Duration Dependent Unemployment Insurance and Stabilisation Policy.

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Abstract

In the context of a standard equilibrium matching framework, this paper shows how a duration dependent unemployment insurance (UI) system stabilises unemployment levels over the business cycle. It establishes that reentitlement effects induced by a finite duration UI program generate intertemporal tranfers from firms that hire in future booms to firms that hire in current recessions. These transfers imply a net hiring subsidy in recessions which stabilises unemployment levels over the cycle.

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1 Introduction

In the context of a standard equilibrium matching framework (e.g. Pissarides [2000], Mortensen and Pissarides [1994], Cole and Rogerson [1999]), this paper shows how a duration dependent unemployment insurance (UI) system stabilises unemployment levels over the business cycle. It establishes that re-entitlement effects induced by a finite duration UI program generate intertemporal tranfers from firms that hire in future booms to firms that hire in current recessions. These transfers imply a net hiring subsidy in recessions which stabilises unemployment levels over the cycle.

Figure 1 provides some corroborative evidence of this effect. It describes average completed spells of unemployment in Britain and the USA for 1986-2001. The UI scheme in the U.S. is typically described as a 6 month scheme. The UI scheme in the U.K. instead pays benefits for one year but, in addition, there is a relatively generous social security scheme which pays benefits indefinitely once a worker's UI payments have expired [see Layard et al (1991)]. Figure 1 demonstrates that the average spell of unemployment in the U.S. exhibits a lower mean and lower variance over the cycle than in the U.K.. This fact is partly explained by the use of temporary layoffs in the U.S. But we show that as average unemployment spells increase, re-entitlement effects imply a direct hiring subsidy in a U.S. recession, while the U.K. system generates no such stabilising effect. The results are also consistent with Nickell [1997] who argues that it is the difference in the duration of benefits which mainly accounts for observed international differences in the incidence of long-term unemployment.

The transfer mechanism works in a way analogous to Acemoglu [1997] and Acemoglu and Pischke [1999]. Those papers argue that with job destruction shocks, a current worker/firm pair underinvests in general human capital. Their central insight is that should the worker be laid off in the future, ex-post wage bargaining implies the worker's next, as yet unknown, employer will extract part of those investment rents. As that employer is not identified at the time when the training takes place, this market failure leads to too little training. Our point is that in a non-competitive

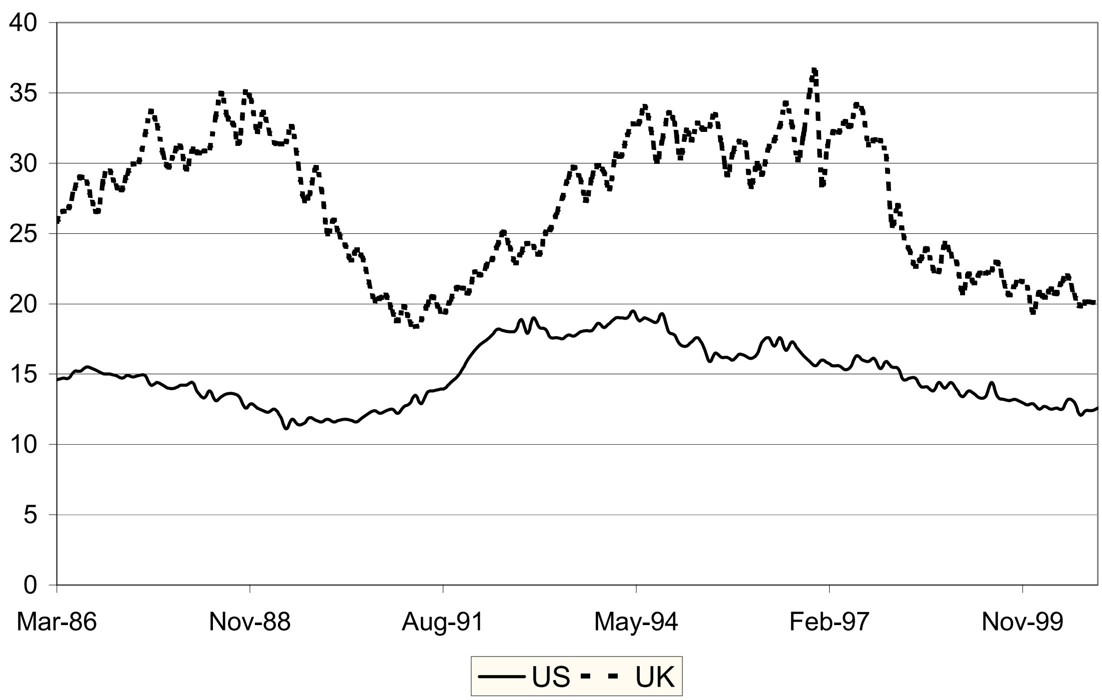

Figure 1: Average duration of unemployment, US and UK

labour market, a UI system generates the opposite transfer effect. Should the worker be laid off in the future, then being entitled to receive UI payments increases the worker's reservation wage when next unemployed, and the worker extracts greater rents from his/her next future employer.

Recent findings in the on-the-job search literature provide a useful perspective for our results (e.g. Stevens (2003)). With job turnover, regardless of whether it is through a quit or layoff, a current worker/firm pair would like to extract surplus from the worker's next future employer. To illustrate the issue, consider Postel-Vinay and Robin (2002a,2002b) who assume that when an employed worker receives an outside offer through on-the-job search, the two firms then Bertrand compete for the worker's services. With identical firms, the wage is bid up to marginal product and so, if the worker quits, the outside firm makes no surplus by hiring the worker. This 'mechanism' is jointly efficient for the original firm/worker pair as it extracts full rents from the worker's next employer (should the worker quit). In contrast Burdett and Mortensen (1998), Stevens (2003), Burdett and Coles (2003) assume firms do not respond to outside offers. If the outside firm hires the worker at a wage below marginal product, the original worker/firm pair fail to extract full rents from that employer and so some surplus is lost.

So what would be an efficient separation contract in a Pissarides-type matching environment with job destruction shocks? With identical firms and full information, the optimal separation contract pays the worker marginal product while unemployed, and nothing once the worker is re-employed; i.e., it is a private UI contract. This contract is jointly efficient as it raises the worker's reservation wage (while unemployed) to marginal product and so, even with ex-post wage bargaining, the worker's next employer cannot extract surplus rents - it hires the worker with wage equal to marginal product. Clearly this contract also corrects the market failure identified in Acemoglu [1997] and Acemoglu and Pischke [1999]. Presumably such contracts do not exist as firms do not observe when ex-employees find new work. One interpretation of a government sponsored UI program, however, is that it acts as a third party enforcement agency.

A simple numerical example illustrates the underlying mechanism and the potential magnitude of these transfers. Suppose as in the U.S. that the UI program stops payments after 26 weeks of unemployment. Further suppose the business cycle is simply a two state phenomenon - the economy is either in recession with an average duration of unemployment equal to 18 weeks, or in a boom with an average duration of unemployment of 8 weeks. At first sight it seems trivially obvious that a finite duration UI scheme will dampen employment variations over the cycle - recessions imply lower reservation wages as more unemployed workers have expired UI benefits. Our argument is stronger - re-entitlement effects generate an intertemporal transfer between firms that hire in current recessions and firms that hire in future booms. Those transfers are most easily understood by assuming firms have all the bargaining power and so pay unemployed workers their reservation wage. If new entrants into the labor market are not entitled to UI (only previously employed workers receive UI compensation while unemployed) an immediate implication is that entrant workers obtain no surplus from employment. Although the UI scheme may distort an entrant worker's reservation wage in the future, and so affects the surplus obtained by a firm which employs that worker in the future, that distortion is merely a transfer to the current hiring firm which extracts those expected rents through a lower wage. In this way a UI scheme with re-entitlement effects generates a transfer of rents from future to current hiring firms.

The numerical values above imply that in the recession, with average unemployment spell of 18 weeks, the mean remaining UI entitlement of a currently unemployed worker is 12 weeks more UI.[1] As the option of receiving those UI payments raises the value of remaining unemployed, the reservation wage reflects the appropriately annuitised value of those remaining payments. Most importantly, however, the wage

[1] This is computed using $\int_0^\infty \alpha_w e^{-\alpha_w s} \max[26 - s, 0] ds$ with $\alpha_w = 1/18$.

also reflects that the worker becomes re-entitled to full UI coverage. As has already been established, this re-entitlement effect means the worker can extract greater rents from a future employer in the event of a job destruction shock.

In contrast in the boom, with average unemployment spell of 8 weeks, the mean remaining entitlement of an unemployed worker is around 18 weeks more UI. This raises the worker's reservation wage and the hiring firm has to compensate the worker for those foregone payments. But who enjoys those rents? As the worker has no bargaining power (by assumption) those rents were fully extracted by the worker's previous employer who paid a lower wage to capture the expected value of these re-entitlement rents. In this numerical example, therefore, the re-entitlement effect implies an average transfer of 18-12 = 6 weeks UI from firms that hire in booms to firms that hire in recessions. Being a pure hiring subsidy in recessions, it is directly employment stabilising over the recession. Furthermore, this hiring subsidy is not insubstantial.

Of course the above is a stylised numerical example. The paper formally establishes the existence of this transfer effect using a standard equilibrium matching framework, where firms are subject to idiosyncratic job destruction shocks, and the aggregate rate of job destruction evolves stochastically over time.[2] Simulations establish that a reduction in the duration of UI, tied to a compensating increase in the level of benefits so that the budget balancing tax rate is held constant, implies a reduction both in the average level of unemployment and in the variance of unemployment over the cycle.

There are several related papers on duration dependent UI systems but, apart from Millard and Mortensen (1997), all assume steady state. The optimal UI literature does not consider equilibrium - taking matching rates and wages as given, that literature designs UI programs which insure employed workers against idiosynchratic

[2] Recent work by Shimer [2003] asserts that the labor market data for the US are inconsistent with business cycles caused by changes in the job destruction rate. However, the effects we discuss here will be present whenever the expected duration of unemployment is higher in recessions.

layoff risk [e.g. Shavell and Weiss [1979], Hopenhayn and Nicolini [1997], Werning (2002)]. The optimal job search literature instead asks how a duration dependent UI program affects reservation wages (e.g. Mortensen [1977], van den Berg [1990] but also see Albrecht and Vroman [2001]). Fredriksson and Holmlund (2001), Davidson and Woodbury (1997), Millard and Mortensen (1997) consider how a duration dependent UI system affects unemployment in an equilibrium matching environment. Those papers simplify by assuming wages are determined by Nash bargaining where the worker's threatpoint is the value of being unemployed while fully entitled to UI payments. This assumes that firms cannot extract any rents due to re-entitlement effects and so rules out the intertemporal linkages identified here.

2 The Model.

Time is continuous and has an infinite horizon. There is a continuum of identical workers with mass normalized to one, and all workers are infinitely lived. Each worker may be in one of two states, employed or unemployed, where U_t denotes the measure of workers unemployed at time t. There is also a continuum of vacancies with measure V_t which will be determined endogenously via a standard free entry condition.

There are matching frictions where a matching function $M_t = M(U_t, V_t)$ describes the contact rate between the unemployed job seekers and the firms holding vacancies. M is strictly increasing in both arguments, continuous, concave and homogenous of degree 1 with $M(0, V) = M(U, 0) = 0$ and $M_V(U, 0) = \infty$ for $U > 0$. $\theta_t = V_t/U_t$ denotes labor market tightness at time t. For dt arbitrarily small, the probability an unemployed worker contacts a vacancy over time interval $[t, t + dt)$, denoted $\alpha_w(t)dt$, is given by

$$\alpha_w = \frac{1}{U_t} M(U_t, V_t) = M(1, \frac{V_t}{U_t}) \equiv m(\theta_t)$$

and m is a strictly increasing, concave function of θ with $m(0) = 0, m'(0) = \infty$.

Similarly, the probability a vacancy is contacted by a searching worker over time interval $[t, t + dt)$,denoted $\alpha_f(t)dt$,is given by

$$\alpha_f = \frac{1}{V_t} M(U_t, V_t) = \frac{U_t}{V_t} M(1, \frac{V_t}{U_t}) \equiv \frac{m(\theta_t)}{\theta_t}.$$

For simplicity, all are risk neutral and have the same discount rate r. If a worker is employed at wage w, and employment is taxed at rate τ by the government, then the employee receives utility $w\,dt$ per instant dt, the firm obtains net profit $(p - w - \tau)dt$ and $\tau\,dt$ is tax revenue collected per employed worker. Note, all firms are equally productive and p does not vary over time. There is no on-the-job search - a worker must quit before searching for alternative employment.

There are idiosynchratic job destruction shocks, where each job is destroyed according to an independent Poisson process with parameter $\lambda_t > 0$, where λ_t describes the aggregate rate of job destruction at time t. λ_t evolves according to an N-state Markov process: λ_t can take one of N values λ^i, where $0 < \lambda^1 < \lambda^2 < .. < \lambda^N$. Given $\lambda_t = \lambda^i$, λ_t switches state according to a Poisson process with parameter $\gamma > 0$, whereupon the new realised job destruction state is λ^j with probability π^j. Assume that when a job is destroyed, the worker is laid off and becomes unemployed.

The unemployment insurance system (UI) is described by a benefit function $b(.)$, where $b(s)dt$ describes the benefit paid over instant dt to a worker who has unemployment duration s, and an employment tax τ. Note, the benefit profile $b(.)$ and tax rate τ do not vary over the cycle. More generally, these policy parameters could vary with time and be conditioned on the state of the economy. Assuming the scheme is fixed over the cycle, however, is empirically realistic and allows us to assess how such schemes stabilise unemployment. Given $b(.)$, the employment tax τ has to ensure (long run) budget balance; i.e. the expected discounted revenues from the employment tax must equal the expected discounted benefits paid. Hence, on average, τ describes a fair insurance premium.[3]

[3] A technical issue here is that recessions could last so long that debt repayment would exceed

Given that all jobs are equally likely to be destroyed, assume that the UI program provides universal coverage - that each worker when laid-off through job destruction returns to the pool of unemployed workers with duration $s = 0$. This assumes there are no qualification periods for re-entitlement to full UI coverage, which is counterfactual. In the simulations that follow, however, the average employment spell is around 4 years which is much longer than standard qualification periods. (This choice is consistent with Cole and Rogerson [1999] who report workers in the U.S. get laid-off, on average, every 4.5 years). Assume also that only workers who have been laid off are entitled to receive UI payments - workers who quit receive nothing.

Let $F_t(s)$ denote the proportion of unemployed workers at time t whose current unemployment spell is no greater than s. As negotiated wages generally depend on a worker's unemployment duration s, then the equilibrium rate of job creation at time t depends on F_t. As the value of being unemployed depends on (future) job creation rates, it will depend on how F_t evolves stochastically over time. Unfortunately F_t is infinitely dimensional. Even given the above simple policy paradigm, describing equilibrium is not tractable unless we assume firms have all the bargaining power. An additional advantage of that assumption, however, is that it also makes transparent that a duration dependent UI system generates intergenerational transfers which stabilise employment over the cycle.[4]

Assume $b(.)$ is positive and non-increasing with duration and a worker obtains flow value $l > 0$ while unemployed. Assume $b(0) + l < p - \tau$ so that a gain to trade always exists and so (efficient) bargaining implies that any contact between a vacancy and an unemployed worker always results in a match.

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the total output of the economy. One way to avoid this problem would be to sell the financing of the scheme to an organization with deep pockets.

[4] Cahuc et al (2003) estimate bargaining power in a model of on-the job search and find that firms have all the bargaining power. In their framework, on-the-job search implies employed workers obtain higher wages over time by generating outside offers, but those expected rents are extracted by the hiring firm through a lower starting wage.

When a firm hires a worker, they write an enforceable contract which states that the worker earns some fixed wage w until job destruction occurs. The previous matching literature (e.g. Millard and Mortensen [1997], Fredriksson and Holmlund [2001]) instead assumes that workers always renegotiate ex-post, and that wages are determined by Nash bargaining where the worker's threatpoint is the value of being unemployed with full UI coverage. This is a convenient assumption rather than a compelling one. Indeed, given a worker cannot claim UI during renegotiations (the worker has not been laid off), and that a worker who quits is not entitled to receive UI then, in the absence of an enforceable contract, the firm (with all the bargaining power) would ex-post renegotiate $w = l$ and the worker would be indifferent to quitting (with no UI support).

To advertise a vacancy, a firm must pay a flow cost $a\,dt > 0$ per instant $dt > 0$. If the firm does not advertise, its contact probability is zero. With free entry, the number of vacancies adjusts so that the expected discounted value of advertising is zero.

3 Characterising Equilibrium.

In general the relevant aggregate state variable at time t is $\phi_t = (U_t, F_t, \lambda_t)$. Let $V_u(s, \phi_t)$ denote the value of being unemployed in state ϕ_t with unemployment duration $s \geq 0$. As firms have all the bargaining power, a worker with unemployment duration s in state ϕ_t is hired with an employment contract which has value equal to $V_u(s, \phi_t)$. Hence the recursive Bellman equation describing V_u over arbitrarily small interval $dt > 0$ is

$$V_u(s, \phi_t) = \frac{1}{1 + rdt} \left[[l + b(s)]dt + E_t V_u(s + dt, \phi_{t+dt}) \right];$$

where the worker obtains flow payoff $[l + b(s)]dt$ over the next instant, and obtains payoff $V_u(s + dt, \phi_{t+dt})$ from then on, regardless of whether the worker receives a job offer or not. The value of being unemployed is therefore the expected discounted value of being unemployed forever. As by assumption UI payments are independent of ϕ_t then, with a slight abuse of notation, the value of being unemployed is simply

$$V_u(s) = \int_s^\infty e^{-r(x-s)}[l + b(x)]dx = l/r + B(s), \tag{1}$$

where

$$B(s) = \int_s^\infty e^{-r(x-s)} b(x)dx \tag{2}$$

is the worker's option value of consuming his/her remaining UI entitlement at duration s. It is now straightforward to compute equilibrium.

3.1 Equilibrium Wage Formation

Consider the value of being employed on wage contract w in state ϕ_t. Should a job destruction shock occur, the worker is laid off and obtains payoff $V_u(0)$ as described above. As the wage paid is constant over time, the value of the worker's employment contract depends only on ϕ_t via the current job destruction rate λ_t. Let $V_e^i(w)$ denote the value of being employed on wage contract w in job destruction state i. Standard arguments imply

$$rV_e^i(w) = w + \lambda^i[V_u(0) - V_e^i(w)] + \gamma \sum_j \pi^j [V_e^j(w) - V_e^i(w)]$$

where the worker obtains flow utility w while employed, is laid off at rate λ^i in state i, and the economy switches state at rate γ. Putting $i = 1$ implies

$$(r + \lambda^1 + \gamma)V_e^1(w) = w + \lambda^1 V_u(0) + \gamma \sum_j \pi^j V_e^j(w)$$

and so yields

$$(r + \lambda^1 + \gamma)V_e^1(w) - (r + \lambda^i + \gamma)V_e^i(w) = (\lambda^1 - \lambda^i)V_u(0).$$

Rearrange this equation for $V_e^i(w)$ in terms of $V_e^1(w)$, and use that to substitute out the $V_e^j(w)$ in the previous equation. Solving and simplification yields the following.

Lemma 1. For $i = 1, .., N$,

$$V_e^i(w) = \frac{w + \overline{\lambda}^i V_u(0)}{r + \overline{\lambda}^i} \tag{3}$$

where

$$\overline{\lambda}^i = \lambda^i - \sum_j \pi^j \frac{\gamma}{r + \lambda^j + \gamma}(\lambda^i - \lambda^j).$$

If job destruction rates did not switch over time, i.e. if $\gamma = 0$, then $\overline{\lambda}^i = \lambda^i$ and the solution above simplifies to the more recognisable form $V_e^i = (w + \lambda^i V_u(0))/(r + \lambda^i)$. Stochastic job destruction rates, however, imply $\overline{\lambda}^i$ reflects that with positive probability the economy will switch to a different job destruction state in the future. For example, the above implies $\overline{\lambda}^1 > \lambda^1$, reflecting that job destruction rates will be higher in the future. Also note that $\lambda^k > \lambda^i$ implies $\overline{\lambda}^k > \overline{\lambda}^i$.

As firms have all the bargaining power, the negotiated wage is set where the worker is indifferent to accepting employment. Given a worker with unemployment duration s and in job destruction state i, the equilibrium negotiated wage $w = w^i(s)$ satisfies

$$V_e^i(w) = V_u(s). \tag{4}$$

Solving this equation using (1) and (3) implies the following.

Proposition 1. Equilibrium Wages

Given unemployment duration s and job destruction state i, the equilibrium wage agreement $w^i(s)$ is

$$w^i(s) = l + rB(s) - \overline{\lambda}^i [V_u(0) - V_u(s)]. \tag{5}$$

Equilibrium wages are composed of three terms: the wage compensates for foregone leisure, the option value of foregone UI payments at the point of hire (appropriately annuitised) and there is a wage deduction which takes into account the value of becoming re-entitled to full UI coverage in the event of a future job destruction shock. Section 4 discusses this wage equation in detail. Here we complete the description of equilibrium.

3.2 Equilibrium Vacancy Creation.

Let $\Pi^i(w)$ denote the firm's expected discounted profit with contracted wage w in job destruction state i. As a free entry equilibrium implies the firm makes zero profit if the job is destroyed, then standard arguments imply

$$r\Pi^i(w) = [p - w - \tau] + \lambda^i[0 - \Pi^i(w)] + \gamma \sum_j \pi^j[\Pi^j(w) - \Pi^i(w)].$$

Using the same method as before yields

$$\Pi^i(w) = \frac{p - w - \tau}{r + \overline{\lambda}^i}. \tag{6}$$

Not surprisingly $\lambda^k > \lambda^i$ implies $\Pi^k(w) < \Pi^i(w)$; filled jobs are less valuable in high job destruction states.

Proposition 2. Equilibrium Job Creation.

In state ϕ_t with $\lambda_t = \lambda^i$, free entry of vacancies implies equilibrium labor market tightness $\theta_t = \theta(\phi_t)$ defined by the implicit function:

$$a = \frac{m(\theta)}{\theta} \int_0^\infty \Pi^i(w^i(s))dF_t(s). \tag{7}$$

Proof: Given $\lambda_t = \lambda^i$ and contact with an unemployed worker with unemployment duration s, the firm negotiates a labor contract with equilibrium wage $w^i(s)$ described by Proposition 1. This generates expected discounted profit $\Pi^i(w^i(s))$. Given the distribution of uncompleted spells of unemployment F_t, free entry of vacancies implies the flow cost of creating a vacancy equals the expected gain through contacting a currently unemployed job seeker, where $m(\theta)/\theta$ describes the instantaneous contact rate given labor market tightness θ.

Having described equilibrium wage formation and equilibrium market tightness, the description of the equilibrium market dynamics ϕ_t is now straightforward.

3.3 Equilibrium Market Dynamics

Given ϕ_t, unemployment at time t evolves according to the differential equation

$$\frac{dU_t}{dt} = \lambda_t(1 - U_t) - m(\theta_t)U_t,$$

where the first term on the right hand side describes the inflow of workers into unemployment through job destruction, while the second describes the outflow through matching.

Given ϕ_t and for $dt > 0$ but arbitrarily small, the distribution of unemployment spells F_t evolves according to

$$U_{t+dt}F_{t+dt}(s) = [1 - m(\theta_t)dt]U_tF_t(s - dt) + \lambda^i dt[1 - U_t] + o(dt)$$

where the left hand side describes the number of unemployed workers at date $t + dt$ with unemployment duration no greater than s, which equals the number unemployed in the previous instant with duration no more than $s - dt$ and who failed to get a job over that instant, plus those employed who lost their job and so entered the pool of unemployed workers with duration $s = 0$. Taking the limit $dt \to 0$ and using the above solution for dU_t/dt implies F_t evolves over time according to the differential equation

$$\frac{\partial F_t(s)}{\partial t} = \lambda_t \frac{1 - U_t}{U_t}[1 - F_t(s)] - \frac{\partial F_t(s)}{\partial s}.$$

Given an initial distribution of unemployment spells, $F_0(s)$, initial level of unemployment U_0 and the Markov process describing λ_t, these two differential equations, together with Proposition 2 describing θ_t, imply a first order Markov process for $\phi_t = \{U_t, F_t, \lambda_t\}$.

Finally given the UI profile $b(.)$ and the initial state of the economy (U_0, F_0, λ_0), the employment tax rate τ has to achieve long run budget balance. Given the above Markov process for ϕ_t, this requires:

$$E_0 \int_0^\infty e^{-rt} \left[(1 - U_t)\tau - U_t \int_0^\infty b(s)dF_t(s) \right] dt = 0.$$

3.4 Existence of a Market Equilibrium.

When $\lambda^i = \lambda$ for all i and for a constant UI program $b(s) = \overline{b}$ for all s, it is straightfoward to show that a steady state equilibrium exists if $\overline{b}$ is small enough. In fact Coles and Masters (2002) establish that if one equilibrium exists, then generically there are two. That paper identifies such equilibria by first fixing an arbitrary value for τ and solving for steady state labour market tightness, denoted $\theta^*(\tau)$, and unemployment level $U^*(\tau)$. Budget balance then requires identifying a tax rate τ satisfying

$$\tau[1 - U^*(\tau)] = \overline{b}U^*(\tau).$$

For Laffer curve reasons, either budget balance is not possible (benefits $\overline{b}$ are too high to be fully funded) or there are two tax rates which achieve budget balance. Not surprisingly the equilibria are Pareto rankable, where the equilibrium with the lower tax rate and higher employment level is preferred.

The same existence argument applies to the stochastic structure described above. For given benefit profile $b(.)$ and initial values U_0, F_0, λ_0, fix an arbitrary tax rate τ. Equation (6) describes equilibrium profits Π^i which are continuous in τ. Hence for given ϕ_t, Propositions 1 and 2 imply that the aggregate vacancy creation decision, which determines equilibrium labor market tightness θ_t, is continuous in τ. Hence the differential equations describing the evolution of U_t, F_t, λ_t are continuous in τ and so given (U_0, F_0, λ_0), the expected discounted tax returns and benefit payments are also continuous in τ. The Laffer curve argument now goes through: $\tau = 0$ implies zero tax revenues, while $\tau = p - l$ implies no vacancy creation. Hence the budget surplus is hump-shaped in τ, and typically there is either no tax rate which achieves budget balance, or there will be at least two. Obviously the lowest tax rate which achieves budget balance is preferred.

4 Discussion and Simulations

4.1 Intergenerational Transfer of Rents

A primary insight of this framework is that with non-competitive wage formation, the UI system transfers rents from future employers to current matched firm/worker pairs. The point is made most readily in the steady state case ($\lambda^i = \lambda$ for all i and α_w constant). In that case, Proposition 1 implies an unemployed worker with duration s negotiates wage

$$w(s) = l + rB(s) - \lambda[V_u(0) - V_u(s)]. \tag{8}$$

The worker extracts rents $B(s)$ [suitably annuitised] reflecting the worker's option value of consuming his/her remaining UI entitlement, while the firm extracts the surplus attached to becoming re-entitled to full UI coverage in the future.

It is useful to decompose $V_u(0)$, which is the expected discounted lifetime utility of a worker with unemployment duration $s = 0$, as

$$V_u(0) = \int_0^\infty e^{-rx}\{e^{-\alpha_w x}[l + b(x) + \alpha_w V_u(x)]\}dx.$$

where with probability $e^{-\alpha_w x}$ the worker remains unemployed at duration x and so receives flow utility $[l+b(x)]dx$ over the next instant, and with probability $e^{-\alpha_w x}\alpha_w dx$ finds work at that duration with expected payoff $V_e = V_u(x)$.[5] This expression decomposes $V_u(0)$ into expected UI payments received from the government, and expected rents extracted from the worker's next employer.

Now fair insurance in a steady state implies

$$\tau = \lambda \int_0^\infty e^{-rx}[e^{-\alpha_w x} b(x)dx] \tag{9}$$

where the integral term computes the expected discounted UI payments made to a worker who is laid-off. As $V_u(x) \equiv l/r + B(x)$, the above decomposition of $V_u(0)$

[5] One way to derive this equation is to note that $V_u(.)$ satisfies the differential equation

$$rV_u - \frac{dV_u}{ds} = l + b(s) + \alpha_w[V_e - V_u]$$

where $V_e(s)$ is the value of becoming employed at duration s. Hence

$$(r + \alpha_w)V_u - \frac{dV_u}{ds} = l + b(s) + \alpha_w V_e.$$

Integration using integrating factor $e^{-(r+\alpha_w)s}$ implies the form stated, where $V_e(s) = V_u(s)$ when firms have all the bargaining power.

simplifies to

$$V_u(0) = \frac{l}{r} + \frac{\tau}{\lambda} + \int_0^\infty e^{-(r+\alpha_w)x}\alpha_w B(x)dx \qquad (10)$$

The value of being laid off is composed of three terms: the value of leisure while unemployed, the expected UI benefits received from the government (with fair insurance) and the expected rents from finding employment at a new firm. The third term makes it explicit that the UI system, by raising the option value of remaining unemployed, allows the worker to extract greater rents from future employers.

Using (10) and $V_u(s) = l/r + B(s)$ in (8) now implies

$$w(s) = l - \tau + (r+\lambda)B(s) - \lambda \int_0^\infty e^{-(r+\alpha_w)x}\alpha_w B(x)dx,$$

which makes explicit the intergenerational transfer of rents across firms. When hiring a worker, who becomes re-entitled to full UI coverage, the firm pays a lower wage reflecting the rents the worker will extract from his/her next employer in the event of a job destruction shock. The firm, however, also has to pay a wage premium to compensate the worker for his/her option value of continued UI. Of course those rents were appropriated by the worker's previous employer. The UI system therefore implies a transfer of rents from future hiring firms to current hiring firms. Also note that the worker pays the insurance tax τ (but is fully compensated by expected future UI receipts when laid-off).

Define the rent extraction term $R = R(\alpha_w, b(.))$ as

$$R = \int_0^\infty e^{-(r+\alpha_w)x}\alpha_w B(x)dx, \qquad (11)$$

which describes the expected rents extracted from the next employer by a laid-off worker. Note also that the above implies the joint value of the match

$$\frac{p-\tau-w}{r+\lambda} + [\frac{w+\lambda V_u(0)}{r+\lambda} - \frac{l}{r}] = \frac{p-l}{r+\lambda} + \frac{\lambda}{r+\lambda}R,$$

is directly proportional to R. Hence given α_w, the joint value of the match is increasing in the level of UI benefits - the worker/firm pair extract greater rents from the worker's next employer. Indeed, the privately optimal UI contract (with free entry of firms) raises the worker's reservation wage to the point where the worker's next employer makes zero profit by hiring that worker at his/her reservation wage.

An important feature for what follows is that the rent extraction term, R, is increasing in the re-employment rate α_w. To see this, note that $\alpha_w e^{-\alpha_w s}$ is the density function corresponding to the exponential distribution and that a lower α_w implies first order stochastic dominance. As $e^{-rs}B(s)$ is decreasing in s, then (11) implies a lower α_w yields a lower R. The intuition is that when laid off, a lower α_w implies the worker expects to be unemployed longer and so expects a smaller remaining entitlement $B(.)$ at the point of hire, and the longer duration implies those rents are discounted more. This insight plays an important part in the simulations that follow - firms that hire in recessions (characterised by low re-employment rates) lose fewer rents to unemployed workers.

There is, however, an alternative interpretation for this result. Note that (10) implies $R \equiv V_u(0) - \tau/\lambda - l/r$. As $V_u(0) = l/r + \int_0^\infty e^{-rs}b(s)ds$, we also have

$$R = \int_0^\infty e^{-rs}b(s)ds - \tau/\lambda.$$

The first term does not depend on α_w. Hence R is increasing in α_w because τ falls with α_w ((see (9)). A higher re-employment rate implies the government expects to make fewer UI payments to each laid off worker and so lowers the (fair) insurance tax.

The two expressions for R are equivalent (use integration by parts in (11)), and so the two interpretations have to be consistent. The underlying insight is that there is a funding externality - when a firm hires a worker, the firm does not take into account that it saves the government money (the government pays no more UI to that worker). The UI system essentially guarantees each laid-off worker a payoff equal to $V_u(0)$, but the funding of that payoff - whether as government UI or higher wages from a future employer - depends on the hiring rate. A lower hiring rate implies future hiring firms do not bear so much of the cost of the UI system and so current firms have to bear more of it - the government raises the insurance tax τ to cover the promised payments.

This insight is particularly valuable for the stochastic case. As we shall see, higher re-employment rates in a boom imply firms lose more rents to unemployed workers (re-employment rates are higher) and so "over-contribute" to the cost of guaranteeing laid-off workers payoff $V_u(0)$. This acts as a job creation subsidy in recessions.

Given these rent transfer effects, it is useful to consider how they affect the expected value of filling a vacancy. As steady state implies unemployment spell distribution $dF(s) = \alpha_w e^{-\alpha_w s} ds$, then given $w(s)$ described above, the expected profit by filling a vacancy

$$\int_0^\infty \frac{p - w(s) - \tau}{r + \lambda} dF(s) = \frac{p - l}{r + \lambda} - \int_0^\infty [1 - \frac{\lambda e^{-rs}}{r + \lambda}] B(s) dF(s).$$

Note, $r > 0$ implies the UI system reduces the expected value of filling a vacancy in a steady state; the expected rents lost to new hires exceeds the (discounted) value of extracting rents from the worker's next employer. More generous UI payments leads, in a steady state, to lower expected profit per filled vacancy and hence lower vacancy creation rates and higher unemployment.

This result, however, needs to be interpreted with care as it ignores non-steady state dynamics. For example, suppose the economy begins life with all workers unemployed and none entitled to receive UI. As firms have all the bargaining power, these workers obtain no surplus by finding work. Assuming the economy converges to the steady state, then any rents lost by firms in that steady state must have been appropriated by previous employers. Hence outside of steady state, the UI scheme allows the early hiring firms to extract rents from later firms. Such transfers imply high initial vacancy creation rates and a more rapid decline in unemployment over time. It is precisely this mechanism which stabilises unemployment levels over the cycle.

4.2 Employment Stabilisation over the Cycle.

With duration dependent UI, Proposition 1 and (6) imply the firm makes expected profit

$$E_t[\Pi^i(w^i(s))] = \frac{p-l}{r+\overline{\lambda}^i} - \int_0^\infty B(s)dF_t(s) + \frac{\overline{\lambda}^i V_u(0) - \tau}{r+\overline{\lambda}^i}, \tag{12}$$

by hiring a worker at time t in state i. Note, the firm loses rents $B(s)$ by hiring a worker with unemployment duration s, but gains expected surplus $\overline{\lambda}^i V_u(0) - \tau$ through re-entitlement effects. The previous section established that in a steady state with $\lambda^i = \lambda$, discounting implies the the expected loss $\int_0^\infty B(s)dF(s)$ dominates the re-entitlement effect. This is not necessarily the case outside of a steady state. In particular the UI scheme raises the expected value of filling a job in the recession if

(i) the currently unemployed have relatively long unemployment spells, i.e. $dF_t(s)$ has more weight at long durations s. In that case, fewer rents are extracted by the currently unemployed, and

(ii) hiring rates are expected to be higher in the future, so that future hiring firms bear more of the cost of providing the laid-off worker payoff $V_u(0)$ when the job is destroyed (and the financing tax rate τ is correspondingly low).

The numerical example given in the Introduction suggests the potential magnitude of the transfer of rents from firms hiring in booms to firms hiring in recessions. We now use a numerical simulation to establish formally that a duration dependent UI system lowers both the mean and the variance of unemployment levels over the cycle.

4.3 A Simulation.

Consider an economy whose welfare system is composed of two schemes: (i) a 6-month UI scheme, which pays $b(s) = b_{UI}$ for unemployment durations s below 6 months, and (ii) a UA (unemployment assistance) scheme which pays b_{UA} to workers whose UI entitlement has expired; i.e. when s exceeds 6 months. A pure UI scheme implies $b_{UA} = 0$, while a pure UA scheme (indefinite payments) implies $b_{UA} = b_{UI}$.

The aim is to consider how changing the composition of this welfare system (*i.e.* changing b_{UI}, b_{UA}) affects labor market activity over the business cycle. Throughout, we shall only consider compensated changes so that the financing tax rate τ is the same in all simulated economies. Hence the difference in economic activity is not due to changes in the implied employment tax rate.

We consider a two state case, $N = 2$, and $\pi_1 = \pi_2 = 0.5$. Assuming a Cobb-Douglas matching function, so that $m(\theta) = A\theta^{\eta}$, the chosen parameter values are described in Table 1.[6]

p	match productivity	1
l	flow value of leisure	0.2
a	flow vacancy cost	100
r	discount rate	0.000107
A	matching scale parameter	0.0333
η	elasticity of the matching rate with respect to the measure of vacancies	0.5
λ^1	job-destruction rate in booms	0.000548
λ^2	job-destruction rate in recessions	0.000913
γ	arrival rate of regime shock	0.0044

Table 1: Structural Parameters

The structural parameters are based on a time unit of one day. The match productivity is a normalization. The flow value of leisure is similar to numbers used elsewhere (e.g. Millard and Mortensen [1997]). The flow vacancy cost is chosen to generate reasonable average unemployment rates. It looks large because it has to capture all the capitalization costs of job creation and any subsequent non-labor pro-

[6] Although we provide some justification for the parameters chosen, this is not meant to be a formal calibration exercise - assuming firms have all the bargaining power rules out a more explicit quantitative analysis.

duction costs.[7] The discount rate is based on the 4% per annum number standard to the real business cycle literature. The matching elasticity and scale parameter are within the range found from estimates of the matching function (e.g. Blanchard and Diamond [1989]).

The job-destruction rates are based on an average job life of 5 years in booms and 3 years in recessions. This compares with the figure obtained by Cole and Rogerson [1999] for the U.S. of 4.5 years. The value of γ [and $\pi^i = 0.5$] implies their preferred switching rate of 0.2 per quarter.

The baseline economy is a pure UA welfare system; i.e. $b_{UA} = b_{UI}$ and the level of payments is set where $b_{UA} = b_{UI} = 0.2$. With $l = 0.2$, this implies an equilibrium wage of 0.4 and hence a replacement rate of 50% in the baseline economy. Simulations find that the employment tax rate τ required for expected long-run budget balance is 0.018; i.e., 1.8% of total output.

Table 2 reports the simulation results. Each row describes a simulation with the same initial values $\{U_0, F_0, \lambda_0\}$ but a different value of b_{UI} and b_{UA}. For each b_{UA}, preliminary simulations were run to find the corresponding value of b_{UI} so that the budget balancing tax rate τ remained neutral at 0.018. Given each pair (b_{UI}, b_{UA}) and the same initial values $\{U_0, F_0, \lambda_0\}$, the results described are for a simulation which is iterated over 100,000 days, the first 10,000 of which are dropped from the calculations (to avoid initial value distortions). Each set of results is computed using the same realized sequence of job destruction shocks.

[7] Some models of this type (e.g. Albrecht and Vroman [2002]) use a parameter to represent a flow cost paid by the firm for the duration of the job, filled or vacant. Such an approach has the cosmetic benefit of a more realistic parameter value in simulations. But when firms have all the bargaining power, so that wages are determined purely by worker-side factors, this has little qualitative effect on the results.

Benefits		w_0	Unemployment		Job Creation		Job Destruction	
b_{UI}	b_{UA}		*mean* %	*st.dev.* $\times 100$	*mean* $\times 10^4$	*st.dev.* $\times 10^4$	*mean* $\times 10^4$	*st.dev.* $\times 10^4$
0.20	0.20	0.400	8.67	1.83	6.69	1.24	6.69	1.56
0.23	0.15	0.352	7.99	1.72	6.75	1.28	6.75	1.58
0.26	0.10	0.303	7.42	1.62	6.79	1.31	6.78	1.59
0.28	0.05	0.254	6.92	1.54	6.83	1.34	6.83	1.61
0.30	0	0.206	6.50	1.46	6.86	1.36	6.86	1.62

Table 2: Unemployment, job creation and job destruction, $T = 6$ Months.

The top row describes the baseline economy with a pure UA scheme (indefinite welfare payments) and a replacement rate of 50%. The bottom describes a pure UI scheme where all welfare payments cease after 6 months. The intervening rows consider a 6 month UI scheme but with different levels of UA support. All require the same budget balancing tax rate $\tau = 0.018$.

Column 4 describes how average unemployment varies across these welfare schemes and demonstrates that the pure UA scheme implies a significant increase in average unemployment. Column 3 shows why. $w^H(0) = w^L(0) = w_0$ is the wage a recently laid off worker negotiates. Although no more costly to operate (the required financing tax rate is the same), the pure UA scheme implies a large increase in the option value of remaining unemployed. As implied in the discussion above, this reduces the expected value of filling a vacancy (in a steady state) and leads to higher average unemployment levels.

For these parameter values, the constant UI scheme implies an average expected duration of unemployment of around 18 weeks (the U.K. in comparison has an average of around 26), while the pure UI scheme implies an average duration of around 13 weeks (as in the U.S.). But note that to obtain the same balancing employment tax rate, the value for b_{UI} is necessarily high in the pure UI scheme ($b_{UI} = 0.3$ in the pure UI scheme, while $b_{UA} = b_{UI} = 0.2$ in the pure UA scheme).

As equilibrium employment levels are higher in the pure UI case, the assumed job destruction process implies that the mean and variance of the number of jobs destroyed per period is greatest in the pure UI scheme (see the Job Destruction figures, columns 8 and 9 of Table 2). Ceteris paribus, this would imply the pure UI system generates greater unemployment variance over the cycle. Column 5, however, reveals that the pure UI system also yields a lower variance of unemployment. This is due to the stabilisation effects discussed above. In essence intergenerational transfers due to re-entitlement effects subsidize job creation rates in recessions, and so prevent unemployment becoming too high during extended periods of high job destruction, while dampening the increase in employment during booms.

Figure 2 depicts an impulse response function which describes how the average wage negotiated by workers hired at any point in time changes as the economy moves into recession. It has been constructed for the pure UI economy (bottom row) of Table 2. Prior to time 0 the economy is in the conditional steady-state associated with $\lambda = \lambda^L$ (a boom). At time 0, λ switches to λ^H forever (though individuals in the model continue to expect the job destruction state to switch at rate γ.)

There is an initial downward jump in the average hiring wage at time 0, which reflects the increased value of becoming re-entitled to future UI (see Proposition 1). The wave of newly laid-off workers, however, causes a decrease in the average uncompleted spell of unemployment. This feature of the data is well documented in the long-term unemployment literature (e.g. Machin and Manning (1999)). In our model, this fall in the average uncompleted spell leads, at least initially, to a spell of rising wages. This initial composition effect washes out at around 9 months.

In the longer–term, the economy moves toward a conditional steady-state associated with high job destruction. Not surprisingly this generates higher unemployment levels and longer unemployment spells. But re-entitlement effects, which enable hiring firms to extract rents from the worker's next future employer (potentially in a

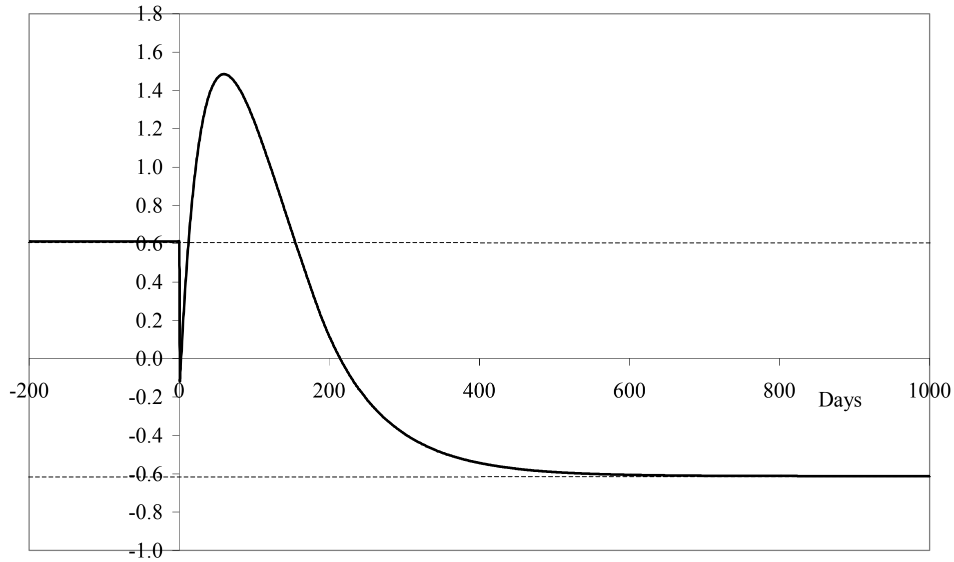

Figure 2: Impulse response: Percent deviation of average hiring wage from its (unconditional) expected value.

future boom), imply unemployment is not so high as it otherwise would have been. The overall effect is a reduction in the variance of unemployment over the cycle.

5 Conclusion

This paper has shown that when UI payments are duration dependent, re-entitlement effects generate transfers from firms that hire in the future to currently hiring firms. As more rents are extracted from hiring firms when re-employment rates are high, this implies a net transfer of rents from firms that hire in booms to firms that hire in recessions. Using an equilibrium matching framework, simulations find that a switch from a pure UA system to a pure 6-month UI system lowers both average unemployment and the variance of unemployment levels over the cycle.

Back-of-the-envelope calculations provided in the Introduction suggest the net transfer may be worth as much as 6 weeks UI (from boom to bust). With a 50%

replacement rate this suggests that firms hiring in recessions receive a subsidy equal to three weeks wages. Suitably annuitised, where an average employment spell is around 4 years, suggests a 1.5% wage subsidy. This is not a huge amount. Indeed, the simulations show that average hiring wages do not move much over the cycle - hiring wages in the conditional steady state associated with low job destruction rates are only 1.2% higher than in the conditional steady state associated with high job destruction rates, and only 0.6% greater than the average wage paid in the ergodic steady state. Indeed, it is interesting that the average wage paid across all employed workers hardly changes over the cycle. Nevertheless being a targeted hiring subsidy in recessions, simulations find these transfers are effective in stabilising employment levels over the cycle.

For ease of exposition, the paper has assumed the business cycle is driven by variations in job destruction rates (e.g. Davis and Haltiwanger [1992]). Shimer [2003] challenges this view of the cycle and argues that the cycle in the U.S. is instead driven by aggregate productivity shocks (and inflexible wages). Introducing productivity shocks complicates our model as renegotiation constraints might bind; e.g. the wage might be renegotiated whenever productivity $p < w$. Of course when hiring, the firm and worker anticipate such renegotiations and, as the firm has all the bargaining power, the starting wage adjusts so that the firm still extracts all expected rents (see Postel-Vinay and Robin (2002a),(2002b) for related insights). Although wages evolve stochastically during the lifetime of the job, the above insights continue to hold - re-entitlement effects imply a net subsidy to firms who hire in low productivity phases (with low re-employment rates).

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