7. EFFICIENCY WAGES AND UNEMPLOYMENT

■ This lecture is concerned with the **causes and consequences of a minimal departure from the competitive labour market model**. We keep all the **traditional characteristics** that are usually seen as **underlying competitive market** behaviour such as a **multiplicity of buyers and sellers, a homogeneous product**, etc.

■ We then just add the feature that the **productivity of labour may depend positively on the wage**. We will demonstrate that there are good justifications for this idea, and that the macroeconomic consequences, mainly with respect to structural unemployment, are important.

■ We start out by giving a **simple example of efficiency wages**. We then consider the **consequences of efficiency wages in a partial equilibrium framework**, focusing on the optimal wage setting **in the individual firm**. Next section takes one step back to discuss the reasons for efficiency wages in more detail, that is, the reasons **why paying higher wages**

may be a way for an employer to increase the productivity of his employees. This section also considers some **empirical evidence in support of efficiency wage theory**. The following section analyses **efficiency wages in a macroeconomic setting**, developing a **general equilibrium model** determining the **equilibrium real wage and the structural rate of unemployment**. On this basis we discuss some possible **structural policies** to fight involuntary unemployment.

Efficiency wages: a basic example

■ The **idea that compensation is important for productivity** could well be an **old one**. Consider a cotton farm where **labour input comes from slaves** owned by the landlord. Assume that the **landlord** does not care about the well-being of the slaves, but only **sees them as labour power**. The landlord provides **food and shelter** for the slaves and their families and will be faced with a basic **trade-off when he decides on the quantity and quality of food and shelter to provide**. Think of this amount as the **slaves' "wage"**.

■ The **wage has to have a certain level just to keep the slaves alive**. Above this minimum level, **a higher wage will mean less miserable lives and better health** for the slaves, and **better health means higher productivity**.

■ So, a **higher wage has a positive influence on the profits** of the farm due to the improved **productivity** of the slaves, and a **negative influence due to the higher costs** of providing the slaves with the necessities of life. **When the wage is still close to the minimum level**, the **productivity effect should be large and dominate the cost effect**, because a higher wage in this range will prevent the slaves from being physically weak and ill most of the time. The **wage should thus, for pure profit reasons, be raised above this minimum**.

■ However, **at sufficiently high wages**, the c**ost effect of an increased wage will dominate the productivity effect**, since only little further improvement in the slaves' health conditions can be obtained by higher wages if the health conditions are already good. So the wage should, for pure profit reasons, be set lower than that. **In between there has to be an "optimal wage"**, a level of provision of food and shelter for the slaves **at which the positive productivity effect and the negative cost effect just offset each other**.

■ Starting from this optimal wage, **a 1 per cent increase in the wage**, meaning a 1 per cent increase in the labour cost of one slave, **must also imply a 1 per cent increase in the output** of each slave. If the increase in productivity (production per slave) were larger than 1 per cent, then the 1 per cent increase in wage would increase profits, and the original wage could not be optimal. **At the optimal wage the elasticity of productivity with respect to wage thus has to be exactly 1**, a famous condition of which you will hear more in this lecture.

■ Under **slavery** there are **pure health reasons for a positive influence of wages on productivity**. In **developed economies** we would perhaps **not expect health to be an important reason** for such an influence, but as we shall see, there may be other reasons. In so far as there is a positive connection, a **modern firm will be faced with a trade-off concerning wages** similar to the one faced by the slave owner. This **trade-off in wage determination may have serious macroeconomic implications**, as this lecture will demonstrate.

■ A **positive influence of pay on productivity can be the cause of structural unemployment** and may therefore motivate structural policies intended to fight the permanent part of unemployment.

A first look at the consequences of efficiency wages in a partial equilibrium framework

A simple partial equilibrium model

■ Consider a s**ingle firm that produces output from labour** input L. Let the **total revenue** of the firm be $zR(L)$, where we assume that $R'(L) > 0$, and $R''(L) < 0$, and where $\boldsymbol{z}$ is just a multiplicative **shift parameter**. We can think of **revenue as price times production**, so $zR(L) = zp(f(L))f(L)$, where $\boldsymbol{f(L)}$ **is the production function**, $\boldsymbol{p(y)}$ **is price as a function of output** $y = f(L)$, and $\boldsymbol{z}$ **is a (demand) shock to** $\boldsymbol{p}$, or a **(supply) shock to** $\boldsymbol{f}$.

■ **If the firm is a perfect competitor on the output market the function** $\boldsymbol{p}$ **is constant**, and in that case the revenue curve R must have its property $R'' < 0$ from $f'' < 0$. **If the firm is large on the output market,** $\boldsymbol{p(y)}$ **can be a downward sloping curve** associated with a downward sloping (inverse) demand curve. For a clean argument **we will first**, and only temporarily, **depart from the conditions usually seen as underlying wage-taking behaviour** and assume that the **firm is a monopsonist**, the sole buyer, on the labour market. The **firm faces an upward sloping labour supply curve**, $L^S(w)$, **coming from many wage-taking workers**, as illustrated in Figure 7.1.

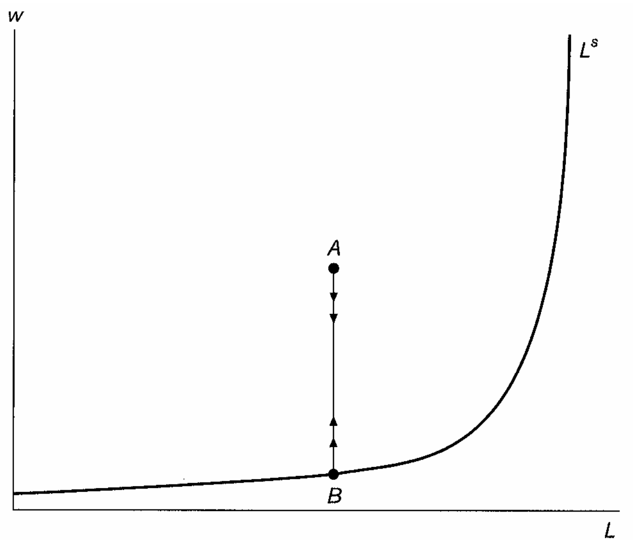

Figure 7.1: Positioning oneself above or on the labour supply curve

■ The **firm sets the (real) wage *w***, and it also **decides how much labour *L* to buy**. It must, of course, obey the **restriction** $L \leq L^s(w)$. The **profits of the firm** are $zR(L) - wL$.

■ **Such a firm would never choose a combination (*w*, *L*) above the labour supply curve**, like the point A in Figure 7.1. From a position above the labour supply curve the **firm can lower the wage rate and buy the same amount of labour**, that is, it can **move vertically downwards from *A* towards *B***, which **lowers labour costs**, wL, **leaves revenue**, $zR(L)$, **unchanged**, and hence unambiguously **raises profits**.

■ Likewise, **moving upwards from *B* means buying the same amount of labour more expensively**, which unambiguously lowers profits. Therefore the **firm will position itself on the labour supply curve** which means that there will be **no unemployment**: the firm wants to **buy the full amount of labour supplied at the going wage rate**.

■ This **argument assumes that productivity does not depend on pay**. The **wage rate does not enter the revenue curve**. Assume now that **there is a positive influence of the wage** rate on the productivity of labour, and that the **relationship is given by the function $a(w)$**, where **a is productivity** and $a' > 0$. The **revenue curve** will then be $zR(a(w)L)$, which we can think of as $zp(f(a(w)L))f(a(w)L)$.

■ A first important insight is that it is **no longer necessarily true that moving downwards from a point like A increases profits**, or that **moving upwards from a point like B decreases profits**. Moving **upwards from B still means that the firm buys the same number of hours of work at a higher price per hour**, which raises labour costs wL, but it also means that the **revenue**, $zR(a(w)L)$, **increases**, because $a(w)$ increases. The **latter effect may dominate**, and in this case the firm will prefer a point above B to the point B itself.

Analysing the model

■ The **phenomenon of a positive dependence of productivity on wage** is called "**efficiency wages**" (wages that work to promote productive efficiency). We have argued that **efficiency wages may undermine the argument that a monopsonist wage setter would never position itself above the labour supply curve**.

■ To show that the firm's **optimal combination of real wage and employment could actually be above the labour supply curve**, one must study the full **optimization problem** of the firm which is to choose w and L to maximize profits $zR(a(w)L) - wL$, subject to the constraint $L \leq L^s(w)$. It is a usual **trick to first look at the unconstrained optimization** (disregarding $L \leq L^s(w)$). If this gives a combination (w^*, L^*) that fulfils the constraint, $L^* \leq L^s(w^*)$, the constrained optimum will also be (w^*, L^*).

■ The **first-order conditions** for an unconstrained **maximization of** $zR(a(w)L) - wL$ **with respect to** $\boldsymbol{w}$ **and** $\boldsymbol{L}$ are:

$$zR'(a(w)L)a'(w)L = L \tag{7.1}$$

$$zR'(a(w)L)a(w) = w \tag{7.2}$$

■ From the second of these, $zR'(a(w)L) = w/a(w)$. **Inserting into the first condition** gives:

$$\frac{a'(w)w}{a(w)} = 1 \qquad 7.3$$

■ You will recognize this as the **condition we derived in the discussion of the slave** economy above: the **wage rate should be set at a point where the elasticity of labour productivity with respect to the real wage is 1** (if there is such a wage rate and if the optimum is interior). The intuition is also the same, but worth elaborating now that we have a formal framework.

■ **In the absence of efficiency wages**, **output and revenue is produced by labour** input **measured in hours**, *L*, and **profits** are $zR(L) - wL$. **Whatever the optimal value of *L*** turns out to be, it **must be profit maximizing to buy that amount at the lowest possible cost**, *w*, per unit, so the **firm should set *w* at the lowest level required for buying *L***.

■ **In the presence of efficiency wages**, output and revenue is produced by **labour input measured in efficiency units**, $a(w)L$, and profits are $zR(a(w)L) - wL = zR(a(w)L) - (w/a(w))a(w)L$.

■ **Whatever the optimal value of $a(w)L$** turns out to be (and note that for varying w one can keep $a(w)L$ fixed by adjusting L appropriately), it **must be profit maximizing to acquire that amount of labour in efficiency units at the lowest possible cost, $w/a(w)$**, per unit, so w **should be set to minimize $w/a(w)$**.

■ The **numerator here is the price of one hour of work**, and the **denominator is the number of efficiency units arising from one work hour**, so the **fraction is the price per efficiency unit**. Hence, **$w/a(w)$ should be minimized** which, if the minimizing wage rate is interior (not 0 and not infinite) **requires that a 1 per cent increase in w exactly gives a 1 per cent increase in a** (if it gave more, $w/a(w)$ could be lowered by increasing w, etc.). This is exactly what is stated in (7.3), the so-called "**Solow condition**". The condition is named after the Robert M. Solow you know from growth theory.

■ The wage rate w^* **of an interior optimum is the solution** to (7.3) and it is thus **given by the efficiency function $a(w)$ alone**. To find the **optimal labour demand**, L^*, one **inserts w^*** into (7.2) and **solves for L**. For w fixed at w^*, this **equation** is the usual one **saying that the marginal cost of one hour of work should equal the marginal revenue** that the hour gives rise to. Still assuming an interior optimum, (w^*, L^*) is simply given as the **solution to the two equations** (7.2) and (7.3). It may well be that $L^* < L^s(w^*)$, and in this case the unconstrained optimum is also the constrained optimum. Furthermore, **if it happens to be the case that $L^* < L^s(w^*)$**, then there is **unemployment in an equilibrium with a fully-adjusted wage rate**.

■ **Can one be sure that the unconstrained optimum is indeed interior** and that it is **given by the first-order conditions?** This **depends on the shapes of the functions R and a**. Assume that the **efficiency function**, $a(w)$, looks like the **thick curve** shown in Figure 7.2.

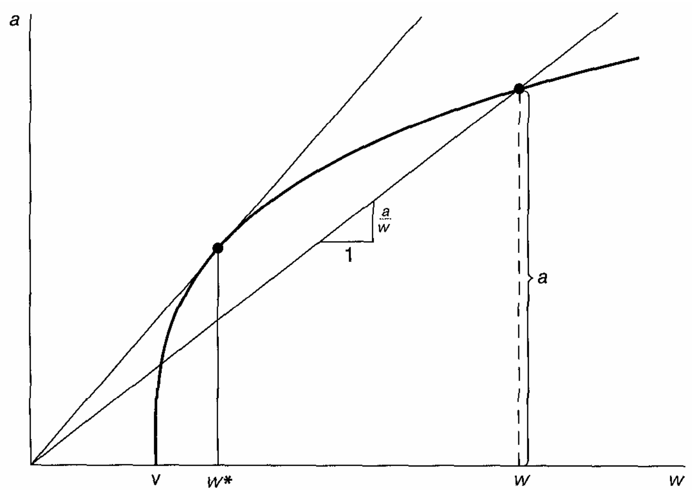

Figure 7.2: An efficiency curve and the optimal wage rate

■ The **wage rate *w* has to be above a certain minimal level, *v*, to obtain positive productivity at all**, and the **marginal increase in productivity** obtained by a given increase in the wage is **decreasing in *w***, but **possibly large for wages close to *v***.

■ For any given wage rate w, the **fraction $a(w)/w$ is the slope of the ray** through the origin and the point $(w, a(w))$. **For profit maximization this slope should be maximized, since $w/a(w)$ should be minimized**. The **maximal slope** is obtained just **where the ray becomes a tangent to the a curve** as indicated by the ray most to the left in Figure 7.2, that is, at the wage rate w^* where the slope $a'(w^*)$ of the a curve is equal to the slope $a(w^*)/w^*$ of the ray. Note that $a'(w^*) = a(w^*)/w^*$ is equivalent to the Solow condition.

■ **Given an efficiency curve** as in Figure 7.2, the **optimal wage rate is indeed interior** ($0 < w^* < \infty$) and **given by the Solow condition**. Standard assumptions on the revenue curve, e.g. $R'(0) = \infty$, ensure that the **full unconstrained optimum is interior** and **given by the first-order conditions**. The **shape of the efficiency curve** in Figure 7.2 **was not just chosen to ensure a well-behaved optimum**. It seems reasonable, and it was the **kind of shape that was implicitly argued in our slave economy** example above.

■ We started this lecture by saying that **we would consider a minimal departure from the competitive labour market** and keep all the other characteristics usually seen as underlying wage-taking behaviour. We then, **nevertheless, assumed that the firm was a monopsonist** on the labour market. However, **if there were many buying firms** the **labour market** would, with the efficiency wage effect, **work essentially as under monopsony**.

■ **With many firms** on the labour market the s**ituation of each firm is just as the situation for the monopsonist**. Usually we would say that **many firms should imply that each firm is a wage taker**, so no firm sets a wage rate. The informal **argument behind** this is that if there are **many buyers**, **no buyer can get away with lowering the price** (compared to the "going market price"), because then **no one would want to sell to that buyer**, and **no buyer would be interested in setting a higher price**, since the **buyer already gets the demanded quantity at the going price**. Therefore each buyer takes the price as given.

■ Here, however, we have a **situation** where a **buyer may want to pay a price above the market clearing level**. **Nothing prevents a buyer from setting a higher price**. If there were many firms on the labour market, each identical to the firm considered above, then **each of these firms would have an unconstrained optimum**, (w^*, L^*), as the one above, and **total (unconstrained) labour demand would be L^* times the number of firms** which could still be **smaller than $L^s(w^*)$**.

■ There would then be **unemployment in an equilibrium with fully-adjusted wages**. Thus we **do not have to think of the labour market as a monopsony**. All the **characteristics usually seen as underlying perfect competition, many buyers and many sellers, etc., can be fulfilled**, and still, with the efficiency wage effect, the labour market will work as described.

Discussion of the model's main implications

■ The partial equilibrium model above shows that **efficiency wages can potentially cause unemployment in an equilibrium with fully-adjusted wages** if $L^s(w^*)$ happens to be greater than L^* times the number of firms. In the partial equilibrium model e**fficiency wages do not necessarily imply unemployment**.

■ Assuming that there is unemployment in equilibrium, the **model has the implication that variations in the supply/demand shift parameter *z* do not affect *w***, since the **optimal wage rate is given entirely by the efficiency function** $a(w)$. Changes in ***z* only affect *L***, and high values of z go with high values of L.

■ **This fits well with**, and can be part of an explanation of, **one of the most important empirical facts of the business cycle**: that **real wages are weakly correlated with output over the cycle**, while **employment varies positively and is strongly correlated with output**. For this consideration we **view *z* as a shock variable**.

■ However, the **same result does not fit well with the stylized fact of growth, that in the long run real wages increase in proportion to labour productivity**. Now we **view *z* as a long-run trend in productivity**. In the **model above** a steady and gradual **increase in *z* will have no influence on the real wage rate**. Counterfactually, the **real wage will remain at a given level despite** the steady **growth in productivity**.

■ One **might think** that this is a **serious problem for the efficiency wage model**. However, the **phenomenon is an artifact of the simple partial equilibrium framework** we have considered. We will argue below that the **productivity of the workers in each firm should really depend on the excess of the wage paid in the firm over the "normal income" in society**.

■ For instance, **what makes workers provide more effort is not the wage as such**, but a **wage rate in excess of what could normally be expected**. Furthermore, **if there is a trendwise increase in normal incomes** due to an increasing trend in productivity, it should be the **relative excess of the wage over normal income that motivates effort**.

■ So the **efficiency function should be like** $a(w)$ = $a(w) = \tilde{a}([w - v]/v)$, where $\tilde{a}$ is an increasing function and v is "normal income". In that case the **optimal wage in each firm will be determined relative to** $\boldsymbol{v}$, and **if** $\boldsymbol{v}$ **increases, so will** $\boldsymbol{w}$, while as long as v stays relatively constant, so will w. Hence, **if the expected normal income** is not affected (much) by short-run shocks to z, but is **affected by permanent trend changes in** $\boldsymbol{z}$, then we can have a **situation where the real wage rate does not respond (much) to random fluctuations in productivity**, but does **increase proportionally to permanent productivity**.

■ The **essence of the explanation of unemployment** offered by efficiency wage theory is this: **employers (not employees) drive up wages** to attain an optimal level of productivity from each hired worker, and the **wages thus determined (by the employers) may be so high that the employers do not want to hire all the workers who want jobs at those wages**. The **unemployment** that results is **truly involuntary**. The **workers** really want to have jobs at the going wages, and they are **in no way responsible for wages being so high**.

■ The plausibility of this explanation of structural unemployment stands and falls with the plausibility of the efficiency wage phenomenon. Are there **good reasons to believe that productivity is positively affected by wages?**

The causes of efficiency wages

The four traditional reasons

■ **Besides the health argument**, which we do not consider to be very important in developed economies, usually **four reasons** are given for why labour productivity depends positively on (above average) pay. For more about these reasons and their implications, consult the informative survey by Janet **Yellen**, "Efficiency Wage Models of Unemployment", *American Economic Review*, 74, 1984.

■ **Keeping the workers in the firm.** Paying wages that are high relative to what the workers could otherwise earn gives the workers an **incentive not to quit their jobs so easily**. This **reduces labour turnover** in the firm and **saves the firm costs of recruiting** new employees who are **not fully productive until they have been trained**. Thus, on average the productivity of the workers in the firm will be higher.

■ **Getting good workers when hiring.** Every now and then **some workers quit** their jobs for various reasons and the **firm will want to hire new** employees. It is realistic to assume that when it hires new workers, the **firm cannot perfectly observe the abilities of each**

applicant, and that **workers with higher ability will also demand a higher wage** to be willing to accept a job offer. By **offering relatively high wages**, the firm will thus be able to **recruit the more able** applicants, thereby obtaining a more favourable composition of its workforce. This **raises average labour productivity** in the firm.

■ **Making the workers in the firm work hard I.** Assume realistically that the **firm cannot perfectly monitor the effort** exerted by each and every worker **all the time**, but that it can **from time to time**, by some **control mechanism**, **observe the effort levels of some** of the workers.

■ Assume further that **workers who are caught not exerting an effort level as required** by the firm are **fired**. A relatively **high wage will then create an incentive for the individual worker to work hard** (as hard as required) since the **cost of being fired is the difference between the wage** paid in the firm and the **income that could be earned outside** the firm through **unemployment benefits** or **alternative jobs**.

■ **Working less hard** than required by the employer is sometimes **called "shirking"**, but note that the effort level required by the employer could well be high. The model of efficiency wages based on the motive explained here is often called the "**shirking model**".

■ **Making the workers in the firm work hard II.** While the **incentive effect** just described **builds fully on self-interested "rationality"** in the usual sense, it **may also be that workers** who are paid well compared to what is normal **will work hard simply because they feel that they are treated well** and **want to be nice to people who are nice to them**.

■ Note that here it is **not the risk of being fired that motivates** the worker to work hard, **but pure reciprocity**: the wish to respond to nice behaviour with nice behaviour. This is **not irrationality**. What is argued is that **"treating others as they treat you" increases a person's well-being**, and therefore **reciprocity is in full accordance with utility maximization**.

■ It is **not just individual income and consumption that give utility**. The other side of reciprocity is that a **low wage will be responded to by low effort**. The reciprocity-based model of efficiency wages was presented in the article by George A. **Akerlof** and Janet L. **Yellen**, "The Fair Wage-Effort Hypothesis and Unemployment", *Quarterly Journal of Economics*, 105, 1990. The article reports **plenty of evidence that high wages imply high effort** and **low wages create low effort for "emotional" reasons** based on feelings of **loyalty, gratitude, anger, injustice**, etc.

A closer look at the shirking model

■ We will present the **shirking model of efficiency wages in a little more detail** to illustrate how the **positive effect of wages on productivity may be given a microeconomic foundation**. In this subsection we study some elements (the worker incentive part) of the theory suggested by Carl **Shapiro** and Joseph E. **Stiglitz** in "Equilibrium Unemployment as a Worker Discipline Device", *American Economic Review*, 74, 1984.

■ Consider a **firm** that is currently **employing a certain number of workers**. Assume that for each worker the **utility of working in the firm** at the wage rate w exerting the effort level a is $w - c(a)$, where $c(a)$ is a convex **effort cost function**, $c' > 0$, $c'' > 0$, $c'(0) = 0$, and $c'(a)$

$\to \infty$ as $a \to \bar{a} > 0$, where possibly $\bar{a} = \infty$. The worker's **utility outside the firm would be** ***v***, which reflects what can be obtained by **unemployment benefits, home production, alternative jobs**, etc. The worker gets **utility *v* if** he or she is **fired**.

■ The **employer presents the worker with a contract** $(w, \hat{a})$ that specifies the **wage** w **paid** and the **effort level** $\hat{a}$ **demanded**, where $\hat{a} < \bar{a}$. The employer can only **imperfectly monitor the worker's effort**.

■ **Shirking**, which means $a < \hat{a}$, is **discovered with probability** q, where $0 < q < 1$. A worker who is **discovered shirking will be fired**. The **expected utility of an employed worker** in case $a \geq \hat{a}$, which is non-shirking, is $w - c(a)$, and in case $a < \hat{a}$, which is shirking, the expected utility is $(1 - q)[w - c(a)] + qv$.

■ Since $\boldsymbol{c(a)}$ **enters negatively** in the worker's utility, it **never pays to provide "too much" effort**, so **if a worker does not shirk the effort will be exactly as required**, $a = \hat{a}$, and **if a worker does shirk the effort will be** $\boldsymbol{a = 0}$. Therefore the **condition stating that non-shirking is at least as good as shirking** is $w - c(\hat{a}) \geq (1 - q)w + qv$, or:

$$w \geq v + \frac{c(\hat{a})}{q} \qquad 7.4$$

- This is the **no-shirking condition**, and it is illustrated in Figure 7.3.

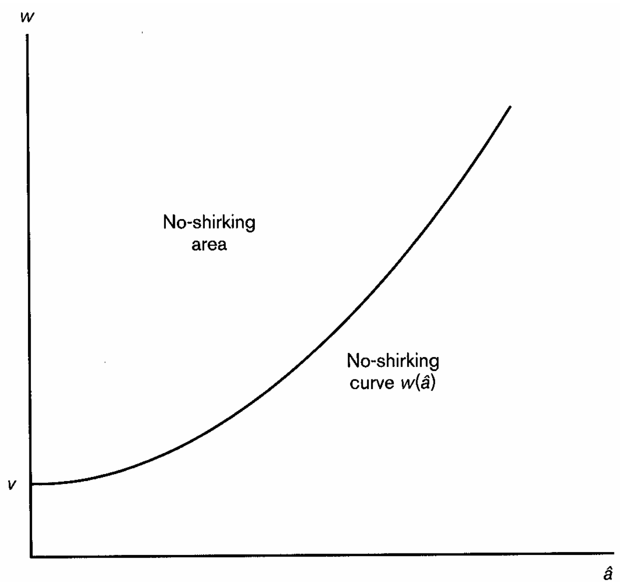

Figure 7.3: The no-shirking condition

■ From the **point of view of the employer** this condition states **how high a wage must be paid for all employed workers to provide a given demanded effort** level $\hat{a}$. Note that the required **wage is increasing in the demanded effort** $\hat{a}$, **decreasing in the probability** q **of detecting shirking**, and **larger than**, and **increasing in, the alternative income** v.

■ Since it **does not pay** for the employer **to offer a higher wage than required for a given effort**, one may as well **write the no-shirking condition with equality**. This gives the combinations of $\hat{a}$ and w indicated by the curve in Figure 7.3.

■ One **can read the condition inversely** as stating **how large an effort each worker will provide for a given wage rate** w. This corresponds to **"reading" Figure 7.3 from the *w*-axis**, that is, with ***w* as the independent variable**, and from this point of view the curve in Figure 7.3 looks exactly like the curve in Figure 7.2 above.

■ The **curve** in Figure 7.3 e**merges from solving the no-shirking equation** for $\hat{a}$. With the assumed properties of the function $c(a)$, this can always be done. One will then arrive at a

function giving the effort level as a function of *w*, *v*, and *q*, that is, a function $a = \hat{a}(w, v, q)$. This function will only assume positive values for w larger than v, it will be increasing in w, decreasing in v, and increasing in q.

■ One **particular form of the effort cost function** that fulfils all the assumptions above and allows us to solve the no-shirking equation analytically is $c(a) = \beta a^{1/\eta}$, where $\beta > 0$ and $0 < \eta < 1$. Using (7.4) with equality gives:

$$a = \hat{a}(w, v, q) = \left[\frac{q}{\beta}(w - v)\right]^{\eta} \qquad 7.5$$

■ The efficiency function that was considered in the partial equilibrium model of above could well have taken the form $a(w) = k(w - v)^{\eta}$, where we have defined $k \equiv (q/\beta)^{\eta}$. Indeed, in Figure 7.2 the efficiency function was drawn exactly that way.

■ The **shirking model** of efficiency wages gives mainly **three insights**.

- First, it gives us an **optimizing behaviour rationale** for the idea of a **positive effect of wages on productivity**.
- Second, it suggests that it is **only for wages above a certain base level that the positive effect on productivity starts to be felt**.
- Third, it gives the interpretation of that b**ase level** as, more or less, the **"normal" income that a worker could obtain if separated from the firm**. This normal income is therefore often referred to as the **worker's "outside option"**.

■ Note that the **other three motives for efficiency wages** mentioned above **have the same character**. It is **only if a firm's wage is above normal** pay that workers will have a special **incentive to stay in a firm**, or to **apply for a job in a firm**, or have **reason to feel particularly well treated by the firm**. Therefore it is only for wages above an alternative or normal level one should expect positive effort, and more effort for higher wages. So, all the **motivations for efficiency wages point to efficiency functions like** $a = k(w - v)^{\eta}$.

Empirical evidence in support of efficiency wages

■ **Akerlof** and **Yellen** have provided **empirical evidence supporting** their theory of efficiency wages based on **reciprocity**. A survey by the Swedish economists Jonas **Agell** and Helge **Bennmarker** ("Endogenous Wage Rigidity", CESIFO Working Paper No. 1081, Category 4: Labour Markets, 2003) presents the results from a **survey among Swedish human resource managers**. The survey is **more representative** than earlier surveys and includes many firms (1200) and covers the relevant production sectors and firm size categories. The response rate obtained was very high (75.1 per cent).

■ An additional feature that makes the **Swedish survey particularly interesting** is that by the spring of 1999, **when the survey was done, unemployment was high**, around 10 per cent after having peaked at 13.6 per cent in 1994, while **inflation was close to zero** and had been very low for some years, on average 1 per cent per year over the preceding five years.

■ This is a **good environment for studying wage rigidity and resistance to wage reductions**. Since **unemployment was high**, **real wages should fall in the absence of real wage rigidity**, and since **inflation was low**, **real wage cuts** of substantial size could only be **achieved by nominal wage cuts**.

■ Hence, **to see if firms resisted real wage cuts** one could simply **ask the human resource managers if they had cut (nominal) wages** and related questions.

■ Table 7.1 presents some of Agell and Bennmarker's results in the form of some of the questions asked and some crude statistics on the answers obtained.

Table 7.1: Selected results from Swedish survey by Agell and Bennmarker

Question	Answer
1. Cut base pay during crisis years of the 1990s?	3.2% affirmative
2. Encountered undercuttors?	13.5% affirmative
3. Rejected offers by undercutters?	89.6% affirmative
4. Undercutting rejected because it “violates firm's personnel policy; creates internal conflict”?	29.5-41.7% affirmative depending on sector
5. Extent to which it can be evaluated if	49.3% less than certain about

an employee performs satisfactorily?	performance
6. Implication for work effort if wages/salaries are increased in comparable firms?	65.9% answered impairment, great or small
7. Do employees who are dissatisfied with their pay normally reduce effort?	49.0% affirmative
8. Do employees who are dissatisfied with their pay normally seek employment elsewhere?	58.5% affirmative

Source: Jonas Agell and Helge Bennmarker, "Endogenous Wage Rigidity", CESIFO Working Paper No. 1081, Category 4: Labour Markets, 2003.

■ From the table's **first line** it appears that **only 3.2 per cent of the firms** answered in the **affirmative** to the question **whether they had cut regular base pay at any time during the crisis years** of the 1990s (and most of the firms that had cut wages reported that they had **done so for only few** employees, **not for employees in general**). This means that **wage cutting by firms was not widespread despite very high unemployment**.

■ The **next two lines** are related to the first one. Active **underbidding by workers** (job seekers **offering to work under conditions inferior to those normally offered to new employees**) was quite **rare despite the circumstances**. Even more striking, when the **firms** were faced with undercutters a huge **89.6 per cent of them rejected the offers**, which may **explain why undercutting is so rare**.

■ These **findings are consistent** with the theory of **efficiency wages**. As we have just seen, to **induce an appropriate level of productivity** each firm must **pay an individual wage that is sufficiently high** relative to normal pay, or the outside option. This **outside option** is, of course, heavily **influenced by what other firms pay**.

■ Hence, the **individual firm may be reluctant to be the first to cut wages** because, as long as the **other firms have not yet cut** their wages, this will imply a **substantial loss of productivity**.

■ **If the firms could coordinate to cut wages simultaneously** the **productivity drop would not be large** because **normal pay would drop at the same time**, but such a coordination **task is too complex** in an economy with hundreds of **thousands of firms**. Hence the theory of **efficiency wages** may **imply some "relative wage resistance"** (reluctance to decrease one's own wage compared with the wages of other firms) that can provide an **explanation for the findings in the first three lines** of Table 7.1.

■ **Other explanations could be possible**, and therefore the survey of Agell and Bennmarker includes some **questions that relate more directly to the theory of efficiency wages**. As one can see from the **fourth line** of the table, when the **managers were asked to explain why they would not accept the offers of undercutters**, a substantial fraction of them indicated the reason that **acceptance would "violate the firm's personnel policy; create internal conflict"**, a motivation clearly related to how pay affects average productivity.

■ The **managers were also asked** how well they **can monitor work effort**. This is of importance for the shirking model where the **assumption of imperfect monitoring is**

essential. The **fifth line** of the table shows that around **half the firms** indicated that they were **less than certain about work performance**.

■ The table's **sixth line** shows the **question of most direct relevance for efficiency wages**. It asks the subtle question **how workers' effort would be affected by a wage increase in other firms**. According to efficiency wage theory this **should reduce effort** by increasing the workers' outside option. As can be seen, a great **majority of firms** answered that a **wage increase in other firms would indeed affect work effort in their own firm negatively**.

■ The **seventh and eighth lines** of the table show that it is **widely believed among managers that employees who feel their pay is too low will reduce their effort or seek employment elsewhere**. These answers are in line with the **reciprocity motivation** and the **labour turnover motivation for efficiency wages**, respectively.

■ Overall the survey by **Agell** and **Bennmarker** provides a good deal of **evidence** that the **productivity of a firm's employees is positively affected by the excess of the firm's wages over normal incomes**, which is the **central idea of efficiency wage theory**.

Efficiency wages in a macroeconomic framework

■ So far we **took the revenue curve of the individual firm as given**. This was what made it a **partial equilibrium analysis**. We will now **consider the full production side of the economy** and be specific about **how each firm's revenue is associated with the demand for its output**, and **how this demand is derived from the behaviour of the household sector** of the economy.

■ Our analysis will consequently be one of **general equilibrium**. This will enable us to show that the **equilibrium unemployment rate in an economy with efficiency wages will indeed be positive**; a **result we could not establish with certainty in our partial equilibrium** framework.

■ We will study a **general equilibrium model** intended to picture relevant aspects of the **entire (macro)economic system**, just as we did in the lectures on growth theory. There will be an **important difference**, however. The model of this lecture will have only one period and hence **no capital** and no savings. The **only input in production will be labour**, and the only task of **consumers** will be to **allocate their total income and consumption across different products**. This is because our **focus** is not on growth and capital accumulation, but on the **determination of the rate of structural unemployment** in a single period. As usual in economics we **simplify dramatically**, so our model will only involve the few aspects we find most important for the problem we are analysing.

A macroeconomic framework

■ We will take the view that the **product of each firm is a little different** from the product of any other firm, so that each firm is the **sole producer of a specific type of output**. Hence each firm is a "**local monopolist**" and **sets the price of the commodity type it produces**.

■ This **does not mean that each firm** necessarily **has a lot of market power**. Its output may be in **close substitution with the products of other firms**, making **demand highly sensitive to price**, implying that the **control over the price cannot be exploited much**.

■ Since **firms are not price takers**, but **set prices themselves**, there is **imperfect competition in product markets**. The **particular form of imperfect competition** where each firm is a local monopolist is called **monopolistic competition**.

■ To be specific, we assume that there are ***n*** **firms each producing a separate type of output**. The **number of firms is large** so **each firm is large in its own output market**, but **small relative to the entire economy**.

■ The **demand (curve) for each output type** $i = 1,\dots, n$ is

$$D(P_i) = \left(\frac{P_i}{P}\right)^{-\sigma} \frac{Y}{n}, \ \sigma > 1 \qquad 7.6$$

where $\boldsymbol{P_i}$ **is the money price of output type** $\boldsymbol{i}$, and $\boldsymbol{P}$ **is a price index** for, or an average of, the money prices P_j of all output types $j = 1,\dots, n$, so $P = P(P_1,\dots, P_n)$ and $P(x,\dots, x) = x$. The variable ***Y* is an indicator of total demand in the economy** and **taken as given by the individual firm**, since each firm is small relative to the economy.

■ Equation (7.6) says that **total demand is distributed over the output types in a way that reflects their relative prices**: **each product type gets the fraction** $(1/n)(P_j/P)^{-\sigma}$ **of total demand**. There is a specific formula for $P(P_1,..., P_n)$ that is appropriate given that the **demand curves in (7.6) are supposed to come from households optimizing with specific utility functions**, but we do not need the exact formula for our present purposes.

■ Since **all the *n* firms are faced with identical demand curves** and will be assumed to **have identical production functions**, the **optimal prices they set in equilibrium** (to be derived below) **will be identical**, and hence the **value of the price index will be equal to this common price**.

■ In equilibrium therefore $P_j/P = 1$ for all i, and hence **in equilibrium the demand for each firm's output is *Y*/*n***. Since **each firm satisfies all demand, *Y*/*n* will also be the production of each firm**, and thus the **total production, or the GDP, will be *n* times *Y*/*n*, that is, *Y***. ■

Hence the **indicator of total demand**, Y, is the economy's GDP and it will be **determined endogenously in our complete theory**.

■ According to (7.6), the **demand for output of type *i* does not only depend on P_i**, as perhaps suggested by the notation $D(P_i)$, but **on all of P_i, P, Y and n**. However, the **individual producer of output type *i* only has influence over P_i**.

■ The **demand curve** $D(P_i)$ is **iso-elastic** and its **constant price elasticity is σ**, that is, $-D_i'(P_i)P_i/D_i(P_i) = \sigma$ (show this by taking logs on both sides of (7.6) and differentiate with respect to P_i). Note that we **assume $\sigma > 1$**. Otherwise (if $0 < \sigma < 1$) our theory would not be meaningful. From microeconomics it is well known that a **monopolist faced with a demand curve with an elasticity that is smaller than 1 everywhere should let production go to 0 and sell its infinitesimal production at prices going to infinity**.

■ This description of the **economy's demand side** is compatible with **utility maximization by a household sector** with a particular type of utility function, a so-called **constant**

elasticity of substitution, CES, utility function, where the (constant) elasticity of substitution is σ. For our purposes we do not need the exact derivation.

■ From (7.6) it is clear that ***σ*** **measures the degree of substitution between the commodities**. The **larger** ***σ*** is, the **more sensitive is the demand for output of type *i* to** P_i/P, since a higher σ means that consumers are more willing to substitute away from any specific output type towards other types if its relative price increases. Therefore the **market power of each firm is smaller the larger** ***σ*** **is**.

■ In the limit where ***σ*** **goes to infinity the firm has no market power at all** since: if it tries to **set** P_i **above** P, it will **lose all demand**. So, $\sigma \rightarrow \infty$ corresponds to price-taking competitive behaviour which is thus contained as a special case in our analysis.

■ The **production function of each firm** *i* is simply:

$$Y_i = a_i L_i \qquad 7.7$$

where L_i is **labour input** and a_i is the **productivity of labour input**.

■ **All firms** are assumed to **use one and the same type of labour**, and this comes from the household sector of the economy. In the labour market **each firm is just one out of many buyers**, and **labour market conditions are similar to those underlying perfect competition** (many buyers and sellers, homogeneous product, etc.).

■ An **efficiency wage effect can, nevertheless, make each firm a wage setter**, as we explained earlier. In accordance with the idea of efficiency wages, the **labour productivity**, a_i, in firm i is assumed to **depend on the real wage**, $w_i \equiv W_i/P$, paid by firm i, and on the "normal" real income, v, that a worker can obtain outside firm i:

$$a_i = a(w_i) = (w_i - v)^{\eta},\ 0 < \eta < 1 \qquad 7.8$$

■ Compared to (7.5) we have normalized so that $k \equiv (q/\beta)^{\eta} = 1$. Again, $\boldsymbol{a_i}$ **really depends on both** $\boldsymbol{w_i}$ **and** $\boldsymbol{v}$, but the **firm only controls** $\boldsymbol{w_i}$, and has negligible influence over v, since the "normal income" relates to the whole economy. This justifies using $a(w_i)$.

Price and wage setting by the individual firm

■ Above we assumed that the **firm decided on wage and employment**. We could proceed similarly here and derive the **revenue curve of each firm** from (7.6) and (7.7), express profits in terms of W_i and L_i, and **find the optimal values for W_i and L_i.**

■ **This time**, however, it is **most convenient** to proceed by **determining directly the optimal values for W_i and P_i.** Of course, given these (and P and v), an optimal labour demand, L_i, follows.

■ The **real profit of firm** i is $\Pi_i = (P_iY_i - W_iL_i)/P = Y_i[P_i/P - (W_i/P)/(Y_i/L_i)]$ or, inserting for Y_i from the demand function, and $Y_i/L_i = (w_i - v)^\eta$ from the production and efficiency function:

$$\Pi_i = \left(\frac{P_i}{P}\right)^{-\sigma} \frac{Y}{n} \left(\frac{P_i}{P} - \frac{W_i / P}{(W_i / P - v)^{\eta}}\right) \qquad 7.9$$

■ This may be written in terms of the **relative, or real, prices** $p_i \equiv P_i/P$ and $w_i \equiv W_i/P$:

$$\Pi_i = (p_i)^{-\sigma} \frac{Y}{n} \left(p_i - \frac{w_i}{(w_i - v)^{\eta}}\right) \qquad 7.10$$

■ The task of the firm is to **choose p_i and w_i to maximize real profits**. (The firm really chooses the money price, P_i, and the money wage, W_i, such that at the given P, the desired p_i and w_i are established). The first-order conditions for this optimization are necessary and sufficient.

■ Let us **first take w_i as given** – consider it as already chosen optimally – and **look for the optimal p_i**. This is a **standard monopoly problem with iso-elastic demand and constant**

marginal cost. It is well known from microeconomic theory that the firm sets its **price as a mark-up over marginal cost**, where the **mark-up factor** is $m = \sigma(\sigma - 1)$. To confirm, consider the first-order condition for maximizing Π_i, with respect to p_i:

$$\frac{\delta\Pi_i}{\delta p_i} = -\sigma p_i^{-\sigma-1}\frac{Y}{n}\left(p_i - \frac{w_i}{(w_i - v)^\eta}\right) + p_i^{-\sigma}\frac{Y}{n} = p_i^{-\sigma-1}\frac{Y}{n}\left[-\sigma\left(p_i - \frac{w_i}{(w_i - v)^\eta}\right) + p_i\right] = 0$$

■ Here the square bracket must be 0. This gives $p_i(\sigma - 1) = \sigma w_i/(w_i - v)^\eta$, or:

$$p_i = \frac{\sigma}{\sigma - 1}\frac{w_i}{(w_i - v)^\eta} = m\frac{w_i}{(w_i - v)^\eta} \qquad 7.11$$

■ Note that **unit labour cost** is w_i/a_i the cost w_i per hour of work divided by productivity a_i, where $a_i = (w_i - v)^\eta$.

■ **Next consider p_i as already set** (optimally) and **look for the optimal w_i.** The **first order condition** is:

$$\frac{\delta \Pi_i}{\delta w_i} = -p_i^{-\sigma} \frac{Y}{n}[(w_i - v)^{-\eta} - \eta w_i (w_i - v)^{-\eta-1}] = -p_i^{-\sigma} \frac{Y}{n}(w_i - v)^{-\eta-1}[w_i - v - nw_i] = 0$$

■ The square bracket must be 0, which is equivalent to:

$$w_i = \frac{v}{1-\eta} \qquad 7.12$$

■ The **optimal real wage is a mark-up over the alternative or normal real income *v***, and the **mark-up factor**, $1/(1-\eta)$, **is larger the larger the productivity effect of higher wages**.

■ In view of Section 2, the **expression for the optimal real wage** in (7.12) should be **equivalent to the Solow condition** in the present setting. From (7.8) one gets for the elasticity of the efficiency function, $a'(w_i)w_i/a(w_i) = \eta w_i/(w_i - v)$. Equalizing this to 1 gives exactly (7.12).

The wage curve

■ The **normal real income** v should measure **what a worker in firm *i* could expect to earn in the rest of the economy** if separated from firm i. This must **depend on the risk of becoming unemployed** and the **income obtained in that case**, and on the **chance of getting employed** and the **real wage that can be expected in that case**.

■ We will focus on the **simplest possible formulation where *v* is exactly the expected income of a person who becomes unemployed with probability *u***, the **rate of unemployment** in the economy, in that case receiving a **real unemployment benefit *b***, and becomes employed with probability $1 - u$, in that case earning an expected real wage of w:

$$v = ub + (1 - u)w \qquad 7.13$$

■ The rate of **unemployment benefit** b is (for now) assumed to be a **fixed amount in real terms** and, of course, measured in the same units as the real wage rate w, so if w is pay per day (or hour), so is b. We can interpret ***b* to include the value of an unemployed person's home production**.

■ The "**outside option**", v, **is the same from the point of view of all firms** i. According to (7.12) **all firms therefore set the same real wage rate which must then be equal to *w***, the **expected real wage of an employed worker**. Writing ***w* for the w_i** on the left-hand side of (7.12), and inserting the expression in (7.13) for v on the right-hand side gives:

$$w = \frac{ub + (1-u)w}{1-\eta},$$

which can be **solved for *w***:

$$w = \frac{u}{u-\eta} b = \frac{1}{1-(\eta / u)} b \tag{7.14}$$

■ The **real wage is "marked up" over the real rate of unemployment benefit** with a mark-up factor of $u/(u-\eta) > 1$, so $w > b$. For this to be meaningful one should have $u > \eta$, which we assume.

■ Given b, the formula in (7.14) gives the **real wage** $\boldsymbol{w}$ **as a decreasing function of the rate of unemployment**, as illustrated in Figure 7.4.

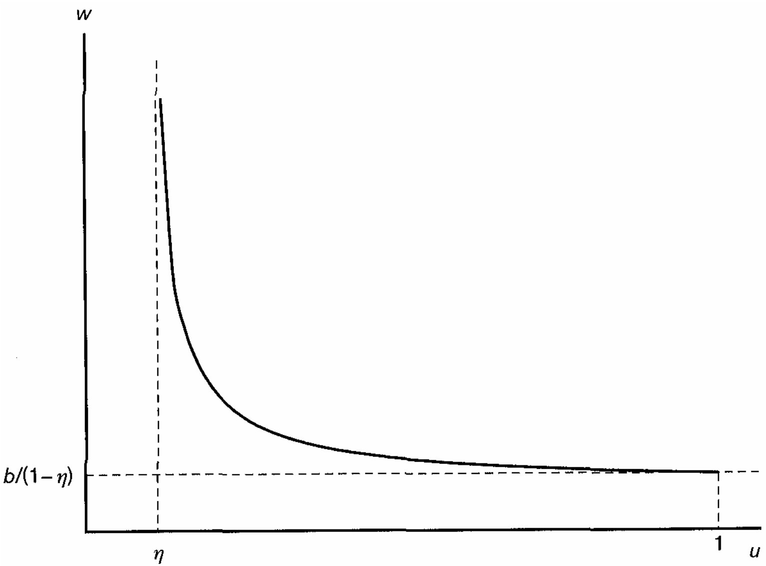

Figure 7.4: The wage curve

■ Since $w > b$, **higher unemployment means a lower value of the outside option** in (7.13) and therefore the **firms can obtain the same level of worker productivity for lower wages**. In other words, **if unemployment increases, wage pressure decreases**. This is the essential **incentive effect** captured by the relationship in (7.14), a relationship called the "**wage setting curve**" or just the "**wage curve**".

■ The economists David G. **Blanchflower** and Andrew L. **Oswald** have written a book entirely on the wage curve, *The Wage Curve*, MIT Press, 1996. Much of the book is concerned with **empirical tests and estimates**. They find quite robustly (with varying methods of estimation and for several countries) that a **wage curve exists**, and estimates of the **elasticity of the real wage with respect to the rate of unemployment are around –0.1**, meaning that a **10 per cent increase in the rate of unemployment, e.g. from 5 to 5.5 per cent, should lead to a 1 per cent decrease in real wages**. This magnitude also has an **implication for how large** one should expect η**, the real wage elasticity of effort or productivity**, to be.

■ In the following it will be **convenient to express the wage curve in terms of the rate of employment** $e = 1 - u$, such that ***w*** **is an increasing function of *e***:

$$w = \frac{1-e}{1-e-\eta} b = \frac{1}{1-\eta/(1-e)} b \qquad 7.15$$

■ The **wage curve in this form** is illustrated as the **curve labelled WS** in Figure 7.6. Note that the **wage curve will shift upwards if *b* or *η* increases**.

<u>The price curve</u>

■ Since **all firms set the same wage rate *w***, it follows from (7.11) that **they also set the same relative price** $\boldsymbol{p_i}$ = P_i/P. Since P is given for each of them, this implies that they all set the **same nominal price** $\boldsymbol{P_i}$, and **hence the value of the price index *P*, an average of the individual nominal prices, must be equal to this common nominal price**. Hence $p_i = P_i/P = 1$ for all firms i. It then follows from (7.11) that:

$$1 = m\frac{w}{(w-v)^{\eta}} \text{ or } mw = (w-v)^{\eta}$$

■ Inserting the **value of the normal income *v*** from (7.13) gives:

$$mw = [u(w-b)]^{\eta} = (1-e)^{\eta}(w-b)^{\eta} \qquad 7.16$$

■ A **real wage *w* must fulfil this equation** in order **to be compatible with the mark-up pricing** behaviour of firms. The **equation does not give a closed form solution for *w***, but rather gives ***w* as the intersection between the left-hand side**, the **straight line** mw, and the **right-hand side**, the **curved function** $(1-e)^{\eta}(w-b)^{\eta}$ of w (see Figure 7.5).

■ **For *b* not too large** there will, for all sufficiently small e, be **two intersections**. However, it is **only the upper one indicated by a small circle** in Figure 7.5 that **corresponds to an**

optimum, because one can show from (7.15) and (7.16) that at an **optimum the slope of the curved function must be smaller than the slope**, m, **of the line**.

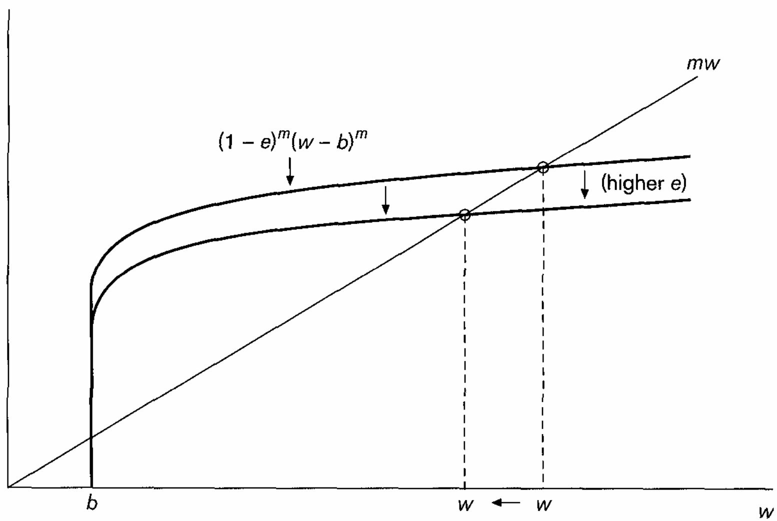

Figure 7.5: Higher *e* gives lower *w* according to the firms' price setting

■ The **fact that the upper intersection is the right one** means that an **increase in *e* implies a decrease in *w***, since a **higher *e* shifts the concave curve downwards** (see Figure 7.5 again). This is because a **higher rate of employment increases the value of the outside option** v (remember $w > b$), **which decreases productivity** so that **unit labour cost**, $w_i/(w_i - v)v$, **increases**, **pushing up real prices** in accordance with (7.11), and **hence reducing real wages**.

■ This is the basic **incentive effect underlying the "price curve"** or "**price-setting curve**", giving the **real wage rate *w* as a decreasing function of the rate of employment *e***. The curve is illustrated in Figure 7.6 and labelled **PS**.

■ As explained, the **price setting curve is decreasing because of the way a change in the rate of employment (or unemployment) affects worker productivity through the value of the normal income, *v***.

■ **If one disregards that effect** by assuming $\eta = 0$, then the **price curve becomes flat**: (7.16) with $\eta = 0$ gives $mw = 1$ or $w = 1/m$, simply **expressing mark-up pricing by the firms**, $P = mW$, when there is a constant labour productivity of unity.

■ A **higher unemployment benefit**, b, as well as **more market power in product markets**, a higher m, **shifts the price-setting curve downwards**, since **both will shift the concave curve** in Figure 7.5 **downwards** for given e.

Macroeconomic equilibrium

■ Figure 7.6 shows both the **wage curve and the price-setting curve in the same diagram**. The diagram assumes that the value of the benefit rate b is sufficiently low to ensure that the decreasing price-setting curve PS reaches far enough to the south-east to ensure an intersection with the wage curve WS.

■ The full l**abour market equilibrium is at the point *E***, where the two curves intersect each other. **Only the employment-wage combination (e^*, w^*)** of the intersection is **compatible**

with both the wage-setting and the price-setting decisions of the firms. In other words, e^* and w^* are the solutions in e and w to the two equations (7.15) and (7.16), repeated here for convenience:

$$w = \frac{1-e}{1-e-n} b \tag{WS}$$

$$mw = (1-e)^{\eta}(w-b)^{\eta} \tag{PS}$$

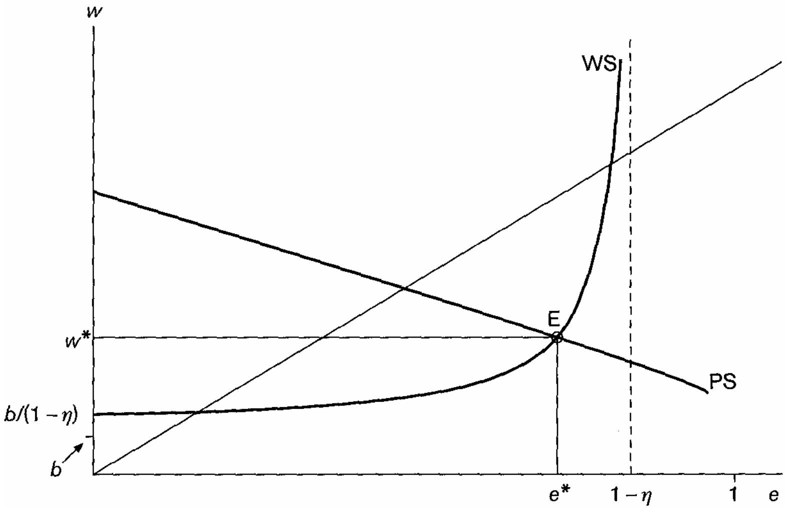

Figure 7.6: Labour market and macroeconomic equilibrium

■ Thus **in macroeconomic equilibrium** $\boldsymbol{e^*}$ **and** $\boldsymbol{w^*}$ **depend (only) on the parameters** $\boldsymbol{\eta}$**,** $\boldsymbol{\sigma}$ **(through** $\boldsymbol{m}$**), and** $\boldsymbol{b}$. Note from Figure 7.6 that $e^* < 1 - n$, which is equivalent to $u^*(= 1 - e^*) > n$.

■ However, the **labour market equilibrium** illustrated in Figure 7.6 **also determines the GDP** of the economy. Given a **total (inelastic) labour supply**, $\overline{L}$, **total employment** will be $e^*\overline{L}$. In equilibrium this is **distributed evenly across the** $\boldsymbol{n}$ **firms**, so **employment in each firm** will be $e^*\overline{L}/n$.

■ Since w^* has also been determined, the **productivity in each firm** will be given by this w^* and the v implied by w^* and $u^* = 1 - e^*$, that is, $a^* = [(1 - e^*)(w^* - b)]^\eta$. Hence the **GDP of this economy** is $[(1-e^*)(w^*-b)]^\eta e^*\overline{L}$. This is the $\boldsymbol{Y}$ **that entered the demand curves** (7.6) from the very beginning. Just **as in a classic macro model or in the Solow growth model, output is in each period determined entirely from the supply side**.

■ It is worth noting how much Figure 7.6 **looks like a traditional demand and supply diagram for the labour market**. Here we have the **rate of employment rather than employment itself** along the horizontal axis, and the **wage curve has taken the place of the labour supply curve**, while the **price-setting curve has taken the place of the labour demand curve**.

■ There is a **particular case** of some interest where the wage curve in Figure 7.6 becomes vertical so the rate of **employment (and unemployment) is determined by the wage curve alone**. If the **rate of unemployment benefit is not fixed as a given amount in real terms**, but as a given **fraction of the real wage rate**, $b = cw$, $0 \le c \le 1$, then the wage curve in (7.15) becomes: $w(1 - e - \eta) = (1 - e)cw$, giving:

$$e^* = \frac{1 - c - \eta}{1 - c} \text{ and hence } u^* = 1 - e^* = \frac{\eta}{1 - c} \qquad 7.17$$

■ We arrive at an explicit expression for u^*, and we see that the **natural rate of unemployment is increasing in the replacement ratio, *c***, and **in the wage elasticity of effort**, η. Furthermore, the formula can be used to say something about **orders of magnitude**. For a (realistically) small value of η of 1 per cent, $\eta = 0.01$, and a replacement ratio of 2/3, one gets $u^* = 0.03$, while, for instance, $\eta = 0.01$ and $c = 0.5$ gives $u^* = 2$ per cent, and **2-3 per cent is a substantial part of real world structural unemployment** which is typically in the range 5-7 per cent.

Main implications and structural policy

■ One of the **main conclusions from the macroeconomic efficiency wage model** is that there is **necessarily unemployment in equilibrium**: As mentioned above, $u^* > n$ and by assumption $n > 0$. In the particular case of a fixed replacement ratio one can see from (7.17) that $u^* > 0$. **Unemployment is thus not just a possibility, as in the partial equilibrium model**. Unemployment is a **necessary property of the macroeconomic equilibrium**.

■ **Why** is it that there must be unemployment in the macroeconomic equilibrium? The key lies in the fact that **workers only deliver a positive level of productivity if they are paid above the normal income**, $v = ub + (1 - u)w$. Each **individual firm therefore has an incentive to set its real wage w_i above v; otherwise it will earn zero profits**. **If $u = 0$, then the normal income is given by the general wage, w, alone**, $v = w$, so **each individual firm wants to set its wage w_i above the general wage level w**. Thus, **whenever unemployment is zero there will be an upward pressure on wages**.

■ **At a positive level of unemployment** (created by firms driving up wages), **it is possible for each firm's individual pay, w_i, to be above $v = ub + (1 - u)w$**, **even when the w entering in v is equal to the individual firm's wage, w_i**, as it must be in equilibrium (this requires, of course, that $w > b$). Basically, **employers bid wages up to a level that is so high that they do not want to buy all the labour supplied**.

■ Other main conclusions come from comparative statics. We will consider **changes in b and σ**, which are naturally **associated with labour market policy** and **competition policy** respectively. We will not consider changes in η, since it is difficult to imagine a kind of policy that can affect η.

■ Consider an **increase in *b***. We have already noted that this **shifts the wage curve WS upwards** and the **price-setting curve PS downwards**, as illustrated in Figure 7.7, where the wage and price-setting curves shift from WS_1 to WS_2 and from PS_1 to PS_2, respectively.

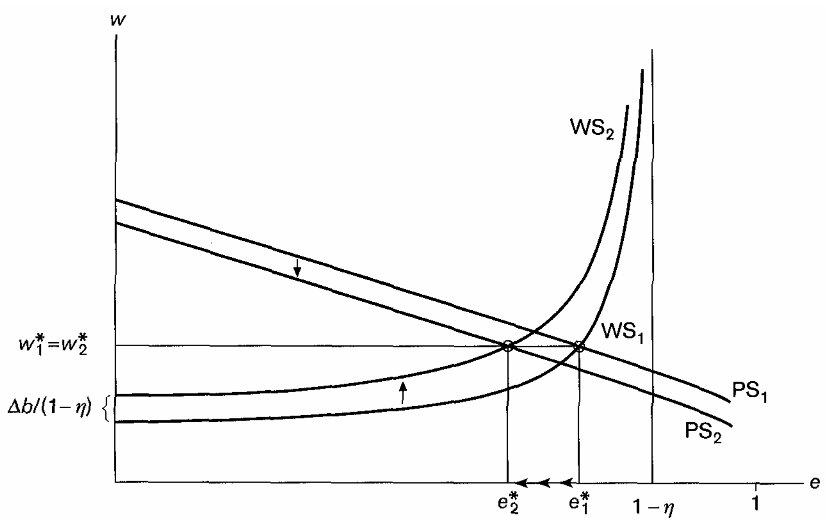

Figure 7.7: Higher *b* gives lower *e in macroeconomic equilibrium**

■ In the new equilibrium there has to be a **lower rate of employment**, that is, a higher natural rate of unemployment. The most important conclusion is that according to the macroeconomic efficiency wage model **more generous unemployment benefits means higher structural unemployment**.

■ Next **consider an increase in σ**, which means **more elastic demand functions and therefore less market power for the firms**, reflected in **lower mark-ups** $m = \sigma/(\sigma - 1)$. We can think of the **reduction in market power as caused by an intensified competition policy by the government**.

■ This **shifts the price-setting curve PS upwards**, but it **does not affect the position of the wage curve**. In the new equilibrium there will be **less unemployment and higher real wages**. According to the macroeconomic efficiency wage model stronger competition in product markets means lower structural unemployment and higher real wages.

■ It is worth emphasizing that conditions in the product markets, namely the **degree of competition, influence the rate of structural unemployment**, since structural unemployment is often viewed as a pure labour market phenomenon that can only be affected by labour market policies.

Summary

■ Under the standard assumption that labour productivity does not depend on the wage rate, a profit-maximizing firm that can choose the wage it pays would never set the wage higher than strictly required for recruiting the workers it wants. Otherwise the wage could be lowered without reducing the labour supply to the firm, which would lower costs and raise profits. The firm would thus always position itself on the labour supply curve, creating full employment through its optimizing behaviour.

■ If labour productivity depends positively on pay, the above argument breaks down. Raising the wage above the level required to recruit the desired workforce has two counteracting effects on profits: the cost of labour increases, but at the same time productivity also increases. It may be that the second impact on profits is the strongest. The phenomenon that labour productivity (or effort) depends positively on the wage is referred to as efficiency wages. With a positive link from wages to productivity, it is a logical possibility that an individual firm will want to raise wages above the market-clearing level.

■ When labour productivity depends on real wages, each firm will set its real wage in accordance with the Solow condition saying that the elasticity of productivity with respect to the real wage should be equal to 1, and set employment at the optimal level given this wage rate. In a partial equilibrium model of the labour market, this behaviour could well imply a total level of employment smaller than the total labour supply induced by the efficiency wages set by firms. Under efficiency wages, unemployment in a full equilibrium with adjusted real wages is therefore a possibility, but in a partial labour market model unemployment is not a necessary feature of equilibrium.

■ In the partial labour market model analysed in the lecture, the equilibrium real wage rate is insensitive to supply and demand shocks to the revenue functions of firms, so employment bears the full burden of adjusting to such shocks. Efficiency wage models can therefore help to explain the fact that real wages fluctuate much less than employment over the business cycle.

■ There are at least four reasons why productivity should depend positively on pay. For the individual firm, setting a relatively high wage can be a way of (i) keeping good workers in the firm, thereby reducing recruiting and training costs, (ii) getting applications from relatively good workers in hiring situations, (iii) motivating workers to comply with a high level of required effort, because a larger difference between the wage paid and what can be earned outside the firm increases the cost to a worker of being fired for “shirking”, and (iv) motivating workers to exert a high level of effort for pure reasons of reciprocity.

■ Under plausible assumptions on the effort cost function, the “shirking” model of efficiency wages implies that the efficiency function linking effort to pay should be an increasing, concave function of the excess of the real wage over the outside option, defined as the normal income a worker can expect to earn outside the firm where currently employed. The other motivating factors for the efficiency wage phenomenon point to similar curves.

■ The efficiency wage effect may be built into a general equilibrium macroeconomic model where the revenues of firms derives from consumer demand, and where the individual worker's outside option is a mixture of the general wage level and the unemployment benefit received in case of unemployment. In such a model unemployment is a necessary property of a macro-economic equilibrium with fully adjusted real wages: if there were no unemployment, the outside option from the point of view of each firm would be the general wage level. To induce any effort at all, each firm would then have to set its own wage above the general wage level, but not all firms' wages can be above the average level. The upward pressure on wages would make labour so expensive that firms would not want to buy all the labour supplied. Unemployment would arise, and with positive unemployment it is possible for each firm to set a wage above the common outside option, since unemployment benefits are lower than wages.

■ The general equilibrium model with efficiency wages implies that more generous unemployment benefits will increase the natural rate of unemployment, whereas intensified competition in product markets will lower it. These features have implications for labour market and competition policies.