Wages and Worker Supervision in African Manufacturing

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Abstract

Using matched employer-employee data on 10 African countries, this paper examines the relationship beween wages, worker supervision, and labor productivity in manufacturing. The evidence shows that large manufacturing firms in Africa pay more to both production workers and supervisors. We develop a two-tier model of supervision that can account for this stylized fact. Using instrumental GMM, we fit the structural model to the data. Employee data is used to derive a firm-specific wage premium that is purged of the effect of worker observables. We find a strong effect of both supervision and wages on effort and hence on labor productivity. Tests results show that some of the model restrictions are supported by the data while others are not. The model can therefore account for some of the features observed in the data.

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1. Introduction

Prosperity varies dramatically across regions of the world. Many economists believe this has to do with differences in the quality of manpower. These beliefs are typically expressed in terms of human capital, that is, of schooling and vocational skills (e.g. Barro & i Martin 1992, Mankiw, Romer & Weil 1992). Countries with uneducated manpower, the story goes, provide low returns on capital and fail to attract foreign investments. As a result, they grow less fast or not at all. The solution is to increase expenditures in education.

Not all economists share these views, however. Economists focusing on sub-Saharan Africa, for instance, have long noted the lack of relationship between school enrollment rates and economic performance, either across countries or over time (e.g. Bigsten, Collier, Dercon, Fafchamps, Gauthier, Gunning, Isaksson, Oduro, Oostendorp, Patillo, Soderbom, Teal, Zeufack & Appleton 2000*a*, Teal 2000, Soderbom & Teal 2001). Africa is often characterized by unemployment among school graduates (e.g. Eicher 1985, Serneels 1999). This situation is hard to reconcile with the idea that a shortage of educated manpower is what stifles growth in the continent. If there is something wrong with African manpower quality, it is unlikely to be schooling per se.

An alternative explanation is labor discipline. During the colonial era, it was customary for authorities to complain about workers' lack of effort. Such claims should be heavily discounted as influenced by the ideology of the time and may have reflected passive resistance to colonialism on the part of workers. Recent evidence is more troubling. It has been claimed that managers and workers in African firms often show little loyalty to their employer (Ezeala-Harrison 1991). Absenteeism is blamed on the 'extended family system' that supposedly obliges employees to assists parents in need. Pilferage is a concern too. Fafchamps & Minten (2001) show that 37% of agricultural traders in Madagascar refrain from hiring more employees for fear of employee theft. Using data from manufacturing firms in Cote d'Ivoire, Azam & Lesueur (1997) show that worker supervision is a serious concern among large firms. Could it be that labor discipline, not education, is the main determinant of labor quality in poor countries with little or no experience in wage employment?

This is not a far-fetched notion. After all, we know that self-discipline is one of the skills imparted by

education – so much so that employers may pay a premium for workers who obtain their diploma from a regular day school (e.g. Cameron & Heckman 1993, Tyler, Murnane & Willett 2000). Corruption, which is blamed for many of the evils of underdevelopment, is largely a worker discipline problem: if workers followed their job description, there would be much less corruption. Lack of loyalty towards large formal organizations such as states and firms has long been noted and blamed for the prevalence of corruption (e.g. Bayart 1989, Bates 1983, Bauer 1971). Such concerns might help explain why African manufacturing firms remain quite small by international standards: 100 workers in average, excluding enterprises of less than 5 workers (Bigsten, Collier, Dercon, Fafchamps, Gauthier, Gunning, Isaksson, Oduro, Oostendorp, Patillo, Soderbom, Teal & Zeufack 2000*b*).

This paper revisits this issue using matched worker-enterprise data in manufacturing. We contrast two mechanisms by which firms seek to motivate their workers: supervision and above-average wages. Drawing on manufacturing surveys in 10 African countries, our results are consistent with a two-tier model of supervision in which middle-level managers must be monitored by shareholders. We show that the worker supervision falls with firm size while wages rise. The cost of motivating workers through higher wages is non-negligible: to keep effort constant, a decrease in supervision from 15 to 14 supervisors per 100 workers must be compensated by a 0.2% increase in wage rate. The figure is much higher at low levels of supervision. Once supervision costs are controlled for, manufacturing is shown to have increasing returns to scale.

This paper contributes to the literature in various ways. The model and analysis presented here might provide an explanation for the often observed positive relationship between wages and firm size (Oi & Idson 1999). The fact that wages in Africa increase particularly rapidly with firm size is consistent with the view that labor discipline is a more acute problem there – possibly because of lower school enrollment rates in the population at large (e.g. Mazumdar & Mazaheri 2002, Strobl & Thornton 2001). If confirmed by subsequent research, this finding has deep implications for our understanding of the early development process. Our contribution is also methodological as we combine non-parametric and structural estimation methods to throw light on labor efficiency issues.

The paper is organized as follows. A conceptual framework is introduced in Section 2. A two-tier

efficiency wage model is constructed in which that middle-rank managers and administrative staff must be monitored by shareholders. The data are presented in Section 3 together with a non-parametric analysis of labor efficiency. Using matched worker-employer data, we find that wages increase with firm size even after we correct for observable human capital. We also find that supervision ratios fall with firm size, a finding contrary to that of Ringuede (1998) for French enterprises. Section 4 estimates a structural efficiency wage model that combines firm level and individual level data. Results suggest that, at the sample average, the elasticity of effort with respect to wage is 0.77 for production workers. In contrast, at the sample average, an increase in the supervision ratio by 10% raises effort by only 0.3%. The elasticity gets much higher a low levels of supervision, however. For instance, when the supervision ratio is 0.015, a 10% increase raises effort by 1.7%. At the same time, firms must increase supervisors' wages as firm size increase in order to maintain their level of supervision effort: a firm with a capital stock such that employment is 1% higher pays its supervisors on average 0.6% more.

2. Conceptual framework

To motivate our empirical analysis, we construct a two-tier model of wages and worker supervision. Our model is an extension of earlier models by Sparks (1986) and Ringuede (1998). Workers have utility of the form $w - e^2$ where w is wage and e denotes effort. Workers face a probability of dismissal $d = \max(0, p(1 - \frac{e}{\bar{e}}))$ where $\bar{e}$ denotes a minimum standard of effort set by the employer and p is the probability of being monitored. We see that d decreases in effort and increases in supervision. If workers' effort is greater than $\bar{e}$, the probability of dismissal is 0. Since effort is costly, it is never in workers' interest to set $e > \bar{e}$; consequently $d = p(1 - \frac{e}{\bar{e}})$. In a stationary equilibrium, workers solve the following optimization problem:

$$\max_{e<\bar{e}} V^E = [w - e^2 + (1 - d)V^E + dV^U]\frac{1}{1 + r} \tag{2.1}$$

where V^U is continuation utility of an unemployed worker which, by assumption, is smaller than $\frac{w-e^2}{r}$. Sparks shows that the optimal level of effort e^* is decreasing in $\bar{e}$ if it is interior but increasing if $e^* = \bar{e}$. Consequently, it is in the employer's interest to set $\bar{e}$ such that the worker is on an interior solution but

$e^* = \bar{e}$. Sparks (1986) shows that optimizing out $\bar{e}$ yields the workers' effort function:

$$e^* = \left(\frac{w - rV^U}{1 + 2\frac{r}{p}} \right)^{\frac{1}{2}} \tag{2.2}$$

There are two categories of workers, production workers denoted b and supervisors denoted s with continuation utility if dismissed V_b^U and V_s^U. Firms choose the number of production workers n_b and supervisors n_s as well as their respective wages w_b and w_s. Output is an increasing function of production labor measured in efficiency units $f(n_b e_b)$. The output price serves as numeraire. The efficiency of production workers depends on their wage w_b and the probability of being monitored p_b. In turn, p_b depends on the number of supervisors n_s and their monitoring effort e_s. The effort of supervisors depends on their wage w_s and their probability of being monitored by shareholders p_s. Effort functions are as in 2.2. We assume that $p_b = \frac{e_s n_s}{n_b}$: the probability of being monitored depends on the number of supervisors per production worker times supervision effort. By analogy, we assume that $p_s = \frac{1}{\alpha n_s}$: the larger the firm, the less closely shareholders monitor supervisors; α is a supervision efficiency parameter.[1] Naturally, both p_b and p_b should be bounded between 0 and 1. With these assumptions, the optimization problem of firms is written:

$$\max_{w_b, n_b, w_s, n_s} \; f(n_b e_b(w_b, p_b(n_s e_s(w_s, p_s)))) - w_b n_b - w_s n_s \tag{2.3}$$

We first solve for w_s conditional on n_s. To this effect, we note that the above problem can be rewritten more simply as:

$$\max_{w_s, n_s} \; g(n_s e_s(w_s, p_s)) - w_s n_s \tag{2.4}$$

which yields two first order conditions of the form $g' \partial e_s / \partial w_s = n_s$ and $g' \partial e_s / \partial p_s = w_s$, from which we obtain $\frac{\partial e_s / \partial p_s}{\partial e_s / \partial w_s} = \frac{w_s}{n_s}$. Replacing throughout by the effort function $e_s(w_s, p_s) = \left(\frac{w_s - r V_s^U}{1 + 2r\alpha n_s} \right)^{\frac{1}{2}}$ yields the

[1] In principle, we could allow for a different number of shareholders. In practice, the overwhelming majority of the firms in our sample are entrepreneurial firms with a single individual or family owner, so we ignore this complication.

closed-form solution:

$$w_s^* = 2rV_s^U(1 + \alpha r n_s) \tag{2.5}$$

This is true for any choice of n_b and w_b. Equation 2.5 shows that the wage paid to supervisors increases with the absolute number of supervisors in the firm. Since the number of supervisors increases with firm size, larger firms pay supervisors more to motivate them better. At the optimal w_s, the supervision effort is $e_s^* = \left(rV_s^U\right)^{\frac{1}{2}}$; it is constant and does not depend on firm size.

Having solved for w_s^*, the firm's objective function can be rewritten:

$$\max_{w_b, n_b, n_s} \; f(n_b e_b(w_b, \frac{e_s n_s}{n_b})) - w_b n_b - w_s(n_s) n_s \tag{2.6}$$

It turns out that the solution is easier to characterize if we express the above problem in terms of supervision ratio $p_b = \frac{e_s n_s}{n_b}$ instead of number of supervisors n_b. With this change of variable, the employer's problem becomes:

$$\max_{w_b, n_b, p_b} \; f(n_b e_b(w_b, p_b)) - w_b n_b - w_s(\frac{p_b n_b}{e_s}) \frac{p_b n_b}{e_s} \tag{2.7}$$

The solution for w_b and p_b is derived in appendix. It is:

$$w_b^* = 2r\left[V_b^U + p_b V_s^U \frac{e_s + 2\alpha r n_b p_b}{e_s^2}\right] \tag{2.8}$$

$$p_b^* = \frac{1}{6\alpha r n_b V_s^U}\left[\frac{e_s^2 V_s^U V_s^U}{B} + B - e_s V_s^U\right] \tag{2.9}$$

where B is a complicated polynomial that increases in n_b. The choice of n_b, in turn, depends on the marginal return to production labor which is determined by the shape of the production function $f(e_b n_b)$. More productive firms and firms with more physical capital hire more production workers. At the optimal w_b, the worker effort is $e_b^* = \left(rV_b^U\right)^{\frac{1}{2}}$; like for supervisors it is constant and does not depend on firm size.

Figures 1 and 2 illustrate the relationship between firm size n_b and incentives. We see that w_s^* and w_b^* are increasing in n_b; p_b^* is decreasing in n_b. Larger firms pay higher wages to both supervisors and production workers. At the same time, they monitor production workers less closely. The rationale behind this result is that larger firms need more supervisors. In order to ensure that supervisors monitor workers effectively, they have to be paid more. This in turn implies that supervision costs increase with firm size. To economize on supervision, large firms lower the supervision ratio. To minimize the negative effect on workers' motivation, they raise the wages of production workers. These effects are illustrated on Figures 1 and 2 which show, for some reasonable choice of parameter values, how wages and supervision ratio change with firm size. The magnitude of the effect is large but commensurate with what is observed in our data.

The purpose of the rest of this paper is to estimate and test the above model. Although we do not observe p_b, we observe the supervision ratio $m \equiv \frac{n_s}{n_b} = \frac{p_b}{e_s}$. We assume that the production function has the form $f(ne) = a(ne)^\beta$. This yields a system of five non-linear equations – the production function and four first order conditions:

$$\begin{aligned}
q &= a(n_b e_b(w_b, \frac{e_s n_s}{n_b}))^\beta + \varepsilon_q \qquad (2.10)\\
w_s &= 2rV_s^U(1+\alpha r n_s) + \varepsilon_w \\
w_b &= 2rV_b^U + 2r\frac{n_s}{n_b}V_s^U(1+2\alpha r n_s) + \varepsilon_v \\
n_s &= \frac{1}{6e_s\alpha r V_s^U}\left[\frac{e_s^2 V_s^U V_s^U}{B} + B - e_s V_s^U\right] + \varepsilon_s \\
n_b &= \left[\frac{w_b + R_n}{a\beta e_b^\beta}\right]^{\frac{1}{\beta-1}} + \varepsilon_b
\end{aligned}$$

where the ε's are error terms, $R_n = \frac{2rn_sV_s^U(1+2\alpha r n_s)}{n_b}$, B is a polynomial in n_b, and e_b and e_s are as before. The above system contains observable variables q, w_s, w_b, n_s, n_b as well as a series of parameters $r, V_s^U, V_b^U, \alpha, \beta$, and a. In general, a depends on the capital stock of the firm, the human capital of the owner, and productivity shifters. The utility of the unemployed V_s^U and V_b^U varies across sectors and locations. The above system can be estimated via GMM using all exogenous variables as instruments. Implementation details are discussed in Section 4. We also estimate non-parametric versions of key model

predictions to check the validity of our choice of functional form.

There are other possible reasons why large firms pay high wages (e.g. Troske 1999, Bayard & Troske 1999). One reason that has received much attention in the literature is the possibility that large firms employ better workers. Stiglitz (1987), for instance, argues that worker productivity – observed and unobserved – will be correlated with firm size if the returns to better workers are larger in large firms. This is because large firms would either screen workers more effectively at hiring, or dismiss those who prove less productive. As a result of this self-selection process, their workforce may be statistically different from that of smaller firms where worker quality has less impact on firm productivity. The self-selection explanation of the relationship between firm size and wages does not predict any systematic relationship between firm size and supervision ratio. If we find such relationship, it would suggest that other factors are at work, such as the ones discussed here.

There are several reasons why large firms may require better workers. One possibility is that they have complicated equipment that is hard to operate and vulnerable to mishandling. This idea is empirically testable by examining whether firms with a larger capital-labor ratio pay higher wages. Another possibility is that, in large firms, the organization of work is complex and worker discipline is important to achieve coordination. This latter idea is close to our focus, except that we regard discipline as an action subject to moral hazard instead of as an immutable individual trait.

Given that we do not have panel data on individual workers, we cannot control for unobserved heterogeneity in workers across firms. But we can control for observed heterogeneity. To purge wages from observed differences between workers, we proceed as follows. Let w_{ij} be wages for a random sample of j workers in firm i. Their observed human capital is written h_{ij}. We regress (the log of) w_{ij} on h_{ij} and a firm-level fixed effect ω_i. This is done separately for supervisors and production workers, yielding different $\widehat{\omega_s}$ and $\widehat{\omega_b}$ estimates for each firm. When estimating 2.10, we replace throughout w_s and w_b by $\widehat{\omega_s}$ and $\widehat{\omega_b}$. This ensures that our firm-specific wage measure is purged of differences in worker productivity due to observable traits (and unobservable traits correlated with them).

3. The data

The ideas presented in the previous section are applicable anywhere. But they are particularly relevant for sub-Saharan Africa because of the rampant belief that African workers are less disciplined than, say, East-Asian or Chinese workers. This belief might explain why international corporations refrain from investing in Africa.

To investigate this possibility, we test the model presented in section 2 on matched employer-employee data collected on the manufacturing sector of nine sub-Saharan African countries and one North-African country. These data have been collected by various teams of researchers. The bulk of the data from sub-Saharan Africa was collected as part of the Regional Program for Enterprise Development (RPED), organized by the World Bank, in which samples of approximately 200 randomly selected firms were interviewed in eight countries (Burundi, Cameroon, Cote d'Ivoire, Ghana, Kenya, Tanzania, Zambia, and Zimbabwe). The surveys started with Ghana in 1992, and most other country surveys were initiated in 1993. Firms were re-interviewed three years in a row in most countries; as some firms dropped out of the sample, they were replaced with other firms with similar characteristics.[2] Four sectors of activity were covered: textile and garments; wood products; metal products; and food processing. Large as well as small firms, including informal ones, were included. Information is available on a wide range of variables, including sales and output, capital stock, entrepreneur characteristics, employment by occupational category, labor turnover, wages, and conflicts with workers. The RPED data have been extensively analyzed and have greatly improved our understanding of manufacturing in the continent (e.g. Bigsten, Collier, Dercon, Fafchamps, Gauthier, Gunning, Isaksson, Oduro, Oostendorp, Patillo, Soderbom, Teal, Zeufack & Appleton 2000*a*, Bigsten, Collier, Dercon, Fafchamps, Gauthier, Gunning, Isaksson, Oduro, Oostendorp, Patillo, Soderbom, Teal & Zeufack 2000*b*).

In order to form as large a sample as possible on sub-Saharan African firms, we augment the RPED sample with data from two sources. First, we use data on Ethiopian manufacturing firms that were collected independently of RPED but using the same questionnaire.[3] Ethiopia was surveyed three times

[2] Burundi was surveyed only once due to the rapid deterioration of the political situation following the Rwandan genocide. Cote d'Ivoire was surveyed only twice due to insufficient funding.

[3] The Ethiopian survey was coordinated by Taye Mengistae.

but we only have data for the first year, 1993. Second, we use data from the Kenyan Manufacturing Enterprise Survey (KMES), fielded in 2000 and designed as a follow-up to the last Kenyan RPED survey.[4] This survey generates data for 1998 and 1999.

In addition to our sample from sub-Saharan Africa, we have data on one North-African country, namely Morocco. The Moroccan data were collected as part of the Firm Analysis and Competitiveness Surveys (FACS), carried out jointly by the Ministry of Commerce and Industry and the World Bank in 2000. A random sample 860 firms were interviewed in six towns and seven sectors. The Moroccan survey generates data for 1998 and 1999.

One unusual feature of the data set is that it contains matched employer-employee information for 10 African countries. At the same time as the firms were surveyed, a sample of workers was chosen from each firm designed to cover the full range of firm employees. The objective was to have up to 10 workers from each firm where firm size allowed. To increase the informational content of the data, the worker sample was stratified according to occupational status. Where there is panel data, samples of workers have been interviewed again in subsequent years, but the identity of the workers differs across survey rounds.

For the purpose of our analysis, workers are divided into two categories: production workers, and supervisors. Production workers are skilled and unskilled workers on the shop floor. These are the workers directly involved in the production process itself. Supervisors include managers, technicians, foremen, and clerical staff. In small and medium-size firms such as the ones in our sample, technicians and foremen represent middle-rank management and can thus be counted as part of the management/supervision process. Among our sample firms, the main role of clerical staff is to assist management in gathering and processing information essential to the monitoring of production workers, such as reports, accounts, inventories, time sheets, and the like. For this reason, we count clerical staff as part of the supervision personnel of the firm: if the small manufacturers in our sample had fewer employees, they essentially would keep accountants and office staff to the strict minimum – which, in our case, is 0.

The characteristics of the firms in our pooled sample are summarized in Table 1.[5] African manufac-

[4] The KMES was organized by the Centre for the Study of African Economies, University of Oxford. See Soderbom (2001) for a report based on these data.

[5] Naturally, there is considerable inter-country variation in many of the variables. We show summary statistics by country

turing firms are small by international standards. The average level of employment is about 125 and the median is 47, a discrepancy consistent with the usual skewed distribution of firm size. The average of the log value-added per employee corresponds to about USD 3,000 in levels. The average supervision ratio, defined as the number of supervisors to the number of production workers, is 0.35. This figure is higher than for OECD data (Acemoglu & Newman 2000). This is largely because our broad definition of supervision workers includes clerical staff, a difference that is justified by the nature of the firms we investigate.

About 20 per cent of the firms have some foreign ownership, and slightly more than half of the firms are located in a capital city. Four percent have no education, 13 percent of the managers interviewed have only primary education, 44 percent have secondary or professional education, and the remaining 39 percent have a university degree. About a third of the firms employ unionized workers. The distribution across countries is highly non-uniform. Forty-four per cent of the observations are from Morocco alone, while the remaining 56 per cent are from sub-Saharan Africa. The largest sub-Saharan sample is Kenya, followed by Zambia and Ghana.

In Table 2 we show summary statistics based on the sample of workers. We have complete data on a total of 16,182 production workers and 9,601 supervisors. The average monthly earnings for production workers is USD 161 and the median earnings is USD 121. For supervisors earnings are much larger, on average USD 343. The median earnings is 214. A breakdown by country (Table A2, Appendix 1) reveals that there are substantial differences across countries. For both production workers and supervisors, Tanzania has the lowest median of earnings (USD 32 and USD 49, respectively) and Morocco the highest (USD 221 and USD 344, respectively). Incidentally, these differentials between the two countries are very close to the differential in per capita income reported in the World Development Indicators database.[6]

Production workers have on average nine years of education and eight years of tenure with the present firm. Interestingly, the level of education does not vary much across countries. Morocco, the country in our sample with by far the highest per capita income, ranks third from the bottom in terms of the

in Table A1, Appendix 1.

[6] Measured in constant 1995 USD, the per capita GNP in Morocco is about 1350 and in Tanzania about 180, hence yielding a difference of factor 7.4.

average level of education of production workers; only Burundi and Ivory Coast record lower sample averages. Supervisors have on average 12 years of education, and seven years of tenure. The average age for both categories of workers is close to 35 years. About a fifth of the sample of production workers, and approximately a third of the sample of supervisors, are women.

4. Econometric estimation

Econometric estimation proceeds in three steps. We begin by estimating earnings regressions using the worker data. As explained in Section 2, the purpose of this regression is to obtain a measure of firm-specific wage premium that is net of observable differences in workforce quality. Next, we take a fairly agnostic view at the data, trying to assess whether they exhibit the kind of patterns predicted by the model. This step is done without imposing much structure on the data. Having validated the model, the third step estimates the model directly by applying instrumented GMM to the non-linear system 2.10.

4.1. Earnings regressions

The estimated earnings equation takes the form:

$$\log w_{ijt} = \omega_{it} + \theta h_{ijt} + \upsilon_{ijt} \tag{4.1}$$

where w_{ijt} is the wage of worker j in firm i at time t, h_{ijt} is a vector of human capital characteristics of worker j, ω_{it} is a firm fixed effect allowed to vary over time, and υ_{ijt} is an error term (Abowd & Kramarz 1999). The regression is estimated separately for production workers (i.e., skilled and unskilled workers) and supervision workers (i.e., management, technical, and clerical staff).

Tables 3 and 4 present the results for production workers and supervisors, respectively, both pooled and by country. Education has a non-linear, convex, effect on earnings, manifesting itself here through the significance of the squared term on education. Since the marginal returns of education varies with the level, for ease of interpretation we show the marginal returns computed at six and twelve years of education. For production workers, the returns are very low at low levels of education; Burundi excepted, they are less than or equal to two per cent at six years of education. At twelve years, the marginal return

is less than or equal to seven per cent in seven out of the ten countries. With a few exceptions, the marginal returns to education are much higher for supervisors.

The age-earnings profile is inverse u-shaped in all cases except for production workers in Burundi and supervisors in Zimbabwe. The tenure coefficient is usually positive and significant, indicating that new workers earn less. This feature is consistent with the idea that firms adjust wages to productivity after hiring – either because workers learn on the job and become better, or because firms learn more about their intrinsic ability. It is noted, however, that the reward to tenure is small – typically about one per cent per year. Amongst production workers, the coefficient on the gender dummy is negative in all countries except Zambia, indicating that women have significantly lower earnings than men with the same observable characteristics. The gender dummy is significant at the five per cent level or better in six countries. Amongst supervisors, the picture with regard to gender bias is more mixed, probably because of the presence of women among clerical staff.

The firm fixed effects explain much of the wage differences between workers. For the pooled production workers model, for instance, the firm effects alone account for 82 per cent of the explained variation in wages.[7] Eighty-nine per cent of total wage variation can be explained either by fixed-effects or human capital differences. The importance of firm-level characteristics is consistent with our theory, where firms adjust their wages in order to motivate workers to exert a certain level of effort.

4.2. Validating the model

Next, we investigate how predicted firm fixed effects $\widehat{\omega_{it}}$ correlate with firm size. The model predicts that large firms pay more to production workers and supervisors and that the wage differential between the two categories also increases with size. We investigate whehter these predictions are at prima facie consistent with our data. To control for worker productivity effects, we do not use actual wages but rely on $\widehat{\omega_{it}}$ instead.

To check for robustness, we experiment with three different ways of measuring $\widehat{\omega_{it}}$. First we compute firm fixed effects both from the pooled and the country regressions (Tables 3 and 4). We also estimate

[7] R-squared reported in Tables 3 and 4 refer to within variation, not between or overall.

earnings regressions without firm-level controls or fixed-effects and take the firm-specific averages of the residuals as an alternative measure of $\widehat{\omega_{it}}$. The reason for doing so is that 'going within' may exacerbate the effects of measurement errors and bias the associated coefficients towards zero (Griliches & Hausman 1986). If this is the case, fixed effects estimates would do a poor job in purging the data from heterogeneity in observable human capital. We then regress the alternative measures of $\widehat{\omega_{it}}$ on various measures of firm size (in logarithms) and a set of country and sector dummies.

Table 5 reports the estimated size coefficients, interpretable as elasticities, and the associated t-values for various permutations. In the top panel of the table, size is measured as the number of production or supervision workers, depending on the earnings function estimated. The size coefficients are about 0.09 for production workers when using the fixed effects estimates and about 0.07 when using firm averages of OLS residuals. For supervisors they are somewhat larger: 0.13 when using fixed effects and 0.12 when based on the OLS residuals. All coefficients are highly significant. The middle panel shows that these results are affected little when we use total employment as size measure instead. In the bottom panel we use the capital stock as final size measure. Coefficients are uniformly smaller, but the size-effect is still highly significant and larger for supervisors than for production workers. The results demonstrate that earnings (purged from observed human capital heterogeneity) increase with firm size. The increase is faster for supervisors than for production workers. Both findings are consistent with the model presented in Section 2.

Figure 3 shows some results from non-parametric analysis of the above mechanisms.[8] The top-left panel of the figure shows the relation between firm size and the firm-specific wage effect $\widehat{\omega_{it}}$ for production workers. The top-right panel shows the corresponding relation for supervisors. Both regression lines suggest that the relation is mildly concave, consistent with the model presented in Section 2 (see Figure 1). The bottom-right panel of Figure 3 shows how the supervision intensity varies with firm size. The relation is strongly negative and highly significant, a result in line with model predictions.

In the bottom-left panel we show how the earnings differential between supervisors and production

[8] Results were obtained using locally weighted regressions based on an Epanechnikov kernel. A 95% asymptotic confidence interval is displayed. It is computed on the basis of the standard error of the constant in locally weighted regressions. The bandwidth is 0.8. All regressions control for country and sector through first difference.

workers varies with size. Recall from Table 5 that the size elasticity of wages is stronger for supervisors, suggesting that the differential increases with firm size. A non-parametric approach, however, does not support this notion. Instead it appears that the earnings differential follows an inverse u-shape with respect to size (defined here as the log of total employment). The differential increases until the level of employment reaches about $\exp(3.7) = 40$ employees, after which it falls sharply. This finding, however, is not robust. In Figure 4 we plot the same differential against the logarithm of capital. With this definition, we find a monotonic increase in the earnings differential over most of the size range. The conclusion from this exercise is that the data suggests the presence of an increasing earnings differential between supervisors and production workers, at least over a certain size range, hence providing some initial evidence in favor of the model presented in Section 2.

Taken together, these stylized facts square very well with model predictions: while wages increase with firm size, supervision intensity falls. As firm size increases, it becomes gradually less efficient to rely on close supervision to prevent workers from shirking, essentially because the supervisors themselves cannot be monitored efficiently by the principal. The response is to increase wages, both for supervisors and production workers, thereby making it more expensive for the employees to shirk.

The next step in our analysis is to examine how supervision and wages impact on productivity. Before estimating the structural model directly, we begin with a standard Cobb-Douglas production function to which we add variables that affect workers' effort, namely the supervision ratio and predicted wages. Value-added is the dependent variable. To minimize omitted variable bias, additional controls are included as well, such as firm age and foreign ownershp. The regression taks the form:

$$\log q = \log a + \beta_1 \log k + \beta_2 \log n_b + \beta_3 \log\left(\frac{n_s}{n_b}\right) + \beta_4 \widehat{\omega_s} + \beta_5 \widehat{\omega_b} + \varepsilon_q \tag{4.2}$$

OLS estimates of equation 4.2 are shown in Table 6. Predicted wages and the supervision ratio are shown to have the anticipated positive effect on productivity. In the pooled model, the estimated coefficient on supervision is equal to 0.33 and significant at the 1 per cent level. In six countries with the largest samples, supervision is significant at the five per cent level or lower. Among this group of countries, the coefficients hover around $0.30 - 0.40$, the only exception being Ghana where it is 0.60. It

is only in the countries with a small sample size that supervision is not significant.

For production workers, the estimated coefficient on firm wage is 0.44 in the pooled regression, and it is highly significant. In seven out of our ten countries, the production worker wage effect is significant at the 10 per cent level or better. The coefficient on the supervisor wage effect is positive, but less precisely estimated than that for production workers. Although significant at the 1 per cent level in the pooled model, in country regressions it is generally not significant, except for the two largest samples, Morocco and Kenya, where we obtain statistical significance at the 10 per cent level or better. As for the other explanatory variables in the production functions, we obtain capital coefficients in the range $(0.18, 0.42)$ for eight of our countries, the outliers being Cameroon (above) and Ghana (below). Foreign ownership is typically associated with higher productivity, whereas the effects of firm age vary considerably across countries.

In Table 7 we report two-stage least squares results, where we have allowed $\log n_b$ and, in column [4], the supervision ratio to be endogenous. Instruments include lagged total employment (in log), a dummy for whether or not the firm is located in the capital city, and the manager's education. Column [1] reports results for the pooled model. Instrumenting doubles the coefficient on the supervision ratio from 0.33 to 0.66. The coefficient on production workers similarly rises from 0.78 to 1.21, but this is mainly caused by the increase in the coefficient of the supervision ratio. Keeping in mind that n_b appears in the denominator of the supervision ratio, instrumenting raises the output elasticity of production workers only moderately, from 0.45 to 0.55. Compared to OLS, the size of firm wage effects decreases somewhat, but the parameter estimates are still significant at the five per cent level. Columns [2] and [3] show separate results for sub-Saharan Africa pooled and for Morocco. Most of the coefficients of interest are quite similar across the two equations, but the wage effect is much larger in sub-Saharan Africa than in Morocco. In column [4] we treat the supervision ratio as an additional endogenous variable, using the same instrument set. We obtain a decrease in some of the t-statistics, but the point estimates change little compared to column [1].

4.3. Structural Estimation

We have seen that many of the qualitative features of the data are consistent with the supervision model presented in section 2. We are now ready to impose more structure on the data by estimating the model directly. Our aim is to estimate the production function and the first order conditions described in Section 2, eq. 2.10. Assuming a Cobb-Douglas production function in capital and effective labor, the empirical equations become:

$$\begin{aligned}
\log q &= \log a + \beta_1 \log k + \beta_2 \log n_b + 0.5\beta_2 \log \frac{w_b - rV_b^U}{1 + 2r\frac{n_b}{n_s}\left(\frac{1+2\alpha n_s r}{w_s - rV_s^U}\right)^{0.5}} + \varepsilon_q \qquad (4.3)\\
w_s &= 2rV_s^U(1+\alpha r n_s) + \varepsilon_w \\
w_b &= 2rV_b^U + 2r\frac{n_s}{n_b}V_s^U(1+2\alpha r n_s) + \varepsilon_v \\
n_s &= \frac{1}{6e_s\alpha r V_s^U}\left[\frac{e_s^2 V_s^U V_s^U}{B} + B - e_s V_s^U\right] + \varepsilon_s \\
n_b &= \left[\frac{w_b + R_n}{a\beta e_b^{\beta}}\right]^{\frac{1}{\beta-1}} + \varepsilon_b
\end{aligned}$$

Our task is to estimate $V_s^U, V_b^U, \alpha, \beta_1, \beta_2$ and a by fitting system 4.3 to the data.[9] This is not as straightforward as it seems because system 4.3 is non-linear in both variables and parameters, and many regressoers are endogenous. To overcome this difficulty, we develop a Generalized Method of Moments (GMM) framework to form a non-linear instrumental variable estimator (Hansen 1982). Assuming that a vector of instruments z_h^i is available, let the moment conditions be written:

$$m_i(\theta) = Z_i' \varepsilon_i(\theta), \qquad (4.4)$$

where θ is a $(p \times 1)$ vector of parameters, $p = p_q + p_w + p_v + p_s + p_b$, Z_i is a $(5 \times q)$ block diagonal matrix with z_h^i in the appropriate block, $q = q_q + q_w + q_v + q_s + q_b$ is the total number of instruments, and $\varepsilon_i = \begin{bmatrix} \varepsilon_{iq} & \varepsilon_{iw} & \varepsilon_{iv} & \varepsilon_{is} & \varepsilon_{ib} \end{bmatrix}$ is the (5×1) vector of residuals for firm i in system 4.3. The GMM

[9] Initially we sought to estimate r as well but could not because of underidentification which manifested itself as severe convergence problems and very high standard errors on $\hat{r}$. Therefore we decided to set r to a 'reasonable' value, namely, $r = 0.10$.

estimator of θ is the vector that minimises the criterion function

$$C(\theta) = m(\theta)' W^{-1} m(\theta) \tag{4.5}$$

where $m(\theta) = \frac{1}{N}\sum_{i=1}^{N} m_i(\theta)$ denotes the sample moments and W is a positive semidefinite $(p \times p)$ weight matrix.[10] The first-order conditions are

$$\nabla_\theta m\left(\hat{\theta}\right) W^{-1} m\left(\hat{\theta}\right) = 0 \tag{4.6}$$

where $\nabla_\theta m\left(\hat{\theta}\right) = \sum_{i=1}^{N} \frac{\partial m_i(\theta)}{\partial \theta}$ is a $(p \times 1)$ vector of partial derivatives of $m(\theta)$ with respect to $\hat{\theta}$. Efficient estimation requires that the covariance matrix for the moment conditions, $\mathrm{Var}[m(\theta)]$, be used as the weight matrix. Since this matrix is unknown, it has to be estimated. Following standard procedure, we begin by obtaining a preliminary (Step 1) consistent but inefficient estimate $\tilde{\theta}$ from 4.5 using $W = \left(N^{-1}\sum Z_i' Z_i\right)^{-1}$. Based on $\tilde{\theta}$ we calculate the N vectors of residuals $\tilde{\varepsilon}_i$ and form a new weight matrix,

$$W = \left(N^{-1}\sum Z_i' \tilde{\varepsilon}_i \tilde{\varepsilon}_i' Z_i\right)^{-1} \tag{4.7}$$

and use this in 4.5 to obtain the Step 2 GMM estimate $\hat{\theta}$.[11] The asymptotic covariance matrix associated with the parameter estimates $\hat{\theta}$ is obtained using the formula

$$\mathrm{Var}\left(\hat{\theta}\right) = \left(\nabla_\theta m\left(\hat{\theta}\right)' W^{-1} \nabla_\theta m\left(\hat{\theta}\right)\right)^{-1} \tag{4.8}$$

Estimation results are summarized in Table 8. Parameter a is time and country specific and varies by sector. Parameters V_s^U and V_b^U – the reservation utility of unemployed supervisors and workers – are

[10] All the standard regularity conditions (see e.g. Hansen (1982)) are assumed to hold.

[11] While Step 2 estimates are consistent and efficient, Monte Carlo results reported by Kocherlakota (1990) indicate that further iteration may improve performance in small samples, yielding the iterative GMM estimator. The idea is simply to use the Step j GMM estimates $\hat{\theta}^{(j)}$ to update the weight matrix, and then obtain the Step $j+1$ GMM estimates $\hat{\theta}^{(j+1)}$ by minimising the criterion function $C(\theta)$ in the usual fashion. Iteration stops when there is little gain from further iteration. We make some, albeit limited, use of the iterative estimator in the empirical analysis.

similarly allowed to vary across countries and sectors.[12] The variables w_s and w_b are replaced with $\widehat{\omega_{it}}_s$ and $\widehat{\omega_{it}}_b$. Three versions of the estimated model are reported. Two of these versions, columns [1] and [2], do not use the full model but only the first three equations – namely the production function and the first order conditions for the wage rate. The reason for this choice will become clearer below. Column [3] reports estimates for the full model. Instruments are as before. Only pooled results are reported at this point.

Results are surprisingly consistent across the three models. The share of capital reverts around .23-.24. The share of labor is higher when the last two first order conditions are not used in the estimation. In that case, we cannot rule out the existence of increasing returns to capital and labor. If confirmed by subsequent runs, this suggests that the need to supervise workers penalize large firms and makes it difficult if not impossible for them to capture increasing returns to size. This issue deserves more investigation.

To facilitate interpretation, we calculate the relationship between firm size, wages, and supervision that is implied by estimated parameter values. Results are presented in Figure 5 for the pooled sample. They show that a doubling in firm capital raises wages to production workers by 5 % while at the same time decreasing the supervision ratio by 22% and raising supervisors' wages by 59%. As a result of this combination, labor effort remains constant across firm sizes but total labor cost per unit of effort (including supervisors' wages) increases by 132%. This is the penalty large firms have to incur in order to motivate workers. Thanks to increasing returns, however, revenues increase by 156%, which is enough to cover increased labor costs.

4.4. Robustness tests and specification checks

Before concluding, it is important that we check the robustness of our results. The first step is to get a sense of how much violence the model does to the data, that is, how restrictive the empirical model is. To test model specification, we consider two types of statistical tests.

The first is a standard Sargan-Hansen specification test. Based on the sample moments, this test

[12] For obvious numerical reasons, $w_b - rV_b^U$ must remain positive everywhere otherwise its evaluation in the efficiency function returns a complex number. To avoid problems during estimation, the estimated value of rV_b^U is constrained to remain everywhere below the lowest value of w_b. Similarly for rV_s^U.

investigates the null hypothesis that the population moments are zero. This test statistic is simply the value of the criterion function 4.5 evaluated at the GMM estimate $\hat{\theta}$, which under the null of no misspecification is asymptotically $\chi^2(R)$ where R is the number of overidentifying restrictions $(q-p)$ plus the number of cross-equation restrictions, l. This test provides a general evaluation of how well the data fits the moment restrictions implied by the model and our choice of instruments.

The value of the Sargan-Hansen test is reported at the bottom of Table 8 for the three model specifications. In all cases, the null hypothesis that the moments are zero is rejected. This test, however, is quite demanding as it jointly tests the restrictions imposed by the model and the overidentifying restrictions imposed by the instruments. What we are more intested in is whether the cross-equation restrictions imposed by the model are rejected by the data. To test the validity of the cross-equation restrictions, we rely on a Lagrange Multiplier (LM) test. The idea for the test is that, if the cross-equation restrictions are valid, then the first-order conditions associated with the unrestricted form of 4.6 evaluated at the restricted parameter estimates should be satisfied. The LM statistic, calculated as

$$LM = \left[\nabla_\theta m_U\left(\hat{\theta}\right) W^{-1} m_U\left(\hat{\theta}\right)\right]' \left[\nabla_\theta m_U\left(\hat{\theta}\right)' W^{-1} \nabla_\theta m_U\left(\hat{\theta}\right)\right]^{-1} \nabla_\theta m_U\left(\hat{\theta}\right) W^{-1} m_U\left(\hat{\theta}\right) \qquad (4.9)$$

where the u-subscript indicates that the underlying criterion function is unrestricted, is asymptotically $\chi^2(l)$. Test statistics 4.9 are also reported at the bottom of Table 8 (LM-stat). We see that the cross-equation restrictions are not rejected for the three equations model. But the restrictions are strongly rejected when the last two first order conditions are included in the structural estimation. This suggests that the last two first order conditions are inconsistent with the data. This issue deserves more investigation.

5. Conclusion

In this paper we have examined whether data on manufacturing firms in 10 African countries are consistent with a two-tier supervision model of worker effort. We begin by constructing a efficiency labor model whereby firms optimally choose their level of supervision and the wage premium they pay their workers and supervisors relative to other firms. This model predicts constant levels of effort across firms but an

increase in wages and supervision effort with firm size. It also predicts a growing differential between the wages of production workers and supervisors as firm size increase. The reason is that supervisors have to be motivated to supervise well.

We then take the model to a data set covering 10 African countries. The main difficulty about testing supervision models is that any observed relationship between wages and firm size can potentially be attributed to systematic differences in workers' traits across firms. To minimize this bias, we take advantage of matched worker-employer data to construct a firm-specific wage measure that is purged of all observable differences across workers. Although this approach does not entirely eliminate the possibility of a selection bias – there might remain systematic differences in unobservable worker traits across firms – we believe our approach singularly reduces the likely magnitude of the bias. This is particularly true given that the sectors on which we have data belong to light manufacturing such as garment and textile or food processing. Most surveyed firms use dated equipment for which production work is relatively straightforward. In such an environment, it is doubtful that unobservable worker traits would account for much of the productivity differences across firms.

We begin by testing whether the data is broadly consistent with model predictions. We find that wages increase with firm size for both production workers and supervisors and that, in the majority of the cases, they increase faster for supervisors. We also find that the supervision ratio drops dramatically with firm size. When we regress value added on capital and labor plus wages and the supervision ratio, both are shown to be strongly correlated with productivity.

Given this encouraging preliminary results, we venture to estimate the structural model itself. To do so, we rely on the general method of moments to estimate a system of five non-linear equations by instrumental variables. Results show that a doubling in firm capital raises wages to production workers by 5 % while at the same time decreasing the supervision ratio by 22% and raising supervisors' wages by 59%. As a result of this combination, labor effort remains constant across firm sizes but total labor cost per unit of effort (including supervisors' wages) increases by 132%. This is the penalty large firms have to incur in order to motivate workers.

We also conduct a number of specification checks. Results suggest that first order conditions for

wages are by and large satisfied but that first order conditions for employment are not. We speculate that this outcome is due to our failure to account for a direct contribution of supervisors to firm output. Estimating a generalized model that allow for a dual supervisor role – as supervisors and as workers – is left for future research.

If confirmed by future work, the analysis presented here suggest that labor discipline is a seriously underestimated problem. This might be especially true in a continent like Africa where manpower has generally spent little time in school and has not been brought up within the routine of daily school attendance throughout adolescence. This issue deserves more investigation.

6. Appendix

To derive the optimal solution to the employer's problem, it is useful to rewrite it as:

$$\max_{n_b, w_b, p_b} f(n_b e_b(w_b, p_b)) - w_b n_b - R(n_b, p_b) \tag{6.1}$$

where $R(n_b, p_b) \equiv w_s(\frac{p_b n_b}{e_s})\frac{p_b n_b}{e_s}$. Dropping b subscripts to improve readability, the first order conditions are:

$$\begin{aligned} f'ne_w &= n \\ f'ne_p &= R_p \\ f'e &= w + R_n \end{aligned} \tag{6.2}$$

from which we obtain

$$\begin{aligned} \frac{e}{e_w} &= w + R_n \\ \frac{e}{e_p} &= \frac{(w + R_n)n}{R_p} \end{aligned} \tag{6.3}$$

We have:

$$\begin{aligned} e &= (w - rV^U)^{\frac{1}{2}}(1 + 2\frac{r}{p})^{-\frac{1}{2}} \\ e_w &= \frac{1}{2}(w - rV^U)^{-\frac{1}{2}}(1 + 2\frac{r}{p})^{-\frac{1}{2}} \\ e_p &= rp^{-2}(w - rV^U)^{\frac{1}{2}}(1 + 2\frac{r}{p})^{-\frac{3}{2}} \end{aligned} \tag{6.4}$$

from which we obtain $\frac{e}{e_w} = 2(w - rV_b^U)$ and $\frac{e}{e_p} = p(\frac{p}{r} + 2)$. This yields:

$$\begin{aligned} w + R_n &= 2(w - rV_b^U) \\ \frac{(w + R_n)n}{R_p} &= p(\frac{p}{r} + 2) \end{aligned} \tag{6.5}$$

The first immediately yields a solution for w_b^* of the form $w_b^* = 2rV_b^U + R_n$.

We also have:

$$\begin{aligned} R_p &\equiv \frac{\partial[w_s(n_s)n_s]}{\partial p} = \frac{2n_b r V_s^U(e_s + 2\alpha r n_b p)}{e_s^2} \\ R_n &\equiv \frac{\partial[w_s(n_s)n_s]}{\partial n_b} = \frac{2pr V_s^U(e_s + 2\alpha r n_b p)}{e_s^2} \end{aligned} \tag{6.6}$$

Replacing R_n by the above, we directly obtain equation 2.8. Replacing R_p by the above, we obtain a third order polynomial in p. Two of the three roots are always negative. The one positive root has the form shown in equation 2.9.

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Table 1: Summary Statistics on Firms, Pooled Sample

	Obs.	Mean	p50	Std. Dev	Min	Max
Employment	3007	124.93	47	246.29	1	4478
log (Value-Added / Employee)	3007	7.98	8.04	1.25	-0.58	12.75
log (Capital / Employee)	3007	8.41	8.49	1.55	-0.26	12.94
Supervision Ratio	3007	0.35	0.21	0.40	0.00	2.83
Firm Age / 100	3007	0.18	0.14	0.13	0.01	1.03
Any Foreign Ownership	3007	0.21				
Location in Capital City	3006	0.56				
Manager's Education, Primary	2675	0.13				
Manager's Education, Secondary / Prof.	2675	0.44				
Manager's Education, University	2675	0.39				
Employees Unionised	2933	0.34				
Kenya	3007	0.19				
Burundi	3007	0.02				
Ivory Coast	3007	0.01				
Ethiopia	3007	0.03				
Cameroon	3007	0.04				
Zambia	3007	0.10				
Tanzania	3007	0.05				
Zimbabwe	3007	0.06				
Ghana	3007	0.06				
Morocco	3007	0.44				
Food Processing	3007	0.18				
Wood & Furniture	3007	0.13				
Textile & Garments	3007	0.43				
Metal & Machinery	3007	0.14				
Leather	3007	0.03				
Electrical	3007	0.02				
Chemicals	3007	0.03				
Plastics	3007	0.03				

Table 2: Summary Statistics on Workers, Pooled Sample

	Firm-year	Firms	Workers	Mean	p50	Std Dev	Min	Max
A. Production Workers								
Earnings (USD)	4428	2407	16182	160.72	121.31	149.36	10.17	3778.24
Educ	4428	2407	16182	9.11	11	4.03	0	24
Age	4428	2407	16182	34.28	33	9.33	12	79
Tenure	4428	2407	16182	7.81	6	7.05	0	50
Female	4428	2407	16182	0.22	0	0.41	0	1
B. Supervisors								
Earnings (USD)	3567	1969	9601	342.93	214.09	463.62	10.46	7278.52
Educ	3567	1969	9601	11.82	12	3.93	0	26
Age	3567	1969	9601	35.67	34	8.89	15	78
Tenure	3567	1969	9601	7.18	5	6.44	0	42
Female	3567	1969	9601	0.31	0	0.46	0	1

Table 3: Earnings Regressions for Production Workers, with Firm Fixed Effects

	Pooled	Kenya	Burundi	Ivory Coast	Ethiopia	Cameroon	Zambia	Tanzania	Zimbabwe	Ghana	Morocco
Educ (years)	-0.01	-0.01	-0.12	0.01	-0.03	-0.07	-0.08	-0.03	0.03	-0.06	0.01
	(4.07)**	(0.84)	(4.43)**	(0.71)	(2.01)*	(3.44)**	(3.89)**	(1.81)	(1.37)	(4.96)**	(2.21)*
$Educ^2$ / 100	0.23	0.26	1.56	0.10	0.41	0.73	0.63	0.40	-0.07	0.62	0.04
	(11.60)**	(4.65)**	(7.24)**	(1.43)	(4.44)**	(6.37)**	(5.30)**	(4.11)**	(0.52)	(6.77)**	(1.82)
Age (years)	0.03	0.02	-0.01	0.02	0.07	0.08	0.04	0.04	0.05	0.02	0.01
	(14.13)**	(3.56)**	(0.36)	(1.61)	(8.47)**	(5.28)**	(4.26)**	(5.04)**	(4.83)**	(3.36)**	(4.01)**
Age^2 / 100	-0.03	-0.01	0.03	-0.01	-0.07	-0.07	-0.04	-0.05	-0.05	-0.02	-0.01
	(9.65)**	(1.57)	(0.99)	(0.58)	(6.50)**	(3.76)**	(3.39)**	(4.28)**	(4.07)**	(2.35)*	(1.20)
Tenure (years)	0.01	0.01	0.02	0.02	0.01	0.02	0.01	0.01	0.01	0.02	0.01
	(15.28)**	(4.78)**	(2.29)*	(5.93)**	(4.07)**	(3.82)**	(4.28)**	(2.19)*	(4.89)**	(9.65)**	(6.90)**
Female	-0.13	-0.15	-0.31	-0.27	-0.36	-0.06	0.06	-0.19	-0.12	-0.00	-0.10
	(12.79)**	(4.90)**	(1.71)	(3.83)**	(9.65)**	(0.74)	(1.03)	(4.22)**	(2.36)*	(0.10)	(9.96)**
Marginal return at Educ = 6	0.02	0.02	0.07	0.02	0.02	0.02	0.00	0.02	0.02	0.01	0.01
Marginal return at Educ = 12	0.04	0.05	0.25	0.03	0.07	0.11	0.07	0.07	0.02	0.09	0.02
R-squared	0.15	0.13	0.42	0.19	0.30	0.28	0.13	0.26	0.15	0.24	0.13
Observations	16182	3249	239	936	957	895	1349	691	816	1213	5837

Absolute value of t-statistics in parentheses
* significant at 5% level; ** significant at 1% level

Table 4: Earnings Regressions for Supervisors, with Firm Fixed Effects

	Pooled	Kenya	Burundi	Ivory Coast	Ethiopia	Cameroon	Zambia	Tanzania	Zimbabwe	Ghana	Morocco
Educ (years)	-0.01	-0.08	-0.01	-0.01	-0.02	-0.10	-0.11	-0.05	0.23	-0.04	0.01
	(0.93)	(2.48)*	(0.12)	(0.34)	(0.33)	(3.76)**	(2.61)**	(1.76)	(0.56)	(1.44)	(1.76)
$Educ^2$ / 100	0.46	0.91	0.67	0.38	0.53	0.87	1.09	0.51	-0.37	0.75	0.36
	(14.90)**	(5.79)**	(2.79)**	(2.00)*	(2.09)*	(6.92)**	(5.59)**	(3.83)**	(0.19)	(4.78)**	(9.71)**
Age (years)	0.04	0.09	0.05	0.04	0.06	0.06	0.07	0.03	-0.00	0.03	0.03
	(8.69)**	(5.40)**	(0.88)	(1.59)	(2.70)**	(2.55)*	(4.44)**	(2.53)*	(0.05)	(2.20)*	(4.05)**
Age^2 / 100	-0.03	-0.09	-0.03	-0.03	-0.06	-0.04	-0.07	-0.02	0.02	-0.02	-0.02
	(5.10)**	(4.14)**	(0.35)	(0.98)	(1.96)	(1.36)	(3.25)**	(1.31)	(0.42)	(1.07)	(1.86)
Tenure (years)	0.01	0.00	-0.00	0.01	0.01	0.00	-0.00	0.01	0.01	0.01	0.02
	(8.51)**	(0.95)	(0.24)	(2.27)*	(1.38)	(0.53)	(0.17)	(2.11)*	(1.68)	(3.26)**	(9.82)**
Female	-0.16	-0.03	0.20	-0.10	-0.04	-0.05	-0.08	-0.10	0.08	-0.14	-0.23
	(11.28)**	(0.70)	(1.25)	(1.30)	(0.40)	(1.12)	(1.73)	(2.19)*	(0.49)	(2.57)*	(11.80)**
Marginal return at Educ = 6	0.05	0.03	0.07	0.04	0.05	0.01	0.02	0.01	0.18	0.05	0.05
Marginal return at Educ = 12	0.10	0.14	0.15	0.08	0.11	0.11	0.15	0.07	0.14	0.14	0.10
R-squared	0.34	0.26	0.65	0.18	0.30	0.32	0.31	0.36	0.22	0.33	0.40
Observations	9601	1258	95	403	246	714	942	654	227	577	4485

Table 5: The Firm-Size Earnings Relation

Definition Wage Variable*	Size Variable	Coef.	t-value	Size Variable	Coef.	t-value
FE, pooled	log(Prod.work.)	0.090	15.773	log(Supervisors)	0.132	12.922
FE, country-spec.		0.091	15.938		0.133	12.930
OLS, pooled		0.069	13.068		0.123	12.557
OLS, country -spec.		0.068	13.114		0.120	12.438
FE, pooled	log(Employment)	0.096	17.047	log(Employment)	0.105	12.623
FE, country-spec.		0.097	17.281		0.110	13.147
OLS, pooled		0.078	14.939		0.098	12.293
OLS, country -spec.		0.076	14.918		0.098	12.497
FE, pooled	log(Capital)	0.050	14.484	log(Capital)	0.065	12.158
FE, country-spec.		0.051	15.021		0.066	12.223
OLS, pooled		0.035	10.812		0.058	11.306
OLS, country -spec.		0.034	10.927		0.057	11.292

Note: FE, pooled = Fixed Effects from Pooled regression; FE, c-spec. = Fixed Effects from country regressions; OLS, pooled = Average residual from Pooled regression; FE, c-spec. = Average residual from country regressions.

Table 6: Value-Added Production Functions: OLS Estimates

	Pooled	Kenya	Burundi	Ivory Coast	Ethiopia	Cameroon	Zambia	Tanzania	Zimbabwe	Ghana	Morocco
log Capital	0.32	0.42	0.20	0.39	0.23	0.52	0.21	0.18	0.23	0.12	0.34
	(16.84)**	(8.93)**	(1.99)	(3.52)**	(1.78)	(6.12)**	(3.06)**	(3.50)**	(4.03)**	(1.96)	(14.71)**
log (Production workers + 1)	0.78	0.63	1.27	0.95	0.95	0.28	0.97	0.98	0.91	1.07	0.85
	(19.26)**	(6.65)**	(3.94)**	(4.00)**	(2.82)**	(2.00)*	(7.14)**	(7.87)**	(8.39)**	(8.00)**	(18.72)**
log (Super-vision ratio)	0.33	0.43	0.14	0.30	0.16	0.18	0.37	0.42	0.27	0.60	0.31
	(9.12)**	(4.77)**	(0.81)	(1.06)	(0.53)	(0.79)	(2.56)*	(2.38)*	(2.39)*	(5.00)**	(6.86)**
Firm earnings effect, prod.w.	0.44	0.57	0.21	-0.12	0.55	0.56	0.55	0.57	0.50	0.28	0.18
	(7.10)**	(3.23)**	(0.55)	(0.25)	(1.89)	(1.98)	(3.00)**	(1.96)	(2.35)*	(1.59)	(2.23)*
Firm earnings effect, superv.	0.20	0.28	-0.10	-0.01	0.15	0.55	0.27	0.24	0.09	0.02	0.23
	(4.19)**	(1.69)	(0.18)	(0.02)	(0.32)	(1.48)	(1.34)	(0.73)	(0.68)	(0.08)	(3.10)**
Earnings effect superv. missing	0.42	0.69	-0.49	0.05	0.32	0.99	0.49	0.26	0.33	-0.24	0.68
	(2.85)**	(1.81)	(0.32)	(0.05)	(0.34)	(0.80)	(0.99)	(0.41)	(0.79)	(0.41)	(2.53)*
Firm age / 100	0.36	0.49	-0.33	-2.52	-3.11	1.55	1.38	-1.09	0.15	0.10	0.14
	(1.90)	(1.06)	(0.28)	(1.64)	(1.80)	(1.17)	(1.76)	(1.03)	(0.40)	(0.14)	(0.55)
Any foreign ownership	0.24	0.21	0.48	0.87	-0.08	0.08	0.27	0.39	0.33	0.27	0.12
	(4.04)**	(1.29)	(1.52)	(3.75)**	(0.10)	(0.29)	(1.05)	(1.12)	(2.43)*	(1.14)	(1.79)
R-squared	0.79	0.77	0.88	0.92	0.44	0.61	0.71	0.71	0.90	0.79	0.77
Observations	3007	585	52	43	82	132	309	140	174	181	1309

Robust t-statistics in parentheses. All regressions include an intercept and dummy variables for sector and time. In the pooled regression there are country specific time trends.

* significant at 5% level; ** significant at 1% level

Table 7: Value-Added Production Functions: IV Estimates[$]

	[1] Pooled	[2] Sub-Saharan Africa	[3] Morocco	[4] Pooled
log Capital	0.21 (9.61)**	0.20 (6.38)**	0.23 (8.53)**	0.19 (5.22)**
log (Production workers + 1)	1.21 (21.20)**	1.17 (14.58)**	1.26 (16.76)**	1.28 (7.45)**
log (Super-vision ratio)	0.66 (11.73)**	0.70 (8.06)**	0.63 (9.29)**	0.79 (2.65)**
Firm earnings effect, prod.w.	0.38 (5.50)**	0.50 (5.17)**	0.13 (1.47)	0.38 (5.28)**
Firm earnings effect, superv.	0.13 (2.56)*	0.16 (1.64)	0.13 (1.58)	0.12 (2.18)*
Earnings effect superv. missing	0.40 (2.51)*	0.41 (1.79)	0.46 (1.49)	0.41 (2.50)*
Firm age / 100	0.50 (2.34)*	0.71 (2.18)*	0.11 (0.43)	0.49 (2.28)*
Any foreign ownership	0.15 (2.14)*	0.28 (2.09)*	0.04 (0.60)	0.14 (2.05)*
Endogenous	log(product. work)	log(product. work)	log(product. work)	log(product. work), log(superv. ratio)
R-squared	0.78	0.71	0.75	0.77
Observations	2446	1176	1270	2446

Robust t-statistics in parentheses. * significant at 5% level; ** significant at 1% level.

[$] The instruments are: total number of employees in previous period; education of manager or owner; location in capital city; and all exogenous variables in the structural specification.

Table 8: GMM Estimates of Structural Parameters[$]

	[1] Eq. (1)-(3)		[2] Eq. (1)-(3)		[3] Eq. (1)-(5)	
	Coef.	Std.	Coef.	Std.	Coef.	Std.
β_1	0.238	0.020	0.229	0.020	0.238	0.008
β_2	0.902	0.031	0.898	0.031	0.602	0.013
α	0.910	0.120	1.100	0.099	0.856	0.044
Firm age / 100	0.653	0.196	0.637	0.198	0.001	0.075
Any foreign ownership	0.061	0.056	0.037	0.058	0.171	0.025
Ivory Coast	0.980	0.301	0.993	0.323	0.519	0.173
Ethiopia	0.257	0.326	0.134	0.305	-0.415	0.205
Cameroon	0.501	0.544	0.356	0.534	0.595	0.092
Zambia	0.244	0.207	0.101	0.204	0.004	0.070
Tanzania	-0.400	0.226	-0.385	0.222	-0.453	0.081
Zimbabwe	-0.044	0.190	-0.045	0.180	0.351	0.088
Ghana	-0.055	0.215	-0.167	0.214	-0.187	0.078
Morocco	0.167	0.143	0.110	0.143	0.774	0.051
Kenya x 1993	-0.423	0.198	-0.519	0.203	-0.072	0.069
Kenya x 1994	-0.297	0.226	-0.355	0.227	-0.069	0.078
Kenya x 1998	0.211	0.273	0.024	0.270	-0.098	0.087
Kenya x 1999	-0.181	0.173	-0.191	0.173	-0.007	0.060
Cameroon x 1993	1.192	0.682	1.299	0.686	-0.460	0.103
Cameroon x 1994	2.180	0.694	2.239	0.676	-0.770	0.151
Zambia x 1993	-0.665	0.251	-0.584	0.249	-0.112	0.082
Zambia x 1994	-0.400	0.243	-0.405	0.241	0.025	0.087
Tanzania x 1993	-0.374	0.411	-0.353	0.483	-0.156	0.168
Tanzania x 1993	0.272	0.279	0.233	0.274	0.186	0.122
Zimbabwe x 1993	0.273	0.154	0.152	0.151	0.084	0.087
Ghana x 1993	-0.392	0.205	-0.255	0.209	0.297	0.087
Morocco x 1999	-0.041	0.043	-0.052	0.044	-0.010	0.020
Food	-0.212	0.132	-0.117	0.133	-0.211	0.045
Wood	-0.667	0.138	-0.618	0.138	-0.104	0.049
Textile	-0.837	0.130	-0.774	0.132	-0.047	0.045
Leather	-0.840	0.160	-0.794	0.161	0.030	0.053
Electrical	-0.421	0.153	-0.297	0.158	0.019	0.058
Chemical	0.015	0.167	0.206	0.169	0.152	0.060
Plastics	-0.388	0.155	-0.349	0.160	-0.394	0.051
Arguments of V_s^U and V_b^U						
Country dummies	yes		yes		yes	
Sector dummies	no		yes		no	
Country and time	no		no		no	

The table continues on the next page.

Table 8 continued

	[1] Eq. (1)-(3)		[2] Eq. (1)-(3)		[3] Eq. (1)-(5)	
Supervisors' outside option, by country*:	$E(rV_s^U)$	$Std(rV_s^U)$	$E(rV_s^U)$	$Std(rV_s^U)$	$E(rV_s^U)$	$Std(rV_s^U)$
Kenya	260.2	18.3	298.3	--	179.6	21.8
Ivory Coast	1220.9	---	1220.9	--	1220.9	---
Ethiopia	176.2	21.8	282.8	--	153.4	44.9
Cameroon	937.6	92.3	1083.9	--	850.1	126.0
Zambia	271.1	22.9	288.7	--	227.5	34.4
Tanzania	177.7	---	177.7	--	177.7	---
Zimbabwe	384.9	48.3	437.9	--	339.9	49.0
Ghana	281.5	27.5	351.6	--	180.9	40.2
Morocco	1438.2	---	1438.2	--	1427.9	28.0
Production workers' outside option, by country*:	$E(rV_s^U)$	$Std(rV_s^U)$	$E(rV_s^U)$	$Std(rV_s^U)$	$E(rV_s^U)$	$Std(rV_s^U)$
Kenya	100.0	14.4	59.0	7.9	102.1	41.7
Ivory Coast	845.6	---	549.6	140.4	845.6	---
Ethiopia	121.5	54.4	248.2	---	211.2	53.4
Cameroon	0.0	---	416.5	92.5	0.0	---
Zambia	0.0	---	49.7	7.6	0.0	---
Tanzania	18.2	12.7	36.9	6.7	6.7	14.0
Zimbabwe	301.1	30.3	136.5	17.1	359.1	46.8
Ghana	79.2	26.1	72.8	12.3	84.0	49.5
Morocco	1293.9	20.9	1314.8	---	1352.9	11.6
Sargan-Hansen *J*-stat.	380.2		218.4		922.8	
p-value	0.000		0.001		0.000	
LM-stat.(1)	30.36		60.39		420.86	
p-value	0.40		0.99		0.00	
Step	5		3		2	
Observations	1794		1794		1794	

$ The instruments are: total number of employees in previous period; education of manager or owner; location in capital city; and all exogenous variables in the structural specification.
* All numbers in USD.
(1) Tests the hypothesis that all cross-equation restrictions hold.

Data Appendix

Table A1: Summary Statistics on Firms, by Country

		N	mean	p50	sd	min	max
Kenya	Employment	585	107.04	35.00	243.71	1.00	2397.00
	log (Value-Added / Employee)	585	7.55	7.57	1.29	3.03	12.39
	log (Capital / Employee)	585	8.38	8.61	1.71	2.94	12.94
	Supervision Ratio	585	0.47	0.34	0.41	0.02	2.83
	Any Foreign Ownership	585	0.18	0.00	0.39	0.00	1.00
	Firm Age / 100	585	0.22	0.20	0.15	0.01	0.74
	Location in Capital City	585	0.61	1.00	0.49	0.00	1.00
	Manager's Education, CAT=1	543	0.15	0.00	0.36	0.00	1.00
	Manager's Education, CAT=2	543	0.54	1.00	0.50	0.00	1.00
	Manager's Education, CAT=3	543	0.30	0.00	0.46	0.00	1.00
	Employees Unionised	577	0.50	0.00	0.50	0.00	1.00
Burundi	Employment	52	85.85	20.00	230.89	1.00	1399.00
	log (Value-Added / Employee)	52	7.31	7.30	1.11	5.55	11.18
	log (Capital / Employee)	52	7.86	7.63	1.75	4.56	11.71
	Supervision Ratio	52	0.35	0.25	0.31	0.05	1.58
	Any Foreign Ownership	52	0.37	0.00	0.49	0.00	1.00
	Firm Age / 100	52	0.10	0.06	0.12	0.01	0.46
	Location in Capital City	51	0.82	1.00	0.39	0.00	1.00
	Manager's Education, CAT=1	38	0.29	0.00	0.46	0.00	1.00
	Manager's Education, CAT=2	38	0.66	1.00	0.48	0.00	1.00
	Manager's Education, CAT=3	38	0.00	0.00	0.00	0.00	0.00
	Employees Unionised	48	0.19	0.00	0.39	0.00	1.00
Ivory Coast	Employment	43	78.60	43.00	95.14	1.00	453.00
	log (Value-Added / Employee)	43	8.57	8.40	1.16	5.95	11.33
	log (Capital / Employee)	43	8.34	8.60	1.64	2.89	10.95
	Supervision Ratio	43	0.34	0.18	0.37	0.03	1.81
	Any Foreign Ownership	43	0.70	1.00	0.46	0.00	1.00
	Firm Age / 100	43	0.15	0.12	0.10	0.02	0.46
	Location in Capital City	43	0.74	1.00	0.44	0.00	1.00
	Manager's Education, CAT=1	30	0.17	0.00	0.38	0.00	1.00
	Manager's Education, CAT=2	30	0.70	1.00	0.47	0.00	1.00
	Manager's Education, CAT=3	30	0.07	0.00	0.25	0.00	1.00
	Employees Unionised	41	0.59	1.00	0.50	0.00	1.00
Ethiopia	Employment	82	14.87	8.00	21.75	2.00	139.00
	log (Value-Added / Employee)	82	7.64	7.57	1.36	4.00	10.80
	log (Capital / Employee)	82	8.27	8.18	1.31	3.80	11.18
	Supervision Ratio	82	0.25	0.20	0.21	0.01	1.50
	Any Foreign Ownership	82	0.02	0.00	0.16	0.00	1.00
	Firm Age / 100	82	0.13	0.14	0.10	0.01	0.50
	Location in Capital City	82	1.00	1.00	0.00	1.00	1.00

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Table A1 (continued)

		N	mean	p50	sd	min	max
Ethiopia	Manager's Education, CAT=1	82	0.32	0.00	0.47	0.00	1.00
	Manager's Education, CAT=2	82	0.44	0.00	0.50	0.00	1.00
	Manager's Education, CAT=3	82	0.15	0.00	0.36	0.00	1.00
	Employees Unionised	82	0.00	0.00	0.00	0.00	0.00
Cameroon	Employment	132	90.08	26.50	314.70	2.00	3262.00
	log (Value-Added / Employee)	132	9.08	9.21	1.43	3.41	12.75
	log (Capital / Employee)	132	9.50	9.50	1.44	5.53	12.70
	Supervision Ratio	132	0.72	0.73	0.51	0.06	2.00
	Any Foreign Ownership	132	0.36	0.00	0.48	0.00	1.00
	Firm Age / 100	132	0.13	0.09	0.11	0.01	0.49
	Location in Capital City	132	0.78	1.00	0.42	0.00	1.00
	Manager's Education, CAT=1	71	0.08	0.00	0.28	0.00	1.00
	Manager's Education, CAT=2	71	0.54	1.00	0.50	0.00	1.00
	Manager's Education, CAT=3	71	0.38	0.00	0.49	0.00	1.00
	Employees Unionised	130	0.41	0.00	0.49	0.00	1.00
Zambia	Employment	309	109.01	35.00	247.68	1.00	3001.00
	log (Value-Added / Employee)	309	7.67	7.82	1.46	0.80	10.79
	log (Capital / Employee)	309	8.45	8.62	1.60	-0.26	12.28
	Supervision Ratio	309	0.67	0.53	0.46	0.08	2.81
	Any Foreign Ownership	309	0.16	0.00	0.37	0.00	1.00
	Firm Age / 100	309	0.19	0.18	0.12	0.01	0.64
	Location in Capital City	309	0.46	0.00	0.50	0.00	1.00
	Manager's Education, CAT=1	226	0.12	0.00	0.32	0.00	1.00
	Manager's Education, CAT=2	226	0.64	1.00	0.48	0.00	1.00
	Manager's Education, CAT=3	226	0.22	0.00	0.42	0.00	1.00
	Employees Unionised	308	0.52	1.00	0.50	0.00	1.00
Tanzania	Employment	140	128.66	19.00	326.89	1.00	2103.00
	log (Value-Added / Employee)	140	6.94	7.03	1.35	-0.58	10.12
	log (Capital / Employee)	140	7.96	8.16	1.93	2.57	12.08
	Supervision Ratio	140	0.59	0.48	0.50	0.04	2.67
	Any Foreign Ownership	140	0.14	0.00	0.34	0.00	1.00
	Firm Age / 100	140	0.16	0.14	0.13	0.01	1.03
	Location in Capital City	140	0.33	0.00	0.47	0.00	1.00
	Manager's Education, CAT=1	101	0.31	0.00	0.46	0.00	1.00
	Manager's Education, CAT=2	101	0.54	1.00	0.50	0.00	1.00
	Manager's Education, CAT=3	101	0.13	0.00	0.34	0.00	1.00
	Employees Unionised	138	0.52	1.00	0.50	0.00	1.00

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Table A1 (continued)

		N	mean	p50	sd	min	max
Zimbabwe	Employment	174	224.10	110.00	422.93	5.00	4478.00
	log (Value-Added / Employee)	174	8.22	8.21	0.91	4.53	10.17
	log (Capital / Employee)	174	8.17	8.18	1.44	0.72	11.66
	Supervision Ratio	174	0.27	0.18	0.24	0.04	1.78
	Any Foreign Ownership	174	0.21	0.00	0.41	0.00	1.00
	Firm Age / 100	174	0.26	0.25	0.16	0.01	0.86
	Location in Capital City	174	0.44	0.00	0.50	0.00	1.00
	Manager's Education, CAT=1	125	0.09	0.00	0.28	0.00	1.00
	Manager's Education, CAT=2	125	0.87	1.00	0.34	0.00	1.00
	Manager's Education, CAT=3	125	0.02	0.00	0.13	0.00	1.00
	Employees Unionised	173	0.82	1.00	0.38	0.00	1.00
Ghana	Employment	181	72.68	29.00	109.18	2.00	617.00
	log (Value-Added / Employee)	181	7.21	7.24	1.12	4.42	9.95
	log (Capital / Employee)	181	7.93	8.25	1.86	2.85	11.43
	Supervision Ratio	181	0.56	0.37	0.50	0.00	2.83
	Any Foreign Ownership	181	0.24	0.00	0.43	0.00	1.00
	Firm Age / 100	181	0.17	0.14	0.13	0.01	0.67
	Location in Capital City	181	0.08	0.00	0.28	0.00	1.00
	Manager's Education, CAT=1	150	0.07	0.00	0.25	0.00	1.00
	Manager's Education, CAT=2	150	0.63	1.00	0.49	0.00	1.00
	Manager's Education, CAT=3	150	0.21	0.00	0.41	0.00	1.00
	Employees Unionised	181	0.39	0.00	0.49	0.00	1.00
Morocco	Employment	1309	143.82	70.00	214.96	2.00	3064.00
	log (Value-Added / Employee)	1309	8.34	8.28	0.94	1.98	11.72
	log (Capital / Employee)	1309	8.48	8.42	1.33	3.38	12.22
	Supervision Ratio	1309	0.14	0.09	0.17	0.00	2.44
	Any Foreign Ownership	1309	0.20	0.00	0.40	0.00	1.00
	Firm Age / 100	1309	0.16	0.13	0.12	0.01	0.81
	Location in Capital City	1309	0.61	1.00	0.49	0.00	1.00
	Manager's Education, CAT=1	1309	0.11	0.00	0.31	0.00	1.00
	Manager's Education, CAT=2	1309	0.28	0.00	0.45	0.00	1.00
	Manager's Education, CAT=3	1309	0.57	1.00	0.49	0.00	1.00
	Employees Unionised	1255	0.15	0.00	0.36	0.00	1.00

Table A2: Summary Statistics on Workers, by Country

		Firm-year	Firms	Workers	Mean	p50	Std Dev	Min	Max
A. Production Workers									
Kenya	Earnings (USD)	835	331	3249	78.57	62.07	58.99	10.17	489.38
	Educ	835	331	3249	9.44	8.00	2.97	0.00	16.00
	Age	835	331	3249	35.04	33.00	9.66	12.00	72.00
	Tenure	835	331	3249	8.88	7.00	7.65	0.00	50.00
	Female	835	331	3249	0.09	0.00	0.29	0.00	1.00
Burundi	Earnings (USD)	93	93	239	73.90	50.89	72.20	13.44	489.67
	Educ	93	93	239	7.58	8.00	3.38	0.00	16.00
	Age	93	93	239	31.77	30.00	9.80	16.00	67.00
	Tenure	93	93	239	5.22	3.00	6.12	0.08	36.00
	Female	93	93	239	0.05	0.00	0.23	0.00	1.00
Ivory	Earnings (USD)	237	170	936	136.96	114.48	80.84	10.81	492.21
Coast	Educ	237	170	936	7.91	8.00	4.81	0.00	16.00
	Age	237	170	936	34.96	34.00	8.72	15.00	69.00
	Tenure	237	170	936	7.72	6.00	6.93	0.00	37.00
	Female	237	170	936	0.06	0.00	0.23	0.00	1.00
Ethiopia	Earnings (USD)	185	185	957	82.94	67.44	60.60	10.26	362.18
	Educ	185	185	957	9.71	12.00	3.77	0.00	16.00
	Age	185	185	957	29.35	27.00	10.16	15.00	70.00
	Tenure	185	185	957	6.68	4.00	6.85	0.00	39.00
	Female	185	185	957	0.25	0.00	0.43	0.00	1.00
Cameroon	Earnings (USD)	301	177	895	225.88	176.58	167.03	15.11	959.70
	Educ	301	177	895	10.58	12.00	2.77	0.00	16.00
	Age	301	177	895	33.72	33.00	7.80	16.00	68.00
	Tenure	301	177	895	6.94	5.00	6.25	0.08	39.00
	Female	301	177	895	0.06	0.00	0.24	0.00	1.00
Zambia	Earnings (USD)	487	240	1349	87.48	66.26	70.02	10.60	499.38
	Educ	487	240	1349	10.57	12.00	2.62	0.00	14.00
	Age	487	240	1349	33.72	32.00	9.91	15.00	67.00
	Tenure	487	240	1349	6.93	4.50	6.97	0.00	38.00
	Female	487	240	1349	0.11	0.00	0.31	0.00	1.00
Tanzania	Earnings (USD)	262	189	691	40.36	31.91	31.39	10.43	463.54
	Educ	262	189	691	8.80	8.00	2.77	0.00	16.00
	Age	262	189	691	33.58	32.00	10.02	16.00	70.00
	Tenure	262	189	691	7.91	6.00	7.19	0.08	38.00
	Female	262	189	691	0.14	0.00	0.35	0.00	1.00

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Table A2 (continued)

		Firm-year	Firms	Workers	Mean	p50	Std Dev	Min	Max
Zimbabwe	Earnings (USD)	206	107	816	110.21	87.00	69.94	10.79	446.60
	Educ	206	107	816	9.72	8.00	2.51	0.00	16.00
	Age	206	107	816	37.21	37.00	10.69	18.00	77.00
	Tenure	206	107	816	10.66	10.00	8.26	0.04	40.00
	Female	206	107	816	0.13	0.00	0.34	0.00	1.00
Ghana	Earnings (USD)	345	161	1213	65.12	55.73	43.38	10.52	402.67
	Educ	345	161	1213	10.41	11.00	3.55	0.00	16.00
	Age	345	161	1213	33.14	31.00	9.80	14.00	79.00
	Tenure	345	161	1213	6.66	5.00	6.54	0.00	48.00
	Female	345	161	1213	0.18	0.00	0.39	0.00	1.00
Morocco	Earnings (USD)	1477	754	5837	274.68	221.39	165.72	68.80	3778.24
	Educ	1477	754	5837	8.20	10.00	4.89	0.00	24.00
	Age	1477	754	5837	34.77	34.00	8.39	16.00	68.00
	Tenure	1477	754	5837	7.70	6.00	6.61	0.00	42.00
	Female	1477	754	5837	0.39	0.00	0.49	0.00	1.00
B. Supervisors									
Kenya	Earnings (USD)	536	249	1258	138.73	100.80	106.16	15.52	497.04
	Educ	536	249	1258	11.38	12.00	2.66	0.00	17.00
	Age	536	249	1258	33.23	31.00	8.74	16.00	65.00
	Tenure	536	249	1258	7.06	5.00	6.70	0.00	38.00
	Female	536	249	1258	0.29	0.00	0.45	0.00	1.00
Burundi	Earnings (USD)	47	47	95	147.96	120.02	109.91	24.00	480.07
	Educ	47	47	95	10.81	11.00	4.37	0.00	16.00
	Age	47	47	95	33.23	32.00	8.66	19.00	63.00
	Tenure	47	47	95	5.57	3.75	6.61	0.17	38.00
	Female	47	47	95	0.22	0.00	0.42	0.00	1.00
Ivory	Earnings (USD)	163	118	403	217.25	189.12	115.95	21.61	498.54
Coast	Educ	163	118	403	11.44	12.00	3.08	0.00	16.00
	Age	163	118	403	35.66	35.00	7.68	19.00	63.00
	Tenure	163	118	403	7.49	5.75	6.27	0.17	29.00
	Female	163	118	403	0.17	0.00	0.38	0.00	1.00
Ethiopia	Earnings (USD)	104	104	246	152.16	124.89	120.19	14.27	713.65
	Educ	104	104	246	11.77	12.00	2.67	0.00	16.00
	Age	104	104	246	31.42	30.00	9.86	17.00	70.00
	Tenure	104	104	246	7.06	5.00	7.22	0.00	40.00
	Female	104	104	246	0.38	0.00	0.49	0.00	1.00

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Figure 1. Supervision and Firm Size

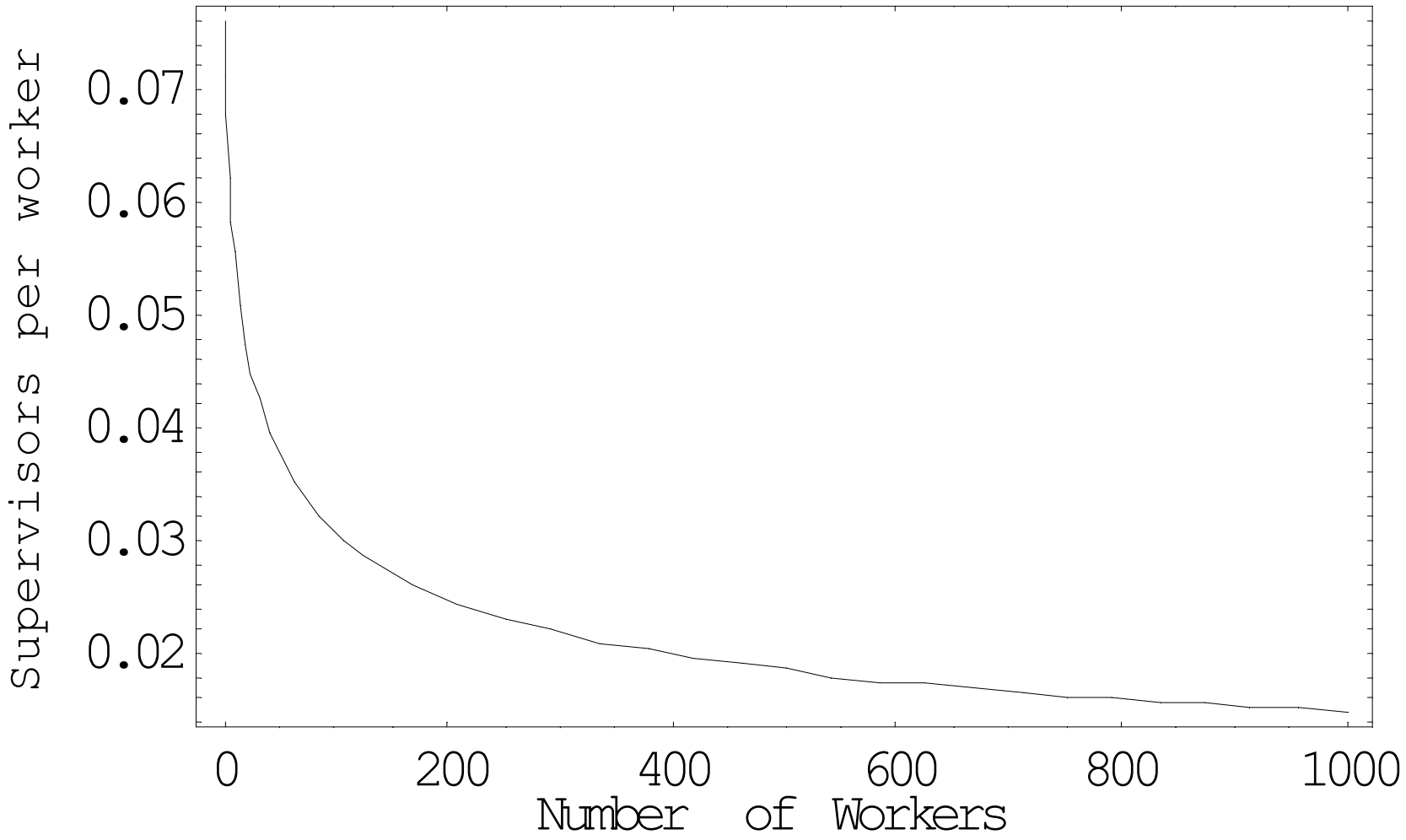

Figure 2. Wages and Firm Size – supervisor wages in bold

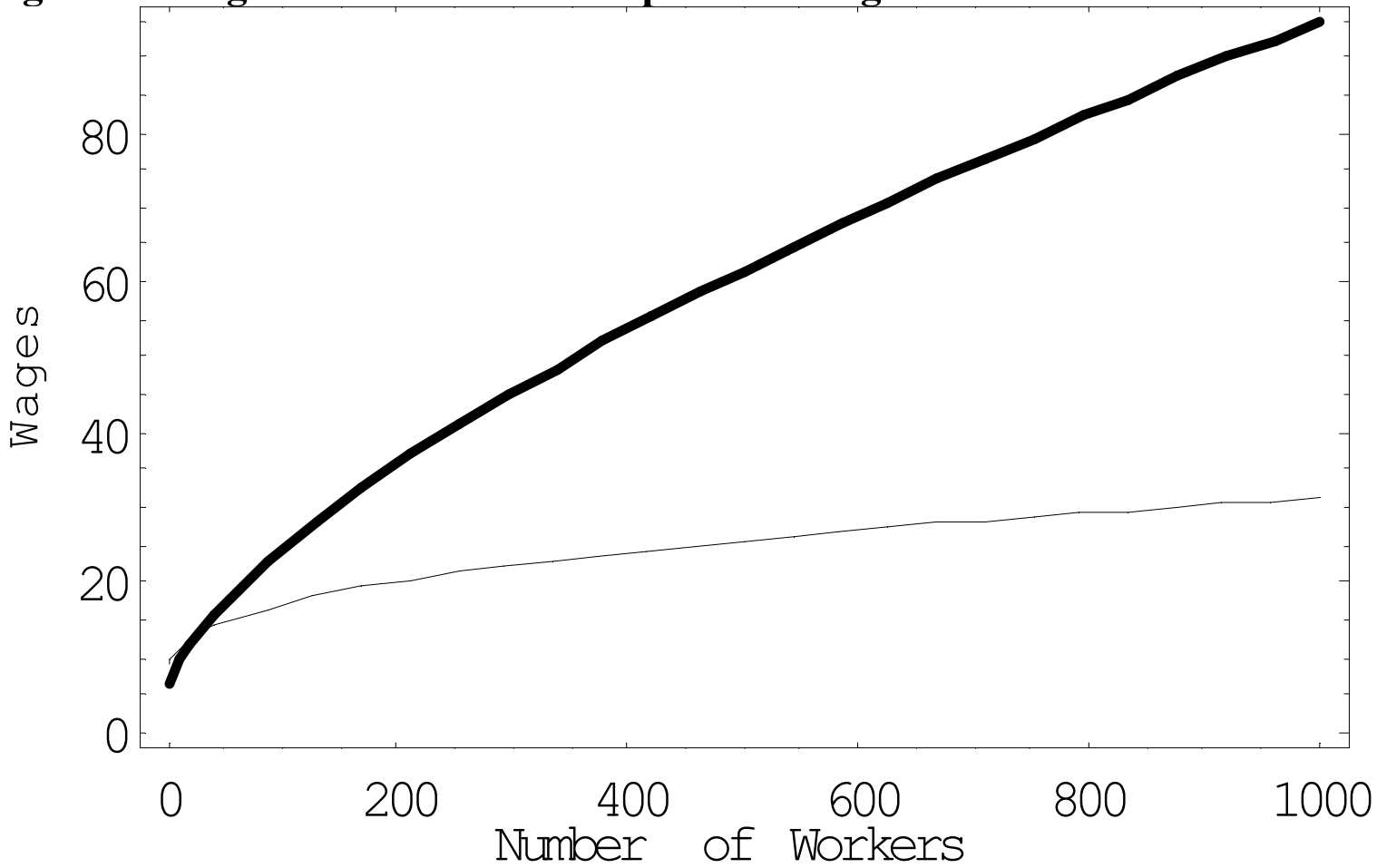

Figure 3a. Supervision Ratio and Firm Size

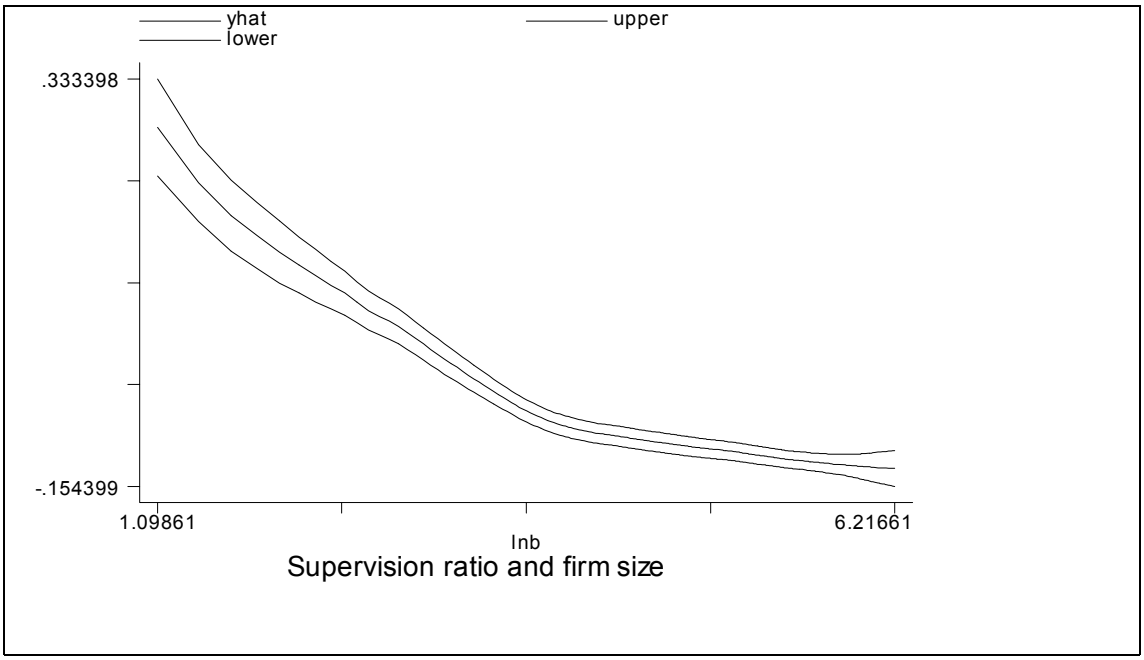

Figure 3b. Producer Wage and Firm Size

Figure 3c. Supervisor Wage and Firm size

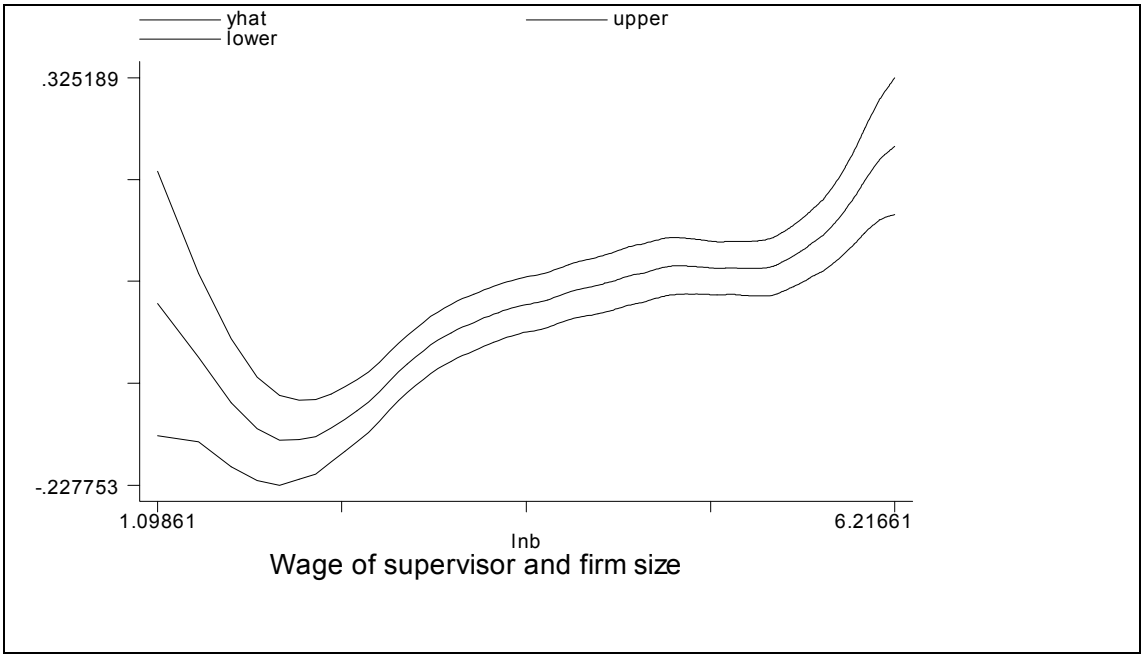

Figure 3d. Supervisor/Producer Wage Differential and Firm size (employment)

Figure 4 Supervisor/Producer Wage Differential and Firm size (capital)

Figure 5. Firm size, Wages and Supervision:

Implications of Structural Estimates