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ABSTRACT

Training, Rent-Sharing and Unions*

We investigate two dimensions of investment in general human capital on-the-job: the number of workers trained and the intensity of training for each worker. In the benchmark case, we consider wage and training decisions made by firms in an imperfectly competitive labour market. The benchmark case generates two types of market failure: too few workers are trained and the workers who are hired receive too little training. This is caused by the firms' discount rate exceeding the social discount rate, due to a 'quitting externality'. We show that the presence of labour unions can increase social welfare by increasing training intensity, while reducing welfare by lowering the number of workers trained. Using the British Household Panel Survey, we confirm the predictions of the model.

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NON-TECHNICAL SUMMARY

Workers in Europe appear to receive more on-the-job training than their counterparts in the United States (see for example OECD, 1995). While there are many differences between generic European and US labour markets, most involve departures from the competitive paradigm. We are interested in one such departure in this paper: the institution of labour unions and their impact on on-the-job training. In this we are supported by studies that have found unionised workers are more likely to receive such training than non-unionised ones and that have found evidence of bargaining by some unions over both wages *and* training intensity.

We consider two dimensions of training: the number of workers trained and the intensity of training per worker. While some recent theoretical work on training has focused on the former (Stevens, 1994; Booth and Chatterji, 1998; Booth and Zoega, 1998), much of the literature tends to focus on the latter (Acemoglu, 1996; Acemoglu and Pischke, 1998; Chang and Wang, 1996; Miller, Ippolito and Zhang, 1998). Our study is the first to our knowledge that explicitly combines both training intensity and the number of workers trained within a single modelling framework.

It is by now well known that firms may want to invest in the general training of their employees due to the labour market being imperfectly competitive (Stevens, 1994; Acemoglu and Pischke, 1998; Booth and Zoega, 1999). Sources of imperfect competition include costs of moving between jobs, a small number of firms in the industry and asymmetric information about worker quality.

We show that when training is general to an industry, firms choose a sub-optimal level of such training, since they realise that workers would take with them any human capital when leaving for other firms in the industry. But the human capital is not lost to society, so a market failure arises: private discount rates are higher than social ones. Unions can remedy the market failure in two ways. First, if an industry-wide union has a direct say in the training decision and maximises the utility of a representative worker, it will choose a level of training closer to the social optimum, as its discount rate is equal to the social discount rate. How close union-set training is to the social optimum depends on the sensitivity of profits, which constrain the union's activity, to changes in the level of on-the-job training. The union will pick the socially-optimal level of training when it can choose the level of training freely, without having to worry about the effect on profits and hence the employability of its members. Second, firm-specific unions can reduce the quitting externality in their firms by raising relative wages, hence reducing quits and the employer's discount rate. Our model has a number of important *ceteris paribus* empirically testable predictions: (i) unionised workers spend more time in training; (ii) unionised workers are more likely to receive any training; (iii) unionised workers experience higher wage growth. We also demonstrate that the union effect on training can be caused either directly by the participation of labour unions in the training decision at the industry or the firm level, or indirectly by unions raising wages and hence reducing quits and in that way inducing firms to offer more training. While it is difficult to measure quantitatively the direct influence of unions, the indirect influence can be tested for, since we expect (iv) unionised workers to have higher wages for the same job tenure and (v) unionised workers to have lower quit rates.

After outlining the predictions of our theoretical model, we then confront the predictions with data from the first six waves of the British Household Panel Survey (conducted over the period 1991 to 1996) for full-time male employees, of whom approximately 60% are covered by union collective bargaining arrangements. In summary, we find that the predictions of the model are consistent with the data. Union-covered men are more likely to experience work-related training than are non-union men and receive larger wage gains consequent upon training.

Our detailed empirical findings are as follows. First, we find that men who are covered by a union are significantly more likely to receive work-related training in the current job. The impact is quite large: union coverage increases the training probability by more than nine percentage points. Moreover, men who are covered by a union receive approximately four more days of training than their non-union covered counterparts. The higher the average quit rate at the two-digit Standard Industrial Classification level, the less likely is a man in that industry to be trained and the fewer training days are experienced. These findings are consistent with our theoretical predictions.

Second, we estimate the impact of training on wage levels and wage growth. Our *wages level* equations show that men covered by a union receive on average 6% higher wages than their non-union covered counterparts. In line with our theory, we find that the union premium works primarily through higher training incidence: union workers who receive training earn almost 10% more than workers who receive training but are not union-covered. Although a higher number of training days increases union workers' wages, this effect is small and not well determined

Our *wages growth* equations show that men who were always covered by a union experience a higher wage growth than men who were never union-covered, by approximately 3% a year. Entry into a union-covered job combined with training increases wage growth by almost 11% a year. Having had some training experience significantly reduces wage growth by 12% a year if the worker moves from a union-covered job to a non-union-covered job.

Finally, we consider the relationship between union coverage and individual quitting behaviour. We find that union coverage significantly reduces workers' quitting probability by about 3%. Almost identical results are found when we use training days rather than training incidence and when we study union coverage interaction with either measure of training.

In summary, using the British Household Panel Survey (BHPS), we found that the main predictions of the theoretical model were confirmed: (i) unionised workers are more likely to receive training, (ii) they are trained more days than their non-unionised counterparts, (iii) they experience a higher wage growth and a greater return to training, (iv) receive higher wages for a given tenure and (v) have lower quit rates. While this is good news for our model, we must caution that other models may also yield similar implications. Further work will involve looking at the institutional structure of training decisions in firms to determine the precise role of unions.

It is well known that workers in Europe appear to receive more on-the-job training than their counterparts in the United States (see for example OECD, 1995). While there are many differences between a generic European and U.S. labour market, most involve departures from the competitive paradigm. We are interested in one such departure in this paper: the institution of labour unions. In this we are supported by micro-econometric studies which have found that unionised workers are more likely to receive such training than non-unionised ones (see for example Booth, 1991; Lynch, 1992). Evidence that unions do bargain over both wages and training intensity is provided in, for example, Mahnkopf (1992) and Streek (1989).[1]

In this paper we consider two dimensions of training—the number of workers who are trained, and the intensity of training for a given worker. While some recent theoretical work on training has focused on the former (Stevens, 1994; Booth and Chatterji, 1998; Booth and Zoega, 1998), much of the literature tends to focus on the latter (Acemoglu, 1996; Acemoglu and Pischke, 1998; Chang and Wang, 1996; Miller, Ippolito and Zhang, 1998). However, our study is the first to our knowledge that explicitly combines both training intensity and the number of workers trained within a single modelling framework.[2]

It is by now well known that firms may want to invest in the general training of their employees due to the labour market being imperfectly competitive (Stevens, 1994; Acemoglu and Pischke, 1998; Booth and Zoega, 1999). Sources of imperfect competition include costs of moving between jobs or switching costs, a small number of firms in the industry, and asymmetric information about worker quality.

We analyse the training decision under the assumption that workers are not paid for the time they spend in the training programme and receive wages that are proportional to their productivity. Given this, we find that workers always choose a higher level of training than do firms, independent of the level of wages and hence independent of the assumptions about labour-market competition. In other words, even if firms take part of the return to training, due to imperfect mobility of workers between firms or elements of monopsony power, the worker would always choose more training than would the firm. The reason can be found by comparing the discount rates of workers and firms. While the discount rate of workers equals the social

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[1] Cully et al (1998) report preliminary findings from the British 1998 Workplace Employee Relations Survey, the first of its kind to ask in detail about work-related training. Their findings support the individual-level survey results that there is a positive correlation between 'access to training and to higher numbers of days of training' in unionised establishments. Unions in aproximately half of the workplaces with union representatives are consulted about training.

[2] Malcomson, Maw and McCormick (1998) examine formal apprenticeship contract length and the number of workers trained. In their model, contract enforceability and cheating are important, because of incomplete

discount rate, firms discount by more than the social rate owing to a "quitting externality". Thus the presence of labour unions can increase the intensity and frequency of general on-the-job training if unions have a say in the design of the employer's training programme.[3]

In our model, there is another reason why unions may increase general training taking place in firms, namely that unions reduce workers' quit rates by raising their relative wages. If unionised workers have a lower propensity to quit because of high wages, firms want to provide more training because their (private) discount rates become lower.[4] Higher relative wages thus reduce the quitting externality.

In the next section, we outline the structure of the model and its underlying assumptions. In Section II, we consider wage and training decisions made by firms when they are unconstrained by any institutional rigidities in the labour market—what we term the benchmark case. Under certain conditions, the benchmark case generates the two types of training inefficiency—(i) too few workers are hired into the training sector, and (ii) those workers who are hired receive too little training. In Section III, we then compare this sub-optimal outcome with the first-best level of hiring and training per worker. This amounts to assuming that there is a social planner who can internalise the training externalities by choosing the number of trainees and their training intensity to maximise the social returns from training. In Section IV, we compare the first-best and the benchmark outcomes with that pertaining in a unionised labour market. We show that unions increase social welfare by increasing training intensity, while reducing welfare by reducing the number of workers trained.[5] Thus unions, while having the standard adverse effect on employment, can in other respects be welfare improving. Finally, in Sections V and VI we confront the predictions of the theory with data from the first six waves of the British Household Panel Survey, conducted over the period 1991 to 1996. We find that the predictions of the model are consistent with the data.

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information about firms' heterogeneous training costs.

[3] Note that while Acemoglu and Pischke (1998) model the way unions can increase general training by compressing the wage distribution, we focus on the way they discount future returns from current investment in human capital.

[4] There could also be a direct effect of higher wages on training as wage costs are affected. But this does not arise if workers are not paid for the time they spend in training. This is made clearer in our model below.

[5] Our model differs fundamentally from that of Booth and Chatterji (1998) who consider how a labour union might affect the number of workers trained in a partial equilibrium situation where training comprises both specific and general elements, and in which the union acts to reduce the hold-up problem that arises if firms have some monopsony power and labour contracts are not legally enforceable.

THE MODEL ASSUMPTIONS

There are two periods. Unskilled workers are hired into the skilled sector at the start of period 1. During this initial period, they receive on-the-job training in work-related skills that are general to all firms in the skilled sector but of no value to firms in the unskilled sector.[6] For simplicity, the unskilled wage is set to zero. We suppose there are two identical firms in the skilled sector.

Each firm in the skilled sector determines in the labour market how many workers it wishes to train, and sets a wage schedule and training per worker. Wages are lower in the training period but higher in the post-training period, as will be explained below. The extent to which wages are lowered in Period 1 depends on how much time workers spend in training, or what we term the 'training intensity'. The degree of 'training intensity' in Period 1 also determines the extent to which post-training productivity and wages are augmented in Period 2.

At the start of Period 2, trained workers may choose either to stay with the firm that provided the training and produce, or quit to work in the other firm in the skilled sector. Workers once trained do not leave the skilled sector. Both firms in the skilled sector are assumed to be identical in terms of production technology, training technology and access to capital markets, unless otherwise stated. The retention probability for each firm is a function of the wage differential between the two firms and individual workers' stochastic preferences. For simplicity, we do not model layoffs in the face of product-market uncertainty. Because some trained workers may quit, each firm in period 2 will produce using some internally trained and some externally trained workers.

Training costs

Training on-the-job is general to the skilled sector, and in period 1 workers bear some of the costs of training in the form of lower wages during training. The firm also bears some of the cost of this general training due to an imperfectly competitive labour market. Their costs consist of workers not producing while undergoing training. What is important to firms is the difference between productivity and wages. There are also some firm-specific costs associated with initial training or induction to production methods. At the start of period 1, each firm trains workers at the cost of $c(N_i)$, where N is the number of workers trained, $i=1,2$, and $c' > 0$ and $c'' > 0$.

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[6] Thus we differ from the recent literature on the property rights theory of the firm, for example de Meza and Lockwood (1998) and Chiu (1998), who model human capital investment occurring before the worker joins the firm, and explore how asset ownership affects ex post bargaining power.

'Training intensity'

During Period 1, workers spend a fraction ϕ of their time taking courses to acquire further general training, where $0<\phi\leq 1$. [7] Thus ϕ denotes training intensity. Time spent training reduces output in that period. Each worker has productivity corresponding to one diminished labour unit in Period 1, and $g(\phi)$ augmented labour units in Period 2, where $g(\phi)$ is a continuous strictly concave differentiable function in which the Inada conditions hold and with the normalisation that $g(\phi)\geq 1$. Each labour unit produces v units of output, where v is productivity.

The retention probability

Following Stevens (1994, 1996:32), we assume stickiness in the movement of workers between firms, so that the retention probability is a function not only of the wage differential between the two firms but also contains a stochastic component. Workers are assumed to have independent and randomly distributed tastes affecting their choice of an employer. The numerical value taken by the retention function and its derivative in equilibrium is a measure of worker loyalty, mobility costs and the randomness of worker preferences. The idea that workers face mobility costs is analogous to the concept of switching costs in the industrial organisation literature (see for example Klemperer, 1995). These switching costs include the physical, transactions, informational, and psychological costs associated with changing employer, which vary across individuals. The presence of such costs give firms a degree of market power over their workforce, as will be demonstrated in the following sections.

The retention probability, illustrated in Figure 1, is denoted by $F(\omega_1-\omega_2) \in [0, 1]$, with $F'(x) \geq 0\ \forall\ x$, $F''(x) \geq 0$ for $x \leq 0$ and $F''(x) \leq 0$ for $x \geq 0$, and $F''' < 0\ \forall\ x$, where $x=\omega_1-\omega_2$ is the difference in wage rates between firms 1 and 2. Hence $xF''(x) \leq 0$, and $F(0)=1/2$. $F(x)$ is a distribution function that corresponds to a density function symmetric around zero, $F(-x)= [1-F(x)]$. As $x \rightarrow -\infty$, $F(x) \rightarrow 0$ and $F'(x) \rightarrow 0$. As $x \rightarrow \infty$ $F(x) \rightarrow 1$ and $F'(x) \rightarrow 0$.

If workers were perfectly loyal, we would have $F(x)=1\ \forall\ x$. We will see below that the source of market failure, and the reason why unions can play a remedial role if training intensity is on the bargaining agenda, lies in $F(0)<1$.

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[7] We do not consider the case where training intensity is zero. Since the two firms are symmetric, it is straightforward to show that, in industry equilibrium, if one firm provides no training neither will the other. Instead, we are interested in modelling the situation where production can only occur in the skilled sector if workers spend

II. THE BENCHMARK CASE

The training sector comprises two identical firms. Each firm takes the other firm's actions as given, and chooses training intensity ϕ , wages ω, and employment N by maximising profits. The expected profits of firm 1 are:

$$P_1 = (1-\phi_1)(v-\omega_1)N_1 + Rg(\phi_1)(v-\omega_1)F(\omega_1-\omega_2)N_1 + Rg(\phi_2)(v-\omega_1)[1-F(\omega_2-\omega_1)]N_2 - c(N_1) \quad (1)$$

where v is the productivity of an augmented labour unit (which is independent of the total number of such units employed), N_1 is the number of workers hired by firm 1, ω_i denotes the wage rate paid by firm i , $i=1,2$, and R is the exogenous discount factor. The first term in equation (1) represents the Period 1 profit from employing N_1 workers, while the second term is the discounted expected profit from employing these skilled workers in Period 2, where the firm discounts by both the discount factor R and the retention probability F. The third term in (1) is the expected discounted profit from employing workers trained in firm 2 but who have quit to find employment in firm 1. Using the symmetry properties of F, *viz.* $F(-x)=[1-F(x)]$, we can rewrite (1) as follows:[8]

$$P_1 = (1-\phi_1)(v-\omega_1)N_1 + Rg(\phi_1)(v-\omega_1)F(\omega_1-\omega_2)N_1 + Rg(\phi_2)(v-\omega_1)F(\omega_1-\omega_2)N_2 - c(N_1) \quad (2)$$

The first order conditions for firm 1 with respect to ϕ, ω and N are as follows:[9]

$$RF(\omega_1-\omega_2)\,g'(\phi_1)=1 \quad (3)$$

$$(1-\phi_1)N_1 = [R\,g(\phi_1)N_1 + R\,g(\phi_2)N_2]\{(v-\omega_1)F'(\omega_1-\omega_2) - F(\omega_1-\omega_2)\} \quad (4)$$

$$[(1-\phi) + RF(x)g(\phi)](v-\omega_1) = c'(N_1) = c'(N_2) \quad (5)$$

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some time in general training.

[8] Firm 1's retention probability for the N_1 skilled workers trained by that firm is *F(.)*, while Firm 2's retention probability of the N_2 workers that it trains is given by *[1-F(.)]*

Notice that, given our assumed constant returns production function, the number of hires and the intensity of training is separable, since the costs and benefits from acquiring on-the-job training do not depend on the number of workers hired.

From the terms in squiggly brackets on the RHS of equation (4), it can be seen that the marginal revenue to firm 1 from raising its wage comprises the extra output of the additional workers retained and recruited as a result, given by $v F'(x)$. The marginal cost comprises not only the higher first period wage, but also the additional cost due to extra retentions given by $\omega_1 F'(x)$, plus the addition to total costs because the higher wage has to be paid to all retained workers, given by *F(x)*.

Inspection of the first order conditions with respect to ω and ϕ reveals that they are separable, since the wage rate cancels out of (3). A higher wage reduces the marginal benefit and the marginal cost of training equally, hence does not affect the firm's training intensity decision. Given symmetry, in industry equilibrium, $\omega_1 = \omega_2$. (The proof of this is given in Appendix A.) It also follows that in equilibrium:

$$RF(0)\, g'(\phi_1) = 1 = RF(0)\, g'(\phi_2) \qquad (6)$$

so that training intensity is the same in each firm.

Proposition 1:

Labour market stickiness characterised by properties of the retention probability function *F(·)* drives a wedge between marginal productivity and the wage rate, and gives some market power to the firm.

Consider firm 1 only, since the equilibrium is symmetric. We obtain from manipulation of the first order conditions (the derivation is given in Appendix B).:

$$\omega_1 = v - \frac{F(x)}{F'(x)}\left[1 + \frac{g'(\phi)(1-\phi)}{2g(\phi)}\right] \qquad (7)$$

[9] The second order conditions for a maximum are satisfied, since the Hessian matrix is negative definite.

Notice that ω_1 is invariant to the number of trainees, given the assumed form of our production function. The term $F(x)/F'(x)$ measures the degree of monopsony power of the firm. In the limit, as $F'(x) \to \infty$, $\omega_1 \to v$ and the firm does not earn any rent on the worker; this is the perfectly competitive labour market. If $F'(x) < \infty$, $\omega_1 < v$, and there is imperfect competition. Reasons for imperfect competition include costs of changing jobs, a small number of firms in the skilled sector and asymmetric information about worker abilities. We have then separated the assumption about the nature of skills from the one about the degree of labour-market competition. In particular, skills are general to the industry but there is imperfect competition in the labour market nevertheless. In doing so, we are following the contributions by Stevens (1994) and Acemoglu and Pischke (1998). This departs from the linkage between the two in Becker (1964).

Equation (7) shows that the difference between the wage and the level of productivity depends on both the form of the retention function *F*, and on the training function *g*. Since $g'(\phi) > 0$, $g''(\phi) < 0$, the second term in the square bracket of (7) is decreasing in ϕ.[10] It follows that the wage per augmented labour-unit will be closer to *v* at high levels of training ϕ.

Now consider the number of workers hired by each firm in the training sector. The number of workers hired is decreasing in ω_1, which - as (7) shows - is a function of the form of the retention function *F* and the human capital acquisition function *g*. More workers are hired if the form of the retention function is such that profits are maximised at a low level of wages. This trade-off is shown in Figure 2.

[Insert Figure 2 near here]

In the following section we show that, compared to first best, the benchmark case developed in this section generates two types of market failure—(i) too few workers are hired into the training sector, and (ii) those workers who are hired receive too little training.

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[10] This is not a causal relationship as it only involves the equalisation of net rates of return to different forms of investment.

III. FIRST-BEST TRAINING INTENSITY AND HIRING

To show the welfare properties of both training decisions - the number of hires and the intensity of training once hired - we examine the outcome were a social planner to maximise the value of net output produced by all trained workers in the economy.

The representative firm's expected profits are given in equations (1) and (2). Because training is general, the productivity of trained workers is the same in both firms in the industry. Suppose that a social planner maximises the value of total output produced by all *N* trained workers - both those retained by any firm, plus those who quit to work in the other firm - less the costs to society of training, given by *S*:[11]

$$\max S = (1-\phi)vN + Rg(\phi)vN - 2c(N/2) \tag{8}$$

where $N = N_1 + N_2$. The first order condition for training intensity is:

$$R\,g'(\phi) = 1 \tag{9}$$

This condition shows that the socially optimal level of training is such that the discounted number of efficiency units of labour created by spending more time training in period 1 is equal to the number of efficiency units sacrificed during training. This leads to our next proposition.

Proposition 2.1:

In a labour market in which each firm sets training intensity unilaterally, each worker receives too little training relative to the first best.

Proof:

Denote first-best training intensity as ϕ^* and training intensity set by the firm as ϕ^c. Where training firms set training intensity unilaterally, the first order condition is given by (3), and thus $RF(x)g'(\phi^c) = R\,g'(\phi^*) = 1$. It follows that $\phi^* > \phi^c$ given the concavity of $g(\phi)$ since $F(x) < 1$.

Since $g'(\phi^*) = 1/R$, we also know - from the properties of the training function - that $\phi^* < 1$. It is optimal for trainees to spend some time producing in period 1.

[11] In principle the latter includes the opportunity cost of labour, but this is assumed zero throughout the paper for

The cause of the market failure is *F(0)* < 1. Some workers leave their original employer even when wages are everywhere the same in the industry. If *F(0)* = 1, the benchmark- and the first-best solutions would be the same. Thus it is the stochastic preferences and a lack of perfect loyalty which are at the root of the problem.

The socially optimal number of workers hired is given by the following equation, in which the marginal benefit to the economy from hiring a worker into the skilled sector is equal to the marginal cost:

$$[(1-\phi)+Rg(\phi)]v = c'(N_1) = c'(N_2) \tag{10}$$

This leads to our next proposition:

Proposition 2.2:

In a labour market in which each firm sets training intensity unilaterally, the number of workers hired is smaller than the social optimum.

Proof:

This proposition is illustrated in Figure 1. A comparison of equations (10) and (5) reveals that, were social returns to the skilled sector maximised rather than firms individually maximising expected profits, the number of workers trained would be higher ($N^* > N^c$). Intuitively, this is because the social planner does not discount by the retention probability, whereas each individual firm does. This result is as per Stevens (1994) and Booth and Zoega (1999), where too few workers are hired into the training sector.

The question remains as to whether or not the social optimum can be attained under different institutional arrangements for setting wages and training intensity. We next consider two situations: first, an industry-wide labour union with the power to set wages and training intensity unilaterally; and second, two firm-specific (monopoly) unions.

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simplicity, as is alternative sector productivity per worker.

IV. UNIONS, WAGES AND TRAINING

IV.1 An Industry-wide Union

Consider an industry-wide (monopoly) union, which determines both wages and the intensity of training. This differs from the two cases outlined in the previous sections, since here the union sets sector-wide wages and training intensity, but each firm retains the 'right-to-manage' and thus determine its number of trainees. At the start of period 1, each firm decides how many workers to hire and train. After these workers have been hired, the industry-wide union forms, and its membership comprises all workers in the skilled sector. The union then makes a take-it-or-leave-it wage and training intensity offer to the two firms. We assume that the union sets the wage such that all union members become employed. For this reason it is concerned about the cost of training the marginal member.

The union maximises the expected utility *U* of its representative member with respect to wages and training intensity,[12] taking into account the marginal training costs, c'.

$$\underset{\omega,\phi}{Max}\; U = (1-\phi)\omega + R\,g(\phi)\omega \tag{11}$$

subject to

$$P_1 = (1-\phi)(v-\omega)N_1 + R\,g(\phi)(v-\omega)F(.)N_1 + R\,g(\phi)(v-\omega)F(.)N_2 - c' = 0$$

and

$$P_2 = (1-\phi)(v-\omega)N_2 + R\,g(\phi)(v-\omega)F(.)N_2 + R\,g(\phi)(v-\omega)F(.)N_1 - c' = 0$$

Since the union's available surplus is declining in firms' profits, it will always choose as a constraint the lowest level of profits commensurate with ensuring the survival of the firm (i.e. with making non-negative profits).[13] For this reason, in (11) each firm's profit from employing the marginal member net of training costs is constrained to be zero. Note that $F(x)$ = ½ since $\omega_1 = \omega_2$ in the case of an industry-wide union. The union takes this retention probability as given, because it only sets one level of wages for the industry. The first-order conditions are:

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[12] The retention rate does not enter equation (15) because the worker can transfer all of his or her productivity between the two firms, which are identical by assumption.

[13] The firm has to make non-negative profits otherwise it will not hire the marginal worker, but the monopoly union sets training intensity and wages so that the firm makes zero profits (since union surplus will be reduced if profits are strictly positive).

$$U_{\phi} = Rg'(\phi)\omega - \omega + \lambda_1\left[\partial P_1 / \partial\phi\right] + \lambda_2\left[\partial P_2 / \partial\phi\right] = 0 \quad (12)$$

$$U_{\omega} = (1-\phi) + Rg(\phi) + \lambda_1(\partial P_1 / \partial\omega) + \lambda_2(\partial P_2 / \partial\omega) = 0 \quad (13)$$

$$U_{\lambda 1} = P_1 = 0; \quad U_{\lambda 2} = P_2 = 0 \quad (14)$$

where $\partial P_1 / \partial\phi = \partial P_2 / \partial\phi = (v-w)(N/2)[Rg'(\phi)-1]$, using the fact that $N_1 = N_2 = N/2$ and $w_1 = w_2$. The variable λ_i (i=1,2), the Lagrangean multiplier in the constrained maximisation problem of (11), denotes the shadow price of the profit constraint, and $F(0)$= ½.[14] With $F(0) < 1$, the interests of the employer and the union diverge and the union has to optimise subject to the effect its actions have on the firm's profits. The importance of this constraint is captured by the shadow price λ. If the effect on profits were not constraining (λ=0), the union's decision would be the socially optimal one and equation (12) would become $Rg'(\phi) = 1$, independent of the value taken by $F(0)$. However, when λ > 0 the level of training intensity lies between the private solution and the social optimum. This leads us to our final proposition.

Proposition 3:

With an industry-wide trade union setting training intensity and wages, training intensity lies between the competitive outcome and the first-best.

The proof is illustrated in Figure 3, where the *i-th* firm's isoprofit curve and the union's indifference curve are plotted in (ω,ϕ) space.[15] The solution to the union's constrained optimisation problem of equation (11) - reaching maximum union-utility subject to the firm achieving zero profits - is illustrated as the point of tangency between the union indifference curve and the firm's isoprofit curve that corresponds to zero profits.

[Insert Figure 3 near here]

The derivation of the slopes of the industry-union indifference curve and the firm's isoprofit curve is given in Appendix C. The slope of the isoprofit curve is:

$$\left.\frac{d\omega}{d\phi}\right|_{\bar{P}} = \frac{(v-\omega_1)N_1\left[1-Rg'(\phi_1)F(x)\right]}{(v-\omega_1)RF'(x)[g(\phi_1)N_1+g(\phi_2)N_2]-\left[(1-\phi_1)+RF(x)[g(\phi_1)N_1+g(\phi_2)N_2]\right]} \quad (15)$$

[14] The second-order condition is also satisfied so that the determinant of the bordered Hessian is positive.
[15] Each firm's isoprofit curve has the same slope.

The slope of the union's indifference curve is:

$$\left.\frac{d\omega}{d\phi}\right|_{\bar{U}} = \frac{\omega\left[1 - Rg'(\phi)\right]}{(1-\phi) + Rg(\phi)} \tag{16}$$

Using equation (3), we can see that the isoprofit curve has a maximum at the level of ϕ such that $RF(x)g'(\phi) = 1$ and $N_1 = N_2$. The union's indifference curve has a minimum at ϕ such that $Rg'(\phi)=1$. The union sets ϕ and ω such that it reaches its highest indifference curve subject to the firm achieving zero profits.

Note that, if $F(0)=1$, the tangency occurs at a level of ϕ such that $Rg'(\phi)=1$ - the socially optimal outcome. In this case the employer's and the union's interests, as far as the level of ϕ is concerned, converge and it is irrelevant who makes the training decision: either party would pick the social optimum (ϕ^s). But when the value of $F(0)$ falls below 1, the maximum of the isoprofit curve moves to the left in the figure.

Figure 3 shows three different points (which coincide when $F(0) =1$). These are E_1, E_2 and E_3. While E_2 shows the firm's preferred training level (ϕ^c), E_3 shows the union's preferred level if it does not have to take the firm's profits into account. The solution to the union's constrained optimisation for ϕ is then shown by point E_1, where the utility of the representative member is maximised subject to the marginal union-member being employed. Our benchmark case is shown as E_4, corresponding to higher profits than the minimum of zero that a monopoly union would allow, but the same level of training as at E_2. The case when the union has full bargaining power is given by E_1.

As Figure 3 shows, the level of training set by an industry-wide union is closer to the socially efficient level than in the benchmark case. Labour unions tend to raise the intensity of training because their discount factor is higher than that of firms: workers own their human capital while firms can only hire it.[16] The flatter is the isoprofit curve, the closer is the constrained optimum (E_1) to the social optimum (E_3). The slope of the isoprofit curve is, from equation (17), a function of the concavity of the training function, $g''(\phi)$. The less concave this

[16] Similar reasoning would lead us to think that firms should pay for the maintenance of machinery, not workers, as they own the machines while workers can only use them while employed and hence have a lower discount rate. An analogy may drive home the same point. Home owners spend more on maintenance and repair of their houses than do lodgers. The reason is that the latter expect their contract to terminate at some future time hence making their

function, the flatter is the isoprofit curve. If g"(ϕ) ≈ 0, the firm's profits are not much affected when the union decides to raise the level of ϕ; an increase in ϕ does not require a large fall in ω for firms to maintain a constant level of profits and the isoproft curve is flat.[17] Here ϕ^u is closer to ϕ^*.

But does employment also rise with the emergence of an industry-wide union? We have assumed that the union maximises the utility of the representative member subject to no union member losing his or her job. This implies that the union prevents any non-union worker from getting a job. It follows, that depending on its initial size, the union either has no effect on employment or reduces it. It reduces employment by forcing firms to allow more on-the-job training than is compatible with profit maximisation and by making them pay higher wages. In both ways, the marginal benefit from hiring new workers in equation (5) is reduced.

IV.2. Firm-level Unions

We now turn to the case of firm-specific unions. Suppose there are two unions in the industry, one corresponding to each firm. At the start of period 1, each firm decides how many workers to hire and train. After these workers have been hired, the two firm-specific unions form, and the membership of each union comprises all workers hired into each firm. Each firm-specific union then makes a take-it-or-leave-it wage and training intensity offer to the two firms. We assume that the union sets the wage such that all union members in the firm become employed. As workers cannot quit in Period 1 by assumption, they will never work for the alternative firm in that period. However, with probability *[1-F(x)]* the trained worker may leave the training firm at the beginning of Period 2 to work for the alternative firm. Because training is entirely general, the productivity of workers is the same in both firms in the industry. The objective function of union 1 in firm 1 can be written as:

$$\max \quad \tilde{U}_1 = (1-\phi_1)\omega_1 + RF(x)g(\phi_1)\omega_1 + R[1-F(x)]g(\phi_1)\omega_2 \qquad (17)$$

subject to

$$\bar{P}_1 = (1-\phi_1)(v-\omega_1)N_1 + R\,g(\phi_1)(v-\omega_1)F(x)N_1 + R\,g(\phi_2)(v-\omega_1)F(x)N_2 - c' = 0$$

ϕ_1 is the level of training and ω_1 the wage rate in firm 1. The first term in equation (17) gives

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maintenance investment worthless while the homeowners have a longer horizon - a higher discount factor.

[17] This can be shown formally, by taking the second derivative of profits wrt ϕ.

the net wage paid to the representative union member for the time spent producing in Period 1. The second term gives the expected discounted wage for working for the training firm in Period 2, and the third term gives the expected discounted wage for working for the alternative firm in Period 2. The first-order conditions give the solution for ω_1, ϕ_1 and λ_1 .

$$\bar{U}_{\phi 1} = Rg'(\phi)\left[F(x)\omega_1\right] - \omega_1 + R[1-F]g'(\phi)\omega_2 + \lambda_1(\partial \bar{P}_1 / \partial\phi_1) = 0 \tag{18}$$

$$\bar{U}_{\omega 1} = (1-\phi_1) + RF'(x)g(\phi_1)\omega_1 + RF(x)g(\phi_1) - RF'(x)g(\phi_1)\omega_2 \quad + \lambda_1(\partial \bar{P}_i / \partial\omega_1) = 0 \tag{19}$$

$$\bar{U}_{\lambda_1} = \bar{P}_1 \quad = 0 \tag{20}$$

where $\partial \bar{P}_1 / \partial\phi_1 = (v-w)[Rg'(\phi)F(x)-1]$, which is not the same as $\partial P_1 / \partial\phi_1$ for the industry-wide union. With two identical firms in symmetric equilibrium, the first order conditions differ from those for the industry union as follows. First, the function *F* appears in the union maximand for the firm-specific union, and secondly the constraint differs. The new equations show that the firm-level union sets slightly higher wages because it calculates that there is an indirect positive effect on profits when higher wages reduce quits in the remaining firm. It may as a result then choose a slightly higher or lower level of training. This depends on whether the direct negative effect of higher wages on profits or the indirect positive effect (in the form of reduced quits) is stronger.

Now suppose there is only one firm-specific union in the industry, so that the wage in the union firm is higher than in the non-unionised firm. From equations (18)-(20) it should be clear that the retention probability goes up in the unionised firm. The union can as a result ask for higher wages or increased training, or both. We conclude that unions can also raise training if they affect relative wages and quit rates. But the downside is obvious: quits must go up in the non-unionised firms, and so also must the quitting externality, which reduces training further.[18]

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[18] A second, but less obvious, effect also arises with only one union. The lower alternative wage reduced the marginal benefit from acquiring training but it does not affect the marginal cost since the latter is always incurred in the training firm in Period 1. This leads the union to decide to have workers spend less of their time in Period 1 training and more time producing.

IV.3 Testable Implications of the Union Model

Part of the motivation for the model developed in this paper was to explain the stylised fact that union presence is associated with more employer-related training. Our model has three important *ceteris paribus* empirically testable predictions: (i) unionised workers spend more time in training; (ii) unionised workers are more likely to receive any training; (iii) unionised workers experience higher wage growth.

In our model we also demonstrate that the union effect on training can be caused either directly by the participation of labour unions in the training decision at the industry or the firm level, or indirectly by unions raising wages and hence reducing quits, and in that way inducing firms to offer more training. While it is difficult to measure quantitatively the direct influence of unions, the indirect one can be tested for, since we expect (iv) unionised workers to have higher wages for the same job tenure, and (v) unionised workers to have lower quit rates. In the following sections we confront the various predictions of the theory with a rich source of individual panel data for Britain.

V. THE DATA

The data used are from the first six waves of the British Household Panel Survey (BHPS), a nationally representative random sample survey of private households in Britain. Wave 1 interviews were conducted during the autumn of 1991, and annually thereafter. Our analysis is based on the sub-sample of men born after 1936, and who provided complete information at each of the six interview dates, were in full-time employment at the time of the survey, and who were not self-employed, in the armed forces or farmers. These restrictions yield a balanced panel of 950 men and 5700 person-year observations. Approximately 60% of the sample is covered by union collective bargaining arrangements..

Our measure of training incidence takes the value unity if individuals received training in the past 12 months to increase or improve skills in the current job, and zero otherwise. Our measure of training intensity is days spent in training to increase or improve skills over the past 12 months in the current job. The responses to the training questions are given in Table 1, for all person-year observations, disaggregated by trade union coverage. The union coverage variable takes the value of unity for workers covered by a union and zero otherwise. This variable was constructed from the responses to the question about whether or not there is a recognised trade union or staff association for negotiation of pay or conditions. (See Appendix D for details of the construction of the variables measuring training incidence, intensity and union coverage.)

The raw data reported in Table 1 show that training incidence for union-covered men is about 10 percentage points higher than for non-union men. On average, union-covered men spend over 2 days more each year in training than do their non-union covered counterparts, and again the union-non-union training days differential is significant. Without exception, these figures show that union-covered men are in receipt of significantly more training than their non-union-covered counterparts.

Hourly wage rates are higher for union than non-union men, and this difference is significant.[19] On average, men who received training have a significant training wage premium of 13.3 percent. But this training wage gap seems to be systematically associated with union coverage, being nearly five times higher for union workers. The 4.2 percent training wage premium for non-union men is insignificant, while the premium for union-covered men is significant reaching almost 21 percent. While the pre-training wages of non-union workers are £1 significantly higher than pre-training wages of union workers, the post-training gap is not significant as a result of the large wage gain consequent upon training for union workers.

In summary, the raw data provide support for the predictions of our theoretical model. Union-covered men are more likely to experience work-related training than non-union men are, and receive larger wage gains consequent upon training. In the next section we use a number of different estimation methods to see if these differences remain significant after controlling for important explanatory variables. These variables—along with the training, union and wage measures—are defined in Table A1, which also reports their sample means.

VI. RESULTS

We now test our model predictions using the BHPS data just described. First, we measure the effect of union coverage on training. Second, we estimate the impact of training on wage levels and wage growth and, third, we consider the relationship between union coverage and individual quitting behaviour. Finally, we investigate the robustness of our findings in two ways: training is allowed to be endogenous with wages, and unmeasured heterogeneity is introduced in all the relationships of interest, exploiting the longitudinal nature of our data.

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[19] The log of the hourly wage rate is given as $\omega=\ln\{PAYGU/[(30/7)(HS+\kappa HOT)]\}$, where PAYGU is the usual gross pay per month in the current job (deflated by the 1996 Retail Price Index), HS is standard weekly hours, HOT is paid overtime hours per week, and κ is the overtime premium. We set κ at 1.5, the standard overtime rate, but all our results below are robust to alternative values of κ ranging between 1 and 2.

VI.1 Do Union-covered Men Get More Training?

The theory outlined in Sections II-IV predicts that union-covered men will receive more training than non-union men (this prediction is derived from implications (i) and (ii) in IV.3). We test this hypothesis in a multivariate framework using probit and tobit regressions, the results of which are reported in Table 2. The first column of Table 2 presents the training incidence probit, while the second column presents the results from the tobit model of days of training. In addition, Table 2 shows the effect on training of the industry quit rate. This is the quit rate at the two-digit SIC level averaged across workers in each survey year. We include this measure because some workers may have lower quit rates due to other reasons than union status. In that case, our model also predicts a positive effect on training incidence and intensity. The estimates of all other variables included in the regressions are listed in Table A2.

Table 2 shows that men who are covered by a union are significantly more likely to receive work-related training in the current job. The impact is quite large: union coverage increases the training probability by more than 9 percentage points. The estimates in Column [2] also reveal that men who are covered by a union receive approximately four more days of training than their non-union covered counterparts. The higher the average quit rate at the two-digit SIC level, the less likely is a man in that industry to be trained, and the fewer training days are experienced. These findings are consistent with our theoretical predictions.[20]

VI.2 Does the Training Effect on Wages Vary with Union Coverage?

To answer this question, we estimate wage-level and wage-growth equations in order to measure the training impact on wages for union and non-union male workers (this exercise is motivated by predictions (iii) and (iv) in IV.3). Our theory predicts that trained men who are union-covered will receive higher wages and higher wage growth than men who are not covered by a union, ceteris paribus. In Table 3 we present estimates of the natural logarithm of real (1996 pounds) hourly wage levels, and in Table 4 we present estimates of the annual wage growth equations. Table 3 shows the pooled OLS estimates of six different specifications in which training (either

[20] The estimates of other individual and employment characteristics are given in Appendix Table A2. Training incidence and days are increasing in educational qualification, although men whose highest educational attainment is a vocational qualification experience higher training incidence and a greater number of training days than men with degrees. Workers with disabilities are less likely to be trained and receive fewer training days. Occupation and firm size have strong effects on training rates and days. Professionals, managers and non-manual and skilled manual workers are more likely to be trained than unskilled or semi-skilled manual workers, as are men employed in larger establishments. Men working in the public sector and particularly in non-profit organisations are more likely to be trained and receive more days of training than men working in the private sector. The labour-market-entry cohort variables are typically insignificant. Training incidence and training days are decreasing in the local unemployment

incidence or intensity or both) are treated as exogenous.[21] Workers who are covered by a union receive on average 6 percent higher wages than their non-union covered counterparts (specifications (i) and (ii)).

In line with our theory, we find that the union premium works primarily through higher training incidence (specifications (iii) and (vi)): union workers who receive training earn almost 10 percent more than workers who receive training but are not union-covered. Although a higher number of training days increases union workers' wages, this effect is small and not well determined: 10 more days of training lead to a 1 percent wage increase, which is significant only at the 10 percent level (specification (iv)). This result may arise because the effect of training intensity on wages is assumed to be linear. However, workers may not need a long period of training particularly if they are already highly skilled. On the other hand, a very short period of training may not be enough to acquire new know-how to apply in the current job. We explore the possibility of non-linear effects of training intensity on wages by introducing a spline function of training days, with cut-off points at one day, one week and one month of training. The OLS estimates, reported in Table A3, support our conjecture: there is an inverse U-shaped relationship between training days and wages. The largest effect of almost 7 percent occurs when workers receive 1 to 4 weeks of training in the last 12 months of the current job (specification (i), Table A3). Again, we find that the 6 percent union premium is largely due to training. Union workers who are trained between 1 and 4 weeks in a given year would receive up to 12 percent higher hourly wages than their non-union covered counterparts, while union workers with no training would earn only 3 percentage points more than untrained non-union workers (specification (ii), Table A3).

Table 4 shows that workers who were always covered by a union experience a higher wage growth than workers who were never union-covered, by approximately 3 percent a year. While an exit from a union-covered job is not associated with any significant wage change (the lower growth found with specification (i) is not precisely estimated), starting a job that is covered by a union leads to a significantly higher wage growth of about 5.5 percent a year, according to both training incidence and intensity measures. From specification (ii), where we interact training with union coverage changes over the six-year period, the significant effects of training and union coverage changes on wage growth are similar to those found with

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rate, suggesting that training volumes are counter-cyclical.

[21] The estimates for the other explanatory variables listed in the notes of Tables 3 and 4 are omitted because of space limitations, and are available from the authors.

specification (i). Entry into a union-covered job combined with training increases wage growth by almost 11 percent a year. Having had some training experience significantly reduces wage growth by 12 percent a year if the worker moves from a union-covered job to a non-union-covered job.

VI.3 Do Union-covered Men Have Lower Quit Rates?

In subsection IV.3 we argue that an indirect effect of unions on welfare can be gauged by the relationship between individual union coverage and quitting behaviour. From our theory, we expect union-covered workers to have lower quit rates than non-union workers (prediction (v)).

Table 5 shows the estimates of the effect of union coverage on the quitting probability, obtained from the pooled sample of workers over the entire period 1991-96. We present the results from four different specifications, which differ in the set of explanatory variables included in the estimation.[22] The dependent variable takes the value of one for men who work for a different employer *and* left for a better job in the last 12 months (or since September of the preceding year), and zero otherwise. Table 5 clearly demonstrates that union coverage significantly reduces workers' chances of quitting by about 3 percent, regardless of the controls included in the regression. Almost identical results are found when we use training days rather than training incidence and when we interact union coverage with either measure of training.

VI.4 Robustness checks

We investigate the robustness of our results in two ways. First, we allow for the possibility of self-selection into training and the simultaneity of training and wages. Second, we explore the role played by individual unobserved heterogeneity in the probability of training, the probability of quitting and wage dynamics.

Workers who are more motivated may choose career patterns that are more training intensive, and similarly employers may place in training programs only those workers who are more trainable. In both cases, the estimated parameters of the various training measures in Table 3 would be biased because of self-selection. A variety of ways to address this issue are described in Maddala (1983), Amemiya (1985) and Heckman and Rob (1986). One method that we use in this paper is a standard Heckman two-stage procedure to correct for the endogeneity of training incidence, using the probit estimates presented in Tables 2 (first column) and A2, and with the

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[22] The coefficients are marginal effects, calculated as the derivatives of the conditional expectation of the observed dependent variable evaluated at the sample mean.

appropriate inverse Mills ratios as regressors in the wage equation. Panel A of Table 6 presents the wage estimates of this selectivity model with no simultaneity, in which training intensity is excluded (similar results were obtained with the inclusion of training days as an exogenous explanatory variable and are not reported for the sake of brevity). None of the results reported in Table 3 is altered by the inclusion of the training selection term. However, in specification (i) the union premium is now higher, at 7.3 percent. As in our earlier results, the estimates in specification (ii) of Table 6 show that the union wage premium is higher for trained than for untrained union workers. Note that the selection term is statistically significant, supporting the view that training is endogenous with respect to the wage (the χ^2 statistic for excluding our instruments from the training probit equation is 13.79, *p*-value=0.0080).[23]

Another method of dealing with selection is to use instrumental variables (IV) and include the expectation of days of training in the wage equation. This is an application of the switching regression model proposed by Lee, Maddala and Trost (1980), and discussed in the training literature by Lynch (1992, p 309).[24] To do this, we first estimate a tobit model of training intensity, where the dependent variable is the number of days of training. Using these estimates, we then create an expected value for days of training and a Mills ratio term, which are then used as extra regressors in the IV wage regression.[25] Panel B of Table 6 reports the results. They confirm the conclusions reached above.[26]

The second robustness check of our results has to do with investigating the importance of unobserved heterogeneity in the estimation of training, quitting, and wage levels. The first and second columns of Table 7 report random effects estimates of the training models of Table 2, while the third and fourth columns report random effects estimates of the quitting and wage models of Tables 5 and 3 respectively. All the results discussed above are robust to the assumption of random effects as a means of controlling for unobserved individual heterogeneity.

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[23] The selection term is also positive, suggesting that workers who received training earn higher wages than they would have earned otherwise.

[24] This method is also known as tobit two-stage method (Maddala, 1983, pp. 240-242), or type-4 tobit model (Amemiya 1985, pp. 395-399).

[25] As in the standard Heckman two-stage method described above, the identifying variables in the training equations are age, age squared, disabled and changed job. The $F_{(4,5664)}$ value is 7.32.

[26] An alternative strategy for dealing with self-selection is to assume that self-selection varies only across individuals and *not* over time (Lynch, 1992). By differencing individuals' wages between the current period and the preceding period, all time-invariant effects (including self-selection into training) will drop out and the training and union coefficients may be then estimated without bias. This leads to a wage growth equation, whose estimates have already been presented in Table 4. Notice, however, that the regressions in Table 4 also contain individual time-invariant controls, such as occupation of origin and cohort of entry in the labour market. The results from wage growth regressions that only include changes (not reported for the sake of brevity and available from the authors upon request) suggest that our previous conclusions are not altered.

We find that workers covered by a union are 6 percent more likely to receive training (first column),[27] and 3 percent less likely to quit their current job (third column) than non-union workers. Similarly, union workers receive about 4.2 more days of training per year than non-union workers (second column), while trained union workers earn on average 8 percent higher wages than trained non-union workers, whose wages are not significantly affected by training (fourth column).

VII. CONCLUSIONS

We have found that, in a model in which training is endogenous, a monopoly union has the standard adverse effects on employment. By raising wages, and making firms raise the intensity of training, the number of workers trained is reduced. But a new and surprising result arises: unions can help reduce and sometimes overcome a market failure in the provision of on-the-job training.

When training is general to an industry, firms choose a suboptimal level of such training, since they realise that workers would take with them any human capital when leaving for other firms in the industry. But the human capital is not lost to society, so a market failure arises: private discount rates are higher than social ones. Unions can remedy the market failure in two ways. First, if the union has a direct say in the training decision and maximises the utility of a representative worker, it will choose a level of training closer to the social optimum as its discount rate is equal to the social discount rate. How close union-set training is to the social optimum depends on the sensitivity of profits—that constrain the union's activity—to changes in the level of on-the-job training. When the union can choose the level of training freely without having to worry about the effect on profits, hence the employability of its members, the union will pick the socially-optimal level of training. Second, firm-specific unions can reduce the quitting externality in their firms by raising relative wages, hence reducing quits and the employer's discount rates.

Using the British Household Panel Survey (BHPS), we found that the basic predictions of the model were confirmed: (i) unionised workers are more likely to receive training, (ii) they are trained more days than their non-unionised counterparts, (iii) they experience a higher wage growth and a greater return to training, (iv) receive higher wages for a given tenure and (v) have lower quit rates. While this is good news for our model, we must caution that other models may

[27] This result is consistent with that found in Arulampalam and Booth (1998). They use a random-effects probit model for a sample of full-time and part-time male and female workers from waves 1-5 of the BHPS.

also yield similar implications. Further work will involve looking at the institutional structure of training decisions in firms to determine the precise role of unions.

APPENDIX A
Proof of Existence and Uniqueness of Symmetric Equilibrium for the Industry

Profits for firm 1 can written as:

$$P_1 = (1-\phi_1)(v-\omega_1)N_1 + Rg(\phi_1)(v-\omega_1)F(x)N_1 + Rg(\phi_2)(v-\omega_1)F(x)N_2 \quad \text{(A1)}$$

Maximisation of (A1) wrt training intensity ϕ and wages ω respectively gives:

$$Rg'(\phi_1)F(x) = 1 \quad \text{(A2)}$$

$$[Rg(\phi_1)N_1 + Rg(\phi_2)N_2]\{(v-\omega_1)F'(x) - F(x)\} = (1-\phi_1)N_1 \quad \text{(A3)}$$

The analogous expected profit equation for firm 2 is:

$$P_2 = (1-\phi_2)(v-\omega_2)N_2 + Rg(\phi_2)(v-\omega_2)[1-F(x)]N_2 + Rg(\phi_1)(v-\omega_2)[1-F(x)]N_1 \quad \text{(A1b)}$$

The first order conditions (FOC) of firm 2 are:

$$Rg'(\phi_2)(1-F(x)) = 1 \quad \text{(A2b)}$$

$$[Rg(\phi_1)N_1 + Rg(\phi_2)N_2]\{(v-\omega_2)F'(x) - [1-F(x)]\} = (1-\phi_2)N_2 \quad \text{(A3b)}$$

Now subtract (A3) from (A3b) to obtain:

$$\frac{(1-\phi_2)N_2 - (1-\phi_1)N_1}{Rg(\phi_2)N_2 + Rg(\phi_1)N_1} = \{xF'(x) - 1 + 2F(x)\} \quad \text{(A4)}$$

Now rearrange (A4) and define the following function, assumed to be continuous from continuity of the underlying functions :

$$\Psi(x) = \{xF'(x) + 2F(x) - 1\} - \left[\frac{(1-\phi_2)N_2 - (1-\phi_1)N_1}{Rg(\phi_2)N_2 + Rg(\phi_1)N_1}\right] = 0 \quad \text{(A5)}$$

We now show existence of an industry equilibrium by showing that equation (A5) only holds for $x = 0$, that is $\omega_1 = \omega_2$.

<u>Case 1: $x \to \infty$</u>

From the properties of the retention function, $F(x)$, we know that as $x \equiv (\omega_1 - \omega_2) \to \infty$, $F(x) \to 1$ and $F'(x) \to 0$. Equation (A5) now becomes

$$1 - \frac{(1-\phi_1)N_1}{Rg(\phi_1)N_1} > 0 \quad \text{(A5a)}$$

since $N_2 = 0$ when $x \rightarrow \infty$. Hence $\Psi(x) > 0$ as $x \rightarrow \infty$.

Case 2: $\omega_1 = \omega_2$

Here $F(x) = ½$ and the first term in (A5) disappears. The equation can only hold if the second term is equal to zero also. Since $x = 0$ we can equate (A2) and (A2b) to obtain $\phi_1 = \phi_2$. Thus (A5) only holds if $N_1 = N_2$. This implies $\Psi(x) = 0$ if $x = 0$.

Case 3: $x \rightarrow -\infty$

As $x \rightarrow -\infty$, $F(x) \rightarrow 0$ and $F'(x) \rightarrow 0$. Equation (A5) now reads as

$$-1 - \frac{(1-\phi_2)N_2}{Rg(\phi_2)N_2} < 0 \qquad \text{(A5b)}$$

To guarantee uniqueness of the symmetric equilibrium $\omega_1 = \omega_2$, note that

$$\Psi'(x) = 3F'(x) + xF''(x) \qquad \text{(A6)}$$

A sufficient condition for uniqueness of solution $\omega_1=\omega_2$ is $3F'(x) > -xF''(x)$ since $xF'(x) < 0$ $\forall\, x$.

APPENDIX B

Rewrite equation (4) using the industry equilibrium results to obtain:

$$2R\,g(\phi)\{(v-\ )F'(x) - F(x)\} = (1-\phi) \qquad \text{(B1)}$$

From equation (3), substitute $Rg'(\phi)=1/F(.)$ into (B1) to obtain (7) in the text.

APPENDIX C

Derivation of Isoprofit and Union Indifference Curves

The industry-wide union's indifference curve is found by totally differentiating equation (11) in the text with respect to ω and ϕ, yielding:

$$[(1-\phi)+R\,g(\phi)]d\,\omega \;\; +[R\,g'(\phi)\omega-\omega]d\phi=0 \qquad \text{(C1)}$$

Rearrangement yields equation (16) in the text, rewritten here as (C2):

$$\left.\frac{d\omega}{d\phi}\right|_{\bar{U}}=\frac{\omega[1-Rg'(\phi)]}{(1-\phi)+Rg(\phi)} \qquad (C2)$$

Since the denominator is everywhere positive, the slope of $d\omega/d\phi$ is given by the sign of the numerator. For $0<\phi<\phi^*$, $d\omega/d\phi<0$, while for $\phi=\phi^*$, $d\omega/d\phi=0$ since $1=Rg'(\phi)$ at $\phi=\phi^*$ (see equation (9) in the text). Recall that the firm, unconstrained, will choose $\phi^c<\phi^*$. Finally, note that $d\omega/d\phi>0$ for $1>Rg(\phi)$.

Firm 1's isoprofit curve is found by totally differentiating equation (1) in the text with respect to ω_1 and ϕ_1, yielding:

$$\{Q[(v-\omega_1)F']-[(1-\phi)+F(.)Q]\}d\omega_{11}=\{(v-\omega)[1-Rg'F]N_1\}d\phi_1 \qquad \text{(C3)}$$

where $Q=[R\,g(\phi_1)N_1+R\,g(\phi_2)N_2]$. Rearrangement of (C3) yields equation (15) in the text, rewritten here for convenience:

$$\left.\frac{d\omega}{d\phi}\right|_{\bar{P}}=\frac{(v-\omega_1)N_1[1-Rg'(\phi_1)F(x)]}{(v-\omega_1)RF'(x)[g(\phi_1)N_1+g(\phi_2)N_2]-[(1-\phi_1)+RF(x)[g(\phi_1)N_1+g(\phi_2)N_2]]} \qquad (C4)$$

The turning point of the isoprofit curve is where $[1=Rg'(\phi_1)F(x)]$, which occurs at some $\phi^c<\phi^*$.

APPENDIX D: DATA

Training Incidence

The precise form of the BHPS training incidence question, asked of all individuals currently in work, is as follows: "Since September 1st last year, have you taken part in any education or training schemes or courses, as part of your present employment?" If yes, the respondent was then asked: "Was any of this training (a) training to help you get started in your current job? (b) to increase your skills in your current job for example by learning new technology? (c) to improve your skills in the current job? (d) to prepare you for a job or jobs you might do in the future? (e) to develop your skills generally?" In addition to the results reported in this paper, we also performed the entire analysis with a measure (incidence and intensity) defined over the five types of training (a)-(e) listed above. We do not present the results obtained from this alternative measure because they were virtually identical to those reported here.

Total Time Spent in Training

The questions on training incidence were followed by a question on total time spent in all forms of training, as follows: "Since September last year, how long have you spent on this training? Please tell me approximately how much time you have spent on training in total." The units of time requested varied across earlier waves of the BHPS. At Wave 1, individuals were asked to report how many days were spent in training; at Wave 2, how many hours per week and the number of weeks; at Waves 3, 4, 5 and 6 respondents were free to choose the unit of time spent in training. For all waves, we converted responses to this question into days spent in training of type (b) and/or (c) over the past 12 months in the current job.[1] This was hours, days, week or other at Waves 3 and 4, and hours, days, weeks months, or other at Waves 5 and 6. The cases for which a measure of training intensity could not be consistently computed were dropped.

Union status

The precise form of the question about union status is as follows: “Is there a trade union, or a similar body such as a staff association, recognised by your management for negotiating pay or conditions for the people doing your sort of job in your workplace?” While Waves 1, 5 and 6 of the BHPS asked both job-movers and job-stayers for information on union status, the Waves 2-4 questionnaires only requested this if individuals changed employer. In our empirical analysis, we assume that Wave 1 union coverage remains constant across Waves 2, 3 and 4 for people who did not change employer, which is reasonable given that there is evidence that coverage did not alter for people in work over the period.

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Table 1: Training in the Current Job and Wages, by Union Coverage, 1991-96				
	All Men	**Union Men**	**Non-union Men**	**Significant Gap**
Training:				
Incidence (%)	38.56	42.46	32.72	yes [0.0000]
Intensity (Days)	4.41	5.25	3.16	yes [0.0000]
Pay:				
Hourly Pay (£)	8.83	8.96	8.63	yes [0.0253]
Hourly Pay for Trained Workers:				
Pre-training wages (£)	7.94	7.50	8.57	yes [0.0088]
Post-training wages (£)	9.00	9.05	8.93	no [0.7279]
Training pay gap (%)[a]	13.3 [0.0001]	20.7 [0.0000]	4.2 [0.4307]	

Note: hourly wages are calculated as per footnote 15.
[a] *p*-values in square brackets.

TABLE 2: Unions and Training, 1991-96 Pooled				
	Column [1] Training incidence (Probit estimates, marginal effects)		**Column [2] Training days (Tobit estimates)**	
	coeff.	**|t-stat|**	**coeff.**	**|t-stat|**
Union coverage	0.092***	5.75	4.348***	5.03
Industry quit rate	-0.946***	3.38	-53.031***	3.53

Note: Estimates of other variables are in Table A2.
*** significant at 0.01 level

TABLE 3: Ln Hourly Wage Levels 1991-96 (Pooled OLS estimates)

Variable	Specification: (i)	(ii)	(iii)	(iv)	(v)	(vi)
Training incidence	0.033***		-0.006		0.040***	0.001
	(3.016)		(0.347)		(3.289)	(0.071)
Training intensity (days)		0.0001		-0.0009	-0.0006	-0.0008
		(0.282)		(1.354)	(1.272)	(1.255)
Union coverage	0.057***	0.060***	0.034**	0.055***	0.057***	0.034**
	(4.676)	(4.920)	(2.352)	(4.402)	(4.686)	(2.318)
Incidence × union			0.064***			0.063***
			(2.896)			(2.619)
Intensity × union				0.001*		0.0003
				(1.676)		(0.298)
Industry quit rate	-1.701***	-1.733***	-1.675***	-1.721***	-1.706***	-1.679***
	(7.474)	(7.613)	(7.341)	(7.560)	(7.499)	(7.359)
Adj. R-squared	0.468	0.467	0.469	0.467	0.468	0.469

Note: Other controls included in all regressions are: highest educational qualifications (4 dummies), experience, experience squared, tenure, tenure squared, married/cohabiting, living in London, firm size dummies (6), sector (public and charity dummies), occupational dummies (4), occupation of origin (4), cohort of entry in the labour market (2), local unemployment rate. Number of person-year observations is 5700.

* significant at 0.10 level, ** significant at 0.05 level, *** significant at 0.01 level.

Absolute *t*-statistic in parentheses (Huber-White standard errors).

TABLE 4: Annual Growth of Hourly Wages, 1991-96		
	Specification:	
Variable	**(i)**	**(ii)**
Training incidence:		
Training	0.020**	0.033**
	(2.396)	(2.245)
Union coverage changes:		
exit	-0.032	0.013
	(1.397)	(0.476)
entry	0.055**	0.015
	(2.186)	(0.510)
always in	0.028***	0.035***
	(2.940)	(3.294)
Training and:		
exit from union coverage		-0.120**
		(2.467)
entry into union coverage		0.107**
		(2.051)
always union covered		-0.020
		(1.151)
Adjusted R-squared	0.1695	0.1722
Training intensity:		
Training (days)	0.0009***	0.001**
	(2.705)	(2.325)
Union coverage changes:		
exit	-0.032	-0.031
	(1.408)	(1.291)
entry	0.055**	0.040
	(2.193)	(1.542)
always in	0.028***	0.030***
	(3.004)	(3.164)
Training and:		
exit from union coverage		-0.0002
		(0.139)
entry into union coverage		0.004
		(1.110)
always union covered		-0.0005
		(0.728)
Adjusted R-squared	0.1701	0.1707

Note: All regressions are performed on 4750 transitions. Other controls included in the regressions but not reported in the table are: highest educational qualification, experience, experience squared, tenure, tenure squared, cohort of entry in the labour market, occupation of origin, and yearly changes in marital status, residential location, firm size, current occupation, sector, 2-digit industry quit rate, and local unemployment rate.

** significant at 0.05 level, *** significant at 0.01 level.

Absolute *t*-statistic in parentheses (Huber-White standard errors).

Table 5: Unions and Quitting Behaviour, 1991-96 Pooled

	Specification:			
	(i)	**(ii)**	**(iii)**	**(iv)**
Union coverage	-0.031*** (4.15)	-0.028*** (3.30)	-0.032*** (3.60)	-0.031*** (3.58)
Demographic and local market	yes	yes	yes	yes
Firm size and sector	no	yes	yes	yes
Occupation	no	no	yes	yes
Occupation of origin and cohort	no	no	no	yes

Note: Dependent variable is one for men who work for a different employer *and* left for a better job in the last 12 months (or since September of the preceding year), and zero otherwise. Table reports probit estimates (marginal effects). Demographic and local market variables are: highest educational qualification, age, age squared, experience, experience squared, disabled, married/cohabiting, living in London, and local unemployment rate. Cohort is cohort of entry in the labour market. All regressions are performed on 4750 person-year observations.

*** significant at 0.01 level.

Absolute *t*-ratio in parentheses.

Table 6: Robustness Checks of Wage Estimates: The Role of Training Selection

Variable and Model	Specification: (i)	Specification: (ii)
A. Model with selectivity and with no simultaneity		
Training incidence	0.034***	-0.005
	(3.053)	(0.290)
Union coverage	0.073***	0.048*
	(3.232)	(1.949)
Incidence × union		0.063***
		(2.839)
Quit rate	-1.853***	-1.802***
	(6.115)	(5.925)
Training selection	0.090**	0.075**
	(2.432)	(2.311)
Adj. R-squared	0.469	0.470
B. Switching regression model of training intensity		
Training intensity (days)	0.005	0.001
	(1.383)	(1.100)
Union coverage	0.112***	0.109***
	(9.426)	(9.289)
Intensity × union		0.046***
		(3.289)
Quit rate	-1.842***	-1.833***
	(7.853)	(7.844)
Training selection	0.019**	0.016**
	(2.427)	(2.480)
Adj. R-squared	0.474	0.476

Note: Other controls included in all wage regressions are: highest qualification (4 dummies), experience, experience squared, tenure, tenure squared, partner present, London, firm size dummies (6), public sector and charity, occupational (4), occupation of origin (4), cohort of entry in the labour market (2), and local unemployment rate. Identification of the training selection term is achieved by: a) inclusion of age, age squared, disabled, and changed job in the probit (panel A) or tobit (panel B) equations only; and b) inclusion of tenure and tenure squared only in the wage equations. Number of person-year observations is 5700.

* significant at 0.10 level, ** significant at 0.05 level, *** significant at 0.01 level.

Absolute *t*-statistic in parentheses (Huber-White standard errors).

Table 7: Robustness Checks: The Role of Unobserved Heterogeneity				
Variable	Column [1] **Training Incidence** (cfr. Tables 2, A2)	Column [2] **Training Intensity** (cfr. Tables 2)	Column [3] **Quitting Behaviour** (cfr. Table 5)	Column [4] **Wage Levels** (cfr. Table 3 (iii))
Union	0.063*** (3.447)	4.207*** (4.878)	-0.030*** (3.451)	0.037*** (2.878)
Industry quit rate	-0.583* (1.884)	-51.875*** (3.465)		-1.133*** (5.127)
Training				-0.018 (1.224)
Training × union				0.042*** (2.577)
ρ	0.373	0.018	0.160	0.624

Note: Columns [1] and [3] report random-effects probit estimates (marginal effects) of the probability of training (incidence) and the probability of quitting, respectively. Column [2] reports random-effects tobit estimates of the number of days of training. Column [4] reports random-effects estimates of log hourly wage level equations. See Tables A2, 5 and 3 (specification (iii)) for list of other regressors used in each regression. The term ρ is the fraction of variance due to the unobserved heterogeneity component.

* significant at 0.10 level, ** significant at 0.05 level, *** significant at 0.01 level

Absolute *t*-statistic in parentheses.

TABLE A1: Definition of variables		
Variable	**Definition**	**Mean**
Union and training:		
Union coverage	Recognised trade union or similar organisation for negotiating pay and other similar conditions in the workplace	0.599
Training incidence	Any training meant to increase or improve skills in the current job over the previous 12 months	0.386
Training intensity (days)	Number of days spent in skill-enhancing training in the past 12 months in the current job	4.412
Individual and labour market characteristics:		
Age	Age (years)	38.093
Partner present	Married or cohabiting at interview date	0.787
Experience	Experience (years) in employment since labour market entry	19.971
Tenure	Tenure (years) in current job	6.657
Disabled	Registered as disabled either with social services or a green card	0.009
Changed job	Changed employer in the previous 12 months (either though a quit or after a layoff)	0.126
London	Resident in Greater London	0.093
No qualification (base)	No educational qualification	0.209
O-level	Highest qualification is one or more ‘Ordinary’-level qualifications (later replaced by GCSE), usually taken at the end of compulsory schooling at age 16	0.323
A-level	Highest qualification is one or more ‘Advanced’-level qualifications, representing university entrance-level qualification typically taken at age 18	0.234
Vocational	HND, HNC, Teaching, other higher qualification, Nursing	0.086
Degree qualification	University degree or above	0.149
Professional[a]	Professional occupations	0.116
Managerial	Managerial occupation	0.195
Non-manual	Skilled non-manual occupation	0.199
Skilled manual	Skilled manual occupation	0.291
Other manual (base)	Semi-skilled and unskilled manual occupations	0.199
Date of labour market entry:		
Cohort 1 (base)	Entered the labour market before 1961	0.098
Cohort 2	Entered the labour market 1961-1970	0.268
Cohort 3	Entered the labour market 1971-1980	0.385
Cohort 4	Entered the labour market 1981-1990	0.248
Firm size:		
Size25 (base)	Fewer than 25 employees at the establishment	0.236
Size50	25-49 employees at the establishment	0.123
Size100	50-99 employees at the establishment	0.141
Size200	100-199 employees at the establishment	0.125
Size500	200-499 employees at the establishment	0.164
Size1000	500-999 employees at the establishment	0.100
Size 1000+	1000+ employees at the establishment	0.111
Public sector	Works in public sector	0.274
Charity	Works in non-profit making organisation (charities, co-operatives etc.)	0.019
Other variables:		
Unemployment rate	Local unemployment rate. The geographic unit is 306 matched job centres. Obtained from the National On-line Manpower Information Service.	0.083
Industry quit rate	Average quit rate for the two-digit Standard Industrial Classification (SIC)	0.074

[a] Occupational categories are constructed from the three-digit Standard Occupation Classification (SOC). Occupation-of-origin categories are the same as for current occupation. Occupations of origin are identified by the first full-time job after leaving full-time education using the retrospective work history information collected in the third wave (1993) of the BHPS.

TABLE A2: The Determinants of Training, 1991-96 Pooled

	Training incidence (Probit estimates, marginal effects)		Training days (Tobit estimates)	
Variable	**coeff.**	**|t-stat|**	**coeff.**	**|t-stat|**
Individual and labour market characteristics:				
Partner present	0.035**	1.99	3.206***	3.53
Age	0.014	1.46	-0.278	0.58
Age squared	-0.0003**	2.03	-0.005	0.73
Experience	-0.008**	2.12	-0.488***	2.61
Experience squared	0.0003**	2.46	0.016***	3.09
Disabled	-0.166**	2.06	-9.830**	2.16
Changed job	-0.017	0.83	0.399	0.39
London	0.027	1.11	-0.182	0.15
O-level	0.069***	3.02	2.695**	2.31
A-level	0.124***	4.86	5.164***	4.02
Vocational qualification	0.201***	6.14	10.713***	6.82
Degree	0.177***	5.28	6.015***	3.68
Occupation:				
Professional	0.203***	6.34	8.867***	5.67
Managerial	0.224***	8.70	9.479***	7.41
Non-manual	0.169***	6.58	7.579***	5.95
Skilled manual	0.117***	5.31	6.932***	6.22
Occupation of origin*:*				
Professional	0.079**	2.44	0.889	0.56
Managerial	0.147***	4.08	4.368**	2.53
Non-manual	0.158***	6.84	4.563***	4.00
Skilled manual	0.131***	6.53	4.326***	4.27
Date of labour market entry:				
Cohort 2	-0.038	1.04	-2.142	1.16
Cohort 3	-0.061	1.20	-4.697*	1.79
Cohort 4	-0.022	0.36	-3.613	1.18
Firm size:				
Size50	0.085***	3.44	2.294*	1.89
Size100	0.064***	2.76	4.418***	3.82
Size200	0.071***	2.96	3.400***	2.84
Size500	0.041***	1.80	3.995***	3.54
Size1000	0.083***	3.14	6.024***	4.66
Size1000+	0.130***	5.09	8.105***	6.59
Public sector	0.028	1.60	3.885***	4.50
Charity	0.131***	2.65	8.287***	3.46
Other variables				
Unemployment rate	-0.740***	2.67	-23.863*	1.72
Pseudo-R-squared	0.082		0.023	
Number of cases	5700		5700	

Note: See Table 2 for estimates of union coverage and industry quit rate.
* significant at 0.10 level, ** significant at 0.05 level, *** significant at 0.01 level.

Table A3: Nonlinear Effects of Training Intensity on Wage Levels

Variable	Specification: (i)	Specification: (ii)
Training intensity:[a]		
> 1 day and ≤ 1 week (ϕ_1)	0.030**	-0.003
	(2.155)	(0.134)
> 1 week and ≤ 1 month (ϕ_2)	0.067***	0.011
	(4.288)	(0.412)
> 1 month (ϕ_3)	0.002	-0.046
	(0.091)	(0.878)
Union coverage	0.056***	0.033**
	(4.588)	(2.315)
$\phi_1 \times$ union coverage		0.055*
		(1.872)
$\phi_2 \times$ union coverage		0.088***
		(2.783)
$\phi_3 \times$ union coverage		0.069
		(1.169)
Industry quit rate	-1.670***	-1.643***
	(7.336)	(7.198)
Ajdusted R-squared	0.4690	0.4700

Note: Other controls included in all regressions are: highest educational qualifications (4 dummies), experience, experience squared, tenure, tenure squared, married/cohabiting, living in London, firm size dummies (6), sector (public and charity dummies), occupational dummies (4), occupation of origin (4), cohort of entry in the labour market (2), local unemployment rate. Number of person-year observations is 5700. See also Table 3.

* significant at 0.10 level, ** significant at 0.05 level, *** significant at 0.01 level.

Absolute *t*-statistic in parentheses (Huber-White standard errors).

[a] Base category is ϕ_0 (trained 1 day or less).

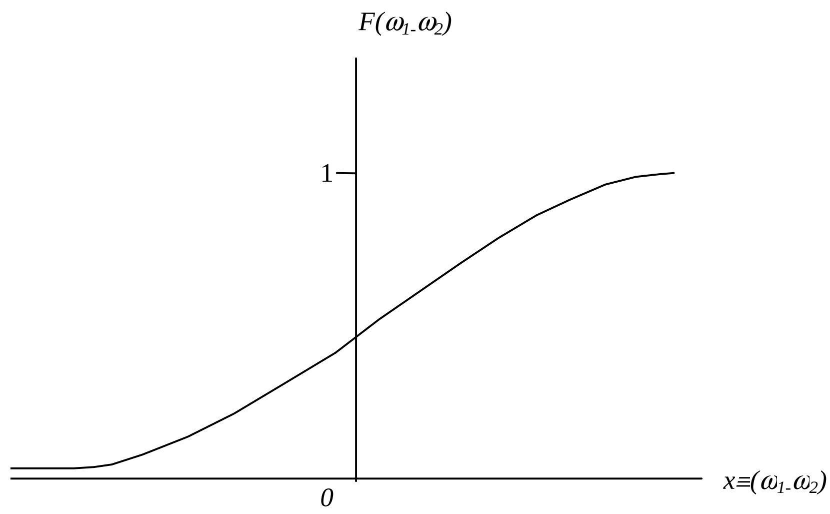

Figure 1: The Retention Function

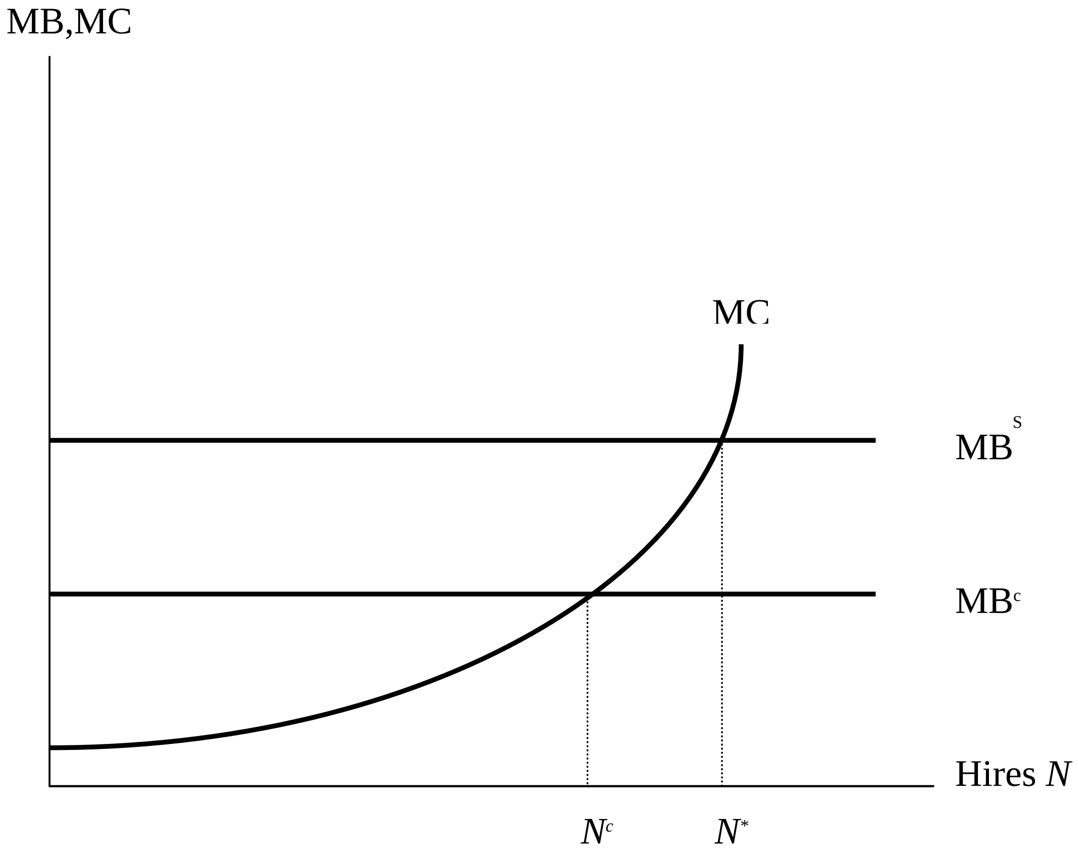

Figure 2: Hires in Period 1 in Skilled Sector

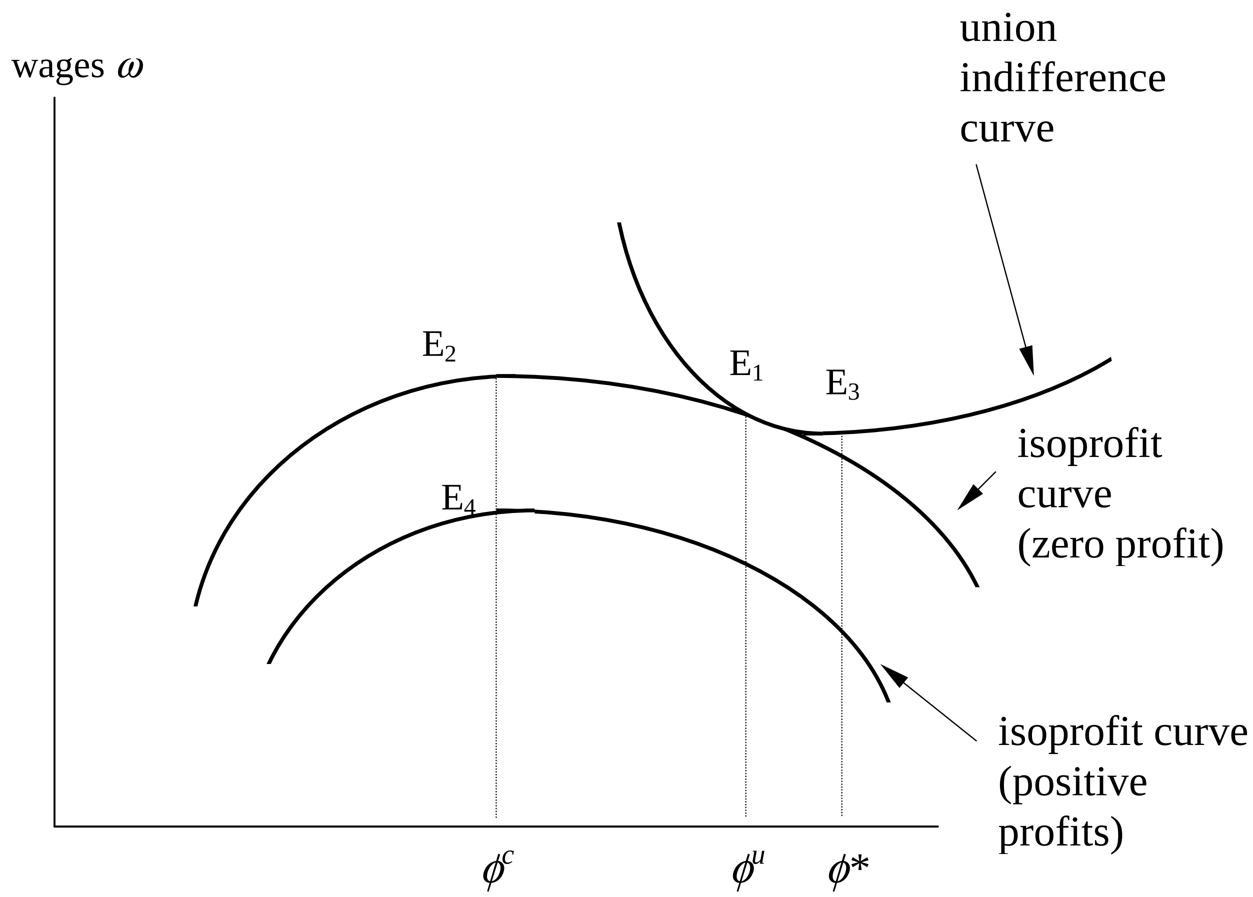

Figure 3: Wages and Training Intensity with Industry-wide Union

Table 1: Training in the Current Job and Wages, by Union Coverage, 1991-96

	All Men	Union Men	Non-union Men	Significant Gap
Training:				
Incidence (%)	38.56	42.46	32.72	yes [0.0000]
Intensity (Days)	4.41	5.25	3.16	yes [0.0000]
Pay:				
Hourly Pay (£)	8.83	8.96	8.63	yes [0.0253]
Hourly Pay for Trained Workers:				
Pre-training wages (£)	7.94	7.50	8.57	yes [0.0088]
Post-training wages (£)	9.00	9.05	8.93	no [0.7279]
Training pay gap (%)[a]	13.3 [0.0001]	20.7 [0.0000]	4.2 [0.4307]	

Note: hourly wages are calculated as per footnote 15.
[a] *p*-values in square brackets.

TABLE 2: Unions and Training, 1991-96 Pooled

	Column [1] Training incidence (Probit estimates, marginal effects)		Column [2] Training days (Tobit estimates)	
	coeff.	|t-stat|	coeff.	|t-stat|
Union coverage	0.092***	5.75	4.348***	5.03
Industry quit rate	-0.946***	3.38	-53.031***	3.53

Note: Estimates of other variables are in Table A2.
*** significant at 0.01 level

TABLE 3: Ln Hourly Wage Levels 1991-96 (Pooled OLS estimates)

Variable	Specification: (i)	(ii)	(iii)	(iv)	(v)	(vi)
Training incidence	0.033***		-0.006		0.040***	0.001
	(3.016)		(0.347)		(3.289)	(0.071)
Training intensity (days)		0.0001		-0.0009	-0.0006	-0.0008
		(0.282)		(1.354)	(1.272)	(1.255)
Union coverage	0.057***	0.060***	0.034**	0.055***	0.057***	0.034**
	(4.676)	(4.920)	(2.352)	(4.402)	(4.686)	(2.318)
Incidence × union			0.064***			0.063***
			(2.896)			(2.619)
Intensity × union				0.001*		0.0003
				(1.676)		(0.298)
Industry quit rate	-1.701***	-1.733***	-1.675***	-1.721***	-1.706***	-1.679***
	(7.474)	(7.613)	(7.341)	(7.560)	(7.499)	(7.359)
Adj. R-squared	0.468	0.467	0.469	0.467	0.468	0.469

Note: Other controls included in all regressions are: highest educational qualifications (4 dummies), experience, experience squared, tenure, tenure squared, married/cohabiting, living in London, firm size dummies (6), sector (public and charity dummies), occupational dummies (4), occupation of origin (4), cohort of entry in the labour market (2), local unemployment rate. Number of person-year observations is 5700.

* significant at 0.10 level, ** significant at 0.05 level, *** significant at 0.01 level.

Absolute *t*-statistic in parentheses (Huber-White standard errors).

TABLE 4: Annual Growth of Hourly Wages, 1991-96		
	Specification:	
Variable	**(i)**	**(ii)**
Training incidence:		
Training	0.020**	0.033**
	(2.396)	(2.245)
Union coverage changes:		
exit	-0.032	0.013
	(1.397)	(0.476)
entry	0.055**	0.015
	(2.186)	(0.510)
always in	0.028***	0.035***
	(2.940)	(3.294)
Training and:		
exit from union coverage		-0.120**
		(2.467)
entry into union coverage		0.107**
		(2.051)
always union covered		-0.020
		(1.151)
Adjusted R-squared	0.1695	0.1722
Training intensity:		
Training (days)	0.0009***	0.001**
	(2.705)	(2.325)
Union coverage changes:		
exit	-0.032	-0.031
	(1.408)	(1.291)
entry	0.055**	0.040
	(2.193)	(1.542)
always in	0.028***	0.030***
	(3.004)	(3.164)
Training and:		
exit from union coverage		-0.0002
		(0.139)
entry into union coverage		0.004
		(1.110)
always union covered		-0.0005
		(0.728)
Adjusted R-squared	0.1701	0.1707

Note: All regressions are performed on 4750 transitions. Other controls included in the regressions but not reported in the table are: highest educational qualification, experience, experience squared, tenure, tenure squared, cohort of entry in the labour market, occupation of origin, and yearly changes in marital status, residential location, firm size, current occupation, sector, 2-digit industry quit rate, and local unemployment rate.

** significant at 0.05 level, *** significant at 0.01 level.

Absolute *t*-statistic in parentheses (Huber-White standard errors).

Table 5: Unions and Quitting Behaviour, 1991-96 Pooled

	Specification:			
	(i)	**(ii)**	**(iii)**	**(iv)**
Union coverage	-0.031*** (4.15)	-0.028*** (3.30)	-0.032*** (3.60)	-0.031*** (3.58)
Demographic and local market	yes	yes	yes	yes
Firm size and sector	no	yes	yes	yes
Occupation	no	no	yes	yes
Occupation of origin and cohort	no	no	no	yes

Note: Dependent variable is one for men who work for a different employer *and* left for a better job in the last 12 months (or since September of the preceding year), and zero otherwise. Table reports probit estimates (marginal effects). Demographic and local market variables are: highest educational qualification, age, age squared, experience, experience squared, disabled, married/cohabiting, living in London, and local unemployment rate. Cohort is cohort of entry in the labour market. All regressions are performed on 4750 person-year observations.

*** significant at 0.01 level.

Absolute *t*-ratio in parentheses.

Table 6: Robustness Checks of Wage Estimates: The Role of Training Selection

Variable and Model	Specification: (i)	(ii)
A. Model with selectivity and with no simultaneity		
Training incidence	0.034***	-0.005
	(3.053)	(0.290)
Union coverage	0.073***	0.048*
	(3.232)	(1.949)
Incidence × union		0.063***
		(2.839)
Quit rate	-1.853***	-1.802***
	(6.115)	(5.925)
Training selection	0.090**	0.075**
	(2.432)	(2.311)
Adj. R-squared	0.469	0.470
B. Switching regression model of training intensity		
Training intensity (days)	0.005	0.001
	(1.383)	(1.100)
Union coverage	0.112***	0.109***
	(9.426)	(9.289)
Intensity × union		0.046***
		(3.289)
Quit rate	-1.842***	-1.833***
	(7.853)	(7.844)
Training selection	0.019**	0.016**
	(2.427)	(2.480)
Adj. R-squared	0.474	0.476

Note: Other controls included in all wage regressions are: highest qualification (4 dummies), experience, experience squared, tenure, tenure squared, partner present, London, firm size dummies (6), public sector and charity, occupational (4), occupation of origin (4), cohort of entry in the labour market (2), and local unemployment rate. Identification of the training selection term is achieved by: a) inclusion of age, age squared, disabled, and changed job in the probit (panel A) or tobit (panel B) equations only; and b) inclusion of tenure and tenure squared only in the wage equations. Number of person-year observations is 5700.

* significant at 0.10 level, ** significant at 0.05 level, *** significant at 0.01 level.

Absolute *t*-statistic in parentheses (Huber-White standard errors).

Table 7: Robustness Checks: The Role of Unobserved Heterogeneity

Variable	Column [1] **Training Incidence** (cfr. Tables 2, A2)	Column [2] **Training Intensity** (cfr. Tables 2)	Column [3] **Quitting Behaviour** (cfr. Table 5)	Column [4] **Wage Levels** (cfr. Table 3 (iii))
Union	0.063*** (3.447)	4.207*** (4.878)	-0.030*** (3.451)	0.037*** (2.878)
Industry quit rate	-0.583* (1.884)	-51.875*** (3.465)		-1.133*** (5.127)
Training				-0.018 (1.224)
Training × union				0.042*** (2.577)
ρ	0.373	0.018	0.160	0.624

Note: Columns [1] and [3] report random-effects probit estimates (marginal effects) of the probability of training (incidence) and the probability of quitting, respectively. Column [2] reports random-effects tobit estimates of the number of days of training. Column [4] reports random-effects estimates of log hourly wage level equations. See Tables A2, 5 and 3 (specification (iii)) for list of other regressors used in each regression. The term ρ is the fraction of variance due to the unobserved heterogeneity component.

* significant at 0.10 level, ** significant at 0.05 level, *** significant at 0.01 level

Absolute *t*-statistic in parentheses.

TABLE A1: Definition of variables		
Variable	**Definition**	**Mean**
Union and training:		
Union coverage	Recognised trade union or similar organisation for negotiating pay and other similar conditions in the workplace	0.599
Training incidence	Any training meant to increase or improve skills in the current job over the previous 12 months	0.386
Training intensity (days)	Number of days spent in skill-enhancing training in the past 12 months in the current job	4.412
Individual and labour market characteristics:		
Age	Age (years)	38.093
Partner present	Married or cohabiting at interview date	0.787
Experience	Experience (years) in employment since labour market entry	19.971
Tenure	Tenure (years) in current job	6.657
Disabled	Registered as disabled either with social services or a green card	0.009
Changed job	Changed employer in the previous 12 months (either though a quit or after a layoff)	0.126
London	Resident in Greater London	0.093
No qualification (base)	No educational qualification	0.209
O-level	Highest qualification is one or more 'Ordinary'-level qualifications (later replaced by GCSE), usually taken at the end of compulsory schooling at age 16	0.323
A-level	Highest qualification is one or more 'Advanced'-level qualifications, representing university entrance-level qualification typically taken at age 18	0.234
Vocational	HND, HNC, Teaching, other higher qualification, Nursing	0.086
Degree qualification	University degree or above	0.149
Professional[a]	Professional occupations	0.116
Managerial	Managerial occupation	0.195
Non-manual	Skilled non-manual occupation	0.199
Skilled manual	Skilled manual occupation	0.291
Other manual (base)	Semi-skilled and unskilled manual occupations	0.199
Date of labour market entry:		
Cohort 1 (base)	Entered the labour market before 1961	0.098
Cohort 2	Entered the labour market 1961-1970	0.268
Cohort 3	Entered the labour market 1971-1980	0.385
Cohort 4	Entered the labour market 1981-1990	0.248
Firm size:		
Size25 (base)	Fewer than 25 employees at the establishment	0.236
Size50	25-49 employees at the establishment	0.123
Size100	50-99 employees at the establishment	0.141
Size200	100-199 employees at the establishment	0.125
Size500	200-499 employees at the establishment	0.164
Size1000	500-999 employees at the establishment	0.100
Size 1000+	1000+ employees at the establishment	0.111
Public sector	Works in public sector	0.274
Charity	Works in non-profit making organisation (charities, co-operatives etc.)	0.019
Other variables:		
Unemployment rate	Local unemployment rate. The geographic unit is 306 matched job centres. Obtained from the National On-line Manpower Information Service.	0.083
Industry quit rate	Average quit rate for the two-digit Standard Industrial Classification (SIC)	0.074

[a] Occupational categories are constructed from the three-digit Standard Occupation Classification (SOC). Occupation-of-origin categories are the same as for current occupation. Occupations of origin are identified by the first full-time job after leaving full-time education using the retrospective work history information collected in the third wave (1993) of the BHPS.

TABLE A2: The Determinants of Training, 1991-96 Pooled

	Training incidence (Probit estimates, marginal effects)		**Training days (Tobit estimates)**	
Variable	**coeff.**	**|t-stat|**	**coeff.**	**|t-stat|**
Individual and labour market characteristics:				
Partner present	0.035**	1.99	3.206***	3.53
Age	0.014	1.46	-0.278	0.58
Age squared	-0.0003**	2.03	-0.005	0.73
Experience	-0.008**	2.12	-0.488***	2.61
Experience squared	0.0003**	2.46	0.016***	3.09
Disabled	-0.166**	2.06	-9.830**	2.16
Changed job	-0.017	0.83	0.399	0.39
London	0.027	1.11	-0.182	0.15
O-level	0.069***	3.02	2.695**	2.31
A-level	0.124***	4.86	5.164***	4.02
Vocational qualification	0.201***	6.14	10.713***	6.82
Degree	0.177***	5.28	6.015***	3.68
Occupation:				
Professional	0.203***	6.34	8.867***	5.67
Managerial	0.224***	8.70	9.479***	7.41
Non-manual	0.169***	6.58	7.579***	5.95
Skilled manual	0.117***	5.31	6.932***	6.22
Occupation of origin*:*				
Professional	0.079**	2.44	0.889	0.56
Managerial	0.147***	4.08	4.368**	2.53
Non-manual	0.158***	6.84	4.563***	4.00
Skilled manual	0.131***	6.53	4.326***	4.27
Date of labour market entry:				
Cohort 2	-0.038	1.04	-2.142	1.16
Cohort 3	-0.061	1.20	-4.697*	1.79
Cohort 4	-0.022	0.36	-3.613	1.18
Firm size:				
Size50	0.085***	3.44	2.294*	1.89
Size100	0.064***	2.76	4.418***	3.82
Size200	0.071***	2.96	3.400***	2.84
Size500	0.041***	1.80	3.995***	3.54
Size1000	0.083***	3.14	6.024***	4.66
Size1000+	0.130***	5.09	8.105***	6.59
Public sector	0.028	1.60	3.885***	4.50
Charity	0.131***	2.65	8.287***	3.46
Other variables				
Unemployment rate	-0.740***	2.67	-23.863*	1.72
Pseudo-R-squared	0.082		0.023	
Number of cases	5700		5700	

Note: See Table 2 for estimates of union coverage and industry quit rate.
* significant at 0.10 level, ** significant at 0.05 level, *** significant at 0.01 level.

Table A3: Nonlinear Effects of Training Intensity on Wage Levels		
	Specification:	
Variable	**(i)**	**(ii)**
Training intensity:[a]		
> 1 day and ≤ 1 week (ϕ_1)	0.030**	-0.003
	(2.155)	(0.134)
> 1 week and ≤ 1 month (ϕ_2)	0.067***	0.011
	(4.288)	(0.412)
> 1 month (ϕ_3)	0.002	-0.046
	(0.091)	(0.878)
Union coverage	0.056***	0.033**
	(4.588)	(2.315)
$\phi_1 \times$ union coverage		0.055*
		(1.872)
$\phi_2 \times$ union coverage		0.088***
		(2.783)
$\phi_3 \times$ union coverage		0.069
		(1.169)
Industry quit rate	-1.670***	-1.643***
	(7.336)	(7.198)
Ajdusted R-squared	0.4690	0.4700

Note: Other controls included in all regressions are: highest educational qualifications (4 dummies), experience, experience squared, tenure, tenure squared, married/cohabiting, living in London, firm size dummies (6), sector (public and charity dummies), occupational dummies (4), occupation of origin (4), cohort of entry in the labour market (2), local unemployment rate. Number of person-year observations is 5700. See also Table 3.

* significant at 0.10 level, ** significant at 0.05 level, *** significant at 0.01 level.

Absolute *t*-statistic in parentheses (Huber-White standard errors).

[a] Base category is ϕ_0 (trained 1 day or less).

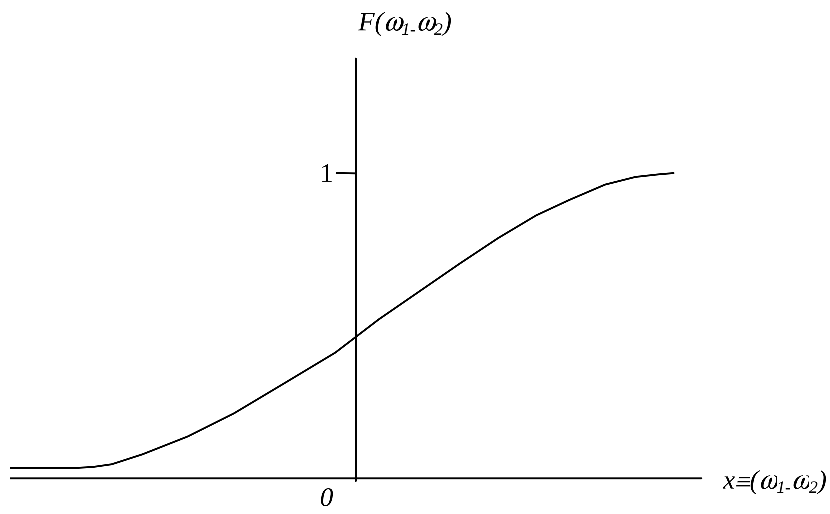

Figure 1: The Retention Function

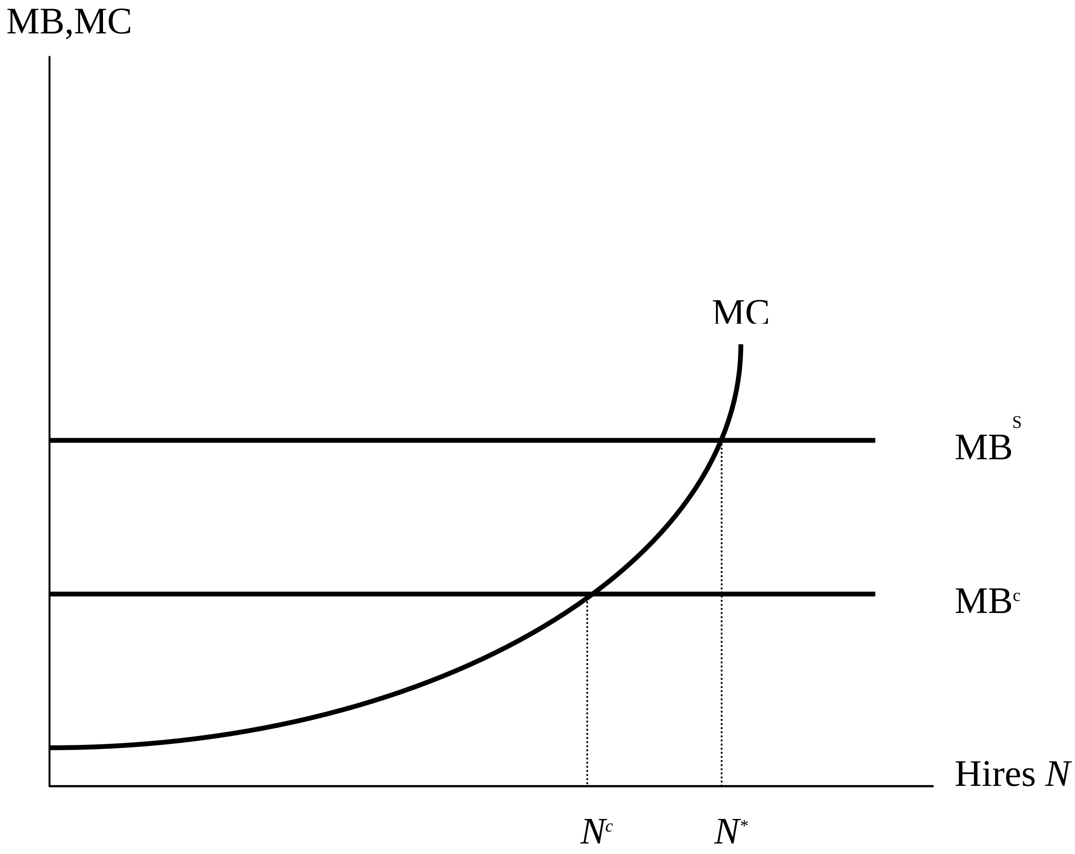

Figure 2: Hires in Period 1 in Skilled Sector

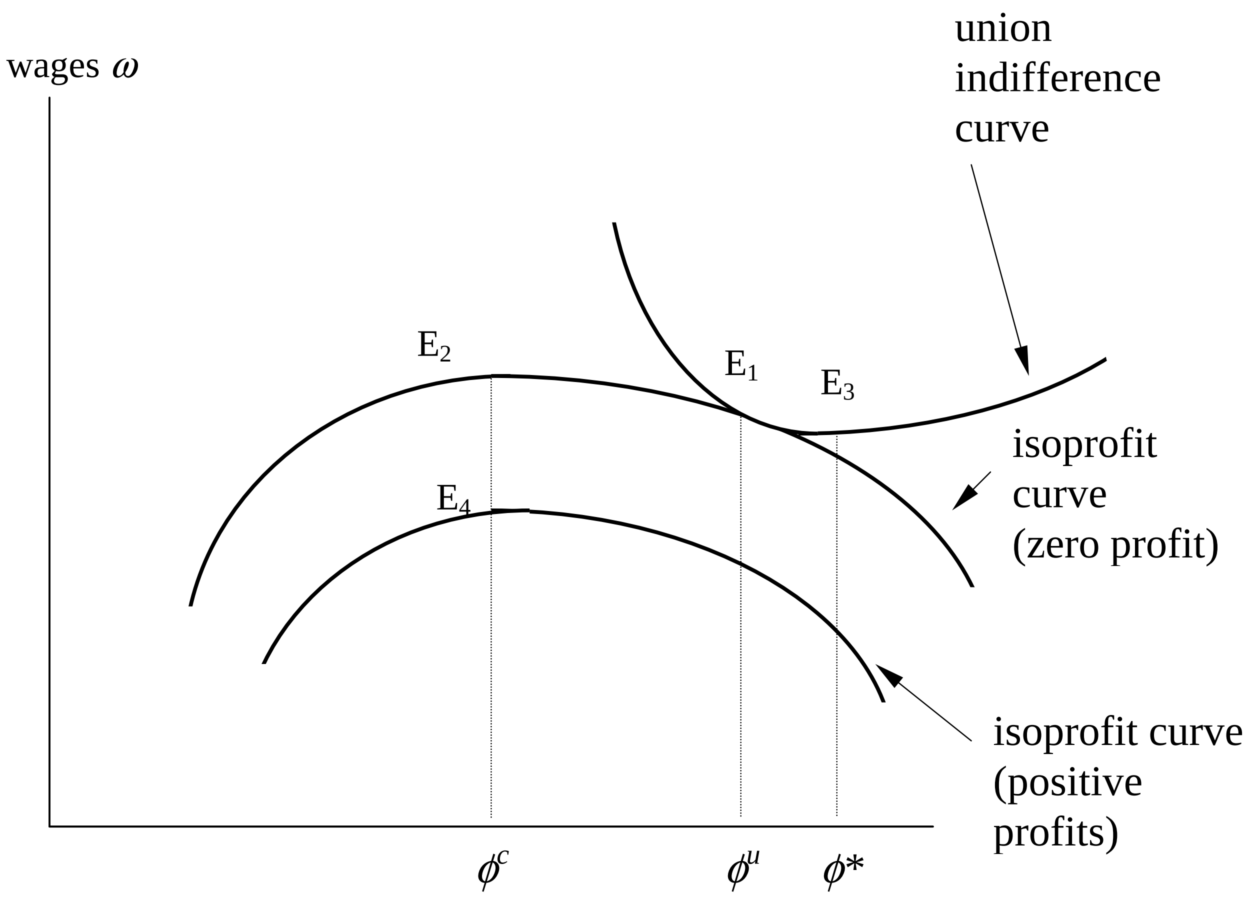

Figure 3: Wages and Training Intensity with Industry-wide Union