LABOUR MARKET SEGMENTATION: WAGE DIFFERENTIALS AND HYSTERESIS EFFECTS

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Competitive labour market analysis proposes that an individual's human capital endowment is the main mechanism for pay determination. This study develops a model to highlight hysteresis effects on either investment in physical capital for firms or investment in human capital for workers on wage differentials.

I. Introduction

The focus of this study is the investigation of wage structure and the forces affecting individual earnings. It attempts to offer a plausible explanation as to why otherwise similar individuals are found in different parts of the wage distribution. Thus, for instance, low paid workers are not spread evenly throughout all firms, even if they operate in similar product markets. They are usually concentrated in a number of firms which have failed, for some reason or other, to provide relatively high wages to their employees.

The study proposes that one important cause of unequal pay for seemingly equal workers is the hysteresis effects on investment in human capital and/or hysteresis effects on investment in physical capital on the structure of offered wages. The hysteresis effect of employees' human capital characteristics and the firm's investment activity on the structure of earnings is illustrated by the use of a simulation model.

Although classical and neo-classical labour market theory recognises the problem of earnings differences, it assumes that pay is largely determined by how productive the individual worker is and how effective market incentives are in mobilising his or her productive effort. Thus earnings differences mainly reflect individuals' relative worth and low pay is symptomatic of low levels of ability and skill or education. Consequently the only important determinant of an individual's position in the earnings distribution is the human capital he or she brings to the labour market and his or her inherent productivity. As a result, low paid labour is "often badly paid, not because it gets less that it is worth, but because it is worth so appallingly little" (Hicks, 1963).

In contrast to this conventional view, alternative approaches to labour market analysis suggest that relationships in the labour market are determined by institutional structures and inequalities in bargaining power which lead to the systematic underpayment of certain labour groups. The basic proposition is that differences in pay derive from the characteristics of the job rather than the worker. Ryan (1990), for example, suggests that "skilled workers will be found in low paid jobs if they lack bargaining power or if their employers either lack economic rent in their product markets or are averse to sharing it with them".

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In addition, individual abilities depend not only on personal efficiency and human capital endowments but also on the opportunities offered to the individuals to utilise these endowments to the best of their advantage. Thus, the capabilities of individuals in a job depend on the terms and conditions of the employment as well as the effectiveness and intensity of work effort. In this case, workers with equivalent skills are distributed across a spectrum of firms that pay different wages. Thus, individual wages do not reflect only individual skills. They reflect the efficiency of the firm in utilising these skills. Such a "segmented labour market" approach[2] implies that workers fortunate enough to work for a high productivity firm are paid higher than those with equivalent skills employed by a low productivity firm.

This study proposes that there are additional reasons for labour market segmentation to occur, namely, hysteresis effects of investment in physical capital by firms and investment in human capital by workers. This paper shows that such hysteresis effects are important causes of wage differentials among otherwise similar individuals. The wage that an individual will ultimately receive depends not only on his or her personal characteristics, such as education and experience, but also on the demand for labour function of the firm or industry in which he or she is employed. The precise position of the demand curve will be determined by differing industrial structures in terms of firms' technology, profit rates, degree of unionisation, and so on. However, to illustrate the effects of hysteresis on the demand curve, these considerations are placed aside in order to focus on the specific impact of changes in the stock of capital. Thus, this study leaves to one side the complexities of wage-bargaining models and intertemporal stochastic frameworks in favour of a simpler approach of a perfectly competitive labour market.

II. Theoretical Considerations

(a) Introduction

Following Bluestone (1970) and Wachtel and Betsey (1971), we first consider a single firm employing individuals with varying amounts of human capital. Such a firm has a supply curve located on the basis of three levels of human capital $h_3 > h_2 > h_1$ is shown on Figure 1. Given a homogenous demand for labour, individuals earn different wages and are employed in different amounts as a unique function of their level of human capital. Thus the labour supply function[3] is

$$n_t^s = \alpha \pm \beta w_t \tag{1}$$

where β reflects the changes in the supply of labour due to changes in workers' work-leisure choices and α represents the shifts in individual labour supply due to variations in the individuals' stocks of human capital.

However, this model ignores the possibly important effects on individual wages of differing levels of physical capital investment by firms. Figure 2, overleaf, depicts a model of the labour market with one homogenous labour supply function and three different firms with differing levels of physical capital investment $k_1 < k_2 < k_3$ though their marginal products of labour are identical. The labour demand function is therefore

[2] Doeringer and Piore (1971), Okun (1981), Wilkinson (1981, 1991) and Thurow (1998).

[3] Note that equations (1) and (2) are general functions allowing for the possibility of the supply and demand schedules being either upwards or downwards sloping, whereas Figures 1 and 2 are drawn to show the normal slopes of the demand and supply schedules.

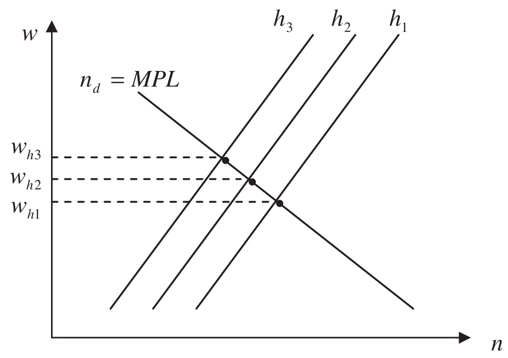

Figure 1. Labour market supply curve for different levels of human capital

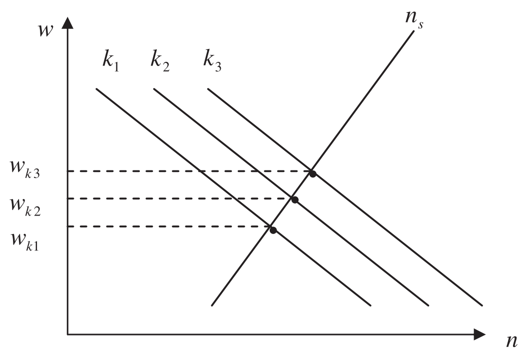

Figure 2. Labour demand curve for different levels of physical capital

$$n_t^d = \sigma \pm \tau w_t \tag{2}$$

where the shift parameter σ captures the differing levels of physical capital investment and τ reflects changes in firms demand for labour due to wage costs.[4]

In the simple model above, multiple equilibria can be generated as can be seen in Figure 3 (which combines Figure 1 and Figure 2). The precise way by which multiple equilibria arise requires detailed analysis of the labour demand function and the determinants of physical capital investment, and the labour supply function and the determinants of human capital investment. These are detailed in sequence in the next four sections. The final section will then look at the interactions between labour demand and labour supply.

(b) The demand for labour

This section looks at the demand for labour in more depth. In view of equation (2), consider an inverse labour demand function that takes the form

[4] For simplicity, the time subscript is suppressed in what follows. It will only appear when necessary for the explanation of the dynamics (for example in equation 13).

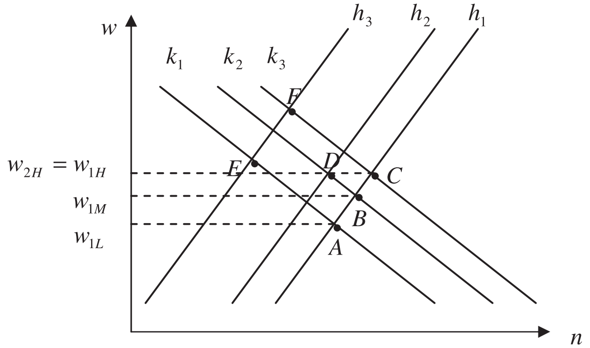

Figure 3. Multiple equilibria in the labour market

$$\partial w/\partial k = l_1 + l_3 R > 0 \tag{3}$$

where $l_1 > 0$, $l_3 > 0$. That is, the sensitivity of labour demand to changes in physical capital investment depends on past capital investment. Real wages are less sensitive to capital investment activity the lower the real interest rate. Thus, the greater the share of capital is compared to labour, the more sensitive real wages are to changes in capital investment. This implies that, when the real interest rate is relatively high, workers are easily replaced with capital, and thus the flexibility of wages with respect to the level of firm activity is correspondingly high on account of the fact that employers have a credible threat to replace labour with capital.

The sensitivity of real wages to changes in the real interest rate is greater when capital investment is greater, as shown in (4).

$$\partial w/\partial R = l_2 + l_3 k > 0 \tag{4}$$

where $l_2 > 0$, $l_3 > 0$. That is, if the level of capital investment is high, this implies labour is relatively scarce, and hence wages are correspondingly much more flexible with respect to the return on the other factor (physical capital). We explore further the issues pertaining to firm entry in the next section.

Hence the inverse labour demand schedule may be written as

$$w = l_1 k + (l_2 + l_3 k)R - l_4 n \tag{5}$$

where $l_1 > 0$, $l_2 > 0$, $l_3 > 0$ and $l_4 > 0$.

(c) The determination of physical capital investment

Dixit (1989b, 1992) pointed out that firms invest in projects that they expect to yield a return in excess of a required threshold rate. Thus firms do not invest until the price rises substantially above long run average cost, in contrast to the conventional view that proposes that when price exceeds the long run average cost firms are induced to expand. Symmetrically on the downside, as Dixit demonstrated, firms retain existing plants for lengthy periods, absorbing operating losses, when price fall substantially below average variable cost without inducing disinvestment.

Dixit (1989b, 1992) and Pindyck (1991) showed that a delayed reaction, or “waiting”, has a positive value with respect to investment decisions and this value is large enough to have a significant impact on investment and disinvestment decisions. Thus firms refuse to invest even when the currently available rates are far in excess of the cost of capital since waiting is optimal since it is a means for the firms to insure that this state of affairs is not transitory. Likewise, firms can carry losses over a long period of time keeping their operations alive on the prospect of future improved state of affairs.

Following Baldwin and Krugman (1989) and McCausland (2000) assume the real interest rate is a random variable, independently and identically distributed (iid)

For a firm already engaging in physical capital investment, there are two options:

(i) to continue doing so, in which case its net present value is

$$NPV = \pi(R, k) - M + \delta V_1 \tag{6}$$

where π is the firm's profit function, M is the per period maintenance cost of the investment, δ is the discount rate and V_1 is the present value of future revenues of the firm evaluated before it knows the real interest rate. Thus V_1 will need to be determined simultaneously with the strategy of the firm once the value of the real interest rate is revealed.

(ii) to cease investing, in which case its net present value is

$$NPV = \delta V_0 \tag{7}$$

where V_0 is the expected value of a firm not investing. Once again, V_0 must be determined simultaneously with the investment strategy of the firm once the real interest rate is revealed.

For a firm not currently engaging in physical capital investment, again there are two options:

(i) to continue not investing, then equation (7) represents its net present value.

(ii) to begin investing, in which case its net present value will be

$$NPV = \pi(R, k) - N + \delta V_1 \tag{8}$$

where N is the one-off lump sum cost of physical capital investment (sunk entry cost), (assume $N > M$).

Once the real interest rate is revealed, the firm must choose its optimal strategy. If the real interest rate falls below some critical value R_n, then the firm, if it is currently not investing, should commence. Should the real interest rate rise above some critical value R_x, however, then, if the firm is currently investing, it should cease. These "entry" and "exit" boundary conditions are shown in Figure 4.

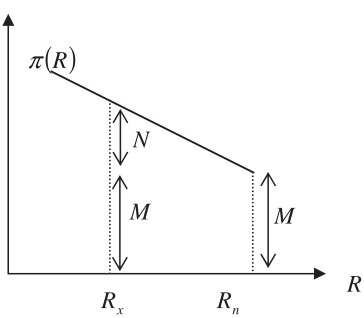

Figure 4. The profit function with sunk entry costs

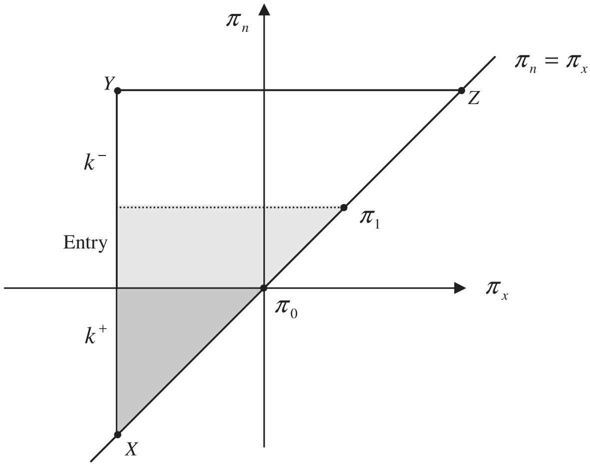

Figure 5. Half plane diagram showing entry (physical capital investment)

$$\pi(R_n, k) - N + \delta V_1 = \delta V_0 \text{ (entry boundary condition)} \tag{9}$$

$$\pi(R_x, k) - M + \delta V_1 = \delta V_0 \text{ (exit boundary condition)} \tag{10}$$

The exit and entry conditions above implicitly define the critical values of interest rates R_n, R_x as

$$\pi(R_n, k) - \pi(R_x, k) = N - M \tag{11}$$

and since $N > M$ and $\pi_R < 0$ this implies

$$R_n < R_x \tag{12}$$

hence determining the level of capital investment, k.

From equation (5), there exist multiple locally stable steady state equilibria if the following conditions are satisfied[5]

$$k_t = k_{t-1} \Leftarrow \pi_x(k_{t-1}) < \pi_t < \pi_n(k_{t-1}) \tag{13}$$

$$\pi_n(k_t) = \pi_t \Leftarrow \pi_t \geq \pi_n(k_{t-1})$$

$$\pi_x(k_t) = \pi_t \Leftarrow \varphi_t \leq \pi_x(k_{t-1})$$

These three conditions describe the dynamics of k. Any value of k_{t-1} has corresponding values of the profit levels accruing to exit and entry, $\pi_x(k_{t-1})$ and $\pi_n(k_{t-1})$, respectively. Suppose that the economy consisted of a continuum of different firms with a continuum of different cost characteristics, then the set of k may be represented by the upper half plane X, Y, Z on Figure 5. This is known as the half plane diagram (Mayergoyz, 1985, 1991). The relevant half plane lies above the 45° line ($\pi_x = \pi_n$) since $\pi_n > \pi_x$. The boundaries of the half plane are tied down by the

[5] For alternative treatments and applications of hysteresis, the reader is referred to Amable *et al.* (1995a,b), who present a formal argument categorising different types of hysteresis, and to Cross (1993), who discusses the methodological foundations of hysteresis in economic systems.

minimum and maximum possible profits, which are normalised to zero and one respectively. The distance of a particular firm from the 45° line is a measure of how important sunk costs are in that industry – the more important are sunk costs, the further away from the 45° line the position of the firm will be. Actual profits, π, are represented by points on the 45° line. Entry is captured by horizontal upward movements of the boundary between the set of active and inactive firms. Exit, on the other hand, is captured by vertical, leftward movements of the set boundary.

Let us suppose that initially profit, π is given by level π_0, and the set of active firms is given by the heavily shaded region k^+. The axes are placed to correspond to this initial situation. If there is then an unanticipated fall in the real interest rate, expected to be permanent, this will trigger capital investment by firms equivalent to the lightly shaded region, augmenting the capital stock k^+, and resulting in the higher profit level π_1. This corresponds to the movement from A to C in Figure 3. Given the supply curve accruing to human capital level h_1, the intersection with the demand curve accruing to capital level k_1 at point A might represent an initial position in which little capital investment has previously taken place. A fall in the real interest rate large enough to trigger physical capital investment to level k_3, for instance, shifts equilibrium to point C giving the higher real wage level w_{1H}.

Now suppose that there is a subsequent unanticipated rise in the real return on capital to its initial level (which is also expected to be permanent). Even if profits fell back to the initial level, π_0, all the firms that had previously entered would not exit, because of the sunk cost of the investment. As can be seen in Figure 6, the number of firms exiting is represented by the lightly shaded region, which now augments the set of investment-inactive firms k^-.

Thus the initial equilibrium A in Figure 3 would not be restored, since the number of investment active firms, k, is now permanently higher since not all the previous investment has been undone. The higher value of k in turn means that there is a new, lower demand curve, positioned between the initial k_1 and k_3, giving an equilibrium such as point B in Figure 3, at which there is a permanently higher real wage level w_{1M}, compared with the initial real wage w_{1L}. We can see that the boundary between the set of investment-active and investment-inactive firms is now kinked. This kink embodies within it the memory of the large fall in the real interest rate that

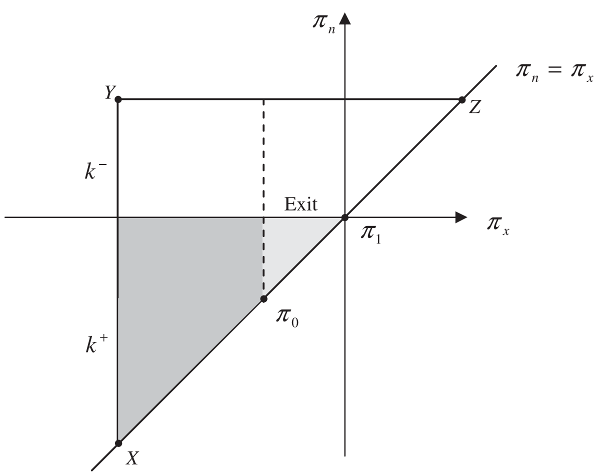

Figure 6. Half plane diagram showing exit (physical capital investment)

has occurred. To eradicate this kink, a much larger rise would be required. Thus, we can say that over time, the set boundary will resemble a step function (see Amable *et al.*, 1995a, for further mathematical and graphical detail), which captures the history of *non-dominated* extrema.

(d) Labour supply

Bluestone (1970) and Wachtel and Betsey (1971) argued that, given a homogenous demand for labour, a single firm employing individuals with varying amounts of human capital may face a number of different labour supply curves according to the level of workers' human capital. To illustrate this, consider first the neo-classical analysis of the labour supply decision in the household, where the worker supplies his/her labour in order to maximise the utility derived from the real income-leisure mix. To simplify matters assume that for a new entrant in the labour market the maximisation problem may be written as

$$\max u(c, \bar{n} - n) \tag{14}$$

$$s.t.\ c = \bar{c} + Wn \tag{15}$$

where c is real consumption, $\bar{c}$ is the real reservation wage, W is the real hourly wage of the representative worker, n is labour supply, and $\bar{n} - n$ represents leisure. The utility function is assumed to have the normal properties and be increasing in both its arguments. Using the standard first order condition, $W = u_{\bar{n}-n}/u_c$, the labour supply schedule $n = f(W, \bar{c})$ is derived, where $f_W > 0$, that is, the labour supply schedule is upwards sloping, and $f_{\bar{c}} < 0$, that is, increases in the reservation wage shift the labour supply curve downwards. Hence the labour supply function may be written as

$$W = g(n) \tag{16}$$

If one assumes that individuals earn different wages as a unique function of variations in their human capital (formal education, on the job training and innate skills), then equation (16) has to be augmented to incorporate these effects.[6] For the purpose of this paper it will suffice to assume that investment in human capital over each period has a rate of return ρ. Let wages in period t be a mark up of wages in period $t - 1$ augmented by human capital investment in the following form

$$W_t = W_{t-1}(1 + \rho h_{t-1}) \tag{17}$$

and thus

$$W_t = W_0 + (1 + \rho h_0)(1 + \rho h_1)(1 + \rho h_2)(1 + \rho h_3) \ldots (1 + \rho h_{t-1}) \tag{18}$$

or in terms of the labour supply function (16)

$$W_t = g_0(n) + (1 + \rho h_0)(1 + \rho h_1)(1 + \rho h_2)(1 + \rho h_3) \ldots (1 + \rho h_{t-1}) \tag{19}$$

Thus the individuals earn different wages as a unique function of variations in their human capital h and the numbers of periods over which these investments took place.

Taking the logarithm of (19) and approximating $\ln(1 + \rho h_t) \approx \rho h_t$

$$\ln W_t \equiv w_t = \ln g_0(n) + \rho \sum_{j}^{t-1} h_j \tag{20}$$

[6] The analysis follows similar but not identical lines to Bluestone (1970) and Wachtel and Betsey (1971). A similar approach is also used by Theodossiou (1995, 1996).

The interpretation of the second term in (20) is that the individual's reservation wage depends upon the individual stock of human capital. Therefore, the sensitivity of labour supply to changes in human capital investment depends on the number of educated workers in the labour market.

First, real wages are expected to be less sensitive to changes in the level of engagement in education the greater the real return on human capital. This implies that, the greater the returns to education, the less sensitive real wages are to changes in the size of the pool of educated workers. This relationship is captured by equation (21) below.

Second, the sensitivity of real wages to changes in the real return on human capital is expected to be less when more individuals are educated. Individuals' incentives to engage in education depend on their perceptions of the market demand for educated workers. The greater the pool of educated workers, the lower the sensitivity of wages to the return to education. This relationship is captured by equation (22) below. We consider the determinants of human capital investment in the next section.

$$\partial w/\partial \eta = \gamma_1 + \gamma_3 \rho < 0 \tag{21}$$

$$\partial w/\partial \rho = \gamma_2 + \gamma_3 \eta > 0 \tag{22}$$

Thus, the supply of labour function $w = \gamma(n; \rho, \eta)$ can be written as

$$w = \gamma_1 \eta + (\gamma_2 + \gamma_3 \eta)\rho + \gamma_4 n \tag{23}$$

where $(\gamma_2 + \gamma_3 \eta) = \sum h > 0$, that is, the sum of human capital investments, per monetary unit, over time determines the number of active workers, $\eta \in (0, 1)$ (that is, the proportion of workers active in the labour market), and $\gamma_1 < 0$, $\gamma_2 > 0$, $\gamma_3 < 0$, $\gamma_4 > 0$ and $\gamma_1 \eta + (\gamma_2 + \gamma_3 \eta)\rho < 0$. The first sign restriction follows from the fact that, keeping all other things constant, a rise in the supply of educated workers reduces the equilibrium wage through the forces of excess supply. The second sign restriction follows from the fact that, all other things held constant, a rise in the return on human capital raises the real wage, given $(\gamma_2 + \gamma_3 \eta) = \sum h > 0$. This is depicted in (2), where individuals with three different levels of human capital endowments, h_1, h_2, and h_3, $(h_1 < h_2 < h_3)$, along a given demand curve, command increasingly higher wages, assuming all other characteristics to be identical.

(e) Human capital investment

The behaviour concerning physical capital investment or disinvestment described earlier applies also to investment on the workforce by a firm. The implications for the labour market equilibrium are potentially significant. Bentolila and Bertola (1990) showed that, since firing and hiring costs are significant especially for skilled occupations, the marginal product of labour may go long way above the wage without any hiring taking place, and below it without any firing.[7]

Following Baldwin and Krugman (1989) and McCausland (2000), assume that the real rate of return on human capital is a random variable, independently and identically distributed (iid). For a worker already investing in human capital, there are two options:

(i) To continue investing in human capital, in which case its net present value is

[7] It should be noted that this paper is concerned only with general training, which develops skills that are equally useful for all firms, and hence is paid for by the worker, as in Becker (1964). Adding specific training, which develops skills of use only to the firm and hence the cost is borne by that firm, does not offer any further insights into the issues considered in this paper.

$$NPV = \lambda(\rho) - X + \delta V_1 \tag{24}$$

where λ is human capital investment, ρ is the sole determinant of human capital investment (the rate of return on human capital investment, ρ), $\lambda_\rho > 0$, X is the per period maintenance cost of investment (the training costs borne by the worker), δ is the discount rate and V_1 is the present value of future returns to the worker evaluated before they knows the real return to human capital investment. Thus V_1 will need to be determined simultaneously with the strategy of the worker once the value of the real return to human capital investment is revealed.

(ii) To cease investing in human capital, in which case its net present value is

$$NPV = \delta V_0 \tag{25}$$

where V_0 is the expected value of a firm not investing. Once again, V_0 must be determined simultaneously with the investment strategy of the firm once the real interest rate is revealed.

For a worker not currently investing in their human capital, again there are two options.

(i) To continue investing in human capital, in which case equation (25) represents their net present value.

(ii) To begin to invest in human capital, in which case their net present value will be

$$NPV = \lambda(\rho) - E + \delta V_1 \tag{26}$$

where E is the one-off lump sum cost of investment (sunk entry cost to the labour market), (assuming $E > X$).

Once the real return on human capital is revealed, the individual must choose their optimal strategy. If the real return on human capital falls below some critical value ρ_n, then the individual, if they are not currently investing in their human capital, should commence to do so. However, should the real return on human capital rise above some critical value ρ_x, then if the individual is currently investing in their human capital, it should cease to so do.

These "entry" and "exit" boundary conditions are shown in Figure 7 and implicitly define the critical values of the real return on human capital:

$$\lambda(\rho_n) - E + \delta V_1 = \delta V_0 \text{ (entry boundary condition)} \tag{27}$$

$$\lambda(\rho_x) - X + \delta V_1 = \delta V_0 \text{ (exit boundary condition)} \tag{28}$$

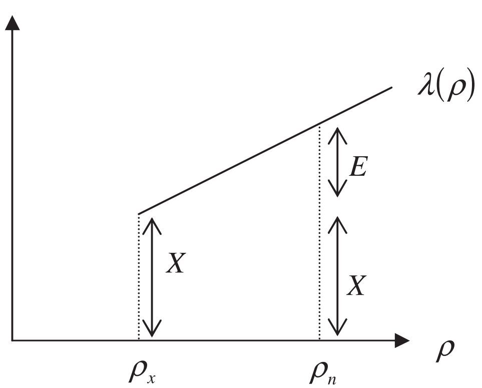

Figure 7. Human capital investment with sunk entry costs

where ρ_n and ρ_x be the critical values of interest rates that trigger entry and exit respectively. The exit and entry conditions in equations (26) and (27) implicitly define these critical values as

$$\lambda(\rho_n) - \lambda(\rho_x) = E - X \tag{29}$$

and since $E > X$ and $\lambda_\rho > 0$ this implies

$$\rho_n > \rho_x \tag{30}$$

hence determining the number of workers who have entered the labour market, η.

From equation (23), there exist multiple locally stable steady state equilibria if the following conditions are satisfied

$$\eta_t = \eta_{t-1} \Leftarrow \lambda_x(\eta_{t-1}) < \lambda_t < \lambda_n(\eta_{t-1})$$
$$\lambda_n(\eta_t) = \lambda_t \Leftarrow \lambda_t \geq \lambda_n(\eta_{t-1})$$
$$\lambda_x(\eta_t) = \lambda_t \Leftarrow \lambda_t \leq \lambda_x(\eta_{t-1})$$

These three conditions describe the dynamics of η. Any value of η_{t-1} has corresponding to the values of the real human capital investment level accruing to exit and entry, $\lambda_x(\eta_{t-1})$ and $\lambda_n(\eta_{t-1})$ respectively. Suppose that the economy consisted of a continuum of different individuals with a continuum of different aptitudes for education, then the set of η may be represented once again by the upper half plane P, Q, R on the Mayergoyz (1985, 1991) half plane diagram shown in Figure 8. The boundaries of the half plane are tied down by the minimum and maximum possible human capital levels, which we normalise to zero and one respectively. The distance of a particular individual from the 45° line is a measure of the importance of the sunk costs of engaging in education are to the worker – the more important sunk costs are, the further away the position of the worker will be from the 45° line. Actual human capital levels, λ, are represented by points on the 45° line. Entry into education is captured by horizontal upward movements of the boundary between the set of educated and uneducated workers. Vertical, leftward movements of the set boundary, on the other hand, capture exit.

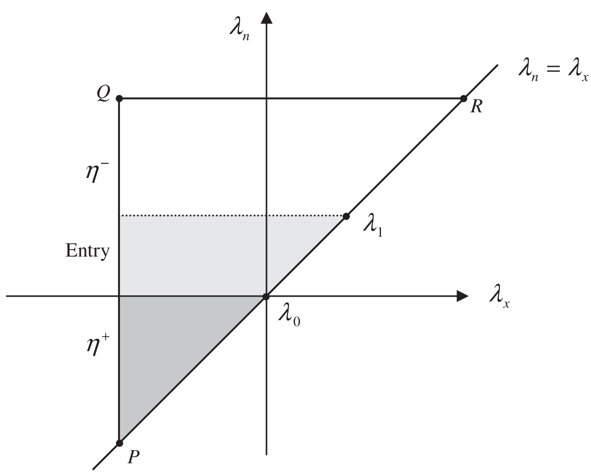

Figure 8. Half plane diagram showing entry (human capital investment)

(f) Multiple equilibria

In the above setting, which incorporates hysteresis in both physical and human capital investment, multiple equilibria may be generated. Let us suppose that initially the human capital level, φ is given by level φ_0, and the set of educated workers is given by the heavily shaded region η^+. An unanticipated rise in the real return on human capital (expected to be permanent) will trigger entry of individuals into education equivalent to the lightly shaded region, augmenting the set of educated workers μ^+, and resulting in the higher human capital level φ_1. This corresponds to the movement from B to D in Figure 3. Given the demand curve accruing to capital level k_2, the intersection with the demand curve accruing to human capital level h_1 at point B might represent an initial position in which little human capital investment has previously taken place. A rise in the real return on human capital large enough to trigger human capital investment to level h_2, for instance, shifts equilibrium to point D giving the higher real wage level w_{2H}.

Hysteresis in human capital investment could be expected to be present in a similar way to the analysis of hysteresis in physical capital investment described earlier. This gives an explanation of why some of those with high aptitudes for education get trapped in low wage employment, such as point E rather than F in Figure 3, in line with Ryan (1990). Starting from point D, assume that there is an unanticipated fall in the real return on human capital to its initial level (which is also expected to be permanent). Even if the human capital level fell back to the initial level, λ_0, all individuals that had previously engaged in education would not drop out. As can be seen in Figure 9, the number of individuals dropping out is represented by the lightly shaded region, which now augments the set of educationally inactive workers η^-.

Thus the initial equilibrium would not be restored, since the number of educated workers, η, is now permanently higher. Not all the previous investment in education has been undone. The higher value of η in turn means that there is a permanently higher real wage level compared with the initial real wage.

Thus, wages do not adjust to clear the market given changes in skill supplies. In fact, wages adjust very slowly to reflect the hysteresis effects on workers decisions to upgrade their skills.

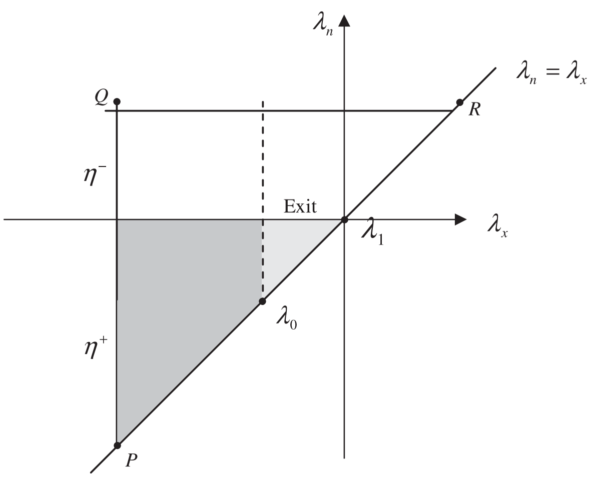

Figure 9. Half plane diagram showing exit (human capital investment)

Figure 3 now illustrates that earnings depend on both individual investments in human capital and on firms' investments in physical capital. Thus an individual can earn w_{1L} if he or she is employed in a low capital investment firm k_1 but w_{1H} if he or she is employed in a high capital investment firm k_3, though the wage could be only w_{1M} if he is employed in firm k_2.[8] In contrast an individual with human capital investment h_2 could earn $w_{1H} = w_{2H}$ in firm k_2. Thus if w_{1M} is taken to be the low pay threshold then whether an individual with human capital endowments h_1 earn below or above this threshold depends solely on whether he or she is employed in firm k_1 or firm k_3.

III. Simulation

We can illustrate the theoretical model developed above using plausible parameter values. In order to calibrate the model, we augment our theoretical model presented in the previous section as follows. First, we invert the inverse labour demand and supply schedules, equations (5) and (23), and the coefficients are adjusted accordingly. Second, in order to capture the time element of the process, we assume that there are some initial stocks of physical and human capital, which evolve over time according to the exit and entry behaviour described in the preceding section. This simple dynamic may be written as $k_{t+1} = k_t + I_t$ for physical capital (where I represents the net additions to the physical capital stock arising from firm entry and exit), and $\lambda_{t+1} = \lambda_t + \Lambda_t$ for human capital (where Λ represents the net additions to the human capital stock arising from firm entry and exit to and from education).

We assume the following initial values. First, the linear coefficients of the labour demand function: $l_1 = l_2 = l_3 = 1/0.2$ (denominator is the physical capital elasticity of labour demand), $l_4 = -1/0.2$ (denominator is wage elasticity of labour demand). Second, the linear coefficients of the labour supply function: $\gamma_1 = \gamma_3 = 1/-0.2$, $\gamma_2 = -1/-0.2$ (denominator is human capital elasticity of labour supply), $\gamma_4 = 1/0.2$ (denominator is wage elasticity of labour supply). Third the maintenance costs of physical and human capital respectively: $M = X = 0.1$, and the entry costs of human and physical capital respectively: $E = N = 0.5$. Finally, the initial physical and human capital stocks: $k_0 = \lambda_0 = 1000$, and initial proportions of active firms and educated workers respectively: $k = \eta = 0.3$. A base run determined the 'initial' equilibrium wage rate $w_{1L} = 1025$ given the real returns on physical and human capital to be respectively $R = \rho = 0.03$.

Experiment 1 (corresponding to movement A to B on Figure 3). Starting from the initial position, the return on physical capital was raised from $R = 0.03$ to $R = 0.17$, increasing the real wage. This induced the entry of 100 firms. The return to physical capital was then restored to the initial level, generating a fall in the real wage, not to the initial level, but to the higher level $w_{1M} = 1077.50$. This is shown on Figure 10.

Thus, a two-tier labour market is generated, since workers with equivalent skills are distributed into two groups, those paid a wage $w_{1L} = 1025$, and those paid a wage $w_{1M} = 1077.50$. In this case, the "segmented labour market" approach to the theory of wages clearly appears to be generated from the hysteresis effects from past human and physical capital investment decisions.

[8] In a competitive framework, it can be argued that this situation can not be a stable one since the flow of workers from the low-paying firms to the high-paying ones will cause a decrease of the wage rates offered by the high-paying firms. However, as Okun (1981) has pointed out, firms, especially those with a higher level of capital investment, do not reduce wages when willing job applicants are queuing outside the factory's gates. Implicit contracts, efficiency wages and 'insider' power considerations are able to account for such behaviour.

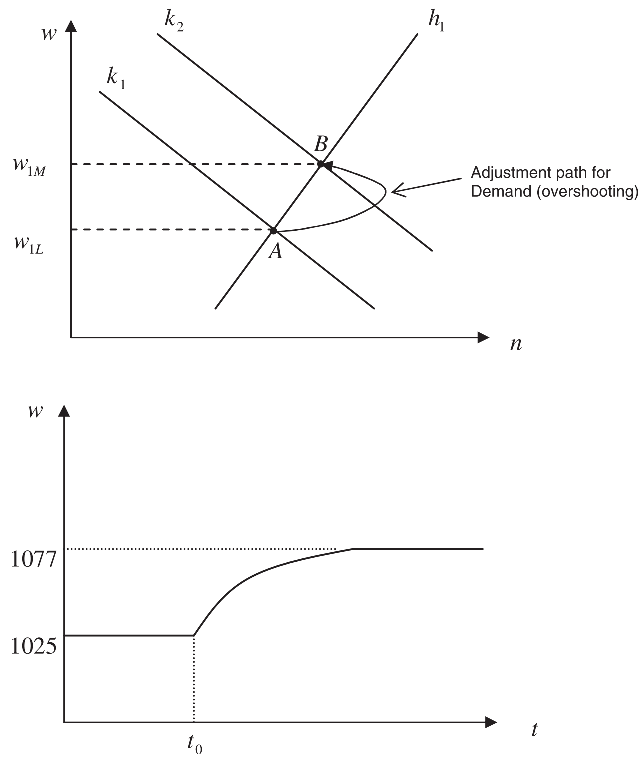

Figure 10. Hysteresis (experiment 1)

Experiment 2 (corresponding to movement B to D on Figure 3). The return to human capital was then raised from $\rho = 0.03$ to $\rho = 0.3$, inducing the education of 100 workers, and increasing the long run real wage to $w_{2H} = 1090.50$. This is shown on Figure 11.

In this case, the Hicksian view to the theory of low pay employment appears to be justified, namely, workers are paid their marginal product and those with lower wages are paid badly because their skills are valued poorly by employers. In other words, the wages paid reflect the amount of human capital possessed.

IV. Concluding Comments

The competitive labour market proposes that individuals' human capital endowments are the sole mechanism for them getting and maintaining a job and that the offered wage reflects precisely these human capital endowments. Thus differences in pay derive solely from differences in individual characteristics. Research in pay differentials has focussed almost exclusively on the problem of the acquisition of human capital but rarely examined how individuals' human capital is used in the labour market. The theory developed in this paper concentrates on evaluating the effects of persistent rigidities in the labour market that do not permit the efficient utilisation of individuals' existing human capital. These rigidities are history dependent. In

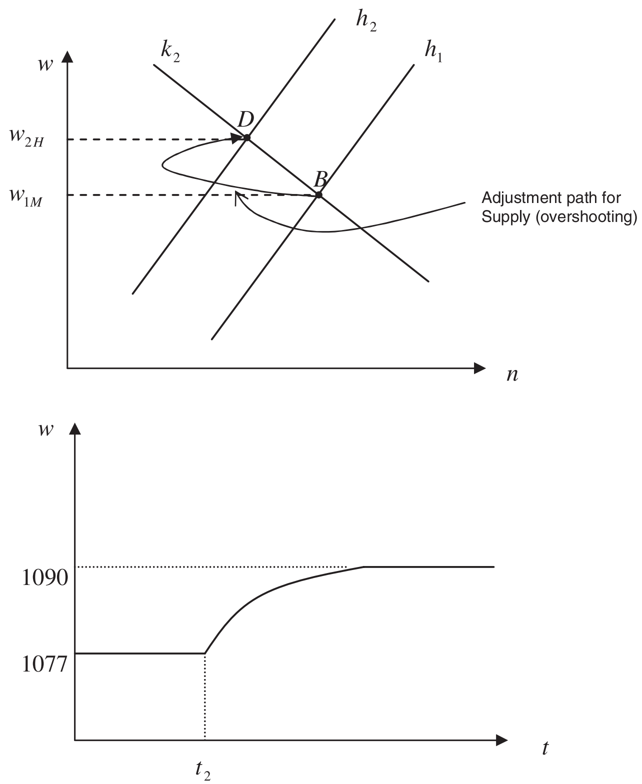

Figure 11. Hysteresis (experiment 2)

particular, this study shows that an important source of pay differentials can arise due to hysteresis effects of decisions either by firms to invest or disinvest in physical capital or by workers' decisions to acquire additional human capital or their decision to permit the depreciation of their human capital endowments in the form of avoiding additional training.

This study proposes that even short-lived policies to either (a) raise the real return on physical capital and/or (b) raise the real return on human capital investment have long lasting positive effects on the skill composition of the workforce. This in turn has corresponding positive effects on the distribution of wages. This is in line with the result of Nickell and Layard (1998) who show that variations in earnings distributions correspond closely to variations in skill distributions. This offers a possible alternative explanation of why those countries that increase the real rate of return on physical and/or human capital remain on a high supply and demand curve compared with countries that do not, even if such policies are subsequently reversed.

Appendix: Symbols List

c Real consumption of the representative worker
E Entry costs of human capital investment
f Labour supply function

g Inverse labour supply function
h Level of human capital
I Real net physical capital investment
j Time subscript
k Real physical capital stock
L Real labour demand function
l Real inverse labour demand function
M Maintenance costs of physical capital investment
n Real labour demand
n (as a subscript: entry)
N Entry costs of physical capital investment
R Real interest rate
t Time subscript
u Utility function of representative worker
W Real wage
w Natural log of the real wage
x (as a subscript: exit)
X Maintenance costs of human capital investment
Y Real production (output)
α Human capital shift parameter in labour supply function
β Wage elasticity parameter in labour supply function
Γ Real labour supply function
γ Real inverse labour supply function
Λ Real net human capital investment
λ Real human capital stock
η Proportion of active workers
ϑ Real physical capital to labour ratio
ρ rate of return to human capital investment
σ Physical capital shift parameter in labour demand function
τ Wage elasticity parameter in labour demand function

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