CESifo *Working Paper Series*

EMPLOYMENT AND WELFARE EFFECTS OF A TWO-TIER UNEMPLOYMENT COMPENSATION SYSTEM

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Working Paper No. 297

May 2000

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* Preliminary versions of this paper have been presented at seminars at the Center for Economic Studies (*CES*) in Munich, the University of Cologne, Erasmus University in Rotterdam, and the University of Mannheim. I would like to thank Lans Bovenberg and Carl Christian von Weizsäcker for his comments on earlier versions of this paper. All remainig errors are mine.

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Abstract

In many OECD countries, e.g. in Germany, France, or the UK, unemploy-ment compensation consists of unemployment insurance and unemployment assistance. Unemployment assistance is provided subsequent to the expiration of entitlement to unemployment insurance and is lower. The effects of this two-tier unemployment compensation system are studied in a general equilibrium job search model with endogenous distributions of in-come, wealth, and employment which is calibrated with regard to the charac-teristics of the German economy. Our results are as follows: i) employment is a decreasing function of both unemployment insurance and unemployment assistance. ii) Savings are (not) a monotone increasing function of unemployment insurance (unemployment assistance payments). iii) Optimal unemployment compensation payments are found to be a decreasing function over time.

Keywords: Unemployment compensation, search unemployment, general equilibrium, overlapping generations

JEL Classification: J65, J64, E60, E62

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1 Introduction

In Germany, like in many other OECD countries such as e.g. in the United Kingdom or France[1], the unemployment compensation system consists of two tiers: unemployment insurance (*Arbeitslosengeld*, henceforth UI) and unemployment assistance (*Arbeitslosenhilfe*, henceforth UA). Unemployed workers receive unemployment insurance if they have been employed for at least 12 months during the last 3 years. Furthermore, unemployment insurance is granted up to one year for agents aged 42 and younger, while it may last up to 3 years for agents aged above 42. After the expiration of unemployment insurance, unemployed workers are entitled to unemployment assistance, which is basically granted without any time limit. As an essential feature of the German unemployment compensation system, UA payments are below UI payments. Consequently, unemployment compensation of the typical unemployed worker is declining over time in Germany.

The existing literature does not provide an unanimous answer to the question as to whether unemployment compensation should decline over time. In their seminal paper, Shavell/Weiss (1979) show that optimal unemployment compensation decreases monotonically over the unemployment spell. In their prinicipal-agent model, the government provides unemployment insurance to the unemployed worker. The government, however, is unable to observe the worker's search effort, which determines the unemployed worker's probability to find a job and also causes disutility to the unemployed worker. Hopenhayn and Nicolini (1997) demonstrate the result of Shavell/Weiss to be also valid in an economy with a wage tax after reemployment. In addition to the moral hazard associated with the unemployed worker's unobservable search effort, Wang and Williamson (1996) also consider moral hazard associated with the employed worker's retention effort.[2] An employment offer may be turned down by a worker without the government's knowledge. In addition, the probability of employment in the current period is higher if the agent was

[1] See Atkinson/Micklewright (1991) for a review of the characteristics of different unemployment compensation systems in OECD countries. Hunt (1995) provides a detailed description of the German unemployment compensation system.

[2] Former notable studies on the effects of unemployment insurance on employment and welfare in the case of unobservable stochastic employment opportunities include the general equilibrium models by Hansen/İmrohoroğlu (1992) and Atkeson/Lucas (1993).

employed in the previous period. As a consequence of the employed worker's moral hazard, optimal unemployment benefits initially increase during an unemployment spell before they decline monotonically thereafter.

Fredriksson and Holmlund (1998) study the optimal sequence of unemployment compensation payments over the spell of unemployment in a general equilibrium model of search unemployment drawing on Pissarides (1990). Employment depends on the search effort of unemployed agents and on wages, which are determined in decentralized Nash-bargains. Unemployment compensation consists of two tiers: unemployment insurance and unemployment assistance.[3] Workers who loose their job are entitled to unemployment insurance; however, unemployed workers may loose their benefit at an exogenous rate subsequently and may have to rely on unemployment assistance which is lower. Fredriksson and Holmlund show that a two-tier system is superior to a system with indefinite constant UI payments. In their numerical example, the percentage difference between UI payments and UA payments is substantial. In a model very similar to the one of Fredriksson and Holmlund, Cahuc and Lehmann (1999) study the importance of a two-tier unemployment compensation system on wage formation.[4] As UI payments rise relative to UA payments, unemployment may rise if wages are renogotiable and, hence, if the relevant fall-back position for the worker is the state of insured unemployment.

The present paper is closely related to the work by Fredriksson and Holmlund (1998). Unemployment compensation also consists of two tiers. Both unobservable search effort and the wage are affected by the parameters of the unemployment compensation system. Similar to Fredriksson/Holmlund (1998), there are two opposing effects of a rise in UI payments relative to UA payments on employment: 1) unemployed workers not entitled to UI payments increase their search effort in order to find a job and be entitled to UI payments in the future. This effect is also known as the 'entitlement effect' in the literature (see Mortenson, 1977, and Hammermesh, 1979). 2)

[3]Fredriksson/Holmlund apply the term 'social assistance' rather than 'unemployment assistance'.

[4]In the model of Cahuc and Lehmann (1999), unemployed workers loose entitlement to UI payments if they are unemployed for more than one period. Besides, Cahuc and Lehmann apply the Rawls criterion of welfare rather than the utilitarian approach applied by Fredriksson and Holmlund (1998).

The reservation wage of the worker increases and, consequently, employment falls as firms post less vacancies. However, unemployment compensation affects wage formation differently in our model than in the model of Fredriksson/Holmlund (1998) as we also introduce intertemporal consumption smoothing of the workers. In particular, the short-term unemployed worker is much more likely to remain unemployed in the next period than the employed worker is likely to loose his job. As a consequence, the short-term unemployed worker also saves a relatively large proportion of his current income for precautionary reasons. Therefore, the utility of the short-term unemployed worker and hence his reservation wage is less sensitive with regard to the level of UI payments (if accompanied by an offsetting decline in UA payments in order to keep government expenditures on unemployment compensation constant) as soon as one allows for consumption smoothing over time.[5]

The organisation of the paper is as follows. Section 3 introduces the model. Our model is an extension of Costain (1997). In section 4, the model is calibrated with regard to characteristics of the German economy. Furthermore, the computational procedure is described. In section 5, our numerical results are presented. Section 6 concludes.

2 The Model

The model follows Costain (1997) with some modifications and extensions. Three sectors can be depicted: the household sector, the production sector, and the government. Households live for 60 years and maximize discounted life-time utility. They inherit no wealth and they do not leave any bequests. Agents can either be employed or unemployed during their working life. If unemployed, agents search for a job. In old age, they receive pensions. Firms maximize the discounted sum of profits. They post vacancies, hire labor and capital, and pay out dividends to their shareholders. The government provides social insurance which it finances by a tax on wage income. In

[5]Neglecting intertemporal consumption smoothing may also result in a biased welfare anaylsis of unemployment compensation as agents cannot build up precautionary savings for times of unemployment.

addition to Costain (1997), we adapt the model to the characteristics of the German unemployment compensation system.[6] Since we will only analyze steady-state allocations, the time index is omitted from stationary variables like, e.g., from the interest rate r or the wage rate w.

2.1 Households

Agents live for $T + T^R = 60$ periods (years). The first $T = 40$ periods, they are workers. They are either employed supplying one unit of labor and receiving wage w, which is taxed at the rate τ, or they are unemployed and search for a job with intensity s. The last $T^R = 20$ periods of their life, they retire and receive pension payments w_R. Households are of measure one and each generation g is of equal measure 1/60. The household maximizes his intertemporal utility:

$$\max_{c_0, s_0} E_0 \sum_{t=1}^{T+T^R} \beta^t \left[\frac{c_0(a, \epsilon, t)^{1-\sigma} - 1}{1 - \sigma} - D^W 1_{\epsilon=1} - D^S s_0(a, \epsilon, t) \right], \tag{1}$$

where $c_0(a, \epsilon, t)$ denotes the consumption of the generation born in period 0 with asset holdings a and employment status ϵ in period t. The employment status can take five different values $\epsilon \in \{1, 2, 3, 4, 5\}$: $\epsilon = 1$) agents are employed in period t and receive after-tax wage $(1 - \tau)w$, $\epsilon = 2$) agents are unemployed for a short-term and hence entitled to unemployment insurance w_{UI}, $\epsilon = 3$) agents are unemployed for a long-term, but have been employed before and hence receive unemployment assistance w_{UA}, $\epsilon = 4$) workers who have never found employment during their life have to rely on welfare payments w_W, and $\epsilon = 5$) retired agents who receive pensions w_R. σ, β, D^w, and D^S are the relative coefficient of risk aversion, the discount factor, the disutility from working, and the marginal disutility from searching. If agents are employed or retired, they do not search $s_0(a, 1, t) = s_0(a, 5, t) = 0$.

Agents are born without any assets. Furthermore, agents are not allowed to borrow, $a \geq 0$. Depending on his employment status ϵ, an agent of generation g receives labor income $y(\epsilon)$ and earns interest income at rate r:

$$a'_g(a, \epsilon, t) + c_g(a, \epsilon, t) = (1 + r)a + y(\epsilon). \tag{2}$$

[6] The model is further different from the one of Costain with regard to the modelling of the wage determination.

where a' denotes next period's asset holdings. The labor income $y(\epsilon)$ of a household with employment status ϵ is given by:

$$y(\epsilon) = \begin{cases} (1-\tau)w & \epsilon = 1 \\ w_{UI} & \epsilon = 2 \\ w_{UA} & \epsilon = 3 \\ w_{W} & \epsilon = 4 \\ w_{R} & \epsilon = 5. \end{cases} \tag{3}$$

The probability of employment in the first period is given by p_0. During their working life, agents loose employment at an exogenous rate $1 - e^{-\delta}$. Unemployed agents looking for a job with search intensity s will find a job with probability $1 - e^{\pi s^z}$, $z \in \{0, 1\}$. For the individual agent, the probabilities of finding a job π and p_0 are exogenous while they are determined endogenously in the labor market. If agents are unemployed for one period, $\epsilon = 2$, they receive unemployment insurance w_{UI} for only one period. The next period, they either find a job or they live on unemployment assistance w_{UA}.

Let u, n, n_{UI}, n_{UA}, n_W, n_R, and $\phi_g(a, \epsilon, t)$ denote the unemployment rate, the number of people who are employed, entitled to unemployment insurance, unemployment assistance and welfare payments, the number of retired agents, and the measure of people in generation g with wealth a and employment status ϵ in period t, respectively, implying:

$$u \equiv 1 - \frac{n}{n + n_{UI} + n_{UA} + n_W} \tag{4}$$

$$n \equiv \sum_g \sum_a \phi_g(a, 1, t) \tag{5}$$

$$n_{UI} \equiv \sum_g \sum_a \phi_g(a, 2, t) \tag{6}$$

$$n_{UA} \equiv \sum_g \sum_a \phi_g(a, 3, t) \tag{7}$$

$$n_W \equiv \sum_g \sum_a \phi_g(a, 4, t) \tag{8}$$

$$1 = \sum_\epsilon \sum_g \sum_a \phi_g(a, \epsilon, t) \tag{9}$$

$$\frac{T^R}{T + T^R} = \sum_g \sum_a \phi_g(a, 5, t) \equiv n_R. \tag{10}$$

2.2 Government

The government uses the revenues from taxing labor in order to finance its expenditures on social security:

$$\tau wn = w_{UI}n_{UI} + w_{UA}n_{UA} + w_W n_W + w^R \frac{T^R}{T+T^R}. \tag{11}$$

The government policy is characterized by the set $\Omega = \{\vartheta_{UI}, \vartheta_{UA}, \vartheta_W, \vartheta_R, \tau\}$, where $\vartheta_x = \frac{x}{(1-\tau)w}$ denotes the replacement ratio of $x = w_{UI}, w_{UA}, w_W, w_R$.

2.3 Firms

Firms are of measure one. They hire labor n and capital k taking the interest rate r as given. Let $V(n_t, k_t)$ denote the value function of the firm:

$$V(n_t, k_t) = \max_{i_t, h_t} \left[A_0 k_t^\alpha n_t^{1-\alpha} - w_t n_t - h_t - i_t + \frac{1}{1+r_t} V(n_{t+1}, k_{t+1}), \right], \tag{12}$$

where i_t and h_t denote investment and the number of vacancies, respectively. Every year, workers separate at the exogenous rate $1 - e^{-\delta}$ from employment:

$$n_{t+1} = q_t h_t + e^{-\delta} n_t. \tag{13}$$

The firm takes the hiring probability q_t as exogenous. The capital stock accumulates according to

$$k_{t+1} = i_t + e^{-\delta_k} k_t, \tag{14}$$

where the depreciation rate of capital is given by $1 - e^{-\delta_k}$. In steady state, employment n, capital k, investment i, and hiring probability q are all constant, and the Euler equations of the firm are described by:

$$1 + r - e^{-\delta_k} = A_0 \alpha k^{\alpha-1} n^{1-\alpha} \tag{15}$$

$$1 + r - e^{-\delta} = q\left(A_0(1-\alpha)k^\alpha n^{-\alpha} - w\right) \tag{16}$$

$$qh = n\left(1 - e^{-\delta}\right) \tag{17}$$

$$i = k\left(1 - e^{-\delta_k}\right). \tag{18}$$

Furthermore, firms pay dividends $d = A_0 k^\alpha n^{1-\alpha} - wn - i - h$ to the asset owners.

2.4 Matching and Wage Determination

Labor markets are subject to frictions and are characterized by two-sided search. Unemployed agents search with intensity $s_g(a, \epsilon, t)$, and firms post vacancies h. There is an externality from additional searching and posting of vacancies. An increase in the number of searchers or the search effort reduces the probability of other searching agents to find a job, while it increases the probability of firms to fill their vacancies. Vice versa, an additional vacancy increases the probability of a searching agent to find a job, while it reduces the probability of other firms to fill a vacancy. Thus, a negative externality arises whenever the number of active agents increases on the same side of the market and a positive externality arises if the number of agents increases on the other side of the market.

More formally, we follow the specification suggested by Costain (1997) with steady-state matching coefficients π and q

$$\pi \equiv \mu h^{\zeta}(n_{UI} + n_{UA} + n_W)^{-\zeta} \tag{19}$$

$$q = \frac{1}{h} \sum_{a,\epsilon,g} \phi(a, \epsilon, g) \left(1 - e^{-\pi s_g(.)^z}\right). \tag{20}$$

Wages result from decentralized bargaining between the firm and the newly employed worker. Both the firm and the employed worker receive a rent from a successful match. The surplus of the worker is given by his change in pay and utility, expressed in money-terms, which arises from employment. Wages can be renogotiated at any time so that the relevant fall-back position for the worker is the state of insured unemployment. We will assume wages are equal in the economy and compute the surplus accrueing to the average employed worker as $(1-\tau)w - w_{UI} - \frac{D^W - D^s \bar{s}}{\bar{c}^{-\sigma}}$, where $\bar{s}$ and $\bar{c}$ are the average search effort and consumption of the short-term unemployed workers ($\epsilon = 2$). The surplus of the firm is given by the marginal product of labor minus the wage, $A_0(1-\alpha)k^{\alpha}n^{-\alpha} - w$. If λ denotes the bargaining power of the worker, Nash bargaining implies:[7]

$$w = \lambda A_0(1-\alpha)k^{\alpha}n^{-\alpha} + (1-\lambda)\left[\frac{1}{1-\tau}\left(w_{UI} + \frac{D^W - D^S \bar{s}}{\bar{c}^{-\sigma}}\right)\right]. \tag{21}$$

2.5 Stationary Equilibrium

The concept of equilibrium applied in this paper uses a recursive representation of the consumer's problem following Stokey et al. (1989). Let $W_g(a,\epsilon,t)$ be the value of the objective function of a generation-g agent in period t with beginning-of-period asset holdings a and employment status ϵ. $W_g(a,\epsilon,t)$ is defined as the solution to the dynamic program:

$$W_g(a,\epsilon,t) = \max_{c,a',s}\left[\frac{c^{1-\sigma}-1}{1-\sigma} - D^W 1_{\epsilon=1} - D^S s + \beta E_t\left\{W_g(a',\epsilon,t+1)\right\}\right], \tag{22}$$

subject to the budget constraint (2). E_t denotes the expectation operator conditional on information in period t.

Definition
A Stationary Equilibrium for a given set of government policy parameters $\Omega = \{\vartheta_{UI}, \vartheta_{UA}, \vartheta_W, \vartheta_R, \tau\}$ is a collection of value functions $W_g(a,\epsilon,t)$ of the households and $V(n,k)$ of the firms, individual policy rules $c_g(a,\epsilon,t)$, $s_g(a,\epsilon,t)$, and $a'_g(a,\epsilon,t)$, age-dependent, time-invariant measures of agent types $\phi_g(a,\epsilon,t)$ for each generation $g = 1,2,\ldots,T+T^R$, relative prices of labor and capital $\{w,r\}$, such that:

1. Given relative prices $\{w,r\}$ and the government policy Ω, the individual policy rules $c_g(.)$, $s_g(.)$, and $a'_g(.)$ solve the consumer's dynamic progam (22) and firms maximize profits (12) with respect to investment i and vacancies h.

[7] Notice that, contrary to the wage equation in Costain (1997), unemployment insurance payments w_{UI} and taxes τ have a direct effect on the wage. In Costain (1997), unemployment insurance payments and taxes only affect wages through their general equilibrium effect on wealth accumulation, consumption, and employment.

2. The goods market clear:

$$A_0 k^\alpha n^{1-\alpha} = \sum_{a,\epsilon,g} c_g(a,\epsilon,t)\phi_g(a,\epsilon,t) + i + h. \tag{23}$$

3. Households hold equity of the firms. The interest earnings by the households on the assets are equal to the dividend payments d by the firms:

$$r \sum_{a,\epsilon,g} \phi_g(a,\epsilon,t)a = d = A_0 k^\alpha n^{1-\alpha} - wn - h - i. \tag{24}$$

4. In each period t, $\sum_a \phi_{40}(a,1,t)$ agents retire from work and the fraction $e^{-\delta}$ of these jobs is inherited by the newborn generation, implying:

$$p_0 = \frac{\sum_a \phi_{40}(a,1,t)e^{-\delta}}{1/60}. \tag{25}$$

5. Wages w result from decentralized bargains according to equation (21).

6. The number of total matches formed in the labor market is equal to the number of job outflows:

$$qh = \sum_{a,\epsilon,g} \phi_g(a,\epsilon,t)\left(1 - e^{-\pi s_g(a,\epsilon,t)^z}\right) = \left(1 - e^{-\delta}\right)n. \tag{26}$$

7. Finally, the government budget (11) is balanced.

3 Calibration and Computation

3.1 Calibration

The steady state distribution of wealth, search effort, and employment and the effects of a change in the unemployment compensation system on welfare and distribution cannot be studied analytically but only numerically.

For this reason, the model is calibrated in order to match characteristics of the German economy after unification. If not mentioned otherwise, the time series data refer to the period 1991-97. The annual data on the unemployment rate, the number of vacancies, the flow of employed workers into unemployment, and the number of unemployment insurance and unemployment assistance recipients are taken from the yearbooks of the *German Statistical Office (Statistisches Bundesamt)*. The data on labor income of workers, GDP, the capital-output ratio, and the numbers of self-employed and workers are taken from *Statistisches Bundesamt, Fachserie 18*.

The following parameters need to be calibrated: σ, β, D^W, D^S, the replacement ratios of unemployment insurance ϑ_{UI}, unemployment assistance ϑ_{UA}, welfare payments ϑ_W, and pensions ϑ_R, μ, δ, δ_k, α, ζ, z, and λ. The remaining variables are computed endogenously in our model.

Households

In our benchmark case, we will assume a coefficient of relative risk aversion $\sigma = 2$.[8] Targeting an annual real interest rate of approximately $r = 4.5\%$, the household's discount factor is set equal to $\beta = 0.99$.

Government

The government provides unemployment compensation. Previous estimates of German replacement ratios, henceforth defined as the ratio of net benefits received in unemployment to net earnings received at work, vary considerably. Replacement ratios computed by the OECD (1996) are sensitive with regard to the household composition. In 1994, couples with no children received 60% of benefits relative to their net earnings in the first month of unemployment, while couples with two children and housing benefits received even 88% of net earnings (for the average production worker). After 5 years of unemployment, these numbers drop to 37% and 71%, respectively. According to a Centre d'Etude des Revenues et des Coûts (CERC) study of European unemployment programs cited by Burtless (1987), replacement ratios drop

[8] All our qualitative results also hold for the case $\sigma \in \{1, 4\}$.

from 66% to 56% from the first to the second year of unemployment for the agent who earned the average wage or two-thirds of the average wage. For the agents who earned twice the average wage, these numbers fall to 51% and 44%, respectively.[9] Steiner (1997) computes the replacement ratio with respect to expected net wage yielding a mean value of 50% for those receiving unemployment insurance between 1983 and 1994. In accordance with the latter two studies, the replacement ratio of unemployment insurance and unemployment assistance are set equal to 50% and 40% in the benchmark case, respectively, but a sensitivity analysis of w_{UI} and w_{UA} is performed in section 4 as well. Welfare payments are computed from the ratio of average current expenditures on welfare, multiplied by a factor of 1.5 in order to correct for rent and health insurance payments provided by the local government, to net average income of a production worker. The welfare payments replacement ratio is set equal to 30%.[10]

Public pension payments are equal to 50% of after-tax-wages. This value is in line with previous studies from Fehr (1997) and Chauveau/Loufir (1997). Fehr (1997) studies the tax and pension reforms proposed in 1997 and assumes that pensions are approximately 70% of average net income and are further taxed at the rate of 40%, while Chauveau/Loufir (1997) take a value of 55% for the pension replacement ratio in Germany for the time period 1985-89. The income tax rate τ is calculated from the government budget (11) and amounts to 23.2%. The calibration of the model's parameters is summarized in table 1.

Production

The production parameters are taken from Heer/Linnemann (1998). The production elasticity of capital is set equal to $\alpha = 0.35$. A_0 is normalized to one. The annual depreciation in Germany amounts to $\delta_k = 0.04$.

[9] At the time of the CERC study, the maximum benefit of unemployment insurance and unemployment assistance amounted to 68% and 58% of net earnings, respectively, while they declined to 67% and 57% during the calibration period, respectively.

[10] Almost the same number results from a computation using average expenditures of local governments for welfare payments relative to average expenditures of the federal government for unemployment insurance, after correcting the former for payments to disabled people (health risk is not considered in our model).

Table 1: Calibration of parameter values for Germany 1991-97

Description	Function	Parameter
utility function	$U_t = \frac{c^{1-\sigma}-1}{1-\sigma} - D^W 1_{\epsilon=1} - D^S s$	$\sigma = 2$, $D^W = 0.24$, $D^S = 0.17$
discount factor	β	$\beta = 0.99$
production function	$y = A_0 k^\alpha n^{1-\alpha}$	$\alpha = 0.35$, $A_0 = 1$
depreciation	δ_k	$\delta_k = 0.04$
job separation rate	δ	$\delta = 8.35\%$
matching functions		
	$\mu h^\zeta (n_{ui} + n_{uA} + n_w)^{-\zeta}$	$\zeta = 0.5$, $\mu = 1$
	$1 - e^{-\pi s^z}$	$z = 0.4$, $\pi = 1.46$
bargaining power	λ	$\lambda = 0.5$
unemployment insurance	w_{UI}	$\vartheta_{UI} \equiv w_{UI}/(1-\tau)w = 50\%$
unemployment assistance	w_{UA}	$\vartheta_{UA} \equiv w_{UA}/(1-\tau)w = 40\%$
welfare payments	w_W	$\vartheta_W \equiv w_W/(1-\tau)w = 30\%$
pension payments	w_R	$\vartheta_R \equiv w_R/(1-\tau)w = 50\%$
income tax rate	τ	$\tau = 23.2\%$

Labor Market and Disutility from Labor and Searching

The paramaters of the matching functions $z = 0.4$ and $\zeta = 0.5$ are taken from Costain (1997). μ is normalized to one. The bargaining power of workers λ is set equal to 0.5. The parameters describing the disutility from working and searching, D^W and D^S, together with the separation rate δ are chosen simultaneously in order to match the following three empirical regularities:[11] i) the unemployment rate amounts to 10.1% on average during 1991-97, ii) the number of unemployment insurance recipients relative to number of unemployment assistance recipients is equal to 2.88,[12] and iii) the number of vacancies relative to all employed workers is 9.3% in Germany. The last number, however, is likely to underestimate the true number of vacancies as not all vacancies are reported to the German Statistical Office. For this reason, we will target a value for the ratio of vacancies relative to employed workers of approximately 20%. For our calibration reported in table 1, we get i) an unemployment rate u equal to 10.2%, ii) $n_{UI}/n_{UA} = 2.73$, and iii) $h/n = 21.3\%$, respectively. The calibrated job separation rate $\delta = 8.35\%$ matches the empirical annual flow from employment into unemployment relative to total employment quite closely: the empircal value over the period 1991-97 is equal to 9.9%[13] and also counts the number of agents who lose their job repeatedly within one year (and which our model does not consider).

3.2 The Solution Algorithm

The model has no analytical solution. Algorithms to solve heterogenous-agent models with an endogenous distribution have only recently been introduced in the economic literature. Notable studies in this area are Aiyagari

[11]Contrary to Costain (1997), we cannot fix the parameters separately because the worker's reservation wage in (21) also contains the disutility from searching $D^S\bar{s}$ and unemployment insurance payments w_{UI}.

[12]The number of short-term unemployed workers (less than one year) relative to the number of long-term unemployed workers (more than one year) is a little less amounting to 2.30.

[13]Total flows in and out of employment are about twice as much, as many agents enter employment from out of the labor force. Since the model, however, does not account for this phenomenon, these flows are neglected. Burda and Wyplosz (1994) provide a detailed analysis of the flows in and out of employment in European countries.

(1994), Costain (1997), den Haan (1996), Huggett (1993), and İmrohoroğlu et al. (1995). Like most of these studies, we will only focus on the steady state of the model.[14] Our algorithm follows İmrohoroğlu et al. (1995) and Costain (1997) who also perform a numerical analysis of a life-cycle model. The solution algorithm is described by the following steps:

1. Choose the policy parameters ϑ_{UI}, ϑ_{UA}, ϑ_W, and ϑ_R.
2. Make initial guesses of r, π, and w.
3. Compute the household's decision function by backwards induction.
4. Compute the steady-state distribution of assets, employment, consumption, and search effort.
5. Compute n, n_{UI}, n_{UA}, n_W, average consumption $\bar{c}$ and search effort $\bar{s}$ of the short-term unemployed worker, and the average asset holdings of all households.
6. Compute the values τ, k, q, i, w, r, and π that solves the firm's Euler equation, the government budget, and the aggregate consistency conditions.
7. Update r, π, and w, and return to step 3 if necessary.

In step 4, a simple finite-time dynamic programming problem is solved by iterating the value function $W_g(a, \epsilon, t)$ of a household of generation g with employment status ϵ and asset holdings a in period t. The dynamic program has three state variables: age, employment status, and wealth. We divide the feasible range $[0, a^{max}]$ for assets a in each period into 1000 nodes. The upper bound on capital $a^{max} = 20$ corresponds to about three times the

[14] den Haan (1996) also computes the transition function of the capital stock distribution. For this reason, he has to choose a specific class of function for the cross-sectional distribution of assets. Choosing the exponential family, he is able to characterize the distribution by a discrete number of parameters. This procedure allows him to model the transition function of the distribution with a dynamic equation in a few parameters. In the present analysis, however, the distribution is calculated without any assumption on its functional form.

average asset holding and is not binding in our numerical computations. Similarly, the grid $[0, s^{max}]$ for search effort in each period is divided into 20 nodes and the upper limit $s^{max} = 4$ is chosen to be not binding. The decision rules of generation g can be found by a single recursion working backwards from the last period of life. In step 5, the steady-state distribution is computed by forward iteration starting with the 21-year old (corresponding to generation $g = 1$ in the model) who has no wealth and given employment probability p_0. A more elaborate description of numerical details can be found in İmrohoroğlu et al. (1995).

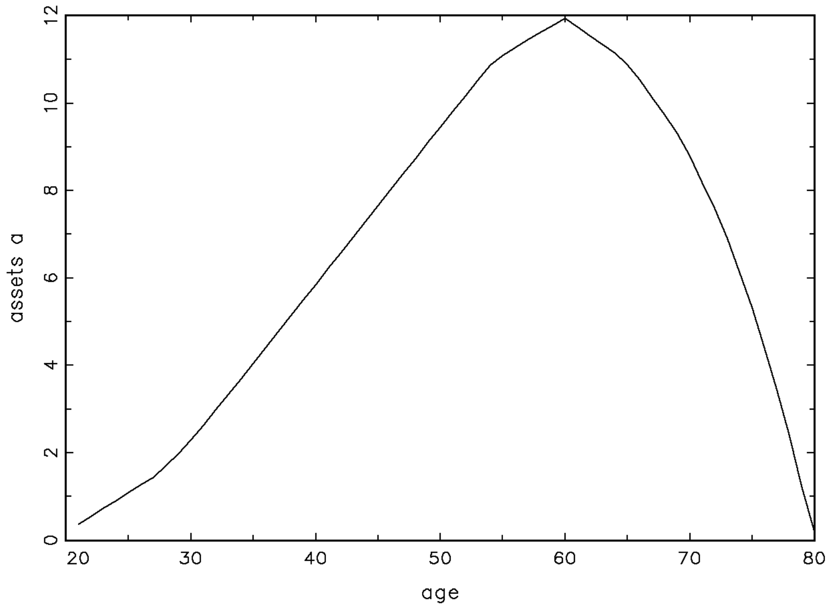
4 Results

In this section, the effects of a two-tier unemployment compensation system on employment and welfare are presented. First, equilibrium properties of the benchmark case are illustrated. Second, a change in the benefit level of both unemployment insurance and unemployment assistance is analyzed. Employment and welfare effects are demonstrated to be considerable.

4.1 Equilibrium Properties

In this subsection, we study the properties of the benchmark equilibrium which is characterized by the parameterization as presented in table 1. The behavior of the households depends on wealth, the employment status, and age. In particular, consumption of the workers is a monotone increasing function of asset holdings (not illustrated) and (compensated) labor income. Furthermore, consumption of unemployed workers, $\epsilon \in \{2, 3, 4\}$, increases sharply at low levels of wealth as agents are liquidity-constrained. Average consumption within cohorts is an increasing function of age (not illustrated) as the subjective annual discount rate of the households $1/\beta - 1 = 1.11\%$ is lower than the annual interest $r = 4.68\%$. In addition, average consumption also increases more rapidly during the first years of life than the later years because young agents are more likely to be liquidity-constrained.

Figure 1: Wealth-age profile

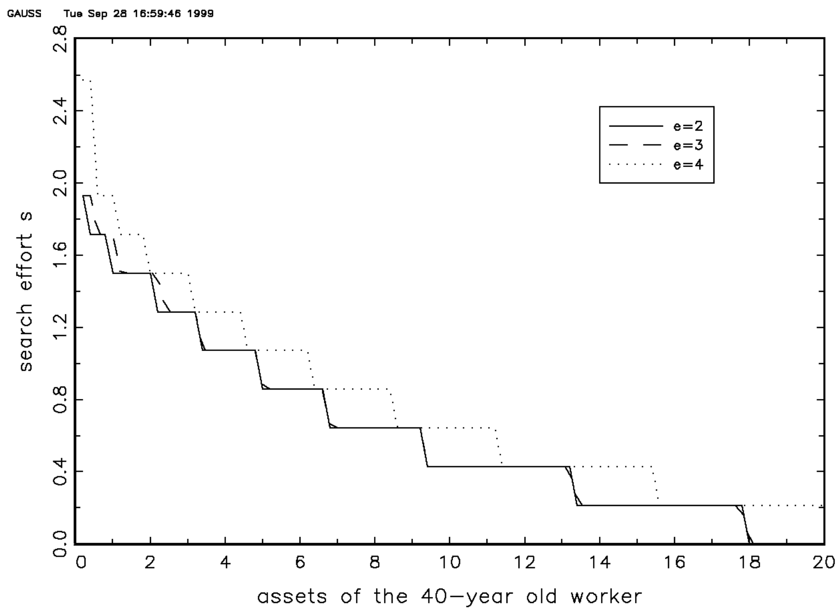


The aggregate capital stock amounts to $k = 4.679$ in our model implying an interest rate of $r = 4.68\%$. The wealth-income ratio is $k/y = 3.804$, which is in the proximity of empirical values of the capital-output ratio observed in Germany. In the years 1991-97, the ratio of the capital stock to GDP was equal to 5.0 (2.6) in Germany for the total economy (producing sector). The age-wealth profile is illustrated in figure 1. During the working life of agents, average wealth of each generation increases before it declines after retirement. The hump-shape of the wealth-age profile is typical of the life-cycle model. The distribution of wealth is more equal than the one observed empirically in the German economy; in our model, the Gini coefficient is equal to 33.7% and falls short of values close to 0.59-0.89 as reported by Bomsdorf (1989).[15] There are two important reasons why our model underestimates the degree of asset dispersion: first, agents are homogenous with regard to their skills

[15] Bomsdorf analyzes Gini coefficients of the wealth distribution for different kind of assets in the periods 1973, 1978, and 1983. Within each asset group, Gini coefficients are remarkably stable. The distribution of savings, securities, and real estate in 1983 are characterized by Gini coefficients equal to 0.59, 0.89, and 0.74, respectively.

and second, we neglect self-employment.[16]

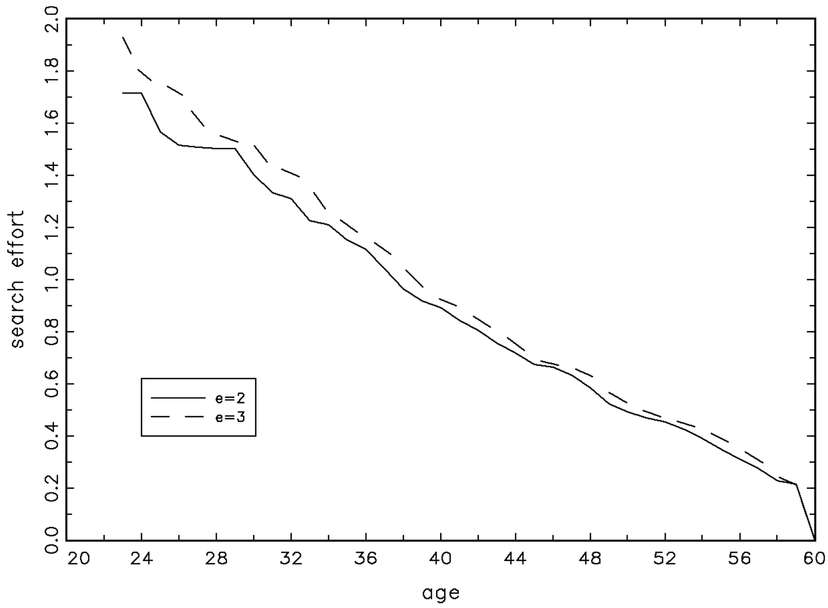
Figure 2: Optimal Search Effort



The optimal search effort of the 40-year old (corresponding to model period $g = 20$) is illustrated in figure 2. The search effort is a monotone declining function of wealth a. Furthermore, average search effort declines with age for two reasons (compare figure 3): i) average wealth of the old unemployed workers exceeds average wealth of the young unemployed workers, and ii) expected discounted labor earnings decrease with age as the potential employment period is getting shorter. At age 60, finally, unemployed workers do not search any more as they will receive pensions in the following period.

[16]Quadrini/Ríos-Rull (1997) review recent studies of endogenous wealth inequality in models of heterogenous agents with uninsurable idiosyncratic exogenous shocks to earnings, including attempts to include business ownership, higher rates of return on high asset levels, and changes in health and marital status, among others.

Figure 3: Search effort-age profiles

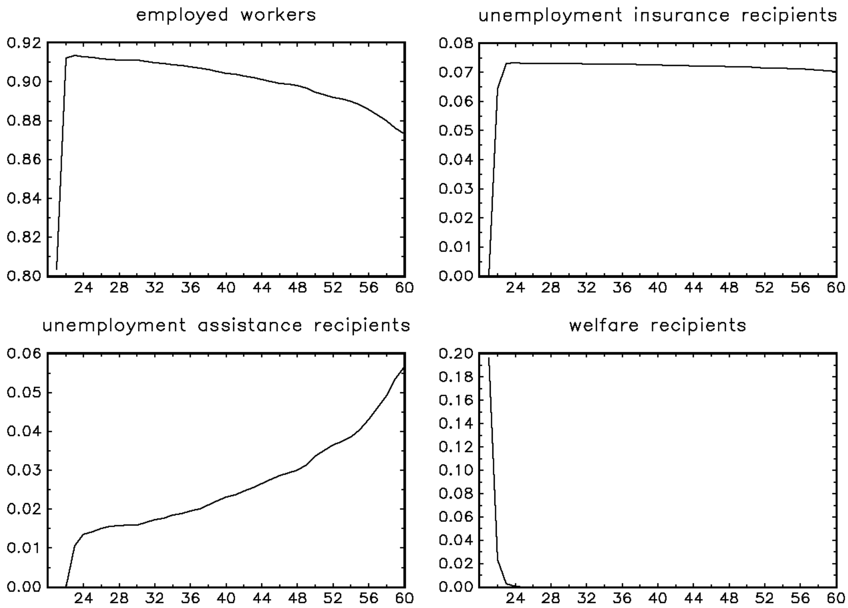


In our benchmark, the equilibrium unemployment rate amounts to 10.15%. The number of short-term unemployed workers exceeds the number of long-term unemployed workers by a factor of 2.73. In order to keep the budget balanced, the government imposes a tax on labor income at the height of $\tau = 23.2\%$. In our model, the number of employed workers and, hence, the number of unemployment insurance recipients are declining over time after an initial rise at age 21 as presented in figure 4. In the first period of their life at age 21, agents have a probability of $p_0 = 80.2\%$[17] to find a job and replace the old employed workers who retire at the end of age 60. The behavior of the employment rate in each cohort, of course, closely mimics the search behavior of the unemployed workers as presented in figure 3. At age 21 (21 and 22), unemployed workers are not entitled to unemployment insurance (assistance) as none among them has worked (received unemployment insurance) before. Over time, the number of unemployment assistance recipients is increasing

[17]This number is in good accordance with empirical findings by Steiner (1997) who provides estimates of survival rates for different ages during 1993-94 using data from the Socio-Economic Panel for West Germany (GSOEP). For the 21-year old, he finds an annual job finding probability of 79.1%.

and amounts to approximately 6% of all workers at age 60. The number of welfare recipients, those who have never found a job in their life, falls to almost zero within four years.

Figure 4: Employment status-age profiles



4.2 Optimal Replacement Ratios

In this subsection, a change in the benefit level of unemployment insurance and unemployment assistance is analyzed. Table 2 presents our results for unemployment insurance w_{UI}. Each row in table 2 represents a different unemployment compensation arrangement. The first column gives the the replacement ratio of unemployment insurance $\vartheta_{UI} = \frac{w_{UI}}{(1-\tau)w}$, and the remaining columns contain the equilibrium values of aggregate variables, the average search effort, the Gini coefficient, and the change in welfare δ_c associated with the unemployment compensation policy. Our benchmark case is given by the replacement ratio of $\zeta_{UI} = 50\%$.

First observe that wages w increase with higher unemployment insurance payments as the worker's fall-back position in the wage bargain improves.

Table 2: Effects of unemployment insurance w_{UI}

ϑ_{UI}	k	u	$\frac{n_{UI}}{n_{UA}}$	w	τ	$\frac{k}{y}$	$\bar{s}$	Gini	δ_c
0.10	3.443	9.71%	3.38	0.647	21.2%	3.11	1.048	36.4%	-1.90%
0.20	3.646	9.76%	3.30	0.698	21.7%	3.23	1.037	36.3%	-1.54%
0.30	3.908	9.84%	3.16	0.761	22.1%	3.38	1.009	35.9%	-1.11%
0.40	4.260	9.94%	2.99	0.839	22.7%	3.58	0.960	34.9%	-0.60%
0.50	4.679	10.15%	2.73	0.932	23.2%	3.80	0.902	33.7%	0%
0.60	5.054	10.31%	2.58	1.017	23.7%	4.01	0.867	32.7%	0.50%
0.70	5.885	11.07%	1.98	1.186	24.4%	4.45	0.805	29.9%	1.51%
0.80	6.395	12.59%	1.37	1.337	25.3%	4.74	0.874	30.3%	2.35%
0.90	7.213	14.01%	1.06	1.511	26.1%	5.19	0.949	31.2%	3.12%
1.00	7.923	16.32%	0.74	1.695	27.8%	5.76	0.979	32.4%	3.54%

Consequently, firms post less vacancies and unemployment increases. Increasing UI payments from current levels, $\vartheta = 50\%$, to full insurance, $\vartheta = 100\%$, increases unemployment from 10.15% to 16.32%. Following an increase of both the number of unemployed workers and the wage, the income taxe rate τ increases from 23.2% to 27.8% as well. There are two opposing effects of a rise in the replacement ratio ϑ_{UI} on the search behavior of the agents. On the one hand, firms post less vacancies and, consequently, the job finding probability and the matching coefficent π decrease. On the other hand, the entitlement effect is more pronounced and long-term unemployed agents increase their search effort in order to become reemployed and receive higher wages w and, in case they loose employment once again, higher unemployment insurance benefits w_{UI} in the future. While the search effort decreases with rising UI benefits for low values of ϑ_{UI}, it increases with rising UI benefits for $\vartheta_{UI} > 0.7$.

Notice further that the aggregate capital stock k and aggregate household savings in the form of equity (not presented) rise with an increase in UI payment w_{UI}.[18] At first glance, this result is surprising as most theoret-

[18]The change in the capital stock k is much more pronounced than the change in aggre-

ical studies concede that unemployment compensation payments decrease earnings uncertainty and hence precautionary savings, as e.g. demonstrated by Drèze/Modigliani (1972), Miller (1976), Sandmo (1970), or Levhari et al. (1980) to name but a few. Contrary to these studies, however, we consider a two-tier unemployment compensation system. Following a rise in unemployment insurance benefits w_{UI}, employed workers decrease their savings. This effect, however, is rather minor as the probability to loose one's job $\delta = 8.35\%$ is rather low for employed workers. Short-term unemployed workers, however, will increase their precautionary savings as they are very likely to remain unemployed the following year as well and will have to rely on unemployment assistance payments w_{UA}, which are lower than unemployment insurance payments w_{UI} or net wages $(1-\tau)w$. In fact, the average reemployment probability of short-term unemployed workers only amounts to approximately 75% in the benchmark case with $\vartheta_{UI} = 50\%$.

For low values of the replacement ratio $\vartheta_{UI} < 70\%$, a rise in unemployment insurance w_{UI} decreases wealth heterogenity as income is redistributed from employed workers with high income to short-term unemployed workers with low income. However, for a replacement ratio exceeding $\vartheta_{UI} = 70\%$, the effect of a rising share of long-term unemployed workers with low (compensated) labor income dominates and wealth inequality as measured by the Gini coefficient increases. For $\vartheta_{UI} = 100\%$, however, the Gini coefficient amounts to 32.4% and is still below the one of the benchmark case, the latter amounting to 33.7%.

As one of our main results, full insurance $\vartheta_{UI} = 100\%$ is found to be optimal for $\vartheta_{UI} \in [0,1]$. Our measure of welfare for government policy Ω is the expected discounted life-time utility of the newborn generation which is simply equal to $W(\Omega) = p_0 W_0(0,1,1) + (1-p_0) W_0(0,4,1)$. The total consumption equivalent increase δ_c[19] following a rise of the replacement ratio ϑ_{UI} from

gate savings $A \equiv \sum_{g,\epsilon,a} \phi_g(a,\epsilon,t)a$, which explains why the capital stock almost doubles following a change in the replacement ratio ϑ_{UI} from 50% to 100%. For a rise of ϑ_{UI} from 50% to 60%, for example, the aggregate capital stock increases by 8.0%, while aggregate savings A only increase by 1.5%. As can be shown from inserting equations (15)-(18) in (24), $k = A - n/q$ holds in equilibrium. Following an increase of ϑ_{UI}, employment n falls while firms' job filling probability q increases.

[19]Let $\{\tilde{c}_t\}_{t=1}^{T+T^R}$ denote the average consumption path of the newborn generation for the benchmark case as presented in table 1. The change in the government policy Ω is

Table 3: Effects of unemployment assistance w_{UA}

ϑ_{UA}	k	u	$\frac{n_{UI}}{n_{UA}}$	w	τ	$\frac{k}{y}$	$\bar{s}$	Gini	δ_c
0.10	4.522	9.31%	4.17	0.891	22.6%	3.76	1.306	34.1%	-2.20%
0.20	4.585	9.55%	3.63	0.906	22.8%	3.74	1.153	34.0%	-1.32%
0.30	4.638	9.82%	3.18	0.910	23.0%	3.77	1.031	33.8%	-0.46%
0.40	4.679	10.15%	2.73	0.932	23.2%	3.80	0.902	33.7%	0%
0.50	4.681	10.71%	2.23	0.939	23.6%	3.82	0.742	33.7%	-0.17%
0.60	4.615	12.49%	1.48	0.949	24.5%	3.84	0.613	34.1%	-1.31%

50% to 100% is considerable and equals 3.54%.[20]

An increase in unemployment assistance payments $w_{UA} = \vartheta_{UA}(1-\tau)w$ has strong disincentive effects on the unemployed worker's search effort. A 20% rise of ϑ_{UA} from 40% to 60%, for example, results in a fall of the average search effort $\bar{s}$ from 0.902 to 0.613. As a consequence, unemployment increase from 10.15% to 12.49%. As both the number of unemployed agents and the level of UA benefits increase, the government has to raise the income tax rate τ (compare table 3) in order to keep the government budget (11) balanced. The quantitative effect of an increase in UA benefits on wages is rather modest and does not exceed 1% for a change in UA replacement ratio of 10%. There are basically four effects on the level of decentralized bargained wages (21) following a rise in ϑ_{UA}: i) the marginal product of labor increases as employment declines, ii) the average search effort of the unemployed worker decreases, iii) the income tax rate τ increases, and iv) average consumption of unemployed agents $\bar{c}$ falls. While the last effect depresses wages, the first three effects push wages upward. The net effect of UA payments w_{UA} on

measured by the consumption equivalent increase δ_c such that $W(\Omega)$ is equal to the welfare implied by a consumption path $\{(1+\delta_c)\tilde{c}_t\}_{t=1}^{T+T^R}$.

[20] As the intertemporal elasticity of substitution, $1/\sigma$, decreases, individuals prefer to increase consumption smoothing. As a consequence, the welfare gain following a change in ϑ_{UI} from 50% to 100% increases with the coefficient of risk aversion σ. For $\sigma = 1$ and $\sigma = 4$, the consumption equivalent increases of such a policy change amount to $\delta_c = 2.78\%$ and $\delta_c = 5.01\%$, respectively.

wages w is positive in our economy.

While aggregate savings A and the aggregate capital stock k are a montone increasing function of UI benefits w_{UI}, UA benefits w_{UA} have an ambiguous effect on savings. For low replacement ratios $\vartheta_{UA} \leq 50\%$, savings increase with a rise in ϑ_{UA}, while they decline for $\vartheta_{UA} > 50\%$. Following a rise of ϑ_{UA} from 50% to 60%, for example, the aggregate capital stock k declines from 4.681 to 4.615. There are multiple effects of higher UA benefits on savings: i) precautionary savings of all agents are reduced, ii) income is redistributed to the long-term unemployed workers, and iii) the decline (rise) in net wages $(1-\tau)w$ for $\vartheta_{UA} > 50\%$ ($\vartheta_{UA} \leq 50\%$) also reduces (increases) welfare payments w_W and, in particular, pensions w_R so that workers accumulate higher (lower) savings for old age. Similarly, the effect of higher UA payments on wealth heterogenity is ambiguous, too. With rising ϑ_{UA}, income is redistributed to the long-term unemployed workers who, on average, are characterized by low wealth. On the other hand, the number of long-term unemployed workers increases as the disincentive effect of higher UA benefits is rather pronounced. For the latter reason, wealth heterogenity even increases for replacement ratio exceeding $\vartheta_{UA} = 40\%$. Not surprisingly, it is not optimal to provide unemployment assistance at replacement rates exceeding 40%, as i) unemployment u increases, ii) both aggregate savings A and output y fall, and iii) wealth inequality as measured by the Gini coefficient rises. The optimal level of unemployment assistance payments is found to be close to the existing one in Germany, which is characterized by a replacement ratio of about $\vartheta_{UA} = 40\%$.[21]

5 Conclusion

We analyzed the effects of a two-tier unemployment compensation system on employment, savings, and welfare in a model of search unemployment with consumption smoothing. Unemployment compensation consists of unemployment insurance, which is paid to the short-term unemployed workers,

[21]In addition, we find the optimal replacement ratio of unemployment assistance to increase with the coefficient of risk aversion, rising from $\vartheta_{UA} = 40\%$ for $\sigma = 1$ to $\vartheta_{UA} = 50\%$ for $\sigma = 4$.

and unemployment assistance, which is paid to the long-term unemployed workers. The effects of UI payments and UA payments on macroeconomic variables such as wages and savings are shown to be fundamentally different. Unemployment insurance payments mainly affect wages as wages can be renogotiated at any time and the relevant fall-back position of the employed worker is insured unemployment. An increase of UI payments relative to UA payments also results in a positive 'entitlement effect' as long-term unemployed workers are searching harder for a job in order to get reemployed. Unemployment assistance payments, on the contrary, mainly affect search behavior of unemployed workers. A rise in UA payments decreases search effort of all unemployed workers. The effect of UA payments on wages, however, is rather modest. Both unemployment insurance and unemployment assistance are demonstrated to reduce equilibrium employment significantly.

Unemployment insurance and unemployment assistance also have different effects on aggregate savings. While the effect of UA payments on savings is ambiguous, UI payments are demonstrated to increase aggregate savings. The main reason for the latter result is the two-tier structure of the unemployment compensation system. On the one hand, precautionary savings of employed workers hardly decrease with higher UI benefits as the job loosing probability of employed workers is rather low. On the other hand, short-term unemployed workers accumlate high precautionary savings because they have a high probability to remain unemployed the next year as well in which case they receive lower unemployment compensation in the form of UA payments. The net effect of unemployment insurance on aggregate savings and capital formation is positive for our calibration.

Not surprisingly, the optimal level of unemployment insurance and unemployment assistance are different from each other as these two forms of unemployment compensation affect the economic behavior of households and firms differently. As our main result, optimal unemployment compensation is shown to decline over time. In our model which is calibrated with regard to the characteristics of the German economy full unemployment insurance is optimal in the short-run, while optimal unemployment assistance is substantially lower than unemployment insurance and approximately equal to the present level of UA payments in Germany.

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