Estimating the Shirking Model with Variable Effort

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Abstract

We show in a theoretical efficiency wage model where firms differ in monitoring intensity that the impact of monitoring intensity on wages is ambiguous, a result that mirrors evidence from the empirical literature. We argue that to correctly specify the impact of monitoring on wages, the interaction between monitoring and effort needs to be modelled. Results using a worker, firm panel from Ghana which contains reasonable effort and monitoring proxies show that the return to effort is higher in poorly monitored sectors as the theory suggests.

Keywords: Efficiency wages, effort, monitoring intensity

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Section I: Introduction

One of the most influential variants of the efficiency wage models is the shirking model, most notably Shapiro and Stiglitz (1984). Accordingly, firms pay wage premiums to ensure workers have the incentive to exert a fixed level of effort when monitoring is imperfect. In terms of establishing an empirical relationship between wages and monitoring this framework has, however, produced mixed results and at best finds small wage differentials. This is not that surprising given that in more recent versions of the shirking model where effort is allowed to vary [Walsh (1999) or Goerke (2001)], increased monitoring has an ambiguous effect on wages.

In the current paper we outline the model from Walsh (1999) to illustrate that when we account for how firms with different monitoring technologies choose effort, poorly monitored workers are indeed paid more for a given level of effort. We subsequently use an employer-employee matched data set for Ghana that allows us to explicitly model the impact of the interaction between monitoring intensity and the effort level on wages. Moreover, while the previous literature has either estimated the impact of monitoring with the level of effort fixed or the impact of effort on wages using various proxies for effort, our dataset has reasonable proxies for both effort and monitoring. In addition we can instrument for effort and monitoring intensity, which are arguably endogenous, using a measure of temporary demand shocks to the firm as an instrument for effort and lagged monitoring as an instrument for monitoring. Our results show that the coefficients on monitoring, effort, and on the interaction between them are precisely estimated and that the signs are in line with theory.

This paper is organised as follows. In the following section we outline our theoretical model. Section III surveys the empirical literature on the impact of monitoring and effort on wages. Our data set is described in Section IV. Empirical results of our econometric investigation are contained in Section V. The final section provides concluding remarks.

Section II: The Theoretical Model

First we summarise the relationship between wage and effort derived in Walsh's (1999) multi-sector version of the Shapiro and Stiglitz (1986) model. Accordingly, workers are assumed to be identical, live forever, and have the following instantaneous utility function:

$$u = w - g(x) \qquad (1)$$

where utility is *u*, *w* is the real wage, *x* is effort, and *g(x)* is a convex function. An employed worker caught shirking is fired instantaneously and receives a benefit *B*. The Poisson arrival rate of exogenous job separations and supervisors are *b* and q_i, respectively, and the discount rate is *r*. In equilibrium these two arrival rates will have opposite effects on the firms no-shirking condition The flow value of a job in sector *i* for shirkers (rV_i^s), and non-shirkers (rV_i^n), respectively, at any point in time (*t*) are:

$$rV_i^s(t) = w_i + (b + q_i)[V^u(t) - V_i^s(t)] + \dot{V}_i^s(t) \qquad (2)$$

$$rV_i^n(t) = w_i - g(x_i) + b[V^u(t) - V_i^n(t)] + \dot{V}_i^n(t)$$

The equations say that the flow value of being a shirker/non-shirker respectively is the wage plus the probability of a separation times the difference in the value of the current state and the value of being unemployed [$V^u(t)$], plus the change in the value of the current state o over time ($\dot{V}^o$).

The firm will pay a wage such that the value of not shirking is as good as the value of shirking. Equating the two equations in (2) gives the following equation for rents in any sector:

$$V_i(t) - V^u(t) = \frac{g(x_i)}{q_i} \qquad (3)$$

This equation is important as it shows that rents are proportional to the disutility of effort and inversely proportional to monitoring intensity. For a given monitoring intensity, if a firm chooses higher effort the wage that satisfies the no-shirking condition will not just give the worker a compensating wage increase, but will also give the worker higher rents. The flow value of unemployment is:

$$rV^u(t) = B + \sum a_j[V_j(t) - V^u(t)] + \dot{V}^u(t) \qquad (4)$$

The flow value of unemployment is the flow of benefits (*B*) plus the acquisition rate into employment in any sector j from unemployment (a_j) times the difference between the value of a job in that sector and the value of unemployment, plus the change in the value of unemployment over time. One can use the above equations to solve for the wage that satisfies the no-shirking condition ($V_i^n = V_i^s$):

$$w_i = g(x_i)D_i + m \qquad (5)$$

where $D_i = (1 + \frac{b+r}{q_i})$ and $m = B + \sum_{j=1}^{n} a_j[\frac{g(x_j)}{q_j}]$. Both D_i and *m* are exogenous to the firm and *m* is constant across sectors representing the value of re-employment opportunities that are available in unemployment. Equation (5) (the effort supply curve) is graphed in Figure 1 for two firms with different monitoring intensities. The firm with more intensive monitoring can get a higher level of effort at any given wage. Next we turn to the firm's profit maximisation problem. In terms of Figure 1 the firm takes the effort supply curve as given for any level of monitoring. The firm in sector *i* will choose a combination of wage and effort along the effort supply curve, while if monitoring were endogenous the firm's choice of monitoring intensity will determine which effort supply curve the firm will lie on.

The profit maximisation problem for a firm in sector *i* is:

$$Max_{w_i, l_i} \pi = p_i f[x_i(w_i, q_i) l_i] - w_i l_i \qquad (6)$$

The output price p_i facing the firm is given. The firm has a well behaved production function in efficiency units of labour, which is the product of effort (x) and employment (l). This formulation is the Solow (1979) model[3]. As we discuss later it is plausible that monitoring intensity be modelled as an endogenous variable. To illustrate the relationship between effort and wages at a given level of monitoring in the clearest possible way we assume monitoring is exogenous for the moment.[4]

The profit maximising choice of *w* and *l* implies:

$$\frac{\partial x_i}{\partial w_i} \frac{w_i}{x_i} = 1 \qquad (7)$$

Using (5) the wage from the effort supply curve and imposing the condition from (7) on this we can solve for the following equation:

$$\frac{m}{D_i} = g_x(x_i) x_i - g(x_i) \qquad (8)$$

Since this equation holds for all sectors, differentiating both sides of (8) with respect to monitoring intensity and effort, we see that firms, who choose a higher monitoring intensity, will also choose higher effort. It also follows that the wage is:

$$w_i = \frac{m}{1 - \frac{1}{\varepsilon_{g(x_i)}}} \qquad (9)$$

Where $\varepsilon_{g(x_i)}$ is the elasticity of the disutility of effort with respect to effort in sector *i*. Whether this elasticity is increasing or decreasing in effort determines whether firms who

[3] There is a literature that argues that the Solow model is overly restrictive [see Akerlof and Yellen (1986) p14 or Faria (2000) for example]. Generalising the production function to overcome these objections would not change the qualitative results.

[4] We could easily assume a simple cost function and solve for the relationship between effort and wages. The Solow condition would not hold in this case and the exposition would be more complicated without changing the essential relationship between wages and effort

choose higher monitoring intensity will choose higher wages. Walsh (1999) calculates the wage for utility functions where wages are lower, the same, or higher in sectors with more intensive monitoring or where the separation rate falls[5]. Figure 1 illustrates the equilibrium for two firms. We trace out the effort supply curves that satisfy the no-shirking condition [equation (5)] for two firms with high and low monitoring respectively. The equilibrium condition [Equation (7)] is where a line from the origin is tangent to the wage effort locus. The firm with high monitoring can buy more effort at any given wage than the low monitoring firm and thus will choose higher effort. It may choose a sufficiently higher effort such that the wage in the high monitoring firm is higher than in the low monitoring firm. We have drawn it so that the high monitoring firm has higher effort but wages are almost the same in equilibrium.

The objective of the empirical exercise we pursue is to estimate the impact of monitoring on wages. It is clear from equation (5) and Figure 1 that lower monitoring increases wages at a given level of effort. Empirical estimation is complicated by the fact that, as we see in equations (6)-(9), effort depends on monitoring and also affects the wage. Because effort is endogenously determined we need to find an exogenous shock which will induce the firm to choose higher effort along a given wage effort locus. This would provide an instrument to estimate the impact of effort on the wage at a given level

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[5] These examples are $g(x) = x + x^{\alpha}$, $g(x) = x^{\alpha}$ and $g(x) = x\ln(x)$, respectively where α>1. If we differentiate these with respect to x the expressions for $\varepsilon_{g(x_i)}$ are respectively: $\varepsilon_{g(x_i)} = \frac{x + \alpha x^{\alpha}}{x + x^{\alpha}}$, $\varepsilon_{g(x_i)} = \alpha$ and $\varepsilon_{g(x_i)} = 1 + \frac{1}{\ln(x)}$. Using these expressions for the elasticity in equation (9) we can see that the wage will be respectively decreasing, constant and increasing in effort. Since equation (8) shows that effort increases with monitoring intensity in all cases this implies that the wage will be respectively decreasing, constant and increasing in monitoring intensity. Note we can also verify this by substituting the above effort functions into equation (5) and imposing the Solow condition (6). This allows us to solve for the wage in terms of the exogenous parameters. See Walsh (1999) for the details.

of monitoring. One would want such a shock to be at the level of the firm because, as shown in Walsh (1999), an aggregate shock in the form of lower unemployment would shift the firm's wage effort locus for a given level of monitoring. We see from equation (7) that when we use the Solow model the firm's optimal wage effort choice will not depend on any firm level demand shock such as a change in the output price. Appendix 1 shows that a change in the firm's output price will change the firm's wage effort choice if we generalise the production function slightly. Additionally, even with the Solow model it seems plausible that the firm would respond to temporary shocks by adjusting the level of effort away from the long run optimum in the short run if there were turnover costs or firm specific human capital.

Efficiency wage models often treat the monitoring variable as exogenous. This is generally reasonable in a theoretical model since, even though firms can choose the degree of monitoring, we expect differences in firms' choice of monitoring intensity to reflect exogenously given differences in the firms' cost functions. For example, Walsh (1999) shows that exogenously given differences in monitoring have ambiguous effects on wages, while Goerke (2001) also demonstrates this in a model with endogenous monitoring, but traces the differences in monitoring intensity back to the firm's cost function. When it comes to estimating the model empirically we should be cautious about interpreting differences in the choice of monitoring intensity as reflecting exogenously given differences in cost functions for firms that are otherwise the same. For instance, given that we use shocks to the firm's output price to identify exogenous variations in effort, we might expect that firms would respond to temporary demand shocks by adjusting monitoring intensity as well as employment and effort. For this reason we model monitoring intensity as an endogenous variable.

Section III: The Empirical Literature on Supervision, Effort and Wages

One can see from equation (5) that for a given effort level the model predicts that wages will be higher for a lower supervision rate. In other words, in the model outlined above, in a given firm the wage will increase more as effort increases the lower the supervision rate is. Strobl and Walsh (2002) incorporate effort into a monopsony model of the labour market and show that firms with monopsony power will pay lower wages but demand higher effort levels. In contrast, competitive labour market theory also predicts that higher effort would be compensated with higher wages, but there would be no relationship between the effort level and monitoring intensity. In terms of Figure 1 the competitive model predicts that movements along an effort supply curve would reflect compensating differentials for higher effort and all firms would have the same effort supply curve since monitoring would not affect wages.[6] In summary, different economic models can predict either a positive or negative relationship between effort and wages across firms, but only the efficiency wage model predicts that the supervision level will be an important determinant of the relationship between effort and wages. However, the efficiency wage model does not necessarily predict that sectors with low supervision will have high wages, since as we saw earlier such a firm may pay the same wage but lower the effort level. The model does predict that firms where it is difficult to supervise will pay higher wages per unit of effort.

In terms of the empirical literature on supervision and wages, there have been mixed results; see Bewley (1999), Goerke (2001), or Walsh (1999) for discussions of these. Different studies find both positive and negative effects of supervision on wages and these effects are typically small. The earlier efficiency wage empirical literature tended to rely on less direct evidence for the efficiency wage hypothesis. For example, Cappelli and Chauvin (1991) looked at wage premiums and discipline for workers in a

[6] Black and Garen (1991) also point out that large wage differentials may reflect equalising differentials for differences in effort rather than efficiency wage payments.

company with many plants, while Krueger (1991) found higher wages in franchised as against owner run fast food outlets (where supervision is taken to be greater in the owner run outlet). While later studies used more direct measures, the results continued to be mixed. Johannsen and Palme (1996) find that while there is a relationship between economic incentives and effort (measured as absenteeism) an increase in monitoring reduces effort, and they discuss some measurement problems that may explain this. Goldsmith et al (2000) use locus of control (a measure of motivation used by psychologists) as a measure of effort and find a significant relationship between wages and effort using two stage least squares to estimate a separate effort equation. The measures of supervision are establishment size and the number of locations the firm has. These do not enter the effort equation significantly, but establishment size may act as a proxy for a number of factors other than supervision.

In light of these inconclusive empirical findings, we argue that the failure to control for effort and the interaction between effort and supervision intensity may be an important omission. Additionally the lack of reasonable proxies for effort used in the past may have played an important role in being unable to find sufficient support for the efficiency wage hypothesis. The current paper not only addresses the issue of allowing for an interaction effect between monitoring and effort, but also is able to use an arguably superior proxy of effort relative to most previous studies. Moreover, we can take advantage of a convincing instrument for effort, which, as was seen in the theoretical section, is likely to be endogenous. We similarly are able to control for the potentially endogeneity of supervision.

Section IV. Data and Summary Statistics

In this paper we attempt to directly test the shirking efficiency wage model outlined above using data from a panel of firms with worker level information in the

Ghanaian manufacturing sector.[7] The data used for our empirical analysis are drawn from the *Regional Programme for Enterprise Development* (RPED) dataset for Ghana manufacturing firms collected by the Centre for Studies of African Economies (CSAE) at the University of Oxford. The data that we use here are for the 1998 sample, i.e., the fifth wave.[8] The initial wave of 200 firms in this survey was drawn from the 1987 Ghana Census of Manufacturing Activities, stratified by size, sector and location.[9] The sectors from which the firms were chosen are Food, Textiles and Garments, Wood, and Metal, which together comprise about 70 per cent of total manufacturing employment in Ghana.[10] When firms were closed down over the period they were replaced with firms in the same size, sector and location category.

The RPED data set is essentially employer-employee matched data in that, while each firm was interviewed for information at the firm level, additionally up to ten of its workers, representative of ten broad occupation categories, were interviewed. One should note that worker level information, unlike that collected at the firm level, cannot be linked over time. Both the firm and worker level data provide us with a rich set of characteristics. Firm level controls used in this paper are employment size, regional location(4 dummies), sector (10 dummies), percentage of union membership, and the percentage of foreign ownership of each firm. We restrict our sample to all non-state-owned firms.[11]

Importantly for our analysis, we use detailed information on the breakdown of employment by occupation category at the level of the firm to generate a proxy of

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[7] Teal (1996) analyses rents to workers using this dataset. However, in terms of the distinction drawn by Konings and Walsh (1994) between rents from efficiency wages and rents arising from workers extracting a share of imperfectly competitive firm's profits, Teal focuses on the latter source of rents.
[8] We use this wave rather than, or in addition to, earlier waves given that it is only the latter wave that provides information on the effort level of the worker.
[9] In the sampling large firms were over-sampled.
[10] In actuality the data set allows us to distinguish among ten sectors within these four main sectors.
[11] Apart from predetermined pay structures, one reason from excluding state owned firms from the analysis is that the count of managers/supervisors may reflect political patronage rather than the level of monitoring.

monitoring intensity, calculated as the percentage of managers and supervisor employed, *MONIT*. One could argue that managers have normally many other tasks and hence may not be a good indicator of the extent of supervision in the firm. However, in the data supervisors only refer to supervisors for production workers, so that we needed to include managers in order to capture the extent of supervision also for non-production workers. Moreover, since workers are sampled in order to be representative of occupation categories, solely focusing our analysis on production workers and their supervisors would have made the sample size unfeasible.[12]

As argued earlier, monitoring itself may be simultaneously determined with wages and hence endogenous in a wage equation. Finding instruments for monitoring is, of course, difficult. While firms may choose wages and monitoring intensity simultaneously, arguably their choice set of monitoring in each and every period will depend on their monitoring 'technology', which may differ across firms. Thus an ideal instrument would be some indicator of these technologies across firms. While this is, unsurprisingly, not directly observable from the data we exploit the panel nature of our firm level data and use the monitoring intensity of the previous period as an instrument for current monitoring intensity.[13] In other words, we are assuming that there is some constant monitoring technology in firms over time, but each and every period their choice, restricted by this technology, may be simultaneously determined with wages. One worry may be that monitoring may not vary enough over time, however, regressing monitoring intensity at *t* on its value at *t-1* and location and industry dummies at the firm

[12]Even apart from this, one has to be cautious in interpreting the fraction of managers/supervisors as a perfect proxy of monitoring intensity. For one, these may only spend a fraction of their time supervising workers.This may exasperate any bias from the simultaneous determination of wages and supervision; see Kruse (1992).

[13] Econometrically speaking we are assuming that monitoring intensity at time t-1 is a predetermined variable in that it is not correlated with the error term of our wage equation at time t. This crucially depends on the lack of serial correlation of the error terms across time in our wage regression. Unfortunately the lack of panel nature of the work level data does not allow us to verify this.

level produced a (statistically significant) coefficient of only 0.58 and an R-squared value of 0.41.

Information from the worker surveys allows us to calculate their (logged) hourly wage rate.[14] Additionally we included worker level controls for the level of education (years), occupation (19 dummies), tenure (years) and its squared value, age (years) and its squared valued, gender (zero-one type dummy), African (zero-one type dummy), marital status (zero-one type dummy), union membership (zero-one type dummy), and permanent worker status (zero-one type dummy). In terms of firm level information we also controlled for employment size, regional location dummies, sector dummies, percentage of union membership, capital intensity, and percentage of foreign ownership of each firm.[15]

Most importantly, the RPED data set provides us with a direct measure of the effort level exerted at the worker level. Specifically, the worker is asked "How tired are you at the end of the day?" and has the choice of the following answers: (a) very tired, (b) tired, (c) not really tired, and (d) not tired at all. We use this information to construct a measure of effort, *EFFORT*, a simple zero-one type dummy variable taking on the value of one if answers (a) or (b) were chosen, and zero otherwise. In interpreting this variable as a proxy for effort one should note that we are assuming that fatigue at the end of a day's work is a reasonable indicator of the effort exerted or is, at the very least, correlated with the amount of effort exerted. Moreover, we assume that while the subjective assessment of what constitutes fatigue may differ across workers, it does so only in a random (across firms) manner. While there are obvious shortcomings in the response to a question about whether a worker is tired as a proxy for effort, we feel it is as good or

[14] One should note that wages are measured as the complete compensation of the individual. In other words, earnings not only include explicit pay, but also the value of other allowances, bonuses and benefits.

[15] Arguably it is particularly important to control for employment size, since this variable has in the past been used to proxy monitoring, but may also capture other factors; see Goldsmith et al (2000).

better than those used to date that we are aware of. Secondly, given that we need a proxy for effort in an environment where there is imperfect monitoring, it seems inevitable that we will have to rely on workers to provide the information. If it could be directly observed by the employer, this would imply perfect monitoring.

The worker is also asked "Is it busy at work at present?". We interpret this as an indicator of temporary positive shocks on the demand for worker level effort, and created a zero-one type dummy variable, *BUSY*, to be used as an instrument for effort. We saw in the theoretical section that the supervision variable affects the firm's choice of both wages and effort. Appendix 1 shows though that at a given level of supervision we can use a firm level demand shock to identify a movement along a firm's effort supply curve. Because the demand shock is at the firm level we do not expect the *BUSY* variable to affect the wage other than through higher effort. This means that if we instrument effort with the BUSY variable we can trace out the impact of effort on wages for firms with different levels of supervision.

It is, of course, important that *BUSY* is capturing temporary positive shocks on the demand for worker level effort and is not simply another indicator of effort. To investigate this we used information at the firm level on whether the firm was currently in peak season and created a simply dummy variable indicating this.[16] We then regressed the *BUSY* variable on our seasonal indicator, whilst also controlling for regional and industry specific effects. The resultant coefficient was 0.20 and statistically significant at the five per cent level, indicating that during peak season workers are more likely to feel busier and, arguably, exert more effort. [17]

[16] The question stated is "Is it peak season now?"

[17] Unfortunately the variable was missing for about 40 per cent of our observations so that these results are for a reduced sample.

Overall non-missing observations for all variables left us with a sample of 1,335 non-supervisory, non-managerial workers employed in firms.[18] Summary statistics for our most important variables are provided in Table 1. Over 80 per cent of our sample are male. These tend to be, on average, around 35 with ten years of education and have been around 7 years with their current employer. Only a few of the jobs are temporary. Sectors such as food, furniture and Metals provide the most of the employment. Moreover, almost half of the firms' workforce is unionised and nearly 17 per cent are at least partially foreign owned.

In terms of our main variables of interest, one finds 74 per cent of all workers in our sample are tired at the end of the workday and, thus, under our interpretation, exerting high effort. We also find that on average 17 per cent of the workforce is in a managerial or supervisory position, although the standard deviation suggests that this varies considerably across firms. If one were to break down our sample into high and low effort workers, then on average high effort workers experience lower earnings in terms of the logged hourly wage rate (1.18 versus 1.31) and higher monitoring (0.17 versus 0.16), although the differences are not substantial and, of course, may be due to unequal distribution of other characteristics across these two categories. Finally, over 80 per cent of workers report being busy at the moment of the survey.

Section V: Empirical Specification and Results

In order to estimate the impact of effort and monitoring intensity of workers' earnings we employ the following standard wage equation:

$$log(Wage) = f(\boldsymbol{Z_1}, \boldsymbol{Z_2}, EFFORT, MONIT) \qquad (10)$$

where $\boldsymbol{Z_1}$ and $\boldsymbol{Z_2}$ are vectors of worker and firm level controls, respectively, as outlined above, *EFFORT* is our measure of effort level exerted, and *MONIT* is our proxy of

[18] Additionally, in terms of outliers, we exclude all observations for which the logged hourly wage rate was two standard deviations above the mean.

monitoring intensity defined above. One can think of (10) as an attempt to estimate the relationship between wages, effort and supervision in equation (5).

We first estimated our wage equation in (10) for the whole sample excluding our effort proxy but instrumenting *MONIT* with its lagged level using Two Stage Least Squares[19] – the resultant coefficient on *MONIT* is given in the first column of Table 2; detailed results on other coefficients are provided in the Appendix 2.[20] As can be seen, the monitoring intensity within the firm acts significantly to decrease a worker's wage rate. Unsurprisingly, one finds from the first stage results that lagged monitoring significantly positively affects current monitoring intensity – we take this as evidence that while supervision intensity is set simultaneously each and every period, firms are characterized by (potentially different) time invariant monitoring technologies that determine their intensity choice set.

We then also re-estimated (10) for those that exert effort and those that do not separately, the coefficient for *MONIT* for these two subsamples are given in columns 2 and 3, respectively. Accordingly, supervision has a much larger negative impact on the wage rate for those exerting effort, than those that do not, although the latter is not significant[21]. We could think of the regressions in columns 2 and 3 as estimating the gap between the effort supply curves in Figure 1 at two different fixed effort levels a low effort level X_0 and a higher effort level X_1. At a high level of effort we expect the wage differential between high and low supervision firms to be larger. While this is a valid exercise and supports the predictions of the theoretical model it misses part of the variation in wages. This is because wages depend on effort, which depends on both the level of supervision and the degree of effort intensity in the firm's technology.

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[19] Another option would have been to estimate a complete simultaneous equation system.
[20] Full results for all other columns in Table 2 are also provided in Appendix 2.
[21] However, it must be noted that the lack of significance could be do to the much smaller sample size.

Our results of estimating (10) including our effort variable and taking into account its potential endogeneity by using *BUSY* as an instrument, are given in the fourth column of Table 2. One should note that from the first stage equation it is clear that *BUSY* acts to increase the level of effort, as would be expected. As can also be seen, effort acts to significantly increase earnings as theory would suggest. Nevertheless, our monitoring proxy remains significantly negative.

Most importantly, we investigated whether supervision affects the wage rate through effort, as suggested by our theoretical model, by including their interaction term. The inclusion of this interaction term necessitates the use of another instrument due to the variables' endogeneity, and the most natural candidate is the interaction of their instruments, *BUSY* and *MONIT(t-1)*. The first and second stage results for our variables of interest are provided in the fifth column of Table 2. Accordingly, we still find that *EFFORT* significantly increases the wage rate. More importantly, however, one can see from the interaction term that this effect decreases with the level of supervision within a firm. It is also notable that the monitoring variable now no longer has a significant impact on wages on its own, only through effort.[22]

Appendix 2 gives the detailed first and second stage results for the two stage regression of column five in Table 2. Accordingly, wages increase with education and firm size and the rate of unionization as we expect. The age profile of earnings is concave but not statistically significant. The only counterintuitive coefficient is a negative tenure effect but this is small and insignificant. As a matter of fact, theory does not give us very strong priors for many of the coefficients in the first stage regressions of Appendix 2 but we see that married workers work less and there is a concave relationship between effort and age. Effort is higher when firms are busy as we expect

[22] One may note that the interaction term of our instruments in the first stage regression is not significant. An examination of our detailed results in the Appendix 2 reveals that MONIT(t-1) remains significant, however, and thus is likely picking up a lot of the variation of the interaction term.

and while lagged monitoring has a positive coefficient on effort this is not significant. Monitoring is lower when the firm is busy, perhaps reflecting the fact that managers who have monitoring as one of their tasks are partially diverted to other activities when the firm is busy.

Since our use of BUSY rests importantly on the assumption that it captures temporary demand shocks, we also experimented with another proxy of this, PEAK, a zero-one dummy indicating whether the firm is currently in peak season. One should note with respect to this, that missing values for this variable reduces our estimation sample by over 40 per cent and thus the findings should be viewed with considerable caution. The results of this exercise are given in the final column of Table 2. As can be seen, the coefficient on EFFORT in the second stage remains significant and of the same sign, although more than double in size. Its interaction term with MONIT similarly increases in size, but is now only significant at the ten per cent level. Nevertheless, given the reduction in sample size, one is inclined to conclude that our empirical results are robust to including this alternative proxy of demand shocks.

We also investigated whether our categorization of the level of tiredness at the end of the day as a measure of effort was appropriate by experimenting with including those that said that they were tired at the end of the day (rather than very tired) into to the no effort category. One should note that this meant re-classifying nearly 35 per cent of our overall sample. Using this new effort definition and re-estimating our specification in the fifth row of Table 2 we found that EFFORT and its interaction with MONIT were no longer significant in the second stage results.[23] This thus reaffirms the importance of including the 'tired' category in the effort group.

[23] Detailed results are available from the authors upon request

Additionally, in order to demonstrate that it is important to instrument for our endogenous variables, we replicate in Table 3 the exercise in Table 2 using OLS. [24] As can be seen, while the results remain qualitatively similar, they are quantitatively very different. In particular, almost all coefficients on our variables of interest are substantially smaller, thus suggesting that the failure to control for the endogeneity of effort and supervision will produce a downward bias in their estimation. This is further substantiated by noticing the change in coefficients when we directly include our instruments, as shown in the last column of the table.

Finally, based on the estimated coefficients in column (5) we can perform some simple simulations to get a rough estimate of the predicted impact of supervision on wages. If β_m is the estimated coefficient on monitoring, β_{mx} the estimated coefficient on the interaction term and x the level of effort and $(m_1 - m_0)$ a change in the ratio of supervisors, the percentage change in the wage from a one point change in the ratio of supervisors to workers is:

$\frac{d\ln(w)}{dm} = \frac{\beta_m}{100} + x(m_1 - m_0)\beta_{mx}$. Starting at the mean levels of x and changing m by one point the results indicate that 1 point increase in the ratio of supervisors to workers lowers the wage by about 1.9% ($\frac{d\ln(w)}{dm} = \frac{4.32}{100} + 0.74*(0.01*(-8.4) = -0.019)$). Given a standard deviation of 12% in the ratio of supervisors to workers the estimated coefficients predict that monitoring can have a large impact on wages when we account for effort. Another interpretation for the negative and significant value for β_{mx} is that the returns to effort are negatively associated with monitoring intensity. This is also consistent with the theoretical predictions. As can be seen from Figure 1, when moving

[24] The need to instrument in all our regressions is confirmed by the Hausman test statistic reported in the Table 2.

onto a higher effort supply curve (supervision becomes more intensive) the return to effort falls.

Section VI: Conclusion

In this paper we argued that in order to estimate the wage differentials associated with the shirking version of the efficiency wage model it is necessary to control for both effort and supervision, for the interaction between the two, and for their endogeneity. To demonstrate this empirically we use a data set that provides us with reasonable proxies of both effort and supervision, the former of which is notoriously difficult to measure, and reasonable candidates for instrumenting these. The empirical results support the predictions of our theoretical model: supervision has a negative and significant impact on wages for high effort workers only. More precisely, when the endogeneity of effort is controlled for, the predicted wage differential is large and returns to effort fall as supervision becomes more intensive. As was discussed, the shirking model predicts that the impact of effort on wages will be affected by the level of monitoring. The empirical section verifies that this is so in the data and shows that, in contrast to the previous literature, when we account for the joint determination of wages and effort, changes in monitoring can be an important determinant of wages and effort.

Appendix 1: The Response of Effort to a Demand Shock

The profit function where we leave out firm subscripts and treat monitoring as exogenous for simplicity is:

$$Max_{w,l}\pi = pf[x(w), l] - wl \tag{A1}$$

The first order conditions are for *w* and *l* are:

$$\pi_w = pf_x[x(w), l]x_w - l = 0 \tag{A2}$$

$$\pi_l = pf_l[x(w), l] - w = 0 \tag{A3}$$

By totally differentiating the first order conditions we calculate the impact of a change in price on the wage as:

$$\frac{dw}{dp} = \frac{\pi_{wl}\pi_{lp} - \pi_{wp}\pi_{ll}}{|H|} \tag{A4}$$

The denominator is the Hessian determinant which we assume is positive. The terms in the numerator are:

$$\pi_{wl} = pf_{xl}x_w - 1 \tag{A5}$$

$$\pi_{lp} = f_l \tag{A6}$$

$$\pi_{wp} = f_x x_w \tag{A7}$$

$$\pi_{ll} = pf_{ll} \tag{A8}$$

We can rewrite (A4) as:

$$\frac{dw}{dp} = \frac{pf_{xl}x_w f_l - f_l - pf_{ll}x_w f_x}{|H|} \tag{A9}$$

Assume the production function is: $f(n) = f[x(w)k(l)]$, where $k(l)$ is an increasing function of *l*. Equation A(9) simplifies to:

$$\frac{dw}{dp} = f_n x[\frac{(\frac{k_l l}{k} - 1)k_l - k_{ll}l}{|H|}]$$

This will only equal zero when $k(l) = l^{\beta}$, of which the Solow model is a special case. In general a change in firm's output price will change the equilibrium wage, which implies a movement along the firm's wage effort locus.

Appendix 2: Detailed Results of Table 2 Column 5

	(1)	(2)	(3)	(4)
Dep. Variable:	**log(WAGE)**	**EFFORT**	**MONIT**	**EFFORT*MONIT**
MALE	0.122	0.039	-0.006	-0.010
	(0.081)	(0.036)	(0.008)	(0.009)
EDUCATION	0.002*	0.002	0.002*	0.002*
	(0.001)	(0.004)	(0.001)	(0.001)
AFRICA D.	-1.580**	0.128	0.051	0.036
	(0.592)	(0.327)	(0.075)	(0.085)
UNION D.	-0.105	0.012	0.000	-0.003
	(0.067)	(0.036)	(0.008)	(0.009)
TENURE	-0.018	-0.000	-0.000	-0.002
	(0.011)	(0.006)	(0.001)	(0.001)
TENURE SQ.	0.001	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)
MARRIED D.	-0.001	-0.070*	0.014	-0.008
	(0.085)	(0.031)	(0.007)	(0.008)
AGE	0.055	0.020**	-0.006**	0.004*
	(0.030)	(0.007)	(0.002)	(0.002)
AGE SQ.	-0.001	-0.000**	0.000**	-0.000*
	(0.000)	(0.000)	(0.000)	(0.000)
% FOREIGN	0.059	-0.014	0.044**	0.032**
	(0.088)	(0.046)	(0.010)	(0.012)
EMPLOYMENT	0.001**	-0.000	-0.000**	-0.000**
	(0.000)	(0.000)	(0.000)	(0.000)
% UNION	0.002*	0.001	0.000	0.000
	(0.001)	(0.000)	(0.000)	(0.000)
EFFORT	2.135**			
	(0.771)			
EFFORT*MONIT	-8.404*			
	(4.166)			
MONIT	4.323			
	(3.159)			
BUSY		0.129*	-0.050**	-0.010
		(0.053)	(0.012)	(0.014)
MONIT(t-1)		0.214	0.174**	0.221**
		(0.189)	(0.043)	(0.049)
MONIT(t-1)*BUSY		-0.023	0.228**	-0.063
		(0.249)	(0.057)	(0.064)
Constant	-1.054	-0.233	0.124	-0.061
	(0.876)	(0.385)	(0.088)	(0.100)
Observations	1335	1335	1335	1335
R-squared	0.08	0.10	0.37	0.25

Notes: (1) Dependent variable is the log hourly wage rate. (2) ** and * are one and five per cent significance levels, respectively. (3) Other (non-reported) controls also include regional location dummies, sector dummies, and occupation dummies.

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Figure 1

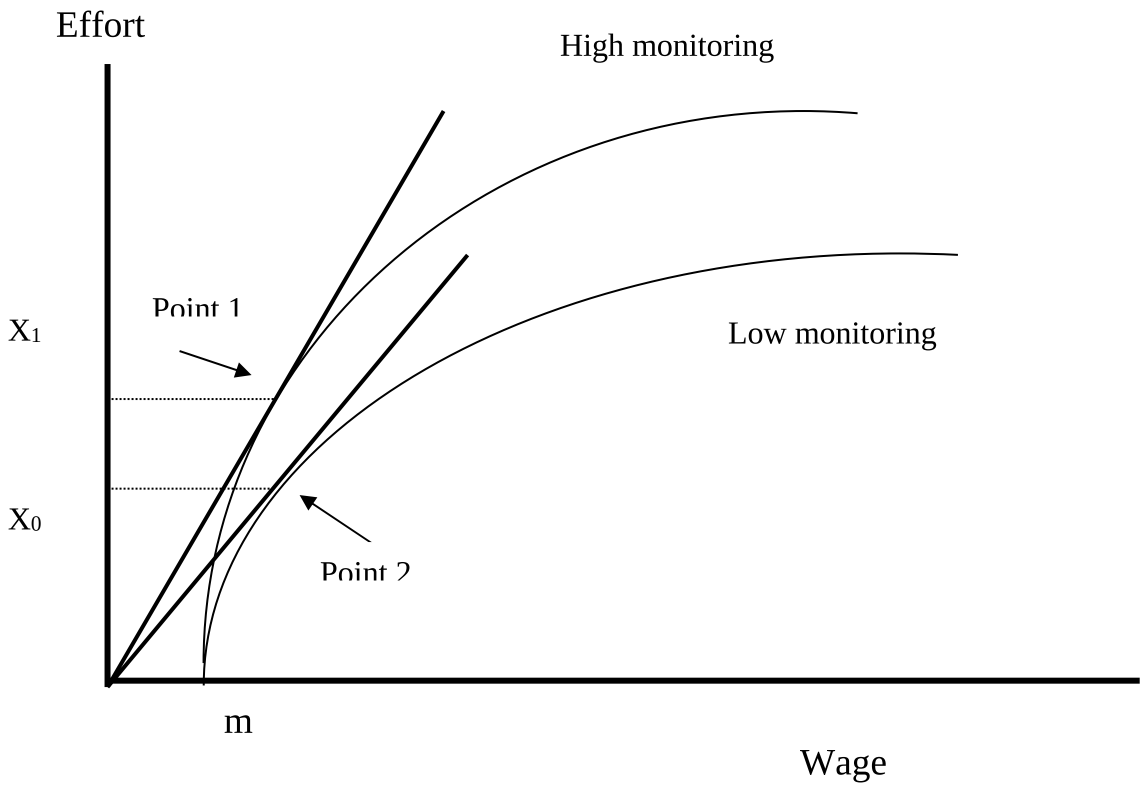
Effort
High monitoring
Point 1
X1
Low monitoring
X0
Point 2
m
Wage

Table 1 – Summary Statistics

	Mean	St. Dev.
log(WAGE)	1.22	0.86
MALE	0.82	0.38
EDUCATION (years)	10.61	4.10
UNION	0.35	0.48
PERMANENT	0.96	0.19
TENURE (years)	7.01	7.21
MARRIED	0.66	0.47
AGE	35.99	11.31
EFFORT	0.74	0.44
BUSY	0.88	0.32
Bakery Goods	0.07	0.25
Chemicals	0.05	0.22
Other Foods	0.17	0.37
Furniture	0.19	0.39
Garments	0.11	0.31
Machinery	0.03	0.18
Metals	0.21	0.41
Other Manuf.	0.01	0.06
Textiles	0.03	0.17
Wood	0.14	0.35
Size	122	195
Foreign (%)	0.17	0.30
Unionised (%)	0.46	0.45
Monit	0.17	0.12

Table 2 – The Impact of Effort and Monitoring on Earnings (IV Results)

	(1)	(2)	(3)	(4)	(5)	(6)
EFFORT	---	---	---	1.824*	2.135**	5.247*
				(0.573)	(0 .771)	(3.713)
EFFORT*MONIT	---	---	---	---	-8.404*	-17.421
					(4.166)	(10.054)
MONIT	-2.008**	-2.658**	-0.092	-2.454**	4.322	10.851
	(0.566)	(0.727)	(0.904)	(0.765)	(3.159)	(22.003)
First Stage EFFORT:						
BUSY	---	---	---	0.123**	0.129**	---
				(0.042)	(0.053)	
PEAK	---	---	---	---	---	0.007*
						(0.003)
First Stage MONIT:						
MONIT(t-1)	0.306**	0.271**	0.436**	0.290**	0.174**	0.279*
	(0.031)	(0.035)	(0.079)	(0.032)	(0.043)	(0.037)
First Stage EFFORT*MONIT:						
BUSY*MONIT(t-1)	---	---	---	---	-0.063	
					(0.064)	
BUSY					-0.011	
					(0.014)	
PEAK*MONIT(-1)						-0.074
						(0.057)
PEAK						0.0291**
						(0.008)
MONIT(t-1)					0.224**	0.282**
					(0.065)	(0.043)
SAMPLE: EFFORT =	All	1	0	ALL	ALL	ALL
N	1335	966	367	1335	1335	876
F-Test (β_i=0)	33.72**	27.19**	14.78**	18.12**	59.97**	2.84**
Hausman Test:	9.27**	9.67**	9.63*	11.38**	23.27**	8.23**
R^2	0.49	0.54	0.64	0.04	0.08	0.11

Notes: (1) Dependent variable is the log hourly wage rate. (2) ** and * are one and five per cent significance levels, respectively. (3) Firm level controls include: employment size, regional location dummies, sector dummies, percentage of union membership, capital intensity, and percentage of foreign ownership of each firm. (4) Worker level controls include level of education, occupation dummies, tenure and its squared value, work experience at the start of the job and its squared value, gender dummy, african dummy, marital status dummy, union membership dummy, and permanent worker status.

Table 3 – The Impact of Effort and Monitoring on Earnings (OLS Results)

	(1)	(2)	(3)	(4)	(5)	(6)
EFFORT	---	---	---	0.047	0.162**	0.118*
				(0.033)	(0 .0.054)	(0.054)
EFFORT*MONIT	---	---	---	---	-0.715**	-0.622*
					(0.267)	(0.267)
MONIT	-0.519**	-0.699**	-0.078	-0.510**	-0.005	0.146
	(0.138)	(0.164)	(0.255)	(0.138)	(0.233)	(0.237)
BUSY						0.182**
						(0.051)
MONIT(-1)						-0.380*
						(0.174)
SAMPLE: EFFORT =	All	1	0	ALL	ALL	ALL
N	1335	966	367	1335	1335	1335
F-Test (β_i=0)	45.12**	34.57**	16.68**	45.16**	44.44**	35.5**
R^2	0.57	0.58	0.65	0.57	0.57	0.54

Notes: (1) Dependent variable is the log hourly wage rate. (2) ** and * are one and five per cent significance levels, respectively. (3) Firm level controls include: employment size, regional location dummies, sector dummies, percentage of union membership, capital intensity, and percentage of foreign ownership of each firm. (4) Worker level controls include level of education, occupation dummies, tenure and its squared value, work experience at the start of the job and its squared value, gender dummy, african dummy, marital status dummy, union membership dummy, and permanent worker status.