Labor Economics

Evidence on Efficiency Wages

Sébastien Roux

ENSAE-Labor Economics

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Efficiency wages

- Explain why wages might be different from market wages :
  - Information asymmetry
  - Adverse selection
  - Turnover costs
  - Equity theory
- Empirical evidence initially based on not well understood wage differentials (mostly inter-industry).
- Need to check the other consequences of efficiency wage theory for a better understanding of market mechanisms.
- Different approaches :
  - Predictions on monitoring.
  - Predictions on turnover rates.
  - Different methods of pay.

Articles

- Capelli and Chauvin, "An Interplant Test of the Efficiency Wage Hypothesis", *Quarterly Journal of Economics*, August 1991.
  Directly test some features of efficiency wage models, especially if higher wage reduce the shirking behavior.
- Cambpbell, "Do Firms Pay Efficiency Wages ? Evidence with Data at the Firm Level", *Journal of Labor Economics*, Jul. 1993, vol.11, N°3.
  Indirect test based on wage and quit equations.
- Chen and Edin, "Efficiency Wages and Industry Wage Differentials : A Comparison across Methods of Pay", *Review of Economics and Statistics*, November 2002, vol.84(4).
  Interpretation of the wage differentials with respect to the methods of pay : test of one feature of the efficiency wage model.

An interplant test of the efficiency wage hypothesis

- Efficiency wage behavior mostly justified by the Shirking Model
- Direct empirical test of such behavior using plant-level data from auto industry.
- Results : Wage premiums are associated with lower levels of disciplinary problems, consistently with the shirking model.
- But less clear that the reduction in shirking exceeds the cost of the wage premium.

Empirical Question

- Is there a relationship between wage premiums and performance ? Difficult empirical question because :
  - Non-wage factors may affect productivity : difference in the quality of workers and/or in the nature of jobs.
  - The efficiency wage effect might be of low magnitude with respect to other effects. Example : Income effects of a rise in wages may reduce productivity, for instance through collective bargaining (cf. Hirsch and Hausman 1987, negative relationship between wages and productivity).
  - Endogeneity problem : are higher wages the result or the cause of greater productivity ?
- Background in psychology : Equity theory. To compensate a rise (or a drop) in wages, workers may work more (or less), cf. Akerlof(1984), evidence from laboratory studies. Note that this equity incentive drops when the relationships lasts several days. Plus, the cost of the rise does not match with the returns in productivity.

Data

- Set of plant-level data for 1982 taken from the internal records of large manufacturing company.
- Many performance related factors are standardized across plants (all terms and conditions of employment are standardized across plants). All data concern production workers, and production jobs are identical across firms.
- Management's personnel policies on issues such as shirking or discipline are centralized : disciplinary practices are standard across plants.
- Wages are not affected by differences in productivity across plants since they are set centrally.
- *However* wages can be a cause of differences in productivity : markets wages differ across plants since they differ with the geographic zone. Differences in wage premiums may affect efficiency. Varies from zero to 100% above the area rate.

- Wage profiles do not differ, because of centralization. Avoid the problem of supplementary efficiency effects induced by different wage profiles. Drawback : lack of generality of the results of this study.
- Costs of finding a new job may differ across areas. Labor performance should be higher and shirking lower in areas where the search costs are high.
- Other reasons may induce high wages :
  - To decrease voluntary turnover. Not such an issue when workers can be easily replaced.
  - Selection of better employees with higher productivity (attraction effect), but operates only through the selection of new employees.
- Measure of Shirking :
  - Cannot be directly measured from productivity indicators because they can depend on other factors.
  - Precise measure from company's internal records : the rate at which workers were dismissed at each plant for disciplinary reasons (DISL).
  - Control of the union (United Auto Workers) about the relevance of such dismissals, eliminates arbitrary and capricious actions.

Specification

DISL is the dependent variable :

$$\ln \frac{DISL}{1-DISL} = a - b_1 WPREM - b_2 UE - b_3 LAIDOFF + b_4 SEN - b_5 VOICE + b_6 ASSMBLY + b_7 MICHIGAN - b_8 SOUTH + b_9 UIBEN + e$$

Explanatory variables that reflect the value of dismissal :

- WPREM : Wage premium for each plant defined as the hourly wage company minus the average hourly wage W_a in the area.
- UIBEN : Maximum state unemployment insurance benefits by plant location.
- UE : Unemployment rate in the area
- LAIDOFF : Percentage of workers on layoff
- SEN : Percentage of workers with less than ten years of seniority

Other variables are included to capture other explanations to discipline rates :

- VOICE : Corporate assessment of cooperation relations/problem-solving at plant (from least cooperative=1 to most=10). The existence of firm-specific arrangements may help reduce discipline problems.
- ASSMBLY : Dummy variable for assembly plants. Jobs in such plants are more oppressive, that might lead to more discipline problems.
- MICHIGAN and SOUTH : Dummy variables for plants in Michigan and in the South. Differences in attitude and behavior depend on the region : more histories of conflict in Michigan and more compliant workers in the south.

Results

Intercpt	−1.071	−1.20	—
	(0.96)	(1.16)	
WPREM	−0.21**	−0.24*	0.547
	(0.10)	(0.13)	
UE	−0.03	−0.012	0.330
	(0.04)	(0.045)	
LAIDOFF	−0.009*	−0.008*	0.207
	(0.005)	(0.005)	
SEN	0.007*	0.008*	0.285
	(0.004)	(0.004)	
VOICE	−0.14***	−0.14***	0.908
	(0.054)	(0.05)	
ASSMBLY	1.008***	1.02***	0.210
	(0.182)	(0.18)	
MICHIGAN	0.09	0.289	0.053
	(0.238)	(0.24)	
SOUTH	0.054	−0.057	0.003
	(0.336)	(0.36)	
UIBEN	−0.00004	−0.00006	0.178
	(0.00009)	(0.00009)	
WPREM'70		0.37	0.291
		(0.54)	
S.E.E. =	0.62	0.61	
F =	6.43	6.32	
n =	78	78	

Interpretation

- The efficient wage hypothesis as applied to shirking seems to be confirmed through the effect of the wage premium on the discipline rate. It dominates income effect (positive effect) or equity theory (nul effect).
- Costs in job loss in addition to the loss of the wage premium influence also the shirking : effect of LAIDOFF and SEN significant. Unemployment as an incentive device.
- The quality of the relationship between plant manager and the employees matters very much (endogeneity issue ?)
- Strong effect of the nature of the work (ASSMBLY), possibly because it is more difficult.
- Alternative explanation to the wage premium effect : better workers could be selected into high-paying firms which would lead to less shirking. Introduction of the wage premium in 1970 does not change the result : the current wage matters, moral hazard problem.

Cost and benefits of the wage premium

- Difficult to assess the benefits of non-shirking : would need a production function approach.
- A one dollar increase in the wage premium lead to 16.5 fewer disciplinary actions per year. The wage cost of such an increase would be over $2 million per year, or $121,000 per disciplinary action.
- The administrative costs of a dismissal is around $75,000. But the cost of shirking might be higher.
- Plus higher wages may decrease turnover costs.

Testing efficiency wage theory from its prediction on firm's behavior

- Concentrate on the labor turnover version of the efficiency wage theory.
- This allows to consider the effect of wages on the quit rate, although it is very difficult to directly assess the effects of wages on productivity (strong endogeneity and omitted variable problems).
- Use of the predictions of the efficiency wage theory on quits and wages :
  Depending on the model, the magnitude of wage effect on quit probability will depend on the wage. Efficiency wage evidences are derived from the inference about this relationship considered at first and second derivative.
- Findings : Positive effect of turnover costs on wages. But its magnitude is smaller than predicted, probably because it ignores productivity effects of wages.

Efficiency wage model

- Consider a firm, which is price-taker P in the product market, and whose production function is $Q = \gamma L^{\alpha} K^{1-\alpha}$
- Firms incur a cost of $\tau q(w, w_a, U) L$ in hiring and training each worker, $q(w, w_a, U)$ is the quit rate, such that $q_w < 0, q_{ww} > 0$ and $q_U < 0$ and τ is the turnover cost. Moreover, $q_{wU} > 0$: when unemployment increases, quits are less responsive to wages.
- Profit function : $\pi = P\gamma L^{\alpha} K^{1-\alpha} - wL - rK - \tau q(w, w_a, U) L$ Which leads to the FOC :

$$
\begin{aligned}
0 &= \frac{\partial \pi}{\partial w} = -L - \tau q_w(w, w_a, U) L \\
0 &= \frac{\partial \pi}{\partial L} = \alpha P \gamma L^{\alpha-1} K^{1-\alpha} - w - \tau q(w, w_a, U) \\
0 &= \frac{\partial \pi}{\partial L} = (1-\alpha) P \gamma L^{\alpha} K^{-\alpha} - r
\end{aligned}
$$

Testable restrictions on quits rate

- The first FOC leads to the equation : $\tau q_w(w, w_a, U) = -1$
- Differentiating this relationship with respect to w, τ and U leads to :

$$\begin{aligned}
\frac{dw}{d\tau} &= -\frac{q_w}{\tau q_{ww}} > 0 \\
\frac{dw}{dU} &= -\frac{q_{wU}}{q_{ww}} < 0 \\
\frac{dq}{d\tau} &= \frac{dq}{dw}\frac{dq}{d\tau} < 0
\end{aligned}$$

- The effect of turnover cost on quits goes through wages. Should it exist controlling for wages might correspond to existence of fringe benefits that would maintain good management-worker relationships.

Accounting for wage Effects on productivity

- Up to now, the model is solely based on turnover. It is possible to add the effort : $Q = \gamma e(w, \phi) L^{\alpha} K^{1-\alpha}$ where $e(w, \phi)$ is the efficiency of a labor unit, ϕ is a firm characteristic. $e_w > 0$, $e_\phi > 0$, $e_{w\phi} > 0$.
- From this setting, we derive the FOC that bring :

$$\begin{aligned} 0 &= P\gamma e_w(w, \phi) k^{1-\alpha} - 1 - \tau q_w(w, w_a, U) \\ 0 &= w + \tau q(w, w_a, U) - \frac{\alpha}{1-\alpha} rk \end{aligned}$$

  where $k = K/L$.
- These equations provide some testing restrictions :

$$\frac{dw}{d\phi} > 0,\ 0 < \frac{dw}{d\tau} < -\frac{q_w}{\tau q_{ww}},\ -\frac{q_{wU}}{q_{ww}} < \frac{dw}{dU} < 0$$

  Both last effects are smaller (in abs. val.) than without wage effects on productivity.

Alternative considerations

- On the long run, firms may have other incentives to propose higher wages, for instance to attract better workers. This may affect the relationships of the model.
- If firms hire in a competitive market, labor is supplied at the market wage, and hiring costs should not affect wages and training costs should raise wages only through their productivity effect. Plus no effect of firm's characteristics.
- If firms are labor-supply constrained, the effect of turnover costs and unemployment on wages is ambiguous. A rise in turnover cost encourage firms to pay higher wages, but also reduces labor demand, which tends to lower wages.
  In this setting, we always have that firms with high productivity tend to offer high wages.

Data

- Employer Opportunity Pilot Project (EOPP) Survey of employers, based on interviews.
- Survey conducted in the spring of 1980 with 5,302 firms.
- Series of questions concerning the personal characteristics, the occupation, the wage and the number of hours spent hiring and training.
- Information added on local unemployment rates and industry capital-labor ratio.

Wage equation

- Wage and quit equations estimated on the most recently hired worker from the EOPP survey. Recall : use of training and hiring costs of *new* workers.
- Two specifications of wage equations : starting wage or top wage as dependent variables.
- Introduction of worker characteristics (age, sex, experience and education + dummy variables for occupation and geographic region).
- Costs of recruiting and training measured by the number of hours spent recruiting (SCREENING) and training the worker in its job first month (TRAINING). Expected positive sign.
- Unemployment rate should have a negative effect on wages.
- Capital-labor ratio and proportion of white collars and crafts are introduced as a characteristic of the firm. These are expected to be positively correlated with wages.

Quit Equation

- Based on the last worker hired, the dependent variable is the length of the worker's employment spell.
- Estimation of duration model, assuming an exponential distribution in a proportional hazard model.
- Same explanatory variables as in the wage equation plus the top wage and the alternate wage.
- Top wage has an expected negative sign, the alternate wage coefficient is expected to be positive.
- Turnover costs (SCREENING and TRAINING) should have a negative impact on quits.
- Highly unionized firms experience fewer quits.

Interpretation of the results

- From the proportional hazard, the quit function writes :

$$q = \exp\left[\alpha + \beta_1 \ln(w) + \beta_2 (w_a) + \beta_3 U\right]$$

- We deduce :

$$q_w = \frac{\beta_1}{w} q,\ q_{ww} = \frac{\beta_1^2 - \beta_1}{w^2} q,\ q_{wu} = \frac{\beta_1 \beta_3}{w} q$$

- Outside estimation of τ from an external study : \$3,500 on average.
- Test of the relationship $-\tau q_w = 1$ strongly rejected, estimates of $-\tau q_w < 0.0749$. Hence labor turnover alone is not enough to account for the relationship between wage and quits.
- Test of the relationship $dw/d\tau = -q_w/\tau q_{ww} = -w/\left[\tau(\beta_1 - 1)\right]$. With the average wage, $-q_w/\tau q_{ww}$ lies between 0.130 and 0.142. Converting the training hours into money, the equivalent concept issued from wage equation is 0.0940. This is consistent with an efficiency model.

- Test of the relationship $dw/dU = -q_{wU}/q_{ww} = \beta_3 w/(1-\beta_1)$. The effect is significant only on the industry unemployment rate.
  From the quit equation, $-q_{wU}/q_{ww}$ is around -2,070. In the wage equation, dw/dU can be estimated -1,260.
  These figures strongly depend on the unemployment concept and the specification.
- Test of the negative correlation between a firm's turnover cost and its wage rate. Directly observed from the wage coefficient in the quit equation.
- Positive relationship between wage and firm characteristics raising worker's productivity : effect of the capital-labor ratio and of the percentage of white-collar in the wage equation.
- Very interesting work but strong untold endogeneity problems.

Efficiency wages and Industry wage differentials : A comparison across methods of pay

- Inter-industry wage differentials have long been considered as a positive test of the efficiency wage theory (Krueger and Summmers, 1988).
- But their only existence was an argument of efficiency wages, not their pattern.
- Idea : industries that require efficiency wage should provide higher wage premia. Considering the theory, these are the industries where pay cannot be performance related. Hence, industries where piece-rate payment requires less efficience pay.
- Direct prediction : if industry wage differentials are related to efficiency wages, then these pay differences should be less important for piece-rate earnings.

Efficiency wage and method of pay

- Time wage rate : price for some unit of time. Earning depend on the amount of time input supplied by the worker.
- Piece rate pay : price for some unit of worker output. This is a performance or incentive pay.
- Effect on the efficiency wage theory :
  - Shirking model : unlike wage rate, piece rate reports on the employee the consequences of shirking, an efficiency wage premium is not required.
  - Adverse selection : piece rate automatically adjust wages with respect to unobserved quality of worker, no need of supplementary premium in this case.
  - Turnover costs : tasks for which piece rate is adopted require less screening and training. Turnover costs should thus be lower.
  - Equity theory : piece rate does not include team work since it is based on individual performance. Time rate would be more relevant.

Institutional context

- Reputation of wage compression and centralized bargaining in Sweden : in contradiction with efficiency wage theory.
- wage bargaining occurs at three levels : centralized, industry and local plant. Wage drift at the plant level.
- From the mid-80s, Centralized bargaining has became less important : the metalworking industry has negotiated separately with its unions.
- Historically, compression of wages from the mid-1960s to the early 1980s, reversed thereafter.
- Data drawn for the year 1985 in the metalworking industry.
- Note that collective bargaining may authorize efficiency wage considerations. Some theoretical arguments explain the observed wage drift (at plant level) by efficiency wages.
- Similitude of inter-industry wage differentials across countries is an evidence that the institutional context may not be that important.
- Some empirical Swedish studies give credence to efficiency wage theory.

Data

- Random sample of 5,000 Swedish blue collar workers from those covered in 1985 by the collective bargaining agreements for the metalworking industry, filled by employers.
- Information on the firm (industry, location, firm size and plant size) and the worker (age, gender, occupation, hours, and earnings).
- Decomposition of hours and earnings by method of pay and details on overtime, shift work,. . .
- 60% of the work force received at least part of their earnings as piece rates. One fourth, were all piece-rate paid.
- Three subsamble to be considered : Mixed rate, piece rate and Pure time rate.
- Only males employed in industry ISIC 38 are conserved in the analysis.
- For each regression, only industries with more than ten observations are conserved.

Mean hourly wage in regression sample

Variable	Mean		
	Mixed Rate	Pure Piece	Pure Time
Log hourly piece earnings	3.884	3.898	—
	(0.110)	(0.097)	
Log hourly time wage	3.819	—	3.818
	(0.150)		(0.105)
No. of observations	577	970	851

Standard deviations in parentheses. Based on samples with at least ten worker observations per industry. The correlation between piece and time earnings for mixed-rate workers is 0.67.

Empirical Approach

- Separate wage equations for piece rates and for time wages.

$$\begin{aligned} \ln w_p &= X\delta_p + D\beta_p + u_p \\ \ln w_t &= X\delta_t + D\beta_t + u_t \end{aligned}$$

- $\ln w_j, j = p, t$ is the log hourly earning excluding overtime and shift-work compensation ;
- X include age, age squared, six plant size dummies, 22 or 23 region dummies
- D represent 15 five-digit level industries.
- $u_j, j = p, t$ is the error term.

Sources of Wage bias : Omitted ability bias

- High paying industries may pay better because they have better workers, which should affect both methods of pay.

$$\begin{aligned} u_p &= \gamma_p A + \varepsilon_p \\ u_t &= \gamma_t A + \varepsilon_t \end{aligned}$$

- If A is correlated with D, b_j is estimated instead of β_j such that (ignoring X) :

$$Eb_j = \beta_j + \left(D'D\right)^{-1} D'A\gamma_j, j = p, t$$

  This bias is a problem if it is very different across methods of pay, i-e if $\gamma_p \neq \gamma_t$.
- For this reason, the preferred estimate will rely on the mixed-worker sample.

Sources of Wage bias : Sample selection

- Worker may choose jobs with different methods of pay with respect to the gain they expect from them. Productive workers may tend to sort into piece-rate jobs.
- Consider an individual i facing the wage structure. Let I_i^* the latent variable reflection his preference for piece-rate pay :

$$I_i^* = \alpha' Z_i + \zeta \left(\ln w_{pi} - \ln w_{ti} \right) + \nu_i$$

- The choice of the method of pay would be :
  - if $I_i^* > \bar{I}$ then i selects pure piece-rate, $w_i = w_{pi}$
  - if $I_i^* \leq \underline{I}$ then i selects pure time-rate, $w_i = w_{pi}$
  - if $\underline{I} < I_i^* \leq \bar{I}$ then i selects mixed rate
- Need of an exclusion variable to properly identify this bias. But such a variable is not available.

Importance of the Industry wage differentials

Row	Statistic	Value			
		Mixed-Rate Workers		Pure-Rate Workers	
		Piece	Time	Piece	Time
(1)	R^2	0.3654	0.4114	0.4023	0.5126
(2)	SEE	0.09533	0.12461	0.07843	0.07691
(3)	Sample size	577	577	970	851
(4)	No. of industry dummies included	15	15	15	15
(5)	F-statistic (P-value)	1.51 (0.0966)	2.98 (0.0002)	1.87 (0.0225)	2.19 (0.0057)
(6)	ΔR^2	0.0293	0.0536	0.0190	0.0209
(7)	ΔSEE	−0.00072[a]	−0.00361[a]	−0.00057	−0.00087
(8)	Unweighted $SD(\beta)$	0.033[b]	0.051[b]	0.030	0.026
(9)	Employment-weighted $SD(\beta)$	0.026[c]	0.046[c]	0.025	0.017
(10)	F-statistic for equality of industry wages across MOP (P-value)	2.75 (0.0005)		1.97 (0.0143)	

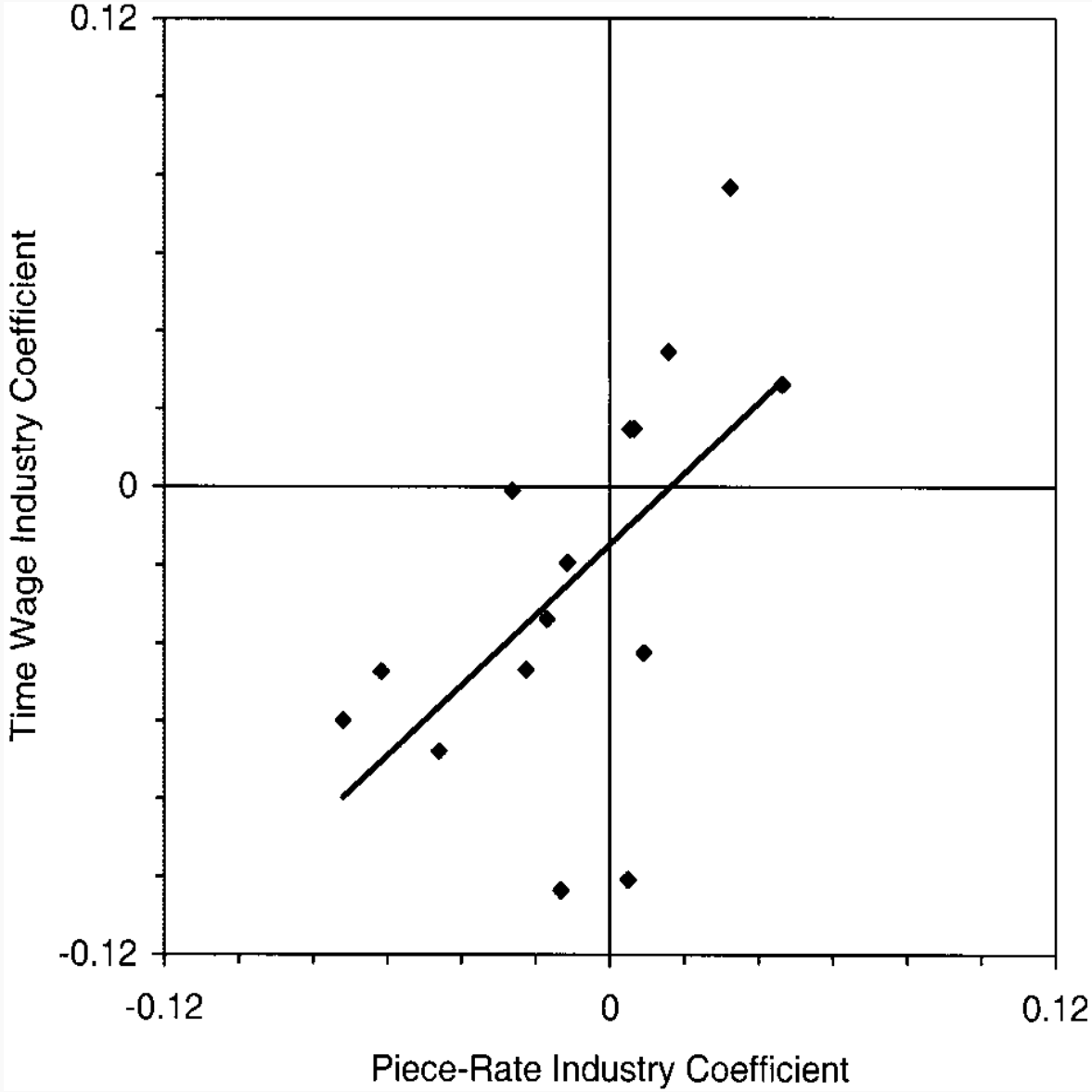
Dependent variable: log of hourly earnings. Control variables included along with industry dummies are: age, age squared, six plant-size dummies, 22 or 23 region dummies, 38 or 39 occupation dummies, and percentage of hours worked under piece (mixed-rate regressions only). ΔR^2 and ΔSEE indicate marginal changes due to addition of industry dummies. $SD(\beta)$ indicates the standard deviation of industry wage effects.

[a] Statistically different across method of pay at 5% significance level (one-tail test), $P = 0.0299$.
[b] Statistically different across method of pay at 10% significance level (one-tail test), $P = 0.0694$.
[c] Statistically different across method of pay at 5% significance level (one-tail test), $P = 0.0427$.

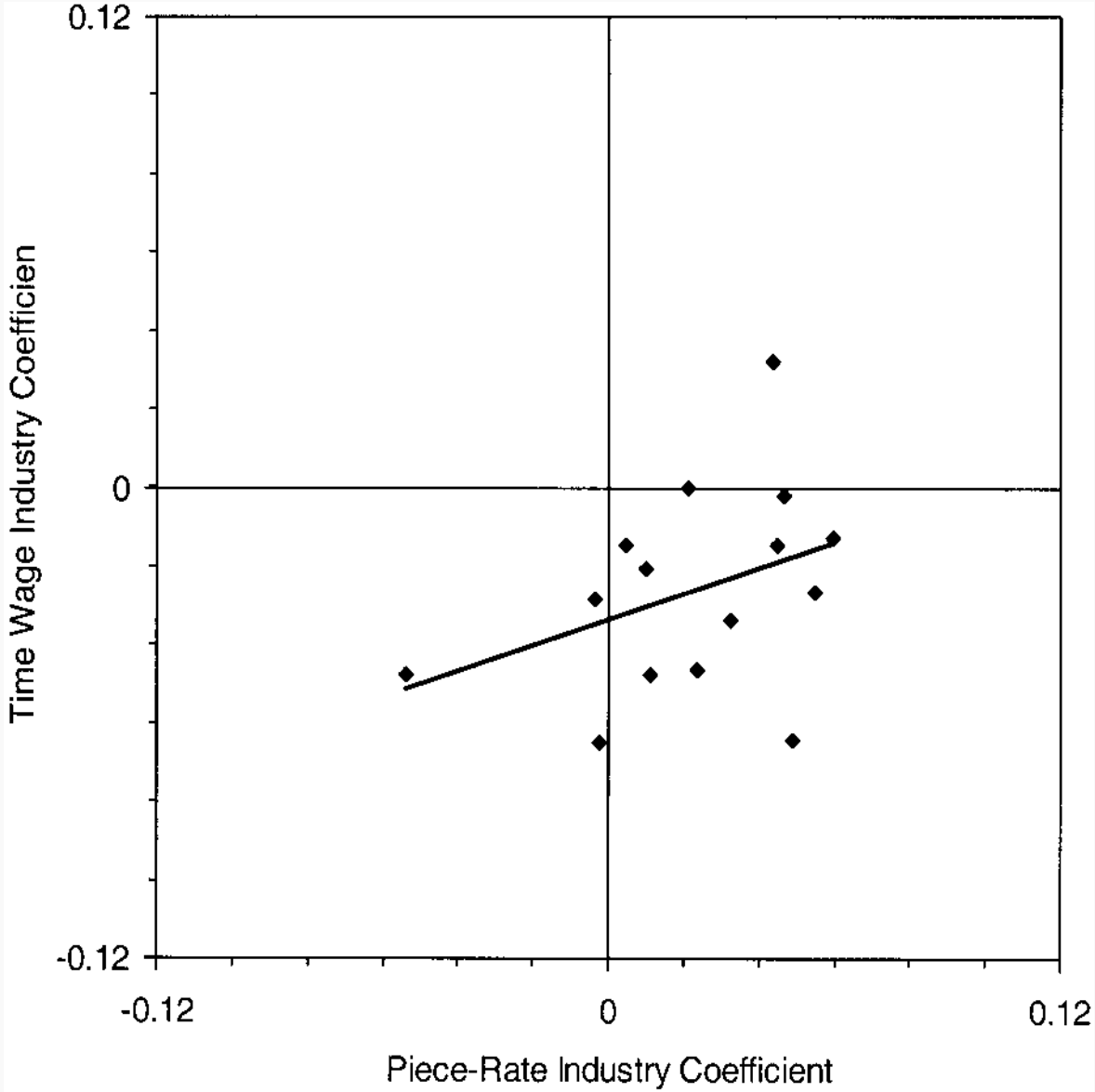
Interpretation

- Evidence on mixed rate workers consistent with efficiency wage theory :
  - The industry wage coefficients for piece rate, non statistically different from zero, are significantly different from the ones for time rate.
  - The industrial wage structure is less dispersed for piecework.
  - The industry effects have a smaller explanatory impact on piece-rate.
- Not such evidence considering pure piece-rate and time-rate. Industry effects are significantly different, but more variable for piece-rate.

Industry wage differentials for mixed-rate workers



Industry wage differentials for pure-rate workers



Correlations of estimated industry coefficients across methods of pay

	Pure Piece	Pure Time	Mixed Piece	Mixed Time
Pure Piece	1.000	0.273	0.274	−0.164
Pure Time		1.000	0.555	0.588
Mixed Piece			1.000	0.397
Mixed Time				1.000

Each of the pure-rate and mixed-rate samples of estimated industry coefficients spans 15 industries, although they are not the same 15. The above correlations are reported for the same 11 industries which are present in both samples. Over all 15 industries, the correlation between pure piece and pure time is 0.371, and between mixed piece and mixed time 0.579.

Discussing the unobserved ability bias

- Puzzle : negative correlation between pure piece-rate and mixed time-rate industry effects. Piece-rate industry effects are particular.
- Theoretical evidence that high-ability workers tend to prefer piece-rate (Lazear, 1986) also empirical (Lazear, 2000 and Parent, 1999)
- Sorting on observable can be seen from the data : it might be arguable that sorting also applies on unobservables.
- Theoretical arguments (Booth and Frank, 1999) conclude that unobserved ability is prominent when determining performance-related pay.
- Hence, the proper evidence on efficiency wage comes from mixed rate population.