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Hiring Standards and Market Clearing

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ABSTRACT

Hiring Standards and Market Clearing

Consider a labour market with heterogeneous workers. Firms recruit workers by fixing a hiring standard and a wage offer simultaneously. A more demanding hiring standard necessitates a better wage offer in order to attract enough qualified applicants. As a result, an efficiency wage effect is obtained. An equilibrium emerges which does not clear the labour market. The wage level depends on structural characteristics of labour supply, such as heterogeneity and mobility of the workers. The model is contrasted with prevailing efficiency wage theories, and policy implications are also discussed.

JEL Classification: J31, J41

Keywords: wage formation, hiring standards, efficiency wages, unemployment

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Introduction

These remarks offer a simple theory of wage formation in a labour market where the emerging wage systematically fails to clear the market. The labour market is characterised by a set of identical firms looking for workers who differ in efficiency. Each firm makes a wage offer. A certain number of workers apply. The firm screens them for their efficiency and selects the most suitable to fill its vacancies. If all firms make the same wage offer, each firm receives a similar mixture of applicants and so ends up with a workforce with the same average qualification as all firms do. If a single firm offers a higher wage, however, it will attract more applicants and, in particular, a greater number of better qualified applicants. This opens up the possibility of hiring better workers and may render it worthwhile for the individual firm to make a wage offer above the going wage rate. In equilibrium, however, such possibilities have to be ruled out. All firms will have to pay the same wage rate and no firm will have an incentive to deviate from the market wage. This condition fixes simultaneously the equilibrium wage rate and the equilibrium employment level.

The market mechanism described here is closely related to Weiss' (1980) efficiency wage model in that the choice of the wage rate affects the quality of the work force. In Weiss' model firms are unable to assess the efficiency of their workers but know that the reservation wage of the more efficient workers is greater than that of the less efficient workers. Lowering the wage rate may induce the good workers to leave, while the less efficient workers remain. This regularity may prevent firms from lowering wages for fear of reducing the fraction of the more efficient workers in their workforce. Weiss' argument relies on the problematic assumption that reservation wages are private information of the workers and are, therefore, not related to other opportunities in the labour market.¹ The present model considers the other important case that firms are able

¹ Because of this problem, Weiss resorted to the assumption that the better workers are also better in moonlighting and enjoying leisure. (For a possible mechanism producing the reservation wage/efficiency link under slightly different assumptions, see Schlicht (1986), however.) There is further problem with Weiss' argument. Assume that there are 10% good workers and 90%

to screen their applicants. The idea has been mentioned by several writers but has never been stated clearly.²

The model presented here is also akin to the efficiency wage models that built on turnover costs or the discipline function of unemployment, as it explains persistently non- cleared markets.³ It differs from those models, however, not only regarding the mechanism of wage formation, but also with respect to the implied economic function unemployment is held to serve.⁴ While unemployment serves the functions of preventing turnover or shirking, in those models, it has no role to play in the model considered here. Taking unemployed workers out of the market would have no impact on employment and the wage level, for instance. In this and other respects the policy predictions differ from those entailed by the traditional efficiency models of wage formation.

I will first introduce the concept of the qualification queue (Section 11), then characterise the set of market equilibria belonging to alternative hiring standards (Section 12), then I will then go on to describe the emerging market equilibrium (Section 13) and will conclude with a discussion on the determinants of wages and employment (Sections 14-17).

mediocre workers in the work force. One good worker produces as much as one and a half mediocre workers. If the firm loses all its good workers, this will decrease the efficiency of the average worker from 1.05 to 1. Thus the composition effect underlying WEISS' mechanism must be very drastic, as the higher wages are shelled out to everybody and must be financed by the better performance of only a few good workers. The theory developed here allows for a Weiss - type result while avoiding these infelicities.

² Stiglitz (1987:17) writes: 'A variant of this [Weiss] model arises when there are job-specific skills and positive search costs; the larger the applicant pool, the higher the expected productivity, simply because the firm can find a larger number of individuals that fit in well with the needs of the firm.' In a similar vein, I have remarked that besides the effect of wages on turnover, 'other considerations might lead to a similar relationship, e.g. direct productivity effects of wage incentives or the possibility to get workers with better background characteristics for a higher wage.' (Schlicht 1978:340).

³ See Phelps (1968), Stiglitz (1974), Schlicht (1978) and Salop (1979) for turnover efficiency wages and Shapiro and Stiglitz (1984) and Fehr (1986) for discipline efficiency wages

⁴ 'Unemployment' is to be understood here in the sense of 'excess supply', in conformity with the use of the term in efficiency wage theories. I shall return to this issue in Section 15 below.

1 Qualification Queues⁵

Consider a market for a certain type of labour. Supply is \bar{N} . This labour is heterogeneous. The workers can be ranked according to their qualifications which can be determined by a test. Denote by $q(N)$ the qualification of worker number N and think of the workers ranked according to their qualification. So the best workers come first, and $q(N)$ will be a decreasing function of N . This is depicted in Figure 1

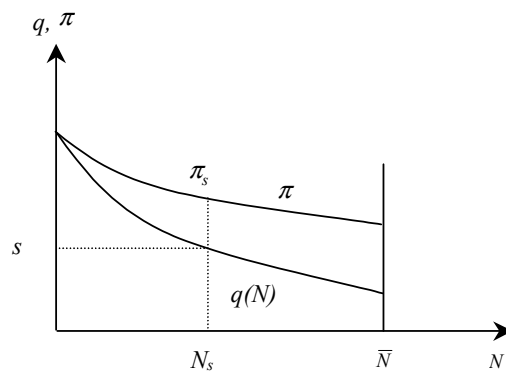


Figure 1

With workers ranked according qualification q , the qualification queue $q(N)$ gives the qualification of worker N . Average qualification is $\pi(N)$. At hiring standard s , N_s workers can be employed. Their average qualification is π_s .

If the N best workers are employed, their average qualification is

$$(1) \quad \pi(N) = \frac{1}{N} \int_0^N q(v) dv, \quad \pi' = -\frac{1}{N} (\pi - q) < 0,$$

as depicted in Figure 1

⁵ The idea of qualification queues relates directly to Thurow's (1975) 'job queues', where workers are ranked according to their trainability, as indicated by their background characteristics.

2 A Set of Equilibrium Candidates

Consider now labour demand. There are z identical firms. Physical labour input in a typical firm is n . As workers' qualifications differ so do physical labour input and effective labour input. Denote by α labour efficiency, i.e. the average qualification of the firm's work force. Effective labour input is obtained by multiplying physical labour input n by labour efficiency α . Each firm produces according to a production function $f(\cdot)$ which relates effective labour input to value added. It is assumed that the marginal product of effective labour f' is positive and decreasing:

$$(2) \quad f(\alpha n) \quad \text{with} \quad f' > 0, f'' < 0.$$

For given labour efficiency α , given labour input n and a given wage rate w , the firm's profit is:

$$(3) \quad f(\alpha n) - w \cdot n.$$

Labour efficiency is influenced by the firm's hiring standard. Let s denote the minimum qualification a worker must have in order to be hired by a typical firm, and consider first that all firms set the same hiring standard. The number of workers meeting these hiring standards can be read from the qualification queue as indicated in Figure 1. Algebraically, it is given as

$$(4) \quad N_s = q^{-1}(s).$$

The corresponding average qualification is

$$(5) \quad \pi_s = \pi(N_s).$$

As we are considering the case of identical firms which all set the same hiring standards, the average qualification of any firm's work force will be just the average qualification of those workers meeting the shared hiring standard. This is

$$(6) \quad \alpha = \pi_s.$$

For this labour efficiency and any given wage rate w , the corresponding profit maximising labour input is determined by the first order condition

$$(7) \quad f'(\alpha n) \cdot \alpha - w = 0.$$

As the first term gives just the expected marginal product of an additional worker, equation (7) is the usual marginal productivity condition for labour input. This determines the individual firm's labour demand.

The resulting total labour demand is obtained by multiplying the individual firm's labour demand n by the number of firms z :

$$(8) \quad N = n \cdot z$$

For a given hiring standard s , equilibrium is attained if demand equals supply, i.e. $N = N_s$. These equilibria are characterised by the two conditions

$$(9) \quad f' \left(\pi(N) \cdot \frac{N}{z} \right) \cdot \pi(N) = w$$

$$(10) \quad q(N) = s$$

which link the wage w , employment N and the corresponding hiring standard s . The solution N is the *employment function*. It gives employment as a decreasing function in the wage rate w :

$$(11) \quad N = N(w) \text{ with } N' = \frac{1}{f'' \cdot \frac{\pi}{z} q - f' \cdot \frac{1}{N} \cdot (\pi - q)} < 0.$$

The employment function is depicted, together with the qualification queue, in **FIGURE 2**

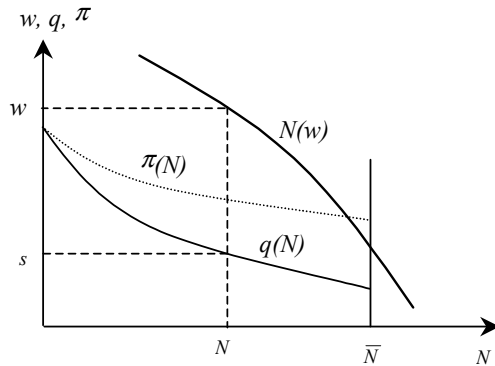


Figure 2

For any given wage w , the employment function $N(w)$ gives the corresponding equilibrium employment. The associated hiring standard is $q(N(w))$.

The labour employment function $N(w)$ gives the set of conventional market equilibria, each of them related to a different hiring standard $s = q(N)$. Each is characterised by a triplet (N, w, s) . Conventional analysis deals with the special case that the hiring standard is fixed independently of the wage rate. It explains the amount of employment in a labour market with heterogeneous workers, given such a standard. The case considered here is more general. As there is a continuum of hiring standards, there is also a continuum of possible equilibria, each belonging to one of these hiring standards. For any given wage rate, a hiring standard will emerge which clears the labour market. If the hiring standard is too low at that wage rate, firms will face an excess of workers which meet that hiring standard. This will induce them to tighten the standard. Conversely, if there are less workers of a given qualification available than required, firms will have to ease their standards. For any given volume of employment N , the hiring standard which emerges in the market will be that only the best N workers are employed, and wages just clear the demand and supply of the hiring standard which has been established. In this sense, the market can be taken to always be in equilibrium, and the employment function, along with the qualification queue, results in a set of conventional equilibria. These are our equilibrium candidates. The next step is to analyse which of these equilibrium candidates can be sustained and can, thus, be considered a true equilibrium.

3 Wages and Hiring Standards

Wages and hiring standards are not fixed externally but are set by the firms themselves in pursuit of their own goals.⁶ This thought allows us to discard some

⁶ Concerning market clearing it may be said that conventional analysis concentrates on the role of wages in market clearing while neglecting other instruments, like varying hiring standards, which may serve the same purpose. The real issue - how wages and these other instruments are combined - remains buried under the umbrella proposition that any problem may be rephrased in conventional terms. This is true, but it is also misleading. It is true, for instance, that we may consider labour of different qualification as belonging to different 'markets', each of them dealing with one fixed qualification. The heterogeneity problem discussed in the text would disappear from this perspective. The view is misleading if different qualifications are actually (in an institutional sense) traded in one market at one price, rather than in many markets at different prices. Under these conditions, the substantive problem of understanding the functioning of the heterogeneous market is substituted by formal problem of how a unified market may arise from a cluster of markets. In other words: The conventional approach tends to shift, rather than solve, the problems encountered in real world heterogeneous markets.

equilibrium candidates, as firms will have an incentive to deviate. Only those candidates which are supported by the firms' strategies for setting wages and hiring standards can be considered market equilibria.

Consider any equilibrium candidate, in the sense discussed in the previous section. Each single firm employs n workers. It pays the wage rate w equal to the market wage W and applies a hiring standard s equal to the standard S prevailing in the market. We may pose now the question what wage rate w , which hiring standard s , and which employment n the firm will select if all the other firms pay the market wage W and maintain the hiring standard S . As W and S pertain to an equilibrium candidate, we have

$$(12) \quad S = q(N(W)).$$

The firm considers how to deviate with its wage w from the market wage W . If the firm pays just the market rate ($w=W$) and imposes the shared hiring standard ($s=S$), it can recruit a workforce with just average qualification $\alpha = \pi(N)$. If the firm raises its wage offer, it will attract more applicants. It can afford to be choosier and can raise its hiring standard up to the point where it can just recruit the necessary number of new workers. (We think here of a flow equilibrium, where the firm loses workers continuously, due to quitting and retirement, and has to recruit replacement workers all the time.⁷) This will raise the efficiency of the firm's workforce α above average efficiency $\pi(N)$. Conversely, if the firm offers a lower wage, it will have fewer applicants, including qualified applicants, and it will have to lower its hiring standard. Eventually, the efficiency of its workforce α will settle below the average $\pi(N)$.

More formally, the firm's labour efficiency α can be viewed as a function of the *relative wage* $v=w/W$ and the volume of employment N . Employment determines the average efficiency of the available workers and is taken as given by the individual firm. The relative wage rate determines the relative number of applicants and ultimately – through its impact on the firm's hiring standard – the quality of the firm's workforce in relation to average efficiency $\pi(N)$:

$$(13) \quad \alpha = \alpha(v, N) \text{ with } \alpha(1, N) = \pi(N), \alpha_v > 0, \alpha_N < 0$$

⁷ We neglect the impact of wages on quits, as this is discussed in theories about turnover-efficiency wages, e.g. Schlicht (1978) and Salop (1979).

The first condition implies that if a firm pays the same wage as everybody else, it gets just an average selection of workers. The second condition implies that the relative wage a firm offers is positively associated with labour efficiency in that firm. The underlying mechanism is that a firm which offers higher wages can apply a more demanding hiring standard. This generates a better workforce. The third condition relates to the idea that only the best workers find employment. If employment increases, the less efficient workers must be hired as well, and this decreases average labour efficiency.

Given a efficiency curve like (13), the firm will face the problem of maximising its profits by selecting an appropriate wage $w=v \cdot W$ and an appropriate employment level:

$$(14) \quad f(\alpha(v,N) \cdot n) - v \cdot W \cdot n = \max_{n, v}!$$

Necessary conditions for a maximum are:

$$(15) \quad f' \cdot \alpha - v \cdot W = 0$$

$$(16) \quad f' \cdot \alpha_v \cdot n - W \cdot n = 0$$

If these conditions are not met, the firm will change its employment and the wages it offers. Condition (15) is again the usual marginal productivity condition. It is met by each of our equilibrium candidates. In order to determine employment, we have to look more closely at the other condition. This can be reduced, in view of (15), to the Solow-condition⁸

$$(17) \quad \alpha_v \cdot v = \alpha.$$

The condition can also be expressed in terms of the elasticity of efficiency η , defined as

$$(18) \quad \eta(v,N) = \frac{\partial \alpha}{\partial v} \cdot \frac{v}{\alpha}.$$

It would then read

⁸ See Solow (1979:80), Schlicht (1978:340).

$$(19) \quad \eta(v, N) = 1$$

If we look for equilibria (where no individual firm has an incentive to deviate with its wage rate w from the common wage rate W and thus selects a relative wage rate v equal to one), condition (19) turns into

$$(20) \quad \eta(1, N) = 1.$$

The interpretation of this condition is as follows: whenever condition (20) is not met, the firm will have an incentive to deviate with its own wage from the market wage. As all firms are alike, the market wage will move and cannot be sustained, and the equilibrium candidate cannot be an equilibrium. Assume that the elasticity of efficiency is greater than that of our equilibrium candidate ($\eta > 1$). Raising the wage w by one per cent above the market wage W will increase efficiency α by more than one per cent in this case. The efficiency of each dollar spent on wages is raised, so to speak, and it is profitable for the firm to set its wage above the market wage.⁹ Conversely, assume that the elasticity of efficiency is less than one ($\eta < 1$). If the firm lowers its wage by one per cent, the efficiency of its labour force will decline by less than one per cent, and it would benefit the firm to offer a wage below the market rate. In other words, a necessary condition for an equilibrium is that condition (20) holds true.

4 The Elasticity of Efficiency and Employment

The elasticity of efficiency (evaluated at an equilibrium candidate) will depend on two main factors: On the mobility of the workers and on the heterogeneity of the work force.

Mobility: If a firm intends to improve the efficiency of its work force by tightening its hiring standard, it must offer higher wages in order to attract additional applicants who would meet the more demanding requirements. If workers react strongly on wage differentials, a slight increase in the wage offer will suffice to accommodate a tightening of the hiring standard. If the supply of workers does not react significantly to wage changes, the firm would need very

⁹ If the firm has selected the optimal labour input for a given wage rate and thus satisfies the marginal productivity condition (15), $\eta > 1$ implies that the derivative of (14) with respect to the relative wage v is positive. Raising the relative wage will increase profit in this case.

large wage changes to accommodate comparatively insignificant changes in their hiring standard. Take a thinly populated area with small towns, and a firm operating in each of them. In this case of a ‘thin market’, the workers in the different towns form virtually non-competing groups. If a firm in one town wanted to attract more qualified workers, they would have to come from other towns, and it would be necessary to offer a wage that would make it worthwhile for the more qualified workers to commute. The situation would be different in a congested region with many firms. In such a ‘thick market’ it would be easy to attract more applicants by offering higher wages. The elasticity of efficiency would be greater. In this vein, we would expect an increase in the elasticity of efficiency in response to a decrease in transportation costs or an increase in the readiness to commute.

Heterogeneity. Significant mobility is, however, only a necessary but not a sufficient condition for a high elasticity of efficiency. If efficiency differentials between workers are insignificant, there is only a very limited scope for improving efficiency by tightening the hiring standard. With a homogeneous work force, we would, thus, expect a low elasticity of efficiency.

Employment. With increasing employment, hiring standards would have to be relaxed and heterogeneity of the workforce would increase. We can therefore assume that the elasticity of efficiency would increase with growing employment:

$$(21) \quad \eta_N(v, N) > 0 .$$

Condition (21) will enable us to envisage the process by which an equilibrium will come about.

5 Excess Supply and Unemployment: A Note on Semantics

Let me add a semantic note. In efficiency wage models, excess supply is routinely identified with the presence of unemployment.¹⁰ This is misleading. Efficiency

¹⁰ ‘All these models have in common that in equilibrium an individual firm’s production costs are reduced if it pays a wage in excess of market-clearing, and, thus, there is equilibrium involuntary unemployment.’ (Akerlof and Yellen 1986:1)). This erroneous phrasing is typical for the interpretation chosen by the various authors of efficiency wage models, including myself (Schlicht 1978). Some authors, like Lazear (1995:71) have partially avoided this pitfall. (Lazear

wage models do not explain unemployment, but rather excess supply in a labour market as an equilibrium phenomenon. It may well be the case that the workers looking for a job in the labour market under discussion hold other less attractive jobs elsewhere. These workers would be employed, although under less attractive conditions.

While it is true that involuntary unemployment implies excess supply in the relevant labour markets, the converse is not true. Hence efficiency-wage theories like the one presented here may provide important elements for a theory of unemployment in the sense that they help to explain persistent excess supply, but they do not explain the absence of cheap jobs for the unemployed.

It seems apposite to make this (mainly semantic) point explicit because many criticisms of efficiency wage theories seem to wrongly identify efficiency wages with the presence of involuntary unemployment, and go on by arguing that such unemployment cannot persist for some reasons, e.g., by offering the opportunity for creating cheap jobs. Such measures may eliminate involuntary unemployment, but would not necessarily turn efficiency wages into market-clearing wages, and would not eliminate the inefficiencies associated with efficiency wages.

6 Equilibrium

In FIGURE 3, the elasticity of efficiency $\eta(l, N)$ is depicted as a function of employment. Equilibrium employment is characterised by condition (20): The elasticity of efficiency is to be equal to one. If the elasticity of efficiency is larger than one ($\eta(l, N) > 1$), the discussion in Section 3 suggests that the typical firm has good reason to raise its hiring standard and increase its wage offer. As all firms behave in this manner, the wage level W rises and firms reduce their labour demand. Employment decreases and the elasticity of efficiency is reduced accordingly, until the equilibrium employment level N^* of is attained. At low employment levels ($N < N^*$) the elasticity of efficiency is be lower than one. The typical firm has good reason to lower its hiring standard and its wage offer. This will drive the wage level down and raise employment until equilibrium

starts a paragraph by noting what has been said above but concludes the very same paragraph by identifying efficiency wages with involuntary unemployment).

employment N^* is attained. The associated hiring standard is $s^*=q(N^*)$ and the wage level satisfies $N(w^*)=N^*$.

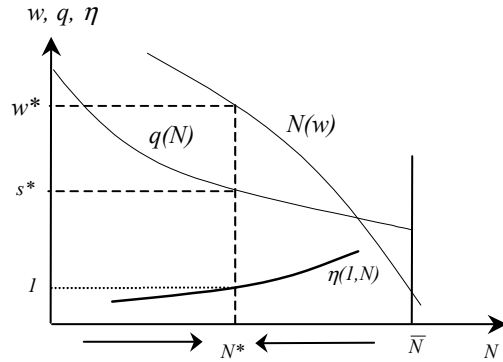


Figure 3

Equilibrium employment N^* and the associated wage rate w^* are characterised by the condition that the elasticity of efficiency is equal to one.

FIGURE 3 depicts the case of unemployment (excess supply) equilibrium. Such a case arises, if the elasticity of productivity at full employment is larger than unity. Otherwise, full employment is obtained in equilibrium (FIGURE 4).

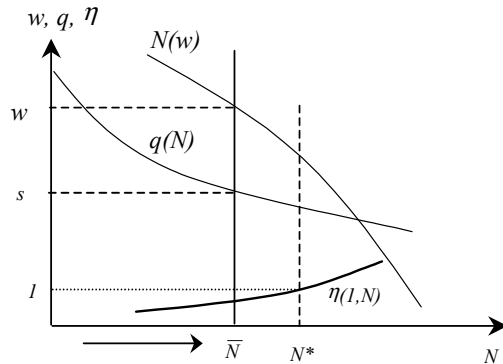


Figure 4

If the elasticity of productivity is less than one at full employment \bar{N} , full employment equilibrium obtains with wage w and hiring standard s .

7 Discussion

Seen from the outside, the equilibrium (w^*, s^*, N^*) introduced in the previous sections looks like a minimum wage equilibrium in the sense that more workers are looking for a job than are actually employed. It could also be interpreted as a market equilibrium in the sense that at the hiring standard s^* demand equals supply.

Productivity Differentials and Efficiency. Consider the case that all workers who do not meet the hiring standard s^* accept a lower paid and less preferred job in the secondary sector. Such a situation may appear as just a conventional equilibrium in two labour markets where the more productive workers obtain a better wage. As Lazear (1995:71) notes, it may be ‘difficult to distinguish between efficiency wage theory and an alternative view that simply says that there are high-ability and low-ability workers who sort across firms.’ This observation cuts both ways, however, and ought not be interpreted as favouring the market clearing view. The problem is actually not that easy to deal with. The efficiency wage view and the market clearing view are not mutually exclusive. Given any hiring standard, the market clearing view is actually correct. The hiring standard may, however, be determined by efficiency wage considerations like those addressed in this paper. This may give rise to inefficiency, and in this sense, the market clearing view may be misleading, as it would imply efficiency in this respect as well.

It is easy to see that such an equilibrium need not be efficient from a social point of view. The marginal product of the worker N^* who just meets the hiring standard is $f'(\alpha(l, N^*) \cdot N^*/z) \cdot q(N^*)$. Optimality would require this marginal product to be equal to this workers’ reservation wage, but this would occur only by coincidence, because the reservation wage will usually be determined independently of N^* .¹¹ If we take the case depicted in FIGURE 1 of a zero

¹¹ More formally, let $r(N)$ be the opportunity cost of employing worker N . The social benefit from employing the best N workers is

$$(*) \quad z \cdot f \left(\int_0^N q(v) dv \cdot \frac{I}{z} \right) - \int_0^N r(v) dv.$$

Maximisation with respect to N gives the necessary condition for a maximum as

cont.

reservation wage and a marginal efficiency positive throughout, the optimum employment is full employment \bar{N} . Equilibrium employment N^* would be inefficiently low. A similar argument can be made for any kind of reservation wage below the marginal productivity of labour, as it occurs in equilibrium.

Excess Supply. Equilibrium employment N^* is determined independently of labour supply \bar{N} . Excess supply $\bar{N} - N^*$ as such does not play any role regarding equilibrium. This contrasts with other efficiency wage models. In the shirking and turnover versions, excess supply ('unemployment') has an important incentive function to perform, in the sense that it reduces the workers' propensity to shirk or to quit. In these models, by taking excess supply out of the market (by retraining programs, for instance) firms will be induced to set higher wages in order to counter the increased propensity of the workers to shirk or to quit, and thus to allow excess supply to re-emerge. In the model discussed here, taking excess supply out of the market has no effect on employment or wage formation, as only the workers meeting hiring standards around and above s^* are of relevance for determining the equilibrium. The model may therefore contribute to understanding the puzzling phenomenon that wage formation has not been significantly affected by dramatic increases in unemployment, as observed over the last twenty years in Germany, for instance.

Product demand. If product demand increases, this can be captured in the model discussed here by an upward shift in the employment function. (If we start from an equilibrium candidate, the labour market is cleared at the corresponding triplet of employment, wage, and hiring standard. If product demand increases, labour demand will increase the hiring standard and wages. Another possible equilibrium

$$(**) \quad f' \cdot q(N) = r(N).$$

Let me note that the socially optimal number of firms is characterised by the additional condition

$$(***) \quad f - f' \cdot \pi = 0$$

which is derived from (*) by putting the derivative with respect to z to zero.

can be obtained by raising the wage rate while keeping employment and the hiring standard fixed at their earlier levels. The corresponding equilibrium candidate lies above the initial one.) The shift of the employment function will, however, not affect the equilibrium level of employment, which is determined by the elasticity of efficiency, being independent of product demand. The sole effect would be an increase in the wage level. This fact may contribute to the understanding of why demand-side policies sometimes fail.

Supply side policy. A similar consideration applies to supply-side policies that increase profitability. This would again translate into an upward shift of the employment function, as value added per worker is increased. The equilibrium condition $\eta(l, N^*) = l$ would remain unaffected, however. As a consequence, equilibrium employment and the hiring standard would stay put and the wage level would increase.

There are, however, other variants of supply side policy which affect labour supply. In the context of the present model, these are measures that would work, as such measures can affect the elasticity of efficiency. Let me discuss policies affecting mobility and heterogeneity. In the section 4 it has been urged that increasing mobility or increasing heterogeneity can be expected to increase the elasticity of efficiency. This would reduce employment. (In FIGURE 3, it would shift the η -curve up.) Hence policy measures which decrease mobility (an increase in the price of gasoline, for example) or reduce heterogeneity (like uniform training and testing programs for workers) would increase employment.

Spatial wage distribution. It well known that the wage level in congested regions exceeds the wage level to be found in sparsely populated regions. The selection theory presented here may help to solve this puzzle. As elaborated in the preceding section, thin labour markets are characterised by lower mobility, as perceived from the point of view of the firm. If the distribution of workforce qualifications as well as technology is comparable across sparsely populated and congested regions, we would expect a higher wage level to prevail in the latter.

Conclusion

The selection theory of wage formation provides an efficiency wage mechanism that differs from those traditionally discussed. It suggests that the simultaneous determination of wage offers and hiring standards may induce persistently non-cleared labour markets. The frequently encountered practice of screening

applicants suggests that the selection-wage mechanism may indeed be of considerable empirical relevance. The mechanism explored here shows that efficiency wage effects may crop up under conditions quite different from those discussed so far, and may entail quite different views about the relevant causalities and policy recommendations.

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Appendix: Long-Run Equilibrium

The argument has been restricted to the case of a fixed number of firms. In the long run, profits or losses will induce market entry or market exit, respectively. If this is taken into account, the employment function $N(w)$ and the elasticity of productivity $\eta(l, N)$ are to be parameterised by the number of firms z . We thus write

$$(22) \quad N = \tilde{N}(w, z)$$

as the employment equation (implicitly given by equation (9)) and

$$(23) \quad \eta = \tilde{\eta}(N, z)$$

as the elasticity of productivity, where $\tilde{\eta}$ refers to the case that each firm pays the equilibrium wage w and employment is given by the employment function. For any given number of firms z , the equilibrium employment level will be given as described in section 6 above: If the elasticity of productivity at full employment is less than unity, full employment will obtain. Otherwise, the employment level is fixed by the condition that the elasticity of productivity is equal to one. If, however, the elasticity of productivity is above one for all levels of employment, equilibrium employment will be zero.

$$(24) \quad \begin{aligned} \tilde{\eta}(N, z) &= 1 \text{ if } \tilde{\eta}(\bar{N}, z) > 1 \text{ and } \tilde{\eta}(0, z) < 1 \\ N &= \bar{N} \text{ for } \tilde{\eta}(\bar{N}, z) < 1 \\ N &= 0 \text{ for } \tilde{\eta}(0, z) > 1. \end{aligned}$$

The employment function (22) can be solved for the w to give the (candidate-) equilibrium wage rate corresponding to employment N and the number of firms z :

$$(25) \quad w = \tilde{w}(N, z) = f\left(\pi(N) \cdot \frac{N}{z}\right) \cdot \pi(N)$$

The associated profits of a single firm (evaluated at a given level of employment N and the associated equilibrium wage \tilde{w}) is

$$(26) \quad P(N, z) = f\left(\pi(N) \cdot \frac{N}{z}\right) - f'\left(\pi(N) \cdot \frac{N}{z}\right) \cdot \pi(N) \cdot \frac{N}{z}$$

In long-run equilibrium, profits must be zero:

$$(27) \quad P(N, z) = 0.$$

Long-run equilibrium is, thus, characterised by the two equations (24) and (27). The level of employment N and the number of firms z is constrained by these equations.

As to the existence of an equilibrium, it suffices to establish that equilibrium will exist under some plausible conditions, as no more general claim is made. For any given number of firms, there will exist an equilibrium level of employment, which may be anywhere between zero and full employment, these limits included. If we assume that the heterogeneity problem ceases to be important at very low levels of employment, as only the best workers will be hired anyway, we can assume that the elasticity of productivity will be small (less than one). Provided there is sufficient demand allowing for profitable production, a positive level of equilibrium employment will emerge. Assume that there exists, for a certain number of firms, a short-run equilibrium yielding positive profits. This will induce market entry. The number of firms can not increase without bounds, however. If z tends to infinity, profits (26) go to $f(0)$, that is, to the value-added of a firm with zero employment. It is reasonable to assume that $f(0)$ is indeed a negative quantity, due to fixed costs. Hence, for a sufficiently large number of firms, losses will occur, inducing market exit. For continuity reasons there must exist an equilibrium for a certain number of firms and a certain level of employment.

As to issues of stability and dynamic adjustment, we may view the movement of the variables z and N as driven by profit and the elasticity of productivity, respectively. First, the number of firms will expand if the typical firm earns a positive profit, and it will contract if there are losses. Hence we write:

$$(28) \quad \dot{z} = \lambda \cdot P(N, z)$$

with $\lambda > 0$ as a speed of adjustment.

Second, the change of employment will follow the movement of the curve giving the elasticity of productivity, as depicted in **FIGURE 3**: If the elasticity is above unity, firms will increase their wage and reduce their employment; if it is below unity, firms will lower their wages and increase employment. We write, hence

$$(29) \quad \dot{N} = \mu \cdot (1 - \tilde{\eta}(N, z))$$

with $\mu > 0$ as the corresponding speed of adjustment.¹²

The Jacobian of the system (28), (29) is

$$(30) \quad \begin{pmatrix} \frac{\partial \dot{z}}{\partial z} & \frac{\partial \dot{z}}{\partial N} \\ \frac{\partial \dot{N}}{\partial z} & \frac{\partial \dot{N}}{\partial N} \end{pmatrix} = \begin{pmatrix} \lambda \cdot f'' \cdot \pi^2 \cdot \frac{N^2}{z^3} & -\lambda \cdot f'' \cdot \frac{q}{z} \\ -\mu \cdot \frac{\partial \tilde{\eta}}{\partial z} & -\mu \cdot \frac{\partial \tilde{\eta}}{\partial N} \end{pmatrix}$$

As the trace (or divergence) of the system is negative (see (2) and (21)), this rules out a limit cycle.¹³ As the number of firms is nonzero and limited from above, and the level of employment is constrained between zero and full employment, there must exist at least one stable equilibrium of the system (28), (29)¹⁴.

The derivative $\frac{\partial \tilde{\eta}}{\partial z}$ is difficult to sign. It is reasonable, however, to assume that it is not large in size. If this is the case, or if this derivative is positive, the determinant of (30) will be positive, and this will establish a unique globally stable equilibrium.¹⁵

¹² This is, of course, a highly simplified analysis, as it depicts a high dimensional dynamical system (involving many firms) in only two dimensions. Alluding to the Moving Equilibrium Theorem (Schlicht (1997)) may defend this procedure.

¹³ According to the Bendixen criterion, see Lefschetz (1977:238). An oval going from and to a critical point is ruled out as well.

¹⁴ According to the Bendixen theorem, see Lefschetz (1977:230-31)

¹⁵ According to Olech's theorem, see Garcia (1972).

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