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Buffer funding of unemployment insurance in a dynamic labour union model

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Abstract

In this paper we study the implications of the unemployment insurance (UI) financing system on wage levels and employment when labour markets are unionised and the revenues of the firms are stochastic. We use the basic monopoly union approach of wage and employment determination and assume that unemployment benefits are financed by employees' UI contributions to the union's UI fund and by the government's tax revenue. The main focus of this paper is on the effects of UI buffer funding on employment fluctuations. We show that, compared with the pay-as-you-go financing system, buffer funding stabilises the economy by decreasing employment fluctuations where wages are flexible. If wages are rigid, buffer funding stabilises net wage variations, but has hardly any effect on employment fluctuations.

Key words: unemployment insurance, unions, stabilisation, buffer funding

JEL classification numbers: E61, J51, J65

Työttömyysvakuutuksen puskurirahastointi dynaamisessa ammattiliittomallissa

Suomen Pankin keskustelualoitteita 24/2003

Marja-Liisa Halko
Tutkimusosasto

Tiivistelmä

Tutkimuksessa tarkastellaan työttömyysvakuutuksen rahoitusjärjestelmän vaikutuksia palkanmuodostukseen ja työllisyyteen, kun ammattiliitot päättävät palkoista ja kun yritysten kannattavuus vaihtelee satunnaisesti. Tutkimuksessa käytetään yleistä monopoliasemassa olevan ammattiliiton mallia selittämään palkanmuodostusta ja työllisyyttä sekä tarkastellaan järjestelmää, jossa työttömyysturva rahoitetaan työntekijöiden työttömyysvakuutusmaksuin ja veroin. Keskeisenä tutkimusongelmana on työttömyysturvan ns. puskurirahoituksen vaikutus työllisyyden vaihtelujen kannalta. Osoitetaan, että puskurirahastointi vakauttaa taloutta ja vähentää työllisyyden vaihteluita, jos palkat ovat joustavat. Jos palkat ovat jäykät, puskurirahastointi vakauttaa työntekijöiden nettopalkkoja, mutta ei juuri vaikuta työllisyyden vaihteluihin.

Avainsanat: työttömyysvakuutus, ammattiliitot, stabilisaatio, puskurirahasto

JEL-luokittelu: E61, J51, J65

Contents

1 Introduction

In most of the EU countries unemployment insurance (UI) is, at least partly, financed from employer and/or employee contributions. The UI funds are, however, usually subsidized by the state and the state also covers the possible deficit. Business cycles cause seasonal variation in unemployment expenses and thereby also in the size of the deficit, if the contributions are kept fixed, or in the contributions, if they are adjusted according to the economic state. If the contributions are kept fixed, the government budget must then be used as a stabilising buffer. In the case of small shocks variations in the contributions or in the UI fund's deficit do not cause problems, but the situation is different when the economy faces a strong negative shock. A sudden large deficit can unbalance public economy for years[1].

Building buffer funds is one way to prepare oneself for negative shocks and unemployment expense variations. Buffer funding is based on the following idea: during a boom UI contributions are kept on a high level when the fund shows a surplus, has a buffer, that could then be used during a recession and thereby prevent the contributions from rising. Buffer funding smooths contribution and labour cost variations and thereby stabilises employment over business cycles. Buffer funding was started in Finland[2] in the end of 1990s, after a serious economical crisis and the system has been discussed also in Sweden[3].

The special interest of the paper lies in the implications of buffer funding on employment variation and thereby on the stability of the economy. We want to find out when the argument for buffer funding holds, under what circumstances, buffer funding decreases employment variations? In this paper we study the effects different systems of UI funding have on wage formation and thereby on employment when labour markets are organized. We examine, in a dynamic environment, wage and employment formation between one union and one firm. The firm's revenues are subject to a technological or a demand shock which implies that the labour demand the union faces is stochastic. Every period a part of the union members are employed when they get the union wage and a part unemployed when they receive a fixed unemployment benefit. The benefits are financed by the union and the government. The government finances its share from general tax revenue and the union its share from UI contributions it collects from its employed members. The union then invests the contributions to the UI fund.

We assume that the union is cut off from all insurance markets when it can not insure itself against employment and thereby unemployment cost fluctuations. The union can, however, save a part of the contributions when it can adjust its savings to obtain self-insurance. The fund therefore does not have to operate on a pay-as-you-go principle but it can show a surplus up to a certain limit. The savings of the union we call a buffer fund. We are interested

[1] For example the case of Finland in 1990s, see Honkapohja and Koskela, 1999.

[2] For details of the unemployment insurance financing system in Finland see Holm and Mäkinen, 1998.

[3] See the raport of The Committee on Stabilisation Policy for full Employment if Sweden joins the Monetary Union, 2002.

in the effects of buffer funding on the union's optimal wage policy and thereby on employment. First we assume that the UI contribution is imposed by the government but later also discuss the case where UI funding is totally under labour market organisations' control.

Buffer funding is clearly a dynamic feature in the UI financing system. Dynamic wage bargaining models have been earlier used to study the implications of the firm's accumulation of inventories or investment in capital on wage level and employment. For example, Coles and Smith (1998) analyse a strategic wage bargaining model where the union and the firm bargain over wages and the firm, in addition, decides on the accumulation of its inventories. In the model the level of inventories affects the threat point of the firm; in the case of disagreement the firm can sell from the stock of its inventories. Coles and Smith show that, given the state of demand, the negotiated wage falls when the inventories increase. Leach (1997) also studies the strategic role of the accumulation of inventories. Leach shows that the level of the inventories affects not only the bargaining power of the firm but also the incidence of strikes. The accumulation of inventories makes the union to accept lower wages. At some point the union is willing to interrupt production, when the firm must sell from its stock of inventories, and wages rise. Van der Ploeg (1987) analyses the implications of investment in capital on non-cooperative wage bargaining outcome. In the model, time inconsistency problems arise because the union can renege on announced low wage strategies once the capital stock has been accumulated.

The paper is organized as follows: The basic model is presented in Section 2; Section 2.1 deals the case where the fund operates on the pay-as-you-go financing principle. In Section 2.2 we compare the results of Section 2.1 the results we get when we allow for buffer funding. In Section 3 we examine the effects of wage rigidity on the results of Section 2. Section 4 discusses a model where also the UI contribution is the union's decision variable. Section 5 concludes.

2 The model

We base our analysis on the basic monopoly union model studied, for example, in Oswald (1985). The basic model represents labour markets between one union and one firm. The union has a monopoly position in the labour markets when it can unilaterally determine the wage level. The firm however can, given the union's wage demand, decide on employment. Unlike in the basic model we assume that the firm's revenue function is subject to a technological or demand shock which leads to stochastic labour demand. First we study, as a benchmark, a case where wages are flexible, when the union can react to shocks on labour demand by changing its wage demand. Later, in Section 3, when we study the effects of wage rigidity, we assume that the union has to give its wage demand before the shock is realized.

The union has m members and the firm can only employ union members. Time runs from zero to infinity, $t = 0, ..., \infty$. When wages are flexible the timing of the decisions is the following. Every period first a technology shock z to the production takes place, and both, the union and the firm, observe the shock. Second, the union announces its wage demand, w and third, the firm decides employment, n. These decisions remain until a new shock takes place in the beginning of the next period.

First we solve the firm's problem. The firm produces output with two factors of production, capital and labour, and we assume that capital is a fixed and labour a variable factor. We can then write the firm's period t profits as

$$\pi_t(n_t, w_t, z_t) = z_t f(n_t, k) - w_t n_t - rk \tag{2.1}$$

where r and k denote the interest rate and the capital, which are assumed to be fixed. In (2.1) we have also normalized the price of the production to one. The firm has the following *CES* production function:

$$f(n_t, k) = [dn_t^{-\xi} + (1-d)k^{-\xi}]^{-\frac{1}{\xi}} \tag{2.2}$$

where $-1 \leq \xi \leq \infty$. The parameter d is related to the share of labour in production; in the limit, as $\xi \to 0$, d equals the share of labour. We do not examine neither the case where the shock the economy faces drives the firm into bankruptcy nor the case where there is excess demand of labour in the economy. Therefore we assume that $\pi_t \geq 0$ and $n_t \leq m$ with all z and all t. We can now write the firm's period t profit function as

$$\pi_t = z_t[dn_t^{-\xi} + (1-d)k^{-\xi}]^{-\frac{1}{\xi}} - w_t n_t - rk. \tag{2.3}$$

The firm maximises a discounted sum of its expected profits which, in our case, is equal to periodwise maximisation. The solution of the firm's period t maximisation problem, $\max_{n_t} \pi_t$, gives us the following period t labour demand function:

$$n_t = n(w_t, z_t) = \left[\left(\frac{dz_t}{w_t}\right)^{\frac{\xi}{1+\xi}} \frac{1}{1-d} - \frac{d}{1-d}\right]^{\frac{1}{\xi}} k. \tag{2.4}$$

In the case of *CES* production function the elasticity of substitution in the production is given by $\sigma = \frac{1}{1+\xi}$. We set the level of capital, without loss of generality, equal to one and write the period t labour demand function in the elasticity of substitution form when

$$n(w_t; z_t) = \left[\left(\frac{dz_t}{w_t}\right)^{1-\sigma} \frac{1}{1-d} - \frac{d}{1-d}\right]^{\frac{\sigma}{1-\sigma}}. \tag{2.5}$$

Every period labour demand increases when the value of the shock increases or when union's wage demand decreases.

All m workers in the labour market are members of the single union, and they all have same, strictly increasing, strictly concave, twice continuously differentiable utility function $u(\cdot)$. The union has a utilitarian utility function when, in period t, its utility is

$$U(n_t, w_t) = n_t u(w_t(1-\tau_t)) + (m - n_t)u(b). \tag{2.6}$$

In period t the firm employs n_t of m union members when $m - n_t$ members are unemployed. Employed members are paid the wage w_t and they pay a UI contribution τ_t.[4] The contributions are invested to the UI fund from where the unemployment benefits are paid to the unemployed members. We assume the union runs the UI fund. We denote the net wage in period t by $\widehat{w}_t = w_t(1-\tau_t)$. Unemployed members receive a fixed unemployment benefit b and we assume that they are exempt from the UI contribution. The government finances a fixed share $1 - \alpha$ of the benefits with its general tax revenue, while the share financed by the union with its employed members' contributions is α. In our benchmark model the government decides both the level of the contribution τ_t and the benefit b.

The union maximises a discounted sum of its expected utilities

$$E \sum_{t=0}^{\infty} \beta^t U(n_t, w_t) \tag{2.7}$$

where $\beta \in [0, 1]$ denotes the discount factor. Several constraints restrict union's choice. We assume that the net wage is always at least as large as the benefit, that is, $\forall t \; w_t(1-\tau_t) \geq b$. In our benchmark model in section 2.1 we assume that the UI fund operates on the pay-as-you-go financing principle when the union is not allowed to save. In other words, first we assume that buffer funding is not possible. The only additional constraint the union then faces is the labour demand function (2.5). The union then, making its wage decision, takes the UI contribution as given, in particular, the union does not 'see through' the government budget constraint. In section 2.2. we add a buffer fund constraint and examine how it changes the results of section 2.1.

2.1 Pay-as-you-go financing principle

First we study the union maximum problem when buffer funding is not possible. The government finances a part of the unemployment benefits with the UI contributions it imposes on employed union members. When buffer funding is not possible the government adjusts the contribution τ such that every period the following budget constraint is satisfied:

$$\tau_t w_t n_t = \alpha(m - n_t)b \tag{2.8}$$

The left hand side of equation (2.8) denotes UI contributions paid by the employed in period t and the right hand side the share α of period t unemployment expenses.

If buffer funding is not possible nothing connects the periods and then, when we omit the time subscripts, the union must solve the following

[4] The well known result from the labour taxation theory is that if the tax bases of the employers and employees are equal the composition of wage and payroll tax does not affect the wage bargaining outcome in the standard trade union models (Koskela and Schöb, 1999). Therefore we assume, for simplicity, that the government imposes UI contribution only on employees.

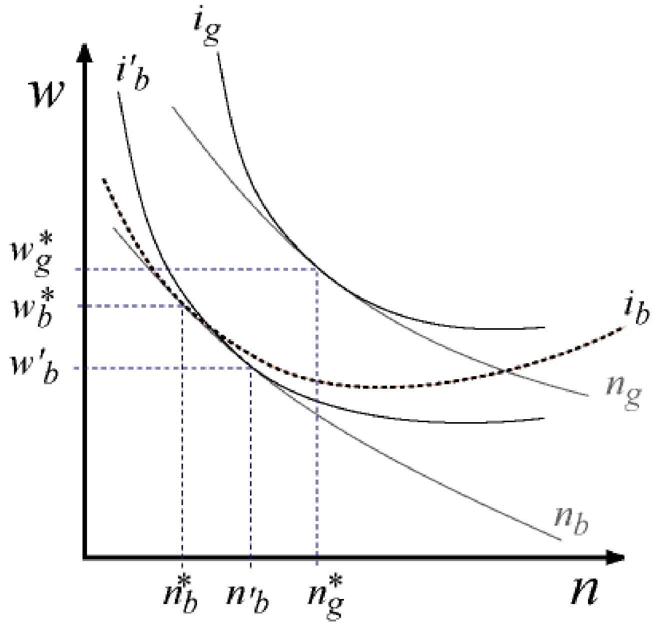

Figure 1:

periodwise maximisation problem

$$\max_{\substack{w \\ w(1-\tau)\geq b}} \quad U(n,w) \tag{2.9}$$

subject to

$$n = n(w;z). \tag{2.10}$$

The first-order condition of the maximisation problem is

$$n'\left(u(\widehat{w}) - u(b)\right) + nu'(\widehat{w})(1-\tau) = 0. \tag{2.11}$$

We can write (2.11) as

$$\eta(w)\left(1 - \frac{u(b)}{u(\widehat{w})}\right) = \frac{u'(\widehat{w})\widehat{w}}{u(\widehat{w})} \tag{2.12}$$

where $\eta(w)$ is the wage elasticity of labour demand. If we assume that the union members have a *CRRA* utility function, $u(x) = \frac{x^{1-\rho}}{1-\rho}$, we can write the union's pricing equation in the following form

$$\widehat{w} = \left(1 + \frac{\rho - 1}{\eta(w)}\right)^{\frac{1}{\rho-1}} b. \tag{2.13}$$

Let us, for simplicity, assume that the shock can only take two values, $z = z_g$ ('good state') and $z = z_b$, ('bad state'), $z_g > z_b$. A fall in z decreases firm's demand for labour and labour demand function, drawn in $(n,w)-$ plane, moves downwards, in Figure 1 from n_g to n_b. In Figure 1 we have also drawn three union indifference curves i_g, i'_b and i_b. The equilibrium of the monopoly union model is at the point where labour demand schedule is a tangent to a union indifference curve. When the economy is in a boom the equilibrium is at point (n_g^*, w_g^*). A negative shock to the firm's revenues decreases labour demand, and equilibrium employment and wage, before the adjustment of τ, fall to (n'_b, w'_b).

How the government adjusts the UI contribution depends on how wages and employment react, on the one hand, to the shock, and, on the other hand, to the changes in the contribution. From (2.13) we can see that the union's optimal wage demand depends on the wage elasticity of labour demand $\eta(w)$ while the wage elasticity, in a case of a CES production function, depends on the elasticity of substitution between the factors of production σ. We assume that σ is small, strictly less than one when labour demand function is (n, w) -plane relatively steep.[5] In Halko (2003) it is shown that when σ is small the government adjusts the UI contribution by increasing it in a recession and decreasing in a boom.[6] In our case a rise in τ has no effect on labour demand function but changes the slope of the union indifference curves. In Appendix A it is shown that if $\rho > 1$ the union indifference curve, with given n, gets flatter when τ increases. If $\rho < 1$ the opposite happens. The former case is represented in Figure 1 where i'_b denotes the union indifference curve before and i_b after adjustment of the UI contribution. When the economy is in a recession the final equilibrium is then at point (n_b^*, w_b^*). We can then conclude that stochastic labour demand causes procyclical fluctuations in employment. When the government adjusts the UI contribution according to its budget constraint (2.8) the contribution varies counter-cyclically and fluctuations in the contribution level strengthen employment fluctuations caused by stochastic labour demand.

2.2 Buffer funding

We next assume that instead of adjusting the UI contribution according to the economic state the government imposes a fixed contribution and allows union savings. The government sets the fixed contribution $\overline{\tau}$ such that its expected budget is in balance when $\tau = \overline{\tau}$. The union can, if desired, save part of the UI contributions when the fund does not have to operate on a pay-as-you-go principle but it can have a buffer. We however assume that the union is borrowing constrained and the buffer must not exceed the upper limit κ which implies that every period the buffer $a_t \in [0, \kappa]$. The upper limit κ

[5] There exists empirical evidence that quite strongly supports the assumption that σ is strictly less than one. Rowthorn (1999) presents a large set of cross-country estimates of σ and bases his estimates on earlier publiced estimates of the real wage elasticity of labour demand. Among 52 estimates of σ Rowthorn reports only ten exceeds 0.5 and only three of them exceed one. In a recent study by Ripatti and Vilmunen (2001) the elasticity of substitution in Finland was estimated to be around 0.5.

[6] In the paper the UI contribution is imposed on the employers but the result holds also when the contribution is imposed on the employees (cf. Koskela, Schöb, 1999).

is exogenously given by the government. The buffer yields interest at rate r when we can present its law of the motion with the following function:

$$a_{t+1} = (1+r)a_t + \tau w_t n_t - \alpha(m-n_t)b = (1+r)a_t + g(n_t, w_t) \tag{2.14}$$

where $g(n_t, w_t)$ denotes period t net contribution surplus.

The union maximises a discounted sum of its expected utility. The union's maximisation problem, for given values of (τ, b, m) and given initial values (a_0, z_0), is to choose a policy for $\{w_t\}_{t=0}^{\infty}$ to maximize

$$E_0 \sum_{t=0}^{\infty} \beta^t U(n_t, w_t) \tag{2.15}$$

subject to

$$\begin{aligned} a_{t+1} &= (1+r)a_t + g(n_t, w_t) && (2.16)\\ n_t &= n(w_t; z_t) && (2.17)\\ w_t(1-\tau) &\geq b && (2.18)\\ a_{t+1} &\in [0, \kappa] && (2.19) \end{aligned}$$

where $\beta \in (0,1)$ is a discount factor and r is fixed rate of return on the fund. When we substitute labour demand function for n_t in (2.15) and (2.16) we can write the Bellman equation as

$$\begin{aligned} v(a;z) &= \max_w \{U(w;z) + \beta E v(a';z') \mid z\} && (2.20)\\ a' &= (1+r)a + g(w;z) \end{aligned}$$

where a' and z' are next period's value of the fund and the shock. The first-order condition is

$$U'(w) + \beta E v'(a', z') g'(w, z) = 0. \tag{2.21}$$

A solution of this problem is a value function $v(a;z)$ that satisfies (2.20) and an associated policy function $w = w(a;z)$ but we can not solve the problem analytically. Dynamic optimisation problems can be solved analytically only when the objective function and the state equation fulfill certain conditions. Often dynamic problems in economics are written in a form where the objective function is either quadratic or logaritmic and the constraint either linear or Cobb-Douglas. Our problem does not fulfill these conditions and therefore we in section 2.3 present a numerical solution to the problem.

Based on the earlier literature we can make some guesses about the nature of the solution. The problem resembles that of finding an optimal consumption and saving paths when consumers' income varies or is stochastic (eg Sotomayor, 1984, Chamberlain and Wilson, 2000). In an infinite horizon consumption-saving problem a consumer has to choose an optimal consumption path in a situation where she can not take an insurance against income fluctuations and can only purchase nonnegative amounts of a single risk-free asset. The consumer then uses savings to insure herself. When income varies but is not stochastic, the interest rate equals the discount rate, and the borrowing constraint is not binding a risk-averse consumer would use savings to equalize her periodwise consumption. It can also be shown that the optimal consumption sequence converges to a finite limit as long as the discounted value of future income is bounded. When income is stochastic optimal sequences of consumption and saving converge to infinity. Including also the labour demand function union's utility function is more complicated than that of consumers'. We can however expect the self-insurance motive to exist also in the union's decision making. In Section 4, where we assume that the union's sets also the UI contribution, the self-insurance motive is even more clear.

2.3 Numerical solution

We can not get closed form solutions neither to the union's static problem (2.9)–(2.10) nor to the dynamic problem (2.15)–(2.19) and therefore we solve the problems numerically. We assume that the union members have a CRRA utility function $u(x) = \frac{x^{1-\rho}}{1-\rho}$ when the union members' relative risk aversion is ρ. The periodwise utility function of the union (2.6) can then be written as

$$U(n_t, w_t) = n_t \frac{[w_t(1-\tau_t)]^{1-\rho}}{1-\rho} + (m - n_t)\frac{b^{1-\rho}}{1-\rho}. \tag{2.22}$$

Both in the static and in the dynamic maximisation problem we have used the following parameter values: unemployment benefit $b = 1$, size of the union $m = 1$, labour's share in the production $d = 0.7$, elasticity of the substitution $\sigma = 0.4$, and the share of the unemployment expenses financed with the contributions $\alpha = 0.5$. In our benchmark case union members' risk aversion $\rho = 1.5$ but we have calculated the model also with a lower value $\rho = 0.9$. The technological shock can only have two values, either good when $z = z_g = 2.55$ or bad when $z = z_b = 2.38$. The shock is i.i.d. and probability of a good shock $\psi = 0.5$. We have gathered the results of the model without buffer funding in Table 1.

Table 1: UI contribution, employment and wage fluctuations when buffer funding is not allowed

	$\rho = 1.5$		$\rho = 0.9$	
	good state	*bad state*	*good state*	*bad state*
UI contribution (%)	1.56	3.85	4.50	6.82
employment (%)	94.50	87.66	84.76	79.00
gross wage	1.86	1.83	2.00	1.95
net wage	1.83	1.76	1.91	1.81

From Table 1 we can see that when the fund operates on a pay-as-you-go financing principle and the relative risk aversion is 1.5 a negative shock decreases employment from 94.5 to 87.7 per cent and increases the UI contribution from 1.58 to 3.85 per cent. The gross wage, and in our case also labour cost, varies between 1.86 and 1.83. When the union members

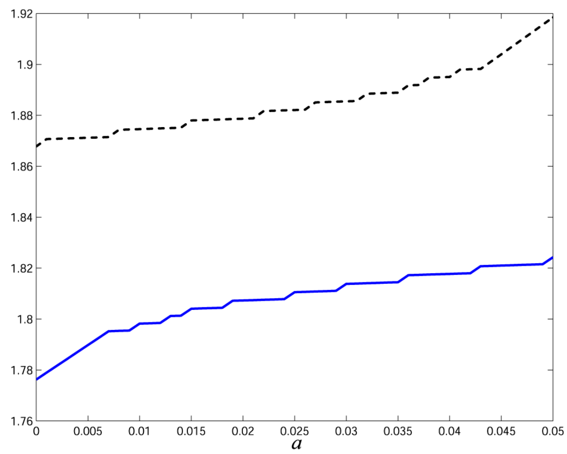

Figure 2: *Policy functions: gross wage $w(a; z_g)$ (dotted line) and $w(a; z_b)$ (solid line)*

become less risk averse the union can increase its wage demand. Both gross and net wages increase and employment decreases.

In solving the dynamic optimisation problem (2.15)–(2.19) we use the method of discretisation of the state space when the fund can have only a finite number of different values, that is, $\forall\ t\ a_t \in \mathcal{A} = \{0, a_1, ..., a_n\}$ where $a_1 < a_2 ... < a_n$. In our example $\mathcal{A} = [0, 0.05]$. The buffer's upper limit 0.05 corresponds to unemployment expenses of 5% unemployment. The fixed contribution we have calculated from the static model. We assume that the government sets the fixed contribution $\overline{\tau}$ such that its expected budget is in balance when $\tau = \overline{\tau}$. In the example $\overline{\tau} = 2.64\%$. In order union saving not to arise from a difference in the interest rates we assume that both the interest rate r and the discount rate r^d are 0.05. In Figures 2 to 6 $\rho = 1.5$.

First we solved the policy functions. In Figure 2 we have drawn the union's optimal gross wage policy as a function of the current state of the fund. The optimal policy depends on whether in period 0 the economy is in a boom (upper curve) or in a recession. We see from the figure that the higher the current state of the fund the higher the union's wage demand. When we substitute the wage functions for w in the state equation and in the labour demand function we get the union's optimal savings policy and the firm's optimal employment policy as functions of the current state of the fund (Figures 3 and 4). In both cases we get two curves; in Figures 3 and 4 the upper ones denoting the optimal policy when the economy in period 0 is in a boom.

Next we used the policy functions we solved to simulate the model. We made a random device that gives us a sequence of i.i.d. shocks such that every period the probability of a good shock is 0.5. We assumed that the initial value $a_0 = 0$. In Figure 5 we have drawn employment fluctuations in a pay-as-you-go system (dotted line) and in a buffer funding system in 100 periods of simulation. From the figure we can see that employment fluctuates less when buffer funding is allowed. In a simulation of 2000 periods the

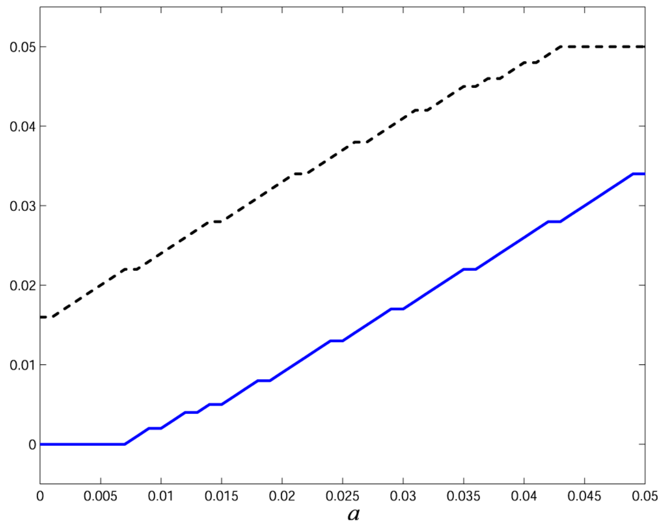

Figure 3: *Policy functions: next period's fund* $a'(a; z_g)$ *(dotted line) and* $a'(a; z_b)$ *(solid line)*

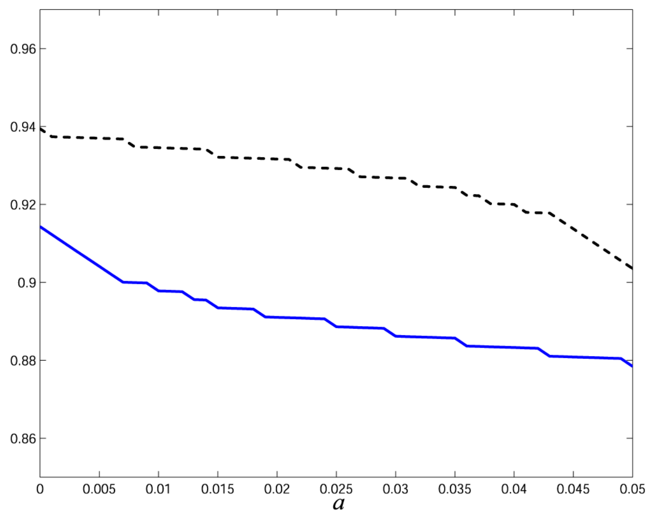

Figure 4: *Policy functions: employment* $n(a; z_g)$ *(dotted line) and* $n(a; z_b)$ *(solid line)*

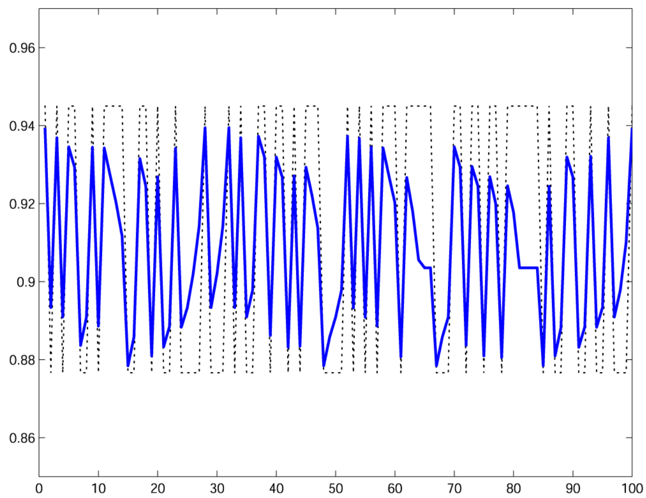

Figure 5: *Employment fluctuations when buffer funding is allowed (solid line) and when it is not allowed (dotted line).*

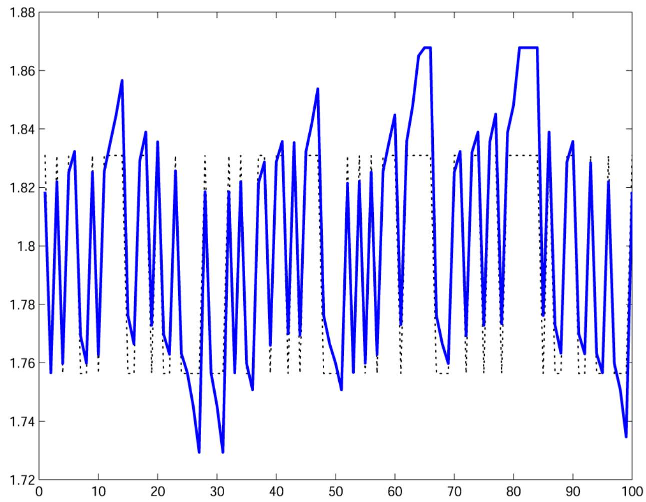

Figure 6: *Net wage fluctuations when buffer funding is allowed (solid line) and when it is not allowed (dotted line).*

standard deviation of employment variation decreases from 3.42 to 2.01 (Table2).

From Figure 6 we can see the reason for employment smoothing effect caused by buffer funding. In a pay-as-you-go system both gross and net wage fluctuate less than in case of buffer funding. In a 2000 periods simulation the standard deviation of the gross wage variation increased from 0.017 to 0.043 and also that of the net wage variation from 0.037 to 0.042 (Table 2). When the union members become less risk averse not only wages rise but also their fluctuation increases. For example, in case of buffer funding the standard deviation of gross wage variation increases from 0.043 to 0.051. On the other hand, employment variation falls when risk aversion decreases.

Table 2: Means and standard deviations

		$\rho = 1.5$		$\rho = 0.9$	
		mean	*st. deviation*	*mean*	*st. deviation*
Pay-as-you-go	*employment (%)*	91.17	3.42	81.90	2.88
	gross wage	1.844	0.017	1.974	0.026
	net wage	1.795	0.037	1.862	0.048
Buffer funding	*employment (%)*	90.88	2.01	81.70	1.68
	gross wage	1.848	0.043	1.978	0.051
	net wage	1.799	0.042	1.867	0.048

3 Wage rigidity

In the previous section we assumed that the union was able to react to the shocks the economy faces by changing its wage demand. We derived the result that buffer funding decreases employment fluctuations but increases gross and net wage fluctuations. In reality wages are more rigid than employment and usually are not flexible downwards. We want to study the effects of wage rigidity in previous framework and therefore assume now that every period the union has to make its wage decision before the economy faces a new shock. After the union's wage decision the shock is realized, the government can adjust the UI contribution and the firm employment. First we again solve the static model assuming that the government uses pay-as-you-go financing principle. Later, in section 3.2, we examine the effects buffer funding have on the results.

3.1 Pay-as-you-go financing principle

Let us first again suppose the government every period adjusts the UI contribution according to its periodwise budget constraint. If buffer funding is not possible the union every period chooses its wage demand such that the choice maximises its expected utility of that period. When the value of the shock only takes two values the union's periodwise maximisation problem can be written as

$$\max_{\substack{w \\ w(1-\tau_g)\geq 0 \\ w(1-\tau_b)\geq 0}} \quad \psi U(n_g, w) + (1-\psi)U(n_b, w) \tag{3.1}$$

subject to

$$n_g = n(w; z_g) \tag{3.2}$$

$$n_b = n(w; z_b) \tag{3.3}$$

where n_g, n_b, τ_g, and τ_b denote labour demand and the UI contribution in a good and in a bad state.

The first order condition of the maximisation problem is

$$\begin{aligned} &\psi \left(n_g' \left(u(\widehat{w}_g) - u(b)\right) + n_g u'(\widehat{w}_g)(1-\tau_g)\right) \\ &+(1-\psi)\left(n_b' \left(u(\widehat{w}_b) - u(b)\right) + n_b u'(\widehat{w}_b)(1-\tau_b)\right) = 0. \end{aligned} \tag{3.4}$$

We can write (3.4) in a form

$$\begin{aligned} &\psi n_g u(\widehat{w}_g) \left[-\eta_g \left(1 - \frac{u(b)}{u(\widehat{w}_g)}\right) + \frac{u'(\widehat{w}_g)\widehat{w}_g}{u(\widehat{w}_g)}\right] \\ &+(1-\psi) n_b u(\widehat{w}_b) \left[-\eta_b \left(1 - \frac{u(b)}{u(\widehat{w}_b)}\right) + \frac{u'(\widehat{w}_b)\widehat{w}_b}{u(\widehat{w}_b)}\right] = 0 \end{aligned} \tag{3.5}$$

where η_g and η_b are the good and bad economic state wage elasticities of labour demand. If wages were flexible we would get the square brackets expressions as statewise first-order conditions (compare with equation (2.12)). According to equation (3.5) the union chooses the fixed wage such that the expected value (weighted with the utilities of the employed) of the statewise first-order conditions is zero.

3.2 Buffer funding

We next assume that the UI fund can show a surplus up to a certain limit and the government instead of adjusting the UI contribution according to the economic state imposes a fixed contribution that corresponds to expected unemployment expenses. Now the union has to make its wage decision in a situation where labour demand is uncertain and it has to base the decision on expected labour demand. We assume that, deciding on wages, the union also makes a preliminary plan how much it will save. The return rate of the fund is r, so that the law of motion of the fund is

$$\widehat{a}_{t+1} = (1+r)a_t + Eg(n_t, w_t; z) \tag{3.6}$$

where $\widehat{a}_{t+1}$ is period $t+1$ planned fund and

$$Eg(n_t, w_t; z) = \tau w_t En(w_t; z) - \alpha(m - En(w_t; z))b \tag{3.7}$$

expected net contribution surplus. The actual fund a_{t+1} can be written as

$$a_{t+1} = \widehat{a}_{t+1} + g(w_t; z_t) - Eg(w_t; z). \quad (3.8)$$

The union's maximisation problem, for given values of (τ, b, m) and given initial value $\{a_0\}$, is to choose a policy for $\{\widehat{a}_{t+1}\}_{t=0}^{\infty}$ to maximize

$$E \sum_{t=0}^{\infty} \beta^t U(n_t, w_t) \quad (3.9)$$

subject to

$$\begin{aligned} \widehat{a}_{t+1} &= (1+r)a_t + Eg(n_t, w_t; z) && (3.10) \\ n_t &= n(w_t; z_t) && (3.11) \\ w_t(1-\tau) &\geq b && (3.12) \\ \widehat{a}_{t+1} &\in [0, \kappa] && (3.13) \end{aligned}$$

We can now write the Bellman equation

$$\begin{aligned} v(a) &= \max_{\widehat{a} \in [0,\kappa]} \{U(w) + \beta v(\widehat{a}')\} && (3.14) \\ \widehat{a}' &= (1+r)a + Eg(w; z) && (3.15) \end{aligned}$$

where $\widehat{a}'$ is next period's planned value of the fund. A solution of this problem is a value function $v(a)$ that satisfies (3.14) and an associated policy function $\widehat{a}' = h(a)$. When we substitute $h(a)$ for $\widehat{a}'$ in (3.15) we get a policy function $w = w(a)$. Function $n = n(a; z)$ we get when we substitute $w(a)$ for w in (3.11). Finally from equation (3.8) we get the actual fund $a' = h(a; z)$.

3.3 Numerical solution

We again have to adopt numerical approximations to solve the problems (3.1)–(3.3) and (3.9)–(3.13). We make same assumptions about the union preferences and the parameter values as in section 2.3. We assumed that the union members have a CRRA utility function $u(x) = \frac{x^{1-\rho}}{1-\rho}$ and the parameters take the following values: unemployment benefit $b = 1$, size of the union $m = 1$, union members' relative risk aversion $\rho = 1.5$ or $\rho = 0.9$, labour's share in the production $d = 0.7$, elasticity of the substitution $\sigma = 0.4$, and the share of the unemployment expenses financed with the contributions $\alpha = 0.5$. The technological shock can only have two values, either good when $z = z_g = 2.55$ or bad when $z = z_b = 2.38$. The shock is i.i.d. and probability of a good shock $\psi = 0.5$. We have gathered the results of the model with pay-as-you-go financing principle in Table 3.

Table 3: UI contribution, employment and wage fluctuations when wages are rigid and buffer funding is not allowed

	$\rho = 1.5$		$\rho = 0.9$	
	good state	*bad state*	*good state*	*bad state*
UI contribution (%)	1.22	4.26	3.94	7.50
employment (%)	95.70	86.44	86.54	77.16
gross wage	1.84	1.84	1.97	1.97
net wage	1.82	1.76	1.90	1.83

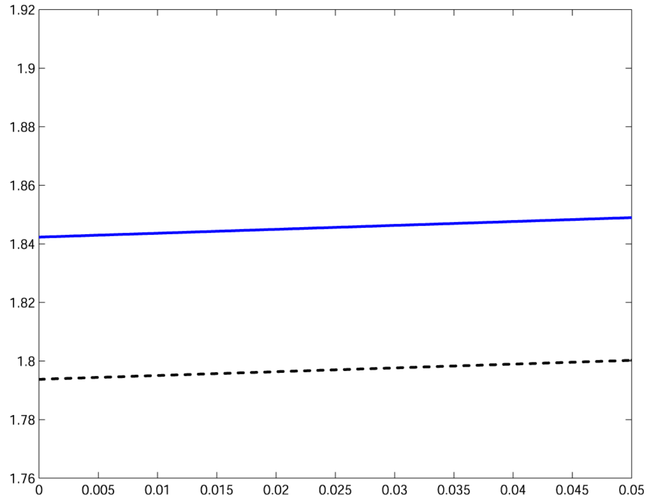

Figure 7: *Policy functions: gross wage $w(a)$ (solid line) and net wage $\widehat{w}(a)$ (dotted line)*

From Table 3 we can see that wage rigidity increases contribution and employment fluctuations. In the case of flexible wages UI contributions varied between 1.56 and 3.85 and employment between 94.5 and 87.7 percent (Table 1). Both gross and net wage of course vary less when the wage decision is made under uncertain labour demand.

In solving the dynamic optimisation problem (3.9)–(3.13) we again used the method of discretisation of the state space. The fixed contribution $\overline{\tau}$ we calculated from the static model by assuming that the government sets $\overline{\tau}$ such that its expected budget is in balance. We got that $\overline{\tau} = 2.64\%$. Fist we solved the policy functions. Figure 7 presents the gross and the net wage functions and we can see that the union's wage demand is increasing in the current state of the fund.

Optimal buffer funding plan and employment policy is obtained by substituting the optimal wage policy to the labour demand function and to the state equation. Optimal buffer funding plan is based on expected labour demand and therefore the optimisation problem is no more stochastic. The middle curve in Figure 8 is the optimal buffer funding plan. The result is the same as in a consumption-savings problem where the interest rate equals the discount rate and income does not vary; consumers do not save. The upper curve is then the actual buffer funding when the economic sate is good and the lower curve when it is bad. When we compare Figures 3 and 8 we can see that wage rigidity causes also more variation in the size of the buffer. Also employment fluctuates more when wages are not flexible which can be seen by comparing Figures 4 and 9.

We again used the policy functions we solved to simulate the model. At Figure 10 we have drawn employment fluctuations when the fund operates on the pay-as-you-go principle (dotted line) and when it operates on the buffer funding principle. the simulation has 100 periods. Now buffer funding

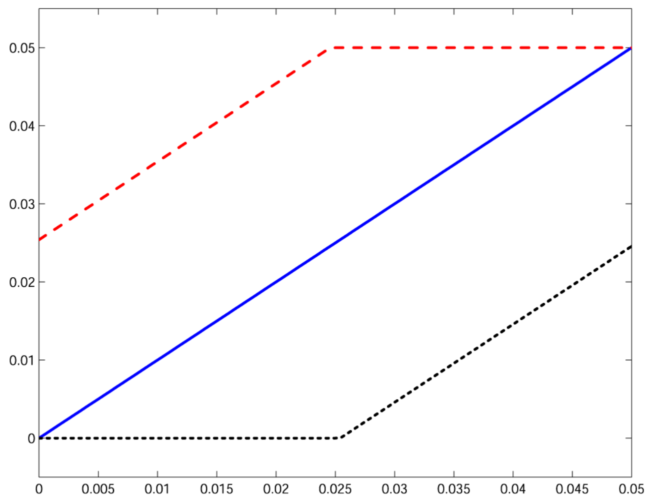

Figure 8: *Policy functions: next period's planned fund $\widehat{a}'(a)$ (solid line), actual fund $a'(a;z_g)$ (dashed line) and actual fund $a'(a;z_b)$ (dotted line)*

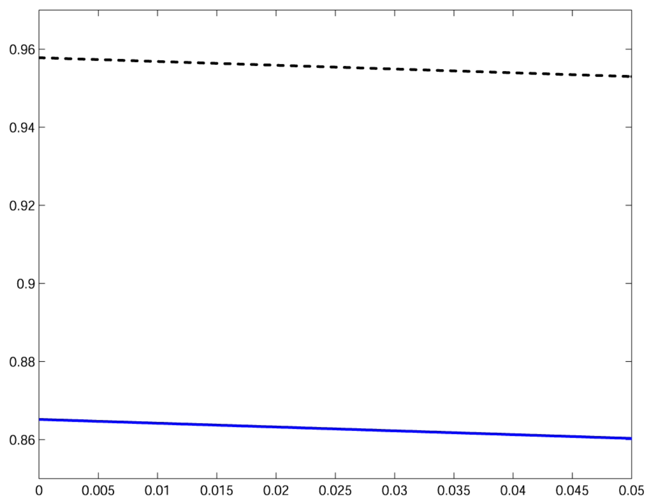

Figure 9: *Policy functions: employment $n(a;z_g)$ (dotted line) and $n(a;z_b)$ (solid line)*

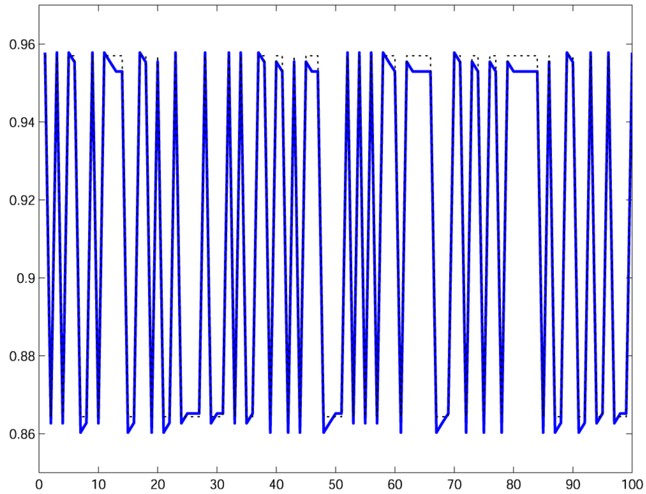

Figure 10: *Employment fluctuations when buffer funding is allowed (solid line) and when it is not allowed (dotted line).*

does not decrease employment fluctuations. In a 2000 periods simulation the standard deviation of employment variation in both cases, pay-as-you-go and buffer funding, is 4.63 (Table 4). On the other hand, net wage fluctuate much less when buffer funding is allowed (Figure 11). In a 2000 periods simulation the standard deviation of the net wage variation decreased from 0.027 to 0.003 (Table 4). A fall in the union members' risks aversion now slightly increases net wage variation when the financing system operates on the pay-as-you-go principle. The standard deviation of employment variation also slightly increases, from 4.63 to 4.69.

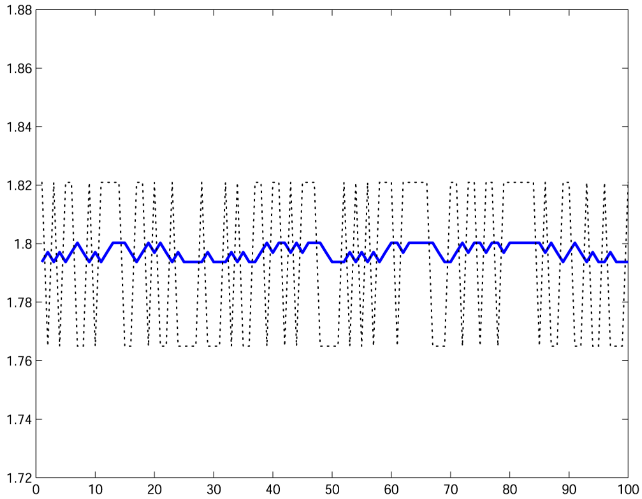

Figure 11: *Net wage fluctuations when buffer funding is allowed (solid line) and when it is not allowed (dotted line).*

Table 4: Means and standard deviations

		$\rho = 1.5$		$\rho = 0.9$	
		mean	*st. deviation*	*mean*	*st. deviation*
Pay-as-you-go	*employment (%)*	91.27	4.63	81.94	4.69
	gross wage	1.843	0.000	1.974	0.000
	net wage	1.794	0.027	1.861	0.035
Buffer funding	*employment (%)*	91.07	4.63	81.83	4.69
	gross wage	1.846	0.003	1.975	0.003
	net wage	1.797	0.003	1.865	0.003

4 UI contribution as the union's decision variable

So far we have assumed that the government imposes the UI contribution and the assumption fits the institutional facts. Another possibility would be to let the labour market participants decide the level of the contribution. The committee that studied the effects of Swedish membership of the Monetary Union on the Swedish economy[7] recommended in their report that if buffer funds are set up in Sweden they should be administrated by the labour market themselves without any government involvement. In the model of Section 2 that change in the institutional framework would mean that the union, instead of having only one, would have two decision variables: wage and UI contribution. The monopoly union then pays a part of the unemployment

[7]The Committee on Stabilisation Policy for full Employment if Sweden joins the Monetary Union.

benefits of its members and therefore imposes a UI contribution on its employed members.

When the union has two decision variables it can influence its utility path more easily; it can use its wage demand to control employment progress and UI contribution to control net wage progress. The union can then decrease its wage demand and thereby increase employment without it affecting the net wage. Table 5 summarises the results of the two decision variable model.

In a 2000 periods simulation the standard deviation of employment variation decreases from 3.49 to 2.92 when buffer funding is allowed. The gross wage varies slightly more in the case of buffer funding: the standard deviation increases from 0.040 to 0.047. On the other hand, the net wage fluctuate much less when buffer funding is allowed. In a 2000 periods simulation the standard deviation of the net wage variation decreased from 0.060 to 0.044.

Table 5: Means and standard deviations

		mean	*st. deviation*
Pay-as-you-go	*employment (%)*	90.85	3.49
	gross wage	1.350	0.040
	net wage	1.300	0.060
Buffer funding	*employment (%)*	90.85	2.92
	gross wage	1.348	0.047
	net wage	1.299	0.044

5 Conclusions

We have studied the implications the unemployment insurance funding system has on the union's wage decisions and thereby on employment when labour demand is stochastic. We assumed that a fixed share of unemployment benefits are financed with employees' UI contributions and the rest with government's tax revenue. In the first part of the paper, we assumed that the government sets the contribution. The main focus of the paper was in the implications of buffer funding on employment fluctuations and thereby on stability of the economy. It turned out that, compared with the situation where the fund operates on the pay-as-you-go financing principle, buffer funding decreases employment fluctuations when wages are flexible. When wages are rigid buffer funding has almost no effect on employment fluctuations but decreases gross and net wage variation. In the end of the paper we also discussed institutionally different system: we assumed that the union, in addition to wage, also imposes the UI contribution. When the union has two decision variables it can use wage to control employment and the contribution to control the net wage. Buffer funding then still decreases employment variation but less than when the contribution is imposed by the government. It turned out that then buffer funding mainly smooths out net wage variations.

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Appendix

A The slope of the union indifference curve

The union indifference curve (we have omitted the time subscripts) is

$$nu(\widehat{w}) + (m-n)u(b) = c \tag{A.1}$$

where $\widehat{w} = w(1-\tau)$ is net wage and c some constant. From (A.1) we can solve

$$\frac{dw}{dn} = -\frac{(u(\widehat{w}) - u(b))}{nu'(\widehat{w})(1-\tau)} < 0. \tag{A.2}$$

Further we can solve

$$\frac{\partial}{\partial\tau}\left(\frac{dw}{dn}\right) = \frac{u'(\widehat{w})^2\widehat{w}n + \left(-nu''(\widehat{w})\widehat{w} - nu'(\widehat{w})\right)\left(u(\widehat{w}) - u(b)\right)}{\left(nu'(\widehat{w})(1-\tau)\right)^2} \tag{A.3}$$

The sign of $\frac{\partial}{\partial\tau}\left(\frac{dw}{dn}\right)$ depends on the sign of the numerator of (A.3). We can write the numerator as

$$nu'(\widehat{w})u(\widehat{w})\left(\frac{u'(\widehat{w})\widehat{w}}{u(\widehat{w})} + \left(-\frac{u''(\widehat{w})\widehat{w}}{u'(\widehat{w})} - 1\right)\left(1 - \frac{u(b)}{u(\widehat{w})}\right)\right) \tag{A.4}$$

that, in a case of CRRA utility function, can be written as

$$nu'(\widehat{w})u(\widehat{w})\left(1 - \rho + (\rho - 1)\left(1 - \frac{u(b)}{u(\widehat{w})}\right)\right) = \tag{A.5}$$

$$nu'(\widehat{w})u(\widehat{w})\left((\rho - 1)\left(-\frac{u(b)}{u(\widehat{w})}\right)\right). \tag{A.6}$$

On grounds of (A.6) we can conclude that

$$\frac{\partial}{\partial\tau}\left(\frac{dw}{dn}\right) \quad \begin{cases} \geq & if \quad \rho \leq 1 \\ < & if \quad \rho > 1 \end{cases} . \tag{A.7}$$

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