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UNEMPLOYMENT BENEFITS, CONTRACT LENGTH AND NOMINAL WAGE FLEXIBILITY

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Abstract

We show in a union-bargaining model that a decrease in the unemployment benefit level increases not only equilibrium employment, but also nominal wage flexibility, and thus reduces employment variations in the case of nominal shocks. Long-term wage contracts lead to highter expected real wages and hence higher expected unemployment than short-term contracts. Therefore lower benefits reduce the expected utility gross of contract costs of a union member more with long-term than with short-term contracts and thus create an incentive for shorter contracts. Incentives for employers work in the same direction. Lower taxes associated with lower benefits also tend to make short-term contracts more attractive.

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1 Introduction

There exists a large theoretical and empirical literature on how various labour-market institutions influence the equilibrium rate of unemployment, i.e. the average rate of unemployment around which there are cyclical variations (see e.g. Layard et al., 1991; Elmeskov et al. 1998; or Nickell and Layard, 1999). Much less is known about how various institutions affect the *sensitivity* of the economy to macroeconomic shocks. The aim here is to analyse how one specific labour-market institution, unemployment insurance, may affect money-wage flexibility and thus the cyclical sensitivity of the economy.

It is often taken for granted that the same labour-market reforms will both lower equilibrium unemployment and stabilise employment in the case of macroeconomic shocks (e.g. OECD, 1994). The basic presumption seems to be that reforms make labour markets more competitive (Calmfors, 1999). However, it remains to be modelled exactly how various reforms, such as a reduction of unemployment benefits, may affect, for example, the length of wage contracts and thus the variability of output and employment.

The models of how unemployment benefits affect real wages and equilibrium unemployment usually have firm microeconomic underpinnings. There is a multitude of approaches (union and bargaining models, insider-outsider models, efficiency-wage models, search and matching models) that all predict that higher unemployment compensation leads to higher real wages and higher equilibrium unemployment (see e.g. Pissarides, 1990; Layard et al., 1991; or Holmlund, 1998).

The standard method to analyse money-wage rigidity is to view the optimal contract length as the outcome of a trade-off between contract costs and costs of output variability (see e.g. Ball, 1987; and Ball et al., 1988). Long contract periods have the benefit of holding down contract costs, but also the drawback that money wages cannot change in response to events that were unforeseen when the contract was struck. The optimal contract length is chosen so that the sum of these costs is minimised. The costs to be minimised are usually modelled in an ad hoc way by assuming quadratic loss functions, which are analytically convenient. This suffices to derive results such that contract length will be reduced if nominal shocks become more prevalent. But the ad-hoc objective functions make it difficult to analyse the effects of such labour-market reforms as, for example, changes in unemployment benefit levels. Nor is it clear to which extent the choice of contract length reflects incentives on the employee side and to which extent it reflects incentives on the employer side.

Here, we use a simple trade union model, which we later extend to a bargaining framework, to explain how both the average real wage over the cycle and the extent of money-wage flexibility depend on unemployment compensation. In the model, wage setters determine both nominal wages and contract length. There is unemployment because unions aim for a higher real wage than the market-clearing level.

There exist two standard ways of modelling unemployment benefits, which also have real-world counterparts (Layard et al., 1991; Pissarides, 1998). The first is to assume that governments set unemployment benefits in real terms. The second way is to assume a fixed replacement rate, i.e. that unemployment compensation is set as a fixed percentage of the aggregate wage. Here, we choose the first approach.[1]

Our conclusion is that higher unemployment benefits, apart from increasing equilibrium unemployment, also lead to more rigid money wages and hence to larger macroeconomic variability. This result is consistent with the general principle that real rigidities reinforce the effects of nominal rigidities (see e.g. Romer, 1996, Ch. 6). The intuition for our conclusion is the following. Wage setters choose contract length by comparing the higher costs of short-term contracts with the utility gain that follows from the possibility

[1] It would seem to correspond to the way that unemployment benefits are set in the U.K (see e.g. Minford, 1994). In many other countries, unemployment insurance would seem to be a mixture of the two systems discussed. In, for example, Sweden there is a fixed replacement rate for medium-income earners, but this does not apply to low-income earners, who instead receive a minimum benefit that is unrelated to the earlier wage, and not to high-income earners, for whom there is a benefit ceiling. In many European countries, it is also common with minimum unemployment (social) assistance levels for long-term unemployed that have lost their eligibility for ordinary unemployment benefits (OECD, 1994).

to adjust wages to unforeseen shocks. We show that wage setters aim for higher real wages with long-term than with short-term contracts. Hence, unemployment is larger with long-term than with short-term contracts. As a consequence, an increase in the unemployment benefit raises the expected utility of a representative union member more if contracts are long-term than if they are short-term. So a higher benefit reduces the utility gain from short-term contracts for unions and thus makes long-term contracts more favourable.

The described result does not follow because higher unemployment compensation reduces the welfare cost of employment variability per se. Instead, it is the consequence of the feature that our model does not exhibit certainty equivalence. In that regard, our paper relates to other recent work stressing how lack of certainty equivalence can "compound or offset the more obvious welfare effects of uncertainty" (Obstfeld and Rogoff, 2000). Other papers are Bacchetta and van Wincoop (1998), Devereaux and Engel (1998, 1999), Obstfeld and Rogoff (1998), and Rankin (1998). However, none of these papers explore the issue we focus on: the determination of the degree of nominal rigidity.

Our analysis also shows that a rise in the benefit level will lead to a tax effect that tends to increase contract length if contracts costs are not deductible for tax purposes. Because a higher benefit implies a higher tax rate, there will be a reduction of the *after-tax* income gain from a short-term contract, which is to be set against the non-deductible contract cost. Finally, if contract costs are related to wages, higher unemployment compensation raises contract costs because wages are pushed up. This may also work in the direction of longer contract periods.

The structure of the paper is as follows. Section 2 presents the basic model using a monopoly-union framework with risk-neutral agents. Section 3 shows how wages and employment depend on contract length, and Section 4 analyses the determination of contract length. Section 5 extends the analysis to a bargaining framework, and Section 6 discusses other possible modifications, such as, for example, an assumption of risk aversion. Section 7 concludes.

2 The basic model

The economy consists of a large number of identical perfectly competitive firms. They produce a homogenous tradable, the price of which is exogenous to the economy. There is a fixed pool of workers attached to each firm, so there is no labor mobility between firms, and workers are organized in firm-specific unions. (The assumption of zero labour mobility is not important for the results, but it simplifies the analysis considerably.) There are two types of shocks: nominal price shocks and real supply shocks.

The production function of a representative firm is

$$Y = \frac{1}{\alpha}\theta L^{\alpha}, \tag{1}$$

where $0 < \alpha < 1$, Y is output, θ is an economy-wide productivity variable and L is employment.

The real profit, π, of a firm is

$$\pi = Y - \frac{W}{P}L, \tag{2}$$

where W is the money wage and P is the price. Profit maximisation results in the labour demand equation

$$L = \left(\frac{W}{\theta P}\right)^{-\varepsilon}, \tag{3}$$

where $\varepsilon = 1/(1-\alpha) > 1$ is the labour demand elasticity.

Productivity θ and the price P are stochastic variables. In most of the analysis, we only have to assume that the probability distributions are known and independent. To derive some results, we shall, however, impose an assumption of log-normality.

The nominal wage in a firm is set by a firm-specific monopoly union, which has the objective function

$$U = \frac{L}{L_0}(1-t)\frac{W}{P} + \left(1 - \frac{L}{L_0}\right)(1-t)\,b, \tag{4}$$

where U is the *gross* utility of the union (neglecting contract costs), L_0 is the number of members, t is the tax rate and b is the real value of unemployment compensation. The objective of the union is thus to maximize the expected income of a representative member.[2] We shall assume that labour demand is always smaller than union membership, i.e. $L < L_0$. Both wage income and unemployment compensation are taxed.

2.1 Choice of contract length

A union can choose between one-period and two-period contracts. The information structure is depicted in Figure 1. Price and productivity shocks occur in the beginning of each period. If a new wage is set in the period, wage setting occurs after shocks have been realised. One-period contracts are thus always concluded on the basis of the actual shocks. The wage is then set so as to maximize the union's utility function (4). If there is a two-period contract, wage setters know the actual price and productivity shocks for the first period and thus set the same wage for this period as in a one-period contract. But for the second period they have to base the wage decision on expectations. So the second-period wage is set by maximizing the expectation of the union's utility function.

A key assumption is that the unemployment benefit is fixed in real terms. This is equivalent to assuming that the government has a target for the real benefit level and adjusts the nominal benefit to the actual price in each period independent of the length of wage contracts. The assumption captures the stylized fact that there appears to be more nominal inertia in wage setting than in government transfer systems: nominal wages are often set in wage contracts that may encompass several years, wheras long-term decisions on nominal transfer levels are rare. Instead, the latter are usually determined in the annual government budget process, possibly through an explicit indexation procedure.[3]

[2] One might ask what purpose unemployment insurance serves if workers are risk-neutral as in (4), in which case there is no welfare gain from evening out incomes between states of employment and unemployment. A possible political-economy answer is that the political majority of workers may vote for unemployment insurance, because it raises the wage level and hence shifts the income distribution in favour or labour (Saint-Paul, 1996).

[3] We do not attempt to model formally *why* nominal transfer are less rigid than nominal wages. But

In our model, there is a fixed cost C_U of writing a wage contract. The cost varies across unions according to a cumulative distribution function $F(C_U)$. F is continuous and differentiable, $F(0) = 0$, and $F'(C_U) > 0$ for all C_U such that $0 < F(C_U) < 1$. We shall examine both the case when the contract cost is deductible for tax purposes (which is analytically the simpler one) and the case when it is not (which is the more realistic one). In the former case, the after-tax contract cost is $C = (1-t)\,C_U$, in the latter case it is $C = C_U$. The fraction of unions that write one-period contracts is x. Each union chooses contract length by comparing the *net* utilities of one two-period and two one-period contracts that are obtained when contract costs are taken into account. The contract cost for a two-period contract is paid in the first period. Because the wage and thus gross utility in the first period is independent of contract length, the comparison only involves the expected net utilities of the second period. One-period contracts are chosen if

$$E(U_1) - C > E(U_2),$$

where $E(U_1)$ is the expected utility from a one-period contract and $E(U_2)$ is the expected utility in the second period of a two-period contract. When the contract cost is deductible, the cut-off point is $E(U_1) - (1-t)\,C_U = E(U_2)$. It follows that the fraction of one-period contracts is

$$x = F\left(\frac{E(U_1) - E(U_2)}{1-t}\right). \tag{5}$$

When the contract cost is not deductible, the cut-off point is instead $E(U_1) - C_U = E(U_2)$, and we have instead

$$x = F\left(E(U_1) - E(U_2)\right). \tag{6}$$

a plausible - though partial - explanation is that the cost of changing nominal transfer levels are small if budget decisions on how to balance government revenues and expenditures have to be taken anyway.

2.2 The government budget constraint

Government expenditures consist only of unemployment benefits, which are financed by a uniform tax on all labour incomes, including benefits. The tax rate, t, is set so that the government budget is balanced *on average*, i.e. so that expected tax revenues each period match expected expenditures. This is equivalent to assuming that the government budget works as an automatic stabiliser, so that temporary surpluses or deficits may arise in response to shocks.[4] For the second period the government budget constraint is thus

$$t\left[xE\left(\frac{W_1}{P}L_1\right)+(1-x)\,E\left(\frac{W_2L_2}{P}\right)\right]=(1-t)\left[xb\left(L_0-E\left(L_1\right)\right)+(1-x)\,b\left(L_0-E\left(L_2\right)\right)\right], \tag{7}$$

where 1 and 2 subscripts refer to one-period and two-period contracts, respectively.[5] The LHS gives expected tax revenues, taking into account that the expected tax base may depend on the relative frequency of the two types of contracts. The RHS gives expected after-tax expenditures on unemployment benefits.

3 The impact of contract length

The first step is to analyse how the wage, employment and union gross utility (income) depend on the length of the wage contract.

3.1 One-period contracts

With one-period contracts, each union sets the nominal wage on the basis of the actual price and productivity levels that have been realised. Each union is so small that it takes the tax rate as given. Maximisation of (4) subject to (3) gives the well-known wage equation

$$W_1=\frac{\varepsilon}{\varepsilon-1}Pb. \tag{8}$$

[4] The assumption that expected rather than actual revenues and expenditures balance simplifies some computations greatly, but it is not important for the results.

[5] We write out the government budget constraint only for the second period because it is only the second-period tax rate that matters for the choice of contract length.

With constant-elastic labour demand, a monopoly union sets the money wage so that the real wage is a fixed mark-up on real unemployment compensation (see e.g. Layard et al., 1991; or Nickell and Layard, 1999). With labour mobility, the mark-up would depend on aggregate employment in the economy (Layard et al., 1991; Nickell and Layard, 1999), but this would not change the analysis qualitatively. Supply shocks do not affect the real wage, as was first pointed out by McDonald and Solow (1981).

(8) together with (3) give expected employment as

$$E(L_1) = E(\theta^{\varepsilon}) \left(\frac{\varepsilon}{\varepsilon - 1}\right)^{-\varepsilon} b^{-\varepsilon}. \tag{9}$$

From (3), (4) , (8) and (9) we obtain

$$E(U_1) = \left(\frac{1}{\varepsilon - 1}\frac{E(L_1)}{L_0} + 1\right)(1 - t)\, b. \tag{10}$$

(10) will prove a convenient way of writing expected utility. It depends positively on expected employment. So to derive the sign of the effects of various changes on expected utility, we need only compute the effect on expected employment.

If we assume that productivity, θ, is log-normally distributed, i.e. that $ln\ \theta \sim N(0, \sigma^2_{\theta})$, it follows that $E(\theta^{\varepsilon}) = \exp((1/2)\,\varepsilon^2\sigma^2_{\theta})$ and hence

$$\frac{dE(\theta^{\varepsilon})}{d\sigma^2_{\theta}} = \frac{1}{2}\varepsilon^2 \exp\left(\frac{1}{2}\varepsilon^2\sigma^2_{\theta}\right) > 0.$$

Consequently, we have from (9) that

$$\frac{dE(L_1)}{d\sigma^2_{\theta}} = \left(\frac{\varepsilon}{\varepsilon - 1}\right)^{-\varepsilon} b^{-\varepsilon}\frac{dE(\theta^{\varepsilon})}{d\sigma^2_{\theta}} > 0.$$

More variability in productivity thus raises expected employment, and hence also, expected utility.[6]

[6] It should be noted that the assumption of a log-normal distribution for productivity is not necessary for increased variability to increase expected employment. Because θ^{ε} is convex, a mean-preserving increase in θ would also raise $E(L_1)$.

3.2 Two-period contracts

The second-period wage, W_2, of a two-period contract (which we shall henceforth refer to as the two-period contract wage) is obtained by maximising the expectation of (4). This gives

$$W_2 = \frac{\varepsilon}{(\varepsilon - 1)} \frac{E(P^{\varepsilon})}{E(P^{\varepsilon-1})} b. \tag{11}$$

The nominal wage in a two-period contract, which is set under uncertainty, is also a mark-up on the unemployment benefit. But the mark-up now depends also on $E(P^{\varepsilon})/E(P^{\varepsilon-1})$. If we assume the distribution of P to be log-normal, i.e. $ln\ P \sim N(0, \sigma_P^2)$, it can be derived that $E(P^{\varepsilon})/E(P^{\varepsilon-1}) = \exp(\sigma_P^2(\varepsilon - 1/2))$, which gives[7]

$$W_2 = \frac{\varepsilon}{(\varepsilon - 1)} \exp\left(\sigma_P^2(\varepsilon - 1/2)\right) b. \tag{12}$$

Proceeding as in the previous section we obtain

$$E(L_2) = \phi E(\theta^{\varepsilon}) \left(\frac{\varepsilon}{(\varepsilon - 1)}\right)^{-\varepsilon} b^{-\varepsilon}, \tag{13}$$

and

$$E(U_2) = \left(\frac{1}{(\varepsilon - 1)} \frac{E(L_2)}{L_0} + 1\right)(1 - t)\, b, \tag{14}$$

where

$$\phi = \frac{(E(P^{\varepsilon-1}))^{\varepsilon}}{(E(P^{\varepsilon}))^{\varepsilon-1}} < 1,$$

follows from Jensen's inequality.[8]

With a log-normal distribution for P, it holds that

$$\phi = \frac{(E(P^{\varepsilon-1}))^{\varepsilon}}{(E(P^{\varepsilon}))^{\varepsilon-1}} = \exp\left(-\frac{1}{2}\varepsilon(\varepsilon - 1)\sigma_P^2\right).$$

[7] Similar formulas have been derived by Andersen and Sørensen (1988), Sørensen (1992), Rankin (1998), and Obstfeld and Rogoff (2000).

[8] The proof is as follows. $\phi < 1$ is equivalent to $E(P^{\varepsilon}) > \left(E\left(P^{\varepsilon-1}\right)\right)^{\frac{\varepsilon}{\varepsilon-1}}$. Let $P^{\varepsilon-1} = x$, so that $P^{\varepsilon} = f(x) = x^{\frac{\varepsilon}{\varepsilon-1}}$. Hence the inequality can be written $E\left(x^{\frac{\varepsilon}{\varepsilon-1}}\right) > (E(x))^{\frac{\varepsilon}{\varepsilon-1}}$ or $E(f(x)) > f(E(x))$. According to Jensen's inequality this holds if f is convex, which is the case here. Harald Lang pointed out the proof to us.

It then follows that

$$\frac{d\phi}{d\sigma_P^2} = -\frac{\varepsilon(\varepsilon-1)}{2}\exp\left(-\frac{\varepsilon(\varepsilon-1)}{2}\sigma_P^2\right) < 0,$$

and

$$\frac{dE(L_2)}{d\sigma_P^2} = E(\theta^{\varepsilon})\left(\frac{\varepsilon}{(\varepsilon-1)}\right)^{-\varepsilon} b^{-\varepsilon}\frac{d\phi}{d\sigma_P^2} < 0.$$

Expected employment thus decreases if price variability increases. From (14) we then know that expected utility also decreases.

With a log-normal productivity distribution, it also holds that

$$\frac{dE(L_2)}{d\sigma_\theta^2} = \phi\left(\frac{\varepsilon}{(\varepsilon-1)}\right)^{-\varepsilon} b^{-\varepsilon}\frac{dE(\theta^{\varepsilon})}{d\sigma_\theta^2} > 0,$$

i.e. expected employment (and hence also expected utility) with a two-period contract increases with the amount of supply shocks, just as was the case with a one-period contract.

3.3 Comparison of one-period and two-period contracts

It is readily established that expected employment and expected gross utility are larger under one-period contracts than under two-period contracts. (9) and (13) give

$$E(L_1) - E(L_2) = (1-\phi)E(\theta^{\varepsilon})\left(\frac{\varepsilon}{\varepsilon-1}\right)^{-\varepsilon} b^{-\varepsilon} > 0, \tag{15}$$

(10) and (14) together with (15) give

$$E(U_1) - E(U_2) = \frac{1}{(\varepsilon-1)}\frac{(E(L_1)-E(L_2))}{L_0}(1-t)\,b > 0. \tag{16}$$

The difference in expected utility between one-period and two-period contracts is thus proportional to the difference in expected employment.

The result that $E(L_1) > E(L_2)$ means that certainty equivalence does not hold in our model. What is the intuition? There are two factors at work. On one hand, expected employment is affected by variations of the real wage around a *given* expected level. Because the labour demand schedule is convex, as shown in Figure 2, the real wage variability that arises with a two-period contract tends to give higher expected employment than the constant real wage with a one-period contract. But on the other hand, the expected real wage is higher with a two-period contract than with a one-period contract. This can most easily be seen in the case of log-normality. Then we have

$$E\left(\frac{W_2}{P}\right)=\frac{\varepsilon}{(\varepsilon-1)}\frac{E\left(P^{\,\varepsilon}\right)\left(E\left(P^{-1}\right)\right)}{E\left(P^{\,\varepsilon-1}\right)}b=\frac{\varepsilon}{(\varepsilon-1)}\left(\exp\left(\varepsilon\sigma_P^2\right)\right)b>\frac{\varepsilon}{(\varepsilon-1)}b=E\left(\frac{W_1}{P}\right).$$

In Appendix A we show that the result that $E\left(W_2/P\right)>E\left(W_1/P\right)$ is general. The higher real wage in a two-period contract than in a one-period contract works in the direction of lower expected employment. The real-wage effect dominates the effect that arises because of the convexity of the labour demand schedule.

The higher expected real wage in a two-period than in a one-period contract can be explained by help of Figure 3, where union utility is drawn as a function of the real wage. The crucial factor is that the utility function exhibits decreasing concavity around the maximum.[9] Under certainty in a one-period contract, the union chooses the real wage ω. Under uncertainty in a two-period contract, the union can set the nominal wage so that the same expected real wage ω is obtained. But then the union will make a larger utility loss if the real wage, because of a high price realisation, turns out to be $(1-k)\,\omega$ than if it, because of a low price realisation, turns out to be $(1+k)\,\omega$. This creates an incentive to choose a higher expected real wage than ω.[10]

It should be noted that price variability is a necessary condition for expected employ-

[9] At the maximum, it holds that $\partial U^3/\partial W^3=2\left(\varepsilon+1\right)\left(\varepsilon-1\right)W^{-\varepsilon-2}>0$. The crucial assumptions that give this are constant-elastic demand and constant relative risk aversion (zero in the analysis above).

[10] The reasoning is taken from Sørensen (1992). In a setting similar to ours, he and earlier Andersson and Sørensen (1988), showed that the expected log of the real wage, $E\left(\ln W-\ln P\right)$, is higher under uncertainty than under certainty and the expected log of employment, $E\left(\ln L\right)$, lower. As they pointed out, based on Rotschild and Stiglitz (1971), this result is not general, but it will always obtain with a log-normal price distribution. The difference in our analysis is that we look at the expectations of the unlogged real wage and employment levels. Our results that $E\left(W/P\right)$ is higher and $E\left(L\right)$ lower under uncertainty than under certainty about prices are general and do not presuppose any specific probability distributions. Rankin (1998) derives the similar, but not identical, result that increased monetary unceratinty will reduce the (unlogged) "natural rate" of employment, which he defines as the employment level when monetary variables take their expected values.

ment and expected gross utility to differ between one-period and two-period contracts. If there were only productivity shocks, but no price uncertainty, then the same real wage would be chosen in one-period and two-period contracts and $\phi = 1$. This follows because the real wage under certainty is invariant to productivity shocks. Variability in productivity has an effect on the difference in expected employment only when it interacts with variability in the price. This is clear as $E\left(\theta^{\varepsilon}\right)$ enters multiplicatively in the expression for $E\left(L_1\right) - E\left(L_2\right)$. With log-normal probability distributions, we obtain

$$\frac{dE\left(L_1\right) - E\left(L_2\right)}{d\sigma_P^2} = -\frac{dE\left(L_2\right)}{d\sigma_P^2} > 0,$$

and

$$\frac{dE\left(L_1\right) - E\left(L_2\right)}{d{\sigma^2}_\theta} = \left(1 - \phi\right)\frac{dE\left(L_1\right)}{d{\sigma^2}_\theta} > 0.$$

Increased variability of both the price and productivity thus increases the difference in expected employment, and hence also the difference in expected utility, between one-period and two-period contracts.

4 Macroeconomic variability, unemployment benefits and contract length

Below, we are mainly interested in the effect of the unemployment benefit level on contract length. This analysis holds for all probability distributions. The assumption of log-normal distributions is made only when we discuss the effects of increased variability.

4.1 Deductible contract costs

We first examine the case when the contract cost is deductible. Then the tax rate will not matter for contract length, because the cut-off point for the distribution of contracts is given by $E\left(U_1\right) - E\left(U_2\right) - C = \left(1 - t\right)\left(b\left(E\left(L_1\right) - E\left(L_2\right)\right)/\left(L_0\left(\varepsilon - 1\right)\right) - C_U\right) = 0$. It is then enough to look at equations (5), (15) and (16). We obtain

$$\frac{dx}{d\sigma_P^2} = F'\left(.\right)\left(\frac{b}{\left(\varepsilon - 1\right)L_0}\frac{d\left(E\left(L_1\right) - E\left(L_2\right)\right)}{d\sigma_P^2}\right) > 0, \tag{17}$$

$$\frac{dx}{d\sigma^2_\theta} = F'(.)\left(\frac{b}{(\varepsilon - 1) L_0}\frac{d(E(L_1) - E(L_2))}{d\sigma^2_\theta}\right) > 0, \tag{18}$$

$$\frac{dx}{db} = -F'(.)\left(\frac{E(L_1) - E(L_2)}{L_0}\right) < 0. \tag{19}$$

Equation (17) says that the fraction of one-period contracts increases if price shocks become larger. This is the standard result that larger nominal variability reduces contract length (Ball, 1987; Ball et al., 1988). Here, it comes about because larger price variability reduces expected employment, and hence also expected gross utility, with a two-period contract.

Equation (18) shows that the fraction of one-period contracts increases with the amount of supply shocks. The explanation is that increased variability of productivity results in a larger employment difference, and thus also in a larger gross utility difference, between one-period and two-period contracts due to the interaction with price variability, as discussed above.

Equation (19) , finally, relates the length of wage contracts to the benefit level. Higher unemployment compensation reduces the fraction of one-period contracts. There is a simple intuition for this result. Because two-period contracts lead to higher expected unemployment than one-period contracts, there is a higher unemployment risk for a representative union member. Hence, the expected gross income gain from a rise in unemployment compensation is larger under two-period contracts than under one-period contracts.[11] The incentive to choose two-period contracts is thus stronger the higher the unemployment benefit.

To our knowledge, this effect of the unemployment benefit level on contract length has not been pointed out before. It means that a higher benefit level will not only raise equilibrium unemployment but also make nominal wages more sticky, and thus increase employment variations, in the case of nominal shocks. The result follows from the lack of

[11] This result follows directly from (10) and (14) Using the envelope theorem, we have $dE(U_1)/db = \partial E(U_1)/\partial b = (1-t)(1 - E(L_1)/L_0)$ and $dE(U_2)/db = \partial E(U_2)/\partial b = (1-t)(1 - E(L_2)/L_0)$. It follows that $d((E(U_1) - E(U_2))/(1-t))/db = (E(L_2) - E(L_1))/L_0$.

certainty equivalence in our model.

4.2 Non-deductible contract costs

Consider next the case when the contract cost is not deductible. Because the cut-off point for the distribution of contracts is then given by $E(U_1) - E(U_2) - C = (1-t)\,b$ $(E(L_1) - E(L_2))/L_0(\varepsilon - 1) - C_U = 0$, contract length in this case depends also on the tax rate. From equations (6), (7), (8), (9), (11), (13) and (16), we obtain

$$\frac{dx}{d\sigma_P^2} = \frac{MF'(.)\,(b/((\varepsilon-1)\,L_0)\,(E(L_2)-E(L_1)))}{S} - \frac{DF'(.)\,((b\,(1-t))/((\varepsilon-1)\,L_0)\,(dE(L_2)/d\sigma_P^2))}{S} \lesseqgtr 0, \tag{20}$$

$$\frac{dx}{d{\sigma^2}_\theta} = \frac{QF'(.)\,(b/((\varepsilon-1)\,L_0)\,(E(L_2)-E(L_1)))}{S} + \frac{DF'(.)\,((b\,(1-t))/((\varepsilon-1)\,L_0)\,((1-\phi)\,(dE(L_1)/d{\sigma^2}_\theta)))}{S} > 0, \tag{21}$$

$$\frac{dx}{db} = \frac{DF'(.)\,(((1-t)/L_0)\,(E(L_2)-E(L_1)))}{S} + \frac{JF'(.)\,((1/(\varepsilon-1))\,(b/L_0)\,(E(L_2)-E(L_1)))}{S} < 0, \tag{22}$$

where $D > 0$, $M > 0$, $H < 0$, $Q < 0$ and $J > 0$ (see Appendix B). We assume that the denominator $S = D - HF'(.)\,(b/((\varepsilon-1)\,L_0)\,(E(L_2)-E(L_1))) > 0$. This can be interpreted as a "dynamic stability condition". It is illustrated in Figures 4-6. The x-function shows that the fraction of one-period contracts, x, depends negatively on the tax rate according to equation (6): a higher tax rate reduces the expected after-tax income difference (gross of contract costs) between one-period and two-period contracts and thus tends to make two-period contracts more attractive. The t-function shows that the tax rate depends negatively on x according to the government budget constraint (7). The reason is that expected employment is higher with one-period than with two-period contracts, which results in a larger tax base and smaller expenditures on unemployment benefits. So a larger x requires a lower tax rate. "Dynamic stability" requires that the t-function is steeper than the x-function.

Equation (20) shows that it is no longer certain that larger price shocks will reduce average contract length: the first term on the RHS is negative and the second is positive. This can be explained by help of Figure 4. Larger price shocks shift the x-curve upwards, because they mean a larger expected gross income difference between one-period and two-period contracts at a given tax rate. This tends to raise x just as before. (The economy moves from A to B with a constant tax rate). But larger price shocks also shift the t-schedule to the right. The reason is that a higher tax rate is required at an unchanged x, because larger price variability means lower expected employment in two-period contracts, and hence a smaller tax base and larger costs for benefits. This second effect tends to lower x, because a higher tax rate works in the direction of reducing the after-tax gross income difference between one-period and two-period contracts. The tax rate increase could be so large that increased price variability actually reduces the fraction of short-term contracts (C might lie below A). Also this unexpected result follows from the feature that our model does not exhibit certainty equivalence.

Equation (21) shows that larger productivity shocks increase the fraction of one-period contracts unambiguously. The x-curve in Figure 5 is shifted upwards because an increase in the variability of productivity increases the expected gross income difference between one-period and two-period contracts at a given tax rate. This tends to raise x just as in the case with a deductible contract cost. (The economy moves from A to B with a given tax rate). Larger variability in productivity also shifts the t-schedule to the left, because it means higher expected employment with two-period contracts, and hence a larger tax base and lower costs for benefits. The implied tax-rate reduction tends to increase the expected after-tax income difference between one-period and two-period contracts (gross of contract costs) even further. This effect reinforces the increase in the frequency of one-period contracts. (The economy moves to C.)

Our earlier result that average contract length is increased by higher unemployment compensation holds in this case, too: both terms on the RHS of (22) are negative. For the same reason as in the case with a deductible contract cost, higher unemployment compensation tends to reduce the expected income difference between one-period and two-period contracts. This shifts the x-schedule downwards in Figure 6 and tends to reduce the frequency of one-period contracts (the economy would move from A to B with a constant tax rate). But the t-schedule also shifts to the right. The reason is that higher unemployment compensation requires a higher tax rate at a given x. The tax-rate increase tends to reduce the expected after-tax income difference between one-period and two-period contracts (gross of contract costs) even further. This reinforces the reduction in the frequency of one-period contracts (the economy moves to C). So with non-deductible contract costs, higher unemployment compensation leads to an increase in average contract length through both an effect on the expected before-tax income difference between one-period and two-period contracts and a tax effect.

5 Wage bargaining and contract length

A natural modification is to assume that the wage is set through bargaining rather than by a monopoly union. More specifically, we assume a Nash bargaining solution. Each union tries as before to maximise the expected income of a representative member, whereas each firm tries to maximise its profit. The fall-back level of income for a union member in case of disagreement is the unemployment benefit. The fall-back level of profit is zero.

5.1 One-period contracts

Consider first a one-period contract. The wage is obtained by maximisation of the Nash bargaining product

$$(\pi)^{\beta}(U - U_0)^{1-\beta}, \tag{23}$$

where $0 < \beta < 1$ is the relative bargaining strength of the firm, π and U are given by equations (2) and (4) and $U_0 = b$. Maximisation of the Nash bargaining product (23) gives the money wage in a one-period contract as

$$W_1 = \frac{\varepsilon - \beta}{\varepsilon - 1} P b. \tag{8a}$$

As is well known, the real wage under bargaining is also a mark-up on the real unemployment compensation, but the mark-up is smaller than in the monopoly union case. Using (8a) we obtain expected employment under a one-period contract as

$$E(L_1) = E(\theta^{\varepsilon}) \left(\frac{\varepsilon - \beta}{\varepsilon - 1} \right)^{-\varepsilon} b^{-\varepsilon}. \tag{9a}$$

We can also derive that expected gross utility of a union is

$$E(U_1) = \left(\frac{(1-\beta)}{(\varepsilon - 1)} \frac{E(L_1)}{L_0} + 1 \right) (1-t) b, \tag{10a}$$

and that the expected profit is

$$E(\pi_1) = E(\theta^{\varepsilon}) \left(\frac{1}{\varepsilon - 1} \right) \left(\frac{\varepsilon - \beta}{\varepsilon - 1} \right)^{1-\varepsilon} b^{1-\varepsilon}. \tag{24}$$

With a log-normal distribution for productivity, θ, we have as before that $dE(\theta^{\varepsilon}) / d\sigma_{\theta}^{2} > 0$ and hence that

$$\frac{d(E(L_1))}{d\sigma_{\theta}^{2}} = \left(\frac{\varepsilon - \beta}{\varepsilon - 1} \right)^{-\varepsilon} b^{-\varepsilon} \frac{dE(\theta^{\varepsilon})}{d\sigma_{\theta}^{2}} > 0,$$

and

$$\frac{d(E(\pi_1))}{d\sigma_{\theta}^{2}} = \left(\frac{1}{\varepsilon - 1} \right) \left(\frac{\varepsilon - \beta}{\varepsilon - 1} \right)^{1-\varepsilon} b^{1-\varepsilon} \frac{dE(\theta^{\varepsilon})}{d\sigma_{\theta}^{2}} > 0.$$

Larger variability in productivity thus leads to both higher expected employment and higher expected profit.

5.2 Two-period contracts

The wage in the second period of a two-period contract is set so that the Nash bargaining product

$$[E(\pi)]^{\beta} [E(U - U_0)]^{1-\beta} = [E(\pi)]^{\beta} E \Box \left((1-t) \frac{L}{L_0} \left(\frac{w}{P} - b \right) \right) \Big]^{1-\beta},$$

is maximised. The outcome is

$$W_2 = \frac{(\varepsilon - \beta)}{(\varepsilon - 1)} \frac{E(P^{\varepsilon})}{E(P^{\varepsilon - 1})} b, \tag{11a}$$

which under assumption of log-normality simplifies to

$$W_2 = \frac{(\varepsilon - \beta)}{(\varepsilon - 1)} \exp\left(\sigma_P^2 (\varepsilon - 1/2)\right) b. \tag{12a}$$

Using (11a) it follows that

$$E(L_2) = \phi E(\theta^{\varepsilon}) \left(\frac{\varepsilon - \beta}{\varepsilon - 1}\right)^{-\varepsilon} b^{-\varepsilon}, \tag{13a}$$

$$E(U_2) = \left(\frac{E(L_2)}{L_0} \frac{(1 - \beta)}{(\varepsilon - 1)} + 1\right) (1 - t) b, \tag{14a}$$

and

$$E(\pi_2) = \frac{\phi}{\varepsilon - 1} E(\theta^{\varepsilon}) \left(\frac{\varepsilon - \beta}{\varepsilon - 1}\right)^{1-\varepsilon} b^{1-\varepsilon}, \tag{25}$$

where $0 < \phi < 1$, as was derived in Section 3.3. Since $dE(\theta^{\varepsilon}) / d\sigma_{\theta}^2 > 0$ we have that

$$\frac{d(E(L_2))}{d\sigma_{\theta}^2} = \phi \left(\frac{\varepsilon - \beta}{\varepsilon - 1}\right)^{-\varepsilon} b^{-\varepsilon} \frac{dE(\theta^{\varepsilon})}{d\sigma_{\theta}^2} > 0,$$

and

$$\frac{dE(\pi_2)}{d\sigma_{\theta}^2} = \frac{\phi}{\varepsilon - 1} \left(\frac{\varepsilon - \beta}{\varepsilon - 1}\right)^{1-\varepsilon} b^{1-\varepsilon} \frac{dE(\theta^{\varepsilon})}{d\sigma_{\theta}^2} > 0.$$

Both the expected employment and the expected profit increase when variability in productivity increases. Because $d\phi/d\sigma_P^2 < 0$ as previously discussed, it holds that

$$\frac{dE(L_2)}{d\sigma_P^2} = \left(\frac{\varepsilon - \beta}{\varepsilon - 1}\right)^{-\varepsilon} E(\theta^{\varepsilon}) b^{-\varepsilon} \frac{d\phi}{d\sigma_P^2} < 0,$$

and

$$\frac{dE(\pi_2)}{d\sigma_P^2} = \frac{1}{\varepsilon - 1} \left(\frac{\varepsilon - \beta}{\varepsilon - 1}\right)^{1-\varepsilon} E(\theta^{\varepsilon}) b^{1-\varepsilon} \frac{d\phi}{d\sigma_P^2} < 0,$$

i.e. the expected employment and the expected profit fall when price variability increases.

(9a) and (13a) give

$$E(L_1) - E(L_2) = (1-\phi) E(\theta^{\varepsilon}) \left(\frac{\varepsilon - \beta}{\varepsilon - 1}\right)^{-\varepsilon} b^{-\varepsilon} > 0. \tag{15a}$$

(10a) and (14a) give

$$E(U_1) - E(U_2) = \frac{(1-\beta)}{(\varepsilon - 1)} \frac{(E(L_1) - E(L_2))}{L_0} (1-t) b > 0. \tag{16a}$$

(24), (25) and (15a) give

$$E(\pi_1) - E(\pi_2) = \frac{\varepsilon - \beta}{(\varepsilon - 1)^2} (E(L_1) - E(L_2)) b > 0.$$

So, as in Section 3, both the expected employment and the expected gross utility of a union is higher with a one-period contract than with a two-period contract. In addition, we have shown that the expected profit is higher with a one-period contract than with a two-period contract. This happens even though the real profit of the firm, which can be written $\pi = (\theta^{\varepsilon}/(\varepsilon - 1))(W/P)^{1-\varepsilon}$, is a convex function of the real wage, so that variations of the real wage around a *given* expected level indeed raise the expected profit. The explanation, which is analogous to the discussion in Section 3.3, is that the price uncertainty in a contract with longer duration leads to a higher expected real wage.

5.3 Determination of contract length

The next step is to analyse the determination of contract length. Because we have assumed a binary choice between one-period and two-period contracts, a Nash bargaining solution is not appropriate. One possibility would be to let firms and unions bargain on the probability with which one-period and two-period contracts are chosen. But we shall follow the simpler strategy of assuming that it is either unions or firms that determine contract length. We continue to assume that taxes are paid only by labour, so the budget constraint (7) still holds.

Consider first the case when the union side decides on contract length. They are assumed to incur the same contract costs in Section 2.2. It is straightforward to show that all qualitative results are the same as in Section 4 (see Appendix C).

Let us then turn to the case when contract length is determined by firms. We then assume that the contract costs for firms, C_F, also vary according to a cumulative distribution function, which we denote $K(C_F)$ and which has the same properties as the F-function.

A firm chooses a one-period contract if

$$E(\pi_1) - C_F > E(\pi_2).$$

The fraction of one-period contracts is now given by

$$x = K[E(\pi_1) - E(\pi_2)]. \tag{26}$$

Because taxes are paid only by the employees and the tax rate does not affect the wage, we do not now have to consider any tax repercussions. It suffices to differentiate (26). This gives

$$\frac{dx}{d\sigma_P^2} = -K'(.)\frac{dE(\pi_2)}{d\sigma_P^2} > 0, \tag{27}$$

$$\frac{dx}{d\sigma_\theta^2} = K'(.)\frac{d(E(\pi_1) - E(\pi_2))}{d\sigma_\theta^2} = K'(.)\frac{(1-\phi)}{(\varepsilon-1)}\left(\frac{\varepsilon-\beta}{\varepsilon-1}\right)^{1-\varepsilon} b^{1-\varepsilon}\frac{dE(\theta^{\varepsilon})}{d\sigma_\theta^2} > 0, \tag{28}$$

$$\frac{dx}{db} = K'(.)\frac{d(E(\pi_1) - E(\pi_2))}{db} = -K'(.)\frac{(\varepsilon-\beta)}{(\varepsilon-1)}(E(L_1) - E(L_2)) < 0. \tag{29}$$

Equation (27) shows that employers, too, have an incentive to reduce contract length when there is more uncertainty about prices and thus also about real wages. According to (28), larger supply shocks increase the fraction of one-period contracts.

Equation (29) shows that higher unemployment compensation strengthens the incentive to choose two-period contracts also when contract length is decided by employers. To understand why, consider a 1 percent increase of the unemployment benefit, b. It is clear from (8a) and (11a) that this gives a 1 percent increase in the money wage in both one-period and two-period contracts. From (24) and (25) we have that the expected profit is reduced by $(\varepsilon - 1)$ percent with both types of contracts. But because the expected profit is larger with a one-period contract than with a two-period contract, it follows that the profit reduction is larger in absolute terms with one-period contracts than with two-period contracts. So an increase in unemployment compensation will reduce the expected profit difference $E(\pi_1) - E(\pi_2)$ and hence create an incentive also for employers to increase contract length.

The upshot is thus that changes in macroeconomic variability and in unemployment compensation affect the incentives of employers and employees with regard to contract length similarly. Both unions and firms prefer shorter contracts when there is more variability and longer contracts when unemployment benefits are more generous.

6 Possible modifications of the analysis

This section discusses various modifications of the assumptions. We focus on the impact of unemployment benefits. The following aspects are considered: (*i*) the assumption of exogenously determined contract costs; (*ii*) the assumption of risk neutrality; and (*iii*) the assumption that unemployment compensation is set in real terms.

6.1 Endogenous contract costs

We have assumed that contract costs are exogenous. Another possibility would be to let them depend on real wages. Let us, for example, interpret contract cost as the costs for labour services that are purchased. It is then natural to relate contract costs to the aggregate real wage in the economy. To illustrate the argument let us assume that the before-tax contract cost in each firm is a fixed proportion of the aggregate real wage in one-period contracts, so that

$$C_U = \lambda \frac{W_1}{P} = \lambda \frac{\varepsilon}{\varepsilon - 1} b.$$

Assume then that λ is given by a cumulative distribution function Γ with the same properties as the earlier F and K-functions. In the monopoly-union case with non-deductible contract costs, one-period contracts are now chosen if

$$E(U_1) - E(U_2) > \lambda \frac{\varepsilon}{\varepsilon - 1} b,$$

so that the fraction of one-period contracts becomes

$$x = \Gamma\left(\frac{(E(U_1) - E(U_2))(\varepsilon - 1)}{\varepsilon b}\right).$$

There is now an additional effect of a rise in unemployment compensation. It raises the aggregate real wage in the economy and hence contract costs relative to the difference in expected gross incomes between one-period and two-period contracts. This effect also tends to reduce the number of one-period contracts and hence to reinforce the increase in average contract length.

6.2 Risk aversion

In Sections 2−5 we have assumed that union members are risk neutral. A natural question is to which extent an assumption of risk aversion would change the analysis. The answer is not very much. The conclusion that higher unemployment compensation tends to raise expected utility more with a two-period than with a one-period contract, because the former implies higher unemployment, still holds.

With risk aversion, the earlier gross utility function (4) of a union is replaced by

$$U = \frac{L}{L_0} \frac{1}{1-\gamma}\left((1-t)\frac{W}{P}\right)^{1-\gamma} + \left(1 - \frac{L}{L_0}\right)\frac{1}{1-\gamma}\left((1-t)b\right)^{1-\gamma}, \tag{4a}$$

where γ is the degree of relative risk aversion. If we replace (4) with (4a) in Sections (2) – (4), we obtain

$$W_1 = \left(\frac{\varepsilon}{\varepsilon + \gamma - 1}\right)^{\frac{1}{1-\gamma}} Pb, \tag{8b}$$

$$E(L_1) = E(\theta^{\varepsilon})\left(\frac{\varepsilon}{\varepsilon + \gamma - 1}\right)^{-\frac{\varepsilon}{1-\gamma}} b^{-\varepsilon}, \tag{9b}$$

$$E(U_1) = \left(\frac{1-\gamma}{\varepsilon + \gamma - 1}\frac{E(L_1)}{L_0} + 1\right)\frac{1}{1-\gamma}\left((1-t)b\right)^{1-\gamma}, \tag{10b}$$

$$W_2 = \left(\frac{\varepsilon}{(\varepsilon+\gamma-1)}\right)^{\frac{1}{1-\gamma}} \left(\frac{E(P^{\varepsilon})}{E(P^{\varepsilon+\gamma-1})}\right)^{\frac{1}{1-\gamma}} b, \tag{11b}$$

$$E(L_2) = E(\theta^{\varepsilon})\,\rho\left(\frac{\varepsilon}{(\varepsilon+\gamma-1)}\right)^{-\frac{\varepsilon}{1-\gamma}} b^{-\varepsilon}, \tag{13b}$$

and

$$E(U_2) = \left(\frac{E(L_2)}{L_0}\left(\frac{(1-\gamma)}{(\varepsilon+\gamma-1)}\right)+1\right)\frac{1}{1-\gamma}\left((1-t)\,b\right)^{1-\gamma}, \tag{14b}$$

where

$$\rho = \frac{E(P^{\varepsilon+\gamma-1})^{\frac{\varepsilon}{1-\gamma}}}{E(P^{\varepsilon})^{\frac{\varepsilon+\gamma-1}{1-\gamma}}}.$$

In analogy with the earlier analysis, it can be shown that Jensen's inequality implies that $0 < \rho < 1$.[12] Hence it again follows that

$$E(L_1) - E(L_2) = (1-\rho)\,E(\theta^{\varepsilon})\left(\frac{\varepsilon}{\varepsilon+\gamma-1}\right)^{-\frac{\varepsilon}{1-\gamma}} b^{-\varepsilon} > 0.$$

Now, consider the case when the (exogenous) contract cost is non-deductible so that (6) applies. An appropriate interpretation could be that the contract cost represents effort which the representative union member has to expend on the writing of a contract. Differentiating (6), taking the government budget constraint (7) into account gives

$$\begin{aligned}\frac{dx}{db} &= \frac{DF'(.)\left(\left((1-t)^{1-\gamma} b^{-\gamma}\right)/L_0\left(E(L_2)-E(L_1)\right)\right)}{T} \\ &+\frac{ZF'(.)\left(\left((1-\gamma)\left((1-t)^{-\gamma} b^{1-\gamma}\right)/\left((\varepsilon+\gamma-1)L_0\right)\right)\left(E(L_2)-E(L_1)\right)\right)}{T} \lesseqgtr 0,\end{aligned} \tag{30}$$

where $Z > 0$, $D > 0$ and $T > 0$ (see Appendix D).

The first term in (30) represents as before a larger gain at a given tax rate of a rise in unemployment compensation with a two-period contract than with a one-period contract. Again, this follows because expected unemployment is higher with two-period contracts. The second term captures the effect on the utility difference of the tax rate increase that

[12] The proof is similar to the earlier one. $\rho < 1$ is equivalent to $E(P^{\varepsilon}) > E\left(P^{\varepsilon+\gamma-1}\right)^{\frac{\varepsilon}{\varepsilon+\gamma-1}}$ if $\gamma < 1$. Let $P^{\varepsilon+\gamma-1} = x$, so that $P^{\varepsilon} = f(x) = x^{\frac{\varepsilon}{\varepsilon+\gamma-1}}$. Thus the inequality can be written $E\left(x^{\frac{\varepsilon}{\varepsilon+\gamma-1}}\right) > E(x)^{\frac{\varepsilon}{\varepsilon+\gamma-1}}$ or $E(f(x)) > f(E(x))$. According to Jensen's inequality this holds if f is convex which is the case if $\gamma < 1$. If $\gamma > 1$, $\rho < 1$ is equivalent to $E(P^{\varepsilon}) < E\left(P^{\varepsilon+\gamma-1}\right)^{\frac{\varepsilon}{\varepsilon+\gamma-1}}$. This holds according to Jensen's inequality if f is concave, which is the case then.

is necessary to finance a rise in unemployment compensation As can be seen, the sign of this tax effect depends on the degree of relative risk aversion. If $\gamma < 1$ the tax effect tends to make two-period contracts relatively more favourable, just as in Section 4. In this case, average contract length thus increases unambiguously. But if $\gamma > 1$, the tax effect tends instead to make one-period contracts more favourable. Then it is no longer clear how average contract length is affected.

The explanation of the ambiguous tax effect is that

$$E(U_1) - E(U_2) = \frac{1}{(\varepsilon + \gamma - 1)} \frac{(E(L_1) - E(L_2))}{L_0} (1-t)^{1-\gamma} b^{1-\gamma},$$

from which follows that a rise in the tax rate, t, tends to decrease the expected gross utility difference if $\gamma < 1$, but to increase it if $\gamma > 1$.

6.3 The determination of unemployment benefits

The last point concerns the determination of unemployment compensation. We have assumed it to be fixed in real terms. We could just as well have assumed it to be a random variable, which is not known when the decision on contract length is taken. If the real unemployment benefit is uncorrelated with the price, we would just have to substitute $E(b)$ for b in our expressions.

However, if the real value of the unemployment benefit would fluctuate with prices, the analysis would be different. Assume for example, that the benefit is fixed in nominal terms for both periods. Then it can be shown that the money wage in a one-period contract will be set as a mark-up on the nominal benefit and will thus be independent of the price. The same fixed money wage would be set in a one-period and two-period contracts. So there would be the same variations in real wages when prices fluctuate in the two types of contracts. Contract length would then no longer matter for expected utility and would not be affected by changes in the (nominal) benefit level. This would, however, seem to be a peculiar model as contract length would be of no importance for the degree of nominal wage rigidity. It is also an institutional fact that wage contracts are of longer duration than the periods for which the nominal values of government transfers, such as unemployment compensation, are decided. To explain why this is the case is, however, an important research topic in its own right.

7 Concluding comments

In policy discussions of labour market reform it is often taken for granted that the same reforms will reduce both equilibrium unemployment and the variability of employment. But no microeconomic underpinnings are usually presented for this view. We look at one particular labour market institution, unemployment insurance, and derive from a standard wage-setting model that a lower unemployment benefit level is indeed likely to increase both equilibrium employment and nominal wage flexibility.

We show that lower unemployment benefits reduce the average length of wage contracts. The crucial feature giving this result is that our model does not exhibit certainty equivalence. Contracts of longer duration are associated with higher expected real wage levels and higher expected unemployment. So the unemployment risk is greater for a representative union member under a long-term than under a short-term wage contract. It follows that a reduction in the unemployment benefit level will reduce the expected utility of a union member (gross of contract costs) more if contracts are long-term than if they are short-term. Hence, such a reduction gives the union side an incentive to shorten the duration of wage contracts. The incentives on the employer side are shown to work in the same direction. In addition, there may be a tax effect tending to give the same result. Lower unemployment benefits are associated with lower taxes. They increase the expected income difference (gross of contract costs) between short-term and long-term wage contracts and therefore tend to make the former relatively more attractive.

We also revisited the standard analysis of how nominal and real variability affect contract length. More variability in productivity always reduced contract length, whereas the effect of larger price variability was ambiguous in the setting with non-deductible contract costs. This was due to the fact that larger price variability tends to lower expected employment and hence raise the tax rate. This works in the direction of reducing the after-tax income gain of shorter wage contracts.

There are several natural extensions of our work. One would be to impose a richer demand structure by abandoning the small-open-economy assumption of our analysis. This is likely to open up the possibility of multiple equilibria. Another extension would be to let contract length in each firm be a continuous variable, which would allow us to analyse the choice of contract length as the outcome of a bargaining process.

A key assumption has been that the unemployment benefit is determined in real terms. Changes in the generosity of unemployment insurance then involves changes in the minimum standard of living. But as the wage in this set-up is determined as a mark-up over the unemployment benefit, it is not possible to analyse changes in the replacement rate, i.e. in the relative income loss when unemployed. To do this would also be a natural extension. It would also be interesting to examine the implications of other wage-setting assumptions. Obvious candidates are insider-outsider models, efficiency-wage models and models where wages are set in individual rather then in collective bargaining.

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Appendix

A Comparision of the one-period and two-period expected real wages

The proposition in Section 3.3 that the expected real wage is higher in a two-period contract than in a one-period contract, i.e. that $E(W_2/P) > E(W_1/P)$, can be proved as follows.[13] Using (8) and (11) it is straightforward to show that the proposition holds if

$$E\left(P^{\varepsilon-1}\right) < E\left(P^{\varepsilon}\right) E\left(P^{-1}\right). \tag{A1}$$

To prove (A1), we first note that we have already derived in footnote 6 that

$$E\left(P^{\varepsilon-1}\right) < E\left(P^{\varepsilon}\right)^{\frac{\varepsilon-1}{\varepsilon}}. \tag{A2}$$

Jensen's inequality also implies that $(E(P))^{\varepsilon} < E(P^{\varepsilon})$ because P^{ε} is convex. This is equivalent to

$$E(P) < E\left(P^{\varepsilon}\right)^{\frac{1}{\varepsilon}}. \tag{A3}$$

Another implication of Jensen's inequality is that

$$(E(P))^{-1} < E\left(P^{-1}\right), \tag{A4}$$

as P^{-1} is convex. (A2) and (A3) together give

$$E\left(P^{\varepsilon-1}\right) < E\left(P^{\varepsilon}\right)(E(P))^{-1}.$$

Because $(E(P))^{-1} < E(P^{-1})$ from (A4), it must hold that

$$E\left(P^{\varepsilon-1}\right) < E\left(P^{\varepsilon}\right) E\left(P^{-1}\right).$$

Q.E.D.

[13] We are grateful to Per Sjölin and Harald Lang for the proof.

B Determination of contract length with non-deductible contract costs

After substitution of the relevant equations into (6) and (7), total differentiation gives

$$\begin{aligned} dx &= F'(.)\left(\frac{1}{(\varepsilon-1)}\frac{b}{L_0}\left(E\left(L_2\right)-E\left(L_1\right)\right)\right)dt+F'(.)\left(\frac{(1-t)}{L_0}\left(E\left(L_2\right)-E\left(L_1\right)\right)\right)db \\ &\quad -F'(.)\left(\frac{(1-t)}{(\varepsilon-1)}\frac{b}{L_0}\frac{dE\left(L_2\right)}{d\sigma_P^2}\right)d\sigma_P^2+F'(.)\left(\frac{(1-t)}{(\varepsilon-1)}\frac{b}{L_0}\left(1-\phi\right)\frac{dE\left(L_1\right)}{d\sigma_\theta^2}\right)d\sigma_\theta^2, \end{aligned}$$

and

$$Ddt = Hdx + Jdb + Md\sigma_P^2 + Qd\sigma_\theta^2,$$

where

$$D = xE\left(\frac{W_1}{P}L_1\right)+(1-x)E\left(\frac{W_2}{P}L_2\right)+xb\left(L_0-E\left(L_1\right)\right)+(1-x)b\left(L_0-E\left(L_2\right)\right)>0,$$

$$\begin{aligned} H &= t\left(E\left(\frac{W_2}{P}L_2\right)-E\left(\frac{W_1}{P}L_1\right)\right)+b\left(1-t\right)\left(E\left(L_2\right)-E\left(L_1\right)\right) \\ &= t\left(\phi-1\right)\left(\frac{\varepsilon}{(\varepsilon-1)}\right)^{1-\varepsilon}b^{1-\varepsilon}E\left(\theta^{\,\varepsilon}\right)+b\left(1-t\right)\left(\phi-1\right)E\left(\theta^{\,\varepsilon}\right)\left(\frac{\varepsilon}{(\varepsilon-1)}\right)^{-\varepsilon}b^{-\varepsilon}<0, \end{aligned}$$

$$\begin{aligned} J &= \varepsilon xE\left(L_1\right)+t\varepsilon\left(1-x\right)\left(\frac{\varepsilon}{(\varepsilon-1)}\right)^{-\varepsilon}b^{-\varepsilon}E\left(\theta^{\,\varepsilon}\right)\phi+\left(1-t\right)x\left(L_0-E\left(L_1\right)\right) \\ &\quad +\left(1-t\right)\left(1-x\right)\left(L_0-E\left(L_2\right)\right)+\varepsilon\left(1-t\right)\left(1-x\right)E\left(L_2\right)>0, \end{aligned}$$

$$M = -t\left(1-x\right)\left(\frac{\varepsilon}{(\varepsilon-1)}\right)^{1-\varepsilon}b^{1-\varepsilon}E\left(\theta^{\,\varepsilon}\right)\frac{d\phi}{d\sigma_P^2}-\left(1-x\right)\left(1-t\right)\left(\frac{\varepsilon}{(\varepsilon-1)}\right)^{-\varepsilon}E\left(\theta^{\,\varepsilon}\right)b^{1-\varepsilon}\frac{d\phi}{d\sigma_P^2}>0,$$

and

$$Q = -txE\left(\frac{W_1}{P}\right)\frac{E\left(L_1\right)}{d\sigma_\theta^2}-t\left(1-x\right)E\left(\frac{W_2}{P}\right)\frac{E\left(L_2\right)}{d\sigma_\theta^2}-\left(1-t\right)xb\frac{E\left(L_1\right)}{d\sigma_\theta^2}-\left(1-t\right)\left(1-x\right)b\frac{E\left(L_2\right)}{d\sigma_\theta^2}<0$$

C Union determination of contract length in the bargaining model of Section 5.

C.1 Deductible contract costs

In this case, we have

$$\frac{dx}{d\sigma^2_{\theta}} = \frac{b(1-\beta)}{(\varepsilon-1)} F'(.) \left(\frac{1}{L_0} (1-\phi) \frac{E(L_1)}{d\sigma^2_{\theta}} \right) > 0,$$
$$\frac{dx}{d\sigma^2_P} = -\frac{b(1-\beta)}{(\varepsilon-1)} F(.)' \left(\frac{1}{L_0} \frac{dE(L_2)}{d\sigma^2_P} \right) > 0,$$
$$\frac{dx}{db} = -(1-\beta) F(.)' \left(\frac{E(L_1) - E(L_2)}{L_0} \right) < 0.$$

C.2 Non-deductible contract costs

We obtain from equation (6) that

$$\begin{aligned} dx &= F'(.) \left(\frac{(1-\beta) b}{(\varepsilon-1) L_0} (E(L_2) - E(L_1)) \right) dt + F'(.) \left(\frac{(1-t)(1-\beta)}{L_0} (E(L_2) - E(L_1)) \right) db - \\ & F'(.) \left(\frac{(1-t)(1-\beta) b}{(\varepsilon-1) L_0} \frac{dE(L_2)}{d\sigma^2_P} \right) d\sigma^2_P + F'(.) \left(\frac{(1-t)(1-\beta) b}{(\varepsilon-1) L_0} (1-\phi) \frac{dE(L_1)}{d\sigma^2_{\theta}.} \right) d\sigma^2_{\theta}. \end{aligned}$$

From (7), we can derive that

$$Ddt = \widetilde{H} dx + \widetilde{J} db + \widetilde{M} d\sigma^2_P + Q d\sigma^2_{\theta},$$

where the expressions for D and Q have the same form as in section B, and

$$\begin{aligned} \widetilde{H} &= t \left(E\left(\frac{W_2}{P} L_2 \right) - E\left(\frac{W_1}{P} L_1 \right) \right) + b(1-t)(E(L_2) - E(L_1)) = \\ &= t(\phi-1) \left(\frac{\varepsilon-\beta}{\varepsilon-1} \right)^{1-\varepsilon} E(\theta^{\,\varepsilon}) b^{1-\varepsilon} + b(1-t)(\phi-1) \left(\frac{\varepsilon-\beta}{\varepsilon-1} \right)^{-\varepsilon} b^{-\varepsilon} < 0, \end{aligned}$$

$$\begin{aligned} \widetilde{J} &= (\varepsilon - t\beta) x E(L_1) + t(1-x)(\varepsilon-\beta) \left(\frac{\varepsilon-\beta}{\varepsilon-1} \right)^{-\varepsilon} b^{-\varepsilon} E(\theta^{\,\varepsilon}) \phi + \\ & (1-t) x (L_0 - E(L_1)) + (1-t)(1-x)(L_0 - E(L_2)) + \varepsilon(1-t)(1-x) E(L_2) > 0, \end{aligned}$$

and

$$\widetilde{M} = -t(1-x)(1-x) \left(\frac{\varepsilon-\beta}{\varepsilon-1} \right)^{1-\varepsilon} b^{1-\varepsilon} E(\theta^{\,\varepsilon}) \frac{d\phi}{d\sigma^2_P} - (1-x)(1-t) \left(\frac{\varepsilon-\beta}{\varepsilon-1} \right)^{-\varepsilon} E(\theta^{\,\varepsilon}) b^{1-\varepsilon} \frac{d\phi}{d\sigma^2_P} > 0$$

Hence, it follows that

$$\begin{aligned} \frac{dx}{d\sigma^2_{\theta}} &= \frac{QF'(.)((1-\beta) b / ((\varepsilon-1) L_0)(E(L_2) - E(L_1)))}{D - \widetilde{H} F'(.)(((1-\beta) b) / ((\varepsilon-1) L_0)(E(L_2) - E(L_1)))} + \\ & \frac{DF'(.)((b(1-\beta)(1-t)) / ((\varepsilon-1) L_0)((1-\phi)(dE(L_1)/d\sigma^2_{\theta})))}{D - \widetilde{H} F'(.)(((1-\beta) b) / ((\varepsilon-1) L_0)(E(L_2) - E(L_1)))} > 0, \end{aligned}$$

$$\frac{dx}{d\sigma_P^2} = \frac{\widetilde{M}F'(.)\left(\left(\left(1-\beta\right)b\right)/\left(\left(\varepsilon-1\right)L_0\right)\left(E\left(L_2\right)-E\left(L_1\right)\right)\right)}{D-\widetilde{H}F'(.)\left(\left(\left(1-\beta\right)b\right)/\left(\left(\varepsilon-1\right)L_0\right)\left(E\left(L_2\right)-E\left(L_1\right)\right)\right)} - \frac{DF'(.)\left(\left(\left(1-t\right)\left(1-\beta\right)b\right)/\left(\left(\varepsilon-1\right)L_0\right)\left(dE\left(L_2\right)/d\sigma_P^2\right)\right)}{D-\widetilde{H}F'(.)\left(\left(\left(1-\beta\right)b\right)/\left(\left(\varepsilon-1\right)L_0\right)\left(E\left(L_2\right)-E\left(L_1\right)\right)\right)} \lesseqgtr 0,$$

and

$$\frac{dx}{db} = \frac{DF'(.)\left(\left(\left(1-t\right)/L_0\right)\left(E\left(L_2\right)-E\left(L_1\right)\right)\right)+\widetilde{J}F'(.)\left(\left(b/\left(\varepsilon-1\right)L_0\right)\left(E\left(L_2\right)-E\left(L_1\right)\right)\right)}{D-\widetilde{H}F'(.)\left(b/\left(\left(\varepsilon-1\right)L_0\right)\left(E\left(L_2\right)-E\left(L_1\right)\right)\right)} < 0.$$

D The risk aversion case

The expressions for Z and T in (30) are given by

$$\begin{aligned} Z &= tx\left(\varepsilon-1\right)E\left(L_1\right)\left(\frac{\varepsilon}{\left(\varepsilon+\gamma-1\right)}\right)^{\frac{1}{1+\gamma}} \\ &+t\left(1-x\right)\left(\varepsilon-1\right)\left(\frac{\varepsilon}{\left(\varepsilon+\gamma-1\right)}\right)^{\frac{1-\varepsilon}{1-\gamma}}E\left(\theta^{\,\varepsilon}\right)b^{-\varepsilon}\frac{\left(E\left(P^{\,\varepsilon}\right)\right)^{\frac{1-\varepsilon}{1-\gamma}}}{\left(E\left(P^{\,\varepsilon-1}\right)\right)^{\frac{1-\varepsilon}{1-\gamma}}}E\left(P^{\,\varepsilon-1}\right) \\ &+\left(1-t\right)x\left(L_0-E\left(L_1\right)\right)+\left(1-t\right)x\varepsilon E\left(L_1\right)+\left(1-t\right)\left(1-x\right)\left(L_0-E\left(L_2\right)\right) \\ &+\varepsilon\left(1-t\right)\left(1-x\right)E\left(L_2\right)>0, \end{aligned}$$

and

$$T = D-\widehat{H}F'(.)\left(\left(\left(1-\gamma\right)\left(\left(1-t\right)^{-\gamma}b^{1-\gamma}\right)/\left(\left(\varepsilon+\gamma-1\right)L_0\right)\right)\left(E\left(L_2\right)-E\left(L_1\right)\right)\right)>0,$$

where

$$\begin{aligned} \widehat{H} &= t\left(\frac{\varepsilon}{\left(\varepsilon+\gamma-1\right)}\right)^{\frac{1-\varepsilon}{1-\gamma}}E\left(\theta^{\,\varepsilon}\right)b^{1-\varepsilon}\left(\left(\frac{E\left(P^{\,\varepsilon}\right)}{E\left(P^{\,\varepsilon+\gamma-1}\right)}\right)^{\frac{1-\varepsilon}{1-\gamma}}E\left(P^{\,\varepsilon-1}\right)-1\right)+ \\ &b\left(1-t\right)\left(E\left(L_2\right)-E\left(L_1\right)\right), \end{aligned}$$

and the expression for D has the same form as in section B. T is positive for the same reason of "dynamic stability" as in the risk-neutral case.

Figure 1: The sequence of events

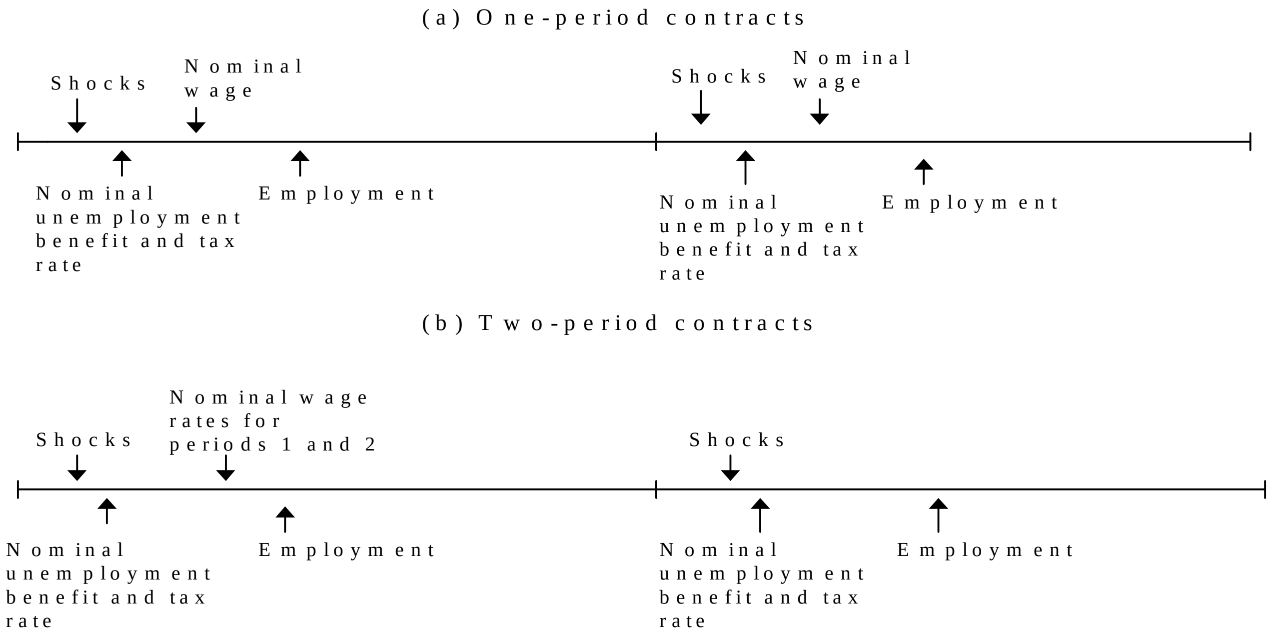

Figure 2: Employment effects of real-wage variability around a given real wage

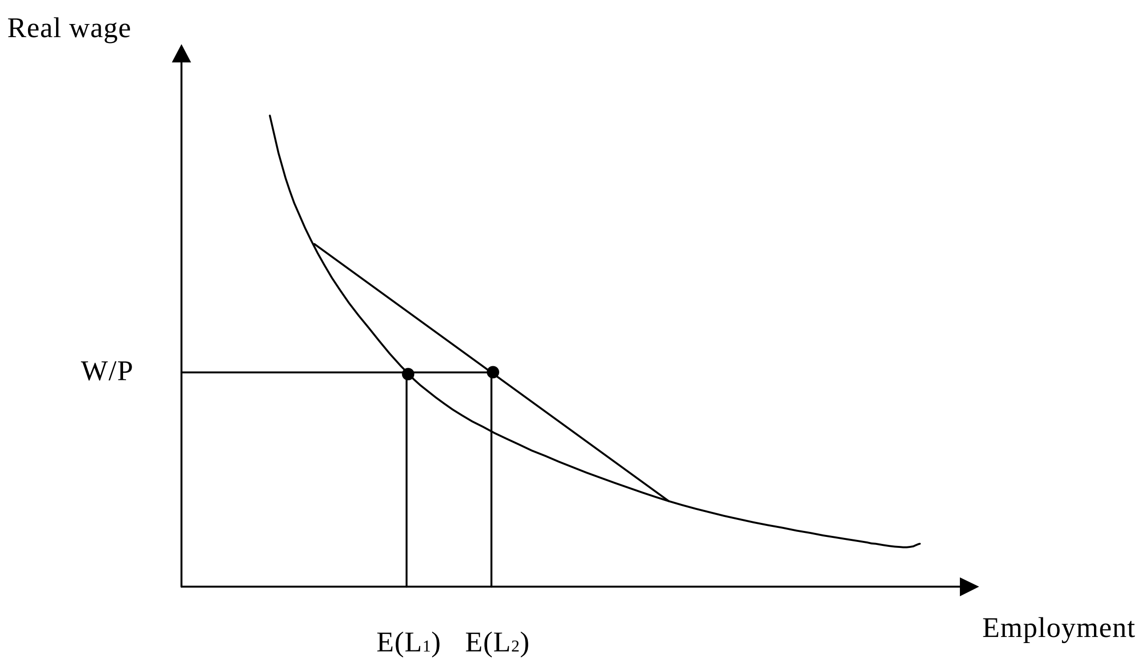

Figure 3: The concavity of the union utility function

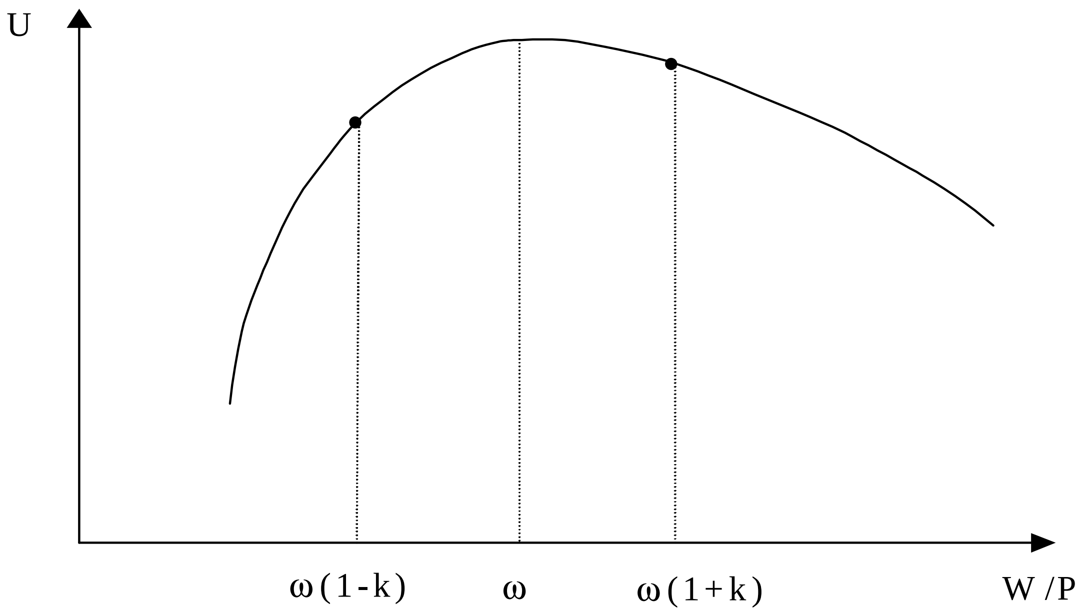

Figure 4: The effect of larger price variability

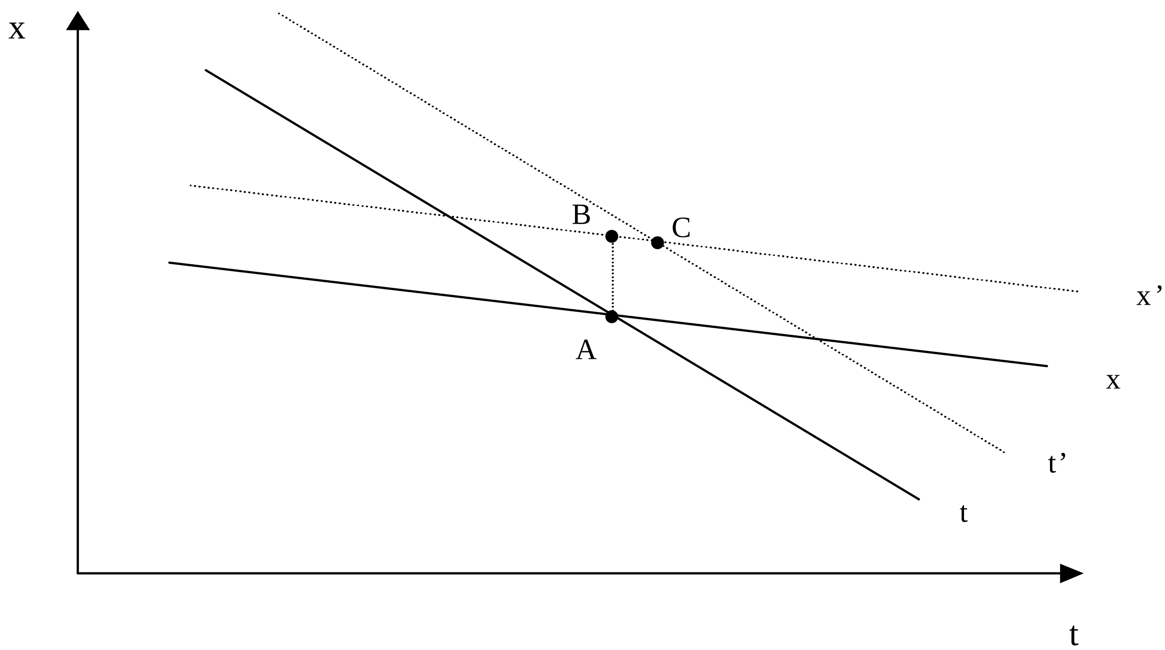

Figure 5: The effect of larger productivity variability

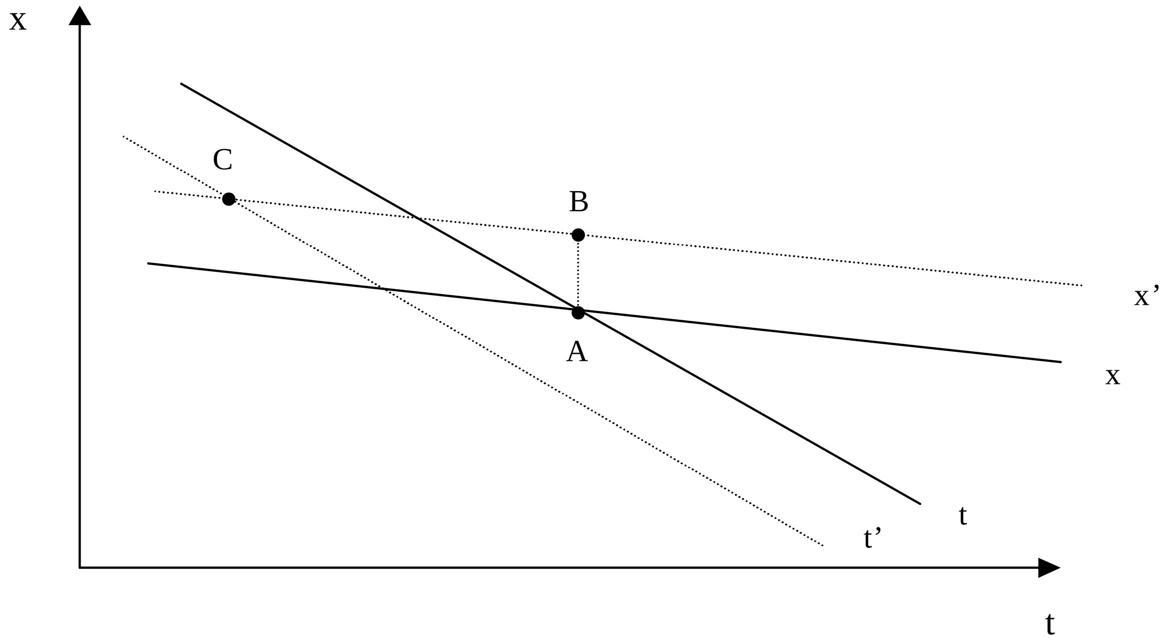

Figure 6: The effect of higher unemployment compensation