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Dynamic Effects of Unemployment Insurance Reform*

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Abstract

We study the transition dynamics and welfare effects of reducing unemployment benefits in a Mortensen-Pissarides matching model with precautionary savings. The dynamic analysis reveals significant transition costs that comparative statics would miss. The main reason is that initially individuals have to increase savings to self-insure. Nevertheless moderate benefit reductions increase average welfare of workers. Gains are much larger when the reform is announced in advance or phased in optimally. Workers can then extract windfalls otherwise accruing to firms with filled jobs which stem from the jump in vacancy costs following an unexpected reform. If instead of the standard periodic vacancy cost we assume hiring to involve a fixed cost, welfare gains also increase because there is no crowding out of efficiency gains through rising hiring costs and hence no windfall. One-off reforms are then optimal.

Keywords: Unemployment risk, precautionary savings, transition dynamics
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1 Introduction

Recently considerable attention has been devoted to the analysis of the influence of unemployment insurance on labor market outcomes and welfare. Several main channels have been identified: Simple matching models like the one used in Pissarides (1990) show that, by increasing workers' outside option in bargaining, unemployment benefits raise wages and thus reduce vacancy creation, job finding rates and ultimately employment. The welfare consequences of this effect are ambiguous unless one imposes parameter restrictions.[1] A clearly negative consequence of unemployment insurance is above all the moral hazard that it induces among both unemployed and employed workers by distorting their search and work effort incentives respectively.[2] Furthermore, to the extent that unemployment insurance lowers employment it will increase welfare losses from distortive taxation because tax rates have to increase to keep revenue constant and the benefit itself has to be financed as well. On the positive side, Marimon & Zilibotti (1999), for example, have pointed to improvements in match quality and hence productivity resulting from the role of unemployment benefits as a subsidy to search. The most obvious benefit of unemployment insurance, however, is its insurance function for risk-averse individuals in an environment of incomplete asset markets. In this role it may not only increase utility but even enhance productive efficiency as Acemoglu & Shimer (1999) show. This is because, absent insurance, risk-aversion would lead to inefficiently high employment. On the other hand, it is well documented that even under incomplete markets individuals can self-insure quite well against temporary income shocks as long as they have access to a safe asset.[3] Thus, given its adverse effects, rather low levels of unemployment insurance are likely to be optimal in steady-state.

Nevertheless, currently most developed countries exhibit fairly high levels of unemployment benefits. - After tax replacement rates around 60% are by no means uncommon. And despite the above theoretical considerations it is not clear *a priori* whether reducing them would be beneficial, for self-insurance crucially depends on having appropriate asset levels. But accumulating assets takes time and has a cost of foregone consumption. Also temporary lack of insurance in the early phase of a reform will impose a welfare cost. Hence, looking at the transition from the initial conditions to the new steady-state is essential before making any statement regarding desirable levels of unemployment insurance.

Such a dynamic analysis of the consequences of reducing unemployment benefits is the main contribution of the present paper. To this end, we embed the standard Mortensen-Pissarides job matching model in an Aiyagari (1994)-type incomplete markets setting. As a by-product, insights are gained on the out-of-steady-state behavior under incomplete markets of this main workhorse of the recent macro-labor literature. In the model individuals are risk-averse and face idiosyncratic income uncertainty due to stochastic transitions between the states of employment and unemployment. In addition to unemployment insurance they have the possibility to self-insure by accumulating an asset that yields a safe exogenously fixed return, but they cannot borrow. Job

[1] E.g. the Hosios (1990)-condition.

[2] Contributions emphasizing search distortions are Shavell & Weiss (1979), Hopenhayn & Nicolini (1997), and more generally the optimal unemployment insurance literature. Moral hazard among employed workers has for example been discussed by Wang & Williamson (1996).

[3] See for example Krusell & Smith (1998) and the references cited therein.

loss occurs exogenously while the reemployment probability is endogenously determined by the vacancy-unemployment ratio and the matching function. Firms' hiring probability is correspondingly endogenous as well. A zero-profit condition determines vacancy creation in the presence of costly vacancy creation. Unions and employers, both without strategic motives, bargain over the wage, which consequently is unique despite the fact that heterogeneous individual assets imply heterogeneous outside options for the agents. For the sake of tractability, labor supply is inelastic and there is no search decision. Nevertheless, there are potentially strong effects of benefits on job finding rates and employment which work through the Nash bargaining and firms' vacancy creation. Appropriate calibration hence yields the right reduced form effects without the extra complications of further decision variables. The solutions for both the steady-state and the transition path are obtained numerically for a calibration to Germany in the mid-1990s. The policy reforms considered are one-off changes in the level of unemployment benefits with and without previous announcement as well as optimal reform paths. We compare the effects for two variants of the model: First we maintain the standard assumption of firms facing a cost for each period that they open a vacancy. Then we alternatively assume that there is a fixed cost of hiring a worker independent of how long it takes to find him.

We find that, even though steady-state comparisons suggest significant welfare gains from reducing unemployment benefits, the dynamic analysis reveals important transition costs. For the standard vacancy cost specification even a one percentage point reduction of the replacement rate (without announcement) harms the unemployed workers. However, average worker welfare improves for moderate reductions. The transition costs are identified to stem on the one hand from the need to increase savings (and hence temporarily reduce consumption) to improve self-insurance and on the other hand from the drop in utility for those who become unemployed before they can adjust their asset holdings to the reduced unemployment income.

The welfare gains for workers can be increased greatly when the reform is announced some time in advance or if it is phased in gradually. The main reason, however, is not a reduction in transition costs that could be achieved this way. Rather announcement or phasing-in allow workers to extract gains from the reform that otherwise accrue to firms. These gains arise due to the upward jump in vacancies following an unexpected reform, which makes recruiting so much more costly that firms with filled jobs earn a large windfall. Bargaining allows workers to extract part of this windfall during an announcement period or during the phasing-in. Vacancies then no longer jump but increase steeply.

The results for our alternative assumption of a fixed hiring cost differ substantially. Despite the costs of transition, even big, unannounced reforms turn out favorably. But advance announcement does not further improve the welfare effects. Since with constant hiring costs there is no windfall to be appropriated by the workers, an announcement period only permits improvements in self-insurance before the reform hits. However, these are quantitatively dominated by the losses from delaying the reform. In fact, an unannounced one-off change in the replacement rate is optimal when there is a fixed hiring cost.

The transition paths of unemployment and wages reflect the general equilibrium nature of the model. In the first periods following an unannounced reform gross wages drop sharply due to insufficient self-insurance, overshooting their new steady-state. This induces so much job creation that unemployment also overshoots with a lag before gradually converging to its new steady-state. Net wages, by contrast, at first drop but then increase above their old steady-state level because the increase in employment reduces the burden from unemployment insurance contributions and other taxes. With announcement dynamics differ in that wages first rise before the reform hits, which reflects the process of rent appropriation described.

The two papers that are most closely related to this work are Joseph & Weitzenblum (2003) and Lentz (2003). To my knowledge they are the only contributions that take account of transition effects in the welfare analysis of unemployment insurance. Both, however, use partial equilibrium models in which the wage is exogenous and does not react to the policy change. Joseph & Weitzenblum (2003) is a numerical analysis calibrated to the low-skilled segment of the French labor market. The authors find that even though steady-state comparisons suggest welfare gains from lowering unemployment insurance transition costs more than outweigh the gains. Lentz (2003) structurally estimates a search model with precautionary savings and variable search intensity. Using Danish data he finds that the search decision is only little distorted by unemployment insurance. Consequently optimal replacement rates turn out rather high, that is between 43% and 82%.

Static analyses of unemployment in general equilibrium search models with incomplete markets have been performed by Costain (1997) and Rebelo, Gomes & Greenwood (2003). In a life-cycle model with matching and search costs Costain (1997) finds mildly positive steady-state effects of unemployment insurance, which become significantly positive for higher coefficients of risk-aversion. Calibrating their model to U.S. replacement rates and higher 'European' levels, Rebelo et al. (2003) find a negative impact of benefits on employment and welfare in a search model with endogenous labor supply.

The paper is structured as follows: Section 2 sets out the model and defines the concept of equilibrium used. The calibration is described in section 3. In section 4 the model's comparative statics for different benefit levels are analyzed. The transition dynamics and their welfare consequences are then investigated in section 5. Section 6 concludes.

2 The Model

In this section I set out the model I am using for my analysis. One of its building blocks is the Mortensen-Pissarides type matching framework with matching function and wage determination through Nash bargaining. The other important feature is market incompleteness in the sense that risk-averse, credit-constrained individuals, who face idiosyncratic income uncertainty due to the risk of job loss, can self-insure only via a safe asset a. There is no aggregate uncertainty since the focus is on unemployment insurance which can clearly cover idiosyncratic risk only. However, the labor market reform considered consists in an unanticipated shock to the level of unemployment benefits. Unemployment benefits are financed through a tax levied on the employed. The firm side is kept as simple as possible with one-worker firms producing a fixed output when they have a worker. Wages and vacancy-unemployment ratio (henceforth sometimes called market tightness) are endogenously determined in general equilibrium. The interest rate r is exogenously fixed at a level below the workers' discount rate β, that is to say the economy can be thought of as small and open. [4]

2.1 The Individual's Problem

The economy is populated by a mass one of risk-averse individuals who are characterized by their asset holdings a_t and by their employment status $s_t \in \{u, e\}$. Their problem consists in optimally choosing consumption c_t and savings a_{t+1} in every period subject to their budget and borrowing constraints and taking into account the Markov transition probabilities $\pi_t(s_{t+1}|s_t)$ between unemployment and employment. The utility function satisfies standard conditions. Labor supply is fixed and there are no search costs. Hence the individual's value is

$$V_t(a_t, s_t) = \max_{c_t, a_{t+1}} \{u(c_t) + \beta(\pi_t(u|s_t)V_{t+1}(a_{t+1}, u) + \pi_t(e|s_t)V_{t+1}(a_{t+1}, e))\} \tag{1}$$

$$\begin{aligned} \text{s.t.} \quad c_t + a_{t+1} &\leq i_t(s_t) + (1+r)a_t \\ a_{t+1} &\geq 0 \end{aligned}$$

where $i_t(s_t)$ is his state-dependent non-asset income. For an employed worker this income equals the wage w_t minus taxes. For unemployed workers it consists in unemployment benefits b_t, which are a fraction $\rho_t \in [0, 1]$ of the net wage. This net replacement rate does not depend on the completed length of an individual unemployment spell but may vary over time during the implementation of a reform. Taxes serve both to finance unemployment benefits and to cover the state's other expenses which are assumed to be a fixed exogenous amount G. Hence they equal $\frac{u_t b_t + G}{1-u_t}$ per employed worker, where u_t is the unemployment rate.[5] This leaves after some manipulations:

$$i_t(s_t) = \begin{cases} \rho_t \frac{(1-u_t)w_t - G}{1-u_t+\rho_t u_t} & s_t = u \\ \frac{(1-u_t)w_t - G}{1-u_t+\rho_t u_t} & s_t = e \end{cases}$$

The value function of the individual is time-indexed because out-of-steady-state wages, taxes, and transition probabilities are not constant. The individual is assumed to know the entire future path of these variables, which are determined in general equilibrium as set out below.

The Markov transition probabilities between unemployment and employment are determined as

$$\begin{bmatrix} \pi_t(u|u) & \pi_t(e|u) \\ \pi_t(u|e) & \pi_t(e|e) \end{bmatrix} = \begin{bmatrix} 1 - \theta_t q(\theta_t) & \theta_t q(\theta_t) \\ \lambda & 1 - \lambda \end{bmatrix} \tag{2}$$

[4]The reason for not endogenizing the interest rate is that workers in reality only own a small fraction of the entire productive capital. With an endogenous interest rate this would either imply a very unrealistic capital-labor ratio or unrealistically high accumulation among workers, which would render an analysis of unemployment insurance useless.

[5]This general purpose tax is introduced for calibration purposes only in order to achieve a realistic range for the wedge between gross and net wages. It can be thought of as the sum of a payroll tax and social security contributions aside from unemployment insurance. The individual's tax burden varies inversely with employment such as to capture the general equilibrium effect of employment on taxes.

Here λ is the exogenous rate of job destruction while $\theta_t q(\theta_t)$ is the job finding rate for unemployed workers. θ_t, the ratio of vacancies to unemployed, is the argument of the matching function $q(\cdot)$ (expressed as matches per vacancy), which is decreasing with an elasticity of less than one in absolute value. θ_t is exogenous to the worker and is determined in general equilibrium.

Note that, in the description of the individual's problem we have taken for granted that jobs are always accepted. This is in fact a safe thing to do because, with unemployment income being no greater than income from working ($\rho_t \leq 1$), individuals will accept any job they find provided $1 - \lambda \geq \theta_t q(\theta_t)$, i.e if their chances of having an employment opportunity next period are at least as big if they accept the offer as if they reject it. This will always hold if one chooses the time period short enough.

2.2 Firms

Firms can be in one of two states: They can have a worker and produce, or they can have a vacancy. Like the workers they know the future path of wages and matching probabilities. A filled job has value

$$J_t = p - w_t + \frac{1}{1+r}\left[\lambda O_{t+1} + (1-\lambda)J_{t+1}\right] \tag{3}$$

where p is the output of a firm that has a filled job. Since with probability λ the match is destroyed, the firm's value next period changes to O_{t+1}, the value of a vacancy, with probability λ. A firm that opens a vacancy has value

$$O_t = -\kappa + \frac{1}{1+r}\left[q(\theta_t)J_{t+1} + (1-q(\theta_t))O_{t+1}\right] \tag{4}$$

with κ being the cost of opening a vacancy for one period.[6] Free entry implies that $O_t = 0$. Thus profits on average just cover hiring costs. This implies that *ex ante*, i.e. in the absence of unexpected parameter changes, the value of a filled job is given by

$$J_{t+1} = \frac{1+r}{q(\theta_t)}\kappa. \tag{5}$$

Combining equations (5) and (3) we can relate wages and market tightness according to

$$w_t = p + \frac{1-\lambda}{q(\theta_t)}\kappa - \frac{1+r}{q(\theta_{t-1})}\kappa \tag{6}$$

which again only holds absent policy shocks. In case policy shocks lead *ex post* to profits or losses, these are attributed to the rest of the world, which is assumed to be the residual claimant.

2.3 Determination of Wages and Matching Probabilities

Nash bargaining between employers' associations/firms and unions determines the wage in a given period conditional on current and future market tightness and taxes and future wages. That is

[6] The alternative specification of the hiring cost referred to in the introduction will be introduced in section 5.2.

to say, agents on both sides do not behave strategically such as to influence aggregate or future variables.[7] The union's objective is the value of the median employed worker, that is of the worker whose assets correspond to the median of the asset distribution for employed workers. This form of wage determination achieves that there is a unique wage for all employees despite their heterogeneous outside options (due to heterogeneous wealth).[8]

Precisely, denoting by a_t^m the asset level of the median worker in period t, bargaining between firms and unions solves

$$\max_{w_t} \left(V_t(a_t^m, e) - V_t(a_t^m, u)\right)^{\sigma} J_t^{(1-\sigma)} \tag{7}$$

The solution to this problem is

$$V_t(a_t^m, e) - V_t(a_t^m, u) = \frac{\sigma}{1-\sigma} V'_t(a_t^m, e) J_t.^{9} \tag{8}$$

The determination of the wage also pins down the number of vacancies created and hence market tightness and matching probabilities, even though with a lead of one period of vacancies. The mechanism is through free entry: Given future wages and matching probabilities the value of a firm one period ahead, J_{t+1}, is known. Entry and vacancy creation has to occur so long as to drive this period's value of a job opening to zero. This link from wage setting to matching probability (and consequently job finding rate, average duration of unemployment, unemployment rate, etc.) is crucial to keep in mind for the analysis of unemployment insurance below. For the level of unemployment benefits directly influences the bargaining strength of workers and thus wages and by the mechanism just explained employment dynamics. Thus, even though we do not model labor supply and search costs, which are usually held to provide the channels for effects of unemployment insurance on employment dynamics, the observed correlation between benefit levels and labor market variables can be generated.

2.4 Competitive Equilibrium

To close the model the behavior of the aggregate state variables, that is unemployment and the asset distribution, has to be determined. The law of motion for the unemployment rate is

$$u_{t+1} = \lambda(1-u_t) + (1 - \theta_t q(\theta_t))u_t. \tag{9}$$

To describe the evolution of the asset distributions for unemployed and employed workers it is necessary to first introduce some more notation. As explained in section 2.1, the individual's asset

[7] Clearly, this assumption is strong in the context of centralized bargaining. But it simplifies the solution of the model greatly. Individual bargaining would make it unnecessary, however at the cost of wage differentials that are due not to productivity differences or job characteristics but asset holdings.

[8] This wage is nevertheless acceptable to all workers regardless of their asset position since jobs are never turned down in this setting (Cf. section 2.1.

[9] The presence of the $V'_t(a_t^m, e)$-term on the right hand side is caused by the fact that workers have strictly concave utility unlike in most matching models. The derivative of the value function with respect to wages is therefore generally not equal one. Intuitively, an extra unit of wages translates into one unit loss of surplus for the firm but into $V'_t(a_t^m, e)$ units gain in surplus for the worker.

choice depends on his individual states plus the paths of wages, taxes, and tightness. Write it hence as $a_{t+1} = F(a_t, s_t; \Theta^t, \omega^t, u_t)$ where Θ^t and ω^t are the paths of tightness and wages, i.e. $\Theta^t = \{\theta_t, \theta_{t+1}, ...\}$ and $\omega^t = \{w_t, w_{t+1}, ...\}$. Today's unemployment u_t features as an argument in the policy function because the path for taxes is determined by the path for tightness and equation (9) together with u_t as an initial condition. The law of motion for the distribution functions of unemployed and employed workers' assets, $G_t^u(\tilde{a})$ and $G_t^e(\tilde{a})$, can now be described as

$$\begin{bmatrix} G_{t+1}^u(a_{t+1}) \\ G_{t+1}^e(a_{t+1}) \end{bmatrix} = \begin{bmatrix} 1-\theta_t q(\theta_t) & \lambda \\ \theta_t q(\theta_t) & 1-\lambda \end{bmatrix} \begin{bmatrix} G_t^u(\bar{a}_t^u(a_{t+1})) \\ G_t^e(\bar{a}_t^e(a_{t+1})) \end{bmatrix} \tag{10}$$

where $\bar{a}_t^{s_t}(a_{t+1}) = \max\{a_t | F(a_t, s_t; \Omega^t, \omega^t, u_t) = a_{t+1}\}$.[10] Note that this law of motion is based on the agents' optimizing choices.

For convenience summarize the aggregate states as $\Gamma_t = (G_t^u(\tilde{a}), G_t^e(\tilde{a}), u_t)$ and denote their joint law of motion as $\Gamma_{t+1} = H_t(\Gamma_t)$. We are now set to define a (potentially non-steady-state) equilibrium for this economy:

Definition 2.1 *A competitive equilibrium for the economy considered is a wage path ω, a tightness path Θ, a policy function F, and a law of motion H such that*
(i) F solves the individual's problem,
(ii) ω solves the Nash bargaining,
(iii) H is generated by F and Θ, and
(iv) vacancies have zero value.

In particular, a steady-state equilibrium is defined as follows:

Definition 2.2 *A competitive steady-state equilibrium for the economy considered is a competitive equilibrium in which θ and w are time-invariant and Γ is a fixed point of H.*

3 Calibration

The solution of the model is entirely numerical. In a first step the steady-state is solved for. Out of steady-state a time path between two steady-states with different levels of unemployment benefits is determined. The algorithms used to find the steady-state and the transition path are contained in appendix B.

I make standard functional choices: Utility is taken to be of the CRRA type with coefficient of relative risk-aversion γ set to 2. This is within the acceptable range according to Mehra & Prescott (1985). The matching function is Cobb-Douglas. Dividing it by vacancies and calling $\theta = \frac{v}{u}$, the ratio of vacancies to unemployment, we have $q(\theta) = \frac{m(u,v)}{v} = \chi \cdot \theta^{\eta}$. η is the elasticity of the matching function with respect to vacancies while χ is a scaling parameter. η is chosen to be -0.5 which is in the middle of the commonly used range of -0.4 to -0.6.[11] The weight of the worker

[10] This formulation relies on continuity and monotonicity of the policy function F in a_t, which is warranted by standard nature of the household problem in this respect.

[11] See Petrongolo & Pissarides (2001).

in bargaining is 0.5. This is the value that has traditionally been assumed in Nash bargaining.[12] Also we thus have $\sigma = |\eta|$ as in most of the literature. The Hosios (1990)-condition regarding absence of search externalities is nevertheless not readily applicable due to the concavity of the workers' utility function which breaks the link between σ and the share of the match surplus going to the workers. Output per match, p, is normalized to one. The time period is set to one month.

All remaining parameters are matched to observations on Germany for the mid-1990s. The parameters governing labor market flows can be inferred from data on unemployment, vacancies, and unemployment duration using the law of motion for unemployment. An unemployment rate of 8.2% (OECD standardized unemployment rate), vacancy-unemployment ratio of 0.10 (calculated from the vacancy data of Nickell & Nunziata (2001)), and average unemployment duration of 12.4 months (Machin & Manning (1999)) then imply a job destruction rate $\lambda = 0.72\%$ and matching efficiency $\chi = 0.254$.

The net replacement rate, that is the ratio of unemployment benefits to net wages ρ, is set to 60%. Obviously, as in most economies in Germany there exists in fact a multitude of replacement rates depending on previous wage, personal circumstances, employment history, and completed length of the unemployment spell. To summarize them into this one rate I construct a weighted average from OECD data (Martin (1996)) reporting net replacement rates for three different classes of workers and three unemployment durations. The weights are obtained from data in the Report on Poverty and Wealth of the Federal Government of Germany (Bundesregierung (2001)).[13] It may be worth noting that a constant replacement ratio independent of the length of the unemployment spell is in fact not a bad approximation for many workers in Germany.

Finding one single rate of taxation is fraught with the same problems as finding a summary replacement rate. The rate According to the Federal Employment Agency (Bundesanstalt für Arbeit), total social security contributions (i.e employer and worker share together) amount to about 33% of labor costs, while wage taxes net of family benefits etc. amount to 7% for an average employee (German Institute for Economic Research (DIW), Bedau & Teichmann (1995)).[14] We thus set taxes including unemployment insurance contributions (i.e. $\frac{u_t b_t + G}{1-u_t}$) to 40% of gross wages. The magnitude of this tax wedge has direct consequences for the elasticity of the unemployment rate with respect to unemployment benefits because it determines the strength of the general equilibrium effect of benefits on unemployment: As unemployment increases with the level of benefits, the tax burden on each worker increases not only due to rising contributions to unemployment insurance but also due to the fact that G has to be financed by fewer employees. This tends to raise gross wages further and reduce employment even more. Hence, the resulting elasticity of unemployment with respect to the benefit level is a measure of success for the calibration of

[12] e.g. in Pissarides (1990).

[13] Martin (1996) also reports an 'overall average' of 54%. However, this measure is the *unweighted* average of the nine categories, in which for example long-term unemployed with spouse in work, who do not receive any benefits, are given far too much weight.

[14] More precisely: On so called 'gross wages' employers and employees each pay about 20% of social security contributions, and the average employee pays 8% in wage tax net of family benefits, subsistence allowance, etc. So in total we have a burden of 48/120 or 40% of labor costs.

γ	2
β	0.9955 ($\widehat{=}$ 0.9479 p.a.)
r	0.0017 ($\widehat{=}$0.02 p.a.)
y	1
κ	2.6534
λ	0.0072
χ	0.254
η	-0.5
σ	0.5

Table 1: Parameters

the tax burden. We compute this elasticity to be 0.75. This is reasonably close to the estimates of approximately one reviewed in Costain & Reiter (2003) given the absence of an endogenous search decision in our model. By assuming a higher tax burden the elasticity of unemployment to benefits could be further raised. But we choose to stick to the data in order to avoid the danger of overstating the welfare gains from reducing unemployment benefits because a fall in unemployment due to increased costly search is less welfare enhancing than one that is due to lower taxation.

The remaining parameters, the vacancy creation cost κ and the discount factor β, are calibrated such that the aggregate state variables, unemployment and asset distribution, match the data. Given that income variation in the model results from the risk of unemployment only it is clearly unrealistic to aim for a realistic asset distribution in all dimensions. Since the model is about dependent workers I focus on this segment of the population and in particular on the share of people with little or no assets. This seems reasonable since it is these people who are most affected by the level of unemployment benefits. Also by assets I understand liquid assets, i.e. those that can readily be used to smooth consumption in case of job loss. Of these 6.5% of German worker and unemployed households did not have any in 1998 (Bedau (1999), Münnich (2001)). Since it is likely that even these households have some money on a current account, I calibrate the difference between discount rate and interest rate such as to achieve a share of 6.5% with less than half a monthly net wage in savings. This requires an annual discount rate of 5.5% while the real interest rate is set at 2% per year. This value of the interest rate is chosen despite the fact that the real return on (rather safe) public debt has tended to be higher. The reason is that people with little financial wealth tend to hold it in assets with extremely low yields such as savings accounts.

4 Steady-State Analysis

Before turning to the numerical results let us briefly recall the main economic forces at work in Mortensen-Pissarides type models. First of all, unemployment benefits have a positive effect on the (gross) wage because they improve the workers' position in the Nash bargaining. Secondly, higher wages go along with lower market tightness, which in steady-state translates into higher unemployment. Formally this relationship can be seen from equation (6) evaluated in steady-state. The economic logic is that at higher wages the flow income of firms is lower and hence, for given

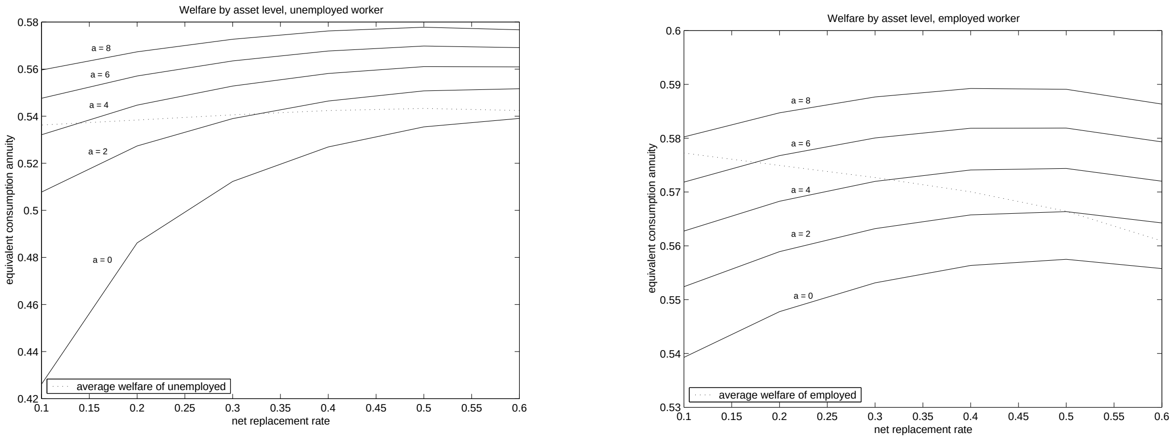

Figure 1: Steady-state welfare by asset level and employment status across replacement rates

interest and job destruction rates, recruitment costs must be lower in order for them to break even in present value terms. But recruitment costs are lower only if market tightness is lower because vacancies are then matched to workers more rapidly. Thus, in choosing their preferred replacement rate workers face a trade-off between higher wage income when employed and the fraction of time they spend unemployed on average. In the presence of discounting, unemployed workers will tend to prefer a higher replacement rate than employed workers, whose potential unemployment spells are more distant. Risk-aversion introduces the aspect of consumption-smoothing and therefore implies higher optimal replacement rates for all workers.

Note that this analysis is not at odds with the constrained efficiency result of Hosios (1990).[15] First of all, the Hosios-result is applicable with risk neutral agents only. Secondly, in the above as well as in the analysis in the next sections we are concerned with the wellbeing of workers in their two employment states only and not with the value of the entire economy. The difference is the value of firms, which reacts to changes in the return to past investment in vacancies. The reason for this choice of welfare criterion is that not only in the model but arguably also in reality workers' preferences over different degrees of unemployment insurance do not depend on these firm value effects since they tend not to be the owners. Hence, with regard to the political economy aspects of unemployment insurance reform, it makes sense to focus on the value of workers under different policies only.

Let us now turn to the numerical results for the model with precautionary savings. Figure 1 summarizes the comparative static welfare analysis. The solid lines depict utility as a function of the replacement rate for different asset levels. In line with intuition both unemployed and employed workers have strictly positive optimal replacement rates for each asset level, welfare depends positively on asset holdings, and richer individuals prefer lower replacement rates because they are

[15] The Hosios-condition says that whenever the matching elasticity is equal to the workers' share in bargaining the decentralized equilibrium (without tax financed benefits) is the same as the social planner's solution, which suggests that any distortion caused by unemployment benefits would be detrimental to welfare.

better self-insured. The dashed lines correspond to the average utility across the steady-state asset distribution for the respective worker group. Utility is measured in units of equivalent certain consumption per period. Even for the unemployed the optimal level of unemployment insurance is lower than the current one of 60% of net wages. For the employed workers it would be best to be in a steady-state with no unemployment insurance whatsoever. Since they are the great majority the same is true for total utility aggregating over all workers. This result is perhaps surprising given the above reasoning. The reason is that, as benefits are withdrawn, the steady-state asset distributions shift towards higher asset levels so strongly that, given the positive relationship between assets and welfare, individuals are better off on average when benefits are lower. That is to say, the general equilibrium effect through the asset distribution dominates all more direct effects via the bargaining or risk-aversion. This result fits in well with the literature on self-insurance, which generally documents that a single safe asset provides a lot of insulation against temporary shocks (see for example Krusell & Smith (1998) and the references cited therein).

Our findings are robust to varying the calibration with regard to vacancy rate, risk aversion, interest rate, and discount rate. Changes in the assumed vacancy rate, which is likely to be measured rather imprecisely, are fully offset by changes in the resulting calibrated value of vacancy costs. Higher or lower risk aversion do not change the steady-state results significantly either. Higher risk-aversion primarily translates into higher savings. Interest rate and discount rate interact to largely determine both the steady-state distribution of asset holdings and its responsiveness to unemployment benefits. The former is what we calibrated to. The latter has turned out rather high.[16] It could be reduced by increasing the wedge between time discount and interest rate. In the *status quo* savings would then be even lower than under the benchmark calibration (which features low savings anyway since we calibrate to the share of people with no savings) while the comparative statics would not change much. For example for a rather extreme calibration with an annual interest rate of 1%, time discount rate of 8% annually, and risk aversion set to three[17] the qualitative picture sketched above still upholds but welfare gains are smaller.

For the calibration shown here the welfare effect of the shifting asset distribution is reenforced by the fact that net wages actually increase as benefits decrease. This is due to the high government spending G whose burden per worker sinks with increasing employment at lower benefit levels. However, lower tax burdens would not change the general picture. Higher G on the other hand would even strengthen the results.[18]

[16]For a reduction of the net replacement rate from 60% to 50%, for example, the ratio of average wealth to monthly income increases from about 1.9 to about 3.3. This is not surprising given the wedge between time discount and interest rate of only about 3% per year. Carroll & Samwick (1997) document the same phenomenon and find they have to increase the annual discount rate to 13% (for an interest rate of 2%) in order to match the empirical responsiveness of asset holdings to income uncertainty.

[17]This choice of parameters yields again roughly a 6.5% fraction of the population with assets less than half a monthly wage. Similar results are obtained if instead of higher risk-aversion a Stone-Geary utility function with a minimum consumption of about one sixth of the wage is used.

[18]This should be the relevant direction to look at given the absence of endogenous search effort. Compare the argument made in section 3

5 Dynamic Analysis

The results presented thus far are mere steady-state comparisons and could impossibly be used to judge the desirability of policy reforms. It was stressed that they hinge to a large extent on the response of the steady state asset distribution to the change in benefit level. However, the asset distribution can adjust only slowly. In the short run individuals are stuck with the assets they have at the point of regime change, which means low consumption during unemployment and initially also reduced consumption during spells of employment in order to build up higher savings. This section will therefore discuss the properties of the transition between steady-states. As a benchmark we will first study simple unannounced one-off changes in the replacement rate. Then we will allow for previous announcement of the reform and show that the results depend to some extent on the specification of recruitment cost in the Mortensen-Pissarides world. Both under the standard assumptions and under the alternative assumption that there is a fixed cost of hiring a worker we will finally discuss the optimal path of reform.

5.1 The Benchmark - Transition Dynamics and Welfare Effects

Figure 2 graphs the paths of market tightness, unemployment, median assets, and net wages following an unannounced reduction of the replacement rate from 60% to 50% of net wages. As can be seen from the behavior of the jump variables tightness and wage, the bargaining position of the workers first worsens strongly. The state of unemployment becomes so unattractive that low gross wages are negotiated. Free entry of firms correspondingly drives up vacancies. The reduction in the gross wage is so large that net wages at first fall as well despite the reduction in the tax burden that is caused by the reduction in unemployment benefits. As workers accumulate assets and thus improve the degree of self-insurance, their outside option unemployment gains in relative value again. The negotiated wage hence increases as is mirrored by the gradual fall in the vacancy-unemployment ratio. Net wages soon rise above their old steady-state level even though gross wages always stay lower because the increase in employment lowers both unemployment insurance contributions and other taxes. The path of unemployment is a consequence of the path of the vacancy-unemployment ratio. It initially increases so strongly after the policy shock that after 19 months unemployment has already fallen below its new steady-state level. After 39 months it reaches its minimum.

This general pattern of the transition paths after a reduction in unemployment benefits is the same as the one described irrespective of calibration and size of reform. The only sensitive aspect is whether net wages converge to a new steady-state that is higher or lower than the old one. This depends on the level of government spending G in the economy. The higher it is, the stronger the positive general equilibrium effect of higher employment on net wages via lower per capita taxes. But for realistic ranges of taxation the net wage always increases.[19]

[19] The general equilibrium effect from G on net wages hinges on the assumption that government expenditure is constant. The alternative assumption would be constant revenue per employee. Even though the net wage would then tend to be lower at lower replacement rates the welfare evaluation would not change much. For the extra

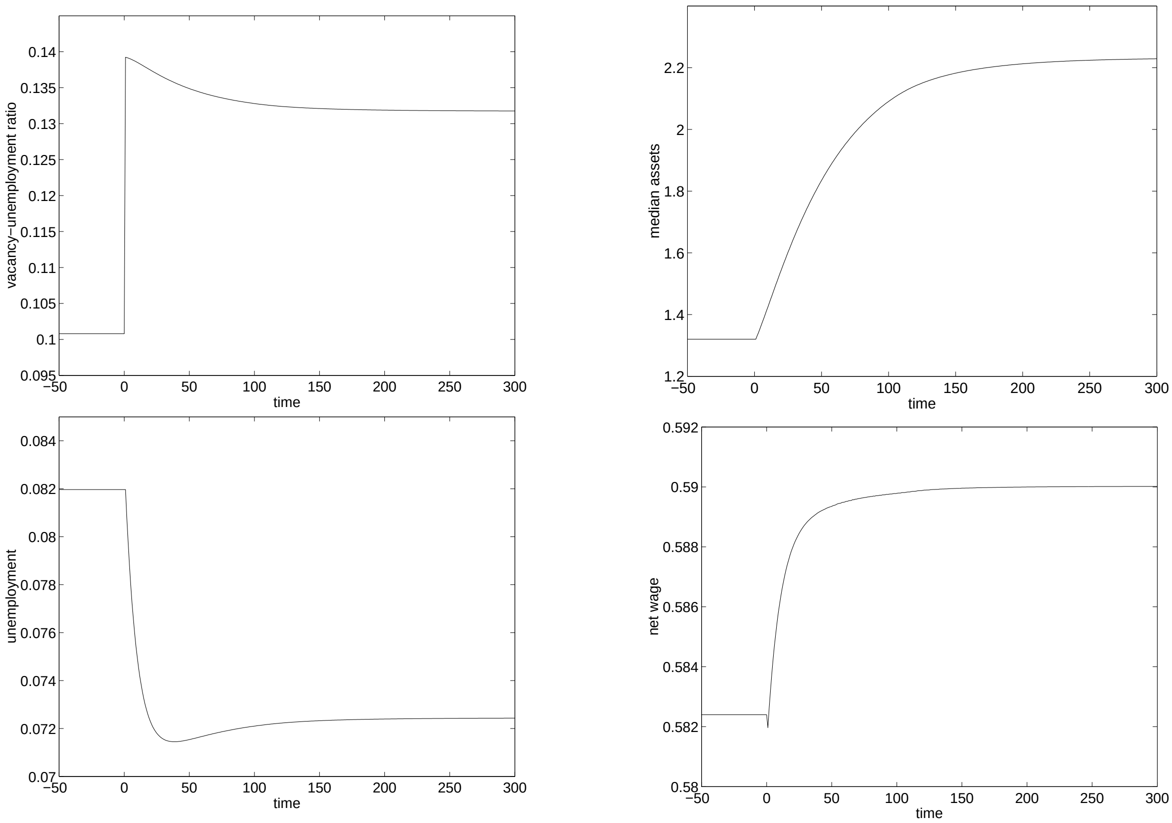

Figure 2: The transition paths of vacancy-unemployment ratio, median asset holdings, unemployment and net wages

new rate	status	static	dynamic	transition cost
59%	unemployed	0.04%	-0.01%	0.05%
	employed	0.12%	0.06%	0.06%
50%	unemployed	0.16%	-0.48%	0.64%
	employed	0.98%	0.29%	0.69%
40%	unemployed	-0.01%	-1.73%	1.72%
	employed	1.63%	0.03%	1.60%
30%	unemployed	-0.34%	-3.88%	4.21%
	employed	2.10%	-0.59%	2.69%

Table 2: Welfare effects of lowering the replacement rate (old level: 60%) without announcement

Welfare effects, on the other hand, depend strongly on the particular reform experiment. Table 2 summarizes the welfare effects of lowering the replacement rate from 60% to various lower levels. The column titled 'static' reports the comparative-static effects discussed in section 4 while the column titled 'dynamic' gives the true, dynamic effects that take the transition period into account. Clearly, the transition period matters for welfare, and that more so the bigger the reform: Not even a reduction of one percentage-point is Pareto-improving. The 10%-decrease that looked beneficial even for the unemployed in the static perspective turns out to reduce the unemployed's welfare in the dynamic perspective. And the reduction of the replacement rate to 30% that statically seems to give to the employed the highest gain of all three reforms considered in fact reduces their welfare by more than half a percent. The dynamic perspective also permits to discriminate winners and losers of the various reforms by asset levels. It turns out that employment status is a far more important predictor than asset level. Only when the overall welfare effect for a group (employed/unemployed) is small, asset holdings separate winners and losers. This is the case for the employed when the replacement rate is reduced to 40%. Then the 17.5% poorest employees, i.e. those with savings of less than about one and a half net wages, lose while the wealthier employees gain. An explanation for this pattern of gains and losses is the persistence of income shocks. Given constant hazard rates, every unemployed worker will remain unemployed for another year on expectation while an employed worker can expect to hold on to his job for another $11\frac{1}{2}$ years. Thus, leaving aside general equilibrium effects via job finding rates, the costs of unemployment insurance are borne largely by today's employed while the benefits accrue primarily to today's unemployed.

As a measure of the transition cost we take the difference between the static and dynamic effects. This transition cost has two sources. One is the foregone consumption during the transition to the new steady-state asset distribution with more self-insurance. This cost is relevant during spells of employment, which is when individuals save. The other source is the utility loss incurred by those who experience unemployment during the early periods after the reform when their asset holdings are still inadequately low. Transition costs from both sources are higher per percentage point benefit reduction the lower benefits are. This is reflected in the more than linear increase of transition costs in the size of the reform (cf. the last column of table 2). Costs arising from accumulation

revenue from higher employment would then have to be added at the point of calculating welfare. However, given that there is no compelling reason why exogenous government spending should be higher at low unemployment levels, we find our way of handling the issue more reasonable.

new rate	agent type	static	dynamic, announcement		
			none	1 yr	2 yrs
40%	unemployed	-0.01%	-1.73%	0.35%	0.71%
	employed	1.63%	0.03%	0.63%	0.75%
	firms	14.32%	35.74%	8.54%	0.78%

Table 3: Welfare effects of reducing the replacement rate from 60% to 40% depending on the length of the announcement period

increase because average asset holdings increase more than linearly as benefits decrease. And due to the concavity of the utility function the drop in flow utility of those becoming unemployed early on after the reform is more than proportional to the reduction of benefits for a given asset level.

Unsurprisingly in the light of the above, the size of transition costs is sensitive to the calibration of the utility function and the interest rate. Higher risk-aversion and time preference rates and lower interest rates yield significantly less positive dynamic welfare effects of lowering unemployment benefits even though the steady-state results are only moderately less positive. For the alternative calibration mentioned in section 4 with a relative risk aversion of 3, time discount rate of 8% annually and interest rate of 1% annually, for example, a reduction of the net replacement rate to 50% has severely negative consequences for all workers.[20]

5.2 The Effects of Announcement and the Nature of Turnover Costs

An obvious (and realistic) way to reduce the welfare cost of the transition is to announce the reduction of the replacement rate some time before it takes effect. This gives people time to partially adjust their asset holdings and be better self-insured once the reform hits. Also, since wage setting will be such as to give rise to job creation less people will be unemployed at the time of benefit reduction. But, on the other hand, announcement also means delaying the gains from the reform. We calculated the transition for several reforms with previous announcement of 12 or 24 months. It turns out that the cost of transition can be greatly reduced or even over-compensated such that a reduction of benefits to a replacement rate of 30% still improves average welfare of workers and only slightly harms the unemployed. In the following we will argue, however, that these strong announcement effects do not stem from improved self-insurance but rather from the redistribution of gains from firms to workers and that they are peculiar to the specification of recruitment costs used.

Table 3 gives exemplary results for a 20 percentage point reduction in the replacement ratio with various announcement periods for the baseline calibration.[21] In addition to the welfare effects for the unemployed and the employed it reports the effect of the reform on the value of a filled job.

[20] Our results are clearly at odds with the ones presented in Joseph & Weitzenblum (2003). The discrepancies arise from the calibration rather than from the model used. The principal differences are that Joseph and Weitzenblum do not calibrate the tax burden and that their elasticity of unemployment with respect to the replacement ratio is very low (despite the endogenous search choice!). Moreover, at the same replacement rate that I am using unemployment is twice as high initially, which means the consequences of a reform for the unemployed have a much higher weight in welfare evaluations.

[21] For the alternative calibration mentioned above welfare effects are positive only with 24 months announcement.

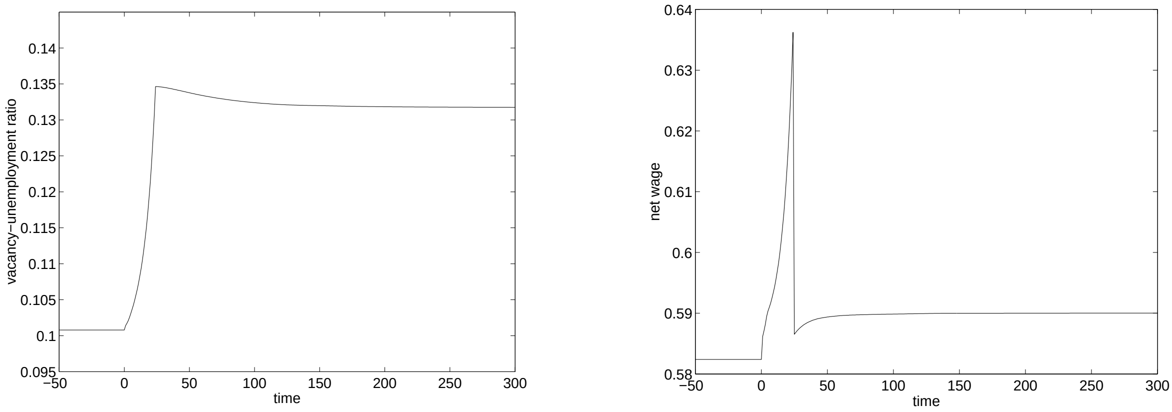

Figure 3: The transition paths of vacancy-unemployment ratio and net wages with announcement

Clearly, this value decreases in the length of the announcement period while the welfare gains of both worker types increase. In fact, the two opposite effects are intimately linked. For the self-insurance effect of announcing the reform in advance is only part of the reason for the welfare gains of individuals. The other part is due to the Nash bargaining through which announcement allows workers to extract (parts of) the windfall gains firms make in case of an unannounced reform. To see this, recall the expressions for the value of a filled job in equations (3) and (5). When an unannounced reform is introduced, the gross wage drops and vacancy creation shoots up (cf. figure 2). This implies that the value of a filled job jumps up as well. The intuition is that, given the new, high value of market tightness, recruiting a worker is very costly and hence the value of having one is higher than before.

With announcement, we still have that after the reduction in benefits the outside option of workers worsens and hence the value of a filled job increases. But now backward recursion implies that this effect feeds through into the value of a filled job, J, in all periods back to the point of announcement. Through Nash bargaining the workers appropriate part of this gain in J in the form of higher wages. The zero-profit condition at the same time implies that vacancies increase as we get closer to the enactment of the reform. These effects can be seen in figure 3. The longer the reform is announced, the less market tightness jumps and the lower the firms' windfall. Hence, the effect of announcement is not only to give the workers time to self-insure but moreover to transfer resources to them from the firms, which in turn improves their capacity to build up assets. Nevertheless, with view to the high future value of jobs vacancy creation sets in immediately, which further improves the lot of the workers.

The above dynamics logically arise from wage determination through Nash bargaining in combination with rents depending on the ratio of vacancies to unemployment. If the value of the firm were independent of market tightness we would not observe the arguably unrealistic spike in the wage. It may therefore be worth considering the opposite polar case of a fixed cost per job. This case obtains in a world in which, instead of periodic vacancy costs, an initial training is required for each worker. Denoting the fixed cost per job by K, equation (4) then turns into

$$O_t = \frac{1}{1+r}\big[q(\theta_t)(J_{t+1} - K) + (1 - q(\theta_t))O_{t+1}\big], \tag{11}$$

which by free entry clearly implies

$$J = K. \tag{12}$$

The gross wage is obviously constant at $w = p - (r + \lambda)K$. Vacancies and hence unemployment respond much more strongly to unemployment benefit changes because the dampening effect of vacancy costs is missing. In fact, for the same calibration used all along the elasticity of unemployment with respect to the replacement rate is about 1.5 (compared to 0.75 in the benchmark case). The welfare effects of lowering benefits are therefore much more positive than under the specification used above. For an unannounced one-off reduction of the replacement rate to 40% welfare gains are 4.3% for the unemployed and 4.9% for the employed.[22] But in this setting not much is to be gained from announcing the reform in advance. Relative to a reform with no announcement, announcement two years ahead makes everybody worse off, and announcement one year ahead only benefits the unemployed. The big welfare effect from extracting the firms' windfalls being absent, it seems that the cost of delaying the gains from the reform dominates the gain in self-insurance.

5.3 The Optimal Path of Reform

The purpose of this section is to investigate whether more sophisticated, gradual reforms can increase the welfare gains by mitigating the trade-off between, on the one hand, delaying the efficiency gains and, on the other hand, improving self-insurance (and extracting firms' rents in the vacancy cost specification). Clearly, it is numerically infeasible to optimize over the entire path of the transition. Instead, we constrain the problem to searching over several classes of continuous functions of time with two degrees of freedom (after fixing beginning and endpoint). Further we impose that the new final replacement rate be reached after 240 periods (20 years) at the latest. The functional classes are monotonously decreasing polynomials of degree three, hyperbolae and linear transformations of decreasing segments of the density function of the normal distribution.[23] These functions allow to check globally concave and convex paths as well as paths with inflection points and announcement.

We search for the optimal path of reform for both specifications of turnover costs, the standard one with a periodic vacancy posting cost and the alternative of a fixed recruitment cost introduced in the last section. The results reflect the dichotomy that was already found for the effects of

[22] The reason they are so similar for unemployed and employed workers is that with the value of a filled job fixed Nash-bargaining holds the difference in values of the unemployed and the employed fixed for the median asset level, such that the divergence only stems from the different asset distributions for the two types.

[23] Precisely, for $0 \leq t \leq 240$ we use

$$\rho_t = \begin{cases} \rho_{old} & t \leq x \\ \alpha + \beta f(t - x|max(x,0),\sigma) & t > x \end{cases}$$

where f is the Gaussian density function. $x > 0$ corresponds to a reform announced x periods in advance. $x < 0$ means the time path of the replacement rate is described by a part of the right half of the Gaussian density function.

announcing one-off benefit reductions in advance: When hiring a worker involves a fixed recruitment cost and the goal is to maximize average worker welfare, the reform should be implemented immediately and at once. For all three functional classes tried the path converged (as far as possible) towards the announced one-off reduction and never yielded a higher welfare. If the goal is to find the path that is optimal for the unemployed, small improvements can be achieved by announcing the policy four months ahead and then reducing benefits gradually over almost two years.

For the standard specification with market-dependent vacancy costs, by contrast, some announcement and/or gradualism in the implementation is desirable. Both forms of delaying the full reform allow workers to appropriate the gains that in the case of the unannounced one-off change in benefits accrued as windfalls to firms. For a reduction of the replacement rate from 60% to 50% a gradual but faster than linear phasing in of the reform seems almost equivalent in terms of welfare to a path that involves an announcement period of 16 months and then a very quick drop in the replacement rate.

In any case, it is noteworthy that neither 'optimal' path yields significant improvements over a one-off reform announced 24 months ahead. For the fixed-cost variant we already saw that allowing for sophisticated reform paths is not helpful. This suggests that fine-tuning the transition to reduce the welfare losses due to lack of appropriate self-insurance is not very important.[24] It seems that the effects working through (not) delaying efficiency gains and rent extraction dominate. Also, that part of the cost of transition that is due to foregone consumption in the process of asset accumulation cannot be avoided anyway. Thus, the welfare effects of reducing unemployment insurance that we found in sections 5.1 and 5.2 on the basis of simple reforms are actually very good approximations of what can be achieved. What also emerges is that ultimately the optimal reform size and path depend paramountly on what is the correct assumption about the nature of hiring costs. We have shown results for the two extreme cases. The truth is likely to be somewhere in between. Solutions of the model for intermediate specifications involving a fixed and a variable hiring cost turn out to be convex combinations of those two polar cases in all respects.

6 Conclusion

In this paper the Mortensen-Pissarides matching model has been introduced in an incomplete markets setting in order to study the dynamics and welfare effects of reductions in unemployment benefits. The various numerical experiments performed for our calibration to Germany in the mid-1990s suggest that reductions of the replacement rate in the order of 10 or 20 percentage points would be welfare improving for workers. However, the welfare gains would be much smaller than simple steady-state comparisons suggest because there are significant transition costs associated with the need for individuals to increase their self-insurance capacity by accumulating higher savings. It was further shown that both the optimal size of reform and its optimal timing depend strongly on the assumptions one makes about the nature of turnover costs faced by firms. Under

[24] Our simulations suggest that this is true irrespective of the size of the reform.

the standard Mortensen-Pissarides assumption that the costs of hiring a worker increase in the equilibrium ratio of vacancies to unemployed parts of the gains from reducing unemployment benefits are crowded out by the increase in (wasteful) vacancy costs. Moreover, since sudden increases in vacancies confer windfall gains upon firms with a filled job, a gradual or announced reform is preferable. It allows workers to appropriate most of those windfalls. Under the alternative assumption of a fixed, market independent cost of hiring a worker, on the other hand, a reduction in benefits should come as fast and fully as possible because the cost of delaying the efficiency gains dominates the gains from giving people time to self-insure before benefits are actually lowered.

Let us conclude with a final remark regarding limitations of the model used in this paper. It stems from the fact that we use Nash-bargaining to determine wages. This is widely done in the literature and there is as yet no well established alternative, but recently a quest for alternative mechanisms has set off because, in particular when used in business-cycle applications, Nash-bargaining causes difficulties in matching the data.[25] It seems that a method of wage determination that gives rise to more wage stickiness would be more appropriate. The consequence for our model would likely be that employment dynamics would be slower, which would tend to reduce welfare gains, even though not by much. It could however worsen the lot of the unemployed and thereby accentuate equity issues involved in reducing unemployment insurance.

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[NOT FOR PUBLICATION]

A Job Acceptance

Lemma A.1 *With $\rho_t \in [0,1]$ and $1-\lambda \geq \theta_t q(\theta_t)$ an individual never rejects a job regardless of his asset level.*

Proof. The proof will make use of a revealed preference argument. Time indices are dropped for ease of notation.
Denote by $V(a,e)$ and $V(a,u)$ the maximized values of an employed and an unemployed worker respectively. Let $(c_u^*, {a'}_u^*)$ describe the unemployed individual's optimal allocation of his current income $b+(1+r)a$ to consumption and savings. Given our assumption that b is no greater than the net wage, this choice is in the feasible set of a worker with assets a who holds a job as well. Suppose the employed worker chose $(c_u^*, {a'}_u^*)$. Then his utility from consumption today would be equal to that of the unemployed and next period he would hold the same assets as the unemployed. With the same assets, starting from next period he cannot be worse off than the one who was unemployed today because i) his probability of being matched no less than for the unemployed and ii) the individual could turn down a job offer if the value of unemployment were higher. Hence, for the same consumption and asset choice the employed worker is at least as well off as the unemployed worker. Since $(c_u^*, {a'}_u^*)$ is feasible for him we can conclude that for his optimal choice he is also at least as well off. Thus $V(a,e) \geq V(a,u)$ and a job offer is never rejected. ■

B The Algorithms

B.1 Computation of the steady state

To find the steady state the following computational strategy is employed:

1. The value functions of the worker and the unemployed are approximated by Schumaker splines in a on a log-linear grid.

2. For a given θ, i.e. for given transition probabilities and wages, the stationary asset distributions of the unemployed and the employed are calculated by forward iterating the asset distributions. That is to say, in a first step next period's asset holdings are determined for each individual state vector (a,s) on a grid. Then these new asset levels are attributed to the support points of the grid adjusting the densities such as to preserve the means. Further the distributions are adjusted to reflect the transition probabilities between employment and unemployment (compare equation (10)). The median assets of employed workers, a^m, are derived from the asset distribution for employed workers.

3. The steady state version of equation (8) is used to update θ.

Steps 1-3 are repeated until convergence.

B.2 Computation of the transition dynamics

To characterize the transition towards steady-state following a policy shock I solve for the time paths of the variables as follows:

1. Solve for the steady-states under the old and the new policy regime.
2. Choose T as the number of out-of-steady-state periods considered. I.e. in the Tth period before the new steady-state is reached the policy shock occurs.
3. Postulate a path for a^m and u in the $T-1$ periods following the shock.
4. Calculate θ_1 from $J^{SS,new}$ (cf. equation 5).
5. Calculate the wage for period 1 from the bargaining problem.
6. Approximate the value function in period 1 given w_1 and θ_1 and the fact that from the next period on we are in steady state.
7. Repeat steps 4-6 for all T periods always using the last period's value function to calculate the new one.
8. Using the wealth distribution in the old steady-state and the calculated paths for θ, wages, and value functions, calculate the evolution of the wealth distribution and hence of a^m. Using the unemployment rate in the old steady-state and the calculated path for θ find a new path for unemployment.
9. Update the guess for the paths of median assets and unemployment and go back to step 4 until convergence.