A proposal to maintain jobs, effort standards and human capital during economic crisis: The scope of mutual insurance in the shirking model*

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Abstract
The current global crisis reveals that employees when confronted with job loss accept income reduction. However, the consequences on worker morale and labor relations are unclear, particularly in efficiency wage settlements, e.g. if quality standards matter. This paper introduces an alternative firm-level instrument to mitigate economic shocks and shows that insurance refined efficiency wages provide sufficient incentives and enhance welfare, provided that insurance materializes through inter-temporal transfer of working hours, where credit and deficit are traced in individual working time accounts (wta). In their wta employees accumulate hours credits (debits) in case of positive (negative) allocative shocks. Since credits of employees match deficits of firms, hours transfers take place on a mutual basis with reversed signs. Thus, wta establish a self-enforcing insurance device. This result also helps to resolve the controversial about suboptimal incentives for unemployment insurance in the labor discipline model. Formal proofs use concepts of stochastic dominance and probability mass shifts.

JEL Classifications: D02, D8, J33, J65, L14

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1. Introduction

The current global crisis reveals that employees in firms that are threatened by extraordinary turbulence and rising job destruction do accept, if confronted with ultimate job loss, income reductions which, moreover, might be irreversible. In principle, however, this is still anecdotal evidence and little is known on potential consequences for industrial relations or on the consistency of incentives and respective (high) performance work systems. Hence, the interdependence of reallocative shocks, cyclical variation, job turnover, labor market fluctuations and the effectiveness of the efficiency wage mechanism and related incentive devices as e.g. bonus payments is little understood. In times of losses rather than profits, for example, the motivational and contract enforcing power of end of period bonus payments may be doubted. Eventually, distorted incentives might drive firms, and consequently employees into a vicious circle of downturn.1

This paper contributes to the closure of this gap. By using general methods of comparing risky prospects we derive a firm level instrument with the potential to internalize reallocative shocks and to cover labor market risks without undermining incentive constraints. From the institutional economics perspective, the existence of a self-enforcing mutual insurance device is proven that may turn out as a successful instrument during crises and cyclical variation. We show that labor adjustment at the intensive margin, i.e. adjustment of hours, that is institutionalized in individual working time accounts constitutes a firm-level instrument of labor market policy that simultaneously provides unemployment insurance for employees and profit insurance for firms, in fact on a reciprocal basis. Technically spoken, working time accounts internalize allocative shocks, e.g. random drops and peaks in demand. Provided that the contracted averages of worked hours, hence, standard hours in general depict labor market conditions, the expected value of an account equals zero. Any working time

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1 Incentives, insurance and compensation are overviewed in Gibbons (1998). Compensation policies that directly link remuneration to random events are, for example, not appropriate when (product or service) quality standards apply or firm reputation matters (cf. Baker/Gibbons/Murphy (1994) for the discussion of objective vs. subjective performance measures). Low powered incentives that embody high opportunity costs of job loss might be more adequate (cf. Akerlof/Yellen 1986). For – informal or discretionary – end of period bonus payments see MacLeod/Malcomsom (1989), MacLeod/Parent (1999a), and Lemieux/MacLeod/Parent (2009).
account belongs to an individual employee within a given firm and traces hours worked by that employee over the cycle and thereby enables to accumulate individual hours credits (deficits, respectively) when actual hours exceed (fall short of, respectively) standard hours.  

Generally situated in a principal-agent environment, this paper gives new insight in the discussion how to maintain effort and quality standards as well as retaining human capital in the light of reallocative shocks, cyclical variation and – depending on the time horizon of the working time account considered – longer lasting recessions and recoveries.

Labor adjustment in working time accounts is already deployed as a practical instrument of labor market policy. Normally, working time accounts are set up as a time banking type of flexible working time schemes and are based on (collective) contractual agreements determining salaries, standard hours, upper and lower limits of worked hours, a reference period for mandatory settlement of an account, and, typically, explicit employment guarantees as well as productivity or output quality standards. As the standard working time accounts arrangement specifies a fixed salary and jobs without scope for moral hazard are essentially of minor impact, implementation of adequate incentives is an important issue. Based on the combination of efficient incentives and risk sharing, the working time accounts approach addresses a general problem in economics with particular relevance for labor

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2 The potential transferability of hours credits and deficits between firms in case of worker mobility will be an interesting issue for further studies. With respect to the more general character of our considerations such an analysis is, however, beyond the scope of the current paper.

3 The challenge of demographic change and recent proposals for redistributing worked hours over the life cycle may also be covered in working time accounts. Hence, there a legal framework with respect to e.g. inter-temporal and inter-employer transferability is required.

4 While incidence of working time accounts is growing in the European Union, they are rarely known in the United States, in particular as a potential instrument of labor market policy and flexibility. In this respect, this paper is intended as a proposal for a broader dissemination of working time accounts in circumstances where both, workers and firms, do benefit from the continuation of an employment relation, as for example under random job destruction.

5 The term flexible working time refers to a variety of working time schedules. The widely known model of flexi-time combines a core time period which is valid for all employees and a surrounding time-corridor that leaves the beginning and end of daily work at the discretion of workers. In flexi-time arrangements an average of weekly or monthly working hours is specified and accumulated credit hours as well as deficit hours are settled in a given period, defined as the reference period. Further explanation can be found in Bell/Elias (2003) and International Labour Office (2004a, 2004b). See Blyton (1995) for the development of annualized hours contracts in the United Kingdom and Bell/Hart (2003) for potential effects concerning labor market flexibility and efficiency. In practice, accordant collective agreements on working time accounts systems include explicit non-dismissal commitments and might be formulated as employment-pacts (cf. Croucher/Singe 2004).
economics, where existing approaches and our approach are related through the efficiency wage mechanism that appears to work.\textsuperscript{6}

With respect to the cited characteristics of working time accounts our paper is directly linked to the labor discipline approach developed by Shapiro/Stiglitz (1984)\textsuperscript{7} with random job destruction as the integrating variable. Despite being logically stochastic, Shapiro/Stiglitz (1984, hereafter ShSt84) formalize random separation of firms and workers as a deterministic variable. We extend by explicitly modeling job destruction as a random variable while also covering more general preferences. Our integrated approach \textit{working time accounts as a mutual insurance device} contributes by developing an insurance refined labor discipline model and discusses the effects on central labor market variables (e.g. job destruction, unemployment, tenure, labor productivity). This paper solves the problem of private incentives for unemployment insurance in the shirking model and the solution is characterized by a self-enforcing institution of private insurance between workers and firms that is established via working time accounts and is based on reciprocity that prevents either party from breaching the implicit contract.\textsuperscript{8}

Mutual insurance by means of working time accounts in the shirking model insures workers against dismissal originated in random job separation as in the current crisis, since – by construction – working time accounts absorb consequences of respective shocks. Absorption capacity is limited to the upper and lower bound of agreed hours deviation, hence,

\textsuperscript{6} MacLeod/Malcomson (1989) developed an important analysis of self-enforcing implicit (employment) contracts under moral hazard. They have shown that contract enforceability depends on sufficient total surplus from contract continuation compared to termination and that workers might be either motivated by discipline-device efficiency wages (in case of positive worker surplus) or by discretionary bonus payments (in case of zero worker surplus). As it is hard to think of situations where worker do not benefit at all from a continuation of employment, with few exceptions of extreme cases, like (i) instantaneous re-employment following layoffs, (ii) suffering from lethal illness, (iii) yearly salary that by far exceeds what one could spent in a whole life, or (iv) employees with minor labor productivity, eventually being better off not working, but receiving social benefits/assistance. With respect to the objective of our paper to suggest how to mitigate negative consequences caused by random job destruction we follow the efficiency wages approach.

\textsuperscript{7} First the shirking model formulates a clear cut threshold on productivity and therefore imposes an effort standard as we do. Second it initiated a still unsolved controversial debate concerning suboptimal private incentives for unemployment insurance and mandatory insurance arrangements in efficiency wage models (e.g. Bull (1985), Shapiro Stiglitz (1985), Carmichael 1989, Fath/Fuest 2005). Third there is strong evidence for the existence of internal reference points, i.e. that worker obviously neglect changes in labor market conditions like increased unemployment, but focus on current contracts or actual wages of peers. Consequently, the non-shirking condition, i.e. the “smart effort” inducing wage or salary, remains rather stable over the cycle and also during crisis (cf. Danthine/Kurmann (2006), Fehr/Hart/Zahnder (2008), Abeler et al. 2009).

\textsuperscript{8} This is very likely accompanied by the accumulation of reputational capital. An overview of formal and informal contract enforcement is given in MacLeod (2007).
the maximum number of hours deficits/credits per period or sub-period. The crucial characteristic of working time accounts is linked to the fact that they not merely provide unemployment insurance for – accurately motivated – employees, but simultaneously cover profit risks of firms, and might even enhance profits.

Essential effects of mutual insurance in working time accounts on labor market outcomes are expected as follows: First inter-temporal transfer of working hours is expected to lower the rate of job destruction. Second as contracted hours credits are not eligible to overtime payment and hours deficits mitigate expenditures for short-time work and idle capacity, profits and labor adjustment at the extensive margin should be smoothed. Moreover, knowledge capital can be maintained during downturn and crisis involving lower expected costs of screening, recruiting and further training, accompanied by extended expected tenure and superior labor productivity.

In sum, working time accounts establish a mutually beneficial (internal) labor market institution for workers and employers. The formal proofs refer to approaches of probability mass shifts, hence, analyze increases and decrease in risk in order to verify certain patterns of stochastic dominance. Strictly speaking, the shock absorbing capacity of working time accounts is evaluated in the two polar environments of (i) perfectly storable production, as well as (ii) non-storable production or services.

The paper is organized as follows: Section 2 briefly recapitulates the seminal shirking model, derives a generalized non-shirking condition, and formally integrates random job reallocation. It also points out labor flexibility at the intensive margin, i.e. working hours flexibility, and illustrates the idea of tracing respective adjustment patterns in a time banking system that relates any account to an individual worker. Section 3 focuses on comparing risks based on probability mass shifts and introduces the notion of mean preserving shift in contrast to mean relocating shift. Section 4 presents the institutional setting of working time accounts including a set oriented definition and applies the stochastic concepts from the preceding section, thereby demonstrating Pareto-superiority of mutual insurance in working time accounts for storable and non-storable production. The role of working time accounts in the
current crisis, expected impact on central labor market variables, a comparison with alternative instruments of adjustment and motivation, as well as potential drawbacks are discussed in section 5. Section 6 concludes.

2. The Labor Discipline Model under Economic Turbulence

We begin with briefly resuming major insights from the original shirking model and then extend the model to study the efficiency wage mechanism under economic turbulence. As an tentative measure for economic turbulence random job separation will be integrated. Given the steady state construction of the shirking model job separation rate and job destruction rate do coincide.  


With imperfect monitoring (moral hazard) and random separation of workers (reallocation due to job destruction) ShSt84 show that, as a solution to the profit maximization problem, firms will remunerate their employees above the market clearing wage level, hence, pay a well defined efficiency wage. The efficiency wage ensures that shirking is unattractive compared to non-shirking and establishes the intended incentive or labor discipline effect (non-shirking condition). As a consequence of the non-shirking condition, labor market equilibrium persistently deviates from full employment and unemployed workers who would agree to take employment at a lower wage could not credibly commit to work properly, once hired.

Since random allocative shocks occur, in every period some employees will be punished with contract termination irrespective of their effort, but firms do not provide unemployment insurance or employment protection, as such behavior would violate the non-shirking condition. Taking severance pay as an instrument for firm provided insurance, ShSt84 argue that profit maximization implies zero payment in case of separation. Consequently, the

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10 For firms the non-shirking constraint implies that severance pay and remuneration strictly move in the same direction. In contrast, workers treat unemployment benefits and wages as substitutes. Projected onto the efficiency-wage — severance-
corner solution of minimum feasible unemployment benefits materializes, at least if parties cannot contract on the cause of separation. The presumption that contracting on the cause of separation is ruled out a priori is very plausible, since the opposite would contradict the moral hazard concern.

The efficiency wage that encourages employees to meet the effort standard and work smart is determined by (i) the shape of the utility function of workers and their time preferences comprising risk attitudes, cost of effort and the discount rate, (ii) the probability of being detected shirking in case of shirking, including task complexity and monitoring technology, and an (iii) exogenous job destruction rate which, in a given period, captures the probability of being randomly separated from the actual firm. Given that – for whatever reason – severance pay or mandatory unemployment benefits were stipulated, (iv) their level would also affect effort choice.

ShSt84 analyze representative workers and firms. They focus on labor as the only variable input factor and any worker might either provide sufficient effort \( e > 0 \) or shirk \( e = 0 \). Effort is incompletely observable. The model operates with a linear utility function and assumes that costs of effort equalize respective effort levels \( c(e) = e \). Time preferences are depicted by the discount rate \( r \). The shirking detection probability \( q \) is for simplicity set exogenous, although endogenizing on monitoring technology or task complexity \( m \) would not change results qualitatively. Recall that the authors presume the separation rate \( b_0 \) as exogenous.

The shirking model will be the fundament for our analysis of working time accounts as a mutual insurance device and is the starting point for the extensions in the subsequent subsections. The crucial variable for integrating our arguments is the separation rate, since the scope for economic turbulence and insurance is based hereupon according to the inherently random nature of \( b \).

payment space the non-shirking condition (representing labor demand side) is upward sloped, while indifference curves (labor supply side) are negatively sloped, eventually implying a socially suboptimal equilibrium (un)employment level.
2.2. Generalized Non-Shirking Condition

The extension of the shirking model is twofold. We first integrate job destruction as a random variable $b$. In other words, temporary deviations from expected turbulence and reallocation $b_0$ are explicitly accounted for. Second we do not restrict analyses to risk neutral agents – an approach which enables us to bypass the critique addressed in implicit contract literature concerning insufficient handling of potential risk sharing in the shirking model.\(^\text{11}\)

We do not rule out increasing marginal disutility from effort and suppose a cost of effort function $c(e)$, with $c'(e) > 0$ and $c''(e) \geq 0$. As workers might be risk averse, compensation for random separation, e.g. an Arrow-Pratt risk premium, is also part of the enriched shirking model. The analysis will show, however, that as long as there is no risk-attitude-type specific pre-selection of employees into shirking or non-shirking the non-shirking condition will be not affected by that generalization.

For reasons of simplicity and straight modeling, let random job destruction $b$ be normally distributed with mean $b_0$ and variance $\sigma_e$. Suppose, for example, that a random shock $\varepsilon$, e.g. introduced by demand shifts, either augments or reduces the standard reallocation “pace” $b_0$. Again, since both shirkers and non-shirkers will face the same shock $\varepsilon$ on job destruction, the effort sustaining constraint on wages will be robust to the specification of $b$, although aspects of potential insurance will certainly be affected. Therefore, the formal analysis of random job destruction will be postponed until subsection 2.3.

\(^{11}\) Initially, implicit contract literature identified missing (third party) enforceability as the driving force behind lack of private insurance arrangements (Bull 1985, see also Shapiro/Stiglitz (1985), Carmichael 1989). For surveys of well established efficiency models cf. Akerlof/Yellen (1986) and Weiss (1991). Shirking equilibria and worker-type screening as substitutes can be derived when adverse selection (as, for example, type specific effort costs) accompanies the moral hazard problem (Strand (1987), Chouikhi/Ramani 2004). Alternatively, wage bargaining of monopoly unions may substitute efficiency wages (Bulky/Myles 1996). Individual bargaining and employment are discussed in Strand (2003). An extended model with firms being more risk averse than workers shows the existence of a full-employment equilibrium when efficiency wages and profit sharing are combined (Chang 2006). The results derived by Fath/Fuest (2005), a study very similar to Shapiro/Stiglitz (1984) with focus on mandatory unemployment insurance, can be interpreted in a manner that potential Pareto-improving effects might be expected in incomplete markets with barriers to entry. In the short run, welfare enhancing effects crucially depend on sufficient concavity of the production function. In the long run, without constraints on entry and exit of firms, however, mandatory insurance strictly reduces welfare. A more general discussion of unemployment insurance and employment protection can be found in Blanchard/Tirole (2008).
In this subsection the objective is to derive the generalized non-shirking condition and to examine its properties. The important question to be answered is, whether composition and level of the efficiency wage as a labor discipline device vary with the above generalizations.

The following figure illustrates the logic of the model:

--- Figure 1 here ---

In a given period, expected utility of shirkers and non-shirkers differs in two aspects: First the expected probability of job loss for shirkers exceeds the corresponding probability for non-shirkers, since it is the sum of expected relocation probability $b_0$ and shirking detection probability $q(m)$. Second a non-shirker faces higher costs of effort, since $c(e) > c(0) = 0$.

Let $V_E^n$ ($V_E^s$, respectively) denote the expected payment stream of an employed non-shirker (employed shirker, respectively). Since third parties will not be able to discriminate between shirking initiated and random dismissal initiated separation, hence, corresponding contracts were not enforceable, we do not need to distinguish different streams of unemployment benefits. In other words, $V_E^n = V_E^s = V_U$, where $V_U$ denotes the expected payoff stream of an unemployed worker (cf. a member of category Jobless in Figure 1). Let $w$, depict remuneration of an employee, and let (mandatory) unemployment benefits or severance pay, respectively, be captured by $w_{b_0}$.

The generalized non-shirking condition can be derived by considering short time intervals and integrating time preferences via the discount rate $r$. Thus, expected utility from non-shirking is given by

$$EU(V_E^n) = \frac{w - c(e)}{b_0 + r} + \frac{b_0}{b_0 + r} \cdot EU(V_U).$$

Correspondingly, expected utility of an employed shirker can be written as

$$EU(V_E^s) = \frac{w}{b_0 + q(m) + r} + \frac{b_0 + q(m)}{b_0 + q(m) + r} \cdot EU(V_U).$$
To motivate an employee to work properly requires that expected utility from non-shirking at least equals expected utility from shirking. Let us, for simplicity, take equality to be sufficient

$$\frac{w - c(e)}{b + r} + \frac{b_0}{b + r} \cdot EU(V_U) = \frac{w}{b + q(m) + r} + \frac{b + q(m)}{b + q(m) + r} \cdot EU(V_U).$$

Solving equation (3) for the corresponding efficiency wage \( w = w_{nc} \equiv w_{eff} \) yields the following expression

$$\frac{q(m) \cdot w_{eff} - (r + b_0 + q(m)) \cdot c(e) - EU(V_U) \cdot rq(m)}{(r + b_0) \cdot (r + b_0 + q(m))} = 0,$$

which can be rearranged as

$$w_{eff} = r \cdot EU(V_U) + \frac{r + b_0 + q(m)}{q(m)} \cdot c(e),$$

identifying the efficiency wage \( w_{eff} \) that serves to motivate employees to work accurately. As easily can be seen, for appropriate motivation of employees it is not sufficient to make them better off than being jobless and to cover their instant costs of effort, but it is also necessary to account for the shadows of future and job destruction as well as for task complexity.

In comparison to the efficiency wage equation derived in ShSt84 (their equation (5)) our generalized non-shirking condition deviates in two aspects. First the expected utility notion of payment streams captures risk premia potentially asked for by risk averse workers and might reflect changes in the trade of between risk-sharing and incentives (recall the corner solution of pure incentives). Second non-linear shapes of the function of worker’s attitudes toward effort are covered compared to the linear cost of effort function in the original shirking model. As \( c(e) \) is given once an employee has made his/her effort decision, the latter deviation collapses
to a rescaling effect. Thus, whenever the original non-shirking constraint and our generalized non-shirking constraint differ in a qualitative manner, such difference has to be embodied in the remaining term $EU(V_u)$.

Consequently, any relative changes between direct remuneration $w_{\text{eff}}$ and unemployment benefit $w_{\text{b}}$ necessarily refer to expression $EU(V_u)$ compared to $V_u$ in ShSt84. To identify – or negate – such differences, we solve for $rEU(V_u)$, thereby using the circumstance that one constituting characteristics of the labor discipline device is given by non-enforceability of contracts that discriminate among causes of separation. Therefore, if the non-shirking condition is satisfied, employees are indifferent between the different states of entry into unemployment

$$EU(V_u) \bigg|_{w=w_{\text{eff}}} = EU(V_u') \bigg|_{w=w_{\text{eff}}} = EU(V_u),$$

with $EU(V_u)$ indicating the incentive compatible expected utility of being jobless.

In a given period, unemployment benefit/severance pay amount to $w_{\text{b}}$, and the (re-)hiring probability is captured by $a^{12}$ Following the procedure as in equations (1) and (2), expected utility from unemployment writes as

$$rEU(V_u) = w_{\text{b}} + a \left[ EU(V_E) - EU(V_U) \right].$$

Using equation (1), the term $EU(V_E)$ from equation (7) can be substituted by the following expression $(w - c(e) + b_0 \cdot EU(V_U)) \cdot (b_0 + r)^{-1}$ which yields after rearranging

$$r \cdot EU(V_u) = \frac{a}{a + r + b_0} \cdot (w_{\text{eff}} - c(e)) + \frac{r + b_0}{a + r + b_0} \cdot w_{\text{b}}.$$

By again substituting for expression $EU(V_E)$ from equation (7), but this time with the term $(EU(V_u) \cdot (b_0 + q(m)) + w) \cdot (b_0 + q(m) + r)^{-1}$ from equation (2) we gain

$$r \cdot EU(V_u) = \frac{a}{a + r + b_0 + q(m)} \cdot w_{\text{eff}} + \frac{r + b_0 + q(m)}{a + r + b_0 + q(m)} \cdot w_{\text{b}}.$$

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12 As we maintain the concept of steady state equilibrium, the job finding rate $a$ is well defined.
Equating the right sides of equations (8) and (9) enables us to solve for the efficiency wage

\[ B \cdot w_{\text{eff}} = B \cdot w_b + \frac{a}{a + r + b_0} \cdot c(e) \]

(10)

\[ w_{\text{eff}} = w_b + \left(1 + \frac{a + r + b_0}{q(m)}\right) \cdot c(e) , \]

with \( B = \frac{a \cdot q(m)}{a + r + b_0} \cdot (a + r + b_0 + q(m))^{-1} \).

Thus, as in the original labor discipline model the efficiency wage \( w_{\text{eff}} \) that prevents workers from shirking can be decomposed into the fallback position of workers \( w_b \) (e.g. unemployment benefit/severance payment) plus a supplement which is determined by the employee’s attitude towards effort and time preferences, by task complexity and monitoring technology, and by labor market conditions.

As previous studies have shown, employees strongly align their individually perceived incentive constraint on what has been stipulated in their current employment relation, and therefore rely on internal reference points as defined by an existing (firm-level) efficiency wage (Danthine/Kurmann 2006). Such findings are compatible with the loss-aversion approach with the actual efficiency wage as the reference point that also drives expectations (Kahneman/Tversky 1979, Gul 1991). Recent experimental evidence on corresponding expectation-based reference-dependent preferences models (cf. Kőszegi/Rabin (2006, 2007)) is also supportive of the internal reference point story as it reveals that fixed payment related individual expectations indeed play an important role in determining a worker’s reference point (Abeler/Falk/Götte/Huffman 2009).

Using these insights, we interpret equation (10) as follows: Incentive constraint and effort standard that are related to the above efficiency wage are negligible affected by changes in the job finding rate or changes in the average job separation rate. In other words, whereas external labor market conditions are initially relevant, once a labor discipline style contract is effective, however, they lose their constituting power. Advances in monitoring technologies, however, continue to interact with the non-shirking condition. From this perspective, firms
should be cautious with intervening existing efficiency wage arrangements, e.g. through wage deductions. We will follow the internal reference evidence throughout the paper.

Except for the refined notion of workers’ disutility the generalized non-shirking condition and the condition identified in the original shirking model do not differ. Intuitively, the coincidence of the generalized efficiency wage is driven by the fact that, in a given period, both types of employees, i.e. shirkers and non-shirkers, will be equally treated by a separation shock, namely the realization of $\varepsilon$. As long as workers in a given firm are homogeneous concerning their attitudes towards risk, the non-shirking condition will be robust against a generalization of risk attitudes, leaving the level of the efficiency wage unaffected.

Consequently, the open question of suboptimal private incentives for unemployment insurance in the shirking model remains. In order to solve, we will formalize random separation shocks in the next subsection.

2.3. Formal Integration of Random Job Destruction and Labor Adjustment

As has been shown in the previous subsection, firms determine the profit maximizing efficiency wage within each of the three potential worker’s risk attitude regimes (risk neutrality, risk aversion, risk proclivity) by exactly trading off a worker’s marginal gain in expected utility from increased leisure against worker’s marginal loss in expected utility due to lowered income during spells of unemployment.

In the shirking model there are two principal sources of separation of workers and firms: First employees who get caught shirking are dismissed. Second random job destruction takes place. Let us focus on the latter source.\(^{13}\) Shapiro/Stiglitz (1984) take random job reallocation as exogenous and homogeneous. This paper adds to the literature by relaxing these assumptions, since reallocation is in fact subject to random variation. Moreover, shocks are likely to be idiosyncratic as well as duration of shocks might be heterogeneous.

\(^{13}\) Recall that with the non-shirking constraint effective, no shirking-detection initiated dismissal occurs.
Imagine a random job separation rate $b_{jt}$ that affects firm $j$ in period $t$, and is separable into a baseline – rather natural – separation rate $b_{j0}$ plus a firm specific shock component in job destruction $\varepsilon_{jt}$

\[(11a) \quad b_{jt} = b_{j0} + \varepsilon_{jt} .\]

Moreover, incidents like the current global crisis might add a further shock component

\[(11b) \quad \nu_{jt} ,\]

where $i$ is integrated to index country specific profiles.\(^{14}\)

To provide simple intuition, clarity and compelling argumentation, let us skip the firm specific notion. Further, let the random shock $\varepsilon_{t}$ follow a Normal distribution, whereas the crisis shock $\nu_{t}$ follows a Half-Normal distribution. During the current economic crisis the realization of the random job destruction rate $b_{t}$ in period $t$ then writes as

\[(12) \quad b_{t} = b_{0} + \varepsilon_{t} + \nu_{t} ,\]

\[(13) \quad \text{with} \quad \varepsilon_{t} \sim N\left(0, \sigma_{\varepsilon}^2\right) ,\]

\[(14) \quad \text{and} \quad \nu_{t} \sim N^{+}\left(0, \sigma_{\nu}^2\right).\]

The corresponding moments of the half-sided normally distributed variable $\nu_{t}$ are given with $E(\nu_{t}) = \sqrt{2 / \pi} \cdot \sigma_{\nu}$, and $V(\nu_{t}) = (\pi - 2 / \pi) \cdot \sigma_{\nu}^2$. The properties of the moments will be recalled in the subsequent discussion of probability mass shifts and stochastic dominance.\(^{15}\)

With a working definition of firm level turbulence at hand – operationalized by additive shocks in random job destruction, the next step will be to illustrate related labor adjustment patterns and to point out their potential to maintain jobs and human capital in the face of turbulence as well as their capability to smooth profit variation. In doing so, we always achieve

\[\text{\footnotesize \(^{14}\) Further shock components might exist, as e.g. a sector-wide shock in job destruction. For reasons of simplicity, and as qualitative results will not change, we do not write down an all-encompassing notion.}\]

\[\text{\footnotesize \(^{15}\) For a general discussion of functions and distributions see Johnson/Kotz/Balakrishan (1994), Abramowitz/Stegun (1985), and Barr/Sherril (1999).}\]
the labor discipline device, hence, pay the effort standard sustaining efficiency wage that, however, might undermine the insurance potential of several adjustment strategies.

Possible adjustment patterns of production with impact on input factor labor can be categorized into two sets of adjustment (cf. Haskel/Kersley/Martin 1997): On the one hand adjustment at the *extensive margin* covers per capita adjustment, hence, exit and entry of employees and therefore induces variations in the size of the workforce. Job destruction and job creation refer to extensive margin adjustment. On the other hand adjustment at the *intensive margin* denotes variation of working hours, hence reflects fluctuation in the worked time per capita. Temporary work sharing, overtime, short-time, and working time accounts refer to intensive margin adjustment of labor. With extensive margin adjustment of labor the reallocative shocks $\varepsilon$ and $\nu$ are directly transmitted to the workforce via per capita adaption. In contrast, intensive margin adjustment internalizes part of either shock, thereby lowering employment variation and depreciation of human capital introduced by the dismissal-entry patterns which are exhibited by per capita adaption.\footnote{For analyses of cyclical variation and duration of demand shocks as determinants of labor adjustment behavior cf. Bils (1987), Chang (2000), Chang/Kwark (2001). The interplay of extensive and intensive margin labor adjustment over the product life cycle or the business cycle, respectively, is e.g. addressed in Nickell (1978) and Cho/Cooley (1994).}

With respect to quasi-fixed labor costs (Oi 1962) the potential of extensive labor adjustment to internalize reallocative labor market shocks will be restricted a priori. Moreover, in our incentive device context it is very likely that firm’s reputation seriously suffers from dismissing highly motivated employees, eventually distorting the labor discipline device for future periods. Intensive margin adjustment, however, with inherently reversible adjustment patterns indeed internalizes and absorbs at least part of the firm specific and global crisis related shocks we have specified in (11a) and (11b). The specific adjustment costs of labor adjustment at the intensive margin depend on the particular rules of related arrangements.

2.4. *Practical Relevance of Labor Adjustment at the Intensive Margin*

Internationally well recognized arrangements of intensive margin labor adjustment that enable firms to adapt to market changes are given by sequences of overtime work, standard working
time, idle capacity, and short-time work. In labor market practice, labor adjustment at the intensive margin not only introduces working hours flexibility, but also transforms (un)employment risks into hours risks for firms as well as for workers. Moreover, this adjustment strategy seems to be of particular relevance at the beginning and end of a product’s life cycle, and at the edges of business cycle phases.\textsuperscript{17}

In Europe, the intensive margin adjustment instrument of working time accounts – a very specific kind of working time flexibility – faces increasing popularity. Within a working time account, each worked hour is documented at the individual employee level and is then compared to contracted standard hours for pre-defined spells. The difference is denoted as plus-hours or minus-hours, respectively. Plus-hours capture hours credits that an employee has granted to the firm. For example, in overtime settings worked hours exceed standard hours. Minus-hours denote hours deficits. In periods of, e.g., short-time work or temporary work sharing worked hours fall short of standard hours. All differences are traced and might offset over the time spell under consideration. One of the constituting characteristics of working time accounts is that worked hours and standard hours are supposed to match on average. Moreover, within a well defined time-budget no adjustments costs appear, because neither credit nor deficit hours affect remuneration. One consequence of such a time banking institution is that labor costs and salaries are predetermined, a property that is definitely in contrast to the salary and labor costs shifting and re-shifting effects that would emerge under the common, more traditional, sequences of hours adjustment.

In the labor discipline context, the salary maintaining property of potential adjustment practices in conjunction with the (un)employment insurance property is essential. First the predetermined wage level sustains the efficiency wage mechanism. Obviously, the working time accounting system needs to be established with individual accounts, as collective accounts would dilute the intended incentive device. Second the research gap of lack of private

\textsuperscript{17} Under labor adjustment at the extensive margin employment risk materializes as the (temporary) loss of job slots (firms) and loss of employment with the option of being re-hired post to recovery (workers). In contrast, with labor adjustment at the intensive margin the number of hours worked is adapted, and indeed insurance against cutbacks of job (slots) is introduced at the price of increased variation in hours worked. This result points out an interesting parallel to end of period bonus payments contracts as developed by MacLeod/Malcomson (1989), since empirical research has shown that the level of bonus pay indeed varies in response to the business cycle (e.g. MacLeod Parent 1999b).
incentives for unemployment insurance in the shirking model closes if we use the potential for reduction in the risk of job loss for our argumentation. Formally, this argumentation relies on mean preserving and mean altering manipulations of risky prospect and the related statistical concept will be described in the following section.


This section presents a method to compare risky prospects under only weak assumptions. As our objectives are to improve the understanding of the linkages between reallocative shocks, economic downturn, remuneration and labor adjustment for environments where the success of firms is constraint to the effectiveness of an efficiency wage mechanism with a clear threshold on productivity as well to propose an appropriate strategy for adjustment of labor, we need to utilize an intuitively understandable, but general concept for evaluation. By evaluation we mean the ability to formulate a (social) preference ordering over alternative adaptation policies.

The main advantage of the concept we introduce is the general applicability plus the clear intuition which is given by moving probability mass within risky prospects. Furthermore, the concept of comparing risk with probability mass shifts perfectly fits with the random job destruction approach we introduced in the previous section.


Although the probability mass shift approach is applicable to any arbitrary probability distribution function, let us first concentrate on the familiar standard normal distribution \( f(X) = (2\pi)^{-0.5} \cdot e^{-0.5x^2} \). Let us further depict a) probability density as well as b) the value of the cumulative density function for the realizations -2, -1, 1, and 2 of random variable \( X \). The probability density for values -2, and 2 is given by \( f(-2) = f(2) = 0.054 \). The respective probability density for realizations -1 or 1 is \( f(-1) = f(1) = 0.242 \). Cumulative densities amount to \( F(-2) = 0.023 \), \( F(-1) = 0.159 \), \( F(1) = 0.691 \) as well as \( F(2) = 0.977 \). The probability mass covered by the interval \([-2,-1]\) equals the probability mass covered by the interval \([1,2]\), and comprises 13.6 percent of the overall probability mass.
The idea of comparing risks by probability mass shifts is as follows: Let us at a time shift e.g. those 13.6 percent of probability mass without affecting the first moment of the distribution. First consider an outward shift. This generates a new random variable \( Y \) with more weight in the tails of the distribution. In our example, \( Y \) might be generated by shifting both probability mass areas to -2 and 2, respectively, thereby increasing the corresponding probability density to 0.19. Of course, these shifts imply a probability density of 0 in the interval \((-2, -1]\) and \([1, 2)\), respectively. Second consider an inward shift which puts more weight to the center of the distribution. Here, the above probability mass might be shifted to -1 and 1, respectively, eventually implementing the probability densities of
\[
f(-1) = f(1) = 0.378
\]
as well zero density in the intervals of shifted probability mass.

To summarize, shifting probability mass to the tails of a distribution increases dispersion and therefore risk, whereas shifting probability mass to the center of a distribution decreases dispersion and therefore risk. For any two distributions with identical expected value, the well-known notion of second-order stochastic dominance is equivalent to the notion of probability mass shift to the center. With respect to the discussed (mutual) insurance problem, the task will be to identify instruments of labor adjustment that imply a shift of probability mass to the center.\(^{18}\)

Shifting probability mass while keeping the mean of pre- and post-shift distributions constant is attached to mean preserving manipulations of random variables, and is typically discussed in conjunction with symmetric distributions as captured by the job destruction shock \( \varepsilon \), in equation (13). In contrast, mean altering shifts of probability mass essentially apply to

\(^{18}\) In economic theory, the concept of defining variability under only weak assumptions and – based thereon – the comparison of risky prospects has been first addressed by Rothschild/Stiglitz (1970) who prove the equivalence of the following definitions of “increasing risk”: On the one hand, random variable \( Y \) is more risky than random variable \( X \) if
\[
\begin{align*}
&\text{every risk averter prefers } X \text{ to } Y, \\
&Y \text{ is generated from } X \text{ by adding a random variable } Z \text{ with } E[Z|X] = 0, \\
&Y \text{ has more weight in the tails.}
\end{align*}
\]

On the other hand, let \( F(x) \) and \( G(y) \) be the respective cumulative probability functions of \( X \) and \( Y \). \( G(y) \) is second-order stochastically dominated by \( F(x) \), iff (integral condition):
\[
\int_{-\infty}^{t} [G(z) - F(z)]dz \geq 0, \text{ for all } t, \text{ with strict inequality for some (non-zero) interval of values of } z.
\]
half-sided or censored distributions. In our paper, the shock that depicts actual crisis (see equation (14)) and temporary demand shifts within an environment of non-storable production or services are situated in the area of the latter distributions and will be studied in the light of mean altering shifts of probability mass.

The corresponding definitions of mean preserving spread (DEFINITION 1), mean preserving contraction or shrink, respectively (DEFINITION 2), as well as mean augmenting contraction or shrink, respectively (DEFINITION 3), are given in the remaining two subsections of this section.

3.2. Mean Preserving Shifts

For an overview on mean preserving spreads, probability mass shifts, stochastic dominance, and a critique of Rothschild/Stiglitz (1970) see Rasmusen/Petrakis (1992). DEFINITION 1 below comprises the rather common notion of mean preserving spread as a general concept to rank risky prospects.

**DEFINITION 1 (MEAN PRESERVING SPREAD):** Let the expected value of random variables $X$ and $Y$ be identical. $Y$ is a mean preserving spread of $X$, if $Y$ shifts probability mass to the tails of $X$. Hence, $X$ second-order stochastically dominates $Y$ ($X$ ssd $Y$).

Equivalently, the integral condition is satisfied: $F(x)$ second-order stochastically dominates $G(y)$, where $F$ and $G$, respectively, represent the cumulative probability distribution functions of $X$ and $Y$.

As we have illustrated before, probability mass shift to the tails and probability mass shift to the center are just reverse notations, as we could easily interchange the data between random variables $X$ and $Y$. In this sense, the counterpart to a mean preserving spread (mps) is defined as mean preserving contraction (mpc) or, equivalently, as mean preserving shrink (mpsh). Any mpc (mpsh, respectively) second-order stochastically dominates it’s source random variable, and any mps is second-order stochastically dominated by it’s source. **DEFINITION 2** for mean preserving contraction (mean preserving shrink, respectively) is

**DEFINITION 2 (MEAN PRESERVING CONTRACTION – MEAN PRESERVING SHRINK):** Given two random variables $X$ and $Y$ with identical expected values $\mathbb{E}[X] = \mathbb{E}[Y]$, and $X$ being generated from $Y$ by a shift
of probability mass from the tails to the center of $Y$, then $X$ is a mean preserving contraction of $Y$. The equivalent, but less technical notion identifies $X$ as a mean preserving shrink of $Y$.

For the treatment of adjustment inertia and non-symmetrically distributed random variables it is useful to define effects of probability mass shifts that do not preserve the mean.

### 3.3. Mean Altering Shifts

A direct implication of economic crisis and of temporary demand shifts in the service sector or under non-storable production/lack of inventories is that, on average, shocks and temporary shifts do not set off. Therefore, DEFINITION 3 defines correspondingly to DEFINITION 2 the mean augmenting contraction (mac), and – equivalently – mean augmenting shrink (mash).

**DEFINITION 3 (MEAN AUGMENTING CONTRACTION – MEAN AUGMENTING SHRINK):** Fix a pair of right censored random variables $X$ and $Y$ with identical censoring point $\alpha \in \mathbb{R}$, and $F$ and $G$ as their respective cumulative density functions. Let $X$ have been generated from $Y$ by right shifting probability mass from the tail to the censoring point. Then $F(\cdot) \geq G(\cdot)$ holds, with strict inequality on the interval $[z_l, z_h]$, and $-\infty < z_l < z_h \leq \alpha$. $X$ is identified as a mean augmenting contraction, or, equivalently, as a mean augmenting shrink of $Y$.

Now let $Y$ be a half-sided normally distributed random variable with truncation point $\alpha$. Let $X$ be defined as before. Then $X$ is a mean augmenting contraction/shrink of $Y$.

There are two stages inherent to DEFINITION 3. At a first stage, the shift of probability mass from the tail to the censoring point unequivocally increases the expected value, i.e. $E[X] > E[Y]$ (*mean augmenting property*). Hence, $X$ first-order stochastically dominates $Y$ ($X \text{ fsd } Y$). At the second stage, the shift generates a random distribution that second-order stochastically dominates the unmodified distribution (*contracting property*).

Whereas the mean augmenting property is evident, the contracting property is worth to be further explored. Since the overall probability distribution function of any half-sided distributed or right censored random variable $z$ is a combination of (i) the mode or a spike at $\alpha$ and (ii) a continuous probability density function for values $z < \alpha$, the right shift of probability mass either transfers cumulated density from the continuous part (ii) to the...
censoring point or decreases the incidence of realizations in the interval \([z_{y_0}, z_{y_1}]\) while simultaneously increasing the frequency of realizations in a successive interval \([z_{x_0}, z_{x_1}]\), where \(G(z_{y_1}) - G(z_{y_0}) = F(z_{x_1}) - F(z_{x_0})\) identifies the area of the shifted probability mass, and with \(-\infty < z_{y_0} < z_{y_1} < z_{x_0} < z_{x_1} < \alpha\). Then, cumulative density \(G(Y)\) strictly exceeds \(F(X)\) in the interval \([z_{y_0}, z_{y_1}]\) and at least equals \(F(X)\), otherwise. Thus, the integral condition is satisfied, and the contracting property is established.

The mutual insurance approach that will be developed in the next section applies the concept of mean preserving contraction/shrink (mpc/mpsh) and also the concept of mean augmenting contraction/shrink (mac/mash) to prove the benefits of working time accounts in terms of Pareto superiority. We will show that working time accounts as a mutual insurance device give scope for insurance in the shirking model, while retaining the crucial incentive device property.


This section discusses a stylized model of working time accounts as a mutual insurance device in labor discipline contracts and applies the statistical concepts from the previous section to proof the major insights from our model of double-sided buffering of labor market risks. We begin with the institutional setting of working time accounts that will be presented in a set oriented way and then evaluate the adjustment potential of working time accounts as well as their capability to provide private insurance by means of assessing the effects of the corresponding probability mass shifts.

4.1. Working Time Accounts: Institutional Setting

The unique property of time banking is to formally trace worked hours in a statement of account. In general, working time accounts are determined by (i) remuneration, (ii) standard hours, (iii) distribution of working time, i.e. total hours including upper and lower limits of hours worked, and (iv) a reference period over which worked hours have to be averaged.
Working time accounts as an insurance device, in addition, encompass an element of (v) job security and are immediately linked to implicit contracts and efficiency wage mechanisms.

**DEFINITION 4 (WORKING TIME ACCOUNTS):** A working time account belongs to an individual employee in a given firm and formally traces worked hours over time. Working time accounts are settled in collective or individual agreements. Let the formal definition \( \text{wta} \) be as follows:

\[
\text{wta} := \{ w, h, h_{\mu}, \Delta h_t, T_{\text{ref}}, 1_{\text{jsec}} \}.
\]

Working time accounts include remuneration (package) \( w \), the vector of contracted daily, weekly, monthly etc. standard working time \( h_{\mu} \), the vector of maximum daily, weekly, monthly, etc. allowance of hours deviation from contracted average \( \Delta h_t \), the reference period \( T_{\text{ref}} \), and possible employment security elements \( \text{jsec} \), integrated by the corresponding indicator variable. For example, the \( \text{wta} \) system might guarantee that no dismissals due to operational reasons or restructuring will occur (indicator function \( 1_{\text{jsec}} \) takes value 1).

The explicit definition of working time accounts as a mutual insurance device is based on the job security element on the one hand (covered by \( \text{jsec} \)) and integrates the property that firms in general benefit from inter-temporal transfer of worked hours on the other hand (e.g., exemption from overtime pay, covered by the payment vector \( w = [w_{\text{eff}}, 1_{\text{hp}}] \)). Recall that in our context proper incentives form a prerequisite for the insurance mechanism as we have illustrated in the introduction. Under this mechanism it is straightforward that working time accounts systems define employment relations where a positive surplus from contract continuation accrues to both, workers and firms. As Malcomson/MacLeod (1989) have shown, efficiency wages and discretionary bonus payment denote crucial variables in the process of establishing incentive compatibility and self-enforceability. **DEFINITION 5** integrates these insights by partitioning the remuneration package vector \( w \). In fact, working time accounts as a mutual insurance device \( \text{wta}_{\text{mi}} \) in **DEFINITION 5** address the most common type of working time accounts in labor market practice:

**DEFINITION 5 (WORKING TIME ACCOUNTS AS A MUTUAL INSURANCE DEVICE):** If working time accounts explicitly insure employees against unemployment from shocks in random job destruction, then
employment security \textit{jsec} is effective. Working time accounts as a mutual insurance device \textit{wta}\_mi write as

\[
\text{wta}\_mi := \left\{ \frac{w_{\text{eff}}}{1_{\text{ibp}}}, h_{\mu}, \Delta h_{t}, T_{\text{ref}}, \text{jsec} \right\}
\]

with efficiency wage \( w_{\text{eff}} \) representing the appropriate incentive device to meet the effort standard. The indicator variable \( 1_{\text{ibp}} \) takes value 1 if informal bonus payments arrangements are effective. Technically spoken, informal bonus payments \( \text{ibp} \) allow firms in principle to add further stochastic performance related components supplementary to the basic incentive device \( w_{\text{eff}} \), e.g. in order to control for idiosyncratic worker characteristics in addition to the non-shirking condition à la ShSt84.

The first part of the compensation vector \( w \) denotes the incentive compatible fixed salary \( w_{\text{eff}} \) that implements the non-shirking mechanism which is crucial to the mutual insurance mechanism. Within a broader context, the efficiency wage would account for task composition and job-characteristics, thereby capturing the effort standard we discussed so far, whereas the second part, i.e. informal bonus payment component \( 1_{\text{ibp}} \), rewards personal characteristics, and integrates voluntary profit sharing.\(^{19}\)

Expected working time \( h_{\mu} \) captures component (ii) and is related to the expected profit maximizing output level. Further, the maximum limit of hours credits/debits\(^{20}\) \( \Delta h_{t} > 0 \) can be accumulated on a daily, weekly or alternatively defined basis and represents component (iii). Of course, \( \Delta h_{t} \) might be regulated by law. With \( h_{t} \) as realized worked hours in a given period, actual amount of hours transfer \( \delta h_{t} \) either matches the desired value or is identical with the contracted limit. Formally, \( \delta h_{t} \) is given by \( \delta h_{t} = \min[\Delta h_{t}, |h_{t} - h_{\mu}|] \).

\(^{19}\) Despite not necessary for the proofs that are at the core of our paper, we already introduce the bonus payment component here to prepare for future extensions of the mutual insurance device concerning heterogeneity of workers and idiosyncratic productivity patterns. As originally shown by Malcomson/MacLeod 1989, informal end of period bonus payments refer to efficient incentives when firms acquire any potential surplus from employment contract continuation. Recent studies discuss discretionary end of period bonus payments as an instrument to consistently integrate heterogeneous personal characteristics into incentive schemes (Lemieux/MacLeod/Parent (2007), 2009). Extending those views and consistent with insights from behavioural economics, we integrate informal bonus payments because firms also benefit from working time accounts, and might consider voluntary sharing of profits with employees to honor profit enhancing effects of inter-temporal hours transfer in working time accounts.

\(^{20}\) As long as random separation will be symmetrically distributed, the limits for hours credits and debits will coincide.
Component (iv) is specified by the time horizon $T_{\text{ref}}$ over which positive and negative hours transfers balance on a mandatory basis. Reference periods may vary from a few months up to several years. For example, annualized hours contracts comprise a reference period of 12 months. Explicit settlement of a reference period assures enforceability of the insurance device. Moreover, re-adjustment for systematic changes in underlying variables is not ruled out a priori. Finally, employers commit to refrain from layoffs in response to temporary negative demand shifts or comparable shocks, where jsfc represents the obligation of providing employment security (v) which is imposed on firms and is usually settled in collective agreements.\(^{21}\) We will see that this combination of (random) transfer of worked hours and job security is crucial for the success of mutual insurance in the shirking model.

In the sequel, we will write *working time accounts as a mutual insurance device* (wta_mi) synonymously as *insurance refined labor discipline contracts* (ins_ld).

### 4.2. Working Time Accounts and Storable Production

Suppose the random variation of separation probability to be driven by random demand shifts. Let us further focus on the following two polar cases of potential adjustment: As polar case one, let us consider the capability of instantaneous adjustment of production (cf. costless buffering or quantity imitating price adjustments) which is discussed in this subsection. As our second polar case (which will be discussed in the subsequent subsection) we consider the case of prohibitively-costly adjustment of production (cf. economic crisis or binding non-storability with price-rigidity).

In principle, polar case one addresses an adjustment context corresponding to random job destruction shock $\varepsilon_t$ (equations (11a) and (13)). Using the concept of mean preserving shrink, we obtain

**Proposition 1 (Instantaneous Adjustment):** When costless buffering or perfect price adjustment are feasible, insurance refined labor discipline contracts wta_mi second-order stochastically dominate their pure efficiency wage contract counterparts.

PROOF: As working time accounts reverse any temporary demand shift up to the bound \( \Delta h_i > 0 \), insurance refined labor discipline contracts definitely alter the shape of the related profit distribution. Inter-temporal transfer of worked hours shifts probability mass from the tails to the center of the uninsured distribution (the green area in Figure 2b depicts the corresponding probability mass that has been shifted to the mean). Statistically speaking, the frequency of the mean is boosted, while expected profits do not alter – eventually implying a less risky distribution of profits.

4.3. Working Time Accounts and Economic Crisis, Non-Storabilities, and Services

By either imposing the restriction of non-storability or integrating current economic crisis with half-normally distributed disturbance term we introduce polar case two. Polar case two concentrates on adjustment contexts which in addition to polar case one integrate shock component \( \nu_i \) (equations (11a) and (14)). Given this, we can further derive

PROPOSITION 2 (NON-STORABLE GOOD): During economic crisis or when buffering or price adjustments are ruled out (e.g. according to quality standards), an insurance refined labor discipline contract \( wta_{mi} \) first-order stochastically dominates the pure efficiency wage contract. Firms have strict incentives for the introduction of working time accounts as a mutual insurance device.

PROOF: In polar case two, a transfer of worked hours modifies shape and expected value of the related profit distribution, thereby introducing a mean augmenting shrink (DEFINITION 3). Probability mass (compare the green area in Figure 2d) is shifted from the tail to the censoring point of the uninsured distribution and frequency of the censoring point increases. Thus, with binding adjustment inertia, working time accounts as mutual insurance device raise expected profits and first-order dominate their pure efficiency wage contract counterparts.

Since the discussed polar cases in subsection 4.2 and 4.3 treat the upper and lower bound of adjustment capabilities, the dominance of risk sharing in working time accounts in combination with given effort standards has been shown.

--- Figure 2 here ---
Then firms who face repeated moral hazard of employees have private incentives to establish and maintain working time accounts as a mutual insurance device. The following subsection establishes the mutuality concern, i.e. proves that workers also prefer private unemployment insurance via working time accounts.

4.4. Working Time Accounts as a Mutual Insurance Device: Unemployment Insurance

From section 2.2 we know that the level of the efficiency wage is independent of the attitude of workers towards risk. In other words, incentive objectives clearly dominate potential aspects of efficient risk allocation. Thus, in pure shirking type efficiency wage contracts employees are not insured against layoffs which result from random variation as demand shifts and other allocative shocks or economic downturn. As a consequence, a job-loss-lottery for (high-effort) employees results. Given this risky prospect, risk averse employees would, in principle, agree to a reduced wage level $w_{\text{eff}}^{\text{ins}}$ where the cut-off $w_{\text{eff}} - w_{\text{eff}}^{\text{ins}} > 0$ depicts their willingness to pay for employment protection, and might be interpreted as the corresponding insurance fee for being exempted from (part of) the income uncertainty that results from recurrent employment-unemployment-spells.\(^{22}\)

According to the discipline device any deviation from the efficiency wage level would violate the non-shirking constraint. Thus, the above implicit insurance-fee arrangement is no option in our context. Legally forced severance payment $w_{h} > 0$ as discussed in the literature in terms of mandatory unemployment benefits does not alter the core of the problem either, since profit and employment are likely to fall (cf. Lazear (1990) for employment decreasing effects severance payment requirements, and Falk/Huffman/MacLeod (2008) for negative incentive effects).

Using these arguments and the definitions above, we obtain

**PROPOSITION 3 (INCOME SMOOTHING):** Any risk averse worker prefers working time accounts as a mutual insurance device to the pure efficiency wage contract counterpart: $w_{\text{ta\_mi\_pew\_ld}} > w_{\text{pew\_ld}}$.

\(^{22}\) Since we concentrate on the fundamental properties of working time accounts, we do not discuss issues of human or knowledge capital in detail. However, one should expect that incentives for firms and workers to establish insurance refined labor discipline contracts will be reinforced when explicitly accounting for human capital.
PROOF: Since any insurance refined labor discipline contract \( wta_{mi} \) corresponds with \( X \), as in DEFINITION 2 and DEFINITION 3, working time accounts as defined in DEFINITION 5 are a mean preserving contraction or a mean augmenting contraction of some pure labor discipline contract (\( pew_{ld} \)) which in turn corresponds with \( Y \). In other words, working time accounts introduce an elementary decrease in risk. Consequently, every risk averter prefers mutual insurance in working time accounts (the related proof is in Rothschild/Stiglitz 1970) and the mutuality of this insurance device is proven.

Imposing again the restriction of non-storability, we can further derive

PROPOSITION 4 (INCOME GAIN): During economic crisis and when costless buffering as well as instantaneous price adjustment of allocative shocks are not feasible, any worker prefers mutual insurance via working time accounts \( wta_{mi} \), irrespective of his/her risk attitude.

PROOF: Similar to PROPOSITION 2, working time accounts as a mutual insurance device first-order stochastically dominate pure efficiency wage contract counterparts. Expected income, given the job-loss lottery, moves upward with insurance refined labor discipline contracts, since negative allocative shocks are up to a certain limit eliminated via the inter-temporal transfer of hours operated within the time banking system.

In terms of expected utility theory PROPOSITION 5 can be formulated

PROPOSITION 5 (CERTAINTY EQUIVALENT – SELF-ENFORCEABILITY): For any risk averse worker the certainty equivalent of an insurance refined labor discipline contract exceeds the certainty equivalent of the pure efficiency wage contract counterpart. Workers with well-behaved utility functions strictly prefer working time accounts as a mutual insurance device, and therefore \( wta_{mi} \) establish a self-enforcing institution of insurance and labor adjustment in the shirking model.

\[ \text{PROPOSITION 5 for reasons of lean notation we concentrate on symmetric shocks, since they even impose a weaker constraint on the sign of the difference of the respective certainty equivalents (PROPOSITION 5), and eventually on working time accounts to be established as a self-enforcing institution of mutual insurance. To integrate the crisis shock component } \nu \text { explicitly, we simply need to add this random variable to the shock term } \varepsilon. \text { Effects on the certainty equivalent would be twofold. First the risk premium will rise in response to increased income variance (add } (\pi - 2)\pi^{-1} \cdot \sigma_{\nu}^2 \text { to variance term } \sigma_{\varepsilon}^2 \text { in equation (15), provided these shocks are independently distributed). Second the certainty equivalent will further decrease according to non-zero mean } (2 / \pi)^{0.5} \cdot \sigma_{\nu}^2 \text { of crisis shock } \nu \text { that would appear in the middle term of the final row in equation (15), thereby downsizing } C(e), \text { and further confirming PROPOSITION 5.} \]
PROOF: Given that the non-shirking condition is satisfied, an employee’s certainty equivalent of the working contract can be written as

\[
CE_{\text{nsc}} = E\left[\text{income}\mid \text{nsc holds}\right] - C\left(e\mid \text{nsc holds}\right) - \frac{R_A}{2} \cdot \text{VAR}[\text{income}]_{\text{nsc holds}}
\]

\[
= E\left[\left(b_0 + \varepsilon\right) \cdot w_{h_0} + (1 - b_0 - \varepsilon) \cdot w_{h_0} \cdot \left(1 + \frac{a + r + b_0}{q(m)}\right) \cdot C(e)\right]_{\text{in case of separation}} - C(e) - \frac{\sigma^2}{2} R_A \cdot \left(1 + \frac{a + r + b_0}{q(m)}\right)^2 \cdot C^2(e)_{\text{when employment is continued}}
\]

\[
= w_{h_0} + \left[(1 - b_0) k - b_0\right] \cdot C(e) - \frac{R_A}{2} \cdot \left[(1 + k) \cdot C(e)\right]_{\text{in case of separation}}^2 - \frac{\sigma^2}{2} R_A \cdot \left(1 + \frac{a + r + b_0}{q(m)}\right)^2 \cdot C^2(e)
\]

(15)

with \(k = \frac{a + r + b_0}{q(m)} = \text{const.}\) and \(R_A\) as the Arrow-Pratt coefficient of absolute risk aversion.

For risk averse workers \(D > 0\) holds. In the agency literature, CARA preferences\(^ {24}\) are widely used: Given this, the difference in the certainty equivalents of working time accounts as a mutual insurance device (\(CE_{\text{wta}}\)) and pure labor discipline efficiency wage contracts (\(CE_{\text{pew}}\)) is driven by the – inverted – difference in their variances. The corresponding difference writes as \(CE_{\text{wta}} - CE_{\text{pew}} = D \times \left[\sigma_{\varepsilon,\text{pew}}^2 - \sigma_{\varepsilon,\text{wta}}^2\right] > 0\), iff \(D > 0\), and \(D\) as abbreviated in the final row of equation (15). The term \(\sigma_{\varepsilon,\text{pew}}^2\) (\(\sigma_{\varepsilon,\text{wta}}^2\), respectively) captures the variance of random job destruction, and basically turbulence, in the pure shirking model regime (in the scope for mutual insurance in the shirking model regime, respectively). Because inter-temporal transfer of worked hours acts as a double-sided buffering of labor market risks, it decreases the variation of the income path. Correspondingly, \(\sigma_{\varepsilon,\text{pew}}^2\) exceeds \(\sigma_{\varepsilon,\text{wta}}^2\) such that with intensive adjustment in working time accounts worker’s certainty equivalent in fact increases (cf. mean preserving contracting, and Figures 2b and 2c).

\(^{24}\) With exponential utility \(U(W) = 1 + e^{-\rho W}\) the coefficient of (absolute) risk aversion is \(R_A = \rho\).
To conclude, working time accounts that are integrated into an efficiency wage contract arrangement in the labor discipline context in the sense of Shapiro/Stiglitz (1984) establish an enforceable reciprocal insurance institution between workers and firms with the – likewise reciprocal – risk premium of a varying calculative hourly wage which temporarily falls above or below the contracted standard value. The empirical relevance of just in time production and delivery, price rigidities, and non-storability as well as a rising incidence of time banking systems in Europe are in line with our argumentation.

During current crisis working time accounts agreements might prove as a fruitful instrument that also helps to retain crucial knowledge capital, not only in Europe.

5. Discussion

Labor adjustment at the intensive margin opens the scope for insurance in the shirking model. If the adjustment pattern of hours is traced in individual working time accounts and employment guarantees with respect to market driven reallocative shocks are given, this firm-level instrument of a labor market policy establishes a self-enforcing institution of mutual insurance in the labor discipline context. Mutual insurance refined efficiency wage contracts are self-enforcing, since for firms and workers the respective hours transfers are just mirror inverted, and, by construction, working time accounts imply that worker’s credit hours denote deficit hours for firms and vice versa. In fact, a reciprocal threat position is assembled, making breach of contract unattractive, since the benefits that have been proven in the PROPOSITIONS rely on a bilateral functioning of the transfer mechanism.

We might also use insights from Chiappiori et al. (1994) to show the self-enforceability of working time accounts as a mutual insurance device in the shirking model. The authors discussed motivation and double-sided commitment under repeated moral hazard, and have shown that renegotiation-proof and self-enforcing employment relations that provide long-term incentives are enacted if remuneration of employees is characterized by random savings in termination contracts. As the unemployment as a labor discipline device approach corresponds to a termination contract, and since the amount of hours saved (credit hours) or invested (debit
hours) is random according to random turbulence, hourly wages as well as period savings are random as well, eventually establishing our mutual insurance refined labor discipline contract as a renegotiation-proof and self-enforcing firm-level institution of labor market.

In labor market practice, of course, quasi-fixed costs of settling respective agreements have to be taken in consideration, and the processes of implementation as well as documentation of hours transfers have to be carefully governed.

5.1. The Role of Working Time Accounts in the Current Crisis, and Impact on Central Labor Market Variables

One objective of our paper has been to address the problem of keeping sufficient incentives during the current economic crisis. In the current crisis working time accounts as a mutual insurance device are in particular useful in environments with binding incentive constraints with straightforward effort or quality standards. They are able to credibly sustain the availability of internal reference points for accurate motivation. As has been shown, labor market turbulence will be smoothed, implying lowered rates of job destruction, improved maintenance of knowledge capital and extended tenure, increased employment as well as higher labor productivity compared to a system without working time accounts. These positive effects on central labor market figures result from the mean preserving and mean augmenting contractions that are introduced through the working time accounts system.

Depending on the duration of the crisis, working time accounts hopefully bridge the gap until recovery. Simultaneously sustaining motivation and job slots further improves future matches of job slots and workers which might prove as a competitive advantage when recovery starts. As more jobs will be maintained during the current crisis, human capital will depreciate less rapidly, and accumulated hours deficits might be transferred to further training hours.

Working time accounts moreover strengthen credibility of employees to continue repaying long term liabilities as e.g. interest rates for mortgages. Technically spoken, working time accounts introduce hours flexibility and variation in calculatory hourly wages which in
turn imply fixed salaries. Because of the fixed salary, employees dispose of a reliable budget, and may almost afford their lifestyle before crisis.

Although the implicit contract literature neither focused on crisis nor on labor market turbulence, it yields effects that are similarly to those we have derived for internal labor adjustment via working time accounts. In particular, the trade-off between hours risk and employment risk emerges, given that predominantly firms benefit from continuing an implicit employment contract, e.g. in tight labor markets. For example, MacLeod/Parent (1999a) find that the estimated propensity of using bonus contracts as an implicit contract device is higher in regions with low unemployment rates. For the United States further empirical support for the hours- vs. employment-risk trading hypothesis in bonus pay jobs exist (Parent/MacLeod 1999b), and bonus pay contracts as an labor market institution may compete with working time accounts contracts.

Consequently, future empirical analysis will address the question, whether job characteristics and task complexity driven approaches that potentially integrate country-specific developments of job environments are more appropriate to explain existing differences in the coverage of bonus payment contracts and working time accounts, or whether approaches with a focus on cultural diversity, industrial relations and idiosyncratic characteristics of employees are more suitable.

Since end of period bonuses are stochastic and informal, as they are subject to cyclical variation and to discretionary assessments of an employee’s contribution by his/her employer, another issue for further research will be the interplay of bonus payment contracts and compensation packages with effort standards during the cycle, with special reference to the impact of downturns on motivation and job turnover.25

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25 As the bulk of bonus contract firms will lack ability to pay informal bonuses at all during these times, a first hypothesis will be to expect bonus contracts to be more likely to fail to sustain the incentive mechanism by means of the (informal) bonus than the opposite. On the other hand bonus payment contracts might exhibit powerful incentives at the beginning of recovery.
5.2. Alternative Instruments of Intensive Labor Adjustment

Common to all instruments of labor adjustment at the intensive margin are costs that might be categorized within sets like labor relations or industrial relations. Such cost will be in major part (quasi-) fixed, as e.g. costs of reaching, settling, and governing a respective agreement. From the perspective of firms, working time accounts arrangements prevent or sharply reduce overtime payment, costs of idle capacity, and short-run costs of regulation and announcement involving employee representatives. As overtime premia usually do not set-off income reductions during short-time work or during temporary layoff, respective workers are likely to prefer working time account arrangements compared to alternative instruments. During prolonged crisis alternative instruments like temporary work sharing or temporary short time work might accompany working time accounts, possibly as a complementary instrument.

It will be up to empirical analysis and experimental evidence to assess to what extent the costs of internal adjustment contracts differ. Concerning the variable costs of internal labor adjustment, working time accounts are superior, as long as the inter-temporal transfer of hours is not penalized by substantial interest rates or are hypothetically taxed.

5.3. Potential Drawbacks

The critical assumption within the working time accounts approach is that hours transfers are truly documented. In other words, if either firms or workers try to manipulate the balance of the working time account, the system of mutual insurance will be cheated. In order to prevent such manipulations, e.g. computerized time registration combined with worker involvement in decision-making, firm-sided transparency on market conditions, and substantial worker autonomy might be installed. Enforcement rules concerning unemployment protection and employment guarantees might also be part of respective arrangements. Co-determination and involvement of works councils may further encourage firms not to manipulate the system. A well established system of industrial relations with reciprocal threat-points of potentially undermining the system in the sense of double-sided moral hazard might further mitigate the issue of hours manipulation.
Another potential drawback of working time accounts related to the long-term prospect of such systems. According to lack of long-term experience, it is an open question whether an ideal time horizon for mandatory settlement of accounts can be identified, whether coexistence of subsystems of working time accounts with diverging time-horizons is useful, how potential interest rates on hours should be calculated in long-term accounts, and whether encompassing legally ruled procedures are required.

We based our argumentation on a stylized model with rather homogeneous workers and tasks plus a strictly binding incentive constraint. A further future issue then addresses job selection, since sector, task complexity, degree of repetitiveness or relevance of team work and team consensus might be important determinants for the implementation of working time accounts. Post recovery research also needs to address the question, whether bonus pay and working hours transfer complement or substitute each other, whether working time accounts become obsolete for extremely complex or variable tasks, and whether working time accounts might be applicable under a variety of industrial relations regimes or not.

6. Conclusions

This paper has developed an approach to maintain jobs and firm success during crisis without distorting existing incentive mechanisms. We introduced a stylized extension of the widely recognized shirking model that is capable of internalizing reallocative shocks. In particular, double-side buffering of labor market risks is realized via inter-temporal transfer of working time in working time accounts, and mutual insurance is integrated into the shirking model. As inter-temporal transfer of worked hours does not affect monthly income or labor costs, the effort eliciting function of efficiency wages and internal reference points remains despite the economic turbulence, and therefore working time accounts as a mutual insurance device solve a key open question in the labor discipline model.

To summarize, working time accounts establish a self-enforcing insurance device that simultaneously smoothes profits, prevents dismissal of highly motivated employees, and might even enhance profits and income. The formal proofs are based on the concept of probability
mass shifts, namely mean preserving contraction and mean augmenting contraction, and have shown that the adjustment practice of mutual insurance in the shirking model via working time accounts at least second-order stochastically dominates alternative practices. Given that firms operate under binding adjustment inertia as imposed by non-storable production/services and economic crisis, they even first-order stochastically dominate pure labor discipline contracts.

In a working time account, deviations between contracted standard hours and actually worked hours are feasible and traced. Within pre-defined time-spans, for each participating worker any hour that has been worked is individually documented and matched to contracted standard hours. Measured deviations are denoted as plus-hours or minus-hours, respectively. Plus-hours indicate hours credits that have been granted by employees to their firms (worked hours exceeded standard hours). Minus-hours coincide with hours deficits (worked hours fell short of standard hours). This mechanism implies mutual risk bearing and risk sharing that takes place on a reciprocal basis among firms and employees, since deficit hours of workers match credit hours of firms, and vice versa.

In labor market practice, working time accounts are introduced as collective or individual agreements and transform potential income and employment risks into hours risks, given that realized inter-temporal transfer of worked hours is within the contracted time-transfer budget, since neither credit nor deficit hours affect remuneration. From a labor adjustment practice point of view, extensive adjustment of labor e.g. caused by economic crisis is substituted by intensive adjustment of labor that in addition to the adjustment potential allows firms and workers to almost retain their pre-shock budget constraints, and therefore demonstrates reliability. If we consider developments in the current crisis, reliability seems to be the key success factor of recovery, and working time accounts systems might point out as promising for US and other Labor Markets where this alternative is little known.

Future research on adjustment and incentives will address the interplay between working time accounts contracts and bonus payment contracts as well as their dynamic behavior along crisis and recovery. Moreover, inter-firm transferability of hours credits and
deficits, mutual insurance and job selection as well as the role of long-term working time accounts within work-life balance will be investigated, both theoretically and empirically.

References


Appendix.

Crisis in $t$: random separation process follows $b_i = b_0 + \varepsilon_i + \nu_i$,

with $\varepsilon_i \sim N(0, \sigma_\varepsilon^2)$, and $\nu_i \sim N^+(0, \sigma_\nu^2)$

Legend: job acquisition rate $a$, expected job destruction rate $b_0$, cost of effort $c(e)$, random “turbulence” shock $\varepsilon$, crisis shock component $\nu$, shirking detection probability $q$.

Figure 1: Unemployment as a discipline device – the idea
(2a) – perfect adjustment of production: deviation $\pi$ from deterministic profit maximum (impact of economic turbulence)

(2c) – adjustment inertia, non-storability, and crisis: deviation $\pi$ from deterministic profit maximum (impact of economic turbulence)

(2b) – perfect adjustment of production: working time accounts ssd pure efficiency wages (imposed by mean preserving contraction)

(2d) – adjustment inertia, non-storability, and crisis: working time accounts fsd pure efficiency wages (imposed by mean preserving contraction)

**Figure 2:** Double-sided buffering of labor market risks – pdf of the deviation $\pi$

between first-best expected profits and realized profits