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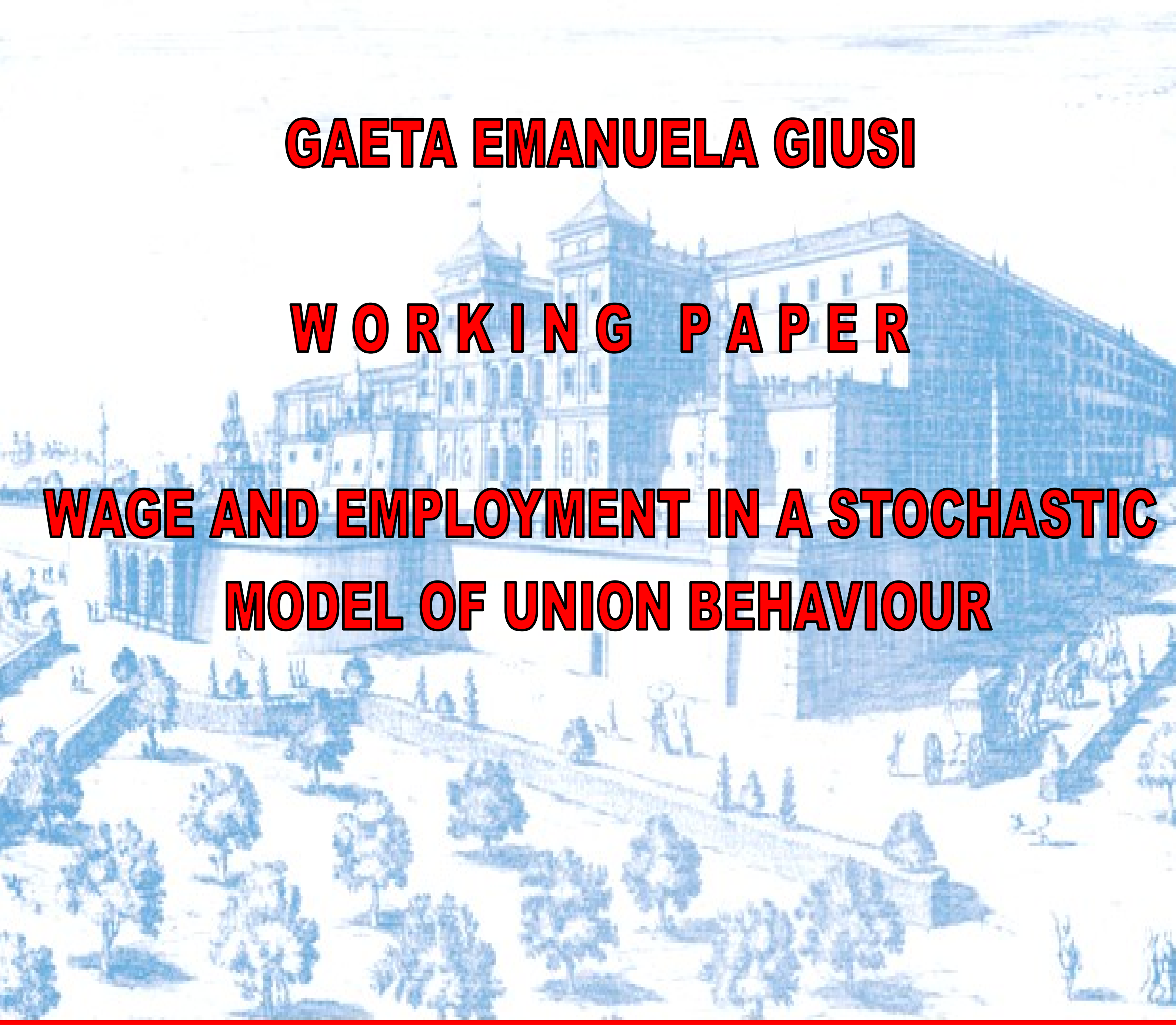

GAETA EMANUELA GIUSI

WORKING PAPER

WAGE AND EMPLOYMENT IN A STOCHASTIC MODEL OF UNION BEHAVIOUR

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Wage and Employment in a Stochastic Model of Union Behaviour

*Emanuela Giusi Gaeta**

Abstract:
In this paper we emphasise the variability of the unemployment benefit system as a measure of benefit uncertainty and analyse its effects on the labour market. Higher unemployment benefits gives stronger power to the union in collective bargaining over wages. We suppose that a higher uncertainty of the insurance system determined an improvement in the working of the UK labour market and reduced union strength in the 1980s. We investigate these issues with a theoretical stochastic union model of the Kidd-Oswald-Jones' type, randomising the benefit variable.

Key words: stochastic dynamic union models, benefit policy, uncertainty.
JEL: J32; J51; J65.

***University of Rome Tor Vergata, Gaeta@juris.uniroma2.it**

INTRODUCTION

The discussed feature of how unemployment interacts with the government fiscal policy concerns the effect of the benefits conferred to those out of work on the labour supply. In unemployment benefit models, government benefits may impinge on the supply curve of unemployment, determining an indifference condition: wage offered to unemployed in the market place may turn out to be so low that the employed are better off not working. Search theory models show important implications. Unemployment benefits change the cost of search, modifying also the relative costs of on-the-job and full-time search. The higher the unemployment benefits the higher the unemployment level is a solution which has generated considerable debate involving the magnitude of the fall in unemployment that would result, the externality that a higher pressure to accept the first job offered would produce and the inequalities in the distribution of incomes across the labour market population that would generate, say, a cut in the benefits.

When the labour market context concerns itself with the behaviour of trade unions, unemployment benefits may affect unemployment in a further way. In these circumstances, the union optimises a well-defined utility function (the sum of the utilities of its members) by choosing a wage rate for its members, given unemployment benefits for the workers not employed. All of the models of union behaviour predict a positive relationship between benefits and union optimal wage. Thus, also in a non-competitive labour market context, a cut in the benefit level should improve employment. Since it is assumed in these models (monopoly, efficient bargaining, median voter models) that unions do not affect the benefit levels, the latter are always treated by the union as a constant. The comparative static predictions of the union models may be defined by shocking the parameters of the problems such as union strength and benefit. It is straightforward to show that as the benefit level increases, the union wage increases.

In this article we use a dynamic union model of the Kidd-Oswald-Jones' type. *This well-known dynamical framework allows us to take into consideration the relationship between employment and membership over time. As stressed by several authors (see, among others, Jones and McKenna 1994) the standard static model of a utilitarian union does not allow the analysis of the interplay between employment and membership because employment is, in fact, never constrained by the membership level. Conversely, the dynamical setting involves some link between present wage, employment level and the future path of membership. Our analysis introduce a novelty in this intertemporal link by allowing the reservation wage to be stochastically driven over time.*

Since our main goal is the analysis of how uncertainty on the reservation wage affects union behaviour over time, the Kidd Oswald model fits this aim once we introduce uncertainty on the reservation wage. We are aware that the closed shop assumption implied in this class of models is unsatisfactory for several reasons (see Booth 1995, page 110) and in general, empirical works tend to refuse this hypothesis. Nevertheless the Kidd Oswald framework is still useful for our aims for two reasons: at first, it represent the simplest dynamic model of union behaviour that allows the investigation into the intertemporal relationship between uncertainty and labour market performance. Second, it allows us to compare our results to the well-known deterministic case represented by the Kidd and Oswald model.

As previously said, we are interested in assessing the impact of the reforms, on labour market performance, of altering unemployment benefits. Our hypothesis is that higher benefits uncertainty, induced by an increasing complexity and variability of the system, encourages wage moderation. *Stochastic optimal control may provide a useful framework for assessing this argument; as stressed by the option pricing literature this mathematical tool fits particularly well when we want to measure the effect of uncertainty on the steady state solution; in words, the standard deterministic steady state solution provided by Kidd and Oswald is enriched by the presence of the uncertainty component, here represented by the second central moment of the random variable, a result which can not be obtained in the standard model.*

Main point of the paper is that with higher unemployment benefits, employed people may take greater risk with the security of their jobs. This gives stronger power to the union in collective bargaining over wages. Thus a reduction in unemployment benefits raises the cost of search, pressing more people to accept employment at any real wage but there is also an argument that goes directly from the level of benefits to the bargained real wage. In this context we emphasise the variability of the insurance system as a measure of uncertainty and its effects on union behaviour. The hypothesis is that the higher uncertainty of the benefit system has affected the working of the UK labour market in the 1980s. Our secondary purpose concerns the relationship between unemployment insurance uncertainty and union strength and, in particular, whether the benefits uncertainty succeeded in weakening union power. We investigate these issues with a theoretical stochastic union model, setting up empirically testable predictions of the model for UK.

In British case the empirical significance of the effects of benefits is hotly disputed, and the question of whether unemployment benefits are high or not is a complex matter which involves a wide range of aspects. Here, we follow many authors (see, for instance, Blanchflower and Freeman 1993) claiming that the main reason for reforming the unemployment benefit system in UK during the 1980s, was not the high budgetary cost of the benefits but the change in the UK labour market conditions. However, we stress that this policy has determined further effects, raising uncertainty in a unionised labour market. It is worth stressing, however, that our analysis assumes a positive rather than a normative point of view; our end is just to investigate in which way a higher uncertainty in the benefit system, whatever the source, affects a unionized labour market.

The paper is organised as follows. Section 1 deals with the complexity of the UK benefit system. Section 2 reports a dynamic monopoly union model while section 3 defines a stochastic version of the model, where benefits are assumed to follow a Brownian process.

1. A complex unemployment benefit system

The prevailing wisdom concerning the relationship between the unemployment benefits (unemployment insurance and unemployment assistance) and unemployed states that higher benefits lead to higher levels of unemployment as well as to a longer duration. A less tight hypothesis is that unemployment benefits may contribute to exacerbate or prolong the unemployment.

In general economic research assumes a link between unemployment benefits and unemployment. The benefit system may affect unemployment through different channels. The search theory provides well suited models which stress this relationship. However, often, empirical evidence does not confirm the qualitative prediction. The statistical significance of the econometric models is often weak and even the expected signs of the relationships are not robust. It is not surprising that in Britain, countless studies on unemployment benefits, both time series and cross-section-longitudinal data, do not yield a clear-cut qualitative prediction. The benefit system is characterised by several types of benefits. Moreover the calculation of the earning-related supplement to national insurance benefit requires some assumptions that may not to be close to reality. Finally, in addition to the national insurance benefits there is also a stream of supplementary and family allowances-child benefits. Since many aspects play a part in the unemployment-benefit relationship, weighting the various influences is a difficult task.

Table 1: Main changes in unemployment benefits in UK 1979-1988

Abolition of earnings related supplement	Supplementary benefit 1980 reform
Taxation of unemployment benefit: unemployment benefit and supplementary benefit (SB) became taxable	Long-term supplementary benefit rate (SB)
Suspension of statutory indexation	Non-householder fixed housing cost addition (SB)
Changes in the uprating of short-term national insurance benefits.	Voluntary unemployment deductions (SB)
Abolition of child additions.	Board and lodgings (SB)
Abolition of lower rate benefits	School leavers entitlements reduced: more stringent entitlement conditions (SB)
Earning rule	Part-time study (SB)
Equal treatment provisions (NI and SB)	Changes in income support for school-leavers aged under 18: 16 & 17 years olds entitlements removed (SB)
Linked spell rule	Social fund. In 1988 Social fund payments (in most cases loans) replaced supplementary benefit single payments (SB)
Abatement for occupational pensioners	Heating additions (SB)
More stringent administration procedures (NI and SB)	Income support (SB)
Definition of voluntary redundancy	Social security and housing benefits act 1982
Disqualification period increased: the period of benefit disqualification (for quitting or loss a job or refuse offers) has been extended (NI) and (SB)	Minimum payments (HB)
Full extent normal rule	Changes in needs allowances (HB)
Student entitlements removed	Changes in tapers (HB)
Tight contribution conditions	Non-dependent deductions (HB)
Mortgage interest deductions reduced (SB)	Payment of rates and poll tax: claimants had to pay a portion, and subsequently all, of their poll/council tax (HS) and (IS).
Payment of benefits	
Sources: Atkinson and Micklewright 1989; Blanchflower and Freeman 1993.	

The British unemployment benefit systems are multidimensional and, therefore, difficult to characterise in a single indicator (see OECD 1994). In fact the type of benefits are not quantifiable with certainty at all, both conceptual and measurement problems make it very difficult to define an aggregate measure of the unemployment benefits. As strongly emphasised by Atkinson and Micklewright (1991), empirical works use highly simplified versions of the unemployment benefit system based upon unrealistic assumptions about the duration of benefits, the behaviour of individual workers and firms and the share of unemployed which receive benefits. The study of the relationship with unemployment, requires detailed entitlement conditions and institutional factors to be taken into account. The level of entitlements are correlated to some factors as duration and employment record. Moreover, age and family circumstances may be important. Yet, the degree of generosity of a benefit system may rely upon a system of assistance, in turn determined by several characteristics (earnings, family size, family employees). A measure of benefit entitlements should be attributable at least to duration categories and family circumstances.

In their survey of empirical results, Atkinson and Micklewright (but see also the recent works of Blanchflower and Freeman 1993, Blondal and Pearson 1995, Martin 1996, OECD 1997a, b), emphasise the potential danger of over-simplification and aggregation in representing a complex benefit system by a simple replacement ratio index or the level of benefits. The problem is even worse with cross- and multy-country studies: since the unemployment insurance systems are determined by national institutional characteristics, these results comparing simple measures of benefit generosity might be misleading. Nevertheless, in this paper we evaluate the effect of unemployment benefits expenditure on wage and unemployment in a bargaining context using an aggregate statistic of the unemployment benefits. Our hypothesis is that the change in the UK benefits system in the 1980s caused an improvement in the workings of the labour market, reducing union bargaining power. We put emphasis on the volatility of the benefits rather than the levels effect, using aggregate statistics and relying on detailed changes of the complex benefits system. Unemployment benefits may influence the cost of becoming unemployed and, therefore, lead unions to take greater or lower risk in bargaining over wages.

Since our model is embedded firmly in a macroeconomic framework, our purpose is not to investigate the particular changes in legislation which have characterised detailed circumstances during the period examined, but to verify whether the alteration of the benefit system and in particular its *variability*, determined by a stream of changes in benefits for unemployed caused a weakening of union power. A detailed description of the change in unemployment benefits is reported in Atkinson and Micklewright (1989) and Blanchflower and Freeman (1993). In the following table 1 we report a catalogue of the main changes described by the cited authors during the period examined.

It is worth stressing that: "in the economic literature benefits are usually considered as one of the main institutions that characterize labour market. Institutions are generally treated as time invariant or time varying but with a high degree of inertia"[1]. However during the ten years examined, Atkinson and Micklewright (1989) detect at least 38 relevant changes, which altered significantly the structure of benefits for unemployed and provided a smaller proportion of claimants and a fall in the value of benefits relative to average earnings. Thus, the microeconomic effects of unemployment benefits cannot be ascertained by reference to the amount of money paid to the unemployed in a given period. They are difficult to characterise with a single indicator. However, in this work we are interested in evaluating the effects of the dynamic and variability of the unemployment expenditure on aggregate outcomes. We do not consider uncertainty about the system of unemployment compensation at the individual level; the uncertainty of their entitlement, means-tested benefit and other anxieties as described in Atkinson and Micklewright and several other studies (see, for instance Jenkins and Millar 1989) are not the object of this analysis neither do we consider the subject in the search theory context**.** We deal with this problem contrasting some model simulations for (theoretically) selected variables from 1979 to 1989.

Our problem is to assess the macro-consequences of the plethora of micro-reforms and, under this point of view, the high number of changes characterizing the '80s have undoubtedly induced large modifications in the macro variable measuring benefits in Uk over time, as well shown in the time series of figures 3,4 and 5.

2. A dynamic union model

Our interest is in whether the presence of benefits uncertainty causes unions to moderate their wage premium more than they would otherwise. Our starting point is the intertemporal monopoly union model set out by Kidd, Oswald and Jones (see, Kidd and Oswald 1987; Jones 1987). Union has to select a time path for employment n (and, implicitly, the wage rate w):

$$\max_n \int_0^\infty U e^{-\rho t} dt; U = u(w,m,\theta); \quad w = pf'(n)$$

$$s.t. \dot{m} = n - m; \qquad m(0) = m_0 \tag{1}$$

where n, w and m are, respectively, employment, wage and membership. The former two variables may alternatively represent the control variable whereas m is the state variable; m_0 is the initial membership.

Considering a utilitarian union $U=u(w)n+(m-n)u(\theta)$, where $u(\ .\ )$ is a non-negative and concave increasing utility function with outside opportunities (here, unemployment benefits) θ. The evolution of membership in a *post-entry closed shop* union model, constrains $(m-n)$ to be non-negative. The solution procedure for (1) generates two differential equations:

$$\dot{n} = \frac{1}{d\beta(n)/dn}\left[(1+\rho)\beta(n) - \rho u(\theta)\right]; \quad \beta(n) = \{u(w) + u'(w)npf''(n)\} \tag{2}$$

$$\dot{m} = n - m \tag{2.1}$$

and the steady state conditions:

$$\beta(n^*) = [\rho/(1+\rho)]u(\theta); \qquad n^*=m^* \tag{3}$$

Kidd and Oswald show that there is only one path to this steady state equilibrium.

3. A union model with uncertainty in benefits

Often replacement rates cannot be identified with certainty. Predicting the net incomes of the unemployed, considering a host of unclear factors such as family allowance, the tax system, regulations, earning entitlements, complex administrative procedures, etc. may not turn out to be easy even for a union organisation. The picture may be worsened if the benefits system undergoes frequent modifications. If the net incomes of out-of-work people may not be defined, the workers' risk aversion may also be affected.

The lack of understanding of the provision of the benefits system can entail a misperception of the unemployment effects of a certain wage policy, adding uncertainty to the union strategies. Here we are interested in the impact of the reforms on aggregate outcomes of altering unemployment benefits. Our hypothesis is that higher benefits uncertainty, with increasing complexity and variability of the systems, encourages wage moderation.

Stochastic optimal control may provide a useful framework for assessing this argument[2]. This section examines the effect of benefits uncertainty in a dynamic context by treating the benefit variable in the union utility function as a stochastic process.

Consider now, a union that faces the Kidd-Oswald membership function. However, here $\theta(t)$, the benefit variable, evolves according to the stochastic process:

$$d\theta = -\lambda(\theta - \theta_0)dt + \sigma dW; \qquad dW = \varepsilon(t)(dt)^{1/2}$$

where W is a Wiener process, with $\varepsilon(t)$ serially uncorrelated and normally distributed random variable ($E(dW) = 0;\ E[(dW)^2] = dt$) and θ_0.is the deterministic value of the reservation wage. In this model, the unemployment benefits are exogenous, but they are specified by a Brownian motion, that is by a continuous-time scalar stochastic process with instantaneous mean $\lambda(\theta\text{-}\theta_0)dt$ and variance $\sigma^2 dt$; in the long run $\theta(t)$ is a *n.i.i.d.* (θ_0.,σ^2) random process. Technically speaking, this type of stochastic process is an Ornstein-Ulembeck diffusion process whose main feature is to achieve, in the long run, a stationary random process. The choice of this particular process has been motivated by empirical observations: the analysis of the benefit time series does not show any particular trend of cyclical regularity, whilst behaving as random fluctuations around a well given mean value. The Ornstein-Ulembeck process can successfully approximate such dynamical behaviour.

The dynamic optimization problem may be reformulated as:

$$\underset{n}{Max}\, E_t\left[\int_o^\infty e^{-\rho t}U(n,m,\theta)dt\right] \qquad (4)$$

subject to:

$$\begin{aligned} dm &= (n-m)dt \\ d\theta &= -\lambda(\theta-\theta_0)dt + \sigma dW \qquad (5) \\ w &= f'(n) \end{aligned}$$

In the following we set $U^d = e^{-\rho t}U(n,m,\theta)$ and $\theta_0 = 0$ for simplicity. Notice that now the movement of the state variable is not fully deterministic but it is subject to stochastic disturbance. Moreover, unlike the deterministic Kidd-Oswald control problem, benefits cannot be known in advance by the union**.** The value function of the stochastic optimal control problem is:

$$V(t,m,\theta) = \underset{n}{Max}\ E_t\left[\int_t^\infty U^d(n,m,\theta)d\tau\right]$$

where $V(t,m,\theta)$ is the maximised expected discounted utility stream with respect to the employment level $n(t)$; in other words it represents the total mean return, in utility terms, of a given hiring choice. The value function satisfies the following optimality condition:

$$\rho V(t,m,\theta) = \underset{n}{Max}[U(n,m,\theta)dt] + E_t(dV) \qquad (6)$$

which requires equality between the total mean return required by the union over the interval *dt* (left hand side) and the expected total return (right hand side) consisting in the maximum discounted utility flow plus the expected gain or loss *E(dV)*.

Stochastic dynamic programming allows us to show how desired wage and employment change as the level of uncertainty over future benefits grows. The union knows the current value of θ and, therefore, the proportion of employees that join the union, but it does not know the future values of θ. A change in unemployment insurance and the governments' determination to weaken union power (at least in some sectors) tend to create a climate characterised by a higher uncertainty, increasing the prospect of further change in benefits. The union agenda for the future periods is therefore likely to be influenced by these factors. Optimal decisions, under these conditions, may be figured out using the Bellman equation to solve the stochastic version of the Kidd -Oswald model.

In order to solve the stochastic control problem entailed in (4) and (5), the unknown value function must satisfy the following *Hamilton-Jacobi-Bellman* equation, which comes directly from (6) by applying Ito's lemma:

$$0 = \underset{n}{Max}\left[U^d + (n-m)V_m\right] - \lambda\theta V_\theta + \frac{1}{2}\sigma^2 V_{\theta\theta} + V_t$$

By maximising the *HJB* equation we obtain the first order condition:

$$V_m(m,\theta) = -U_n^d$$

which shows the classical condition of equality between the shadow price of the state variable V_m and the discounted marginal utility; stated differently it says that the shadow price of an additional worker joining the union, an additional unit in m, must be equal to (minus) the change in the discounted utility flow caused by this additional unit.

By applying Ito's lemma to V_m, recalling that $dt^2=0$, $E(dtdW)=0$, $E(dW)=0$, $E(dW)^2=dt$ and $E(d\theta)^2=\sigma^2 dt$, we have:

$$dV_m = V_{mt}dt + V_{mm}dm + V_{m\theta}d\theta + \frac{1}{2}V_{mmm}(dm)^2 + \frac{1}{2}V_{m\theta\theta}(d\theta)^2$$

Hence:

$$\frac{E(dV_m)}{dt} = V_{mt} + (n-m)V_{mm} - \lambda\theta V_{m\theta} + \frac{1}{2}\sigma^2 V_{m\theta\theta} \qquad (7)$$

Using the *HJB* equation:

$$0 = Max\left[U_m^d + (n-m)V_{mm}\right] - V_m + V_{tm} - \lambda\theta V_{\theta m} + \frac{1}{2}\sigma^2 V_{\theta\theta m} \qquad (8)$$

and by substituting equation (7) in (8) we obtain:

$$0 = Max\left[U_m^d - V_m + \frac{E(dV_m)}{dt}\right] \qquad (9)$$

From the first order condition we can write:

$$\frac{E(dV_m)}{dt} = -\frac{E(dU_n^d)}{dt}$$

which along with equation (9) provides the *Euler equation* for the discounted stochastic problem:

$$\frac{E(dU_n^d)}{dt} = U_m^d + U_n^d \qquad (10)$$

which simply states that the instantaneous expected change in the discounted utility results from a linear combination of marginal utilities. By applying Ito's lemma to U_n^d and ignoring higher order terms with respect to *dt*, we have:

$$dU_n^d = U_{nn}^d dn + \frac{1}{2}U_{nnn}^d (dn)^2 \qquad (11)$$

Generally speaking, along the transition path the optimal control *n* depends on the state variable *m* and benefit variable θ. In the following we refer to such a relationship by writing $n=g^*(m,\theta)$. From here we have: $dn = g_m^* dm + g_\theta^* d\theta + g_{\theta\theta}^*(d\theta)^2 \Rightarrow (dn)^2 = \left(g_\theta^* d\theta\right)^2$, since $(dm)^2=(n-m)^2dt^2$ and $(d\theta)^2$ can be neglected because of the square on the infinitesimal term *dt*. Using this relationship we finally obtain:

$$E(dn)^2 = g_\theta^{*2} E(d\theta)^2 = g_\theta^{*2}\sigma^2 dt \qquad (12)$$

From equation (11) and (12) we obtain:

$$E(dU_n^d) = U_{nn}^d E(dn) + \frac{1}{2}U_{nnn}^d E(dn)^2 = U_{nn}^d E(dn) + \frac{1}{2}U_{nnn}^d g_\theta^{2*}\sigma^2 dt \qquad (13)$$

Applying the *1/dt* operator to both sides of (13) and by substituting it in (10), we have:

$$\frac{E(dn)}{dt} = \frac{U_n^d + U_m^d - 1/2U_{nnn}^d g_\theta^{*2}\sigma^2}{U_{nn}^d} = \frac{(1+\rho)U_n + U_m - 1/2U_{nnn}^* g_\theta^{*2}\sigma^2}{U_{nn}} \qquad (14)$$

which is analogous of the deterministic law of motion (2); the only difference we observe between (14) and (2) is the extra-term on the right hand side of the former equation whose sign depends on the third derivative of U. It should be noted that this derivative is positive for conventional well-behaved utility functions. For instance, if we assume $L(w)=w^\alpha/\alpha$, $\alpha<1$, $f(n)=n^\beta$ and $L(\theta)=\theta$, the third derivative of *U* with respect to employment is:

$$U_{nnn} = \frac{(1-\beta)\beta^\alpha n^{-\alpha(1-\beta)}}{n^2}\left(1-\alpha^2(1-\beta)^2\right)>0.$$

The extra term is, therefore, $U_{nnn} g_\theta^{*2} > 0$.

By imposing $E(dn)/dt=0$ in equation (14) we can compare the steady state in presence of a stochastic shock on the unemployment benefits with respect to the standard case:

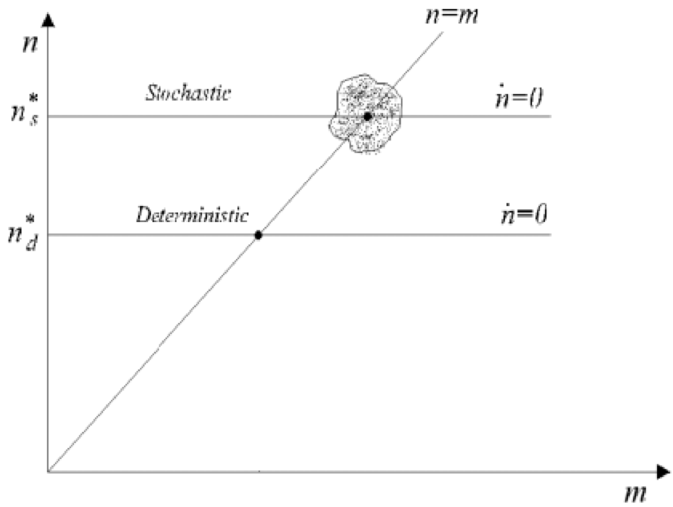
$$\frac{E(dn)}{dt} = 0 \Rightarrow L_w f_{nn} n^* + L(w) = \frac{\rho}{1+\rho} L(\theta) + \frac{1}{1+\rho} U^*_{nnn} g_\theta^{*2} \sigma^2$$

IN TERMS OF EQUATION (3) NOTATION, WE HAVE THE FOLLOWING STEADY STATE:

$$\beta(n^*) = \frac{\rho}{1+\rho} u(\theta) + \frac{1}{1+\rho} U^*_{nnn} g_\theta^{*2} \sigma^2 \qquad (15)$$

Equation (15) says that, for the case $U'_{nnn} > 0$, the effect of introducing unemployment benefit uncertainty shifts the curve *(1/dt)Edn=0* upward, providing a higher employment level with respect to the deterministic case. The union's target employment (or wage) is related to σ in a way dependent on $U'_{nnn} > 0$. Above we have shown that this condition is met when the underlying functions are *well behaved*. Thus, the benefit uncertainty, measured by the coefficient σ^2, will lead the monopoly union to claim moderate wages, increasing the steady state employment.

The following picture show the phase diagram in the deterministic and stochastic case (Figure 1). As the figure shows, the introduction of uncertainty in benefits makes the optimal employment higher than the deterministic case, inducing random fluctuations of *n(t)* around the deterministic steady state $n^*(t)$, stylised by the cloudy area in the phase diagram.



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Notes:

[1] We wish to thank an anonymous referee for having stressed this point.

[2] See, among others, Malliaris and Brock (1982), Chow (1979), Dixit and Pindyck (1994).