8 Relative Pay Effects in Models of the Labour Market

Peter W. Kennedy

I. INTRODUCTION

Psychologists and sociologists have long recognized the importance of relative pay effects in the determination of worker productivity. A host of studies from the psychology and sociology literatures indicate that paying similar workers differentially can be detrimental to morale and can undermine productivity.[64] Those who design real world compensation schemes are also well aware of this fact. Personnel management texts routinely stress the importance of "equitable" pay rates in fostering harmonious and productive work environments.[65] Moreover, there is considerable empirical evidence to suggest that actual pay differentials do not fully reflect productivity differences; workers are paid more equitably than their relative productivities would seem to dictate.[66] This weight of evidence has increasingly forced economists to question the adequacy of traditional models of the labour market that ignore relative pay effects. The purpose of this paper is to review some recent contributions to the labour market literature that attempt to address this shortcoming by incorporating relative pay effects into otherwise fairly standard economic models.

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[64]See the studies cited in Vroom (1964), Lawler (1971), Pencavel (1977), Frank (1985) and Akerlof and Yellen (1990).

[65]See Akerlof and Yellen (1990) for some examples.

[66]See Frank (1984a), and for a survey of other work, see Baker, Jensen and Murphy (1988).

Models of relative pay effects divide roughly into two types. The first type focuses on the implications of relative pay effects in competitive labour markets in which firms are wage-takers. Models of this type include those of Hamermesh (1975), Summers (1988) and Akerlof and Yellen (1990). The second group of models consider the implications of relative pay effects for the design of optimal pay schemes at the firm level. Frank (1984b), Lazear (1989) and Kennedy (1992) examine models of this type. The next section discusses the competitive wage models. The optimal pay scheme models are discussed in Section 3. Section 4 concludes.

II. COMPETITIVE WAGE MODELS

The earlier model of relative pay effects is due to Hamermesh (1975). He presents a model where wage-taking firms employ two complementary types of labour to produce output according to the production function:

$$Q = F[e(w_1, w_2)L_1, L_2] \qquad (1)$$

where L_1 is the number of employees of type i and e(.) is a productivity factor for type one workers such that $e_1>0$ and $e_2<0$. That is, the productivity of type one workers is increasing in their own wage but decreasing in the wage paid to type two workers. This captures a relative pay effect for type one workers. (There are no relative pay effects for type two workers). This effect can potentially change the standard comparative static results for the labour market. Hamermesh examines the effect of a change in w_1 on the demand for type one labour and finds that the relationship may be positive if the relative pay effect is sufficiently strong. The reason is the following. A fall in w_1 (relative to w_2) may reduce the relative productivity of type one labour by enough to induce the firm to employ less of it. This paradoxical result cannot arise in the absence of a relative pay effect.

In a separate model, Hamermesh also examines the labour supply decision in the presence of a relative pay effect. Workers have utility defined directly over leisure, income and their relative wage:

$$u = u(T-H, wH, w/w^*) \qquad (2)$$

where T is available time, H is time devoted to work, w is the wage received and w* is some reference wage. Utility is increasing in all its arguments. A relative pay effect (which Hamermesh calls a "conspicuous earnings effect") arises in the labour supply decision if $u_{13} \neq 0$. Hamermesh assumes that $u_{13} < 0$; that is, the marginal disutility of work increases if the relative wage falls. This seems to be consistent with the findings of many psychological studies. For example, Lawler (1971, p.226) states that "the more [an individual] perceives that others receive, the less he may feel he receives and consequently the less satisfied he may be with his pay". Hamermesh finds that the presence of the relative pay effect distorts the slope of the individual's labour supply curve. The change in hours worked in response to a change in the wage reflects the usual positive substitution effect and (normally negative) income effect, plus an additional effect: a positive relative pay effect. A fall in the worker's wage (relative to the reference wage) increases the marginal disutility of work and leads her to reduce her supply of labour by more than the usual substitution effect. (The overall effect is still ambiguous if leisure is normal).

In his demand-side model, Hamermesh assumes that the relative supply of the two types of labour adjusts in response to relative wages in the long-run. This means that the long-run competitive equilibrium is unaffected by the presence of relative pay effects and standard long-run results continue to hold. But this need not be the case if there is no relative supply adjustment. Akerlof and Yellen (1990) construct a model in which relative pay effects generate equilibrium unemployment. Their model is in some respects quite similar to the Hamermesh (1975) demand-side model.[67] Wage-taking firms employ two types of complementary labour, and output is a function of effective labour units $e_i L_i$ of each type, where L_i is the number of type i workers employed and e_i is their productivity or effort. The effort forthcoming from a worker of type i is given by:

$$e_i = \min (w_i / w_i^*, 1) \qquad (3)$$

where w_i is the wage received and w_i^* is the reference wage for type i. This relationship between effort and the relative wage differs from the Hamermesh (1975) specification in two important respects. First, the relationship is asymmetric. If a

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[67] Akerlof and Yellen do not cite the Hamermesh (1975) paper.

worker receives a wage higher than her reference wage then she supplies full effort (normalized to unity), but in response to a wage that is less than her reference wage she will reduce effort proportionately. Akerlof and Yellen refer to this asymmetric relative wage effort as the "fair wage hypothesis". Productivity is adversely affected when a worker receives a wage less than what she perceives to be fair (the reference wage) because the unfair treatment causes her to "get mad" and then "get even" by not supplying her full effort. Akerlof and Yellen do not relate this response to some underlying preferences over relative earnings but instead suggest that it is an irrational response by a worker who is not thinking clearly because she is "mad" at having been treated unfairly.[68] The second distinct feature of the Akerlof and Yellen relative pay effect is the specification of the reference wage. The reference wage for labour of a given type is a weighted average of the "market-clearing" wage for that type and the wage received by the other type:

$$w_i^* = \beta w_j + (1-\beta) w_i^c \qquad (4)$$

where w_I^c is the "market-clearing" wage. This is not a market-clearing wage in the true sense; it is the wage that would clear market i if workers did not care about wage relativities.[69] Akerlof and Yellen motivate this assumption by citing a study by Kahneman, Knetsch and Thaler (1986) that indicates that a person's view of what is a fair price is influenced (but not wholly determined) by the market clearing price. However, this motivation is perhaps not entirely satisfactory because some workers in the equilibrium of this model never observe their "market-clearing" wage. They must instead calculate this wage on the basis of hypothetical behaviour that they themselves do not exhibit. Nonetheless, the assumption is critical for Akerlof and Yellen's results. The final important assumption of the model is that the supplies of the two types of labour are independently fixed; there are no relative supply adjustments.

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[68] It does not seem necessary to resort to stories of irrational behaviour to support this response by the worker. One can envisage an underlying model of rational agents in which agents who receive unfair treatment respond reciprocally in a type of trigger-strategy equilibrium.

[69] Importantly, if workers receive at least a fair wage then they will supply full effort, acting as if they did not care about relativities. In that case, w_i^c and the true market-clearing wage coincide.

Akerlof and Yellen focus on what they call the "integrated equilibrium" of their model. This equilibrium is characterized by full employment for one type of labour and some unemployment for the other type. In particular, the type that receives the lower wage in equilibrium (as determined by the relative supply of the two types and their relative importance in the production function) will experience some unemployment. These workers receive their fair wage in equilibrium but this exceeds the market-clearing wage for their type. Workers of the other type receive their market clearing wage (which exceeds their fair wage) and so are fully employed. The intuition underlying this equilibrium is the following. At least one type must be fully employed or else both wages could fall (without reducing productivity since relativity is unaffected) until one type is fully employed. This type then receives its market-clearing wage. The other type must receive a lower wage than this, unless by coincidence they have the same market-clearing wage, and so they will regard their own market-clearing wage as unfair.[70] However, payment of this or any other unfair wage w will elicit an effort response of only w/w^* from this type and imply an effective labour cost of $w/e = w^*$ for this type. Thus, any wage $w \leq w^*$ has an effective labour cost of w^*. If firms have a slight preference for fairness they will pay w^*. Notice that this equilibrium exhibits wage compression in the sense that the differential between the wages paid to the two types does not fully reflect the difference in their "market-clearing" wages.

The possibility of unemployment in this model relies crucially on the fixedness of relative labour type supplies and the weight given to the market-clearing wage in the determination of the reference wage. If the relative supply of labour adjusts in response to wage relativities then $w_1=w_2=w^*$ in long-run equilibrium and there is no unemployment. If $\beta=1$ in equation (4) then $w_1=w_2=w^*$ in the candidate equilibrium but this equilibrium cannot exist unless it just happens that $w_1^c=w_2^c$, in which case there will be no unemployment. The $\beta=1$ case with relative supply adjustment is essentially the case examined by Hamermesh (1975). Notice also that the existence of equilibrium when $\beta<1$ relies on the asymmetry of the relative pay effect. If $e=w/w^*$ instead of being bounded above by unity

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[70] If the market-clearing wage happens to be the same for both types then both types will be fully employed.

then the effective cost of labour is w* at any wage and so wages will be bid up without bound.

Summers (1988) presents a simple model with homogeneous labour that also yields an equilibrium with unemployment. In common with the Hamermesh (1975) and Akerlof and Yellen (1990) models, productivity is assumed to depend on relative wages:

$$e = (w - w^*)^{\alpha} \quad 0 \leq \alpha \leq 1 \tag{5}$$

where w* is the reference wage. However, the reference wage here is the worker's perceived outside opportunity. This in turn is determined by market conditions:

$$w^* = \bar{w}(1 - (1-b)r) \tag{6}$$

where $\bar{w}$ is the average wage paid by other firms and r is the unemployment rate. Identical firms take w* as given and choose w to minimize the effective cost of labour w/e. This implies that $w = w^*/(1-\alpha)$. In equilibrium $\bar{w} = w$, so solving for r yields $r = \alpha/(1-b)$. Thus, a positive relative pay effect ($\alpha>0$) leads to unemployment.[71] Despite the different interpretation, the specification of the reference wage in (6) is clearly reminiscent of the relationship between w* and the "market-clearing" wage in the Akerlof and Yellen (1990) model. It is this common feature that generates the equilibrium unemployment in both models. Notice also that if b=1 in the Summers model then no equilibrium exists with finite unemployment. This is analogous to the $\beta=1$ case in Akerlof and Yellen (1990) in which an equilibrium generally does not exist without relative supply adjustment.

III. OPTIMAL PAY SCHEMES

Firms play only a passive role in the models discussed so far. There is no consideration given to how firms might attempt to

[71] This clearly has the flavour of an efficiency wage model in which unemployment is implied by and at the same time sustains the equilibrium.

moderate the adverse productivity implications of relative pay effects through the design of the internal pay scheme. This section reviews three models that examine the optimal behaviour of firms in response to relative pay effects.

Frank (1984b) constructs a model in which the firm is viewed as a free association of workers who are free to bargain over their relative income within the firm. Workers have a preference for high relative income status among their co-workers but, in contrast to the models discussed in Section II, they do not choose their effort level in response to that relative status. These workers have fixed productivities and instead choose the firm for whom they are willing to work based on their relative income status within that firm. Frank shows that there cannot exist a competitive equilibrium in which all workers are paid their marginal products if workers are free to associate with whom they choose. Highly productive workers want to associate with less productive workers and so earn a higher relative income, but the less productive workers are willing to accept that association only if they are compensated for their lower status with a higher absolute income. The resulting trading equilibrium exhibits wage compression in the sense that the distribution of wages within the firm is much less dispersed than the corresponding distribution of marginal products. Less productive workers receive a wage in excess of their marginal product to compensate for their lower status while highly skilled workers are willing to accept a wage lower than their marginal product in return for the higher status they receive.

The relative pay effect in the Frank (1984b) model has no implications for incentives at the margin; workers simply leave the firm if they are dissatisfied with their pay. More interesting questions arise with respect to the optimal design of the pay scheme when the relative pay effect has implications for productivity. This requires a principal-agent framework. In Kennedy (1992) I construct a model within such a framework. Heterogeneous workers have a preference for higher relative income among their co-workers and choose their level of effort in response to their relative and absolute pay. Worker i has utility function:

$$u_i = \phi_i y_i - c_i e_i^2 \qquad (7)$$

where y_i is income, e_i is effort, c_i is the cost of effort (or inverse of skill) and $\phi_i = y_i / \bar{y}$ is a measure of the worker's income relative

to the average income in the firm $\bar{y}$.[72] Workers differ only in their cost of effort c_i. There are n workers whose heterogeneous abilities are taken as given. The firm's production function is

$Q=kE$ where $E = \sum_{i=1}^{n} e_i$ and $k>0$[73], and the price of output is one. There are no non-labour costs. The firm's problem is to choose a payment scheme to maximize profit given the response by workers and subject to participation constraints. Consideration is confined to schemes which offer a wage w per unit of effort plus a share s of total output:

$$y_i = we_i + sQ \tag{8}$$

The output-sharing component can be interpreted as a gross profit-sharing arrangement. Such arrangements are widely used in practice despite their associated free-rider problem.[74] It is frequently argued that profit-sharing is an effective way of boosting morale by engendering a "team spirit" among workers; this can potentially generate productivity gains sufficient to offset the free-rider problem. The profit-sharing component in (8) serves precisely that role: it can mitigate the adverse relative pay effect that arises under a pure wage scheme by reducing the differential across worker's incomes.

Effort levels are determined in a Nash equilibrium among workers in response to the contract offered. Some interesting results emerge when the contract is restricted to be a pure wage contrast (s=0). First, a worker will not supply positive effort if the average skill level in the firm is too much higher than his own. In particular, all workers supply positive effort under a pure wage contract if and only if:

$$c_i<2(n-1)\bar{c}_{-i}/(2n-3) \quad \forall i \tag{9}$$

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[72]Notice that this specification implies that the marginal utility of income is decreasing in relative income, as in the Hamermesh (1975) supply-side model.

[73]In a more complete model k would be a quadratic function of n, reflecting initial gains to task specialization but eventual increasing coordination costs. A balance of these two factors determines the optimal size of this stylized firm.

[74]See Baker, Jensen and Murphy (1988, p.605).

where $\bar{c}_{-i} \equiv (C-\bar{c}_{-i})/(n-1)$ is the average cost of effort for workers other than worker i and $C = \sum_{i=1}^{n} c_i$. In a firm with highly skilled workers, a relatively unskilled worker is disadvantaged in the competition for relative income status and may choose not to participate.[75] This phenomenon is analogous to the perverse incentive effects that can arise under tournament promotion schemes when candidates differ in ability.[76] Under a tournament scheme, lower ability workers may be discouraged from competing for the promotion "prize" because their probability of success is so low and effort *per se* is not rewarded. The result here is somewhat stronger. It suggests that workers may become discouraged even when they are rewarded for each unit of productive effort regardless of relative performance. The worker's perception of the reward in a relative context introduces a tournament-like aspect to the wage contract. A natural corollary of this result is that the firm's workforce cannot be too heterogeneous with respect to ability if all workers are to supply positive effort.[77]

When the composition of the workforce is restricted to satisfy (9) it turns out that each worker's equilibrium effort is increasing in the average cost of effort of his co-workers. That is: $\delta e_i/\delta \bar{c}_{-i} > 0$. This means that a worker of given ability will supply less effort when teamed with highly skilled co-workers than when teamed with less able co-workers. This can again be interpreted in terms of the worker's morale. A worker with less ability than his co-workers has little prospect of achieving a high relative income status within the firm and will be discouraged from trying. The converse is true for a worker of high relative ability, who is well positioned to achieve a high relative status.

In Kennedy (1992) I also compare the equilibrium effort by worker i under a pure wage contract with that predicted by a traditional model which implicitly sets $\phi=1$. The comparison is

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[75]Analogously, Frank (1985) argues that no worker likes to be "a small frog in a big pond".

[76]See Lazear and Rosen (1981).

[77]An argument analogous to this is often cited in support of talent "streaming" in children's sports and in the classroom. Talent streaming places similarly talented children together often to ensure that the least talented children are not discouraged from participating.

illustrated in Figures 8.1 and 8.2. Figure 8.1 shows a two-worker firm in which the workers have the same cost of effort c. Their equilibrium effort is $e=3\alpha/4c$. In contrast, when $\phi_i=1$, worker i chooses an effort level of $e_i=\alpha/2c_i$ regardless of his relative ability. Thus, a model which ignores the importance of relative income status understates the strength of the incentives created by the wage contract in this case. The wage contract creates a competitive environment that stimulates productivity. None of the workers is disadvantaged relative to his co-workers in competing for relative income status and so none of the workers become discouraged. On the other hand, Figure 2 shows a firm in which one worker has a much lower cost of effort than his co-worker. In this case the less skilled worker supplies less effort than predicted by the $\phi=1$ model, while the more skilled worker supplies more effort. The $\phi=1$ model overstates the effort supplied by the less able worker because it fails to account for the adverse affect of the pure wage contract on this worker's morale.

The adverse relative pay effects associated with the pure wage contract can be moderated by the inclusion of a profit-sharing component in the contract. This serves to "level the playing field" on which workers compete for relative income status and thereby improve the morale of the least skilled workers. But this improved morale for the least skilled workers comes at a price. The inclusion of a profit-sharing component dilutes the competitive environment that motivates highly skilled workers, and at the same time introduces an incentive for all workers to free-ride. The optimal contact must balance these two effects. It has two main characteristics. First, the optimal contact always includes a positive wage component. That is, a pure profit-sharing arrangement is never optimal. Second, the optimal contract includes a positive profit-sharing component if and only if:

$$\sum_{i=1}^{n} [2C - (2n-1)c_i]^{-1} > (2n-1)n/C \qquad (10)$$

It is instructive to interpret this condition in terms of the heterogeneity of the firm's workforce. For a given aggregate cost of effort C, the right-side of (10) is independent of the

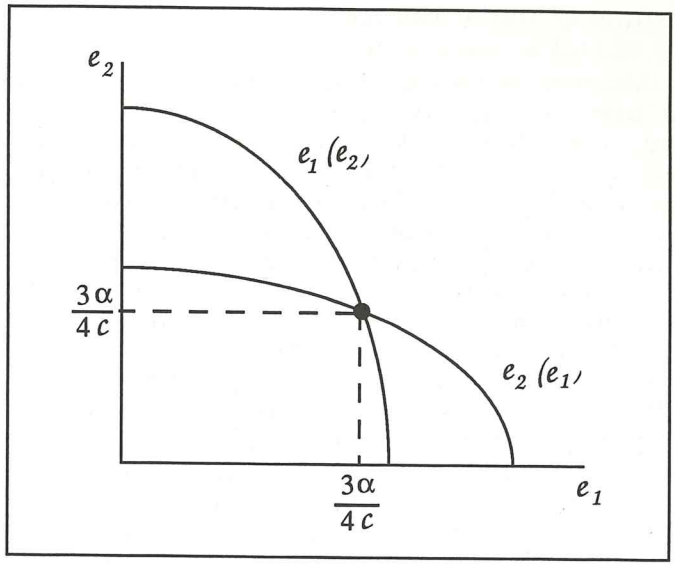

Figure 8.1

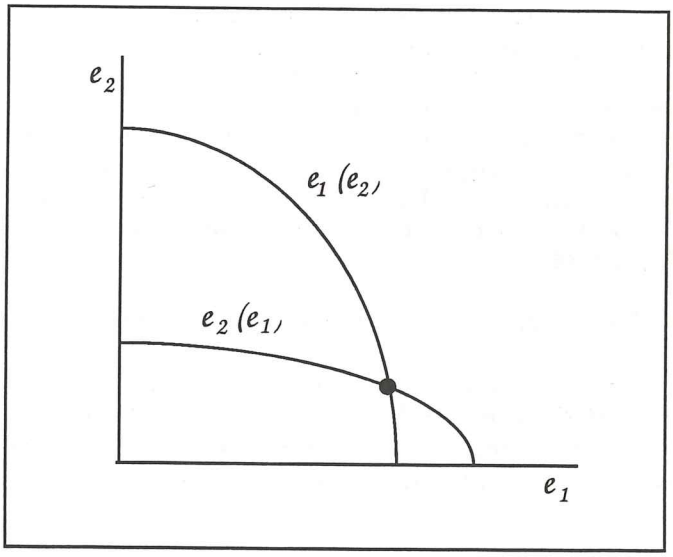

Figure 8.2

composition of the workforce. Conversely, for a given C, the left-side of (10) is increasing in the variance of the c_i's. Hence, for a sufficiently heterogeneous workforce, the optimal contract will include a profit-sharing component. This result is quite intuitive. The adverse relative pay effect associated with a pure wage contract increases with the heterogeneity of the workforce because the degree of differential treatment across workers necessarily increases. Consequently, the benefits of including a profit-sharing component increase with worker heterogeneity. So if the firm's workforce is sufficiently heterogeneous, the incentive costs of including a profit-sharing component will be more than offset by the productivity gains amongst the least skilled workers. These productivity gains will tend to decrease with firm size (for a given degree of heterogeneity across workers) because the free-rider problem associated with profit-sharing is likely to be more severe in large firms.

Lazear (1989) also examines a firm's optimal response to adverse relative pay effects but in an explicit tournament setting. He constructs a model in which relative pay effects stem directly from the nature of the tournament rather than from worker preference for high relative income status. Worker i wins a price of W_1 if her output q_i is higher than the output of worker j, otherwise she wins a prize of only $W_2 < W_1$. The output of worker i is a function of her effort e_i, an idiosyncratic random shock ε_i and, crucially, the "sabotage activity" of worker j, θ_j. This sabotage activity represents any sort of uncooperative activity by worker j that adversely affects the productivity of her co-workers. This sabotage possibility is the key feature of the model. Workers can enhance their chances of winning the bigger prize by engaging in productive effort but they can achieve the same goal by sabotaging the efforts of co-workers. Each worker chooses a mix of these activities to maximize her expected payoff:

$$W_1 P(e_i, \theta_i; e_j, \theta_j,) + W_2[1 - P(.)] - c(e_i, \theta_i) \qquad (11)$$

where P(.) is the probability of winning, and c(.) is the joint cost of effort and sabotage, with $c_1>0$ and $c_2>0$. Lazear shows that if c_{12} is not too negative, then increasing the prize spread increases the equilibrium level of sabotage among symmetric

workers.[78] Thus pay equality implies less sabotage. Of course, pay equality also implies less effort because the competitive incentives are diluted. However, it turns out that if c_{12} is not too negative, then the optimal prize differential is lower when sabotage is possible than when it is not. The reasoning is the following. Consider the prize differential that includes the optimal level of effort when sabotage is fixed at zero. k At that differential, workers will chose $\theta>0$ if sabotage is possible. A small reduction in the differential will induce a small change in e that has no first-order effect k(by the envelope theorem) and a small change in θ which does have a strictly positive first-order effect. Thus, the prize differential should be reduced. The intuition is simply that a large prize differential will induce too much uncooperative behaviour among workers and thereby reduce overall productivity. Thus, the adverse relative pay effect induced by the possibility of sabotage calls for some pay compression within the firm.

IV. CONCLUSION

An important theme common to most of the models reviewed here is that the presence of relative pay effects can explain pay compression. In Akerlof and Yellen (1990) and Frank (1984b) this is a necessary feature of the competitive equilibrium with a relative pay effect. In Lazear (1989) and Kennedy (1992) pay compression is part of an optimal pay scheme. The results of Akerlof and Yellen and Frank suggest that such pay schemes can be sustained in equilibrium. The Akerlof land Yellen model also indicates that such an equilibrium may exhibit unemployment. The Summers (1988) model has a similar implication in a similar context.

A second important theme that emerges from these models is that complex sociological phenomena can be successfully analyzed in terms of an economic model. Standard economic models have traditionally tended to ignore issues of social interaction that psychologists and sociologists consider so important. This has often brought the usefulness of such models into question. The innovative models reviewed here,

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[78] If c_{12} is highly negative then the reduced effort that accompanies a reduction in the prize differential can reduce the marginal cost of sabotage to the point where the privately optimal level of sabotage actually increases.

despite their deficiencies, demonstrate that economic models need not suffer from this shortcoming, and in overcoming it are better able to explain real world phenomena.

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