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Do Wages reflect Productivity?

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Abstract

We investigate wage and productivity profiles in the Ghanaian Manufacturing sector using matched firm and worker data. Following Medoff and Abraham (1980,1981), we use performance appraisal as our measure of individual productivity. Controlling for a wide range of human capital variables, including cognitive skills, we find that on average wage profiles do reflect productivity profiles. However, wages are steeper in large and unionized firms. This suggests that human capital theory holds for small and non-unionized firms, but that not hold for large and unionized companies.

Key words: wage profile, individual productivity, performance appraisal
JEL classification: J24, J31

1. Introduction

Twenty years ago Medoff and Abraham investigated wage and productivity profiles over the life cycle using performance evaluation as a measure of productivity at the individual level (Medoff and Abraham 1980, 1981). They found that wages do not necessarily reflect productivity. Although their findings triggered off substantial discussion, it is hard to find work that reproduces or contradicts the results using a measure of individual productivity. We find only two papers that study productivity at the individual, using a similar method: Bishop (1987) and Flabbi and Ichino (1998). Nevertheless, as Bartelsman and Doms (2000) state in their review in the Journal of Economic Literature '… at the micro level, productivity remains very much a measure of our ignorance.' (p586).

Other studies analyse productivity profiles on a more aggregate level, namely for groups of workers or indeed for the entire workforce of a firm. 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)]. However, the obtained variable is the average for a group of workers. [1] Although taking the average may reduce the

[1] It is the average per category, as entered in the production function. For example if one studies the returns to education, the labour component in the production function is split into different components, one for each level of education. The obtained estimate reflects the average returns for that level of education. A draw back is that one can only enter a limited number of categories in the production function because it becomes quickly too complicated (even more so if one wants to test the translog specification which includes interaction terms - see Berndt and Christensen 1972). It becomes especially complicated when one wants to simultaneously analyse the effect for different (overlapping) characteristics, like for example education and gender. Another problem with including many categories is that is more likely that a category has zero observations for some cases, which makes the variable undefined when taking the log. The correction that is sometimes applied is to add one, but this

measurement error, it also suppresses heterogeneity. The group average may therefore have less variation across firms than productivity measured at the individual level. A (second stage) regression of productivity on individual characteristics may then result in coefficients that have lower significance.[2] This shows the attraction of a direct measure of individual productivity: It allows a more precise analysis, and should give a more accurate understanding of the determinants of productivity at the individual level. It should also increase our understanding of whether wages reflect productivity, and more general, how labour markets work.[3] However, the question is not *whether* it is useful to investigate productivity at the individual level, but *how to measure it*.

The ideal measure of individual productivity is a measure of individual output. Even though there seems to be a renewed interest in this approach among economists [4], most of the work in this area has been done by personnel psychology [see Sacket et al (1988)]. The difficulty with measuring individual output is that not all production

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biases the results, in particular when there are other firms with a small number of observations in the considered category.

[2] A second method to obtain a prediction of individual productivity is to include the average of individual worker's characteristic in a log linear firm level production function (see Hall and Jones (1999), Bils and Klenow (2000), Soderbom and Teal (2002)), for example the years of schooling. [see for example Bigsten et al (2000), Söderbom and Teal (2001).] The obtained result reflects the effect of the mean years of schooling on firm level productivity. 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. The first one can be generated by different distributions and depends heavily on the composition of the labour force and on whether a characteristic has external effects beyond the individual. Take the example of education. Certain jobs do not need 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. There is convincing evidence that such externalities exist in households, as shown by Basu and Foster (1998) for India and Valenti (2001) for South Africa. It seems reasonable to expect that such externalities also play a role in a firm. [Further more, this approach does not solve the small sample problem when we want to allow for group specific effects. When for example we want to investigate whether the mean years of schooling has a different effect for female and male workers, the sample will still have missing values for firms without female workers. Not allowing for different age effects for male and female workers will give biased results] The problem with both approaches is that a productivity figure obtained from aggregate data is compared with the wage figure, obtained from individual data

[3] It may for example shy a new light on why a firm hires worker A rather than worker B since we expect that employers will decide based on comparing his wage with his expected productivity.

[4] see for example Bandiera, Barankay and Rasul (2005)

processes lend themselves to this type of measurement, and if they do, that the measure is costly to obtain. Other methods have therefore been developed. A popular measure is to consider individual performance using the personal assessment of the worker's supervisor. Bommer et al. (1995), in their meta study, indicate that individual performance assessment, in spite of its shortcomings, is a successful measure. Medoff and Abraham (1980,1981) were the first to use this type of measure for economic analysis. We replicate their study in a different setting. Using the same evaluation tool - a well-defined ordinal scale for the evaluation of individual performance by the worker's supervisor – we investigate the determinants of individual performance for a large sample of workers from different firms. We then investigate whether changes in wages reflect changes in individual productivity. If this holds, it is interpreted as supportive evidence for human capital theory: workers accumulate human capital over time and therefore earn more as they grow older. Medoff and Abraham (1981), as well as Flabbi and Ichino (1998) find that wages have a steeper profile than productivity measured at the individual level, indicating that wages are determined by other factors than human capital. However, both papers use data from one or two firms only. Using a large sample of firms we find that changes in wages *do* reflect changes in productivity in small and non-unionized firms, but less so in large and unionized ones. This confirms results obtained by Bishop (1987).

The paper has six sections. In the next section we describe the Ghanaian context and data while Section 3 describes the econometric method and measurement. Section 4 reports the empirical results and Section 5 summarizes and concludes.

2. The Ghanaian 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 the Ghana Statistical Office. The advantage of using data from a developing country is that small firms, which are a substantial part of the sample, operate in an environment that is closer to the competitive model, as argued by Maloney (2003). This allows us to see whether wages reflect productivity in this sub set of firms. The data has rich information on the firm and has matched data for a sample of workers in each firm. Table 1 reports the descriptive statistics. The survey contains firms from the most important sub-sectors in manufacturing; all firms are located in one of the four centres of economic activity: Accra – the capital, Kumasi - the capital of the Ashanti region, Takoradi, an important port in the country, and Cape Coast.[5] We use a sub-sample of 666 workers coming from 82 firms. Our sample contains both small and large firms. The average firm employs 99 workers, but the majority of firms are small. In 46% of the firms there is at least one worker member of a trade union. Average revenue per firm is close to 3,400,000 USD and average value added around 500,000 USD. The bottom part of Table 1 reports the descriptive statistics for the workers in our sample. Four fifth of the labour force is male and the majority are skilled workers. The average worker is 37 years old and has 11 years of schooling. Average monthly payment is 67 USD and average performance appraisal by their supervisor is Good (3).

[5] Details of the sample are described in Teal (1996)

Our measure of individual productivity is the same as the one used by Medoff and Abraham (1980). The direct supervisor was asked to evaluate the worker on a scale from one to six to evaluate his performance.

Table 2 reproduces the exact question with each of the six possible replies carefully defined. Having surveyed these firms every two years for the last decade, we have developed a relationship with the managers, who keenly accepted our proposal to collect precise information on individual performance. Both the manager and supervisors were briefed in detail and asked to evaluate the workers with great accuracy.

The data also has rich information on different aspects of the workers' human capital. Apart from years of schooling, we have information on the main subject of the curriculum, the quality of the school and educational achievements. To obtain the latter we carried out a test on mathematics and English reading with a subset of the workers.[6] The tests are a short version of those used in Tanzania by Boissiere, Knight and Sabott (1985) and replicated in Ghana by Glewwe (1996).[7] To measure cognitive ability independent of schooling achievements, we also conducted a Raven's matrix test which has been widely used in research in both industrialised and developing countries [see Raven, Raven and Court, (1998)]. The tests requests the subject to match pictorial patterns; the score reveals the subject's reasoning ability, independent of literacy and numeracy skills [see Raven (1997)].[8] As reported in Table 1, the

[6] 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.

[7] We shortened them after pretesting.

[8] The test is widely used in psychological research in both rich and developing countries [for an overview see Raven (1997), a.o. others in Nigeria, South-Africa, Indonesia) and more recently also in economic applications, a.o. in developing countries (see for example Boissiere, Knight and Sabot

average score, out of 100, is 53% for mathematics, 64% for English reading and 60% for Raven's matrix test. [9]

Because most workers are engaged in manual labour, and given the high incidence of health poverty in Ghana, we also collected information on physical health. We measured the individuals to obtain their height, which is widely used in poverty and health economics to measure the 'stock' of health built up over the years.[10] We also have information on tenure and other characteristics like household background and ethnicity.

Is our measure of individual productivity an accurate measure? The literature in personnel psychology has a long tradition using measures of performance appraisal and has over the years debated the potential shortcomings of this type of measure. Medoff and Abraham (1980) present the arguments pro and contra in detail and conclude that their measure can be used as a proxy for relative productivity. Flabbi and Ichino (1998) come to a similar conclusion for their data. We summarise the arguments and provide updated evidence where available. 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 objective measures of performance, and is therefore not comparable across individuals or firms. Whether the measure is comparable has received attention in the early literature. Both Borman (1978) and Whitlock (1963) have shown in lab experiments that supervisors tend to

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(1985) for Tanzania and Kenya; Glewwe (1996) for Ghana; Kingdon (1994) for India.) The explanation of the test was adapted to the local context. The task was explained as 'to search for the missing part in the pattern of a dress'.

[9] Although the test results have some correlation, it is not as high as one may expect. Maths and English have a correlation coefficient of 0.69, maths and matrix of 0.57 and matrix and English of 0.44.

[10] See for example Behrman & Rosenzweig (2001) and Micklewright & Ismail (2001)

agree on the score and that there is a high degree of ‘inter-rater reliability’. More recent and more comprehensive evidence, provided by the meta study from Bommer, Johnson, Rich Podsakoff and Mackenzie (1995) argues that the correlation depends heavily on how objective performance is measured. Most psychological studies define ‘objective performance’ in terms of psychological functioning rather than economic productivity. However, the studies that measure performance in the economic sense of productivity find a high correlation [(see Nathan and Alexander (1988), McEvoy and Cascio (1989), Viswesvaran and Schmidt (1993)] and also provide strong evidence that outcomes at the bottom of the performance distribution are caused by poor productivity and not by other factors [see Carson et al (1991)].

One way to address this concern for our data is to analyze the relationship between the firm average in performance appraisal and the average worker productivity per firm. When we regress the firm’s average score of performance evaluation on firm output per worker[11], we observe a strong positive relationship, as shown in Figure 1, indicating that firms with a higher average performance evaluation also have more productive workers on average. The slope is 1.26 (standard deviation 0.26) and is significantly different from zero (at the p=0.00 level). 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). This confirms that the measure of performance appraisal is related to productivity and that it is comparable across firms.

[11] We take the log of firm output and divide it by the number of workers.

3. Econometric method

To compare the profiles of wages and productivity over the life cycle, we first model wages and then apply the same model to productivity. Finally we compare both sets of results after making them comparable. By modelling wages and productivity separately we expose ourselves to criticism that the two variables should be modelled simultaneous since they are interdependent. However, there is no agreement in economic theory in how far wages and productivity depend on each other. Classic theory argues that wages reflect marginal productivity; efficiency wage theory suggests that productivity depends on wages and contract theory argues that wages are the outcome of a bargaining process. Modelling model wages and productivity separately we investigate whether they follow a similar trajectory over the life cycle. An alternative would be to include productivity in the wage equation and to include wages in the productivity equation. Although this method would lead to the same conclusion, it would not produce the visual representations used in this paper, which allow for easy comparison.[12] Future work should explore to model wages and productivity simultaneously. Our results identify factors that influence wages but not productivity, and vice verse, which may help to model them simultaneous.

Wages

The model we us is the following:

[12] Not including wages or productivity, some would say implies that both the wage and productivity model suffers from an omitted variable problem. This is a shortcoming we have to live with. But perhaps we are in good company: it is a shortcoming of almost all wage equations in the literature.

$$W = f(A, A^2, T, YOS, SCHQ, CURTECH, CUREC, LNHEIGHT, MANREL \\ MANET, MAR, SEN, MID, SKIL, UN, FS, FA, PRIV, sector, location) \quad (1)$$

Where *W* is the log of monthly earnings, including cash and kind allowances. *A* reflects the worker's age in years and will be a crucial variable to consider the wage profile over the life cycle. We use age as a proxy for experience.[13] The variable *T* reflects tenure and is included to see whether there are returns to firm specific human capital.

The variables *YOS, SCHQ* and *SCHCUR* are all education variables. Most of the literature focuses on the Mincerian returns to education, following Mincer (1974), where wages are a log linear function of the level of schooling. *YOS* reflects the years of schooling, and its coefficient can be interpreted as the Mincerian returns to education. Because the quality of the school may have a distinct effect, we include *SCHQ*, which in the Ghanaian context is proxied by whether the school is public or private.[14] We also look at *what* is learned in school and include *CURTECH and CUREC*, which indicate whether the main subject of the curriculum was technical or economic, with as reference group general curriculum.

LNHEIGHT is the log of the height of the person and serves as our measure for physical health. Nutrition experts consider a person's height to reflect the stock of health built up over the long term. A number of studies provide evidence that increased adult height reflects greater childhood nutrition, confirming the accepted

[13] Most respondents remember their age more accurately than the years they have been working, and the two measures are highly correlated (0.86). We carried out the same analysis with the experience variable, which gives similar results.

[14] Betts (1995) argues that the school attended does play a role and Card and Krueger (1992) find for the US that school quality matters.

wisdom that height is a measure of accumulated health. It can therefore be considered exogenous to wages (cf. Thomas and Strauss 1997).

According to contract theory, wages are the outcome of a bargaining process. Factors that may affect the worker's bargaining position is how the worker is related to the manager of the firm, as suggested by Schafgans (1998), and Frazer (2001) and Barr & Obena (2001) for Ghana. *MANREL* indicates whether the worker is a relative of the manager, while *MANET* indicates whether they belong to the same ethnic group. Another factor that may affect the worker's bargaining position is the home situation. Lazear (1979) and Salop and Salop (1976) argue that norms impose implicit contracts where workers with a family may receive higher wages. We include *MAR*, which indicates whether the worker is married or not.

Since different jobs have different characteristics, and wages may compensate for undesirable job characteristics[15], we include job and firm characteristics as well as regional dummies as control variables. We include three dummy variables that indicate the individual's occupation. *SEN* indicates senior and top management, *MID* indicates middle management and *SKIL* indicates skilled labour; unskilled labour is the omitted category.

We include a number of firm characteristics. *UN* is the degree of unionization of the firm's work force. Oswald (1987) argues that workers in unionized firms are expected to have a stronger bargaining position and are therefore able to negotiate higher wages. We prefer the degree of unionization above union membership of the

[15] The equalizing wage differentials argument argues that differences in wages are the sum of monetary and non-monetary attributes of a job (Rosen 1986).

individual worker because wage negotiation takes place at the firm (or sector) level and the resulting agreement includes non-members. *FS* reflects firm size in number of workers. Masters (1969) for example argues that large firms pay more because they offer poor working conditions, which has to be compensated by higher wages. Since the mid eighties the Ghanaian economy underwent different reforms. Firms owned by the government were gradually sold off, the process is still going on. We include two variables that help to control for this. *FA* reflects firm age; *PRIV* reflects whether the firm is a private owned company. We also control for the sector, including dummies for each of the sectors with the largest sector, metal, as reference category. Finally, we include three dummies for Kumasi, Takoradi and Cape Coast respectively. Location is important because they reflect the conditions of the local labour market, as shown by Leuven and Oosterbeek (2001).

To test whether school achievements and cognitive ability affect wages, we run a separate extended model with the sub sample for which we have this data. We include the test results on mathematics, English reading and Raven's matrix test in the wage equation, following the approach of Boissiere, Knight and Sabot (1985) and others.[16] It turned out to be impossible to select the participants for the tests randomly, and thus we control for potential selection bias. [17] We add the test results and a mills ratio term to model (1) and estimate the following equation:

$$\begin{aligned} W = f(&A, A^2, T, YOS, SCHQ, CURTECH, CUREC, \underline{TEST}, LNHEIGHT, MANREL \\ &MANET, MAR, SEN, MID, SKIL, UN, FS, FA, PRIV, SEC, R, \underline{\lambda}) \end{aligned} \quad (2)$$

[16] See also Glewwe (1996), Alderman et al, (1996), Joliffe (1998); for the matrix test see also Glewwe (1996), and Murnane (1995)

[17] It turns out that older individuals are over-represented in the sub-sample, as are better off individuals (those with higher earnings and higher asset ownership), those with skills (relative to non-skilled) and those coming from large firms. The result is that we get larger standard errors for the sub-sample compared to the original sample, which reduces the significance of the estimated coefficients.

Individual productivity

To model individual productivity we use the same independent variables as in (1) and estimate the following equation:

$$\begin{aligned} P = f(&A, A^2, T, YOS, SCHQ, CURTECH, CUREC, LNHEIGHT, MANREL \\ &MANET, MAR, SEN, MID, SKIL, UN, FS, FA, PRIV, SEC, R) \end{aligned} \tag{3}$$

P stands for individual productivity and is an ordinal measure, so we use an ordered probit to estimate equation (3). We also estimate the equivalent of model (2) with cognitive skills and the selection correction term, but with performance appraisal as the dependent variable.

Comparing wages and individual productivity

To make the estimation results for wages and individual productivity comparable, we transform the coefficients of the productivity model. One crucial assumption we make is that productivity has the same variance as wages. Consider the ordered probit, which is a latent variable model of the form $y_i^* = \beta^* x_i + \varepsilon_i$ where y_i^* is determined by the value of y and the cut off points τ_j, which are estimated simultaneously with β by maximum likelihood.

$$y_i = \begin{cases} 1 & if \quad \tau_0 = -\infty \le y_i^* < \tau_1 \\ 2 & if \quad \tau_1 \le y_i^* < \tau_2 \\ 3 & if \quad \tau_2 \le y_i^* < \tau_3 \\ 4 & if \quad \tau_3 \le y_i^* < \tau_4 \\ 5 & if \quad \tau_4 \le y_i^* < \tau_5 \\ 6 & if \quad \tau_5 \le y_i^* < \tau_4 = +\infty \end{cases}$$

The obtained coefficients are difficult to interpret because the dependent variable is measured on an ordinal scale, so there is no unit of measurement for the latent variable. One solution is to report the coefficients in terms of standard deviation change of the latent variable. Another way is to use a standardization on which we have more information. Normally the error term is assumed to be normally distributed with a mean zero and a standard deviation one $\left(\varepsilon_{ij} \sim N\left(0,1\right)\right)$. However, this is an arbitrary choice and any alternative standard deviation can be chosen to make the model identified. Our benchmark, the OLS model for wages, assumes that its error term is normally distributed with a mean zero $\left(\varepsilon_w \sim N\left(0,\sigma_w^2\right)\right)$, and its variance is calculated from the data. To make the estimates from the productivity model comparable with those from the wage model, we use the same standardization and assume that the error term in the ordered probit of productivity has the same variance as the error term in the OLS equation of wages. All this does is produce transformed coefficients that are comparable to those from the wage equation. More formally, we introduce an alternative latent variable $z_i^* = \delta y_i^*$. Using the equation of y_i^* above, we can rewrite this as $z_i^* = \delta\left(x_i\beta^* + \varepsilon\right) = x_i\left(\delta\beta^*\right) + \delta\varepsilon_i$. The coefficients in this new model reflect the effects on latent variable z_i^* rather than y_i^*, and are equal to the old coefficients multiplied by a factor δ. [18]

So by assuming the same variance for the errors terms, the coefficients in the two models are comparable. Since the models contain the same independent variables, this is equivalent to assuming the same variance for the dependent variables.

[18] δ can also be interpreted as the ratio between the two standard deviations

4. Empirical Analysis

We first analyse the profile of wages over the life cycle. In a second part we analyse the course of productivity over the life cycle. We then compare the two.

The wage profile

Figure 2 plots the wage distribution, reflecting the familiar pattern. We estimate model (1) by OLS for male and female separately; the results are reported in Column 1 of Table 3.[19] Given our interest in the wage profile over the life cycle, we focus on the coefficient of age and will only briefly discuss the coefficients of the other variables. Other studies find that age (or experience) have a positive, sometimes concave, effect [see for example Brown (1989), Topel (1991), Altonji and Williams (1997)], while some have found a very small and insignificant effect [see for example Abraham and Farber (1987)]. We observe that the coefficient on age is significant and large for men, but not for women. One additional year adds 5% to a man's wage. The coefficient of squared age is also significant, which gives the typical concave pattern of earnings over the life cycle for men with a maximum occurring at age forty eight implying age has a positive effect on earnings up to age forty eight and negative beyond that. This suggests that middle-aged people earn more than young adults and older people. Life expectancy in Ghana is 57 years [UNDP, (1997)]. For women the maximum occurs at age thirty nine (but age is not significant).

[19] Both pass a Ramsey RESET test for omitted variable at the three and five percent level respectively. Because the equation for men suffers from heteroscedasticity, we report Hubert White sandwich estimates of the robust standard errors.

Although not the main focus of this paper, it is interesting to consider the other independent variables. Tenure has no significant effect for men but it does for women, indicating that the accumulation of firm specific capital is especially relevant in female jobs. An alternative explanation is that, if women do not change jobs often, tenure may be a better proxy than age for the accumulation of human capital since their participation in the labour force depends crucially on the number of children they have. Years of schooling is significant for both men and women, but has a much smaller effect for men than for women. One additional year of schooling increases the male wage with 2% and the female wage with 7%. The quality and subject of education have no effect. The stock of health (height) also has no significant effect.[20] Variables that may indicate the existence of implicit contracts like being a relative of the manager or being married, have no significant effect. The occupation variables on the other hand, do have a strong and significant effect. Male senior and top management earn double the amount of middle management, who earn double as much as skilled workers. The latter earn 24% more than unskilled workers. Female senior and top management earn 92% more than unskilled female workers.

A number of firm characteristics also have a significant effect on the wages. Larger firms pay both their male and female workers more. This is in line with other research for Ghana (Söderbom and Teal, 2001) and elsewhere (Strobl and Thornton, 2001). We do not find any significant effect of the degree of firm unionization on wages, but male workers are better paid in older firms and worse paid in private firms.

[20] The evidence for an effect of height on wages is mixed. Thomas and Strauss (1997) find no effect in Brazil, while Behrman and Rosenzweig (2001) find that there are real payoffs to increasing body weight at birth for identical twins in the US. Using data on US, Ghana and Brazil, Schultz (2002) also finds an effect of height on wages.

Because firm characteristics have such an important effect, we estimate the same model with firm individual effects. Column 2 and 3 in Table 3 report both the random and fixed effects models and show the robustness of our estimates. Although the coefficient on age becomes smaller, suggesting that firm specific characteristics affect the earnings profile over the life cycle, the difference is not significant.

To further inspect the robustness of our results, we estimate model (2) for a sub sample of the data for men since the sub-sample for women is too small. Model (2) includes test results and a selection correction term as discussed above. Because the test results for all three, maths, English reading and Raven's matrix, are relatively highly correlated, we include them separately.[21] Because the sample suffers from self-selection (lambda is significant), we first estimate the model without test variables in column one of Table 4 and then compare the coefficient of age in column one with the coefficient of age obtained when including the test variables (columns two to four of Table 4).[22] We observe that the coefficient of age does not change significantly. We also find that arithmetic skills have a positive significant effect on wages, while literacy or cognitive skills as measured by Raven's matrix test, have no significant effect.[23]

[21] The correlation between maths and English reading is 0.69; between maths and matrix is 0.57, and between English reading and matrix is 0.44.

[22] We used the classic methodology for self-correction and tried six different models: the Heckman maximum likelihood, the Heckman two step, as well as a manual construction of the selection term. All six models give similar results. When including a squared lambda term, the results remain the same.

[23] These results are consistent with the results from Glewwe (1996) who finds a positive effect for mathematics in public schools in Ghana; and Boissiere. Knight and Sabot (1985) find a positive effect from both numeracy and literacy on wages in Tanzania and Kenya.

The productivity profile

The measure of performance appraisal - our proxy for individual productivity - has a distribution that is skewed to the left, as shown in Figure 2. Table 5 reports the results of ordered probit analysis. Because the dependent variable is ordinal, it has no units of measurement and no interpretation can be given to the usually obtained coefficients. However, since we can give an interpretation to the latent variable of the model, namely relative productivity, it makes sense to express the coefficients in terms of the standard deviations change, which is in the case of an ordered probit more straightforward to interpret than marginal effects. The coefficients reported in Table 5 reflect the standard deviations change in productivity due to a unit change in the corresponding independent variable. [24]

We find that age has a significant concave effect on relative productivity for both men and women. One additional year increases relative productivity with 0.0006 standard deviations for men and 0.0002 standard deviations for women. A maximum is reached at age forty nine for men and age forty one for women, after which productivity falls, suggesting that middle-aged people are more productive than young and old people.

The coefficient of tenure, which reflects the effect of firm specific human capital, is insignificant and very small, suggesting that in the Ghanaian context, firm specific human capital has a limited effect on individual performance. Years of education, representing general human capital, has no significant effect on male productivity, but

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[24] The results from categorical models like the ordered probit are often reported in terms of marginal effects, reflecting how the probability of belonging to a specific category is affected by a change in (one of) the independent variable(s). However, this becomes cumbersome when the dependent variable has more than one category. In our case, however, the latent variable has a clear meaning, namely relative productivity, therefore we do not report marginal effects, but rather standardize the coefficients with respect to the latent variable.

it has an effect on female productivity. The quality of the school does not affect male or female productivity. School curriculum has a substantial and significant effect for men: those who enjoyed technical education or learned a craft are more productive. Physical health has no significant effect on male but it does have an effect on female productivity. Being a relative of the employer does not have an impact on someone's productivity, but men with the same ethnicity as the manager are less productive while women are more productive. Married women are less productive. Senior and top management are more productive, as is male middle management.

Concerning firm characteristics, we find that firm size has no effect on individual productivity while unionization has a negative effect, both for men and women. [25]

To investigate the validity of our estimates, we test the econometric assumptions underlying the model. The ordered probit assumes that the coefficients are equal across the categories (excellent, superior, etc). We first test whether this assumption holds in general, i.e. for all coefficients, using a likelihood ratio test, and find that it is violated. [26] This may indicate that our model is not well specified. But when we test whether the coefficient on age or experience is different over the categories, we find that it is not. [27] This is confirmed when we run a multinomial logit, which shows that the coefficient of age is not significantly different over the categories. So although our

[25] We also investigated whether a companies 'culture', the firm average of the questions (1) whether they thought that it was currently busy at work and (2) whether their colleagues have to work hard or not, has an effect, but find that it has a small and insignificant effect, while the other coefficients remain the same. We also run an OLS model where we control for firm individual effects. Since in our case the estimated cut off point in the ordered probit are equidistant, a linear regression gives a good approximation of the ordered probit. We find that the inclusion of firm individual effects does not change results

[26] To calculate the test statistic, we use two approximate log-likelihood scores for the constrained and unconstrained model. Both are modelled as K-1 binary variables obtained from dichotomisation of the ordered scale.

[27] The main concern is that the coefficient would for example increase or decrease monotonically with the level of productivity. We use a test where we compare the estimated coefficient of different probit models. The first model is a probit on the first category versus all others; the second model is a probit on the first two categories, versus all others, etc. We find that the coefficients on age and age squared are not different. This is a strong indication that the coefficient on age is constant across the categories.

model may be not entirely well specified, we find strong evidence that the estimated coefficient on age is robust.

To further investigate the robustness of the estimated coefficient on age, we include cognitive skills in the model, while also including a selection correction term. [28] Unfortunately the number of female observations on the combined variables is too small, so we only report the results for men. The results in Table 6 shows that the coefficient of age is not significantly different when including the test results.[29] We find again that mathematical skills have a significant positive effect on male productivity, while literacy or cognitive ability, as measured by Raven's Matrix test has no significant effect.

How do our estimates compare with results from other research? As argued before, labour economics has focused on the determinants of wages; while the determinants of individual productivity have not been researched extensively. What has been investigated is the effect of firm characteristics, for example the composition of the workforce and its average characteristics on firm productivity (usually per worker and time unit). Age is found to have a positive concave effect; while tenure also has a positive effect. Education is observed to have a positive or insignificant effect, depending on the specification. Women have been found to be less productive than

[28] We used the classic methodology for self-correction and use a Heckman model, first applied to the linear model (OLS) and then to the ordered probit. Note that because the ordered probit has equidistant cut off points in our case, it gives very similar results to the linear regression. We then include the self-selection term (Mill's ratio or lambda) in the ordered probit. When including a squared lambda term, the results remain the same.

[29] Note that the insignificance of the effect of age is not due to the inclusion of the test results of maths or English, which are both weakly positively correlated with age, but are the consequence of the fact that the lambda term does not control perfectly for self-selection. Because older people are over sampled in the sub-sample, the variation of age increases, which drives up standard errors and reduces significance.

men, although the result is not stable, which may be caused by the large variation in working hours. [30]

Comparing the wage and productivity profiles

Figure 2 plots the distribution of wages and individual productivity and suggests that the two measures follow a similar distribution, indicating that the assumption of equal variance is not unreasonable. Table 7 reports the results for both the wage equation and the ordered probit after standardizing the coefficients as set out above. In Columns one and three we copied the OLS estimates for the wage equation (from columns one and four in Table 3). The coefficients in the productivity equation in columns two and four reflect how many units the log of monthly productivity changes due to a unit change in the independent variable. We observe that the coefficients for age are similar in the wage and productivity equation for men, but not for women. To check the robustness of these results, we model wages as an ordinal variable. This is not efficient, but it is a good robustness check. The results (not reported) are very similar.

Figure 3 plots the wage and productivity profile for men. Because our measure of productivity is ordinal we cannot say anything about the relative position of the two - the level of productivity may be equal to, higher than, or lower than the level of wages – but we can analyse their slope. The productivity profile is less steep than the wage profile, but not significantly so. Productivity has a turning point at age forty nine and

[30] See Hellerstein and Neumark (1993), Hellerstein et al (1996), Bigsten et al (2000), Jones (2001) and Soderbom and Teal (2001).

wages at age forty six. The two profiles are very similar, which is remarkable given that the underlying variables are measured independently. With male life expectancy in Ghana at fifty seven, the curve is upwards sloping for the majority of the male labour force.

The female productivity profile, plotted in Figure 4, has a very similar shape to the male one, with a maximum at age forty one, but women's earnings decrease monotonically with age. To verify whether this is due to a missing variable bias - female wage equations often control for the household income or the income of the partner because women coming from a poorer back ground may have lower reservation wages and be more ready to accept a job - we proxy household income by a dummy variable indicating whether the household has a tv or not. While the variable is significant, its inclusion does not affect the wage or productivity profile (results not reported).

Our finding, that wages reflect productivity for men, contrasts with the conclusion from other research. Medoff and Abraham (1980) and (1981) found that more senior workers have higher wages but not productivity. Flabbi and Ichino (1998) find the same using performance appraisal as well as recorded absenteeism and misconduct. Hellerstein and Neumark (1992) using individual productivity estimated from a firm level production function conclude that they cannot reject flat productivity profiles, but can reject flat wage profiles.

Our findings suggest that we get different results even though we use the same measure of relative productivity as Medoff & Abraham and Flabbi & Ichino.

However, an important difference is that our sample contains data on both large and small firms, and unionized as well as non-unionized firms, while the sample used by both Medoff and Abraham (1981) and Flabbi and Ichino (1998) only contains data on large firms. Our analysis suggests that firm size and firm unionization affect the level of wages and productivity.[31] Do firm size and unionization also affect the profile of wages and productivity over the life cycle? To investigate this, we include two interaction terms: one between age and firms size, and one between age and firm unionization. The results are reported in Table 8. The coefficient on the interaction term with firm size is significant and positive in the wage equations for both men and women, but not in the productivity equations. The coefficient on the interaction term with unionization is positive and significant for women, but not for men in the wage equation and is never significant in the productivity equation. To visualize the difference in effects we split our sample in large and small firms and unionized and non-unionized firms. We focus on the profiles for men. The point estimates for the coefficient of age are reported in Table 9.

Figure 5 and Figure 6 plot the profiles for men in small and large firms respectively. Again we cannot compare the levels of the curves within or between the graphs; we focus on the course. We observe that wages grow faster in large firms and conclude that wage and productivity profiles are more similar in small than in large firms. Figure 7and Figure 8 plot the profiles for men in non-unionized and unionized firms and suggest that the profiles are more similar in non-unionized firms, although the difference is not very strong. These results are similar to Bishop (1987) who finds

[31] Although large firms are often more unionized, the relationship between firm size and unionization is not linear, as indicated by Bishop (1987) and confirmed for our data where percentage of the workforce unionized is only moderately correlated with firm size.

that the wedge between productivity and wages is larger in large and unionized firms. In our case the wage profiles are especially steeper in large firms. The importance of firm size – it affects both on the level and the profile of wages over the life cycle - is consistent with Söderbom and Teal (2001) who find that firm size has a significant effect on both firm productivity and wages in Ghana and can be explained as a consequence of rent sharing. Our finding unravels this further and indicates that firm size, while increasing wages, does not increase individual productivity, suggesting that there are economies of scale which create externalities beyond the individual such that firm productivity is higher for larger firms. These externalities create the opportunity to share the rent by paying higher wages. [32]

Our results also indicates that the findings from Medoff & Abraham and Ichino & Flabbi hold only for large firms and cannot be extrapolated to small firms.

We conclude that human capital theory, which assumes that wages reflect productivity, still has considerable appeal to explain wage setting in small firms, which operate in a more competitive environment, while alternative theories like implicit contract theory may be better at explaining wage setting in large and unionized firms.

5. <u>Summary and Conclusion</u>

Following the approach of Medoff and Abraham (1980, 1981) to use a measure of performance appraisal as proxy for individual productivity, this paper investigates

[32] Supporting evidence from our own data that employees in large or unionized firms manage to obtain better contracts is that workers in large or unionized firms are significantly more likely to have a permanent contract than those in small and non-unionized firms. p-value 0.00 for large versus small fims and p-value 0.05 for unionized versus non-unionized firms

whether wages and individual productivity follow the same course over the life cycle. This is a common test to see whether human capital theory holds.

To compare the wage and productivity profiles we make one crucial assumption, namely that productivity has the same standard deviation as wages. This enables us to standardize the ordered probit for individual productivity – which is an ordinal variable – in a way that estimation results can be compared with those from the wage equation. The nature of our data does not allow us to compare the *level* of productivity and wages; we concentrate on the changes of wages and individual productivity over the life cycle. Our main result is that wage and productivity profiles look remarkably similar for men but not for women. We also find that the wages and individual productivity do not have the same determinants. Especially the degree of unionization in the firm and firm size have a different effect, with the former affecting productivity but not wages, and the latter affecting wages but not productivity.

How do our results compare with those of existing research? Medoff and Abraham (1980,1981) as well as Flabbi and Ichino (1998) use a similar measure and find that wage profiles are steeper than productivity profiles. However, the data they use is restricted to large companies. We find that the wage profile is significantly steeper in large firms, and insignificantly steeper in unionized firms. This confirms the findings from Bishop (1987), who finds that the divergence between wages and productivity is larger in large and unionized firms.

Our finding also indicates that the results from Medoff & Abraham and Ichino & Flabby should not be extrapolated outside the sample of large firms. We conclude that human capital theory may still have explanatory power in a more competitive environment like small and non-unionized firms in a developing country, while alternative explanations, like contract theory, may be better in more institutionalized environments.

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7. Tables and Figures

Table 1: descriptive statistics

Firms	
Number of firms	82
Sector distribution:	
Metal	30 %
Machine	4 %
Wood	12 %
Furniture	15 %
Food	18 %
Bakery	9 %
Garment	11 %
Textile	3 %
Chemical	8 %
Regional distribution	
Accra	60 %
Kumasi	27 %
Takoradi	9 %
Cape Coast	4 %
Firm size	
Average number of workers per firm	99
Firms with less than 100 workers	76%
Firms with 100 workers or more	24%
Unionization	
Unionized firms	46%
Non-unionized firms	54%
Average revenue	3,384,371 USD
	(2,177,143)
Average valued added	527,003 USD
	(339,716)
Workers	
Number of workers	666
Gender distribution	
Men	82%
Women	18%
Occupational distribution	
Senior and top management	11%
Middle management	14%
Skilled	63%
Unskilled	12%
Average age	37
	(11)
Average years of schooling	11
	(4)
Average monthly payment	67 USD
	(73)
Average relative productivity	Good
Average Height	169cm
	(8)
Cognitive skills, for a sub-sample only:	
Average score for mathematics test	53%
Average score for English reading test	64%
Average score for Raven's matrix test	60%

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: models on the log of net monthly wages: OLS, random effects, fixed effects GLS

	Male			Female		
	(1)	(2)	(3)	(4)	(5)	(6)
	OLS	Random effects	Fixed effects	OLS	Random effects	Fixed effects
	Ln(wage)	Ln(wage)	Ln(wage)	Ln(wage)	Ln(wage)	Ln(wage)
Age	**0.0504**	**0.0328**	**0.0281**	**0.0182**	**0.0546**	**0.0898**
	(0.0161)**	**(0.0141)***	**(0.0143)+**	**(0.0481)**	**(0.0535)**	**(0.0556)**
Age squared	**-0.0005**	**-0.0003**	**-0.0002**	**-0.0005**	**-0.0010**	**-0.0015**
	(0.0002)**	**(0.0002)***	**(0.0002)**	**(0.0008)**	**(0.0008)**	**(0.0008)+**
Tenure	-0.0002	0.0004	0.0006	0.0034	0.0045	0.0066
	(0.0003)	(0.0003)	(0.0003)*	(0.0019)+	(0.0012)**	(0.0012)**
Years of schooling	0.0196	0.0117	0.0090	0.0707	0.0544	0.0025
	(0.0092)*	(0.0079)	(0.0080)	(0.0227)**	(0.0238)*	(0.0317)
Public school	0.0490	0.0573	0.0620	0.0776	0.1018	0.1569
	(0.0612)	(0.0614)	(0.0612)	(0.1230)	(0.1365)	(0.1468)
subject of school is craft /technical	0.0418	0.0511	0.0387	0.0730	-0.0807	-0.3860
	(0.0845)	(0.0703)	(0.0708)	(0.3343)	(0.2200)	(0.2231)+
subject of school is econ/bus/acc	0.1014	0.1590	0.1776	0.0467	0.0695	0.2601
	(0.0790)	(0.0678)*	(0.0667)**	(0.2177)	(0.1917)	(0.2273)
Ln(height)	-0.2820	0.2355	0.5523	-1.1595	-1.6618	-2.4055
	(0.5038)	(0.4662)	(0.4743)	(0.9753)	(0.9087)+	(0.8736)**
Relative of manager	0.0481	-0.0715	-0.1507	0.3434	0.3150	0.1792
	(0.0993)	(0.0863)	(0.0900)+	(0.2480)	(0.2157)	(0.2440)
Same ethnicity as manager	-0.0878	-0.0764	-0.0879	-0.1695	-0.0678	0.1940
	(0.0498)+	(0.0522)	(0.0542)	(0.1770)	(0.1921)	(0.2639)
Married	0.0735	0.1019	0.1130	0.1583	0.0356	-0.0692
	(0.0642)	(0.0578)+	(0.0582)+	(0.1374)	(0.1354)	(0.1352)
senior and top management	1.0928	1.0640	1.0471	0.9272	0.9128	0.9552
	(0.1048)**	(0.0918)**	(0.0919)**	(0.2851)**	(0.2630)**	(0.2746)**
middle management	0.5753	0.4824	0.4459	-0.1247	0.0156	0.0749
	(0.0961)**	(0.0840)**	(0.0842)**	(0.3162)	(0.3038)	(0.3341)
skilled worker	0.2400	0.2255	0.2254	-0.0197	0.0593	0.2606
	(0.0814)**	(0.0729)**	(0.0735)**	(0.2232)	(0.2050)	(0.2367)
Firm size	0.0008	0.0008		0.0007	0.0008	
	(0.0001)**	(0.0002)**		(0.0002)**	(0.0003)**	
percentage unionized	0.0008	0.0011		0.0018	0.0004	
	(0.0007)	(0.0011)		(0.0027)	(0.0030)	
Firm age	0.0054	0.0040		0.0001	0.0019	
	(0.0017)**	(0.0031)		(0.0068)	(0.0071)	
Private firm	-0.1706	-0.1632		-0.3003	-0.2269	
	(0.0573)**	(0.0976)+		(0.2445)	(0.2162)	
R-squared	0.61		0.48	0.82		0.67

Robust standard errors in parentheses; + significant at 10%; * significant at 5%; ** significant at 1%
The model contains control variables for industrial sector with the metal sector as a base; for location with Accra as a base; and a constant

Table 4: linear regression wages, including cognitive skills

	men			
	(1)	**(2)**	**(3)**	**(4)**
Age	**0.0307**	**0.0198**	**0.0271**	**0.0358**
	(0.0429)	**(0.0302)**	**(0.0271)**	**(0.0429)**
Age squared	**-0.0003**	**-0.0002**	**-0.0003**	**-0.0004**
	(0.0005)	**(0.0003)**	**(0.0003)**	**(0.0005)**
Tenure	0.0007	0.0009	0.0008	0.0006
	(0.0008)	(0.0006)	(0.0006)	(0.0008)
Years of schooling	0.0033	-0.0192	-0.0003	-0.0055
	(0.0253)	(0.0178)	(0.0156)	(0.0265)
Ln(maths)		**0.2676**		
		(0.1148)*		
Ln(english)			**0.0419**	
			(0.0534)	
Ln(matrix)				**0.0995**
				(0.1101)
Public school	0.1316	0.1882	0.1529	0.1935
	(0.1921)	(0.1349)	(0.1435)	(0.2013)
subject of school is craft /technical	0.1878	0.1954	0.1764	0.1670
	(0.1924)	(0.1452)	(0.1325)	(0.1943)
subject of school is econ/bus/accoun	0.2033	0.2425	0.2171	0.1942
	(0.2292)	(0.1508)	(0.1481)	(0.2334)
Ln(height)	0.4752	-0.0664	0.4355	0.0191
	(1.5984)	(0.1392)	(0.1263)**	(1.6026)
Relative of manager	0.2806	0.2993	0.2826	0.1934
	(0.2257)	(0.1106)**	(0.0860)**	(0.2272)
Same ethnicity as manager	0.0310	0.0507	0.0486	0.0759
	(0.1332)	(0.0992)	(0.0972)	(0.1368)
married	0.0819	0.0473	0.0721	0.0456
	(0.1865)	(0.1347)	(0.1151)	(0.1885)
senior and top management	0.6266	0.6778	0.6044	0.6398
	(0.3242)+	(0.2283)**	(0.1962)**	(0.3332)+
middle management	0.6596	0.7056	0.6534	0.6786
	(0.3037)*	(0.1966)**	(0.1907)**	(0.3015)*
skilled worker	0.4133	0.5504	0.4179	0.4818
	(0.2542)	(0.1641)**	(0.1529)**	(0.2558)+
Firm size	0.0009	0.0009	0.0009	0.0009
	(0.0002)**	(0.0002)**	(0.0002)**	(0.0002)**
percentage unionized labour force	0.0007	0.0012	0.0012	0.0018
	(0.0020)	(0.0013)	(0.0008)	(0.0020)
Firm age	0.0043	0.0029	0.0040	0.0026
	(0.0041)	(0.0032)	(0.0031)	(0.0043)
Private firm	-0.2200	-0.1547	-0.2135	-0.1993
	(0.1452)	(0.1071)	(0.0948)*	(0.1569)
lambda	0.6079**	0.5903**	0.6050**	0.6014**
	(5.26 e-10)	(0.0529)	(0.0496)	(0.0002)

Standard errors in parentheses, + significant at 10%; * significant at 5%; ** significant at 1%
The model contains control variables for industrial sector with the metal sector as a base; for location with Accra as a base, and a constant

Table 5: ordered probit of performance appraisal with coefficients expressed in terms of standard deviations of the latent variable

	men (1) Individual performance appraisal	women (2) Individual performance appraisal
Age	**0.00056**	**0.00024**
	(0.00028)*	**(0.00011)***
Age squared	**-0.00001**	**-0.00000**
	(0.00000)+	**(0.00000)+**
Tenure	-0.00000	-0.00000
	(0.00001)	(0.00000)
Years of schooling	-0.00013	0.00011
	(0.00014)	(0.00005)*
Public school	0.00011	-0.00034
	(0.00112)	(0.00035)
subject at school is craft /technical	0.00247	-0.00097
	(0.00118)*	(0.00070)
subject of school is econ/bus/accoun	0.00144	0.00001
	(0.00125)	(0.00055)
Ln(height)	0.00646	0.00383
	(0.00804)	(0.00203)+
Relative of manager	-0.00273	-0.00040
	(0.00173)	(0.00053)
Same ethnicity as manager	-0.00201	0.00085
	(0.00092)*	(0.00043)*
Married	-0.00156	-0.00075
	(0.00107)	(0.00033)*
senior and top management	0.00490	0.00105
	(0.00157)**	(0.00060)+
middle management	0.00283	-0.00044
	(0.00134)*	(0.00098)
skilled workers	0.00116	-0.00023
	(0.00122)	(0.00046)
Firm size	-0.00000	-0.00000
	(0.00000)	(0.00000)
percentage unionized labour force	-0.00003	-0.00001
	(0.00001)**	(0.00000)+
Firm age	-0.00003	0.00001
	(0.00003)	(0.00001)
Private firm	0.00258	0.00026
	(0.00083)**	(0.00030)

Standard errors in parentheses; + significant at 10%; * significant at 5%; ** significant at 1%
The model contains control variables for industrial sector with the metal sector as a base; for location with Accra as a base; and a constant
The coefficients the standard deviations change in productivity due to a unit change in the independent variable

Table 6: Ordered probit including cognitive skills and a self-selection term for men only

	(1)	(2)	(3)	(4)
age9	**0.00001598**	**0.00001596**	**0.00002028**	**0.00002057**
	(0.00002284)	**(0.00003085)**	**(0.00002383)**	**(0.00002566)**
age9sq	**-0.00000014**	**-0.00000016**	**-0.00000017**	**-0.00000019**
	(0.00000024)	**(0.00000034)**	**(0.00000025)**	**(0.00000026)**
Tenure	0.00000046	0.00000091	0.00000055	0.00000051
	(0.00000051)	(0.00000081)	(0.00000058)	(0.00000054)
Years of schooling	-0.00001946	-0.00004021	-0.00002598	-0.00002207
	(0.00002070)	(0.00003209)	(0.00002338)	(0.00002227)
lnmaths		0.00029370		
		(0.00015017)+		
lneng			0.00013346	
			(0.00008170)	
lnmatrix				0.00003666
				(0.00007890)
Public school	0.00011100	0.00022454	0.00012907	0.00013867
	(0.00011432)	(0.00016238)	(0.00011835)	(0.00012763)
subject of school is craft /technical	0.00030366	0.00043459	0.00028521	0.00031052
	(0.00008782)**	(0.00011334)**	(0.00010191)**	(0.00009306)**
subject of school is econ/bus/account	0.00007047	0.00008516	0.00006528	0.00006966
	(0.00010298)	(0.00013894)	(0.00010603)	(0.00010776)
Ln(height)	0.00219761	0.00220604	0.00211726	0.00217587
	(0.00084050)**	(0.00117411)+	(0.00091032)*	(0.00087565)*
Relative of manager	-0.00013619	-0.00002932	-0.00011441	-0.00011654
	(0.00017909)	(0.00027901)	(0.00019247)	(0.00018402)
Same ethnicity as manager	-0.00023848	-0.00027518	-0.00024827	-0.00022786
	(0.00007651)**	(0.00011349)*	(0.00008355)**	(0.00007404)**
Married	-0.00000793	-0.00007210	-0.00007355	-0.00003642
	(0.00012305)	(0.00016716)	(0.00013302)	(0.00013872)
senior and top management	-0.00000384	-0.00019128	-0.00003166	-0.00000482
	(0.00021538)	(0.00036122)	(0.00023799)	(0.00022681)
middle management	0.00021517	0.00007884	0.00025725	0.00021799
	(0.00018554)	(0.00032254)	(0.00021117)	(0.00019541)
skilled workers	0.00030569	0.00026662	0.00034398	0.00032498
	(0.00014807)*	(0.00024303)	(0.00016704)*	(0.00015628)*
Firm size	-0.00000031	-0.00000045	-0.00000033	-0.00000033
	(0.00000014)*	(0.00000021)*	(0.00000015)*	(0.00000015)*
percentage unionized labour force in firm	-0.00000060	-0.00000087	-0.00000044	-0.00000048
	(0.00000137)	(0.00000187)	(0.00000145)	(0.00000144)
Firm age	-0.00000630	-0.00000797	-0.00000645	-0.00000665
	(0.00000282)*	(0.00000387)*	(0.00000296)*	(0.00000297)*
Private firm	-0.00011796	-0.00021144	-0.00015104	-0.00012563
	(0.00010763)	(0.00017226)	(0.00012775)	(0.00011344)
Mills' ratio	-0.00027475	-0.00040687	-0.00031772	-0.00028612
	(0.00008334)**	(0.00011955)**	(0.00009264)**	(0.00008534)**

Table 7: comparing the determinants of relative productivity and wages

	Men		Women	
	Ln(wage)	productivity	Ln(wage)	Productivity
Age	**0.050**	**0.039**	**0.018**	**0.112**
	(0.016)**	**(0.019)***	**(0.048)**	**(0.055)***
Age squared	**-0.001**	**-0.000**	**-0.001**	**-0.001**
	(0.000)**	**(0.000)+**	**(0.001)**	**(0.001)**
Tenure	-0.000	-0.000	0.003	-0.001
	(0.000)	(0.000)	(0.002)+	(0.001)
Years of schooling	0.020	-0.009	0.071	0.049
	(0.009)*	(0.010)	(0.023)**	(0.025)*
Public school	0.049	0.008	0.078	-0.159
	(0.061)	(0.079)	(0.123)	(0.173)
subject of school is craft /technical	0.042	0.173	0.073	-0.493
	(0.085)	(0.083)*	(0.334)	(0.341)
subject of school is econ/bus/account	0.101	0.098	0.047	0.023
	(0.079)	(0.088)	(0.218)	(0.270)
Ln(height)	-0.282	0.452	-1.160	1.868
	(0.504)	(0.567)	(0.975)	(1.003)+
Relative of manager	0.048	-0.195	0.343	-0.174
	(0.099)	(0.122)	(0.248)	(0.260)
Same ethnicity as manager	-0.088	-0.147	-0.169	0.466
	(0.050)+	(0.065)*	(0.177)	(0.216)*
Married	0.073	-0.104	0.158	-0.306
	(0.064)	(0.076)	(0.137)	(0.159)+
senior and top management	1.093	0.359	0.927	0.549
	(0.105)**	(0.113)**	(0.285)**	(0.290)+
middle management	0.575	0.213	-0.125	-0.204
	(0.096)**	(0.096)*	(0.316)	(0.481)
skilled workers	0.240	0.098	-0.020	-0.087
	(0.081)**	(0.089)	(0.223)	(0.222)
Firm size	0.001	-0.000	0.001	-0.000
	(0.000)**	(0.000)	(0.000)**	(0.000)
Percentage unionized labour force in firm	0.001	-0.002	0.002	-0.003
	(0.001)	(0.001)**	(0.003)	(0.002)
Firm age	0.005	-0.002	0.000	0.003
	(0.002)**	(0.002)	(0.007)	(0.006)
Private firm	-0.171	0.181	-0.300	0.074
	(0.057)**	(0.058)**	(0.244)	(0.148)
R-squared	0.61		0.82	

Robust standard errors in parentheses, + significant at 10%; * significant at 5%; ** significant at 1%
The model contains control variables for industrial sector with the metal sector as a base; for location with Accra as a base, and a constant

Table 8: Do firm size and unionization affect the wage and productivity profile?

	Men		Women	
	Ln(wage)	productivity	Ln(wage)	productivity
Age	0.051	0.037	0.002	0.114
	(0.015)**	(0.019)+	(0.044)	(0.051)*
Age squared	-0.001	-0.000	-0.000	-0.001
	(0.000)**	(0.000)+	(0.001)	(0.001)+
Age x firm size	**0.006**	**0.001**	**0.016**	**0.002**
	(0.002)**	**(0.002)**	**(0.007)***	**(0.005)**
Age x unionization of firm	**0.001**	**0.002**	**0.024**	**-0.018**
	(0.002)	**(0.003)**	**(0.009)****	**(0.011)**
Tenure	-0.000	-0.000	0.004	-0.001
	(0.000)	(0.000)	(0.002)*	(0.001)
Years of schooling	0.018	-0.008	0.053	0.052
	(0.009)*	(0.010)	(0.023)*	(0.025)*
Public school	0.032	0.010	0.200	-0.188
	(0.059)	(0.078)	(0.111)+	(0.160)
subject of school is craft /technical	0.020	0.165	0.101	-0.505
	(0.083)	(0.082)*	(0.285)	(0.320)
subject of school is econ/bus/account	0.090	0.090	0.174	0.021
	(0.077)	(0.087)	(0.250)	(0.249)
Ln(height)	-0.466	0.412	-1.300	1.545
	(0.501)	(0.561)	(1.156)	(0.936)+
Relative of manager	0.029	-0.209	0.336	-0.148
	(0.097)	(0.121)+	(0.222)	(0.243)
Same ethnicity as manager	-0.067	-0.139	-0.017	0.366
	(0.050)	(0.065)*	(0.170)	(0.201)+
Married	0.054	-0.101	0.163	-0.285
	(0.063)	(0.075)	(0.114)	(0.147)+
senior and top management	1.086	0.357	0.702	0.571
	(0.105)**	(0.111)**	(0.275)*	(0.281)*
middle management	0.546	0.215	-0.330	-0.084
	(0.097)**	(0.096)*	(0.265)	(0.447)
skilled workers	0.239	0.104	-0.014	-0.075
	(0.081)**	(0.088)	(0.224)	(0.209)
total labour force in firm	0.001	-0.000	0.000	-0.000
	(0.000)**	(0.000)	(0.000)*	(0.000)
percentage unionized	0.001	-0.003	-0.008	0.003
	(0.001)	(0.001)*	(0.003)*	(0.005)
Firm age	0.003	-0.003	-0.008	0.003
	(0.002)+	(0.002)	(0.006)	(0.006)
Private firm	-0.170	0.183	-0.050	0.012
	(0.056)**	(0.058)**	(0.220)	(0.156)
R-squared	0.63		0.85	

Robust standard errors in parentheses
+ significant at 10%; * significant at 5%; ** significant at 1%
The model contains control variables for industrial sector with the metal sector as a base; for location with Accra as a base, and a constant

Table 9: estimates for small and large, non-unionized and unionized firms

	Small firms		Large firms	
	Ln(wage)	Productivity	Ln(wage)	Productivity
Age	0.0353	0.0350	0.0890	0.0351
	(0.0171)	(0.0220)	(0.0347)	(0.3111)
Age squared	-0.0004	-0.0004	-0.0009	-0.0004
	(0.0002)	(0.0003)	(0.0004)	(0.0004)

	Non-unionized firms		Unionized firms	
	Ln(wage)	Productivity	Ln(wage)	Productivity
Age	0.0144	0.0347	0.0673	0.0396
	(0.0216)	(0.0323)	(0.0212)	(0.0239)
Age squared	-0.0001	-0.0003	-0.0007	-0.0005
	(0.0002)	(0.0004)	(0.0002)	(0.0003)

Figure 1: OLS regression of product per worker on average score of performance evaluation

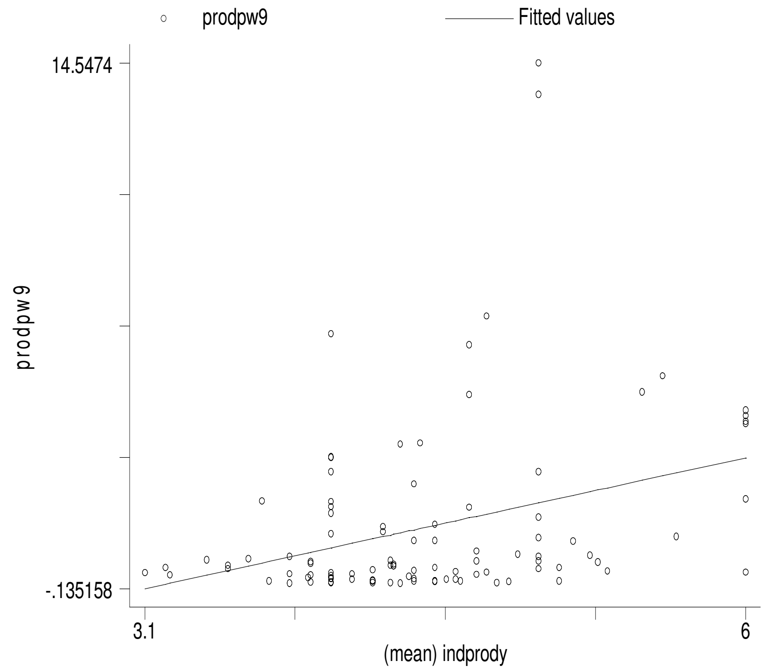

Figure 2: Distribution of wages and individual performance

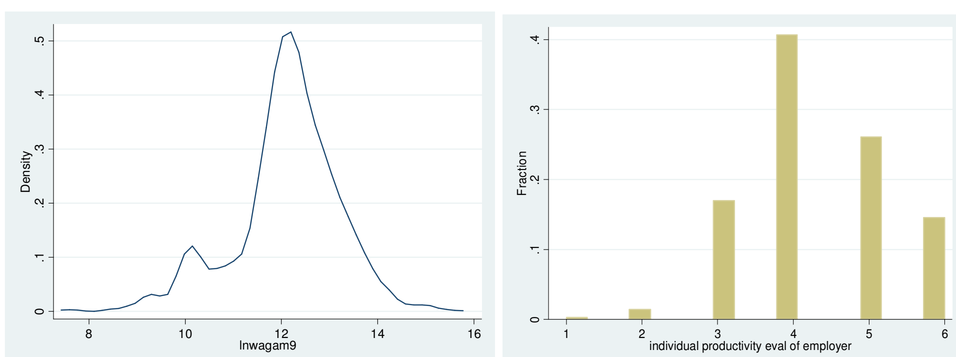

Figure 3: wage and productivity profiles for men

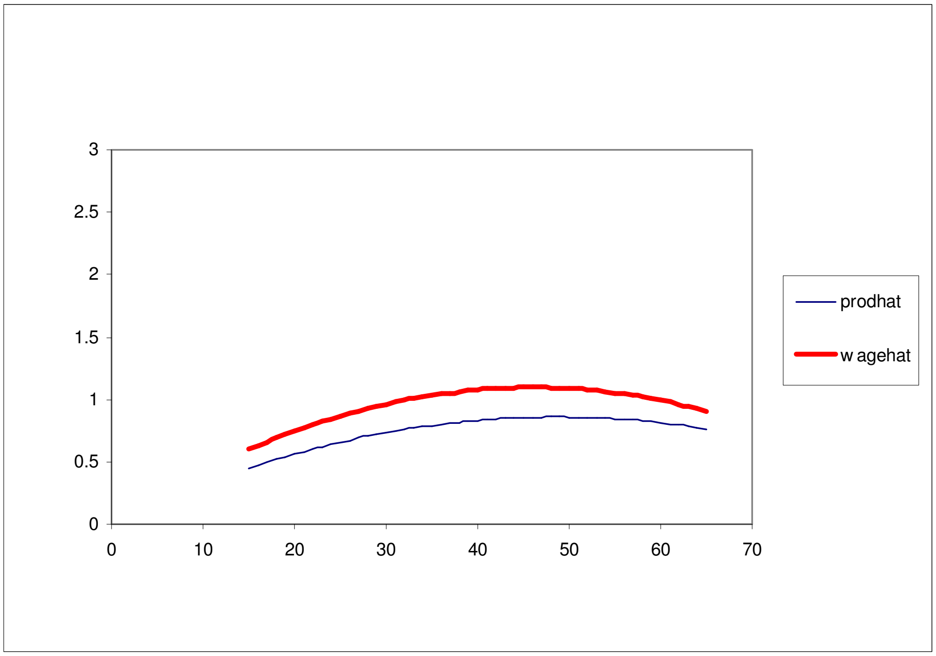

Figure 4: wage and productivity profiles for women

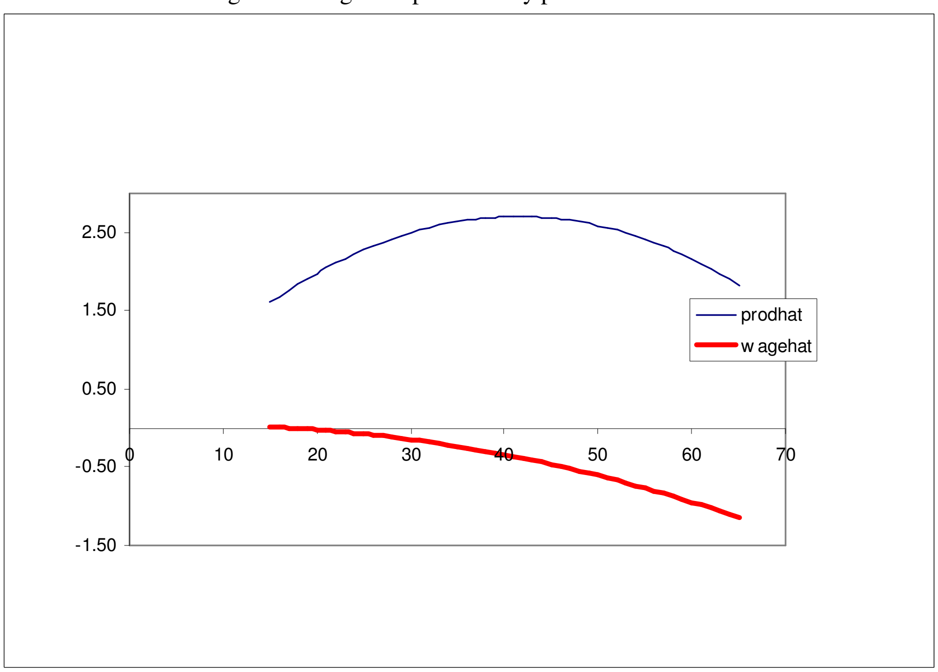

Figure 5: Wage and productivity profiles over the life cycle for men working in small firms

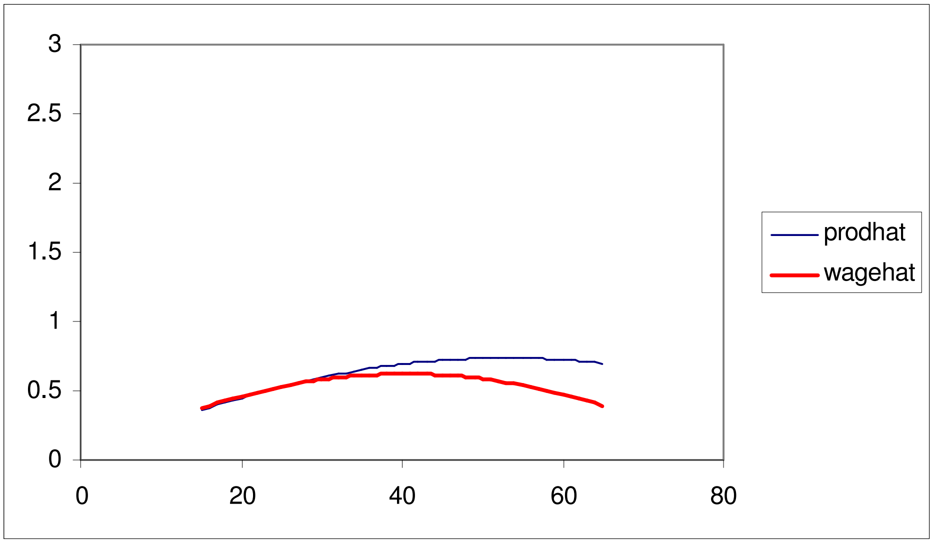

Figure 6: Wage and productivity profiles over the life cycle for men working in large firms

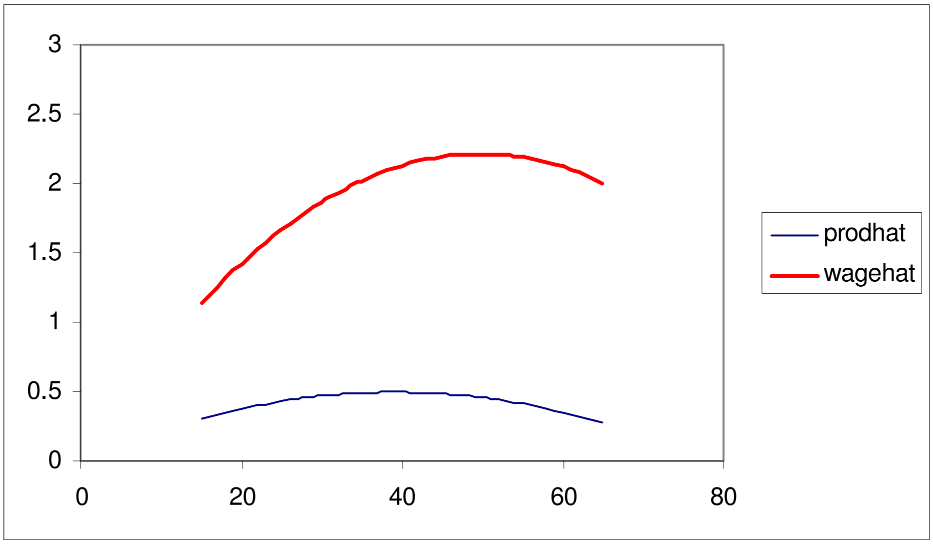

Figure 7: wage and productivity profile over the life cycle for men working in non-unionized firms

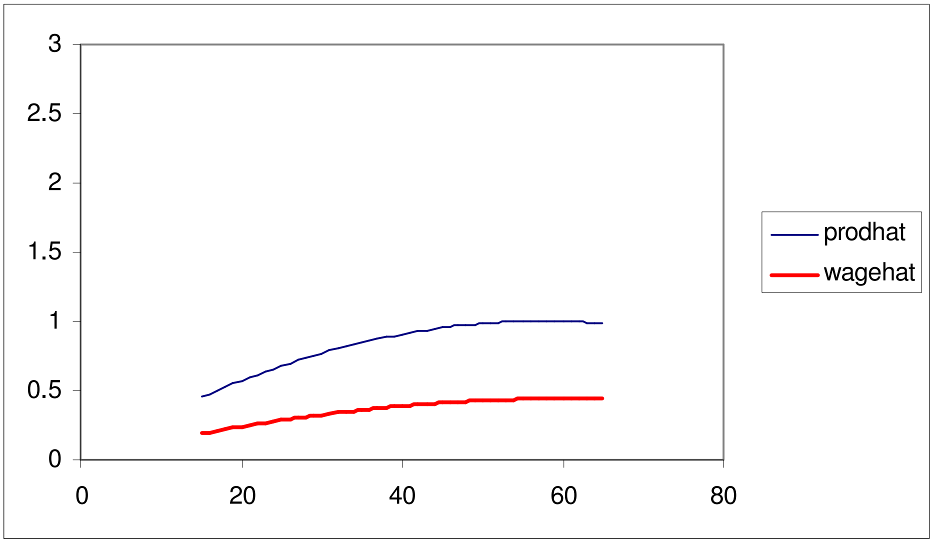

Figure 8: wage and productivity profile over the life cycle for men working in unionized firms