

Alpern, Steve; Snower, Dennis J.

**Working Paper — Digitized Version**

## Unemployment through learning from experience

CEPR Discussion Paper Series, Centre for Economic Policy Research (CEPR), London, No. 483

**Provided in Cooperation with:**

Kiel Institute for the World Economy – Leibniz Center for Research on Global Economic Challenges

*Suggested Citation:* Alpern, Steve; Snower, Dennis J. (1990) : Unemployment through learning from experience, CEPR Discussion Paper Series, Centre for Economic Policy Research (CEPR), London, No. 483, Centre for Economic Policy Research (CEPR), London

This Version is available at:

<https://hdl.handle.net/10419/1161>

**Standard-Nutzungsbedingungen:**

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

**Terms of use:**

*Documents in EconStor may be saved and copied for your personal and scholarly purposes.*

*You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.*

*If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.*

DISCUSSION PAPER SERIES

315509

No. 483

UNEMPLOYMENT THROUGH  
'LEARNING FROM EXPERIENCE'

Steve Alpern and Dennis J Snower

38094

10205



**Centre for Economic Policy Research**

18. FEB. 1991 Walter Dukes of York Street, London SW1Y 6LA  
Kiel

W 32 - 483

# UNEMPLOYMENT THROUGH 'LEARNING FROM EXPERIENCE'

Steve Alpern and Dennis J Snower

Discussion Paper No. 483  
December 1990

Centre for Economic Policy Research  
6 Duke of York Street  
London SW1Y 6LA  
Tel: (44 71) 930 2963

This Discussion Paper is issued under the auspices of the Centre's research programme in **Applied Microeconomics**. Any opinions expressed here are those of the author(s) and not those of the Centre for Economic Policy Research. Research disseminated by CEPR may include views on policy, but the Centre itself takes no institutional policy positions.

The Centre for Economic Policy Research was established in 1983 as a private educational charity, to promote independent analysis and public discussion of open economies and the relations among them. It is pluralist and non-partisan, bringing economic research to bear on the analysis of medium- and long-run policy questions. Institutional (core) finance for the Centre has been provided through major grants from the Leverhulme Trust, the Esmée Fairbairn Trust, the Baring Foundation, the Bank of England and Citibank; these organizations do not give prior review to the Centre's publications, nor do they necessarily endorse the views expressed therein.

These Discussion Papers often represent preliminary or incomplete work, circulated to encourage discussion and comment. Citation and use of such a paper should take account of its provisional character.

December 1990

## ABSTRACT

### Unemployment Through 'Learning From Experience'

This paper shows that when workers have some market power and face substantial uncertainty concerning their productivity, it may be in their interest to formulate their wage claims with a view to the information thereby revealed. This learning behaviour may in turn be responsible for unemployment. Our analysis shows how the process of information acquisition through wage claims generates a higher rate of youth unemployment and long-term unemployment and a lower probability of dismissal for incumbent workers than would otherwise be the case.

JEL classification: 022, 023, 026, 821

Keywords: unemployment, learning, wage information

Steve Alpern  
Department of Mathematics  
London School of Economics  
Houghton Street  
LONDON  
WC2A 2AE

Dennis Snower  
Department of Economics  
Birkbeck College  
7-15 Gresse Street  
LONDON  
WIP 1PA

\*Submitted October 1990

## NON-TECHNICAL SUMMARY

The paper explores how workers may use their wage claims to gain information about their own productivity. We show that this learning behaviour can have an important by-product: unemployment. Furthermore, we show that the incidence of such unemployment falls primarily on the young and the long-term unemployed, rather than on those currently employed.

To bring our underlying idea into sharp relief, we start by supposing that workers have less information than their employers about their productivity and are able to acquire productivity information from their employers by making wage claims and observing the resulting job offers. We show that in this context, workers have an incentive to use their wage claims as a learning tool when their productivities are correlated through time.

It is easy to imagine situations in which workers face uncertain and autocorrelated productivities. New entrants to the labour force, for example, may have little knowledge of their future productivities at particular jobs but may expect them to be autocorrelated, since these productivities depend on their abilities and on the technologies associated with the jobs, both of which change only gradually through time. When a persistent macroeconomic shock such as an oil-price increase occurs, workers may be uncertain about their new, post-shock productivities, but they have reason to expect that these productivities will remain reasonably stable for some time.

The distinctive feature of our analysis is that workers use wage negotiations as a means of acquiring information about their productivity. Different wage claims generate different types of information; not all information is of equal value to the worker. A worker who receives a job offer in response to a high wage claim gains more information than he would have if he had received that offer in response to a low wage claim. In both events, the wage claim may be viewed as a lower bound on the worker's productivity (since the firm makes a job offer only if the wage is no larger than the worker's marginal product). The greater the wage claim that elicits a job offer, the higher is the lower bound the worker can place on his productivity. It is because different wage claims have different information contents that workers have an incentive to make these claims with a view to the quality of information thereby revealed. The process whereby agents gain information by observing the consequences of their wage claims we call 'learning by experience'.

We use a simple two-period model to show how workers' wage claims can reveal information about their marginal revenue product (MRP). We assume that each worker has a working life of two periods, and is called 'young' in the first and 'senior' in the second period. We assume that the actual value of the worker's

MRP at a particular job is known to the firm but unknown to the worker, who has only a prior notion of the probability distribution of his MRP at any vacant job. If he finds a vacancy as a young worker, he makes a wage claim and the firm responds by making or withholding a job offer. The response of the firm is informative: a job offer implies that the worker's MRP is greater than or equal to his wage claim. Should he get a job in response to his wage claim, he becomes an incumbent in the second period of his working life. As such he makes another wage claim. Should he fail to find a job as a young worker, he joins the ranks of the young unemployed and receives an unemployment benefit. In the second period he then becomes a 'senior outsider'. If this senior job-seeker finds a vacancy, he makes a wage claim. If the worker's MRP when young is correlated with his MRP when older, then the MRP information he gains in the first period may be of value to him in formulating his second-period wage claim and the young worker has an incentive to make his wage claim with a view to gaining information about his productivity. A young worker who receives a job offer gains information about his MRP, which is useful in formulating his second-period wage demand, whereas a young worker who receives no offer gains no information.

Young workers therefore face a trade-off in formulating their wage claims: on the one hand a higher wage claim reduces the probability of getting a job in the current period and lowers his expected lifetime income. On the other hand, a higher wage claim raises his expected lifetime income if he does manage to receive a job offer, not only because the higher wage increases current income, but also because the higher wage reduces uncertainty about the MRP and so increases income in the second period (because productivity in the two periods are correlated).

Our analysis suggests that learning through experience affects the level of unemployment. In particular, the youth unemployment rate exceeds that of the senior outsiders. This is so not merely because some of the workers who were unemployed in their youth do find vacancies once they become senior outsiders. In addition, young workers set their wage claims higher than the senior outsiders, because the former have an incentive to gain information through their wage claims while the latter do not. Consequently each young worker runs a greater risk of having his wage claim rejected than does a senior worker.

In addition, the unemployment rate among senior outsiders exceeds that among incumbents. Incumbents have more information about their MRPs than do senior outsiders, and thus, even if senior outsiders have the same probability of finding a vacancy as do incumbents (i.e., unity), incumbents can afford to make wage claims that expose them to less risk of rejection than do the wage claims of the senior outsiders.

Conventional economic theory on learning deals primarily with 'passive learning': agents are portrayed as gaining information (generally through Bayesian

updating) and using this information in making their market decisions, but not as making their market decisions with a view to the information they can thereby acquire. We show, however, that when workers' productivities are uncertain but correlated through time, such passive learning is generally sub-optimal.

Our analysis shows that under 'learning by experience' there is more youth unemployment and more long-term unemployment than under passive learning. It also indicates how learning by experience may help explain why unemployment among these groups tends to be greater than that among incumbent employees. Finally, the analysis shows that an increase in uncertainty about productivity raises the equilibrium unemployment rate. It does so by increasing the unemployment rates among the young workers and the senior outsiders, rather than among the incumbents. Thus a rise in uncertainty leads to a fall in the outflow rate from the unemployment pool, rather than a rise in the inflow rate to the unemployment pool.

We argue that 'learning from experience' may help illuminate the labour-market experience of various European countries in the wake of the oil-price shocks in the middle and late 1970s. These shocks were quite persistent and initiated prolonged periods of uncertainty regarding firms' sales prospects, factor substitution, and labour productivity. In the aftermath, many workers were likely to have perceived themselves to face uncertain but autocorrelated productivities. Moreover, many European labour markets are characterized by high rates of unionization, pervasive job-security legislation, and established bargaining procedures, so that workers wield substantial market power in the wage determination process. We suggest that these groups of workers may have had a strong incentive to use their wage claims as a learning tool. In this way 'learning by experience' – alongside other explanations of imperfectly competitive wage-setting (say, those depicted by the efficiency wage and insider-outsider theories) – may have had a role to play in generating the youth unemployment and long-term unemployment that has characterized the recent recessions.

## 1. Introduction

This paper analyzes how workers' wage claims can serve as a learning tool. We argue that when workers have some market power and face substantial uncertainty in the labor market, it may be in their interests to formulate their wage claims with a view to the information thereby revealed, in order to make more informed wage claims in the future. This learning behavior can have an important by-product: unemployment. Our analysis shows how the process of information acquisition through wage claims generates

- (a) rate of youth unemployment and long-term unemployment that are *higher*, and
- (b) dismissal probabilities for incumbent workers that are *lower* than would otherwise be the case.

We construct a model of wage setting in which the central problem is one of asymmetric information: Workers are assumed to have less information than their employers about their marginal revenue products (MRPs), and are able to acquire MRP information from their employers by making wage claims and observing the resulting job offers.

In this context, a worker has the incentive to gain MRP information through his wage claims if his actual MRPs (about which he has imperfect information) are correlated through time. This implies that when the worker acquires information about his current MRP, he thereby also gains information about his future MRP. Examples of situations in which workers face uncertain and autocorrelated MRPs are easy to come by. A new entrant to the labor force may have little knowledge of his future MRPs at any particular job but he may expect them to be autocorrelated, since his MRP depends on his ability and on the technologies associated with the job, both of which change only gradually through time. Moreover, when an economy experiences a "permanent" macroeconomic shock (i.e. a shock that persists through time), workers may be uncertain about their new, post-shock MRPs, but



they have reason to expect that these MRPs will be related to their future MRPs.

Our model has two important general features:

(i) Information acquisition is not conducted independently of wage decisions. In particular, agents gain information by observing the consequences of their wage claims. This may be called "learning from experience".

(ii) The information that is acquired in this way tends to be qualitative rather than quantitative. For example, a worker who receives no job offer can infer that his wage claim was "too high" (say, greater than his MRP), whereas a worker who is hired can infer that his wage claim was "too low" or "just right" (say, less than or equal to his MRP).

Different wage claims generate different types of information and these, in turn, are not all of the same value to the worker. In our model, for example, a worker gains more information from a high wage claim that elicits a job offer than from a low wage claim that also elicits that job offer.<sup>1</sup> It is because different wage decisions have different information contents that agents have an incentive to make these decisions with a view to the quality of information thereby revealed. The process of acquiring high-low information through wage setting is an example of "high-low search", which has been surveyed in Alpern and Snower (1988).

We argue that our analysis may help illuminate the labor market experience of various European countries in the wake of the oil price shocks in the mid- and late-1970s. An important open question is why European real wages remained as high as they did in the face of substantial uncertainty. Why did workers not take wage cuts in order to reduce their chances of unemployment? Although we do not dispute

---

<sup>1</sup>Assuming that the worker knows his marginal product to lie within a fixed interval, each observation allows him to infer a lower bound of his marginal revenue product. But this lower bound is higher in the former case than in the latter.

the various answers that this question has received in the recent labor market literature (e.g. in the insider-outsider and efficiency-wage theories), we wish to argue here that workers' "learning by experience" may have had a role to play as well.

The oil price shocks of the mid- and late-1970s were quite persistent and initiated prolonged periods of uncertainty regarding firms' sales prospects, factor substitution, and labor productivity. In the aftermath, many workers are likely to have perceived themselves to be facing uncertain but autocorrelated MRPs. We suggest that under these conditions - which are consonant with the spirit of our analysis - those groups of European workers with sufficient market power may have had an incentive to use their wage claims as a learning tool. Our analysis shows how the information motive underlying wage claims may give rise to youth unemployment and make it more difficult for senior unemployed workers to get jobs.

However, the potential purview of our analysis extends well beyond these historical periods. In the "formal" sectors - where jobs are associated with significant labor turnover costs - employees generally exercise some market power in the wage bargaining process (regardless of whether they are unionized)<sup>2</sup>. Furthermore, these employees generally are able to gain information about their current MRPs by observing whether they are offered jobs at the negotiated wages. Insofar as the determinants of the MRPs (e.g. the employees' abilities, the firms' technologies) remain reasonably stable through time, the employees are able to learn about their future MRPs by observing their current job offers.

The paper is organized as follows. Section 2 clarifies the relation of our contribution to the relevant literature and explains some underlying concepts. Section 3 presents our model of wage setting as a learning tool and examines how unemployment can arise as result. Section 4 explores the effect of learning on unemployment by examining wage formation under alternative learning scenarios.

---

<sup>2</sup>See, for example, Lindbeck and Snower (1989).

Finally, Section 5 outlines some practical implications.

## 2. Related Literature and Underlying Concepts

Some current theories of labor market behavior have implications for the relation between uncertainty and unemployment. For example, in the search theories of Diamond (1982), Mortensen (1970), Pissarides (1985) a rise in uncertainty may be associated with a rise in "mismatch", which leads to a rise in unemployment (*ceteris paribus*). In the theory of employment adjustment costs (e.g. Bertola, (1989), Bentolila and Bertola (1988), Nickell (1978, 1986)), and the insider-outsider theory (e.g. Lindbeck and Snower (1989)), a rise in uncertainty implies a rise in firms' average hiring, training and firing costs required at any given level of employment and therefore leads to a drop in employment. In the context of efficiency wage theory (e.g. Shapiro and Stiglitz (1984), Weiss (1980)), a rise in uncertainty may weaken the incentive effect of wages on productivity and may thereby induce firms to raise their wage offers and generate more unemployment.<sup>3</sup>

However, the formal implications of these theories for the ways in which uncertainty affects unemployment remain largely unexplored. Moreover, the theories above are not concerned with the way in which learning under uncertainty affects unemployment.

Conventional micro- and macro-economic theory tends to portray information acquisition and price-quantity decisions as independent

---

<sup>3</sup>For example, in the Shapiro-Stiglitz model, a rise in uncertainty may lead to a decline in the effectiveness of monitoring and thereby to a rise in the wage that discourages shirking. In the "gift exchange" model of Akerlof (1982, 1988), a rise in uncertainty may make it more expensive for firms to offer "fair" wages and thus may lead to a fall in employment and a rise in unemployment.

activities. In particular, economic agents are generally seen to make their decisions in two stages: first, they acquire their information; then, on the basis of this information, prices and quantities are set. For example, in the New Classical Macroeconomics, the public formulates its price expectations, given its information set; and given the discrepancy between these expectations and actual prices, the levels of production and employment may be determined. We are not told what the public does to acquire its current information set and there is an implicit presumption that its information acquisition activities have no significant macroeconomic implications.

Although we do not deny that learning activities and price-quantity decisions are sometimes conducted independently of one another, we wish to argue that the conventional theories tend leave out an important feature of everyday economic activity, namely, that price-quantity decisions may be used as learning tools.

It is useful to distinguish between two different types of learning:

- (i) "passive learning", whereby agents acquire information merely by passively observing their environment, and
- (ii) "active learning", whereby agents' market decisions are made with a view to acquiring information.

In practice, the participants in the labor market engage in both types of learning. Learning is passive whenever information acquisition is not the result of market participation, as when workers and firms gain labor market information from the news media and friends, and these activities generally do not require them to make price-quantity decisions. Yet active learning also has an important role to play - and not only with regard to wage setting (analyzed here), but also regarding a wide variety of market activities. For example, firms that do not produce exclusively to order often gain information about the product demands they face by putting specified quantities of output up for sale at specified prices and observing how much is sold. This may be a major source of information when customer surveys are inaccurate or very costly. Other examples include strikes called by unions in order to gain information about firms' profits, or lock-outs called by firms in

order to gain information about unions' fall-back positions.

Economic theory has something to say about passive learning, but surprisingly little about active learning. The main paradigm for analyzing decision making under uncertainty comprises optimization subject to constraints that include error terms whose distribution is known. For example, the monopoly union model generally portrays the union as maximizing its objective function (which depends, say, on the real wage and employment) subject to a labor demand function which may have an additive or multiplicative error term whose distribution the union is assumed to know. The union is not portrayed as making its decisions with a view to acquiring more information.

Although the principal-agent literature involves market activities (such as advertising, screening and monitoring) that reveal information (e.g. the efficiency wage models of Calvo and Wellisz (1978), Shapiro and Stiglitz (1984), and Weiss (1980)), the focus of attention is the provision of incentives rather than the acquisition of new information. In the traditional job search literature (e.g. Mortensen (1970), Phelps (1970)), agents engage in market activities (e.g. bearing the costs of search) in order to elicit wage offers, but the search activity takes the form of sampling from a known distribution. The search decisions are not made with a view to discovering what the distribution is.

The literature on Bayesian learning (e.g. Rothschild (1974)) also tends to be about passive learning. Although agents are assumed to update their subjective distributions by observing the consequences of their actions, the updating is a passive by-product of past search activities; it does not provide a  *motive*  for these activities.

Our models of active learning are based on the mathematical theory of high-low search, developed by Baston and Bostock (1985) and Alpern (1985). It has been used to analyze firms' pricing decisions (Aghion, Bolton, and Jullien (1987), Lazear (1986)), the demand for inventories (Alpern and Snower (1987a)), and the supply of goods (Alpern and Snower (1987b), Reyniers (1989)).

This paper analyzes a process of active learning that involves the following sequence of decisions: (i) making a wage claim under uncertain market conditions, (ii) observing the employment

repercussions, and (iii) using these observations to make inferences about the market conditions, which (in turn) are used to make subsequent wage decisions. The wage decision is based on given information, but it is made with a view to providing employment observations that reveal an optimal amount of new information. In short, the wage setter seeks to "learn" from the employment "experience" generated by the wage decision.

### 3. Wage Setting as a Learning Tool

We use a simple two-period model to show how workers' wage claims can reveal information about their MRP. In particular, let each worker have a working life of two periods, so that he may be called "young" in the first and "senior" in the second. If he finds a vacancy as a young worker, he makes a wage claim  $w_y$  (where the subscript "y" stands for "young"). Should he get a job in response to his wage claim, he becomes an "incumbent" in the second period of his working life. As such, he makes another wage claim,  $w_i$  (where the subscript "i" stands for "incumbent").

However, should he fail to get a job as a young worker, he joins the ranks of the youth unemployed and receives the transfer payment  $t$  (say, an unemployment benefit). In the second period, he then becomes a "senior outsider". If this senior job seeker finds a vacancy, he makes a wage claim  $w_s$  (where the subscript "s" stands for "senior" unemployed).

In what follows, we first describe the MRP uncertainty faced by the young and the senior workers, then we derive their optimal wage claims, and finally we analyze the resulting levels of unemployment.

#### 3.1 MRP Uncertainty

A worker's MRP at a particular job depends both on the characteristics of that worker (such as his ability and motivation) and on the characteristics of the job (such as the technologies and

cooperating factors associated with the job and the prospects of selling the output). Whereas the worker may be expected to know more about the former characteristics than his employer, the employer may be expected to know more about the latter characteristics. Since our aim is to show how a worker's wage claim can reveal information about his MRP, we start by assuming that the employer has the informational advantage and we then examine how the worker can use his wage claim as a tool to gain some of the information available to his employer.

To put this idea into sharp focus, let the actual value of the worker's MRP (net of any labor turnover costs) at a particular job,  $b^a$ , be known to the firm but unknown to the worker. The worker's actual MRPs at different jobs are assumed to be iid. Each young worker is assumed to have a prior (subjective) notion of the density of his MRP at any vacant job. For simplicity, we take this density to be uniform over the "uncertainty interval"  $[(\underline{b}-v), (\underline{b}+v)]$ , where  $\underline{b}$  and  $v$  are positive constants and  $(\underline{b}-v) > 0$ . We assume that jobs are "idiosyncratic", so that the worker cannot gain information about his own MRP by observing the wage claims and employment outcomes of other workers. The transfer payment  $t$  is assumed to be such that  $t < (\underline{b}-v)$ .

The young worker makes his wage claim  $w_y$  taking into account this transfer payment and the subjective MRP density, and the firm responds by making or withholding a job offer. If  $b^a \geq w_y$ , the worker gets the vacant job; if  $b^a < w_y$ , he is rejected. By implication, the worker will set his wage claim  $w_y$  within the MRP uncertainty interval  $[(\underline{b}-v), (\underline{b}+v)]$ . The firm's employment decisions reveal information to the worker: a job offer implies that the worker's MRP is greater than or equal to his wage claim; and a rejection implies that his MRP falls short of his wage claim.

As noted in Section 1, if the worker's MRP when he is young is correlated with his MRP when he is senior, then the MRP information he gains in the first period may be of value to him in formulating his second-period wage claim. To fix ideas, let the worker's actual MRP,  $b^a$ , be constant over his working life. Then, if he gets a job as a young worker at wage  $w_y$ , his MRP uncertainty interval in the second period of his working life becomes  $[w_y, (\underline{b}+v)]$ . Here, the size of the second-period uncertainty interval depends on the magnitude of the

first-period wage claim ( $w_y$ ). Under these circumstances, we show that the young worker has an incentive to make his wage claim with a view to gaining MRP information.

On the other hand, if the young worker does not get a job and thus remains unemployed, he seeks a vacancy at a new job<sup>4</sup> in the next period. Given that he knows his MRPs at different jobs to be iid, his MRP uncertainty interval is that same as that of a young worker:  $[(\underline{b}-v), (\underline{b}+v)]$ . In short, whereas a young worker who receives a job offer gains MRP information that he can use in formulating his second-period wage demand, a young worker who receives no offer does not acquire such information.

To derive the optimal wage claims, it is convenient to normalize the young worker's MRP uncertainty interval to  $[0, 1]$ , as shown in Figure 1. Accordingly, any unnormalized wage claim,  $w$ , corresponds to the following position  $W$  in the normalized uncertainty interval:

$$(1a) \quad W = (w - \underline{b} + v)/(2 \cdot v),$$

any unnormalized MRP value,  $b$ , corresponds to the normalized value,  $B$ :

$$(1b) \quad B = (b - \underline{b} + v)/(2 \cdot v),$$

and the unnormalized transfer payment  $t$  corresponds to the normalized value  $T$ :

$$(1b) \quad T = (\underline{b} - v - t)/(2 \cdot v)$$

The parameter  $T$  has an important role to play in our subsequent analysis; it may be interpreted as follows.  $2 \cdot v$  is the magnitude of the MRP uncertainty interval; and  $(v - t - \underline{b})$  is the difference between the minimum MRP ( $\underline{b} - v$ ) and the transfer payment ( $t$ ), which we

---

<sup>4</sup>We discuss below why it is not in his interest to seek a vacancy at the old job.



may call the minimum "penalty" associated with unemployment. Thus,  $T$  may be called the "penalty-uncertainty ratio". Note that a fall in the penalty-uncertainty ratio may be due to

- an increase in uncertainty (viz, a rise in  $v$ ),
- a rise in the transfer payment ( $t$ ), or
- a fall in the average MRP level ( $b$ ).

### 3.2 Wage Claim of the Senior Workers

Our analysis of the optimal wage claims begins with the decision problems of the senior workers, whom we have divided into "senior outsiders" and "incumbents". Each senior outsider makes a wage claim  $W_s$  so as to maximize his current expected income,<sup>5</sup> given his MRP uncertainty interval of  $[0,1]$ , pictured in Figure 2a. For any given wage claim  $W_s$ , his prior probability of getting the job (pictured by the shaded area to the right of  $W_s$  in Figure 2a) is

$$(2a) \text{ Prob } (B \geq W_s) = 1 - W_s,$$

and his prior probability of being rejected (pictured by the shaded area to the left of  $W_s$ ) is

$$(2b) \text{ Prob } (B < W_s) = W_s.$$

The senior outsider's problem is to make a wage claim  $W_i$  that maximizes his expected income,  $Y(0)$ :<sup>6</sup>

$$(3) \text{ Max } Y(0) = (1 - W_s) \cdot W_s - W_s \cdot T.$$

---

<sup>5</sup>In other words, the worker's utility is assumed to be equal to the income he receives.

<sup>6</sup>The variable in brackets denotes the lower bound of the MRP uncertainty interval.

$$W_s$$

The optimal wage claim is

$$(4a) \quad W_s^* = \max\left[\frac{(1-T)}{2}, 0\right].$$

We call this the "myopic wage", since it is optimal for a worker with a one-period time horizon. Let us assume that  $0 < T < 1$ , which has the plausible implication that the senior worker makes a wage claim associated with a positive probability of unemployment.<sup>7</sup> Thus,

$$(4b) \quad W_s^* = (1-T)/2.$$

The corresponding level of expected income is

$$(5) \quad Y(0)^* = \left[\frac{1-T}{2}\right]^2$$

Now turn to the incumbent's decision problem. Having received a job offer in response to his wage claim  $W_y$  in the previous period, he infers that his MRP uncertainty interval is  $[W_y, 1]$  (under the normalization above). Consequently, his prior probability getting the job (pictured by the shaded area to the right of  $W_i$  in Figure 2b) is

$$(6a) \quad \text{Prob}(B \geq W_i) = (1 - W_i)/(1 - W_y),$$

and his prior probability of being rejected (pictured by the shaded area to the left of  $W_i$ ) is

$$(6b) \quad \text{Prob}(B < W_i) = (W_i - W_y)/(1 - W_y).$$

If the incumbent gets a job offer, his income is  $W_i$ ; and if he does not, it is  $-T$ . He makes his wage claim  $W_i$  so as to maximize his

---

<sup>7</sup>Clearly, if  $T \geq 1$ , then  $W_s = 0$ , and thus the worker is certain to receive a job offer.

expected income,  $Y(W_y)$ , given his MRP uncertainty interval:

$$(7) \max_{W_i} Y(W_y) = [(1 - W_i)/(1 - W_y)] \cdot W_i - [(W_i - W_y)/(1 - W_y)] \cdot T.$$

It is easy to show that the optimal wage claim is

$$(8) W_i^* = \max\{[(1-T)/2], W_y\}.$$

The corresponding level of expected income is

$$(9) Y(W_y)^* = \begin{cases} \left[ \frac{1}{1-W_y} \right] \cdot \left[ \left[ \frac{1-T}{2} \right]^2 + T \cdot W_y \right] & \text{if } W_y \leq (1-T)/2, \\ W_y & \text{if } W_y \geq (1-T)/2. \end{cases}$$

Observe that if the young worker's wage claim ( $W_y$ ) is less than the myopic wage  $((1-T)/2)$ , then the incumbent's optimal wage is associated with a positive probability of dismissal. On the other hand, if the young worker's wage claim exceeds the myopic wage, then the incumbent's optimal wage is equal to the young worker's wage. In the latter event, the incumbent is certain to be retained, since his experience as a young worker indicates that the firm finds it profitable to employ him at  $W_y$ .

### 3.3 Wage Claim of the Young Workers

For any wage claim  $W_y$  that a young worker makes, his prior probability of receiving a rejection is  $\text{Prob}(B < W_y) = W_y$  (given by the shaded area to the left of  $W_y$  in Figure 2a), and the probability of receiving a job offer is  $\text{Prob}(B \geq W_y) = 1 - W_y$  (given by the shaded area to the right of  $W_y$  in Figure 2a). We consider each of these cases in turn.

What happens when the young worker fails to get a job is pictured in the left-hand side of Figure 3. In his youth he receives  $-T$ . In

the next period he searches for a new job<sup>8</sup> as a senior outsider, and has a probability  $(1-\rho)$  of finding no vacancy and a probability of  $\rho$  of finding one (where  $\rho$  is assumed to be an exogenously given constant between zero and unity). In the absence of a vacancy, he again receives  $-T$ . Yet if he finds a vacancy, he makes another wage claim,  $W_s^*$  (in Equation (4b)), which is associated with the expected income  $Y(0)^*$  (in Equation (5)). Thus, the present value of the worker's expected income if he receives no job offer in the first period is

$$(10) \quad A = -T + \delta \cdot [\rho \cdot Y^*(0) - (1-\rho) \cdot T],$$

where  $\delta$  is the worker's time discount factor.

The right-hand side of Figure 3 shows what happens if the young worker receives a job offer in response to his wage claim  $W_y$ , so that he becomes an incumbent in the next period. As we have seen, an incumbent's optimal wage claim is  $W_i^*$  (in Equation (8)) and his expected income is  $Y(W_y)^*$  (in Equation (9)). Incumbents are assumed to face more favorable employment opportunities than senior

<sup>8</sup> It is easy to see why the worker has an incentive to seek a new job rather than to reapply at the old one, provided that he faces the same probability of finding a second-period vacancy in the old job as in the new one. The reason is that his uncertainty interval at the old firm is  $[0, W_s]$ , where  $W_s < 1$ , whereas his uncertainty interval at a new firm is  $[0, 1]$ . Thus, he found a vacancy at the old firm, his expected income resulting from a second-period wage claim  $W_s$  would be  $Y(W_y) = \text{Prob}(b \geq W_s) \cdot W_s - \text{Prob}(b < W_s) \cdot T = [(W_y - W_s)/W_y] \cdot W_s - [W_s/W_y] \cdot T$ . Maximizing this with respect to  $W_s$ , we obtain the optimal second-period wage claim:  $W_s^* = (W_y - T)/2$  and the associated level of second-period expected income is  $Y_s^* = (W_y - T)^2 / (4 \cdot W_y)$ . From Equation (5) it is clear that this expected income is identical to the expected income from applying for a new job when  $W_y = 1$ . Since  $W_y^* < 1$  and  $(\partial Y_s^*) / (\partial W_y) > 0$ , the expected income from applying to a new job is greater than that from applying to the old one.

outsiders. Specifically, we assume that each incumbent has the opportunity to reapply for his previous job; thus his probability of finding a vacancy is unity (whereas an corresponding probability of a senior outsider is  $\rho$ , which may be less than unity).<sup>9</sup> By implication, the present value of a worker's expected income if he receives a job offer in the first period is  $[W_y + \delta \cdot Y(W_y)^*]$ .

In sum, the present value of a worker's lifetime income, given optimal second-period wage claims, is

$$(11) \quad V = \text{Prob}(B \geq W_y) \cdot [W_y + \delta \cdot Y^*(W_y)] + \text{Prob}(B < W_y) \cdot A \\ = (1 - W_y) \cdot [W_y + \delta \cdot Y^*(W_y)] + W_y \cdot A.$$

The young worker seeks to set his wage claim  $W_y$  so as to maximize this present value  $V$ . It can be shown that the optimal wage claim is:

$$(12) \quad W_y^* = \left[ \frac{1-T}{2} \right] + \left[ \frac{\delta \cdot \rho \cdot (1+T)}{8 \cdot (1+\delta)} \right]^2.$$

Observe that the young worker's wage claim ( $W_y^*$ ) exceeds the myopic wage  $((1-T)/2)$ , and thus - by Equation (9) - the optimal wage claim of the incumbent is equal to that of the young worker:

$$(8') \quad W_i^* = W_y^* = \left[ \frac{1-T}{2} \right] + \left[ \frac{\delta \cdot \rho \cdot (1+T)}{8 \cdot (1+\delta)} \right]^2.$$

To gain an intuitive understanding of these results, observe that a young worker faces the following tradeoff when formulating his wage

---

<sup>9</sup>The incumbents' preferential employment opportunities may be rationalized through the insider-outsider theory (see, for example, Lindbeck and Snower (1989).) If the firm faces labor turnover costs, it may have an incentive to give the incumbents (last period's "insiders") preference over the "outsiders" in occupying the available job slots.

claim:

- (a) On the one hand, a rise in his wage claim  $W_y$  reduces his probability of getting a job in the current period and this reduces his expected lifetime income, because (i) the young worker's current income when unemployed ( $-T < 0$ ) is less than his current income from employment ( $W_y \geq 0$ ) and (ii) if he is unemployed in his youth, he has a smaller chance of finding future employment than if he is employed in his youth.
- (b) On the other hand, a rise in the wage claim  $W_y$  raises his expected lifetime income if he does manage to receive a job offer in his youth, because the greater his wage claim  $W_y$ , (i) the greater the young worker's current income, and (ii) the smaller his MRP uncertainty interval if he becomes incumbent and thus the greater the incumbent's optimal wage claim.

The last element (b.ii) of this tradeoff indicates the role of information acquisition in the formulation of the wage claim  $W_y$ . Observe that if the young worker does not get a job at  $W_y$ , he gain no information of value, since he seeks a new job in the next period. On the other hand, if he receives a job at  $W_y$ , he gains valuable information, since he can infer that his next period's MRP uncertainty interval is  $[W_y, 1]$ . Clearly, the value of this latter information depends on the initial wage claim  $W_y$ . Thus we see that when the young worker raises his wage claim  $W_y$ , he not only raises the probability of gaining no information of value, but also raises the value of the information that he does gain in the event of getting a job.

#### 4. Unemployment

We are now in a position to evaluate how this use of wage claims as a learning tool affects the level of unemployment. Moving from the micro- to the macro-economic level, consider a labor market with  $n$  workers. The actual MRPs of each of these worker across all jobs are assumed to be uniformly distributed over the normalized interval  $[0,1]$ . (This distribution is identical to each worker's prior in the

first period.) Workers are assumed to apply randomly for the available jobs.

In accordance with our two-period analytical framework, we assume that the labor market contains two generations of workers: in any period, there are  $n/2$  "young" workers and  $n/2$  "senior" workers. All workers looking for new jobs (viz, the young workers and the senior outsiders) face the same probability  $\rho$  of finding a vacancy. Each young worker who finds a vacancy makes a wage claim of  $W_y^*$ , each senior outsider who finds a vacancy claims  $W_s^*$ , and each incumbent claims  $W_i^*$ .

The levels of unemployment among these workers are summarized in Figure 4. The top of the figure shows  $(n/2)$  young workers entering the labor force in a particular period of time,  $t$ . Each of these workers faces a probability  $\rho \cdot \text{Prob}(B \geq W_y^*) = \rho \cdot (1 - W_y^*)$  of finding employment, given the MRP uncertainty interval of  $[0,1]$ . When  $n$  is a large number, the level of youth employment (in the top right of Figure 4) may be approximated by  $\rho \cdot (1 - W_y^*) \cdot (n/2)$ . Similarly, the probability that a young worker will remain unemployed is approximately equal to the youth unemployment rate, which is

$$(13) \quad u_y = [1 - \rho \cdot (1 - W_y^*)]$$

(where the time subscript is suppressed for simplicity).  $u_y \cdot (n/2)$  is the level of youth unemployment.

These unemployed young workers in period  $t$  turn into senior outsiders in period  $t+1$ , each facing a probability of  $\rho \cdot \text{Prob}(B \geq W_s^*) = \rho \cdot (1 - W_s^*)$  of finding employment, given the MRP uncertainty interval of  $[0,1]$ . Thus, the number of employed senior outsiders is  $\rho \cdot [1 - \rho \cdot (1 - W_y^*)] \cdot (1 - W_s^*) \cdot (n/2)$ . Thus, unemployment rate among the senior outsiders is

$$(14) \quad u_s = [1 - \rho \cdot (1 - W_y^*)] \cdot [1 - \rho \cdot (1 - W_s^*)]$$

and  $u_s \cdot (n/2)$  is the number of unemployed senior outsiders.

Finally, each incumbent faces a probability of  $\text{Prob}(b > W_i^*)$  of gaining employment. Thus, the number of employed incumbents is

$\text{Prob}(B > W_i^*) \cdot \rho \cdot (1 - W_y^*) \cdot (n/2)$ . Conversely, the unemployment probability of each incumbent is  $[1 - \text{Prob}(B > W_i^*)]$ , and thus the unemployment rate among incumbents is

$$(15a) \quad u_i = [1 - \text{Prob}(B > W_i^*)] \cdot \rho \cdot (1 - W_y^*),$$

and  $u_i \cdot (n/2)$  is the number of unemployed incumbents.

Since the employment probability of an incumbent is  $\text{Prob}(B \geq W_i^*) = [1 - W_i^*]/[1 - W_y^*]$  the number of employed incumbents is  $\rho \cdot [1 - W_i^*] \cdot (n/2)$ . Moreover, the probability that an incumbent will lose his job is  $\text{Prob}(B < W_i^*) = [W_i^* - W_y^*]/[1 - W_y^*]$ , so that the unemployment rate among incumbents is

$$(15b) \quad u_i = \rho \cdot [W_i^* - W_y^*] = 0,$$

since  $W_i^* = W_y^*$  (by Equations (8') and (12)).

Observe that when the vacancy probability  $\rho$  is positive, the youth unemployment rate in our model exceeds that of the senior outsiders. The reason does not lie merely in the positive vacancy probability, implying that some of the workers who were unemployed in their youth do find vacancies once they become senior outsiders. Beyond that, young workers set their wage claims higher than the senior outsiders, because the former have an incentive to gain information through their wage claims while the latter do not. Consequently each young worker runs a greater risk of having his wage claim rejected than a senior worker does.

Also observe that the youth unemployment rate exceeds that of the incumbents.<sup>10</sup> Due to the information acquisition motive, workers find it worthwhile to make wage claims over their working lifetimes so as

---

<sup>10</sup>It is worth noting that our extreme result of zero unemployment among incumbents is an artifact of our two-period framework of analysis. For long time horizons it can be shown that incumbents make wage claims associated with a positive probability of dismissal.



to bear greater risk of becoming unemployed when they are young (and wage claims can reveal MRP information) than when they are incumbents. As incumbents, they take advantage of previously-gained MRP information partly through higher wages and partly through greater job security than they achieve in the absence of learning.

Furthermore, note that the unemployment rate among senior outsiders exceeds that among incumbents. This is not merely due to differences in these workers' vacancy probabilities (i.e. each incumbent is sure to find a vacancy, whereas each senior outsider finds a vacancy only with probability  $\rho$ ). Even if the senior outsiders' vacancy probability is  $\rho=1$  in our model (so that the senior outsider and the incumbents have the same chance of finding a vacancy), some senior outsiders remain unemployed whereas incumbents do not. The reason is that incumbents have more information about their MRPs than the senior outsiders do, and thus the incumbents can afford to make wage claims that expose them to less risk of rejection than the wage claims of the senior outsiders.

The above results may be summarized by the following proposition:

**Proposition 1:** *In the context of the model above, in which young workers make wage claims with a view to acquiring MRP information, the youth unemployment rate exceeds the unemployment rate among senior outsiders which, in turn, exceeds the incumbents' unemployment rate.*

Figures 5 illustrate the effects of exogenous parameter changes on the rates of youth unemployment ( $u_y$ ) and senior unemployment ( $u_s$ ). Figures 5a and b indicate that both unemployment rates are declining functions of the penalty-uncertainty ratio,  $T$ . This means that a mean-preserving increase in the MRP uncertainty interval ( $2 \cdot v$ ), a rise in the transfer payment ( $t$ ), and a fall in the average MRP ( $b$ ) - all of which are associated with a fall in  $T$  (by Equation (1b)) - will raise the rates of youth and senior unemployment.

Figures 5c and d show that these unemployment rates are declining functions of the vacancy probability, ( $\rho$ ). Thus, although a rise in the vacancy probability  $\rho$  leads young workers to raise their wage claim  $w_y$ , this wage claim does not rise sufficiently to keep the

unemployment rates from falling.

The aggregate level of unemployment is  $[u_y + u_s + u_i] \cdot (n/2)$ , and thus the aggregate unemployment rate is

$$(16) \quad u = u_y + u_s + u_i,$$

where  $u_i = 0$ . Figure 6 pictures this aggregate unemployment rate as a function of the vacancy probability ( $\rho$ ) for  $T = 0, 0.5, 1.0$ . We call this relation the "unemployment function", for short.

To find the equilibrium unemployment rate for the labor market above, we endogenize the vacancy probability  $\rho$ . In general, this vacancy probability depends on (i) the ratio of vacancies to job searchers and (ii) the degree of "mismatch" (i.e. information imperfections which prevent vacant jobs from being filled by job searchers). For simplicity, let us assume that there is no mismatch in our labor market and that all job searchers have an equal chance of finding a vacancy. Then the vacancy probability must be equal to the ratio of the number of vacancies to the number of unemployed workers, provided that this ratio does not exceed unity.

Let  $m$  be the aggregate number of available job slots. Since the aggregate number of employed workers is  $(1 - u) \cdot n$ , the aggregate number of vacancies is  $m - (1 - u) \cdot n$ . Thus, the ratio of vacancies to unemployment is

$$(17) \quad \frac{m - (1-u) \cdot n}{u \cdot n} = 1 - \frac{1 - N}{u}$$

and  $N = (m/n)$ , the ratio of job slots to workers, which we take to be exogenously given. Consequently, the vacancy probability is

$$(17b) \quad \rho = \min\left[1 - \frac{1 - N}{u}, 1\right],$$

Note that when  $N < 1$  (so that  $\rho < 1$ ), the vacancy probability ( $\rho$ ) depends positively on the unemployment rate ( $u$ ). The reason is that if the number of vacancies is less than the number of unemployed workers, an equal rise in the number of unemployed workers and the number of

vacancies raises the ratio of vacancies to unemployed workers.<sup>11</sup> The relation between the vacancy probability and the unemployment rate we call the "vacancy function", for short.

The equilibrium unemployment rate,  $u^*$ , and the equilibrium vacancy probability,  $\rho^*$ , lie at the intersection of the unemployment function (16) and the vacancy function (17a). This is pictured in Figure 6 for three different values of the penalty-uncertainty ratio:  $T = 0, 0.5, 1.0$ .

Recall that an expansion of the MRP uncertainty interval ( $2 \cdot v$ ), a rise in the transfer payment to unemployed workers ( $t$ ), and a fall in the average MRP level ( $b$ ) are all associated with a fall in the penalty-uncertainty ratio,  $T$ . As Figure 6 illustrates, a fall in  $T$  shifts the unemployment function upwards in  $\rho$ - $u$  space and thereby raise in the equilibrium unemployment rate. In short, a rise in uncertainty, a rise in unemployment benefits, or a fall in average MRPs all lead to a rise in unemployment.

## 5. Wages and Unemployment in Different Learning Scenarios

In order to explore the role that "active learning from experience" plays in generating unemployment, let us compare our model above with two alternate models, which are the same in all respects except with regard to workers' learning behavior. The two alternate models have the following salient features:

(i) In the *Passive Learning Model*, workers face the same conditions of uncertainty as in our model above (in particular, each worker's MRP at any job is uncertain and constant through time), but their wage claims

---

<sup>11</sup>To take an extreme example, if one vacancy is available to 100 unemployed applicants, then a unit increase in both the number of vacancies (to 2) and the number of applicants (to 101) raises the ratio of vacancies to unemployed applicants.

are based only on "passive learning", i.e. the wage claims make use of the workers' available information but are not formulated with a view to revealing information. It is clear that such passive learning does not generate optimal wage claims for the workers, for we have shown in Section 3 that it is in the workers' interests to use their wage claims as tools for acquiring MRP information. Nevertheless it is instructive to compare the wage and unemployment outcomes of active and passive learning, since the distinctive contribution of our analysis to the standard Bayesian updating models lies in the role wage decisions play in information acquisition.

(ii) In the *No-Learning Model*, workers face the same conditions as in our model above, except that each worker's MRPs at any particular job is assumed to be statistically independent through time. Consequently, a worker's employment observations in one time period yield no information about his MRP in subsequent time periods. In short, the worker has *no* opportunity to "learn from experience" about his MRP by observing the employment responses to his wage claims.

Now consider wage formation in the *Passive Learning Model*. For the senior workers, the nature of their decision problem is the same as in the *Active Learning Model*. Each senior outsider makes a wage claim ( $W_s(PL)$ ) so as to maximize his expected current income, given an MRP uncertainty interval of  $[0, 1]$ . As in the *Active Learning Model*, his optimal wage claim is the myopic wage:

$$(18) \quad W_s^*(PL) = (1-T)/2,$$

by Equation (4b); the corresponding level of expected income is  $Y(0)^*$ , given by Equation (5).

Each incumbent's wage claim ( $W_i(PL)$ ) maximizes his expected income, given the uncertainty interval  $[W_y(PL), 1]$ . By Equation (8), his optimal wage claim is

$$(19) \quad W_i(PL)^* = \max\{[(1-T)/2], W_y(PL)^*\},$$

and his expected income,  $Y[W_y(PL)]^*$ , is given by Equation (9), for  $W_y = W_y(PL)^*$ .

The difference between the Passive and Active Learning Models lies in the behavior of the young workers. Whereas a young active learner makes his wage claim with a view to the information he will thereby acquire, a young passive learner does not take such information into account. Thus, the decision problem of the young passive learner may be summarized as follows: For any given wage claim  $W_y(PL)$ , he faces the probability  $\text{Prob}[B \geq W_y(PL)] = 1 - W_y(PL)$  of receiving a job offer. In that case, his current income is  $W_y(PL)$ , and his expected future income - given that he does not take account of information revealed by the wage claim  $W_y(PL)$  - is  $Y^*(0)$ . His probability of receiving no job offer is  $\text{Prob}[B < W_y(PL)]$ , in which case his current income is  $T$  and his expected future income is  $(\rho \cdot Y^*(0) + (1-\rho) \cdot T)$ .

The young worker's problem is to make a wage claim  $W_y(PL)$  that maximizes the present value  $V(PL)$  of his expected income over both periods:

$$\begin{aligned}
 (20) \quad \text{Max } V(PL) &= \text{Prob}[b \geq W_y(PL)] \cdot [W_y(PL) + \delta \cdot Y^*(0)] \\
 &\quad + \text{Prob}[b < W_y(PL)] \cdot \{-T + \delta \cdot [\rho \cdot Y^*(0) - (1-\rho) \cdot T]\} \\
 &= [1 - W_y(PL)] \cdot [W_y(PL) + \delta \cdot [(1+T)/2]^2 \\
 &\quad + W_y(PL) \cdot \{-T + \delta \cdot [\rho \cdot [(1+T)/2]^2 - (1-\rho) \cdot T]\},
 \end{aligned}$$

by Equation (5). Solving this problem, it can be shown that the young worker's optimal wage claim under Passive Learning is:

$$(21) \quad W_y^*(PL) = \max\left\{0, \left[\frac{1-T}{2}\right] - \left[\frac{\delta \cdot (1-\rho) \cdot (1+T)^2}{8}\right]\right\}.$$

From Equations (19) and (21), it is clear that the optimal wage of an incumbent under Passive Learning is the myopic wage:

$$(19') \quad W_1(PL)^* = (1-T)/2.$$

Observe that young workers make lower wage claims than senior workers (both incumbents and senior outsiders) in the No Learning Model. The intuitive reason is that finding a job in the first period of the worker's lifetime gives him an advantage in the second period, for an incumbent is assumed certain to find a vacancy (at his previous job), whereas a senior outsider finds such a vacancy only with probability  $\rho$ . Thus, it is in the young worker's interest to make a comparatively low wage claim so as to raise his chances of getting this advantage. As the vacancy probability  $\rho$  approaches unity, or as the worker's time discount factor  $\delta$  approaches zero (so that the worker becomes progressively more myopic), the young workers' optimal wage claim ( $W_y(PL)^*$ ) rises to the level of senior workers' optimal wage claim ( $W_s(PL)^*$  and  $W_1(PL)$ ), by Equations (8), (19), and (20).

Now consider the No Learning Model. The difference between the MRP uncertainty intervals under Active Learning and No Learning arises because of the difference in the assumed behavior of workers' MRPs through time. In the Active Learning Model, as we have seen, workers face job-specific MRPs that are unknown but constant through time, as in the aftermath of a long-lasting macroeconomic shock that workers had not anticipated. It is the stability of the MRPs through time that permits incumbents to infer their MRPs from previous employment observations. Yet in the No Learning Model, workers' job-specific MRPs are subject to transient shocks, as in the course of transient shocks which workers do not anticipate. Here, a young worker who receives a job offer in response to his wage claim  $W_y(NL)$  can infer that his current MRP must lie in the interval  $[W_y(NL), 1]$ , but this information is not useful in formulating subsequent wage claims since his current and future MRPs are statistically independent. Hence, the incumbent's MRP uncertainty interval - like that of the young worker - is  $[0, 1]$ .

Clearly, the decision problems of the senior outsiders is the same as in the Passive Learning Model, so that their optimal wage claim is

$$(22) \quad W_s(NL)^* = W_s(PL)^*,$$

Since incumbents in the No Learning Model do not have superior MRP information to senior outsiders, their optimal wage claim is the same as that above. Thus,<sup>12</sup>

$$(23) \quad W_i(NL)^* = W_s(NL)^*.$$

The young workers' decision problem is also the same in the Passive Learning and No Learning Models. To see this, observe that the young worker's current MRP uncertainty interval is  $[0,1]$  in both models, and those that turn into senior outsiders will clearly face the same uncertainty interval. Furthermore, those that turn into incumbents also face this uncertainty interval, but for different reasons in the two models. In the Passive Learning Models it is because the young worker does not make his wage claim with a view to reducing his future MRP uncertainty interval, whereas in the No Learning Model it is because the worker's MRP in one period is not related to his MRP in the next.<sup>13</sup> Hence, the young workers' optimal wage claim in the No Learning Model is

$$(23) \quad W_y(NL)^* = W_y(PL)^*.$$

---

<sup>12</sup>This result is an artifact of the two-period framework of our analysis. Over longer time horizons, incumbents in the Passive Learning Model do gain MRP information even though their wage claims are not formulated with a view to eliciting such information.

<sup>13</sup>Our conclusion that  $W_y(PL)^* = W_y(NL)^*$  is an artifact of the two-period time horizon, because young workers with a longer time horizon would anticipate a shrinking of their MRP uncertainty interval in the Passive Learning Model, for reasons given in the previous footnote.

The optimal wage claims in the Active, Passive, and No Learning Models are summarized in Table 1.

Observe that the optimal wage claims in the Active Learning Model exceed those in the Passive Learning and No Learning Models: the incentive to learn induces the young workers to make greater wage claims than they otherwise would, and given that this learning has taken place, the incumbents find it worthwhile to make greater wage claims than they otherwise would. The intuitive reason for this result emerges straightforwardly when we compare workers' expected incomes in the different models. The present value of a young worker's income in the Active Learning Model is

$$(24) \quad V(\text{AL}) = \text{Prob}[B \geq W_y(\text{AL})] \cdot [W_y(\text{AL}) + \delta \cdot Y^*(W_y(\text{AL}))] \\ + \text{Prob}[B < W_y(\text{AL})] \cdot A$$

(by Equation (11)), and the corresponding present values in the Passive and No Learning Models is

$$(25) \quad V(j) = \text{Prob}[B \geq W_y(j)] \cdot [W_y(\text{AL}) + \delta \cdot Y^*(0)] \\ + \text{Prob}[B < W_y(j)] \cdot A, \quad j = \text{PL}, \text{NL}$$

(by Equation (20)). Note that these two present values differ only in terms of the incumbent's expected income (which is  $Y^*(W_y(\text{AL}))$  in the Active Learning Model and  $Y^*(0)$  in the Passive and No Learning Models).

Starting from any particular wage claim  $W_y = \bar{W}_y$  in all three models, a rise in  $W_y$  has a different effect on the incumbent's expected income in the two sets of models. In the Passive and No Learning Models, a rise in  $W_y$  clearly has no influence on the incumbent's income  $Y^*(0)$  ( $(\partial Y^*(0)/\partial W_y) = 0$ ), since the first-period MRP information revealed by  $W_y$  is irrelevant to his second-period MRP. However, in the Active Learning Model, a rise in  $W_y$  does affect the incumbent's income  $Y^*(W_y)$ , because here the first-period MRP information can be used in formulating the second-period wage claim.



The greater the first-period wage claim ( $W_y$ ), the smaller the incumbent's MRP uncertainty interval [ $W_y$ , 1], and the greater the incumbent's wage claim can be ( $(\partial Y^*(W_y)/\partial W_y) = 1$ , by Equations (9) and (12)). Thus, a rise in the young worker's wage claim  $W_y$  is associated with a greater payoff in the Active Learning Model than in the Passive and No Learning Models, and consequently the optimal wage claim of the young worker is greater in the Active Learning Model than in the Passive and No Learning Models.

The implications of these wage comparisons for the unemployment rate are straightforward. By Equation (13), the youth unemployment rate ( $u_y$ ) is positively related to the young workers' wage claim ( $W_y$ ), and thus the youth unemployment rate is greater under Active Learning than under Passive or No Learning.

As for the senior outsiders, recall that their wage claim is the same in all three models, since their past failure to get job offers does not reveal information about their MRPs at the new jobs for which they are applying. By implication, in all three models the same fraction of the young unemployed in one period remain unemployed in the next period. However, since the youth unemployment rate is greater under Active Learning than under Passive and No Learning, the unemployment rate among senior outsiders is greater under Active Learning.

Finally, it can be shown that the unemployment rate among incumbents is *smaller* under Active Learning than under Passive or No Learning. To see this, recall that under Active Learning the incumbents' MRP uncertainty interval is [ $W_y(\text{AL})$ , 1], and the incumbents set their wage claim at the lower bound of this interval. Consequently no incumbents become unemployed. By contrast, the incumbents' MRP uncertainty interval under No Learning is [0, 1], and under Passive Learning is [ $W_y(\text{PL})$ , 1], and the incumbents' wage claims lie above the lower bounds of these intervals (i.e.  $W_i(\text{NL}) = W_i(\text{PL}) > W_y(\text{PL}) \geq 0$ ). This means that some incumbents lose their jobs under No Learning and Passive Learning.

Specifically, under No Learning the probability that a young worker will gain employment is  $\rho \cdot (1 - W_y(\text{NL})^*)$  and the probability that an incumbent will lose his job is  $\text{Prob}(B < W_i(\text{NL})) = W_i(\text{NL})^*$ . Thus, the

incumbents' unemployment rate is

$$(26a) \quad u_i(NL) = \rho \cdot [1 - W_y^*(NL)] \cdot W_i(NL)^*$$

Under Passive Learning, an incumbent's probability of job loss is  $\text{Prob}(B < W_i(PL)) = [W_i(PL) - W_y(PL)]/[1 - W_y(PL)]$ . Thus, the incumbents' unemployment rate is

$$(26b) \quad u_i(PL) = \rho \cdot (1 - W_y^*(PL)) \cdot [(W_i(PL) - W_y(PL))/(1 - W_y(PL))].$$

The results above may be summarized in the following proposition:

**Proposition 2:** *In the analytical context above,*

*(a) the unemployment rate among the youth and the senior outsiders is higher, and*

*(b) the unemployment rate among the incumbents is lower, for any given vacancy probability  $\rho$ , when workers when workers use their wage claims as an instrument of "Active Learning" than when they engage in "Passive Learning" or "No Learning".*

## 6. Implications

Of the three models considered above, the Passive Learning Model is a "straw man" while the Active Learning and No Learning Models have straightforward practical interpretations.

As noted, conventional economic theory on learning deals primarily with passive learning: agents are portrayed as gaining information (generally through Bayesian updating) and using this information in making their market decisions, but not as making their market decisions with a view to the information they can thereby acquire. We have shown, however, that such passive learning may be suboptimal; in our model of learning, workers have an incentive to use their wage claims as learning instruments. It is for this reason that the Passive Learning Model is merely a "straw man" against which the impact of active learning on wage formation and unemployment may be

assessed.

As we have seen, the Active Learning and No Learning Models differ only with regard to the assumed behavior about workers' MRPs: in the Active Learning Model a worker's MRPs at a particular job are perfectly correlated through time,<sup>14</sup> whereas in the No Learning Model these MRPs are taken to be statistically independent. In practice, workers' MRPs at given jobs tend to be correlated, but not perfectly correlated. In this sense, workers' potential opportunities for gaining information through wage claims may be expected to lie somewhere between the two extremes represented by the Active Learning and No Learning Models.

On an economy-wide level, the behavior of MRPs in the Active Learning Model may be viewed as relevant to "persistent" macroeconomic shocks, in particular, shocks that are unanticipated by the workers and which may be expected to last for a prolonged span of time. Such shocks may lead workers to view their MRPs as uncertain but stable through time. By contrast, the behavior of MRPs in the No Learning Model may be viewed as relevant to "transient" sectoral shocks, in particular, short-lived sectoral changes that are unanticipated by the workers. These shocks may leave workers' average MRPs across all sectors unchanged, but may lead them to view their MRPs in a particular sector as uncertain and unstable through time.

Our main focus of attention has been on the Active Learning Model. This model shows how active learning can generate youth unemployment (i.e. unemployment among new entrants to the labor force) and long-term unemployment (i.e. unemployment among senior workers who were unemployed in their youth). It also indicates how active

---

<sup>14</sup>For expositional simplicity, we assumed that these MRPs are constant through time, but this is not an assumption of substance. The critical feature of the Learning Model is that the information which a worker gains about his MRP at a particular job in one time period continues to apply in the next time period. For this purpose, the worker's MRPs at that job must be perfectly correlated.

learning may help explain why unemployment among these groups tends to be greater than that among incumbent workers.

Specifically, a marginal wage increase (*ceteris paribus*) has a greater payoff for a young worker under Active Learning than under No Learning, because under Active Learning this wage increase means that the worker can demand a higher wage if he becomes an incumbent. For this reason, young workers have an incentive to make higher wage claims - and consequently face a higher incidence of unemployment - when there are opportunities for Active Learning than when there are none. The incumbent takes advantage of his prior MRP information by reaping both higher wages and greater job security than he could otherwise have achieved. Consequently, the incumbents' unemployment rate falls short of the youth unemployment rate. Moreover, the senior outsiders' unemployment rate lies between these two extremes, for the senior outsiders (in contrast to the young workers) have no incentive to use their wage claims as learning instruments, and (in contrast to the incumbents) cannot take advantage of prior MRP information.

In the context of the Active Learning Model, we have shown that an increase in MRP uncertainty (represented by a mean-preserving increase in the MRP uncertainty interval) raises the equilibrium aggregate unemployment rate. It does so, moreover, by increasing the unemployment rates among the young workers and the senior outsiders, rather than among the incumbents.

It is important to emphasize that workers have the opportunity to use their wage claims as learning instruments, along the lines described by our analysis, only when workers (i) view their marginal revenue products as uncertain but correlated through time, (ii) have less information about their MRPs than their employers do, and (iii) are able to exercise market power in the wage determination process. On these three counts, we may expect our analysis to be relevant to European labor markets in the aftermath of "persistent" macroeconomic shocks, such as the supply-side shocks of the mid- and late-1970s.

Many European labor markets are characterized by high rate of unionization, pervasive job security legislation, and established bargaining procedures, and consequently workers wield substantial market power in the wage determination process. Furthermore, as we

have argued above, "persistent" macroeconomic shocks may lead workers to view their MRPs as uncertain but stable through time. These shocks - whether of the demand-side or supply-side variety - may be expected to have MRP effects that are more widely known to firms than to their employees, since firms tend to be more intimately acquainted with changes in factor prices, factor supplies, and sales prospects.

The adverse supply-side shocks that initiated the European recessions of starting in the the mid- and late-1970s undoubtedly brought in their wake periods of persistent uncertainty regarding workers' marginal revenue products. The underlying causes were diverse. First, the supply-side shocks induced firms to employ new, raw-material-saving technologies which made marginal products of labor more difficult to predict than heretofore. Second, the magnitude of the business downturns may be expected to have led some European firms to shed labor that would have been hoarded in milder recessions. By implication, there would be greater MRP uncertainty once the recession was over and a new business upturn was beginning, since it is more difficult to predict the marginal products of new recruits than of hoarded labor. Third, a precipitate fall in aggregate product demand - such as the one initiated by the comparatively contractionary monetary and fiscal policies in many European countries in the early 1980s - must have led to greater uncertainty regarding firms' sales prospects and thereby generated MRP uncertainty.

Our model of Active Learning also implies that a rise in uncertainty leads to a fall in the *outflow rate* from the unemployment pool (viz, a fall in the employment probabilities of the young workers and the senior outsiders) rather than a rise in the *inflow rate* to the unemployment pool (viz, increased firing of incumbents).

The conclusions above - particularly those concerning youth unemployment and long-term unemployment, as well as the effect of uncertainty on unemployment - are broadly in consonance with the European unemployment experience in the mid-1970s and early 1980s.<sup>15</sup>

---

<sup>15</sup>Note that some of these predictions are similar to those of the insider-outsider theory (e.g. Lindbeck and Snower (1989), but the

Of course, our model is far too simple and too single-mindedly learning-oriented to be of use as a predictive instrument on its own. Our analysis merely serves to suggest that workers' use of wage claims as learning instrument may contribute to unemployment.

---

underlying rationale is quite different. Our theory examines how unemployment can arise through the use of wage claims as tools of active learning, whereas the insider-outsider theory describes the unemployment generated through labor turnover costs and insider power.

## REFERENCES

- Akerlof, George, 1982, "Labor Contracts as Partial Gift Exchange," *Quarterly Journal of Economics*, 97, 543-569.
- Akerlof, George, and Janet L. Yellen, 1988, "Fairness and Unemployment," *American Economic Review, Papers and Proceedings*, May, 78, 44-49.
- Aghion, Philippe, Patrick Bolton, and Bruno Jullien, 1987, "Learning through Price Experimentation by a Monopolist facing Unknown Demand," Working Paper No. 8748, University of California, Berkeley.
- Alpern, Steve, 1985, "Search for a Point in an Interval, with High-Low Feedback," *Math. Proc. Camb. Phil. Soc.*, 98, 569-578.
- Alpern, Steve, and Dennis J. Snower, 1987a, "Inventories as an Information-Gathering Device," ICERD Discussion Paper No. 87/151, London School of Economics, London.
- \_\_\_\_\_, 1987b, "Production Decisions under Demand Uncertainty: the High-Low Search Approach," Discussion Paper No. 223, Centre for Economic Policy Research, London.
- \_\_\_\_\_, 1988, "'High-Low Search' in Product and Labor Markets," *American Economic Review*, May, 78(2), 356-362.
- Baston, V.J., and F.A. Bostock, 1985, "A High-Low Search Game on the Unit Interval," *Math. Proc. Camb. Phil. Soc.*, 97, 345-348.
- Bentolila, Samuel, and Guiseppe Bertola, 1988, "Firing Costs and Labor Demand: How Bad is Euroscelosis?" mimeo.
- Bertola, Guiseppe, 1989, "Job Security, Employment and Wages," mimeo.
- Calvo, Guillermo, and Stanislav Wellisz, 1978, "Supervision, Loss of Control, and the Optimum Size of the Firm," *Journal of Political Economy*, 86, 943-952.
- Diamond, Peter, 1982, "Aggregate Demand Management in Search Equilibrium," *Journal of Political Economy*, 86, 943-952.
- Lazear, Edward P., 1986, "Retail Pricing and Clearance Sales," *American Economic Review*, 76, 14-32.
- Lindbeck, Assar, and Dennis J. Snower, 1989, *The Insider-Outsider Theory of Employment and Unemployment*, Cambridge, Mass.: MIT Press.
- Mortensen, Dale T., 1970, "A Theory of Wage and Employment Dynamics," in E. Phelps, et al., 1970.
- Nickell, Stephen, 1978, "Fixed Costs, Employment and Labour Demand over the Cycle," *Economica*.

- \_\_\_\_\_, 1986, "Dynamic Models of Labor Demand," in *Handbook of Labor Economics*, ed. by O. Ashenfelter and R. Layard, Amsterdam: North-Holland.
- Phelps, Edmund, S., 1970, "Money Wage Dynamics and Labor Market Equilibrium," in E. Phelps, et al., 1970.
- \_\_\_\_\_, et al., 1970, *Microeconomic Foundations of Employment and Inflation Theory*, New York: Norton.
- Pissarides, Christopher, 1985, "Short Run Equilibrium Dynamics of Unemployment, Vacancies and Real Wages," *American Economic Review*, 75.
- Reyniers, Diane, 1987, "Active Learning about the Demand Distribution in the Newsboy Problem," *Management Science*, forthcoming.
- Rothschild, Michael, 1974, "A Two-Armed Bandit Theory of Market Pricing," *Journal of Economic Theory*, 9, 185-202.
- Shapiro, Carl, and Joseph Stiglitz, 1984, "Equilibrium Unemployment as a Worker Discipline Device," *American Economic Review*, 74(3), 433-444.
- Weiss, Andrew, 1980, "Job Queues and Layoffs in Labor Markets with Flexible Wages," *Journal of Political Economy*, 88, 526-538.



**TABLE 1***The Active Learning Model*

Young workers:  $W_y(\text{AL})^* = \left[ \frac{1-T}{2} \right] + \left[ \frac{\delta \cdot \rho \cdot (1+T)^2}{8 \cdot (1+\delta)} \right].$

Senior outsiders:  $W_s(\text{AL})^* = (1-T)/2.$

Incumbents:  $W_i(\text{AL})^* = \left[ \frac{1-T}{2} \right] + \left[ \frac{\delta \cdot \rho \cdot (1+T)^2}{8 \cdot (1+\delta)} \right].$

*The Passive Learning and No-Learning Models*

Young workers:  $W_y(\text{PL})^* = W_y(\text{NL})^* = \left[ \frac{1-T}{2} \right] - \left[ \frac{\delta \cdot (1-\rho) \cdot (1+T)^2}{8} \right].$

Senior outsiders:  $W_s(\text{PL})^* = W_s(\text{NL})^* = (1-T)/2.$

Incumbents:  $W_i(\text{PL})^* = W_i(\text{NL})^* = (1-T)/2.$

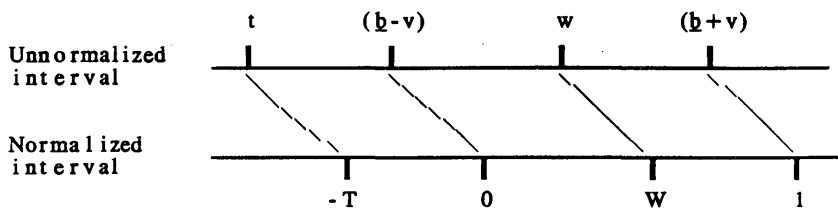


FIGURE 1: The Normalization

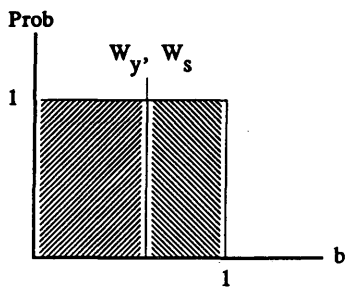


FIGURE 2a: The Wage Decision of a Young Worker and a Senior Outsider

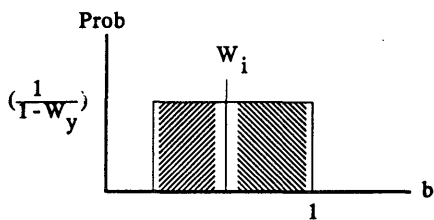


FIGURE 2b: The Wage Decision of an Incumbent

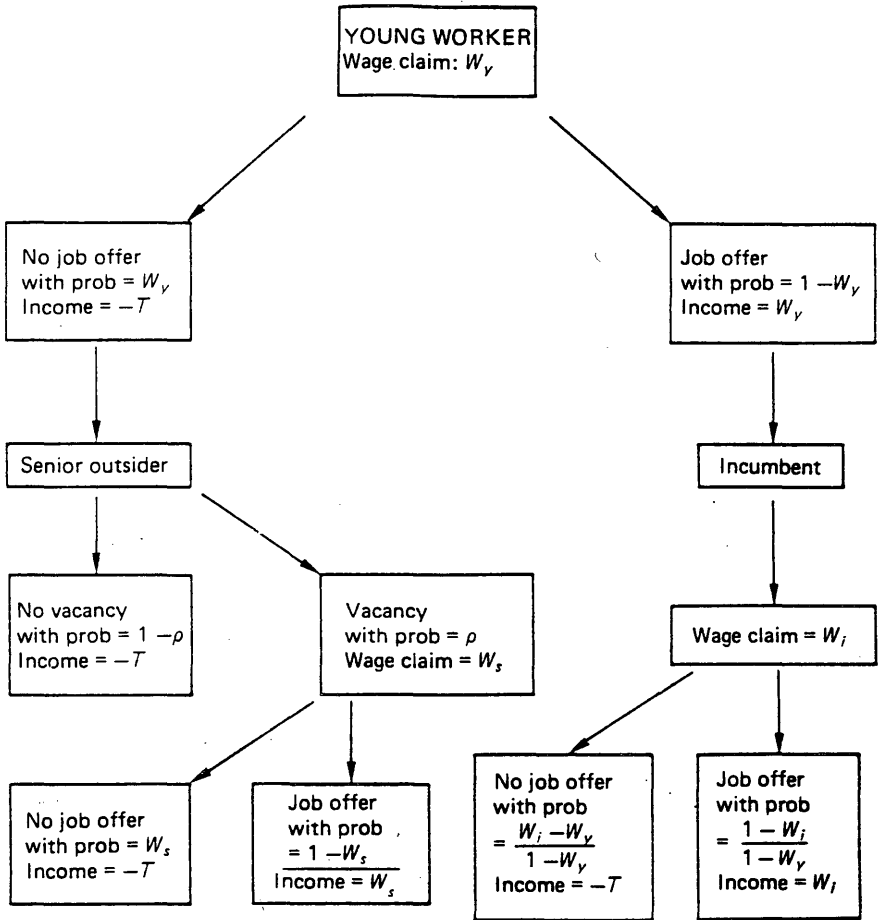


Figure 3 The sequence of decisions

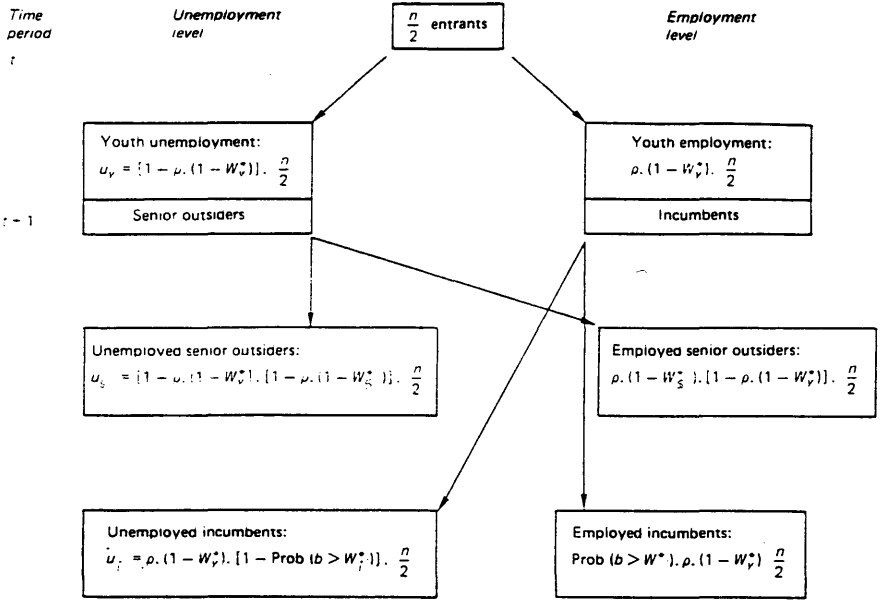


Figure 4 Unemployment

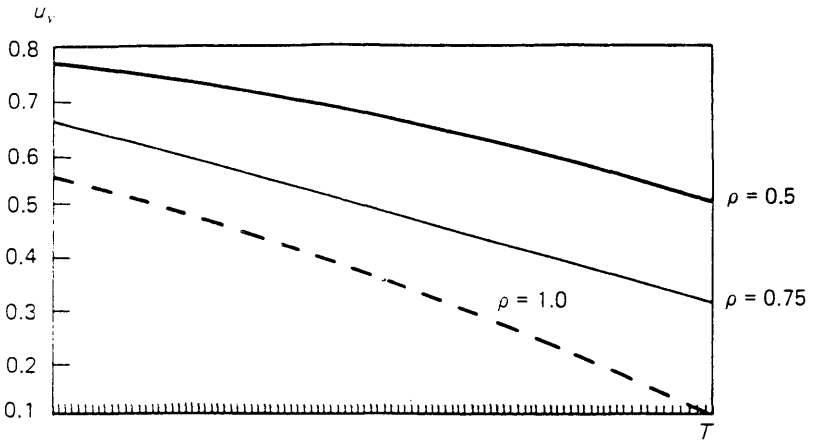


Figure 5a Youth unemployment as a function of penalty/uncertainty

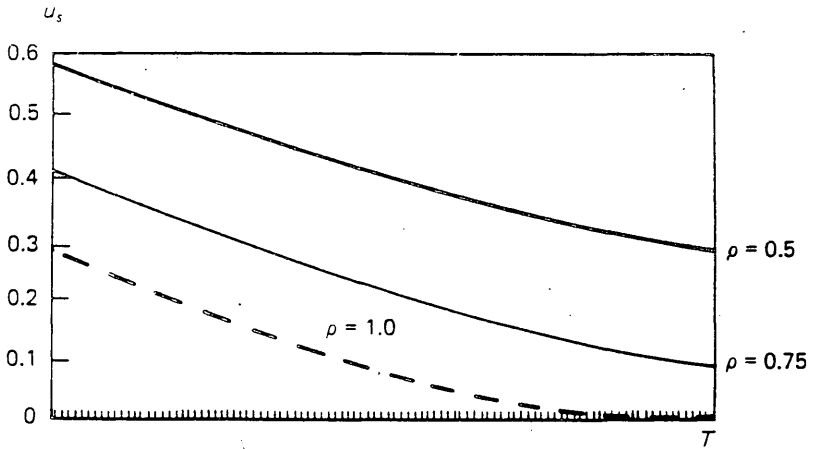


Figure 5b Senior unemployment as a function of penalty/uncertainty

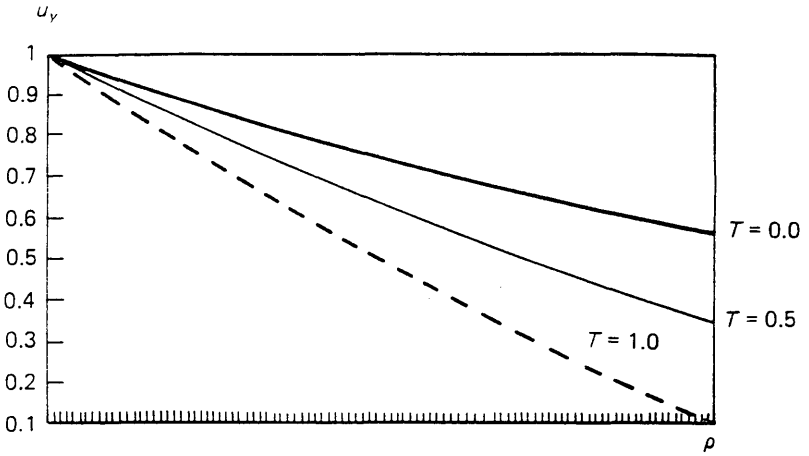


Figure 5c Youth unemployment as a function of vacancy probability

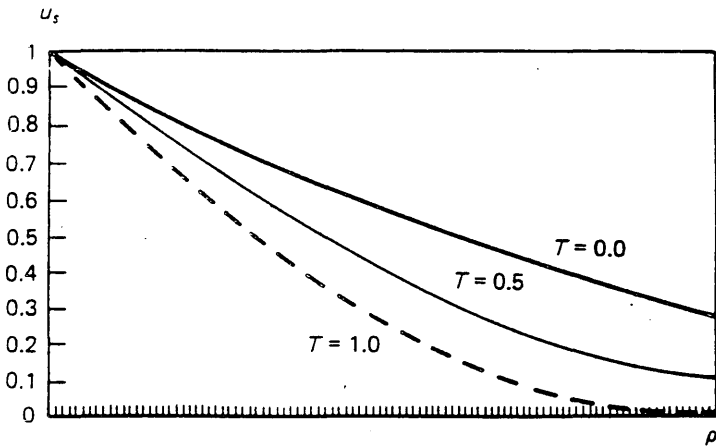


Figure 5d Senior unemployment as a function of vacancy probability

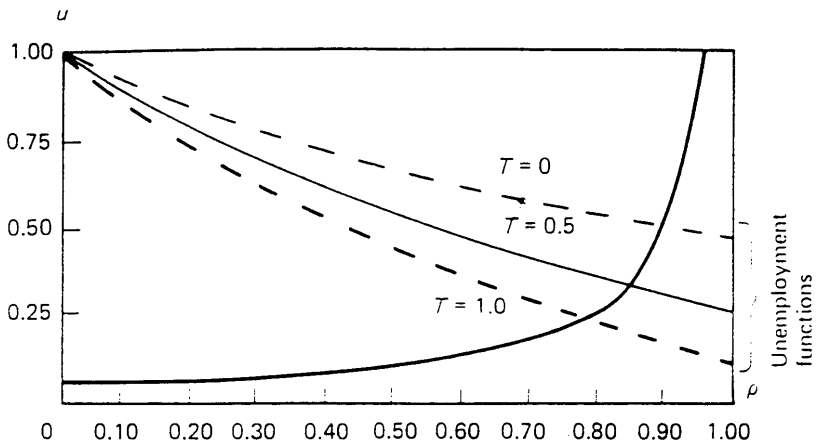


Figure 5 The equilibrium unemployment rate ( $N = 0.95$ ;  $\delta = 0.9$ )