the first can be generated from different distributions and depends heavily on the composition of the labour force and on whether a characteristic has external effects beyond the individual. (Certain jobs do not require literacy, but only access to literate people. In this case it is the *presence* of an educated worker that has an effect on firm productivity; and the effect of his education goes beyond the effect on his own productivity. Basu and Foster, 1998 and Valenti, 2001 show that such externalities exist in a household setting.)

of controls for reported performance in cross–sectional wage regressions, and, using panel data, that performance evaluation also shapes life cycle earnings profiles since it affects how fast a worker climbs the firm's career (and wage) ladder. These papers all focus on one or two large firms. Bishop (1987) uses data across a sample of firms, and, applying a different methodology, finds that large and unionized firms have steeper earnings profiles, but not performance profiles.

We collected a measure of performance appraisal identical to the one used by MA. Although the measure remains somewhat controversial for many, research by personnel economists and psychologists provides supportive evidence in favour of the measure, as discussed by MA and by work that has appeared since then, which we will discuss in the next section.

We first reproduce MA's analysis and confirm their results. We also test whether these results are robust for the difference in our sample design by controlling for firm fixed effects, and find that they are. We then extend the analysis by using on-the-job training data. If human capital is accumulated on the job, including a measure for on-the-job training in the wage equation should attenuate the effect of seniority on wages. We find that it does not.

Exploiting the fact that we have data across firms, we further assess the role of firm characteristics. We find that wage-seniority profiles are steeper in large firms, but performance profiles are not, suggesting that the results from MA hold especially for large firms.

To test the second prediction, that higher educated workers earn more because their accumulated human capital increases their productivity, we include a measure for cognitive ability in the wage equation. Other work has followed a similar approach

but has typically focused on the returns to cognitive skills.[5] In our approach we are interested in how including cognitive ability in the wage equation affects the coefficient of schooling. If the main function of the education system is to screen more cognitive able students (rather than to accumulate human capital), including this measure should reduce the effect of schooling on wages. Using a non-verbal test for cognitive ability (IQ) that is commonly used in cognitive psychology, we find that its inclusion reduces the effect of education, suggesting that schooling works as a screening device. We also find evidence that the returns to cognitive ability, rather than those to education, are related to performance.

The next section discusses the context, data, and key variables. In section 3 we assess the role of experience, both reproducing and extending the analysis carried out by MA. Section 4 analyzes the role of education, while section 5 concludes.

2. Context, data and measurement

We use data from the Ghana Manufacturing Enterprise Survey 2000, collected by a team from Oxford University in co-operation with Ghana Statistical Services. The survey revisits firms that were interviewed before. The initial sample of firms was based on the Census of Manufacturing Activities, and represents firms located outside the household. Within each firm a maximum of ten workers was selected randomly from a list of all workers, stratified by occupation. A detailed description of the sample can be found in appendix.

[5] See for instance Cawley et al (1993), Farkas et al (1997), Murnane (1995). Bowles, Gintis and Osborne (2001) provide a further overview.

There are a number of reasons why it is interesting to look at a developing country. Since the analysis carried out by MA has not been applied to data from a developing country before, our study provides a further test whether the results hold in a different context. Having data across firms in a developing country also allows to analyze the role of firm characteristics. For example, it has been argued that small firms in developing countries operate in an environment that is closer to the competitive model, as institutions and regulations are less enforced (see for example Maloney 2003). The data allows us to verify whether the predictions of human capital theory hold better in this more competitive (as opposed to institutionalized) environment. Finally, empirical analysis of labour markets in developing countries remains relatively scarce, and this work contributes to a better understanding of how labour markets in developing countries function. A general characteristic of these markets, especially in Africa, is that 'good' jobs, with relative high earnings, exist alongside 'bad' jobs, with relatively low earnings (see for instance Rosenzweig 1988). A question that remains unaddressed, however, is whether this gap in wages is explained by institutions or whether it reflects a fundamental difference in performance.[6]

The data has rich information on firm characteristics and on worker characteristics for a sample of workers in each firm. Table 1 reports the descriptive statistics for 543 male workers coming from 92 firms, both large and small. The average firm employs

[6] Elsewhere in the literature this is sometimes referred to as testing whether labour markets in developing countries are segmented or competitive (see for example Magnac 1991). Indeed if differences in wages reflect differences in performance, the competitive model cannot be rejected, while if they are largely explained by institutions, the competitive model has limited explanatory power. But as argued by Heckman and Sedlacek (1985) testing for labour market segmentation is difficult because of the presence of unobserved characteristics. However, having data on performance allows for testing the key assumption that underlies the competitive model - that wages reflect performance. In that sense our approach offers an alternative way of testing whether the competitive model holds.

145 workers, but the majority of firms are relatively small.[7] In 46% of the firms at least one worker is a member of a trade union. Regarding worker characteristics, we have two measures on work-experience: experience before the current job – which we will call experience, and time in the current job, which we will call tenure. The average worker is 37 years old, has six years of experience before this job and has had nine years of tenure in the current firm. The majority of workers have completed middle school or above and 46% of the workers have received on the job training.

During the data collection we paid special attention to gathering detailed and reliable information on earnings. What we call wages in the remainder of this paper represents all income from the current job, including wage and allowances received in cash or kind. The latter includes allowances for food, housing, clothing and transport; as well as Christmas, production or merit bonus, and other gifts from the employer received during the last year. The average monthly payment is 67 USD and its distribution is skewed to the right (see Figure 1a).

Our measure of performance evaluation is identical to the one used by Medoff and Abraham (1980). We collected this information for each worker from his direct supervisor using a well-defined scale from one to six. Table 2 reproduces the exact question. Having surveyed these firms every two years for the last decade, we have developed a close working relationship with the managers, who keenly accepted our proposal to collect this information. Supervisors were briefed in detail and asked to evaluate the workers with great accuracy. The average performance appraisal is Good (3), and the distribution is strongly skewed to the right (see Figure 1b).

[7] The median is 46, the third quantile 157.

Though personnel economists have increasingly accepted the usefulness of this approach, the measure remains controversial for many economists. The main concern is that since the appraisal is carried out by different supervisors, who each use their own norm and threshold, the measure has no strong relationship with an objective measure of performance, and is therefore not comparable across supervisors or firms. MA provide evidence in support of the measure, quoting among others early empirical work which, using lab experiments, indicates that supervisors tend to agree on the score and that there is a high degree of 'inter-rater reliability' (see Borman, 1978 and Whitlock, 1963). More recent work, available since MA, provides further supportive evidence. Bommer, Johnson, Rich, Podsakoff and Mackenzie (1995) review the existing work in this field carrying out a meta-study and conclude that performance appraisal is highly correlated with economic performance. [8] Bishop (1987) argues that the widespread use of formal performance appraisal itself testifies that 'most employers believe they can rate the productivity of their employees'.

To address the concern that performance appraisal is comparable across firms we regress the firm's average output per worker[9] on the firm's average score of performance evaluation. We observe a strong positive relationship, with a slope of 1.26 (standard deviation 0.26) that is significantly different from zero at the p=0.00 level.[10] Figure 2 plots the relationship, illustrating that firms with more productive

[8] Much of the psychological literature looks at how the measure is related to *psychological*, rather than *economic* performance. Bommer et al (1995) argues that the correlation of performance evaluation with 'objective performance' depends on how the latter is defined and concludes that studies measuring performance in an economic sense find a high correlation [for example Nathan and Alexander (1988), McEvoy and Cascio (1989), Viswesvaran and Schmidt (1993), Carson et al (1991)].

[9] Defined here as the log of firm output divided by the number of workers in the firm.

[10] If we leave out the two outliers with a high output per worker, the slope is 0.95 (sd 0.18) and is still significantly different from zero at the p=0.00 level.

workers also have a higher average performance evaluation. This suggests that the measure of performance evaluation is related to worker productivity and is comparable across firms. Since "at the micro level, productivity remains very much a measure of our ignorance"[11], performance evaluation seems a useful proxy for productivity, despite its shortcomings.

In line with the analysis carried out by MA, we control for the employee's grade level, which reflects the different levels of hierarchy and identifies the typical career paths within the firms. We distinguish six categories varying from lowest ranked production and service workers to the highest ranked professionals and managers. Table 1 summarizes the distribution of workers across grade levels.

We extend the analysis of MA by including a measure of on-the-job training. A common assumption for human capital theory is that a worker's experience (or tenure) reflects human capital accumulated on-the-job. We asked workers directly whether they received on-the-job training, which enables us to assess the relationship between experience (tenure) and wages when controlling for on-the- job training.

To evaluate the effect of education, we also collected information on cognitive ability, but only for a sub-sample of workers. [12] To measure cognitive ability independent of schooling achievements (numeracy and literacy), we conducted a Raven's matrix test.

[11] From Bartelsman and Doms, 2000, Journal of Economic Litearture, p586.

[12] The logistical cost of organizing these tests forced us to limit ourselves to a sub-sample of workers. 96 male workers or 18% of the male workers took the tests. The participants for the tests were selected randomly from the list of workers that we had interviewed. We assessed a potential selection bias post factum and found that older individuals are over-represented. The main consequence is that in the models that include cognitive ability, the coefficient on experience is upwards biased and has a large standard error. However, including a self-selection term in each of the regressions does not change the results. (The selection equation of this Heckman model contains additional variables like 'being married', 'working full time' and 'having a motor bike' to identify a potential selection bias, as the tests were conducted after working hours.)

This is a non-verbal IQ test where the proof person is required to match pictorial patterns; the test has been widely used in both industrialised and developing countries.[13] The test score reveals the subject's reasoning ability, independent of literacy and numeracy skills (see Raven, Raven and Court, 1998). We also carried out tests on mathematics and English reading, which were adapted to the Ghanaian curriculum with the help of researchers from Leghon University, Accra.[14] Average scores on the tests are 59% (standard deviation 23) for the Raven's matrix test, 50% (21) for mathematics and 61% (24) for English reading.

3. The role of experience

Reproducing the results from MA

To get a better idea of the raw relationship between wages and performance appraisal we first regress wages on performance evaluation without controlling for other variables. The results, reported in Column 1 in Table 3, indicate a strong relationship: those with superior performance earn on average 20% more than those with satisfactory performance or lower, while those with excellent performance earn on average 25% more (both significant at the 5% level).

[13] For a list of applications, see Raven (1997). The test has among others been used in research in Nigeria, South-Africa and Indonesia and also in economic research in Tanzania and Kenya (Boissiere, Knight and Sabot, 1985), Ghana (Glewwe, 1996), and India (Kingdon, 1994). We adapted the explanation of the test to the local context (for instance, the task was explained as 'to search for the missing part in the pattern of a cloth, as Ghana has a rich culture of colourful textiles with repetitive patterns.

[14] We would like to thank Abena Odura, John Knight and Paul Glewwe for their help. Both tests are based on those used by Boissiere, Knight and Sabott (1985) in Tanzania, and Glewwe (1996) in Ghana, which are shortened and adapted after pre-testing. We test for English rather than another language because it is the language for writing, and school based education is in English, as is formal economic written communication. Akan, Twi, Fantu and other local languages are rarely used in written communication, apart from religious texts.

Next, we run a traditional wage equation. The results, reported in Column 2 of Table 3, show that education has a strong convex effect, similar to the one observed in other African countries (see_Kingdon, Sandefur and Teal 2005). In line with most other studies, experience and tenure have a concave effect with a maximum at 17 years for experience, and 19 years for tenure. [15] The effect of tenure is bigger than the one of experience – a result that holds throughout the analysis - indicating that returns to firm specific skills are higher.

In Column 3 of Table 3 we enrich the traditional wage equation with job grade dummies – this is a reproduction of MA's model. The inclusion of the job grade dummies reduces especially the effect of education, and to a lesser extent that of experience and tenure. These results are consistent with MA, and the reproductions thereof by Flabbi and Ichino (2001) and Dohmen (2004), and indicate that education plays an important role in the allocation of workers to a job level. These results are also consistent with those obtained from other research on the manufacturing sector in Africa.[16]

Adding the performance evaluation variables to the wage equation (see Column 4 of Table 3), does not attenuate the seniority-wage profile: the effects of experience and tenure stay virtually the same. This is also the case when we add the performance appraisal variables to the model without job level variables that we reported in

[15] Most studies find a concave effect (see for example Brown (1989), Topel (1991), Altonji and Williams (1997)), but some find a very small and insignificant effect (see for example Abraham and Farber (1987)).

[16] Benhassine, Fafchamps and Soderbom (2006), using firm-worker matched data on the manufacturing sector in eleven African countries, find that selection across occupations plays an important part in explaining the returns to education.

Column 2 of Table 3 (results not reported). Thus, adding the performance evaluation variables to the equation does not seem to add value. This means that either performance evaluation is entirely determined by the education and experience of the worker, or that performance evaluation is not considered in the wage setting process. The first seems unlikely, and is indeed rejected for our data.[17] We therefore conclude that supervisor's performance evaluation is not taken into account when wages are set.

Our analysis underlines the importance of job grade levels to explain the variation in wages. But the effect of job grade level on wages remains the same after the inclusion of performance evaluation (comparing the results of Columns 3 and 4 of Table 3). This suggests that either job grade levels are fully determined by performance, or that performance evaluation plays no role in wage setting. Further analysis indicates that the relationship between job grade levels and performance is weak[18], and thus from this perspective as well, adding performance evaluation to the wage equation adds little value.

The above results confirm those obtained by previous work, even though we used a different sample design: while existing work uses data on a large sample of workers from one or two firms, our work uses data coming from a large number of firms with a small number of sampled workers per firm. To assess whether our sample design

[17] When we run an ordered probit of performance evaluation on education and experience, these variables are highly insignificant and the pseudo-R squared is 0.007.

[18] A Spearman correlation coefficient is 0.13, although we cannot reject full independence. When we run an ordered probit of performance evaluation on job grade levels, only the highest job grade level has significantly higher performance evaluation. We are of course limited by the cross nature of the data and cannot analyse how past performance evaluation may affect future job grade levels, as Dohmen (2004) does.

affects the results we reproduce the above analysis while taking firm individual effects into account. We find that, when we include firm fixed effects[19], the experience profile falls while the tenure profile remains almost the same and the effect of education is also reduced substantially, as reported in Column 5 of Table 3. When we repeat the above stepwise approach to first add the job grade dummies (Column 6 of Table 3), and then add performance evaluation (Column 7 of Table 3) to the equation, the coefficients of experience and education first drop and then remain virtually the same, leading to exactly the same conclusions as before. MA's findings thus hold, even when we control for firm individual effects.

Summarized, the results indicate that people enter a certain level of job at a certain firm, based on their education and experience, and their earnings increase as they stay longer in the firm. We find no evidence that supervisor's evaluation is taken into account in the wage setting process.

On-the-job training

We carry out a further extension of MA's approach by introducing on-the-job training in the wage equation. According to human capital theory, the positive effects of experience and tenure on earnings reflect the returns to human capital accumulated on the job. Using a dummy variable that indicates whether the worker received on-the-job training or not, we test whether its inclusion affects the seniority profile. The result in Column 1 of Table 4 shows that those who received on-the-job training

[19] We opt for firm fixed rather than random effects as a Breusch Pagan LM test with H_0 that the variance of the random effects equals zero is rejected at 0.01 level. A Hausman specification test of the fixed against the random effects model also rejects similarity of the coefficients at the 0.01 level. However, using random effects leads to the same conclusions.

receive on average 12% higher wages.[20] When we add the on-the-job training variable to the model without performance evaluation, the seniority profile does not change, while the effect of on-the job training remains highly significant, as reported in Column 3 of Table 4. The results remain the same when we add performance evaluation to the model, as reported in Column 4 of Table 4, and suggest two possibilities. It may indicate that seniority is not related to productivity as affected by on-the-job training. Alternatively, it may reflect that on-the-job training does not increase productivity, but serves as a reason to increase wages – for example because training is given to the most productive workers in the first place. Both are at odds with the conjecture that wage increases reflect productivity increases that stem from human capital accumulation on the job.

The role of firm characteristics

As pointed out above, a unique feature of our data is that we have information on workers across different firms, in contrast with MA and other replications thereof, who use data from one or two large firms. [21] This allows us to study whether the observed relationship depends on firm characteristics. Other work indicates that firm size and unionization play an important role in the wage setting process. Since previous work (both MA and previous reproductions) use data on large firms only, their results may only hold for this type of firms. To assess what firm characteristics are important we save the firm individual component of the error term of the model

[20] Here we do not control for firm individual effects, but all results hold when we include firm fixed (or random) effects.

[21] Medoff and Abraham (1980,1981) use data on workers from two large American manufacturing firms counting 4,788 and 2,481 workers respectively; Flabbi and Ichino (2001) use data on 10,809 male employees from the same Italian bank; while Dohmen (2004) uses data on 7,141 workers of the Dutch aircraft manufacturer Fokker.

presented in Column 7 of Table 3, and regress this term on firm characteristics. We consider firm size, firm unionization, firm age and ownership of the firm. Large firms are expected to pay more because they are more productive in the presence of economies of scale (Van Biesebroeck, 2005), because of an efficiency wage argument (Shapiro and Stiglitz 1984) or because of compensating differentials (Masters, 1969). Workers in unionized firms can often negotiate higher wages because they have a stronger bargaining position (Oswald 1987). Firm age has also been found to have an effect on wages, which is explained by the fact that longer surviving firms tend to be more productive (Soderbom,Teal and Harding 2006). Finally, wage setting in public firms can be more constrained than in private firms and therefore we include a variable to control for firm ownership. The results, reported in Table 5 indicate that both in the fixed and random effects model, especially firm size and possibly worker unionization explain the variation in firm individual effects.[22] We proceed by including these two variables directly in the wage equation.

In Column 1 of Table 6 we include both firm size and unionization and find that especially the former has a substantial and highly significant effect.[23] Larger firms pay their workers more. This is in line with other research for Ghana (Söderbom and Teal, 2001) and other developing countries (Strobl and Thornton, 2001). To assess whether firm size and unionization also affect the seniority profile, we add interaction terms between experience and firm size, tenure and firm size, experience and

[22] Because the dependent variable in this regression is predicted, we test whether the regression suffers from heteroscedasticity, but it does not; hence we do not use the Huber/White sandwich estimator for the standard errors.

[23] We consider the degree of firm unionization, rather than individual union membership since wage negotiation takes place at the firm (or sector) level and the resulting agreement also holds for those who are not a union member. Throughout the analysis unionization has a strong and significant effect on its own, but this is attenuated when we introduce firm size. Firm size and unionization are highly correlated (0.66).

unionization and tenure and unionization in the model (see Column 2 of Table 6). We find that large firms have steeper earnings profiles, but the effect is only significant for the interaction with tenure and not for the interaction with experience (before starting in this firm) indicating that workers earn more as they stay longer in the firm.

A possible explanation for this would be that workers in large firms perform better. In Column 3 we add interaction terms between the performance levels and firm size and unionization respectively; but we find no evidence that workers in large firms perform better. Since performance is not determined by experience, as seen before, this suggests that the increase in earnings with seniority in large firms, is not related to an increase in individual performance, but is the product of (implicit) institutional arrangements.[24] The results are in line with those obtained by Bishop (1987), who finds that large firms in the US have steeper wage profiles, but do not have steeper performance profiles. We conclude the findings by MA and its reproductions hold for large firms, but not necessarily for small ones.

4. The role of education

The above analysis shows three results regarding education in our data: (i) that education has a convex relationship with wages; (ii) that it plays an important role in the allocation to a job level and a firm; and (iii) that the effect of education is independent of performance evaluation (including performance evaluation leaves the coefficient of education virtually unchanged while education does not determine performance). To further assess the role of education and whether it builds productive

[24] Some more suggestive evidence on the role of institutions is that married men are paid more, while they do not have better performance evaluations, although it is difficult to separate this effect from a firm size effect as married men tend to work for larger firms.

human capital, we introduce cognitive ability in the basic model. Since we are now using a smaller sample, for ease of comparison we reproduce the basic model in Column 1 in Table 7, starting with the model without job level variables.[25] When we include the IQ variable, we find that its coefficient is significant and large - increasing the test result by 1 percentage point increases earnings by 19 percentage points. Its inclusion also reduces the size and significance of the coefficients of education, as reported in Column 2 of Table 7. This indicates that schooling serves at least partially as a screening device. When we add the performance evaluation variables (see Column 3), like before, the coefficients on the education variables stay largely the same, while the coefficient of cognitive ability falls, suggesting that the returns to cognitive ability are related to performance.

Further support for the importance of cognitive ability is that the results from the IQ test (Raven's matrix test) are highly correlated with the results from the mathematics test (coefficient of correlation of 0.62) and the results from the English reading test (0.58). And when we substitute the cognitive ability variable by these school achievement variables (maths and reading) we obtain very similar results to the above ones, which underlines the role to cognitive ability, rather than accumulated skills.[26]

[25] This is the same model as the one reported in Column 1 in Table 3.

[26] Other work investigating the relationship between wages and cognitive skills mostly focuses on the returns to cognitive skills, and do not always separate cognitive ability from cognitive skills. More importantly, most studies looking at cognitive ability do not include a control for schooling, while we are mostly interested in how the inclusion of cognitive ability affects the coefficient of schooling. Bowles, Gintis and Osborne (2001) follow a similar approach to ours. Summarizing findings for the US, they conclude that introducing cognitive performance (measured by either ability or skills) reduces the coefficient of years of education by an average of 18 percent (-18%). The median is -16 percent and the range is -52 percent to +13 percent. For developing countries, Boissiere, Knight and Sabbot (1990) find that the returns to secondary education in Tanzania and Kenya drop by 60% after including both a control for cognitive ability and cognitive achievement, while Glewwe (1996) finds that the returns in Ghana drop 43%. Both use similar tests as ours. We find that the coefficient drops by 35% for middle school, by 26% for senior secondary and by 18% for tertiary. These are lower than the ones found one decade earlier by Boissiere et al. and Glewwe, and well within the findings for the US.

Including the cognitive ability variable also sheds light on the role of education for the allocation of workers to job levels. We saw before that education plays an important role in this process. In Columns 4-6 of Table 7 we reproduce the results of Columns 1-3 but now including the job level dummies. Including these especially affects the coefficients of the education variables, in particular at higher levels of education, while it has limited effect on the coefficient of the cognitive ability variable. This confirms that education, and not cognitive ability - which remains mostly unobserved- is used as a key to allocate workers to a certain job level.

Summarized, the effect of education on wages operates in two ways. First, education is the key for the allocation to a certain job level, with better educated workers allocated to higher job levels. Second, education serves at least partially as a signalling device for cognitive ability. We also find that performance is related to cognitive ability.

5. Summary and conclusion

Human capital theory predicts that differences in wages arise because of differences in human capital. The latter can be accumulated in two ways: through experience and education. Using matched firm - worker data for the Ghanaian Manufacturing sector, this paper tests two predictions that are associated with human capital theory. In a first part we test whether the changes in wages over the life cycle reflect changes in performance due to changes in human capital accumulated on the job. Using a measure of performance evaluation identical to the one used by Medoff and Abraham (1980,1981), we confirm their result, namely that wage seniority profiles are

independent of performance evaluation. Thus, performance evaluation is not taken into account in the wage setting process. This result holds when we control for firm fixed effects – to account for the fact that our data spans across a sample of firms. We extend the analysis by including a measure for on-the-job training in the wage equation. Although the variable has a positive effect on wages, its inclusion does not attenuate the effect of experience, as expected from human capital theory. This suggests that either on-the-job training serves as a reason to increase wages without increasing performance, or that seniority is not related to productivity. Both are at odds with the human capital interpretation. Exploiting the fact that we have data across firms, we also assess the role of firm characteristics and find that especially firm size plays a role. While seniority profiles are steeper in large firms, performance profiles are not, indicating that the results from existing work – Medoff and Abraham (1980,1981), Flabbi and Ichino (2001) and Dohmen (2004), which all use data on one or two large firms – do not necessarily hold for small firms, where earnings profiles are less steep. Thus, although human capital theory may have limited explanatory power in a more institutionalised setting, like large (and unionized) firms, it may still be powerful in a more competitive environment (like small firms in a developing country).

We also assess the role of education and find that education is important for the allocation to a job level and a firm. The direct effect of education on wages is at least partially because it signals cognitive ability. We find no evidence that the returns to education are related to performance, while the returns to cognitive ability are. Education does, however, play a key role in the allocation of workers to a job level.

The analysis in this paper, like the work of Medoff and Abraham and the reproductions thereof, is based on a measure of performance evaluation. We report evidence in support of this measure, including empirical proof from our own data on the strong relationship between average performance evaluation in the firm and average output per worker. We find that adding performance evaluation does not add value to the wage equation and that education and experience are sufficient indicators to explain the variation in wages. However, caution is needed in the interpretation of their coefficients as the returns to experience and education do not necessarily reflect returns to accumulated human capital.

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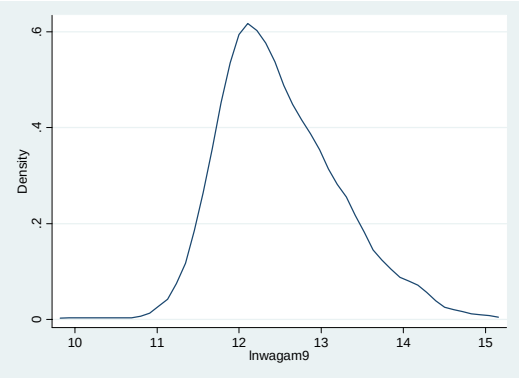
7. Figures and Tables

Figure 1: Distribution of Wages and Performance Appraisal

(a) Wages



(b) performance appraisal

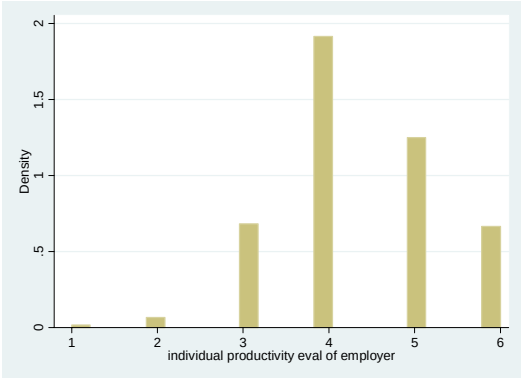


Figure 2: Relationship between Mean Worker Productivity per Firm and Mean Worker Performance Appraisal per Firm

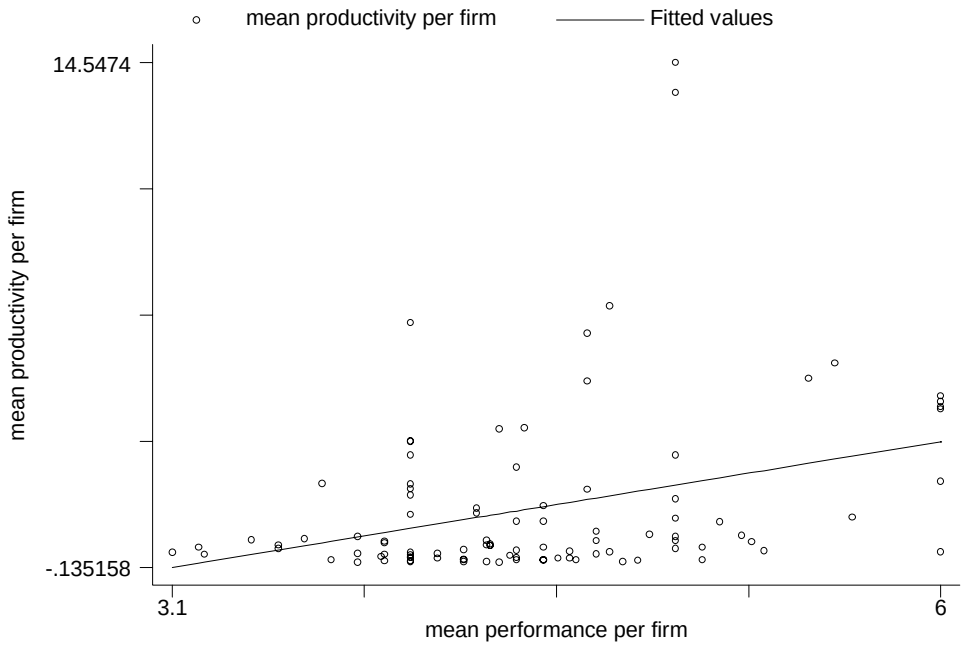


Table 1: Descriptive Statistics

Firms	
Number of firms	92
Average number of workers per firm	145
Average unionization of work force	46%
Workers	
Number of male workers	543
Average monthly payment	67 USD
	(73)
Education levels	
Below primary	8%
Completed primary	3%
Completed junior secondary	8%
Completed middle school	46%
Completed senior secondary	6%
Completed more than secondary	29%
Average age	37
	(11)
Mean experience (before this job) in years/10	0.60
	(0.77)
Tenure (in this job) in years/10	0.90
	(0.76)
On the job training	46%
	(61%)
Performance evaluation	
Unacceptable	0.2%
Minimum acceptable	1%
Satisfactory	17%
Good	41%
Superior	26%
Excellent	15%
Average relative productivity	Good
Grade Levels	
Grade 1	1%
Grade 2	17%
Grade 3	32%
Grade 4	39%
Grade 5	8%
Grade 6	3%

Standard errors in brackets

Table 2: Individual Performance Evaluation

How would you evaluate the performance of the following worker in his/her job?

1 = excellent: consistently exceeds expected performance;

2 = superior: exceeds expectations and demonstrates high level performance;

3 = good: performs as expected;

4 = satisfactory: acceptable performance with ability for improvement;

5 = minimum acceptable: minimum performance level, requires improvement within a designated period of time;

6 = unacceptable: does not perform at an acceptable level.

Table 3: Reproducing the Results from Medoff-Abraham
Dependent Variable is the Log of Wages

	OLS				Firm fixed effects		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Middle school		0.242	0.190	0.199	0.107	0.071	0.073
		(0.080)***	(0.072)***	(0.072)***	(0.069)	(0.056)	(0.055)
Senior secondary		0.283	0.181	0.197	0.085	-0.009	0.001
		(0.124)**	(0.111)	(0.111)*	(0.103)	(0.083)	(0.082)
Tertiary		0.936	0.540	0.550	0.502	0.173	0.172
		(0.087)***	(0.084)***	(0.084)***	(0.078)***	(0.066)***	(0.066)***
Experience in years /10		0.332	0.223	0.217	0.264	0.179	0.156
		(0.087)***	(0.078)***	(0.078)***	(0.072)***	(0.058)***	(0.058)***
Experience in years squared / 10		-0.001	-0.001	-0.001	-0.000	-0.000	-0.000
		(0.000)***	(0.000)***	(0.000)***	(0.000)**	(0.000)*	(0.000)
Tenure in years / 10		0.374	0.330	0.331	0.368	0.363	0.350
		(0.101)***	(0.091)***	(0.091)***	(0.091)***	(0.073)***	(0.073)***
Tenure in years squared / 10		-0.001	-0.001	-0.001	-0.001	-0.001	-0.001
		(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)***	(0.000)***
Performance appraisal 'good'	0.009			-0.062			-0.002
	(0.088)			(0.067)			(0.049)
Performance appraisal 'superior'	0.195			-0.002			0.078
	(0.094)**			(0.073)			(0.055)
Performance appraisal 'excellent'	0.249			0.065			0.180
	(0.108)**			(0.084)			(0.066)***
Job level dummies	no	no	yes	yes	no	yes	yes
Constant	12.412	11.779	11.571	11.586	11.967	11.809	11.773
	(0.074)***	(0.078)***	(0.231)***	(0.234)***	(0.076)***	(0.171)***	(0.171)***
Observations	543	543	543	543	543	543	543
R-squared	0.02	0.29	0.45	0.45	0.20	0.49	0.51

standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%

Table 4: Introducing On-the-Job Training
Dependent Variable is the Log of Wages

	(1)	(2)	(3)	(4)
Middle school		0.190	0.188	0.197
		(0.072)***	(0.072)***	(0.072)***
Senior secondary		0.181	0.169	0.185
		(0.111)	(0.110)	(0.110)*
Tertiary		0.540	0.526	0.537
		(0.084)***	(0.084)***	(0.084)***
Experience in years /10		0.223	0.232	0.227
		(0.078)***	(0.078)***	(0.078)***
Experience in years squared / 10		-0.001	-0.001	-0.001
		(0.000)***	(0.000)***	(0.000)***
Tenure in years / 10		0.330	0.341	0.341
		(0.091)***	(0.091)***	(0.091)***
Tenure in years squared / 10		-0.001	-0.001	-0.001
		(0.000)**	(0.000)***	(0.000)***
Received on the job training	0.121		0.129	0.130
	(0.041)***		(0.039)***	(0.039)***
Performance appraisal 'good'				-0.046
				(0.067)
Performance appraisal 'superior'				0.012
				(0.072)
Performance appraisal 'excellent'				0.080
				(0.084)
Job level dummies	yes	yes	yes	yes
Constant	12.054	11.571	11.564	11.570
	(0.232)***	(0.231)***	(0.229)***	(0.232)***
Observations	543	543	543	543
R-squared	0.37	0.45	0.46	0.46

Standard errors in parentheses, * significant at 10%; ** significant at 5%; *** significant at 1%

Table 5: Regressing Firm Individual Effects on Institutional Variables
Dependent Variable is the Firm Fixed Effect

	Fixed effect component of the error term	Random effect component of the error term
Firm size	0.203	0.167
	(0.016)***	(0.013)***
Percentage unionized	-0.001	-0.001
	(0.000)	(0.000)**
Firm age	0.001	0.001
	(0.001)	(0.001)
Firm is state owned	0.158	0.134
	(0.104)	(0.089)
Constant	-0.864	-0.671
	(0.066)***	(0.057)***
R-squared	0.30	0.28

Table 6: Introducing Firm Size and Unionization
Dependent Variable is the Log of Wages

	(1)	(2)	(3)
Middle school	0.100	0.116	0.111
	(0.070)	(0.071)	(0.071)
Senior secondary	0.047	0.064	0.081
	(0.108)	(0.107)	(0.107)
Tertiary	0.349	0.371	0.357
	(0.083)***	(0.084)***	(0.084)***
Experience in years /10	0.117	0.140	0.128
	(0.075)	(0.143)	(0.142)
Experience in years squared / 10	-0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)
Tenure in years / 10	0.211	-0.022	-0.002
	(0.088)**	(0.127)	(0.126)
Tenure in years squared / 10	-0.000	-0.001	-0.001
	(0.000)*	(0.000)**	(0.000)**
Performance appraisal 'good'	-0.049	-0.037	0.253
	(0.064)	(0.064)	(0.238)
Performance appraisal 'superior'	0.025	0.036	-0.212
	(0.070)	(0.070)	(0.254)
Performance appraisal 'excellent'	0.180	0.182	0.001
	(0.082)**	(0.081)**	(0.290)
Firm size	0.194	0.141	0.128
	(0.021)***	(0.038)***	(0.059)**
Percentage unionized	-0.000	-0.001	0.001
	(0.001)	(0.001)	(0.002)
Experience X firm size		0.003	0.009
		(0.030)	(0.030)
Tenure X firm size		0.052	0.049
		(0.027)*	(0.027)*
Experience X % unionized		-0.000	-0.001
		(0.001)	(0.001)
Tenure X % unionized		0.001	0.001
		(0.001)	(0.001)
Performance 'good' X firm size			-0.046
			(0.058)
Performance 'superior' X firm size			0.095
			(0.060)
Performance 'excellent' X firm size			0.040
			(0.077)
Performance 'good' X % unionized			-0.001
			(0.002)
Performance 'superior' X % unionized			-0.003
			(0.002)*
Performance 'excellent' X % unionized			0.001
			(0.002)
Job level dummies	yes	yes	yes
Constant	10.867	11.074	11.037
	(0.230)***	(0.247)***	(0.322)***
Observations	543	543	543
R-squared	0.54	0.55	0.57

Robust standard errors in parentheses, * significant at 10%; ** significant at 5%; *** significant at 1%

Table 7: The Role of Cognitive Ability
Dependent Variable is the Log of Wages

	(1)	(2)	(3)	(4)	(5)	(6)
Middle school	0.278	0.180	0.212	0.237	0.153	0.187
	(0.197)	(0.203)	(0.214)	(0.191)	(0.197)	(0.207)
Senior secondary	0.485	0.358	0.369	0.341	0.234	0.247
	(0.277)*	(0.284)	(0.289)	(0.267)	(0.273)	(0.278)
Tertiary	0.805	0.657	0.688	0.546	0.428	0.460
	(0.224)***	(0.237)***	(0.241)***	(0.230)**	(0.240)*	(0.244)*
Experience in years /10	0.137	0.213	0.194	0.091	0.161	0.141
	(0.198)	(0.201)	(0.203)	(0.193)	(0.196)	(0.198)
Experience in years squared / 10	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Tenure in years / 10	0.364	0.407	0.374	0.211	0.255	0.227
	(0.216)*	(0.215)*	(0.222)*	(0.210)	(0.210)	(0.217)
Tenure in years squared / 10	-0.000	-0.001	-0.000	-0.000	-0.000	-0.000
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Raven's matrix test result		0.192	0.145		0.169	0.125
		(0.111)*	(0.115)		(0.107)	(0.111)
Performance appraisal 'good'			0.028			0.036
			(0.172)			(0.164)
Performance appraisal 'superior'			0.231			0.216
			(0.186)			(0.178)
Performance appraisal 'excellent'			-0.018			-0.021
			(0.197)			(0.193)
Job level dummies	no	no	no	yes	yes	yes
Constant	11.795	11.263	11.330	11.797	11.322	11.385
	(0.166)***	(0.349)***	(0.371)***	(0.180)***	(0.350)***	(0.375)***
Observations	96	96	96	96	96	96
R-squared	0.28	0.30	0.32	0.37	0.39	0.40

Standard errors in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

8. Appendix

The data used in this paper were collected by a team from Oxford University, in which the author participated, in cooperation with Ghana Statistical Services. The data collection is part of an on going effort to build a long panel data set on firms and workers for the Ghanaian manufacturing sector. The initial sample was drawn from 1987 Census of Manufacturing Activities. The sample was stratified by size, sector and location. Four size categories were used: micro firms, employing less than five employees; small firms, employing between 5 and 29 workers; medium firms, employing between 30 and 99 persons, and large firms, employing more than 100. Large enterprises were over-sampled. Two other criteria for stratification were sector and location. The initial focus was on four sectors that represent 70% of employment: food, textiles and garments, wood and metal. Since textiles and wood have relatively large firms while furniture and garments are dominated by small firms, a finer classification was used eventually. The localities were Greater Accra, Kumasi, Takoradi and Cape Coast. Firms that had gone out of business were replaced by firms of the same size category, sector and location. Teal (2000) discusses in how far the data is representative for the sector, considering conflicting evidence from the Population Census and Industrial Census, and concludes that the data reflect the situation for manufacturing enterprises located outside the household. Unfortunately there is no more up-to-date information to use population weights in our estimates.

Within each firm a maximum of ten workers and ten apprentices was selected from a complete list, stratified by occupation to cover the full list of firm employees. The interviews were conducted in private in or near the workplace. The 2000 data also collected information on performance evaluation, but there is no past data available for this variable. In the 2000 round a sub sample of workers was randomly selected, with the approval of the employer, to participate in cognitive skills and IQ tests, which were conducted after working hours (during the evenings or weekends) in a nearby school. The participants received a small monetary incentive to reimburse their travel expenses. This paper only considers male workers, and excludes apprentices and female workers from the analysis.