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Elke J. Jahn and Thomas Wagner

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Department of Economics

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Job Security as an Endogenous Job Characteristic*)

Elke J. Jahn[a] and Thomas Wagner[b]

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Abstract: This paper develops a hedonic model of job security (JS). Workers with heterogeneous JS-preferences pay the hedonic price for JS to employers, who incur labor-hoarding costs from supplying JS. In contrast to the Wage-Bill Argument, equilibrium unemployment is strictly positive, as workers with weak JS-preferences trade JS for higher wages. The relation between optimal job insecurity and the perceived dismissal probability is hump-shaped. If firms observe demand, but workers do not, separation is not contractible and firms dismiss workers at-will. Although the workers are risk-averse, they respond to the one-sided private information by trading wage-risk for a higher JS. With two-sided private information, even JS-neutral workers pay the price for a JS guarantee, if their risk premium associated with the wage-replacement risk is larger than the social net loss from production.

Key words: job security, hedonic market, implicit contract theory, guaranteed employment contract, severance pay contract, asymmetric information, prudence

JEL-Code: D86, J41, J65, K31

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[a] *Corresponding Author:* Aarhus School of Business, University of Aarhus, IAB and IZA, Prismet, Silkeborgvej 2, 8000 Aarhus C, Denmark, elja@asb.dk.

[b] University of Applied Sciences, Nuremberg, Burgschmietstr. 18, 90419 Nuremberg, Germany, Thomas.Wagner@ohm-hochschule.de

I Introduction

Many believe that globalization and ICT progress have significantly increased job insecurity (JI) over the past decades. Empirical labor market research has investigated the issue since the 1990s and tested the hypotheses of an upward JI-trend for the labor markets in the USA, UK and continental Europe, but did not come up with conclusive results. One possible reason for this mixed evidence for or against the JI-hypotheses could be that there is no economic theory of JI. Is job security (JS) an endogenous job characteristic or is JI a result of exogenous forces of culture, aggregate demand or supply shocks or the legal system?

This lack of theory is the more noteworthy, because JS ranks among the “very important” job characteristics just below or even higher than the wage, the career chances and the hours worked, as is shown by the US General Social Survey (GSS), the widespread call for private and public employment protection, the demand for public sector jobs or for work contracts with job security guarantees. The significance of JS is also reflected in the substantial amount of JS research in psychology[1], sociology[2] and economics (see Section 2) since at least the 1980s.

There are many reasons why workers demand JS and in particular, JS guarantees. A stable employment relation is the basis for a steady income stream, provides information about job vacancies, career paths, wages and fringe benefits or creates emotional utility from socializing with the worker community of a firm. Moreover, participation is an important means to gain and signal social status (*Becker* et al. 2005). These and other benefits are threatened, if the employment relation is terminated. We call the welfare loss associated with the transition from employment to unemployment the “scar of unemployment”. The far-reaching importance of the scar has also been emphasized by the happiness research and the research over the scar of unemployment[3].

Our paper is an attempt to fill the gap in economic theory. We assume that JS is an endogenous job attribute, comparable to the wage or hours, which is traded on the hedonic market for job characteristics. The perceived scar of unemployment generates the JS preferences of a worker. The hedonic price for JS reflects *ceteris paribus* the JS preferences and the labor-hoarding costs of the firms providing JS. The paper builds on both the theory of hedonic mar-

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1 *De Witte* 1999, *Isaksson* et al. 2003, *Sverke* et al. 2006

2 *Kalleberg* et al. 2000, *Burchell* et al. 2001, *Burgard* et al. 2006, *Giddens* and *Birdsall* 2006

3 *Ruhm* 1991, *Clark* and *Oswald* 1994, *Winkelmann et al.* 1998, *Arulampalam et al.* 2001a, b, *Clark* 2001, *Clark et al.* 2001, *Di Tella et al.* 2001, *Frey* and *Stutzer* 2002, *Rogerson* and *Schindler* 2002, *Farber* 2005, *Oreopoulos* et al. 2005, *Clark et al*. 2007.

kets[4] and the theory of implicit contracts[5]. The market system is incomplete. Hidden information or hidden action prevent the risk-averse workers from buying insurance against the risks of job loss. The labor contract is the only means available to a worker to accomplish protection against the risks of a dismissal.

The paper is organized as follows. Section II presents results from the empirical JS research. Section III introduces the JS model with symmetric information and derives the offer curve for JS. The offer curve spans a continuum of severance pay contracts (SPC), which converge to the guaranteed employment contract (GEC) that firms supply to workers with particularly strong JS preferences. In the symmetric information equilibrium, all workers are fully insured against the wage-risk, but only one part is willing to pay the hedonic price for the JS guarantee of the GEC. The other part with weaker JS preferences trades JS for a higher wage and accepts a strictly positive dismissal probability. Thus, contrary to the Wage-Bill Argument of *Akerlof* and *Miyazaki* (1980), the unemployment rate in the symmetric information equilibrium of the JS model is strictly positive. Section IV addresses the case of private information on the demand. JS is not contractible, firms terminate workers at will and the first-best SPCs of the JS seekers are not incentive compatible. To contain the perceived JI, the risk-averse workers trade wage risk for a higher JS.

In Section V, we introduce in addition private information on the re-employment status of a dismissed worker. Supplemental unemployment benefits are not contractible and terminated workers face a wage-replacement risk. With two-sided private information, even JS-neutral workers are willing to pay the price for a JS guarantee, if their risk premium associated with the wage-replacement risk is larger than the social net loss from production. In this case, the labor market equilibrium is indeed a "fixed-wage-*cum*-full-employment equilibrium" (*Akerlof* and *Miyazaki* 1980).

Although it is a common view that a higher aggregate JI is associated with a significant welfare loss, the JS model does not support this intuition. First, JS is endogenous. Second, comparing, for example, the common knowledge equilibrium with the one-sided private information equilibrium discloses that only a fraction of workers is confronted with higher JI in the second best situation, the others enjoy a strictly higher JS. Section VI summarizes the results; the Appendix provides proofs of the propositions.

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4 *Rosen* (1974, 1986), *Ekeland* et al. (2004).

5 *Baily* (1974), *Azariadis* (1975), *Grossman* and *Hart* (1981, 1983), *Hart* (1983), *Kahn* (1985), *Rosen* (1985).

II Literature

As basic economic theory provides no measure for JI, empirical research has developed various concepts of subjective or objective JI. Objective JI is derived from macroeconomic data, and survey data are used for the measurement of subjective JI. Nickell et al. (2002) define JI as the fear by workers of substantial income losses “whether or not they lose their job” (p. 3). The authors follow Gottschalk and Moffitt (1999) in assuming that the probability of a job loss derived from macro data, the costs of unemployment and the probability of real wage losses in the same job can be used to estimate the volatility and trend of JI. Nickell et al. find that JI increased for British men between 1982 and 1996, but not due to increased probability of a job loss, but rather due to higher costs of unemployment. In contrast, Gottschalk and Moffitt do not find an upward trend of JI in any of the three dimensions in the US labor market between 1981 and 1995. According to Green (2003), JI correlates with four factors. JI increases, if the probability and the costs of a job loss increase or if the likelihood of a wage loss in the same job rises. Green found no surge in JI in the US or in the UK during the 90s.

Manski and *Straub* (2000) and *Manski* (2004) develop a composite probabilistic measure of JI on the basis of the Survey of Economic Expectation (SEE), which weights the perceived probability of a job loss within the next 12 months with the probability of not finding a comparable new job. The composite measure of JI of our JS-model is similar to the measure used by *Manski* and *Straub* (2000). *Bryson* et al. (2004) and *Bryson* and *White* (2006) suggest that employers offer JSGs to reduce labor turnover and turnover costs. An increase of the perceived JI as a consequence of, for example, organizational change raises labor turnover, while JSGs reduce feelings of job insecurity and contain the number of quits. The authors find, based on the data of the British Workplace Employment Relations Survey (WERS), that the JS-policies of the firms are indeed negatively correlated to perceived JI.

Aaronson and *Sullivan* (1998) use data from the GSS and find a negative, but insignificant association between perceived JI and US wage growth in the 1990s. Schmidt (1999) also uses GSS data to test for an upward trend in perceived JI, measured by the expectation of a job loss during the next 12 months that would have resulted in a wage reduction or a spell of unemployment due to termination. Compared to the recoveries of the late 1970s and late 1980s, the author finds a significant increase in perceived JI for the recovery years 1993-96. In addition, the analysis of the period from 1977 to 1997 uncovers a close positive correlation between the perceived probability of a job loss and the volatility of the unemployment rate.

Erlinghagen (2007) uses data of the European Social Survey (ESS) to show that there are significant differences among the 17 countries in the EU regarding the perceived JI, which the author ascribes to institutional differences (employment law) and "country-specific anxiety cultures". *Erlinghagen* finds in particular a positive association between the fraction of long-term unemployed and perceived JI. Thus, one should expect that European countries with strict employment protection legislation (EPL) would have particularly high levels of perceived JI. However, *Erlinghagen's* results do not confirm this expectation; to the contrary, the author shows that the prevailing EPL has no significant influence on perceived JI. On the other hand, *Clark* and *Postel-Vinay* (2005) conclude from the data of the European Community Household Panel (ECHP) for twelve countries of the EU that more stringent EPL lowers the perceived JS significantly, whereas the generosity of the unemployment insurance benefits is positively associated with perceived JS.

Valetta (1999) appears to be the only theoretical model that analyzes the economic implications of JS. The author classifies his JS model, which is a simplified version of *Ramey* and *Watson* (1997), as an implicit contract model of JS. *Valetta* argues that the desire for JS arises only in a world with inefficient separations. The worker would prefer to continue, but the firm terminates the employment relation. If all separations are efficient, "job security is irrelevant" (p. S172). There are two types of labor contracts and two states. The robust contracts are linked to specific investments that permit the continuation of a match in the good as well as in the bad state. For the fragile contract, the specific investment is just sufficient to produce in the good state. In a recession, even though the joint return of the match is positive and it would be efficient to maintain the job, the employment relationship is dissolved because one of the contracting parties will succumb to the temptation to shirk. Shirking will be detected immediately and will lead to separation. The incidence of fragile contracts and thus JI will increase, if the value of the outside options of the respective shirker rises, the probability of a recession decreases and the probability of re-employment after separation increases.

III The Model

1 Sequence of Events

There are two labor markets, a spot market and a contract market. On the spot market, the wage, the wage-replacement payments and the probability to become unemployed are exogenous. Workers face uninsurable wage-risk and exogenous JI. On the contract market, the wages, wage-replacement payments and individual JI are endogenous. The only difference between the two market types is the endogeneity of the wage, the wage-risk and the individual JI.

Why a spot market? First, dismissed workers search on the spot market for a new job. Thus, as suggested by *Manski* and *Straub* (2000, *Manski* 2004), we can make use of composite measures of individual and aggregate JI that are functions of the chance of a recession, the perceived probability of separation and the chance of finding re-employment. Second, the spot market assures that the entire labor force will conclude a labor contract. Thus, the decision to close a labor contract in order to insure one's income and to protect against JI is endogenous and socially efficient. Finally, the spot market allows us to analyze the effects of two-sided private information with uninsurable wage-risk for the equilibrium JI allocation.

Spot Market. The model is static. A worker may search the spot market at any time during the period. If he opts for the spot market, he will find a job with probability $p \in (0,1)$ due to search frictions, or he will become unemployed and suffer the scar of unemployment otherwise. v is the spot market wage. The unemployed receive unemployment benefits b. Thus, workers, who opt for the spot market, have an expected income equal to $I_S = pv + (1-p)b$. Firms have a constant returns-to-scale technology that uses only labor, where y is the capacity output of a job-worker pair. We assume for the "replacement incomes" b and v that

(A1) $$0 \le b < v \le y.$$

Contract Market. The sequence of events consists of three stages. Jobs with a contract are available only at stage 0. The market offers two contract forms. The GEC specifies a wage and a job-security guarantee, where we exclude the case of nonperformance by assumption. The terms of a SPC depend on the presumed information structure. With symmetric information, the SPC defines a severance pay A and supplemental unemployment benefits (SUB) B, in addition to the wage w. A separation clause completes the SPC. The clause specifies a reservation demand yR at which firm and worker separate when the job is hit by an adverse shock at stage 1 and demand falls below yR. Based on the observed demand yx, the firm decides whether to produce ($x \ge R$) or to terminate the job and to disburse the severance pay A ($x < R$).

At stage 2, a released worker searches for a new job on the spot market. He fails to find a job and becomes unemployed with probability $1-p$. An unemployed worker receives SUB B from his former employer in addition to the unemployment benefits b. The income of the unemployed is thus equal to $A+B+b$, while the earnings of a terminated worker, who did find a new job, amount to $A+v$.

At the last stage, the jobless experience the scar of unemployment, an adverse idiosyncratic shock to the welfare of the unemployed worker.

2 Profit and Utility Function

Demand shocks. y is the capacity output of a filled job in the good state. Demand shocks arrive with probability $\lambda \in (0,1)$. The output of a job hit by a shock is yx, where x is drawn from a general distribution G with support $0 \le \alpha \le x \le 1$. We assume throughout that G is common knowledge. The shock x has a probability density g with $g(x) = G'(x) > 0$ for all $x \in [\alpha,1]$, so that $\alpha < \mu < 1$, where μ is the mean of the shock distribution. When characterizing the hedonic price function, we assume also that the density function g is differentiable.

Contract. An employment contract $C = [w, C_\lambda]$ consists of the wage w, which is paid in the good state, and a real-valued function $C_\lambda : [\alpha,1] \to \mathbf{R}^4$, which specifies the contract provisions in case of a demand recession. $C_\lambda(x) = [r(x), \omega(x), A(x), B(x)]$ are the provisions conditional on the occurrence of the recession state $x \in [\alpha,1]$. The indicator function r specifies whether the job will produce ($r(x)=1$) and the worker is paid the wage $\omega(x)$, or whether the job is closed down ($r(x)=0$) and the worker receives the severance pay $A(x)$ and the option to claim $B(x)$, if he does not find a new job and becomes unemployed.

Profit and Utility Function. The *ex ante* expected profit of a risk-neutral firm bound to the contract $C = [w, C_\lambda]$ is

$$J(C) = (1-\lambda)(y-w) + \lambda \int_\alpha^1 [r(x)[yx - \omega(x)] - (1-r(x))[A(x) + (1-p)B(x)]]dG(x).$$

In the good state, the profit of the firm is $y-w$. If the job is hit by a shock x and the contract stipulates production, the profit is $yx - \omega(x)$. If $r(x)=0$, the parties separate and the profit is equal to the termination costs $-[A(x)+(1-p)B(x)]$.

The worker is either employed or unemployed. If employed, his end-of-period utility from consuming c is $u(c)$. If unemployed, his end-of-period utility is $\upsilon(c,\zeta)$, where ζ is the scar of unemployment. The utility functions u and υ fulfill the assumption:

(A2) $u : \mathbf{R}_+ \to \mathbf{R}$, the von-Neumann-Morgenstern utility function of the employed, is a C^2 function with $u' > 0$ and $u'' < 0$. The utility function of the unemployed, $\upsilon : \mathbf{R}_+ \times \mathbf{R}_+ \to \mathbf{R}$, is quasi-linear with respect to the scar of unemployment, $\upsilon(c, \zeta) = u(c) - \zeta$. The scar $\zeta \geq 0$ is a worker-specific random variable with distribution function Z and mean $z = \int_0^\infty \zeta dZ(\zeta) \geq 0$.

If a worker signs the contract $C = [w, C_\lambda]$, his *ex ante* expected utility is

$$U(C) = (1-\lambda)u(w) + \lambda \int_\alpha^1 [r(x)u(\omega(x)) + (1-r(x))V(A(x), B(x), z)]dG(x).$$

In the good state, the budget of the worker is $c = w$, and his utility is $u(w)$. If the job is hit by a shock x and the contract stipulates production, the firm pays the remuneration $\omega(x)$ and the utility of the worker is $u(\omega(x))$. If $r(x) = 0$, the job is closed down, and the terminated worker moves to the spot market to look for a new job. With probability p, he finds a job with wage v. Together with the severance pay $A(x)$, his consumption is $c(x) = A(x) + v$ and his *ex post* utility $u(A(x) + v)$. With probability $1 - p$, he becomes unemployed. As the contract stipulates the severance pay $A(x)$ and the SUB $B(x)$, his consumption is $c(x) = A(x) + B(x) + b$. Accounting for the scar, his *ex post* utility is $u(A(x) + B(x) + b) - \zeta$. Hence, the *ex ante* expected utility conditional on termination is

$$V(A(x), B(x), z) = pu(A(x) + v) + (1-p)[u(A(x) + B(x) + b) - z].$$

JS-seeker. Our ζ-theory presupposes that the additive scar of unemployment is exogenous and resembles a negative termination externality, which causes material or psychic costs. The jobless compare their deprived status with their self-perception or with the socio-economic status of a reference group and, as in the literature on the happiness research, suffer *ceteris paribus* a welfare loss equal to $\zeta \geq 0$. The scarring effect could depend, for example, on the employment career of the worker, on his age and education, on his family status, on the local unemployment rate or on private or social norms[6]. We consider this heterogeneity by assuming different worker types $z \geq 0$, where F is the distribution function of the scar z.

$F(z)$ is the proportion of workers who expect a scar equal to or less than z. Presumably, F has a point mass at $z = 0$, such that $F_0 \equiv F(0) > 0$, given that not all jobless will suffer a scar of unemployment. F_0 is the proportion of JS-neutral workers. In contrast to the JS-neutral workers, the JS seekers expect a scar of unemployment $z > 0$ and are looking *ex ante* for pro-

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6 *Clark* and *Oswald* (1994), *Clark* et al. (2001), *Böckerman* (2002), *Stutzer* and *Lalive* (2004), *Layard* (2005).

tection from the welfare loss caused by z. We assume that the proportion of JS seekers, $F_{-0} = 1 - F_0$, is strictly larger than zero $F_{-0} > 0$. Neoclassical labor market theory generally assumes that $F_0 = 1$ and thus $F_{-0} = 0$, so that all neoclassical workers belong to the JS-neutral type.

3 Risk-Efficient Labor Contracts

With symmetrical information, the expected utility of a worker is additively separable in the wage-risk and JI, as will be shown shortly. Therefore, we will discuss first the optimal insurance conditions and afterwards the conditions for the optimal JS for a given worker type. Note that risk-neutral firms in a competitive market will implement the optimal full insurance conditions without compensation, but will charge the workers the hedonic price for providing the employee-specific optimal dismissal rules.

Lagrangian function. Because workers can opt for either the spot or the contract market, the utility from searching the spot market $V(z)$, where $V(z) = pu(v) + (1-p)[u(b) - z]$, is the reservation utility for all worker types $z \geq 0$. Before we demonstrate (see Proposition 2) that the expected utility from a contract job is strictly larger than $V(z)$ for all $z \geq 0$, we will first present characteristics of the set of efficient employment contracts.

An employment contract $C = [w, C_\lambda]$ is called efficient with respect to a worker of type z, if C maximizes the *ex ante* expected utility $U(C)$ of z subject to the a non-negative profit constraint for the employer of z, $J(C) \geq 0$. $\mathcal{L}(C,\delta) = U(C) + \delta J(C)$ is the Lagrangian of the maximization problem, and $\delta \geq 0$ is the Lagrangian multiplier associated with the participation constraint. The Lagrangian is a concave function of the contract terms with the following first-order conditions (FOC) for an interior solution

$$\frac{\partial \mathcal{L}}{\partial w} = (1-\lambda)[u'(w) - \delta] = 0$$

$$\frac{\partial \mathcal{L}}{\partial \omega(x)} = \lambda r(x)[u'(\omega(x)) - \delta] = 0$$

$$\frac{\partial \mathcal{L}}{\partial A(x)} = \lambda(1-r(x))[pu'(A(x)+v) + (1-p)u'(A(x)+B(x)+b) - \delta] = 0$$

$$\frac{\partial \mathcal{L}}{\partial B(x)} = \lambda(1-r(x))(1-p)[u'(A(x)+B(x)+b) - \delta] = 0 .$$

Inspection of the FOC yields the following results

LEMMA 1. (i) The Lagrangian multiplier δ is equal to the marginal utility of consumption in the good state, where $u'(w) = \delta > 0$, given (A2). (ii) If production occurs in a recession state x, then $r(x) = 1$ and $u'(\omega(x)) = \delta$. (iii) If the job is closed down, then $r(x) = 0$ and $u'(A(x)+v) = u'(A(x)+B(x)+b) = \delta$. Therefore, the following full insurance conditions for the worker's income risk hold

(1) $$w = \omega = A + (1-p)B + I_S = A + v = A + B + b .$$

An *ex ante* risk-efficient employment contract fully shifts the consumption risk of the risk-averse worker to the risk-neutral firm. The contract wages w and ω, the severance pay A, and the SUB B are all state independent, while the marginal utility of consumption is equal in all possible states, which in turn implies the full insurance conditions (1). The *ex ante* expected wage-replacement rate, which relates the expected replacement income of a terminated worker, $A + (1-p)B + I_S$, to his contract wage w, is equal to one. Likewise, the *ex post* replacement rates, which relate the income of a terminated worker, who found a spot market job, $A + v$, or who became unemployed, $A + B + b$, to his contract wage, are both equal to one.

Reservation productivity. To characterize the optimal *ex ante* separation clause, assume that $C = [w, C_\lambda]$ is a risk-efficient contract for worker $z \geq 0$. Furthermore, assume that the job is hit by a shock $x \in [\alpha, 1]$. If production occurs, firm and worker earn the joint return yx. If firm and worker separate, their joint expected income is I_S. Thus, $h(x)$, with $h(x) = yx - I_S$, is the social net return from continuing the job. For the continuation rent $h(x)$, we assume

(A3) $$h(\alpha) < 0 < h(1) .$$

The inequality on the right side follows from (A1); the inequality on the left can be justified as follows. If the continuation rent is positive for all $x \in [\alpha, 1]$, such that $h(\alpha) \geq 0$, then the set of efficient labor contracts consists only of the GEC, as we will show below. Thus, firms in an economy with $h(\alpha) \geq 0$ bear no labor-hoarding costs, so that they supply JS as a free service.

Given (A3), the continuation rent $h(x)$ has an interior zero at a point $R_m \in (\alpha, 1)$. Let the wage w and the endogenous replacement payments of contract C, A and B, be given. Then, given (A3), the following lemma characterizes the reservation property of the separation clause of C.

LEMMA 2. (i) The worker $z \geq 0$ favors production to separation for all $x \in [\alpha, 1]$, the preference being strict, if the worker is a JS seeker, such that $z > 0$. (ii) The employer of z prefers production in all states $x \geq R_m$ and strictly prefers separation, if $x < R_m$. (iii) Therefore, regardless of the worker type z, $r(x)=1$ holds, whenever $x \geq R_m$. (iv) In addition, for all $z \geq 0$, there is a unique reservation productivity $R(z)$ depending on z, with $\alpha \leq R(z) \leq R_m$, such that $r(x)=1 \Leftrightarrow x \geq R(z)$.

Job Security. Due to the reservation property of the termination clause and the full insurance conditions (1), the terms of an efficient employment contract for a worker of type $z \geq 0$ are uniquely determined by the contract wage w and the reservation productivity R, which are both functions of z. Consequently, we obtain the *ex ante* expected utility of z from

$$\begin{aligned} U(w,R) &= (1-\lambda)u(w) + \lambda \int_R^1 u(\omega(x))dG(x) + \lambda \int_\alpha^R V(A(x),B(x),z)dG(x) \\ &= u(w) - \lambda G(R)(1-p)z \end{aligned} \tag{2}$$

The expected utility is the sum of the utility from consumption $u(w)$ and the job insecurity $JI(z) = \varphi(R)z$, where $\varphi(R) = \lambda G(R)(1-p)$. As in *Manski* and *Straub* (2000) and *Manski* (2004) $\varphi(R)$ is a composite probabilistic measure of the event that the job of z will fall into a recession, the labor contract will be terminated, z will not find a new job and will eventually become unemployed.

We will show below that the reservation productivity $R(z)$ is a decreasing function of the expected scar of unemployment. In combination with F, the distribution function of z, we thus obtain the following measure Γ for the aggregate JI:

$$\Gamma(z_\alpha) = \int_{0^+}^{z_\alpha} \varphi(R(z))z\, dF(z).$$

By the fact that $R(z) \in [\alpha,1]$ is strictly decreasing, it is the case that we can divide the continuum of worker types $z \in [0,\infty)$ into two disjunct and connected subsets. Only the workers of type $z \in [0, z_\alpha)$ face JI, whereas the workers of type $z \in [z_\alpha, \infty)$ will conclude a JS guarantee. We will characterize the marginal worker type z_α below.

The *ex ante* expected profit of a job bound to the efficient contract $C(z)$ is

$$\begin{aligned} J(w,R) &= (1-\lambda)(y-w) + \lambda \int_R^1 (yx-\omega)dG(x) - \lambda \int_\alpha^R [A+(1-p)B]dG(x) \\ &= Y(R) - l(w,R) \end{aligned} \tag{3}$$

where $Y(R)$ is the *ex ante* expected revenue with $Y(R) = y[(1-\lambda) + \lambda\mu(R)]$ and $\mu(R) = \int_R^1 x\,dG(x)$, and $l(w,R)$ are the *ex ante* expected labor costs. Labor costs l consist of wage and termination costs: $l = (1-\lambda G(R))w + \lambda G(R)[A + (1-p)B]$. Considering the full insurance conditions (1), we can rewrite the termination costs to derive $l = w - \lambda G(R) I_S \equiv l(w,R)$.

Labor-Hoarding Costs. Both the revenue and the labor costs are strictly decreasing functions of *R*, as $Y'(R) = -\lambda g(R) yR < 0$ and $l_R(w,R) = -\lambda g(R) I_S < 0$, where $l_R(w,R)$ denotes the partial derivative of the labor cost function with respect to *R*. Considering (A3), the marginal revenue is strictly larger than the marginal labor costs for all $R \in [\alpha, R_m)$. Thus, the marginal profit is strictly larger than zero, $J_R(R) = -\lambda g(R) h(R) > 0$, if $R \in [\alpha, R_m)$, and strictly smaller than zero, if $R \in (R_m, 1]$. Hence $J(w,R)$ has a maximum at $R_m \in (\alpha, 1)$.

We can now define the labor-hoarding costs $H(R)$ of a firm that pays the wage *w* and that is contractually obligated to implement reservation productivity *R*, through

$$H(R) = \begin{cases} J(w,R_m) - J(w,R), \text{ for } R \in [\alpha, R_m] \\ \\ 0, \text{ otherwise} \end{cases}.$$

$H(R)$ measures the foregone profit of a firm that sacrifices the chance to dismiss workers at-will and agrees by contract to implement a termination rule with reservation productivity $R \in [\alpha, R_m]$. Apparently $H(R_m) = H'(R_m) = 0$, while $H(R) > 0$ and $H'(R) < 0$ for all $R \in [\alpha, R_m)$.

The Wage-Bill Argument. If $h(x) > 0$, then the marginal profit $J_R(x) = -\lambda g(x) h(x) < 0$ is strictly negative. Thus, the profit of the firm has a boundary maximum at $R = \alpha$, if the strictly increasing and continuous joint net return $h(x)$ for all $x \in (\alpha, 1]$ is positive, such that $h(\alpha) \geq 0$. Given the fact that the marginal utility of *R* is non-positive on $[\alpha, 1]$, $\partial U / \partial R = -\lambda g(R)(1-p)z \leq 0$, the GEC with the reservation productivity $R = \alpha$ is the only efficient labor contract, and the labor market equilibrium is a "fixed-wage-*cum*-full-employment equilibrium" (*Akerlof* and *Miyazaki* 1980).

4 Hedonic Price of Job Security

The endogenous variable through which a JS seeker implements his privately optimal JS is the reservation productivity *R*. *R* determines $\varphi(R) = \lambda G(R)(1-p)$, which is the composite probability of becoming unemployed and suffering the scar of unemployment.

First, we will discuss the bid prices, which reflect the willingness of workers to pay for alternative values of *R*. The bid price in turn determines the bid wage. A bid wage is the lowest wage demanded by a worker for a contract with reservation productivity *R* und a JI determined by $\varphi(R)$. Next, we introduce the offer prices of the firms. An offer price is the lowest price demanded by firms to cover the labor-hoarding costs incurred by implementing the job characteristic *R*. The offer price determines the offer wage, which is the highest wage firms are prepared to offer for a labor contract with reservation productivity *R*.

Bid wage. Both workers and firms behave as price takers in the hedonic market for JS. The workers, who are productively homogeneous, earn the equilibrium wage w_m and pay the hedonic price $P(R)$ for job characteristic *R* and thus earn the (net) wage $w(R) = w_m - P(R)$.

Workers of type *z* are willing to pay the bid price $\theta(R;U,z)$ for job characteristic *R* at given utility level *U*. The bid function is implicitly defined by $U = u(w_m - \theta) - \varphi(R)z$, where $u(w_m - \theta)$ is the utility of consumption and $\varphi(R)z$ is the JI of the worker of type *z*. Implicit differentiation determines the signs of the partial derivatives of the bid function with respect to *R*, *U* und *z*, where we get for $R \in (\alpha, 1]$, $u' = u'(w_m - \theta) > 0$ and $\varphi' = \lambda g(R)(1-p) > 0$ that: $\theta_R = -\varphi' z / u' < 0$, if $z > 0$, $\theta_U = -1/u' < 0$ and $\theta_z = -\varphi / u' < 0$.

The labor force consists of JS seekers and JS-neutral workers. JS seekers of type *z* are willing to pay higher prices for a higher level of JS, as is shown by $\theta_R < 0$. The second partial derivative of the bid function with respect to *R* is $\theta_{RR} = -z(\varphi'' u' + \varphi' u'' \theta_R)/(u')^2$. Thus, the bid function is strictly concave in *R*, if JI is (weakly) convex, such that $\varphi''(R) \geq 0$. If, for example, the demand shocks are uniformly distributed, then $g' = 0$ and thus $\varphi''(R) = 0$, such that $\theta_{RR} = -z\varphi' u'' \theta_R /(u')^2 < 0$. A strictly concave bid function implies a diminishing willingness of the JS seekers of type *z* to pay for additional JS.

The bid wage $\underline{w}(R;U,z)$, which is the minimum wage demanded by workers of type *z* and fixed utility level *U* for a labor contract with JI $\varphi(R)z$, is $\underline{w}(R;U,z) = w_m - \theta(R;U,z)$. The bid wage function is strictly increasing with respect to the reservation productivity *R*, the utility index U and the expected scar z, as the partial derivatives with respect to R, U and z show: $\underline{w}_R = -\theta_R > 0$, $\underline{w}_U = -\theta_U > 0$ and $\underline{w}_z = -\theta_z > 0$. To accept an infinitesimally higher JI, the JS seekers of type z will ask for a compensation of at least $\underline{w}_R(R;U,z) > 0$. If JI is convex, such that $\varphi''(R) \geq 0$, the bid wage function will be strictly convex, as $\underline{w}_{RR} = -\theta_{RR} > 0$. The convexity of $\underline{w}(R;U,z)$ implies that the compensation for JI demanded by a JS seeker of type z is strictly increasing with the amount of JI. Figure 1 shows strictly convex bid wage curves for JS seekers of type z_1 and z_2.

$P(R)$ is the minimum price workers must pay for job characteristic R in the market, while $\theta(R;U,z)$ is the maximum price workers of type z are willing to pay for R at given utility level U. Therefore, when utility is maximized, the hedonic price must equal the bid price: $P(R(z)) = \theta(R(z);U(z),z)$, where $U(z)$ and $R(z)$ are the maximal utility and the optimal reservation productivity of the worker type z, respectively. Moreover, when utility is maximized, the bid wage workers of type z ask for when concluding a labor contract with reservation productivity $R(z)$ and the maximal wage paid in the market for that contract must fulfill $\underline{w}(R(z);U(z),z) = w(R(z))$ and $\underline{w}_R(R(z);U(z),z) = w'(R(z))$. The second condition says that when utility is maximized, the compensation demanded by workers of type z for a marginal increase in JI equals the compensation offered in the market.

Offer functions. The offer function $\phi(R;J)$ represents the minimum price firms are willing to accept for reservation productivity R at a fixed expected profit of J. Given equation (3), the offer function is determined by the iso-profit condition $J = Y(R) - [w_m - \phi - \lambda G(R) I_S]$. Rearranging terms yields: $\phi(R;J) = J + w_m - [Y(R) + \lambda G(R) I_S]$. The offer price function is strictly decreasing in R, as follows from the sign of the derivative of $\phi(R;J)$ with respect to $R \in [\alpha, R_m)$, $\phi_R(R) = \lambda g(R) h(R) < 0$, and reaches a minimum at R_m, because $h(R_m) = 0$, so that the FOC for a minimum point $\phi_R(R_m) = 0$ is satisfied. That R_m is indeed a minimum point follows then from $\phi_R(R) > 0$ for $R \in (R_m, 1]$.

The following discussion centers on the long-run equilibrium of the hedonic market. The reason is that unlike in the standard hedonic models, the JS-model focuses on sorting by worker characteristics, whereas the firms adapt their contract terms frictionless to the exogenous distribution of JS preferences.

In the long-run equilibrium $J = 0$, and we can write the offer function as $\phi(R) = w_m - [Y(R) + \lambda G(R) I_S]$. $\phi(R_m)$, the minimum of the offer function, is the lowest offer price for JS in the hedonic market. Hence, without loss of generality, we can set $\phi(R_m) = 0$. The competitive wage w_m then takes on the value $w_m = Y(R_m) + \lambda G(R_m) I_S$ in the long-run equilibrium. If we plug w_m into the offer function, we find that the offer price for $R \in [\alpha, R_m]$ equals the labor-hoarding costs of a firm that commits itself to a labor contract with reservation productivity *R*, so that $\phi(R) = H(R)$ for all $R \in [\alpha, R_m]$. Thus, the competitive offer prices cover the labor-hoarding costs of the JS suppliers.

Given that $P(R)$ is the maximum price for job characteristic *R* that firms will receive in the market, profit maximum must satisfy $\phi(R) = P(R)$, which implies the strictly decreasing hedonic price function for the job characteristic *R*

$$P(R) = w_m - [Y(R) + \lambda G(R) I_S].$$

The wage offer function is given by $\overline{w}(R) = w_m - \phi(R)$. $\overline{w}(R)$ is the maximum (net) wage that firms are willing to pay for a labor contract with reservation productivity *R* at an expected profit $J = 0$. The wage offer function is strictly increasing on the interval $[\alpha, R_m)$, as $\overline{w}'(R) = -\lambda g(R) h(R) > 0$ shows, and reaches a maximum at R_m, where the necessary condition $\overline{w}'(R_m) = 0$ holds. The second derivative of the offer function with respect to *R* is $\overline{w}''(R) = -\lambda[g'(R) h(R) + g(R) y]$, so that the sufficient condition for a maximum of $\overline{w}(R)$ at R_m is satisfied, as $\overline{w}''(R_m) = -\lambda g(R_m) y < 0$, since $h(R_m) = 0$. Uniformly distributed demand shocks suffice for the strict concavity of the wage offer function, because $\overline{w}''(R) = -\lambda g(R) y < 0$, when $g' = 0$.

Since $w(R)$ is the minimum (net) wage firms must pay for a labor contract with reservation productivity *R* and JI $\varphi(R)$, profit maximization requires that $w(R) = \overline{w}(R)$, so that we obtain the wage function

$$w(R) = Y(R) + \lambda G(R) I_S \tag{4}$$

As is shown in Fig. 1, the offer curve is strictly increasing on $[\alpha, R_m)$, $w'(R) = -\lambda g(R) h(R) > 0$, and reaches its maximum at productivity R_m, where $h(R_m) = 0$. Thus, the highest wage is earned by those workers, who conclude a SPC with the reservation productivity R_m, for which $w(R_m) = w_m$ and $P(R_m) = 0$. The lowest wage, $w_\alpha \equiv w(\alpha) = Y(\alpha)$, is paid to workers that conclude a GEC with the reservation productivity $R = \alpha$. Moreover, the offer curve is strictly concave on $[\alpha, 1]$, see Fig. 1, if the demand shocks are uniformly distributed.

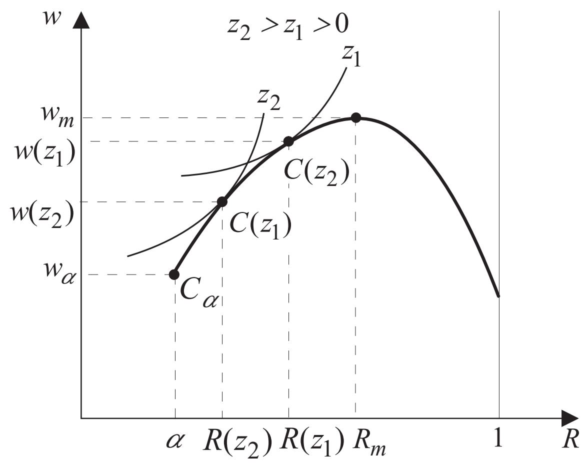

Fig. 1: Severance Pay Contracts of workers z_1 and z_2

Now we can answer the question how the optimal wage and reservation productivity $w(z)$ and $R(z)$ depend on z. At the utility maximum $U(z)$, the marginal bid wage required by workers of type z at given utility $U(z)$ for a small increase of the reservation productivity equals the marginal wage offered in the market, i.e. $\underline{w}_R(R(z); U(z), z) = w'(R(z))$. Inserting the derivatives on both sides of the equation yields the FOC for the utility maximum for type z

(5) $$\frac{(1-p)z}{u'(w(R))} = -h(R).$$

We call a risk efficient labor contract for type z that satisfies equations (4) and (5) an efficient or first-best contract. The relationship between the provisions of an efficient labor contract $C(z) = [w(z), R(z)]$ and the expected scar $z \geq 0$ follows from equations (4) and (5), where we write $w(z)$ instead of $w(R(z))$ for the optimal wage.

LEMMA 3. The reservation productivity $R(z) \in (\alpha, R_m]$, the wage $w(z)$ and hence the severance pay $A(z)$ of the efficient contract $C(z)$ of worker type $z \geq 0$, are strictly decreasing C^1 functions of z. Thus, the equilibrium of the contract market is characterized by wage dispersion, which reflects worker sorting by the expected scar of unemployment z. The terms of the efficient SPC of the JS-neutral worker are in particular determined by $R(0) = R_m$ and $w(0) = w_m$.

Marginal worker type. Some JS seekers prefer the risk-free GEC that eliminates not only the income risk, but also the scarring risk of unemployment. The wage of the GEC is $w_\alpha \equiv w(\alpha) = Y(\alpha)$, and the probability of termination is $\lambda G(\alpha) = 0$. Thus, the JI, when protected by the GEC, is $\varphi(\alpha)z = 0$. We will characterize next the marginal worker type z_{α_1}, who is indifferent between the GEC and the type-specific SPC.

PROPOSITION 1. The z-value of the marginal worker type, z_{α_1}, is determined by

$$z_{\alpha_1} = -\,h(\alpha)\frac{u'(w_\alpha)}{1-p} > 0\,. \tag{6}$$

All workers with a scar that exceeds z_{α_1} prefer the JS guarantee of the GEC, whereas all others prefer to trade JS for a higher wage and conclude a type-specific SPC with a positive exposure to JI. The efficient exposure to JI of a worker of type $z \in (0, z_{\alpha_1})$ is given by $JI(z) = \varphi(R(z))z$. Obviously, $JI(0) = JI(z) = 0$ for all $z \geq z_{\alpha_1}$, such that the JI function $JI(z)$ is initially strictly increasing on the open interval $(0, z_{\alpha_1})$, reaches a global interior maximum and strictly decreases thereafter. Hence, the relationship between $JI(z)$ and the perceived probability of termination $\lambda G(R(z))$ is hump-shaped.

Workers with an expected scar $z > z_{\alpha_1}$ are willing to accept a wage $\underline{w}(z)$ that is strictly lower than the GEC wage w_α. The respective bid wage follows from (6) by replacing z_{α_1} with z and the GEC wage w_α with $\underline{w}(z)$. Implicit differentiation implies that $\underline{w}'(z) = -(1-p)/h(\alpha)u'' < 0$, where $h(\alpha)u'' > 0$. Given that $\underline{w}(z) < w_\alpha$, firms could exploit the vulnerable JS seekers by setting a wage w for which $\underline{w}(z) \leq w < w_\alpha$. As $\underline{w}(z) \leq w$, workers are willing to accept the offered contract, unless they meet competing suppliers of JS guarantees with higher wages. Because $w < w_\alpha$, firms would reap a profit $J(w,\alpha) > J(w_\alpha,\alpha) = 0$ despite the labor hoarding costs of the JS guarantee. However, in the long run, market entry and competition would drive the rent $w_\alpha - w$ down to zero.

5 Contract and Spot Market Jobs

The workers have the choice between the contract market and a spot market job in stage 0. Their decision depends on whether the spot market option is also available after being dismissed in stage 1. If the option can be exercised only in stage 0, a part of the labor force will immediately opt for the spot market and refuse all contract jobs. However, if the spot market is accessible on all stages, the entire labor force prefers a contract to a spot market job, as we will show next.

Assume that the spot market option is available only in stage 0, so that the dismissed workers become irrevocably unemployed and suffer the scar of unemployment. In that case, the JS-neutral workers will strictly prefer to search for a spot market job, despite the uninsurable income risk, if the following two conditions are fulfilled. First, the spot market wage v must exceed the contract wage w_0, where $C_0 = [w_0, R_0]$ is the efficient labor contract for a JS-neutral worker, if unemployment is the inescapable consequence of a dismissal. In analogy to wage equation (4), the wage w_0 is determined by $w_0 = Y(R_0) + \lambda G(R_0)b$. Given the fact that $w_0 < y$, spot market wages v exist, for which $w_0 < v \leq y$. The respective reservation productivity R_0 follows from the continuation rent $\hat{h}(x) = yx - b$ with $\hat{h}(R_0) = 0$. Obviously $R_0 < R_m$, such that $w_0 < w_m$. Second, the probability p of finding a spot market job must satisfy

$$p > p_0 \equiv \frac{u(w_0) - u(b)}{u(v) - u(b)}.$$

If both conditions are strictly satisfied, a continuum of z types will decline to sign a labor contract and will instead search for a spot market job (see Proposition 2). In equilibrium, a part of the active labor force is employed in the spot market, whereas the rest, possibly of measure zero, prefers to work under a labor contract, as a contract provides insurance against the wage risk and protection from the scar of unemployment.

If the spot market option is also available in stage 1 after separation, the entire labor force, including the JS-neutral workers, will sign a labor contract. To prove this and the above proposition, let $U(z)$ denote the expected utility of z, if z concludes the efficient contract $C(z)$ and remember that $V(z) = pu(v) + (1 - p)[u(b) - z]$ is the *ex ante* expected utility of a spot market job.

PROPOSITION 2. (i) If the spot market option is available only in stage 0 and if $v > w_0$ and $p > p_0$, then the JS-neutral workers will strictly prefer to look for a spot market job, i.e. $V(0) > U(0)$. (ii) However, if the spot market option is also available after separation, then $U(z) > V(z)$, for all worker types $z \geq 0$,

In *Jahn* and *Wagner* (2005), we present the comparative static results for the JS-model and address the questions whether the *ex ante* agreed upon termination clauses of a SPC and the GEC are *ex post* efficient and whether re-contracting can improve efficiency, when the firm observes an alternative use for its job endowment at stage 1.

IV One-sided Private Information

If the demand for the output of a job is observed by the firm, but not by the worker, the termination decision is non-contractible and the firms dismiss the workers at will. The hedonic market for JS generates a system of state contingent hedonic prices for JS. The number of prices depends on the coarseness of the worker's information partition. In the common-knowledge equilibrium, each quantity of JS has a unique hedonic price, which compensates the employer for his labor-hoarding costs. In the equilibrium with one-sided private information, employers terminate the workers at will and incur no private labor-hoarding costs. Instead, the prices for JS serve as incentives to stimulate the employer to implement the worker's constrained optimal JS. For the sake of brevity, we skip the derivation of the system of state contingent hedonic prices and derive the risk and JS-allocation of the private-information equilibrium with the instruments of non-linear programming.

We will first discuss the incentive-compatibility constraint, which a JS seeker must take into account in order to move his employer to implement the constrained optimal at-will rule. Next, we show that only the first-best contracts of the extreme z-types are incentive compatible. Then we focus on the question how the JS seekers with first-best SPCs react to the one-sided private information and the resulting employment at-will rule.

We can distinguish between two information structures, depending on whether the private information relates to the demand shock *per se* or, more specifically, to the observability of the demand *yx*. We assume that a worker at stage 1 has sufficient information to verify whether his job is in a recession, but that he cannot observe the specific demand state *yx* before production takes place. Given this information structure, a SPC $C = [w, \omega, A, B]$ has four components, the wages w and ω, which the worker is paid in the good state and in a recession, respectively, the severance pay A, and the SUB B.

The expected profit of a job with a contract *C* and the reservation productivity *R* is

$$J(C,R) = Y(R) - (1-\lambda)w - \lambda\big[(1-G(R))\omega + G(R)[A + (1-p)B]\big], \tag{7}$$

where $Y(R)$ is the *ex ante* expected revenue. In the shadow of the information asymmetry the firm selects the profit maximizing reservation productivity *R*. *R* satisfies the FOC $J_R(C,R) = 0$ if, and only if, the operating loss $\omega - yx$ equals the expected costs of a dismissal $A + (1-p)B$. Thus, the firm terminates the worker, if $x < R$, where the threshold *R* of the profit maximizing at-will rule follows from the incentive compatibility constraint $IC(C,R) \equiv A + (1-p)B - (\omega - yR) = 0$. Solving the equation for *R*, we get the reaction function of the firm $R(\omega, A)$. If the recession wage decreases or the severance pay increases, the firm will reduce *R* and the JI of the worker will decline, as the partial derivatives of the reaction function reveal: $R_\omega > 0$ and $R_A < 0$.

The expected utility of a JS seeker of type *z* with contract *C*, whose employer picks the reservation productivity *R*, is

$$U(C,R) = (1-\lambda)u(w) + \lambda(1-G(R))u(\omega) + \lambda G(R)V(A,B,z). \tag{8}$$

Taking into account the free entry condition, the private information SPC for a worker of type $z \geq 0$ corresponds to the solution of the constrained maximization problem

$$\max_{\{C,R\}} U(C,R) \quad \text{subject to} \quad J(C,R) \geq 0 \text{ and } IC(C,R) = 0. \tag{9}$$

Grossman and *Hart* (1981, 1983) emphasize that the first-best SPC between a JS-neutral worker with $z = 0$ and a risk-neutral firm is incentive compatible, even though the termination decision is not contractible. The authors thus model the consequences of the information asymmetry under the assumption that the firm is risk-averse. In the JS model, the incentive compatibility of the first-best contract follows at once from the JS-neutrality of the neoclassical workers.

In contrast, a risk-neutral firm that employs a JS seeker has a strong incentive in a recession to announce a wrong output demand to terminate the job and to dismiss the worker. The reason is that a first-best SPC not only shifts the income-risk to the risk-neutral firm, but also protects the worker from termination. However, protecting a JS-seeker with the first-best reservation productivity $R(z) < R_m$ against the scar of unemployment forces the firm to hoard his labor in all recession states *x*, for which $R(z) \leq x < R_m$. Hence, if the demand is private information, the firm can save the labor hoarding costs $H(R(z)) > 0$ and terminate the job at the profit maximizing R_m, for which $H(R_m) = 0$.

LEMMA 4. The first-best SPC of a JS-seeker $z \in (0, z_{\alpha_1})$ is not incentive compatible, if the demand for the output of the job is observed by the firm, but not by the worker.

$\mathcal{L}(C, R, \delta, \gamma) = U(C, R) + \delta J(C, R) + \gamma IC(C, R)$, the Lagrangian of the maximization problem (9), is a concave function of the provisions of the private information SPC and *R*. The FOC for an interior solution with $\delta \geq 0$ and γ as the Lagrangian multipliers of the participation and the incentive constraint, respectively, are

$$\frac{\partial \mathcal{L}}{\partial w} = (1-\lambda)[u'(w) - \delta] = 0 \tag{10}$$

$$\frac{\partial \mathcal{L}}{\partial \omega} = \lambda(1 - G(R))[u'(\omega) - \delta] - \gamma = 0 \tag{11}$$

$$\frac{\partial \mathcal{L}}{\partial A} = \lambda G(R)[pu'(A+v) + (1-p)u'(A+B+b) - \delta] + \gamma = 0 \tag{12}$$

$$\frac{\partial \mathcal{L}}{\partial B} = \lambda G(R)(1-p)\big[u'(A+B+b) - \delta\big] + (1-p)\gamma = 0 \tag{13}$$

$$\begin{aligned} \frac{\partial \mathcal{L}}{\partial R} = -\lambda g(R)\big[u(\omega) - pu(A+v) - (1-p)[u(A+B+b) - z] + \\ \delta\big[A + (1-p)B - (\omega - yR)\big]\big] + \gamma y = 0 \end{aligned} \tag{14}$$

Inspection of the FOC (10) - (14) yields the following results for the private information SPC.

LEMMA 5. (i) The multiplier δ is equal to the marginal utility of consumption in the good state, $u'(w) = \delta > 0$. (ii) The multiplier γ, which reflects the difference between the marginal utility of consumption in the bad and in the good state, $\gamma = \lambda(1 - G(R))[u'(\omega) - u'(w)]$, is nonnegative, $\gamma \geq 0$. The contract with z specifies that the firm pays ω in a recession and w in the good state, where $\gamma > 0$, and thus $w > \omega$ if and only if $z > 0$. (iii) As $A + v = A + B + b$, a second-best SPC fully shifts the income-risk of the dismissed worker to the firm. (iv) Nonetheless, in contrast to the JS-neutral workers, JS seekers do not fully insure their income. Rather, they prefer an *ex post* replacement rate which is strictly larger than one, $A + v = A + B + b > w > \omega$. (v) Sorting of workers by the expected scar of unemployment induces a strictly decreasing reservation productivity $R(z) \in [\alpha, R_m]$ with $R(0) = R_m$.

The full insurance conditions (1) of the common knowledge model follow with $\gamma = 0$ from the FOC (10) – (13). JS seekers, who sign a private information SPC, earn a risk-free replacement income in case of a dismissal. However, in order to contain the JI imposed by the profit maximizing at-will rule, the JS seekers accept wage risk. Choosing the terms of the optimal SPC, they observe the following averaging rule derived from the FOC (10) – (13):

(15) $$u'(w) = (1 - G(R))u'(\omega) + G(R)[pu'(A+v) + (1-p)u'(A+B+b)].$$

A JS seeker, who closes a SPC, will equalize the marginal utility of income in the good state with the expected marginal utility of his recession income.

Job security. The prediction of the JS-model that a risk-averse JS-seeker in a recession accepts a wage cut, i.e. $\omega < w$, is confirmed by the literature on JI[7]. The reason for this two-wage structure of a second-best SPC is the prevailing employment at will policy and not the demand recession *per se*. As the separation decision is not contractible, JS seekers use a low recession wage and a high severance pay to stimulate their employer to pick the preferred at-will rule, as the following Lemma confirms.

Let $C(z)$ be the private information SPC for type $z \geq 0$. The behavior of the severance pay and the recession wage of $C(z)$ as functions of z are characterized by:

LEMMA 6. In contrast to the first-best, $A(z)$ is strictly increasing, whereas $\omega(z)$ strictly decreases at least in a neighborhood of $z = 0$.

The marginal worker. The separation decision is not contractible, but there is one exception from the rule, which is the GEC. Because the distribution function G and its support are public knowledge, the asymmetric information on the demand is of no importance for the terms of the risk-free GEC $C_\alpha = [w_\alpha, \alpha]$. The one-sided private information raises the fraction of workers that favors the GEC. To prove this proposition, we first characterize the marginal worker type z_{α_2}, who is indifferent between the GEC and the type-specific second-best SPC.

The marginal worker z_{α_2} would sign a SPC with wages $w = \omega = w_\alpha$. To induce the employer to choose the reservation productivity $R = \alpha$, the severance pay A and the SUB B must satisfy $A + v = \omega - h(\alpha)$ and $B = v - b$. Given these terms of the type-specific SPC, the employer will indeed implement $R = \alpha$. Moreover, the participation constraint of the maximization problem (9) holds as a strict equality. In view of $\gamma = \lambda(1 - G(R))[u'(\omega) - u'(w)] = 0$ and Lemma 5 (iii), FOC (14) implies the following equation for the marginal worker type

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[7] *Gregory* and *Jukes* (2001), *Nickell* et al. (2002), *Farber* (2005).

(16) $$z_{\alpha_2} = \frac{u(w_\alpha - h(\alpha)) - u(w_\alpha)}{1-p}.$$

PROPOSITION 3. The fraction of workers, who conclude the risk-free GEC, is strictly larger in the second-best than in the first-best contract market equilibrium, i.e. $0 < z_{\alpha_2} < z_{\alpha_1}$, where z_{α_1} is given by equation (6).

With the exception of the extreme z-types all JS seekers suffer a welfare loss in the private information equilibrium, even though some of them enjoy more JS than in the first-best equilibrium. We denote the reservation productivities of type z in the first-best and the second-best as $R_1(z)$ and $R_2(z)$, respectively. In particular, the JS seekers $z \in [z_{\alpha_2}, z_{\alpha_1})$ will sign a SPC in the first -best and a GEC with reservation productivity $R_2(z) = \alpha$ in the second-best equilibrium. Comparing the JI, we have $\varphi_1(z)z > \varphi_2(z)z = 0$, where $\varphi_i(z) = \lambda G(R_i(z))(1-p)$, $i = 1,2$. A more general comparison of the JI in the first and second-best equilibrium provides

LEMMA 7. (i) The first-best contract of the JS-neutral workers is incentive compatible, so that $R_1(0) = R_2(0) = R_m$. (ii) Among the JS seekers with private information SPC, there is a type $\hat{z}$ that enjoys the same JS in the first and second-best equilibrium: $R_1(\hat{z}) = R_2(\hat{z})$, where $\hat{z} \in (0, z_{\alpha_2})$. (iii) JS seekers of type $z \in (0, \hat{z})$ face a higher JI in the second-best equilibrium, $R_2(z) > R_1(z)$, whereas JS seekers of type $z \in (\hat{z}, z_{\alpha_1})$, for whom $R_2(z) < R_1(z)$ holds, experience a lower JI than in the first-best equilibrium.

Efficiency. For the extreme z-types $z = 0$ and $z \geq z_{\alpha_1}$, the risk and JS-allocation of the private information equilibrium is efficient. However, the equilibrium allocation is inefficient for the JS seekers $z \in (0, z_{\alpha_1})$. There are two sources for the inefficiency. First, as Lemma 5 indicates, workers concluding a private information SPC are under-insured, as they bear income-risk. Second, all worker types $z \in [z_{\alpha_2}, z_{\alpha_1})$ are over-insured. They conclude the GEC, although their first-best alternative would be a SPC with a positive exposure to JI. To correct the market failure, a social planner, who is subject to the same information asymmetry as the workers, employs three instruments for each type $z \in (0, z_{\alpha_1})$, one to smooth consumption, a second to induce efficient separations and a third to regulate the market entry of the jobs (see *Jahn* and *Wagner* 2005).

V Two-sided Private Information

This section deals with two-sided private information. Workers are unable to observe demand at stage 1, while firms cannot verify the re-employment status of a dismissed worker at stage 2. Thus, neither termination nor SUB are contractible.

The feasibility of a contract claim offering SUB depends on whether the former employer can observe the subsequent employment status of a dismissed worker. In view of the threat $z > 0$, firms can be sure that at least the JS seekers have a strong intrinsic motive to search for re-employment. However, as the result of the job search is unobservable, a released worker would report in any case that he could not find a new job and would insist on his claim to *B*. Thus, SUB are not contractible and a third-best SPC, $C = [w, \omega, A]$, includes a wage for the good state *w*, a wage for the recession states ω and the severance pay *A*. The terms of the contract are determined by the solution to the maximization problem (9) with FOC (10) – (12) and (14), where we must set $B = 0$ throughout.

The non-contractibility of *B* has several consequences. First, workers closing a SPC face wage-replacement risk. The wage-replacement risk is the result of the uncertain replacement income $A + \tilde{I}$, where the random variable $\tilde{I}$ is either equal to *v* or to *b,* depending on whether a dismissed worker finds a spot market job or becomes unemployed. Second, in the third-best situation the GEC is the only labor contract that fully insures a worker against the income risk. It is thus possible to observe both JS seekers and JS-neutral workers closing a GEC. One group wants a secure job, the other wishes to insure their income. Third, the sign of the Lagrangian multiplier γ associated with the incentive compatibility constraint is ambiguous. It is intuitively appealing to expect that the wage of a constrained optimal SPC for the good state *w* is higher than the wage for the recession states ω, such that $\gamma \geq 0$. However, if *B* is un-contractible, the case that $\gamma < 0$ and thus $\omega > w$ cannot be excluded. Below, we first introduce the type-specific risk premium for the wage-replacement risk. We will then characterize the marginal worker type, who is indifferent between the GEC and the type-specific third-best SPC. Next, we present general results for the SPC and discuss thereafter the issue of the sign of γ, where we will supply the utility function *u* with more structure and assume that workers are prudent.

Risk Premium. In the following, $\sigma_S^2 = p(v - I_S)^2 + (1-p)(b - I_S)^2$ is the variance of the risk $\tilde{I}$; $a(c)$ is the Arrow-Pratt measure of absolute risk aversion with $a(c) = -u''(c)/u'(c)$; and $\pi_z = \pi(A(z), \tilde{I})$ is the risk premium associated with wage- replacement risk $\tilde{I}$ for a worker of type z, who is dismissed with severance pay $A(z)$. The worker is indifferent between receiving the risky replacement income $\tilde{I}$ and receiving the certain payment $I_S - \pi_z$:

$$u(A(z) + I_S - \pi_z) = pu(A(z) + v) + (1 - p)u(A(z) + b).$$

Because $\pi(A(z), \tilde{I}) = \pi(A(z) + I_S, \tilde{I} - I_S)$, we can approximate π_z for small risks with the Arrow-Pratt Approximation: $\pi_z \cong \frac{1}{2}\sigma_S^2 a(A(z) + I_S)$. As we will show below, it depends on the risk premium of the marginal worker type π_{α_3}, whether the entire labor force will close a GEC.

Marginal Worker. If workers sign a SPC, the contract terms are determined by the FOC of the maximization problem (9). If no interior solution exists, because all workers prefer the risk-free GEC to a SPC, we set the type of the marginal worker, z_{α_3}, equal to zero. If $z_{\alpha_3} > 0$, the marginal worker type is indifferent between the GEC and the type-specific SPC. If z_{α_3} signs a SPC, the agreed upon severance pay is $A(z_{\alpha_3}) = w_\alpha - y\alpha > 0$, while the wages of the marginal SPC are given by $w = \omega = w_\alpha$, and $R = \alpha$ is the incentive compatible reservation productivity. Thus, the expected replacement income of the marginal worker type is $A(z_{\alpha_3}) + I_S = w_\alpha - h(\alpha)$.

The following proposition generalizes the Wage-Bill Argument of *Akerlof* and *Miyazaki* (1980). In the first-best and the second-best situation, $h(\alpha) \geq 0$ is necessary and sufficient to ensure that the labor market equilibrium is a "fixed-wage-*cum*-full-employment equilibrium," as is shown by equations (6) and (16) for the marginal worker types. The generalization of the Wage-Bill Argument proves that the labor market equilibrium will be a "fixed-wage-*cum*-full-employment equilibrium", if $\pi_{\alpha_3} \geq -h(\alpha)$, where π_{α_3} is the risk premium associated with the wage-replacement risk for a marginal worker, who would be terminated with severance pay $A(z_{\alpha_3})$.

PROPOSITION 4. If neither the SUB nor the separation decision are contractible, then $0 \leq z_{\alpha_3} < z_{\alpha_2} < z_{\alpha_1}$, where $b \geq y\alpha$ is sufficient for $z_{\alpha_3} > 0$. Moreover, $z_{\alpha_3} > 0$ holds if, and only if, $\pi_{\alpha_3} < -h(\alpha)$, where the Arrow-Pratt Approximation of the risk premium for the marginal worker type depends only on exogenous parameters: $\pi_{\alpha_3} \cong \frac{1}{2}\sigma_S^2 a(w_\alpha - h(\alpha))$.

A job that produces and delivers the output $y\alpha$ forgoes the expected replacement income I_S and pays for the decision with the social net loss $-h(\alpha) > 0$. If the social net loss is less than the risk premium, which the marginal worker type is prepared to pay to get rid of the wage-replacement risk, such that $\pi_{\alpha_3} \geq -h(\alpha)$, then $z_{\alpha_3} = 0$ and the entire labor force, including the JS-neutral workers, will close the GEC.

If $z_{\alpha_3} > 0$, then all types $z \in [0, z_{\alpha_3})$ strictly prefer a private information SPC to the GEC, even though they have to cope with both kinds of risk. Let *C* be a third-best SPC, and let *R* be the incentive compatible reservation productivity associated with *C*. The FOC (10) – (12) and (14) yield the following general results for the terms of *C* and *R*.

LEMMA 8. (i) The multiplier δ is equal to the marginal utility of consumption in the good state, $u'(w) = \delta > 0$. (ii) The *ex post* replacement rate of a dismissed worker who found a new job is strictly larger than one, $A + v > \max\{w, \varpi\}$. (iii) Worker sorting by the expected scar of unemployment induces a strictly decreasing incentive compatible reservation productivity $R(z)$.

As in the second-best situation, the JS seekers $z \in (0, z_{\alpha_3})$ will sign a SPC with an *ex post* replacement rate, for which $A + v > \max\{w, \varpi\}$. However, in contrast to the one-sided private information case, even the JS-neutral workers agree upon an *ex post* replacement rate greater than one in view of the wage-replacement risk.

Without insurance against the risk $\tilde{I}$, the FOC provide no information on the properties of the third-best reservation productivities $R(z)$. Lemma 8 (iii) informs us only about the fact that $R(z) \in [\alpha, 1]$ is strictly decreasing as a consequence of worker sorting. We will now introduce stronger assumptions on the utility function *u* and will show first that risk-averse and prudent workers select third-best SPCs, which induce their employers to choose a termination policy for which $R(z) \in [\alpha, R_m)$.

Prudence. We assume that *u* is a C^3 function, which exhibits absolute prudence. In the context of intertemporal expected utility maximization, the precautionary saving of an investor depends on his precautionary saving motive, which can be measured by the coefficient of absolute prudence $P(c)$ for which, $P(c) = -u'''(c)/u''(c)$, where u''' is the third derivative of *u*. The precautionary motive implies $P(c) > 0$ or, in view of the concavity of *u*, $u'''(c) > 0$. Moreover, a worker who is risk-averse can be either prudent or imprudent, i.e. the absolute risk-aversion $a > 0$ is compatible with either $P \geq 0$ or $P < 0$. However, if one believes that decreasing absolute risk-aversion is a valid assumption, then one has to accept also that the workers exhibit absolute prudence. This proposition follows from the identity $P(c) = a(c) - a'(c)/a(c)$, which represents the relationship between absolute prudence and absolute risk-aversion. Obviously, the absolute risk-aversion of u is non-increasing if and only if $P(c) \geq a(c)$ (*Kimball* 1990, *Kimball* and *Weil* 2003).

Assume $z_{\alpha_3} > 0$, and let workers be prudent, such that $P(c) \geq 0$. The following lemma summarizes the more specific results about the contract terms of prudent workers of type $z \in [0, z_{\alpha_3})$ and the termination policy of their employers.

LEMMA 9. (i) JS-neutral and prudent workers conclude a SPC, which stimulates their employers to choose the reservation productivity $R(0) < R_m$. (ii) Workers are prudent and thus close a contract with a precautionary replacement payment $s(z) = [A(z) + I_S] - \max\{w(z), \omega(z)\}$, for which $0 < s(z) \leq -h(R(z))$.

Contract wages. If the *ex post* wage-replacement of an unemployed JS seeker exceeds his recession wage, such that $A + b \geq \omega$, then $w > \omega$ holds. Assume to the contrary, that $w \leq \omega$ would be true. Then Lemma 8 (ii) and (A1) would imply contract provisions $A + v > A + b \geq \omega \geq w$, which violate the averaging rule (15). Thus, one reason why a JS seeker would sign a SPC with $\omega > w$ are low unemployment benefits *b*. The wage-replacement risk is uninsurable, but the high recession wage would contain the income risk in this case and would assure that the averaging rule (15) holds. Therefore, the question arises whether there exists a lower bound $\underline{b}$, such that $b \geq \underline{b}$ implies $w(z) \geq \omega(z)$ for $z \in [0, z_{\alpha_3})$?

If $b \geq y\alpha$ and if for the job finding rate of the spot market $p > 1/2$, then, as we will argue below, there exists a worker type $z_\rho \in [0, z_{\alpha_3})$, such that all JS seekers $z \in [z_\rho, z_{\alpha_3})$ will close a third-best SPC with contract wages $w(z) > \omega(z)$.

For a given SPC $C = [w, \omega, A]$ and the incentive compatible reservation productivity *R,* FOC (11) – (12) yield the following equation for the Lagrangian multiplier γ

$$\gamma = \lambda G(R)(1 - G(R))[u'(\omega) - pu'(A + v) - (1 - p)u'(A + b)].$$

The expression in square brackets measures the welfare gain from a reallocation of a unit of the wage-replacement income $A + \tilde{I}$ to the recession income ω. The reallocation yields a welfare gain, if and only if, $\gamma > 0$. Now solve the incentive compatibility constraint with respect to the recession wage $\omega = A + yR$ and plug the result into the above equation for γ. Furthermore, replace the risk $\tilde{I}$ by the actuarially neutral risk $\tilde{I} - I_S$ to get

$$\gamma = \lambda G(R)(1-G(R))[u'(A+I_S+h(R)) - pu'(A+I_S+v-I_S) - (1-p)u'(A+I_S+b-I_S)].$$

Next, choose a quadratic approximation of the marginal utility terms around the expected wage-replacement income $A + I_S$ to obtain after rearranging terms (see App. A4):

$$\text{(17)} \qquad \gamma \cong \hat{\gamma} \equiv -\lambda G(R)(1-G(R))u''(A+I_S)\left(-h(R) + \tfrac{1}{2}P(A+I_S)[\sigma_R^2 - 2\sigma_S^2]\right).$$

Workers are prudent, so that $P(A+I_S) \geq 0$. Moreover, the continuation rent is strictly negative for all $z \in [0, z_{\alpha_3}]$, as results from Lemma 8 (iii) and Lemma 9 (i), such that $-h(R) > 0$. Thus, $T(R) \equiv \sigma_R^2 - 2\sigma_S^2 \geq 0$ is sufficient for $\hat{\gamma} > 0$. However, the sign of $T(R)$ is ambiguous, where σ_S^2 is the variance and σ_R^2 is the dispersion of the risk $\tilde{I}$ around the reservation demand yR: $\sigma_R^2 = p(v-yR)^2 + (1-p)(b-yR)^2$. Thus, we will investigate the sign of $T(R)$ next.

The following lemma proves that $T(R)$ is a strictly decreasing function which has a zero at productivity ρ, $T(\rho) = 0$, where the output $y\rho$ is one standard deviation σ_S smaller than the output yR_m, such that $y\rho \equiv yR_m - \sigma_S = I_S - \sigma_S$, because $yR_m = I_S$. Given that $T(R)$ is strictly decreasing, the inequality $T(R) \geq 0$, which is sufficient for $\hat{\gamma} > 0$, is satisfied if and only if $R \leq \rho$. The final part of the following lemma proves that $b \geq y\alpha$ and $p > 1/2$ are sufficient for $\rho \in (\alpha, R_m)$.

LEMMA 10. (i) σ_R^2 is a strictly decreasing function of $R \in [\alpha, R_m)$ with a boundary maximum at α and a minimum at R_m, where $\sigma_{R_m}^2 = \sigma_S^2$, such that $T(R_m) = -\sigma_S^2 < 0$. (ii) Productivity ρ is a zero of $T(R)$, such that $T(R) \geq 0$ for all $R \leq \rho$. (iii) Because $y\rho = b + (v-b)[p - \sqrt{p(1-p)}]$, taking into account assumption (A1) $p \geq 1/2$ is sufficient for $y\rho \geq b \geq 0$. (iv) If $b \geq y\alpha$ and $p > 1/2$, then $\rho \in (\alpha, R_m)$.

Regarding the sign of the Lagrangian multiplier γ, approximation (17) provides the following four cases, where we assume for the last two cases that $\rho \in (\alpha, R_m)$.

First, if for the coefficient of absolute prudence $P = 0$, the associated utility function u is quadratic. Considering approximation (17) or, in the quadratic case, the FOC, we can conclude from $P = 0$ that the Lagrangian multiplier γ is uniformly positive for all third-best SPC. Thus, it follows in view of Lemma 9 (ii) that $A(z) + I_S > w(z) > \omega(z)$ holds for all $z \in [0, z_{\alpha_3})$. Second, the Lagrangian multiplier is also positive, if the wage-replacement risk is small and $\sigma_S^2 \to 0$.

Third, if $P > 0$ and $R(0) \le \rho$, then $T(R(z)) \ge 0$ for all worker types $z \in [0, z_{\alpha_3})$, which implies in view of (17) that $A(z) + I_S > w(z) > \omega(z)$.

Fourth, if $\rho < R(0)$, then the Lagrangian multiplier γ is positive for worker types with a strong demand for JS and $R(z) \in (\alpha, \rho]$. However, a negative sign of γ cannot be precluded *a priori* for the SPCs of the worker types $z \in [0, z_\rho)$ with reservation productivity $R(z) \in (\rho, R(0)]$.

VI Summary

Since the 90s, complaints about rising job insecurity (JI) due to globalization and the diffusion of ICT are widespread. One reason that the hypothesis of a significant upward trend in JI has been tested without conclusive results may be the lack of an economic theory of job security (JS) and the impact JS preferences and labor-hoarding costs exert on the choice of a workplace.

Our paper develops a model of a hedonic market for JS, where risk-neutral firms meet risk-averse workers with heterogeneous JS preferences. Revealed JS preferences represent the scar of unemployment that a worker expects in the case of a dismissal. Worker sorting by JS preferences results in an offer curve of the hedonic market for JS that spans a continuum of severance pay contracts (SPC) and the guaranteed employment contract (GEC). In the equilibrium of the labor market, the bid prices workers are willing to pay for the contracted JS equal the offer prices at which their employers are ready to supply the preferred termination policy. Offer prices compensate for the labor-hoarding costs firms incur when implementing a termination rule that deviates from the profit maximizing employment at will. As the hedonic price of JS is strictly increasing, workers with weak JS preferences are willing to trade JS for higher wages. Consequently, the JS model allows for an equilibrium rate of unemployment, which is strictly larger than zero, in contrast to the Wage-Bill Argument of *Akerlof* and *Miyazaki*

(1980), where the total labor force consists of productively homogeneous and JS-neutral workers concluding a labor contract with an unconditional JS guarantee.

We use a composite measure of JI which encompasses four dimensions: the chance that a job is hit by an adverse demand shock and the worker is terminated, combined with the probability that the dismissed worker cannot find a new job and becomes unemployed, weighted with the worker-specific welfare loss from the scar of unemployment. *Ex ante* the relation between the composite measure of JI and the perceived probability of a dismissal is hump-shaped. This means for the evaluation of the JS question of the General Social Survey (GSS) - *Thinking about the next 12 months, how likely do you think it is that you will lose your job or be laid off – very likely, fairly likely, not too likely, or not at all likely?* – that a high frequency of workers who answer *very likely* or *fairly likely* provides no proof of a high individual or aggregate JI.

If the demand for the output of a job is observed by the firm, but not by the worker, JS is not contractible and the firms will terminate the workers at will. Although JS is not contractible, there is one exception that proves the rule, which is the GEC. The GEC and likewise all first best contracts closed by workers with extreme JS preferences are incentive compatible under one-sided private information on the demand. The other risk-avers workers react to the asymmetric information either by choosing the GEC or by trading wage risk for a higher JS. In spite of the fact that firms terminate workers at will, worker sorting by JS preferences and, hence, a strictly positive unemployment rate characterize the one-sided private information equilibrium.

If workers cannot verify demand and firms are unable to control the re-employment status of a dismissed worker, neither JS nor SUB are contractible. Without the option to claim SUB, dismissed workers face wage-replacement risk. Therefore, with two-sided private information, even JS-neutral workers pay the price for a JS guarantee, if their risk premium associated with the wage-replacement risk is larger than the social net loss from production. Thus, in contrast to the common knowledge and the one-sided private information case, the two-sided private information equilibrium can indeed happen to be a “fixed-wage-*cum*-full-employment equilibrium”.

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Appendix

A1 Proof of Lemma 2

Ad (i): Assume that the job of z is hit by a shock $x \in [\alpha,1]$. If the efficient contract C of z stipulates production, the utility of z is $u(w)$. If $r(x)=0$, the job is closed down and the expected utility of z at stage 1 is $u(w)-(1-p)z$ with regard to the full insurance conditions. Therefore, z prefers production to separation for all $x \in [\alpha,1]$, his preference being strict, if $z>0$. Ad (ii): If $r(x)=1$ and C stipulates production, the profit of the firm is $yx-w$. If $r(x)=0$ and the job is closed down, the profit is $I_S - w$, where we take into account the insurance equations (1). Therefore, in case of a shock $x \in [\alpha,1]$, the firm prefers production whenever $yx - w \geq I_S - w$, or if and only if $h(x) \equiv yx - I_S \geq 0$, which is equivalent to $x \geq R_m$. Ad (iii): From (i) and (ii), it follows that $x \geq R_m \Rightarrow r(x) = 1$. Ad (iv): If the reservation productivity for worker type z would not be unique, we could find R_1 and R_2 with $R_m \geq R_1 > R_2 > \alpha$, $r(R_1) = r(R_2) = 1$ and $R_1 > x > R_2 \Rightarrow r(x) = 0$ such that

$$\begin{aligned} J(C) &= (1-\lambda)(y-w) + \lambda \int_{\alpha}^{1} [r(x)(yx-w) + (1-r(x))(I_S - w)]dG(x) \\ &= (1-\lambda)(y-w) + \lambda(I_S - w) + \lambda \int_{\alpha}^{1} r(x)h(x)dG(x) \\ &= (1-\lambda)(y-w) + \lambda(I_S - w) + \lambda[\int_{\alpha}^{R_2} r(x)h(x)dG(x) + \int_{R_1}^{1} r(x)h(x)dG(x)] \end{aligned}$$

Taking into account $r(R_2) = 1$, $h(R_2) < 0$, and $g(R_2) > 0$, differentiating $J(C)$ with respect to R_2 yields $\partial J(C)/\partial R_2 = \lambda r(R_2)h(R_2)g(R_2) < 0$, contradicting the assumption that C is efficient, because $\partial J(C)/\partial R_2 < 0$ implies that a reduction of $R_2 > \alpha$ would not only increase the worker's utility, but also the profit of the firm. Q.E.D.

A2 Proof of Lemma 3 and Proposition 1 and 2

Proof of Lemma 3. From the FOC (5), we obtain the reservation productivity R as an implicit function K of z, where $K(R,z) \equiv h(R) + z(1-p)/u'(w(R)) = 0$. The partial derivatives of K with respect to z and $R \in [\alpha, R_m)$, taking into account the wage function (4), are: $K_z = (1-p)/u' > 0$ and $K_R = y - (z(1-p)u''/(u')^2)(dw(R)/dR) > 0$, where $dw(R)/dR = -\lambda g(R)h(R) > 0$. Therefore, we may use the Implicit Function Theorem, which yields the existence of $R(z)$ and $dR/dz = -K_z / K_R < 0$. Q.E.D.

Proof of Proposition 1. The z-value of the marginal worker type is derived by inserting $R = \alpha$ in the function $K(R,z)$ defined above and solving for z.

Proof of Proposition 2. Ad (i): (A1) and (A2) state that $dV(z)/dp = u(v) - u(b) > 0$ for all z. The substitution of p_0 in $V(0)$ yields $V(0) = u(w_0)$. Thus, it follows for $p > p_0$ that $V(0) > U(C_0) = u(w_0)$. Ad (ii): Worker $z \geq 0$ is strictly better off with a contract market job if and only if $U(z) \equiv u(w(z)) - \lambda G(R(z))(1-p)z > pu(v) + (1-p)[u(b) - z] \equiv V(z)$, where

$R(z) \in [\alpha, R_m]$. Assume to the contrary that $U(z) \le V(z)$. In view of the risk-aversion of *u*, the working hypothesis implies $0 \le (1-\lambda G(R(z)))(1-p)z < u(w(z)+d(z)) - u(w(z))$, with $d(z) = I_S - w(z) > 0$ from the monotonicity of *u*, thus $0 \le (1-\lambda G(R(z)))(1-p)z < d(z)u'(w(z))$. The contract $C(z)$ is efficient, therefore $(1-p)z = -h(R(z))u'(w(z))$, so $-h(R(z))(1-\lambda G(R(z))) < d(z)$ such that $w(z) < yR(z) - h(R(z))\lambda G(R(z))$, a contradiction to $w(z) > yR(z) - h(R(z))\lambda G(R(z))$, which holds for all $z \ge 0$, as is shown next.

By equation (4) and the definition of the continuation rent *h*, the strict inequality above is true if and only if $Y(R) + \lambda G(R) I_S > (1-\lambda G(R))yR + \lambda G(R) I_S$, where we suppress the functional notation and the argument *z*. Inserting $Y(R) = y[(1-\lambda) + \lambda\mu(R)]$, where $\mu(R) = \int_R^1 x\, dG(x)$, dividing through by *y* and rearranging terms yields the conclusion that the above inequality holds if and only if $\Delta(R) \equiv [1-\lambda(1-\mu(R))] - (1-\lambda G(R))R > 0$. $\Delta(R)$ is a strictly decreasing C^2 function, with $\Delta(\alpha) > 0$ and $\Delta(1) = 0$, as will be proved next.

First, note that $\alpha < \mu(\alpha) = \mu < 1$, $\mu(1) = 0$ and $\lambda < 1$, thus $\Delta(\alpha) = [1-\lambda(1-\mu)] - \alpha = (1-\alpha) - \lambda(1-\mu) > \mu - \alpha > 0$ and $\Delta(1) = (1-\lambda) - (1-\lambda) = 0$. Moreover, in view of $\mu'(R) = -Rg(R)$, we obtain $\Delta'(R) = -(1-\lambda G(R)) < 0$. Therefore $w(z) > yR(z) - h(R(z))\lambda G(R(z))$ for all $z \ge 0$. Q.E.D.

A3 Proof of Lemma 4 - 7 and Proposition 3.

Proof of Lemma 4. Under symmetric information, worker $z \in (0, z_{\alpha_1})$ concludes a SPC $C(z) = [w(z), R(z)]$ with $\alpha < R(z) < R_m$. Using the full insurance conditions (1) and rearranging terms yields: $A(z) + (1-p)B = w(z) - I_S$, which in turn implies $IC(C(z), R(z)) \equiv A(z) + (1-p)B - [w(z) - yR(z)] = h(R(z)) < 0$. Q.E.D.

Proof of Lemma 5. Ad (ii): Assume that $\gamma < 0$. Then, the FOC (10) – (13) imply $A + v = A + B + b < w < \omega$, but from (14) $\lambda g(R)[u(A+v) - u(\omega) - (1-p)z] = -\gamma y > 0$ thus $A + v > \omega > A + v$, a contradiction, so $\gamma \ge 0$. From $\gamma > 0$, $z = 0$ and (10) – (13) we obtain $A + v > w > \omega$, but (14) implies $\omega > A + v$, so $\gamma > 0$ implies $z > 0$. Finally, let $\gamma = 0$ and $z > 0$. Then, assuming $R > \alpha$, we obtain $A + v = w = \omega$ from (10) – (13), but (14) implies $A + v > \omega$. Thus, $\gamma > 0$, if $z > 0$ and $R > \alpha$. Ad (iii): Follows from the FOC (12) and (13). Ad (iv): Follows from the FOC and from (ii). Ad (v): Below we prove that *R* is a strictly decreasing function of z. The incentive constraint implies $A+(1-p)B-(\omega-yR)=(A+v)-(\omega-h(R))=0$, so $h(R)\le 0$ since $A+v\ge\omega$. Thus $R(z)\in[\alpha,R_m]$. If $z=0$, we get $\gamma=0$, considering part (ii) of the lemma. For $\gamma=0$, $A+v=\omega$ and thus $(A+v)-(\omega-h(R))=h(R)=0$, so $R(0)=R_m$.

To prove that $R(z)$ is a strictly decreasing function of z, we develop the bordered $(n+k)\times(n+k)=7\times7$ Hessian matrix for the Lagrangian function $\mathcal{L}(C,R,\delta,\gamma)=U(C,R)+\delta J(C,R)+\gamma IC(C,R)$, where $n=5$ and $k=2$. The determinant H of the matrix has the sign $(-1)^n=-1$ at an interior solution of the maximization problem (9). To develop H, we make use of the FOC and obtain

$$H=-(1-\lambda)\begin{vmatrix} u''(w) & 0 & 0 & 0 & 0 & 1-\lambda & 0 \\ 0 & \lambda(1-G)u''(\omega) & 0 & 0 & -\lambda g[u'(\omega)-\delta] & \lambda(1-G) & -1 \\ 0 & 0 & \lambda GV_{AA} & \lambda GV_{AB} & \lambda g[V_A-\delta] & \lambda G & 1 \\ 0 & 0 & \lambda GV_{BA} & \lambda GV_{BB} & \lambda g[V_B-(1-p)\delta] & \lambda G(1-p) & 1-p \\ 0 & -\lambda g[u'(\omega)-\delta] & \lambda g[V_A-\delta] & \lambda g[V_B-(1-p)\delta] & \mathcal{L}_{RR} & 0 & y \\ -1 & -\lambda(1-G) & -\lambda G & -\lambda G(1-p) & 0 & 0 & 0 \\ 0 & -1 & 1 & 1-p & y & 0 & 0 \end{vmatrix}$$

where $g=g(R)$, $G=G(R)$, and V_A and V_{AA}, for example, denote the partial derivative and the second order partial derivative of $V(A,B,z)=pu(A+v)+(1-p)[u(A+B+b)-z]$ with respect to the severance pay A, $V_A=\partial V(A,B,z)/\partial A>0$ and $V_{AA}=\partial^2V(A,B,z)/\partial A^2<0$. The partial derivatives of the FOC with respect to z are zero with the exception of $\mathcal{L}_{Rz}=-\lambda g(R)(1-p)<0$. Replacing the fifth column of H with the negative of $\mathcal{L}_{Rz}$ yields the determinant H_{Rz}

$$H_{Rz}=-(1-\lambda)\begin{vmatrix} u''(w) & 0 & 0 & 0 & 0 & 1-\lambda & 0 \\ 0 & \lambda(1-G)u''(\omega) & 0 & 0 & 0 & \lambda(1-G) & -1 \\ 0 & 0 & \lambda GV_{AA} & \lambda GV_{AB} & 0 & \lambda G & 1 \\ 0 & 0 & \lambda GV_{BA} & \lambda GV_{BB} & 0 & \lambda G(1-p) & 1-p \\ 0 & -\lambda g[u'(\omega)-\delta] & \lambda g[V_A-\delta] & \lambda g[V_B-(1-p)\delta] & -\mathcal{L}_{Rz} & 0 & y \\ -1 & -\lambda(1-G) & -\lambda G & -\lambda G(1-p) & 0 & 0 & 0 \\ 0 & -1 & 1 & 1-p & 0 & 0 & 0 \end{vmatrix}$$

The evaluation of H_{Rz} yields

$$H_{Rz}=-\mathcal{L}_{Rz}\lambda^2(1-\lambda)p(1-p)Gu''(A+v)\big[\lambda u''(w)+(1-\lambda)[(1-G)u''(\omega)+Gu''(A+v)]\big]>0.$$

Thus, there exists a strictly decreasing C^1 function $R(z)$, $R(z) \in (\alpha, R_m]$: $dR(z)/dz = H_{Rz}/H < 0$. Q.E.D.

Proof of Lemma 6. Replacing the third column of the determinant *H* of the Hessian matrix for the Lagrangian function with the negative of $\mathcal{L}_{Rz}$ yields the determinant H_{Az}

$$H_{Az} = -(1-\lambda)\begin{vmatrix} u''(w) & 0 & 0 & 0 & 0 & 1-\lambda & 0 \\ 0 & \lambda(1-G)u''(\omega) & 0 & 0 & -\lambda g[u'(\omega)-\delta] & \lambda(1-G) & -1 \\ 0 & 0 & 0 & \lambda G V_{AB} & \lambda g[V_A - \delta] & \lambda G & 1 \\ 0 & 0 & 0 & \lambda G V_{BB} & \lambda g[V_B - (1-p)\delta] & \lambda G(1-p) & 1-p \\ 0 & -\lambda g[u'(\omega)-\delta] & -\mathcal{L}_{Rz} & \lambda g[V_B-(1-p)\delta] & \mathcal{L}_{RR} & 0 & y \\ -1 & -\lambda(1-G) & 0 & -\lambda G(1-p) & 0 & 0 & 0 \\ 0 & -1 & 0 & 1-p & y & 0 & 0 \end{vmatrix}$$

The evaluation of H_{Az} yields

$$H_{Az} = \mathcal{L}_{Rz}\lambda^2(1-\lambda)p(1-p)Gu''(A+v)\big[(1-G)y[\lambda u''(w)+(1-\lambda)u''(\omega)]+(1-\lambda)g[u'(A+v)-u'(\omega)]\big] < 0$$

Thus, there exists a strictly increasing C^1 function $A(z)$: $dA(z)/dz = H_{Az}/H > 0$.

Replacing the second column of the determinant *H* of the Hessian matrix for the Lagrangian function with the negative of $\mathcal{L}_{Rz}$ yields the determinant $H_{\omega z}$

$$H_{\omega z} = -(1-\lambda)\begin{vmatrix} u''(w) & 0 & 0 & 0 & 0 & 1-\lambda & 0 \\ 0 & 0 & 0 & 0 & -\lambda g[u'(\omega)-\delta] & \lambda(1-G) & -1 \\ 0 & 0 & \lambda G V_{AA} & \lambda G V_{AB} & \lambda g[V_A - \delta] & \lambda G & 1 \\ 0 & 0 & \lambda G V_{BA} & \lambda G V_{BB} & \lambda g[V_B - (1-p)\delta] & \lambda G(1-p) & 1-p \\ 0 & -\mathcal{L}_{Rz} & \lambda g[V_A-\delta] & \lambda g[V_B-(1-p)\delta] & \mathcal{L}_{RR} & 0 & y \\ -1 & 0 & -\lambda G & -\lambda G(1-p) & 0 & 0 & 0 \\ 0 & 0 & 1 & 1-p & y & 0 & 0 \end{vmatrix}$$

The evaluation of $H_{\omega z}$ yields

$$H_{\omega z} = -\mathcal{L}_{Rz}\lambda^2(1-\lambda)p(1-p)Gu''(A+v)\big[Gy[(1-\lambda)u''(A+v)+\lambda u''(w)]+(1-\lambda)g[u'(\omega)-u'(A+v)]\big].$$

Because $\omega = A+v$ for $z=0$, we get $H_{\omega z} > 0$ and $d\omega(z)/dz = H_{\omega z}/H < 0$. Q.E.D.

Proof of Proposition 3. Workers are risk-averse, so that the proposition follows directly from (16), (6) and $h(\alpha) < 0$:

$$0 < z_{\alpha_2} = \frac{u(w_\alpha - h(\alpha)) - u(w_\alpha)}{1-p} < \frac{u'(w_\alpha)(-h(\alpha))}{1-p} = z_{\alpha_1}. \text{ Q.E.D.}$$

Proof of Lemma 7. The functions $R_i(z)$ are strictly decreasing and we know from Proposition 3 that $R_1(z_{\alpha_2}) > R_2(z_{\alpha_2}) = \alpha$ and that $R_1(0) = R_2(0) = R_m$. We will show now that $0 > dR_2(0)/dz > dR_1(0)/dz$ applies for the derivatives $dR_i(z)/dz$ at $z = 0$. Assertions (ii) und (iii) follow directly.

Wage function (4) and the FOC (6) imply:

$$\frac{dR_1(z)}{dz} = -\frac{1-p}{yu'(w_1(z)) + \lambda gh(R_1(z))(1-p)z\dfrac{u''(w_1(z))}{u'(w_1(z))}} < 0,$$

such that $dR_1(0)/dz = -(1-p)/yu'(w_m) < 0$, because $w_1(0) = w_m$.

From the Hessian matrix for the Lagrangian function of the maximization problem (9) and the full insurance conditions (1), we derive for $z = 0$ that

$$\frac{dR_2(0)}{dz} = -\frac{1-p}{yu'(w_m)[u'(w_m) - \dfrac{yG(R_m)(1-G(R_m))}{g(R_m)}\dfrac{u''(w_m)}{u'(w_m)}]} < 0,$$

such that the assertion can be proven by a comparison of the two derivatives $dR_i(0)/dz$ for $z = 0$.

A4 Proof of Proposition 4, Equation (17) and Lemma 8 - 10

Proof of Proposition 4. Let $\hat{z}$ be the worker type being indifferent between the GEC and the type-specific SPC. The type-specific SPC includes the wages $w = \omega = w_\alpha$ and the severance pay $A = \omega - y\alpha$. Under these contract terms, $\hat{z}$ is indeed indifferent between the two contract forms, while the firm employing $\hat{z}$ would choose the reservation productivity $R = \alpha$. Inserting the terms of the SPC and $R = \alpha$ into the constraints of (9), we find that both are fulfilled as strict equalities. In view of $\gamma = \lambda(1-G(R))[u'(\omega) - u'(w)] = 0$ and the FOC (14), it follows from

(a1) $\quad \mathcal{L}_R(\hat{z}) \equiv -\lambda g(\alpha)[u(w_\alpha) - pu(w_\alpha + v - y\alpha) - (1-p)u(w_\alpha + b - y\alpha) + (1-p)\hat{z}] = 0$

that the marginal worker is characterized by $z_{\alpha_3} = \max\{0, \hat{z}\}$. Risk-aversion together with $h(\alpha) < 0$ and $\mathcal{L}_R(z_{\alpha_3}) \leq 0$ imply $(1-p)z_{\alpha_3} < u(w_\alpha - h(\alpha)) - u(w_\alpha) = (1-p)z_{\alpha_2}$. It follows from (a1) and assumptions (A1) and (A2) that $b \geq \alpha$ is sufficient for $z_{\alpha_3} > 0$.

Given that $\omega = w_\alpha$ and $A = w_\alpha - y\alpha$, FOC (14) implies that $z_{\alpha_3} > 0$ applies when $u(w_\alpha) < pu(w_\alpha - y\alpha + v) + (1-p)u(w_\alpha - y\alpha + b) = u(w_\alpha - h(\alpha) - \pi_{\alpha_3})$. However, the inequality is satisfied if and only if $-h(\alpha) > \pi_{\alpha_3}$. Q.E.D.

Proof of Lemma 8. Ad (ii): Assume $\gamma \leq 0$, then the FOC (10) and (11) imply $\omega \geq w$. Moreover, from the FOC (14) $u(\omega) \leq V(A,0,z) \leq V(A,0,0)$, such that $A + v > \omega \geq w$. Next assume $\gamma > 0$, then (10) and (11) imply $\omega < w$, while from (12): $A + v > w$, so that the proposition follows. Ad (iii): To prove that $R(z)$ is a strictly decreasing function of *z*, we develop the bordered $(n+k)\times(n+k) = 6\times 6$ Hessian matrix for the Lagrangian function $\mathcal{L}(C_A, R, \delta, \gamma) = U(C_A, R) + \delta J(C_A, R) + \gamma C(C_A, R)$, where $n = 4$ and $k = 2$. The determinant *H* of the matrix has the sign of $(-1)^n = +1$ at an interior solution of the maximization problem (9) with unobservable $B = 0$. To develop *H*, we make use of the FOC and obtain

$$H = (1-\lambda)\begin{vmatrix} u''(w_A) & 0 & 0 & 0 & 1-\lambda & 0 \\ 0 & \lambda(1-G)u''(\omega_A) & 0 & -\lambda g[u'(\omega)-\delta] & \lambda(1-G) & -1 \\ 0 & 0 & \lambda G V_{AA} & \lambda g[V_A - \delta] & \lambda G & 1 \\ 0 & -\lambda g[u'(\omega)-\delta] & \lambda g[V_A - \delta] & \mathcal{L}_{RR} & 0 & y \\ 1 & \lambda(1-G) & \lambda G & 0 & 0 & 0 \\ 0 & -1 & 1 & y & 0 & 0 \end{vmatrix},$$

where $V_A = \partial V(A,0,z)/\partial A > 0$ and $V_{AA} = \partial^2 V(A,0,z)/\partial A^2 < 0$.

$$H_{Rz} = (1-\lambda)\begin{vmatrix} u''(w) & 0 & 0 & 0 & 1-\lambda & 0 \\ 0 & \lambda(1-G)u''(\omega) & 0 & 0 & \lambda(1-G) & -1 \\ 0 & 0 & \lambda G V_{AA} & 0 & \lambda G & 1 \\ 0 & -\gamma g/(1-G) & \lambda g[V_A - \delta] & -\mathcal{L}_{Rz} & 0 & y \\ 1 & \lambda(1-G) & \lambda G & 0 & 0 & 0 \\ 0 & -1 & 1 & 0 & 0 & 0 \end{vmatrix}.$$

The partial derivatives of the FOC with respect to *z* are zero with the exception of $\mathcal{L}_{Rz} = -\lambda g(R)(1-p) < 0$. Replacing the fourth column of *H* with the negative of the partial derivatives of the FOC with respect to z yields the above determinant H_{Rz}. The evaluation of H_{Rz} gives

$$H_{Rz} = -\lambda(1-\lambda)\mathcal{L}_{Rz}[\lambda u''(w) + (1-\lambda)[(1-G)u''(\omega) + GV_{AA}]] < 0.$$

Thus, R is a strictly decreasing function of z, as $dR(z)/dz = H_{Rz}/H < 0$. Q.E.D.

Proof of Lemma 9. Ad (i): FOC (11) – (12) in conjunction with the incentive compatibility constraint $A = \omega - yR$ imply $\gamma = \lambda G(R)(1-G(R))[u'(\omega) - pu'(\omega + v - yR) - (1-p)u'(\omega + b - yR)]$. Given that $u'''(c) \geq 0$, the marginal utility function is convex, such that $\gamma \leq \lambda G(R)(1-G(R))[u'(\omega) - pu'(\omega - h(R))]$. Assume that $h(R) \geq 0$. It then follows from the convexity of u that $\gamma \leq 0$. This finding, in conjunction with FOC (14) and the convexity of u, implies that $u(\omega) \leq V(A,0,z) < u(A + I_S) - (1-p)z$. Substitution of the incentive compatibility constraint then yields $u(\omega) < u(\omega - h(R)) - (1-p)z$, which implies $h(R) < 0$ contradicting the assumption. Consequently $h(R(z)) < 0$ for all $z \in [0, z_{\alpha_3})$. Ad (ii): We can distinguish three alternatives. **1**. $u(\omega) > V(A,0,z)$. It follows from FOC (14) that $\gamma > 0$, which in turn implies together with FOC (10) - (12) that $w > \omega$ as well as $u'(\omega) > u'(w) > pu'(A+v) + (1-p)u'(A+b)$. Given that the workers are prudent, the marginal utility functions are convex, such that $u'(\omega) > u'(w) > u'(A + I_S)$, which proves the assertion. **2**. $u(\omega) < V(A,0,z)$. Then $\gamma < 0$ and thus $u'(\omega) < u'(w)$, such that $\omega > w$. From (i) we know that $h(R(z)) < 0$, what together with the incentive compatibility requirement yields $A + I_S = \omega - yR(z) + I_S = \omega - h(R(z)) > \omega > w$. **3**. $u(\omega) = V(A,0,z)$. In that case, $\gamma = 0$, such that $\omega = w$. Given that $h(R(z)) < 0$, the incentive compatibility constraint yields $A + I_S > \omega = w$.

We now turn to the last part of the assertion. Given that $s(z) = [A(z) + I_S] - \max\{w(z), \omega(z)\}$, it follows that $s(z) \leq [A(z) + I_S] - \omega(z)$. Substitution of $A(z) = \omega(z) - yR(z)$ yields the claim $s(z) \leq -h(R(z))$. Q.E.D.

*Proof of Equation (*17*)*. It follows from FOC (11) – (12) that $\gamma = \lambda G(R)(1-G(R))[u'(A + I_S + h(R)) - \mathrm{E}[u'(A + I_S + \tilde{I} - I_S)]]$. The second order approximations regarding the expected wage replacement $A + I_S$ are:

$$u'(A + I_S + h(R)) \cong u'(A + I_S) + h(R)u''(A + I_S) + \tfrac{h(R)^2}{2}u'''(A + I_S)$$

$$\mathrm{E}[u'(A+I_S+\tilde{I}-I_S)] \cong \mathrm{E}[u'(A+I_S)+(\tilde{I}-I_S)u''(A+I_S)+\tfrac{(\tilde{I}-I_S)^2}{2}u'''(A+I_S)]$$
$$\cong u'(A+I_S)+\tfrac{\sigma_S^2}{2}u'''(A+I_S)$$

Substitution and factoring out the term $-u''(A+I_S)>0$ yields:

$$\gamma \cong -\lambda G(R)(1-G(R))u''(A+I_S)[-h(R)+\tfrac{1}{2}P(A+I_S)[h(R)^2-\sigma_S^2]].$$

Given that $h(R)^2=\sigma_R^2-\sigma_S^2$, equation (17) follows.Q.E.D.

Proof of Lemma 10. Ad (i): The derivative of σ_R^2 for R is $d\sigma_R^2/dR=2yh(R)<0$ for $R\in[\alpha,R_m)$. At the minimum of σ_R^2, $yR=yR_m=I_S$ and thus $\sigma_{R_m}^2=\sigma_S^2$. Ad (ii): Substitution of $\rho=\frac{1}{y}[I_S-\sigma_S]$ in σ_R^2 yields $\sigma_\rho^2=p(v-I_S+\sigma_S)^2+(1-p)(b-I_S+\sigma_S)^2$, which can be rewritten as $\sigma_\rho^2=\sigma_S^2+p(1-p)(v-b)^2=2\sigma_S^2$, such that $\Delta(\rho)=\sigma_\rho^2-2\sigma_S^2=0$. Ad (iii): Substitution in $y\rho=I_S-\sigma_S$ yields: $y\rho=I_S-(v-b)\sqrt{p(1-p)}=b+(v-b)[p-\sqrt{p(1-p)}]$. For $\eta(p)=p-\sqrt{p(1-p)}$, it is true that $\eta(p)\geq 0$ for $p\in[\frac{1}{2},1]$, such that the assertion follows directly. Q.E.D.

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