Job Security and Working Hours Accounts

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this draft: June 2001

Paper to be presented at the International Workshop on

Wages, Working Hours and Employment

Centre for European Economic Research (ZEW),
Mannheim (Germany), 2-3 July 2001

JEL–Classification: J23, J33, J41, J56, J65, L21, L23

Abstract: This paper proves the Pareto–improving effects of working hours accounts. The latter are characterized by hours deposits, which enable intertemporally optimal allocations of working time. We integrate the shirking model of efficiency wages into an insurance framework. Employees are covered from short termed layoff risks, whereas firms are insured against respective profit reducing reallocative shocks. The renegotiation–proof solution establishes efficient risk allocation despite of sticky wages. Hence, complementarities with characteristic elements of personnel economics exist: Working hours accounts imply spillover effects to systems of firm level communication, thus constituting a coherent subsystem of so called human resource management systems. It can easily be shown that profit sharing, multiskilling, team work and decentralization in decisionmaking enhance positive system effects.

Keywords: complementarities, efficiency wages, risk allocation, working time accounts.

Zusammenfassung: Dieser Beitrag erweitert das wohlbekannte Effizienzlohnmodell von Shapiro/Stiglitz (1984) um nichtpersistente Nachfrageschwankungen. Die von den Autoren diskutierten strukturellen Veränderungen beinhalten stets die Arbeitsplatz-Reallokation und daher den Verlust betroffener Arbeitsplätze. Demgegenüber lässt sich zeigen, dass kurzfristige reallokative Schocks, die in Arbeitszeitkonten ausgeglichen werden, im Einklang mit Arbeitsplatzgarantien stehen. Während das Standardmodell eine effiziente Riskikoteilung nicht zulässt, gelingt dies im vorliegenden Modell: Arbeitszeitkonten versichern gegen das durch entsprechende Nachfrageausfälle induzierte Entlassungsrisiko, und zwar trotz eines rigiden Entlohnungsniveaus oberhalb des markträumenden Wertes. Sie beinhalten eine wechselseitige Versicherung zwischen Unternehmen und Arbeitnehmern und generieren zudem einen abgeschlossenen innerbetrieblichen Kreditmarkt für Arbeitszeit. Daher sind die Lösungen nachverhandlungsstabil, soweit die Parteien über hinreichende Informationen bezüglich der aktuellen Nachfragesituation verfügen.

[a] *Financial support of the German Research Foundation (DFG, Bonn) is gratefully acknowledged. I am indepted to Christiane Clemens, Bernd Fitzenberger, Matthias Kräkel, Bernd Schauenberg and the participants of the research seminar at the University of Hannover for their valuable comments.*

Contents

1. Introduction

Stagnation of sales, increased demand uncertainty, non–storabilities and the need for adequate time management systems are major problems that firms currently face. Stylized facts like persistent and growing unemployment despite of high remuneration levels as well as large (predominantly firm specific) job turnover rates and shortened employment spells for jobholders confirm their economic relevance.

The recent discussion of appropriate instruments for firms to maintain or regain economic success emphasizes multiskilling, just–in–time production, flexibilization and adaption strategies as key succes factors (Holmstrom/ Milgrom (1994), Milgrom/ Roberts (1995a), Carstensen et al. (1995), Drago (1996), Lindbeck/ Snower (1996, 2000), Ichniowski et al. (1997), Capelli et al. (1997)). This contribution also deals with flexibility.

We investigate the timing and readjustment of working hours under annualized hours contracts. Both, firms and workers prefer the variation of labor utilization to the variation of the number of workers. Basically, we enlarge insurance theoretic approaches of the implicit contract literature, where risk neutral employers insure risk averse employess against wage fluctuations that are caused by shifting values of the marginal product of labor (Baily (1974), Azariadis (1975), Holmstrom (1983)): The existence of an double–sided insurance is derived. Unless firms dispose of costless inventory buffers, they turn out to be not indifferent between offering contracts, which imply identical expected wage bills, but vary concerning the mode of labor adjustment.

Our main focus is on the identification of suitable means of personnel policy to cope with the stochastic product demand in an environment, which is characterized by non–storabilities on the one hand and the necessity of worker incentivization on the other hand. The risk sharing device of firm provided employment insurance is integrated into the well known efficiency wage model of Shapiro/ Stiglitz (1984), thereby extending the latter, as the presented model allows for diverging risk attitudes. As a result we simultaneously observe long–term employment relationships at the firm level (insurance argument) and substantial unemployment at the macro level (no–shirking condition).

Research on implicit employment insurance often recommends variants of work sharing (e.g. permanent cutoff of daily hours, job rotation, sabbaticals). In this contribution, the discussion of work sharing will be of minor interest. First, similarities to temporary layoffs are obvious, and second, it is well known that work sharing contradicts incentive considerations (cf. Stiglitz (1997)). Research on long–term employment relations is of major interest in labor economics and economics of personnel (cf. Lazear (1995)). Usually employment duration is measured by tenure, defined as the spell of an unique and identical worker–firm match. Spells can either be completed or refer to ongoing contracts. Here, an alternative explantion for the existence of long–term tenure is given.

The argumentation is as follows: workers are payed the incentive compatible wage and in addition are explicitly guaranteed employment security (within prespecified terms), which in fact implies long–term employment. In implicit insurance contracts, employers commit not to lay off workers, whereas workers agree to supply intertemporally flexible working hours. Such hours deposits comprise firm specific adjustment of the production factor labor under output market uncertainty. The parties agree to well defined constructs, denoted *working time accounts*, which include among other things the waiving of dismissals caused by varying product demand.

As in Akerlof/ Myasaki (1980) the objective is to prove the existence of (compulsory) employ-

ment rigidities to be Pareto superior. But in contrast to them and due to incentive arguments profit maximizing behavior does not admit wage reductions as insurance premiums, therefore inhibiting full employment equilibria at the macro level. Albeit we observe long–term employment relationships at the micro level, which are ruled by working time accounts. Those arrangements represent a typic self–enforcing contract, since the conceded job security is not enforcable by courts.

Altogether, a model of working time flexibility is developed that justifies the advantages of working time accounts compared to other means of flexibilization. Stochastic demand entails the need for adaption, where the results are derived under the assumptions that employers and employees differ with respect to their attitude towards risk and that shirking matters. Moreover, since efficiency wage arguments apply, wage levels within firms are fixed. If the no–shirking condition implies a wage level that exceeds the (hypothetical) wage level in the corresponding insurance model, then traditional insurance models on wage smoothing[1] cannot be applied to deduce downward rigidity of wages. Thus, in order to prove a Pareto improved allocation of risk it is necessary to develop modified models that account for a priori smoothed wage levels.

In the sequel such a model is presented and significant implications are discussed. Among other things it is shown that working time accounts as an insurance device are efficient in the long run, if accompanied by firm level institutions for information and communication[2] and integrated into a coherent over–all conception. Though the presentation concentrates on output market risks, additional risks as random variations at the production level are likely to underscore the positive effects. The paper concludes with a brief summary and outlook, mainly on future empirical research.

2. An Insurance Model

Like any implicit insurance contract, this model is based on Pareto improving effects of an altered risk allocation between employer and employees. But in contrast to the majority of available work it does not derive the smoothing of earnings via insuring income risks. Instead, profit maximizing employers insure their employees against employment risks caused by temporary demand shocks.

In the standard model insurance activity shifts an ex–ante lottery to an ex–post lottery, i.e. the insurer receives a fixed premium with certainty, whereas the parties face a repayment–lottery, whose outcome depends on the state of the world occurred (e.g. Hillier (1997)). The case discussed here differs: The solutions entail insurance rates, which are not fixed, as they vary with alternative realizations of product demand. Premiums are not pecuniary in the literal sense, but in fact are determined by current difference between expected and realized state of the world. Corresponding insurance rates translate into variable hourly earnings under constant monthly earnings

[1] Early contributions integrate just the two variables wages and employment. Superiority of implicit contracts, in which a risk averse employee is covered from fluctuation in wage levels by a risk neutral employer, results from efficient risk allocation. Wage rigidities entail amplified adjustment of labor (hours and per capita, see Rosen (1985), Lowenstein (1983)). For reasons of moral hazard under asymmetric information,insurees are covered only incompletely and compensation depends on the observation of prespecified indicators, thus managing the trade–off between efficient risk allocation and adequate incentives (cf. Hart/ Holmstrom (1987)).

[2] For an empirical implementation of decision making allocation see Colombo/ Delmastro (1999).

and therefore, should be interpreted as compulsory savings and liabilities, as long as hours deposits are evaluated by monetary equivalents.

Flexible working time schedules reflect the insurance part. in particular we focus on schemes, which explicitly allow for working hours deposits (cf. annualized hours contracts). Throughout the paper the term *working time accounts* (or, equivalently, *windows of working time*) is used. The fact that working time deposits are essentially controlled savings, facilitates a reciprocal interpretation of the model, which is more in accordance with traditional theory: Employees insure part of the employer's sales risk, which results from stochastic demand, thus smoothing profits.

Altogether, this double–sided character is crucial in the stability discussion of the model solutions. Neither party has an incentive to deviate from the terms once agreed to. If demand is randomly distributed with reasonable variance, and simultaneously we observe persistent unemployment, which exists for reasons of motivation, then working time accounts are likely to exist even on a long–term basis. Not only are the expenditures that accrue from working time accounts less than the costs of alternative adjustment strategies, but also the equalization of planned and realized product demand levels is achieved ex post. To summarize, working time accounts can be interpreted as a natural occurrence of strategies, which imply (ex post) efficiency of the spot sequence in the recontraction game, consequently generating spot implementability in the sence of Chiappori et al. (1994).

For a further discussion of renegotiation–proof working time arrangements as a promising instrument in the economics of personnel see Section 2.3. The role of working time accounts in an integrated human–resource–management system is discussed in Section 2.4. Critical remarks can be found in Section 2.5.

2.1 Reciprocal Insurance via Hours Deposits in Working Time Accounts

The model applies for existing firms, which dispose of substantial experience in their product markets. One major objective of the paper is to develop an explanation for the existence of employment rigidities at the firm level (in contrast to wage rigidities) and to show the Pareto advantages of working time accounts, when announced as integral parts of so–called "employment pacts", thereby enabling hours deposits.

Albeit the time horizon of the model leads to a dynamic setting, it can be formulated as as a sequence of spot solutions, since this particular form of working time arrangements generates exactly that decision making process. Let's illustrate this in a recontraction game (which implements the long–term optimum, see Rey/ Salanie (1990)): One the first stage the parties agree on the ex–ante optimal (spot) contract that renews in every period. Wage income, optimal output decision and price setting are part of this contract. At stage 2 realized demand becomes known. On a third stage working time flexibility enables ex–post adjustment of production to demand levels.

The shape of the decision process as a spot sequence simplifies the discussion of Pareto characteristics of the solutions. On the one hand, working time accounts imply an inner–firm, and therefore closed, credit market, which is constrained to within–firm credit and debt, i.e. transfer of working hours. On the other hand, working time accounts as an instrument of personnel policy are optimal in the long–run, at least when they are combined with sufficient information participation of employees or are part of coherent human resource bundles, respectively. Such bundles should constitute human–resource–management systems (HRM–systems) as in Topkis (1995, 1998) or in Milgrom/ Roberts (1995a). The argumentation on complementarities is deepened in Section 2.3.

Apart from the assumptions on risk attitudes, temporary demand shocks, price setting behavior, and product range the *lack of inventories* (*prohibitive costs of inventories*, respectively) is postulated. This last assumption is crucial and it is compatible with grown interest in time management as a key success factor for firms, as well as with empirical evidence of just–in–time production. Altogether, model assumptions are as follows:

A1 Decision making units are [i] the firm and [ii] employee(s). Wages w and employment L are chosen by the firm. Employees decide to accept or reject the employment contract (participation constraint). In case of participation each employee fills exactly one job slot.

A2 Attitudes toward risk diverge: the firm is risk neutral, employees are risk averse.

A3 Either Q is the single product produced by the firm or it denotes a product range of close substitutes. Inventories do not exist.

A4 Production of Q consumes two factors: labor L and capital K, with capital fixed in the short run. L is measured in efficiency units and consists of two components: a) working time **h**, b) number of employees **N**. The number of hours worked is the same for all employees within the firm.

A5 The firm fixes prices. It's downward sloping demand curve $P(Q)$ is well known, though the reservation price is random. Demand uncertainties offset over time, i.e. firm's expectations are correct on average and the prediction of demand is unbiased. The chosen price p is constant over a period.

A6 Information on realized random variables become evident instantaneously.

A7 Incentive problems are effective: Effort causes disutility. But the firm can cope with it adequately in an efficiency wage framework, namely the shirking model. (Monthly) time wage w is chosen similarly to the no–shirking condition in Shapiro/ Stiglitz (1984) by equating expected utility from the wealth lottery of shirkers and that of non–shirkers[3]. The compensation system consists of no further pecuniary elements, so that: $w \equiv w_{\text{nsc}}$.

Assumptions **A3** to **A6** are in the style of Nickell (1978). In addition, from **A7** immediately follows that an insurance approach to wage rigidities is inappropriate, since the no–shirking condition predicts a time–invariant compensation above the market clearing level (usual compariative statics apply). Actual compensation exceeds actual value of marginal product in each period and corresponding labor demand generate involuntary unemployment. The size of the wage premium is determined by several parameters as a) firm specific need for control mechanisms or monitoring, b) monitoring costs and monitoring intensity, c) reallocation hazards, d) unemployment benefits

[3] Incentive effects à la Shapiro/ Stiglitz (1984) entail a substantial and persistent level of unemployment, as a necessary condition to discipline workers. It is assumed that both, employer and employees, know the relevant parameters of the no–shirking constraint. They are aware of the fact, that any "caught" shirker would be laid off (in equilibrium no shirking occurs) and is likely to stay unemployed for a remarkable duration. Shapiro/ Stiglitz formulate a job reallocation rate b (e.g. due to technological progress or IT development, for example), that effects both, shirker and non–shirker, and is purely exogenous. Thus, an analysis of the (economywide) turnover rate b is beyond the scope of the presented paper as well as the investigation of persistent unemployment, since the latter results from employer's optimization behavior. The primary focus is on an additional risk, which ensues merely on a second stage from circumstances, which translate into temporarily shifting labor demand curves. Thus, unemployment risks this paper deals with are completely demand driven, as they results from a second stage (downstream) employment lottery that is unaffected by incentive motives and technological factors. Just against these risks workers are insured via working time accounts.

and e) time preferences. Hence, employers cannot credibly commit to lower wages in periods of lack of demand, since workers cannot commit not to lower effort.

This leads to the conclusion that efficiency wages provide sufficient evidence for downward rigid wages. Thus, traditional insurance approaches to implicit contract theory will no longer apply in this context, as corresponding insurance premiums for covering income risks would induce reasonable wage reductions, which contradicts the conclusion.

Nonetheless, the agents agree on risk transfers, although for a different reason, which will be discussed in detail. Workers motive is *insurance* in the context of the above ex–post employment lottery, i.e. the are covered from company specific dismissal risk that high effort individuals face. Employers' motives trace back to non-storabilities. Altogether Pareto improvements result, enabled by working time flexibility that allows for intertemporal transfer of working hours. This is favorable for both parties, employer and employees, if consensus is accomplished with respect to the period of time in order to balance such transfers. *Working time accounts* apply exactly at this stage.

Since a risk neutral firm is indifferent between the certain realization of the expected value of any lottery and the lottery itself, **A2** implies that, given demand fluctuation, the firm fixes the same price as under certainty (see also figure 1). Hence, from **A5** in conjunction with **A3** it follows that in any period either part of the output perishes, or expected demand is met, or part of market demand cannot be satisfied. To conclude, firms will try to adjust for transitory shocks, cf. via output variation, which in turn requires employment adjustment and introduces the risk of job loss.

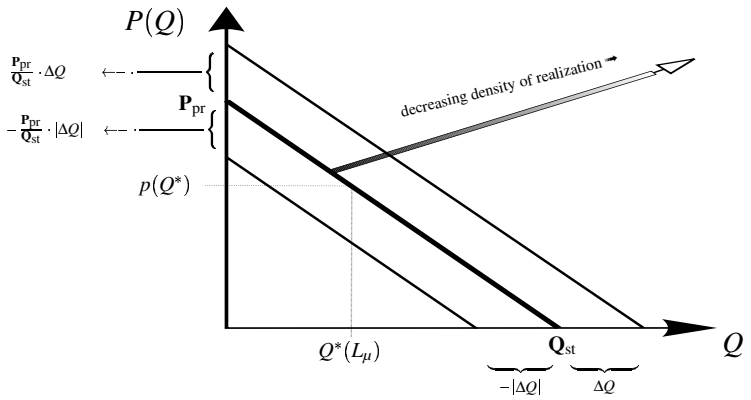
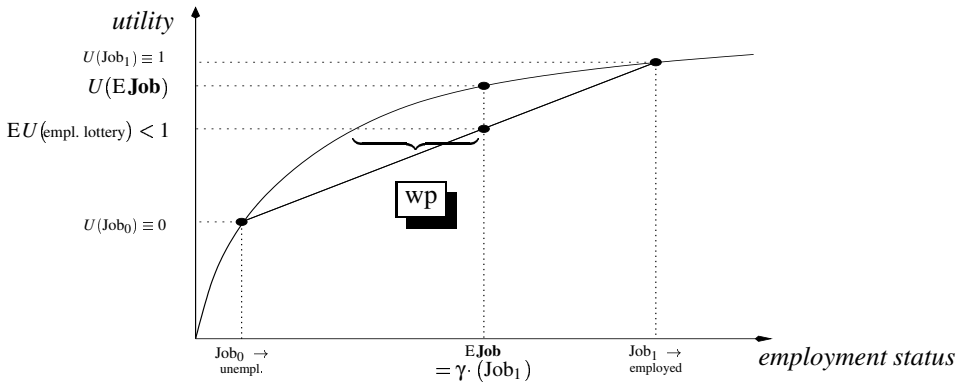


Figure 1: Stochastically shifting product demand with expected reservation price $\mathbf{P}_{pr}$, saturation $\mathbf{Q}_{st}$

On the basis of their risk aversion workers are willing to pay a premium (see wp in figure 2) to insure against the above risk of being dismissed, which results from company idiosyncratic factors. Ex ante, for any *high–effort individuum* its size $1-\gamma$ is determined by the shape of demand uncertainty. Ex post, relative frequency of being laid off is the higher the more employer's output reaction culminates in per capita adjustments, i.e. in staff reduction.

A couple of presumptions simplify matters, but do not alter the results of the model. The utility function is assumed to be intertemporally separable. Let employee preferences for intertemporal



• dismissed in $t+1$: Job_0, • continuously employed: Job_1,
• efficient insurance premium, given irrelevancy of shirking[a]: wp .

[a] See e.g. Akerlof/ Miyazaki (1980).

Figure 2: Ex–post Employment Lottery **Job**: Inefficient Risk Allocation

smoothing of working hours supply be of minor importance[4]. Since the primary objective of the paper is to prove the existence of working time accounts as a firm level insurance device in general, we do not explicitly introduce interest rates on hours deposits on the one hand and insurance fees concerning continuous employment on the other. Without loss of generality we just assume that both coinsice, i.e. balance, although more elegant versions should elaborate on quantitative analysis of willingness to pay and claimed interest rates on hours transfers[5].

The following description defines L_μ as a reference point. As already mentioned, price setting behavior in the model is unaffected by the fact that output demand is randomly distributed. Let $L_\mu = \{N_\mu, h_\mu\}$ denote the optimal employees–hours–combination under certainty. For simplicity, let h_μ correspond to standard working hours. Under uncertainty **h** (see **A4**) comprises two elements: h_t and h_μ, where the first measures actual working hours in period t, which may or may not equal standard working hours. Once working hours flexibility is introduced, **h** discloses information on optimal working time under certainty h_μ and on requested number of hours h_t. For example, expected demand materializes for $h_t = h_\mu$. The same applies to N, so $L_t = \{N_t, h_t\}$ measures the (if so) adjusted factor labor.

Several legal, unionwide and firm specific restrictions have to be considered. An upper limit for per period flexibility exists. It is measured by $\Delta L_\mu \equiv \{\max|N_t - N_\mu|, \max|h_t - h_\mu|\}$, with $\max|\,.\,|$ as the maximum feasible deviation between current and standard variables. The maximum adjustment range derives from alternative sources. First, legal regulation may prescribe a supremum for working time flexibility and for per capita adjustment. Second, this measure can

[4] Worker preferences for continuous employment, i.e. for a reduction of dismissal risk due to the second stage job lottery are not affected. Legislation on working hours stipulates plausible limits for hours transfers between periods that comply with these presumptions (e.g. Anzinger (1994): *Arbeitszeitgesetz*).

[5] I. e. (hypothetical) premiums for firm level employment insurance as well as for reimbursement for the conferment of discretion over hours credits on the employer have to be specified.

be restricted further in collective or firm specific agreements, which may e.g. impede temporary layoffs or permit a scope of daily transfers of x hours. Basically, firms adjust the elements $h_t \gtreqless h_\mu$ and/ or $N_t \lesseqgtr N_\mu$, respectively.

Solving the optimiziation problem subject to all the restrictions yields characteristic $\{N_t, h_t\}$–combinations, where the components vary with the firm's adjustment costs concerning hours variation and recruitment/ displacement decisions. With a time horizon of T periods the assumptions on the stochastic process imply that the periodwise sum over the adjusted factor labor equals T–times the reference point under certainty L_μ, provided that market experience is long enough. In the extreme case of rigid employment merely h_t differs between periods, while the number of job slots always amounts to N_μ. In the other extreme hours are held constant at the level of h_μ, thus labor is completely adjusted via hiring and dismissals. The different strategies are common knowledge.

Consequently, the expected value of hours $\mathrm{E}(\sum_{t=1}^{T} h_t|_{N_t=N_\mu})$ over the horizon T of the model equals $T \cdot \mathrm{E}(h_t) = T \cdot h_\mu$ and the expected number of employees $\mathrm{E}(\sum_{t=1}^{T} N_t|_{h_t=h_\mu})$ over the same number of periods is $T \cdot \mathrm{E}(N_t) = T \cdot N_\mu$. The potential attractivity of the strategy *per capita variation* suffers from fixed and quasi–fixed costs of recruitment and separations, from essential investments in human capital as well as from legally and institutionally enforced regulation (Oi (1962), Hamermesh (1989), Hart/ Moutos (1995)). Alternatives of over–/ underutilization of labor suffer from extensive adjustment costs and substantial losses in labor productivity, if they come along with overtime work or if work sharing is enacted, even on a temporary base. In fact firms will take other alternatives into consideration.

The presented model sails round such shortcomings as it sets up an innovative insurance model by integrating expanding elements of adjustment as well as shrinking elements. This constitutes one unique instrument, namely a specific type of working time flexilbility, where desired variations in labor utilization are generated via *working time accounts*, which comprise job security. During the validity of the "insurance contract" employees are almost fully covered against product market induced dimissal risks and potential concequences, since employers commit themselves not to lay off. Respective insurance aspects and employees' motives will be discussed in detail later. At this point let us remark that the execution of working time accounts generates Pareto improvements that are achieved without recourse to overtime or short–time work. Thus, increases in marginal costs can be avoided, although exactly the same adjustment effects are resulting. Hence, the accounts–approach is Pareto superior compared to well–known strategies of flexibilization.

The production function is stated in equation (1), whereas equation (2) denotes the profit maximizing output–decision of the risk neutral firm. Thus, Q^* measures the company's ex–ante choice of output, i.e. where marginal costs of production equal marginal returns:

$$Q = f(L(N,h),K) \tag{1}$$

$$Q_\mu = f(L(N_\mu,h_\mu),K) \equiv Q^* \quad . \tag{2}$$

As the common assumption was made that capital is fixed in the short run, investment in e.g. machinery equipment is not analyzed. Further, the cost function is assumed to be additively separable. Let us first concentrate on a cost function in a firm that abstains from adjustment activities. Production of Q_μ then causes (a) personnel costs amounting to wN_μ, with w as the incentive compatible time wage (with no–shirking implicitly based on (monthly) standard working hours h_μ), and (b) fixed capital costs, which amount to $\overline{c_K}$. The corresponding cost function equals

the cost function in a world under certainty or when expected and realized demand coincide:

$$C_\mu \quad = \quad g(L_\mu, \overline{K}) = w \cdot N_\mu + \overline{c_{\overline{K}}} \quad . \tag{3}$$

Under stochastic demand, however, it seems not very reasonable that such behavior in fact occurs. Instead appropriate means of adjustment (flexibility strategies) are likely to be developed, at least under **A2**, **A5** and the profit maximization hypothesis. Effects on the cost–side ensue immediately. Respective adjustment costs differ with the flexibility strategy chosen. A generalized version of the cost function in equation (3) is therefore:

$$\begin{aligned} C_t \quad &= \quad g(\mathbf{L}, \overline{K}) = g(L_\mu, \Delta L, \overline{K}) \\ &= \quad w \cdot N_\mu + c_t(\Delta L) + \overline{c_{\overline{K}}} \quad , \end{aligned} \tag{4}$$

where flexibility is measured by the ex–post difference between *adjusted* utilization of the factor labor on the one hand and its expected value on the other hand. It is denoted by $\Delta L = \left\{N_t - N_\mu, h_t - h_\mu\right\}$. Adjustment costs are $c_t(\Delta L)$, with an expected value of $\mathrm{E}(c_t(\Delta L)) = 0$. They result from the objective to align current demand and output. The reference point L_μ comes along with lack of adjustment costs as well as a scenario, where no flexibility strategies are utilized: $c_t(\Delta L) = 0|_{\{0,0\}}$.

Fixed adjustment costs ($c_t(\Delta L) = \overline{c_\Delta}$) do not affect the firm's output decision, since marginal costs remain unchanged. *Working time flexibility*, where — within predetermined limits — intertemporal transfer of monthly (yearly) hours, and therefore the distribution of working time, is within the scope of the entrepreneur's duties, is one example for a strategy, which causes fixed adjustment costs. Here it is at the firm's discretion to temporarily cut hours of work in times of negative shocks of demand and to temporarily extend working hours in the reverse case, thereby avoiding premium payments pertaining to overtime hours.

If negative demand shocks in t are handled with *reduction in staff*, adjustment costs are for instance $c_t(\Delta L) = -w \cdot (N_\mu - N_t) + \sum_{i=1}^{I} S_i^t + c(\textsc{SoPl})$, with severance payment S_i^t to the i–th dismissed person, and overhead costs $c(\textsc{SoPl})$ due to the implementation of a social plan or similar institutions.

A conceivable strategy to cope with positive demand shocks is *overtime work*. Under identical magnitude of overtime for different workers well–known adjustment costs $c_t(\Delta L)$ result: $(1+\tau)\frac{w}{h_\mu} \cdot (h_t - h_\mu) N_{it} =: (1+\tau)\,\omega \cdot \Delta h_t N_{it}$, where the number of employees involved is N_{it}, while τ denotes overtime premiums, and Δh_t measures overtime hours per worker. The mark up τ is based on *standard hourly wages* ω, which can be constructed by dividing the time wage at standard working hours w by the number of standard working hours h_μ.

Under **A5** and supposing normally distributed disturbances, it follows that current demand Q_M is normally distributed with constant variance. ΔQ measures deviations between realized demand Q_M and the firm's ex–ante solution of the maximization problem Q^*. Consequently ΔQ is also normally distributed with identical variance:

$$Q_M \quad \sim \quad N(Q^*, \sigma_M^2) \quad , \tag{5}$$

$$\Delta Q \quad \sim \quad N_0(0, \sigma_M^2) \quad . \tag{6}$$

Though, in principle, the risk neutral firm does not care whether operating on the basis of the demand–lottery Q_M or being confronted with the certain realiziation of the respective expected

value $\mathrm{E}(Q_M) = Q^*$, the discussion of appropriate adjustment strategies is not redundant, because **A3**, namely the absence of inventories, leads to a slightly altered argumentation. The point will now be elucidated.

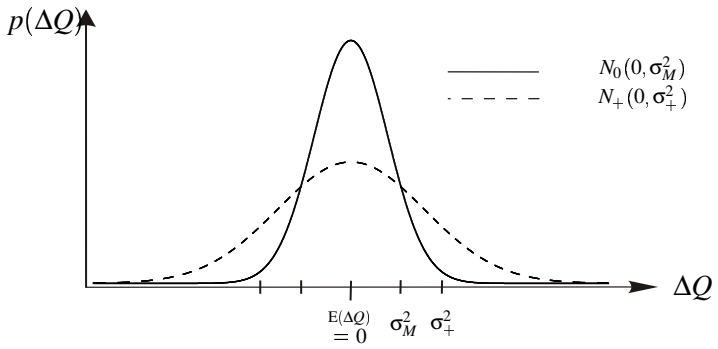


Figure 3: Identical expected demand, divergent dispersion

In figure 3 both random variables $N_0(0,\sigma_M^2)$ and $N_+(0,\sigma_+^2)$ render **A5**. Furthermore, profit maximizing behavior restricts firms to opt for exactly the same price–output–combination $\{p, Q^*\}$, irrespective of N_0 or N_+ as the underlying error distribution. However, distribution N_+ has larger dispersion, is therefore characterized by increased demand risk, and consequently less favorable.

Although risk neutral, the firm prefers the stochastic process $N_0(0,\sigma_M^2)$ to the latter. It is in its interest to be confronted with a distribution that implies as little variance as possible, i.e. a mean preserving random variable with zero variance is strictly preferred to all the other random variables. Correspondingly, define the case under certainty ($\sigma = 0$) as a first–best benchmark, denoted by FBB. This benchmark is of major importance in the following considerations, which treat the random variable $Q_M \sim N(Q^*,\sigma_M^2)$ as given. Remember that Q_M is already an outcome of the employer's optimization behavior.

The following results constitute the core of the paper. It will be proven by means of a comparison of typical scenarios that the introduction of working time accounts is appealing for both, firms *and* for workers: A situation under certainty (1) ist juxtaposed to (2) demand fluctuations with perfect adjustment, as well as to (3) product market uncertainty exclusive of engagement in potential adaption strategies. Evidently working time accounts represent a flexibility strategy that is equivalent to (2), fixed costs of installation are the only difference.

Now the maximum of (ex–ante) expected profits $\mathrm{E}\Pi^*_{fb}$ is derived. This expresses exactly the hypothetical benchmark FBB, just defined:

$$\mathrm{E}\Pi^*_{fb} \quad = \quad p \cdot Q^*(L^*, \overline{K}) - C(Q^*|\overline{K}) \quad , \tag{7}$$

with $C(Q^*|\overline{K})$ as defined in (3), since $c(\Delta L) = 0$ applies. The first order condition becomes:

$$p + P_Q \cdot Q^* \quad \stackrel{!}{=} \quad C_Q \quad , \tag{8}$$

where p denotes the price where output meets the product demand curve $P(Q)$. I.e. the firm fixes p according to it's output decision Q^*, namely time invariant during a period by assumption.

Apparently, no scenario under uncertainty is able to replicate the value of $\mathrm{E}\Pi^*_{fb}$, unless the profit–lottery permits of frictionless adaption (see equation (7)).

Under the given framework any ex–post achievable value of expected profits $\mathrm{E}\Pi_M$ falls short of FBB, since ex–post variables base on realizations of expected demand. The relevant relation is depicted in equation (9). A comparison with equation (7) indicates that ex–ante expectations of risk neutral firms overstate obtainable magnitudes:

$$\begin{aligned} \mathrm{E}\Pi_M &= [1-\mathrm{prob}(Q_M \leq Q-1)]\cdot P(Q)\cdot Q \\ &+ \mathrm{prob}(Q_M \leq Q-1)\cdot P(Q)\cdot Q_{M,\Delta<0} \\ &- C(Q|\overline{K}) \quad . \end{aligned} \tag{9}$$

Q measures expected as well as planned output subject to $P(Q)$, Q_M measures the realization. As excess demand cannot be satisfied, in all states where $Q_M \leq Q^*$ materializes, the equation $Q_M = Q$ holds, i.e. planned and sold output are identical. Otherwise $Q_{M,\Delta<0}$ indicates states where excess supply occurs, i.e. effective sales fall short of the production program. The cumulative density of the latter states ($Q_M \leq Q^*-1$) equals the value of the commensurate distribution function at $F(Q^*-1)$. Moreover $z = \frac{Q_M - \mathrm{E}(Q_M)}{\sigma_M}$ applies as a result of the normal assumption.

Hence, the maximum of expected profits $\mathrm{E}\Pi^*_M$ is given by the following equations:

$$\begin{aligned} \mathrm{E}\Pi^*_M &= \left[1-\Phi\left(-\frac{1}{\sigma_M}\right)\right]\cdot\left(p\cdot Q^* - C(Q^*)\right) \\ &+ \Phi\left(-\frac{1}{\sigma_M}\right)\cdot\left(p\cdot Q_{M,\Delta<0} - C(Q^*)\right) \end{aligned} \tag{10}$$

$$= [1-\Phi(.)]\,\mathrm{E}\Pi^*_{fb} + \Phi(.)\,\mathrm{E}\Pi^*_{fb} + \underbrace{\Phi(.)\,p\cdot\Delta Q}_{<0} \quad , \tag{11}$$

where $\Phi(.)$ describes the standard normal distribution. Obviously, $\mathrm{E}\Pi^*_M < \mathrm{E}\Pi^*_{fb}$ is valid, since $\Delta Q < 0$. Here $\Delta Q = Q_M - Q^* < 0$ is a measure for *perished* output. Negative values of ΔQ correspond to revenues of $p\cdot Q_M < p\cdot Q^*$, while for all $\Delta Q \geq 0$ exactly $p\cdot Q^*$ is earned.

Since adjustment costs and potential gains from flexibility have not materialized so far, production costs at this stage amount to $C(Q^*|\overline{K})$, independent of ΔQ. With a positive probability of states $\Delta Q < 0$ our FBB in equation (7) is merely hypothetical, as $\mathrm{E}\Pi^*_M < \mathrm{E}\Pi^*_{fb}$ holds[6].

To resume, product market uncertainty in combination with increased needs for time management exerts considerable consequences on optimization behavior. Hence, firms are after activities to minimize the difference between (7) and (11) at a reasonable level of adaption costs. Recents emphasis is on strategies that facilitate flexibility and reversability. We concentrate on the innovative instrument of working time accounts (their equivalent windows of working time) as a unique

[6] An example may illustrate: Suppose a lottery with expected value Q^* and exactly three different realizations. State 1, the realization of the expected value, occurs with probability $(1-a)$. State 2 and state 3 materialize each with probability $a/2$, where state 2 depicts $(Q^*-\sigma_M)$ and state 3 depicts $(Q^*+\sigma_M)$. Thus expected revenue $\widetilde{\mathrm{ER}}$ under uncertainty is exactly $(1-a)\cdot pQ^* + (a/2)\cdot pQ^* + (a/2)\cdot p(Q^*-\sigma_M)$. Then $\mathrm{E}\Pi^*_M$ is given as $\widetilde{\mathrm{ER}} - K(Q^*) = \mathrm{E}\Pi^*_{fb} - (a/2)\cdot p\cdot\sigma_M < \mathrm{E}\Pi^*_{fb}$.
In general the extent of profit–loss increases with the degree of uncertainty, measured by σ_M.

form of working time flexibility, as they enable companies to imitate demand fluctuations via intertemporal transfers of actual working hours. In contrast to traditional flexibility instruments such transfers are not penalized with increased marginal costs or compensated idle capacity.

Several advantages emerge for the firm: First, working time accounts are appealing because of their capability to adapt almost perfectly to either direction of demand shifts. Second, the costs argument is persuasive, since the constant time wage for an employee over all periods implies constant wage costs per period (remember the number of employees is fixed, as they are guaranteed job security while participating in the schedules for insurance motives). Thus, on the one hand no overtime premiums augment wage costs in periods of temporary positive demand shocks. On the other hand periods of negative demand shocks are not characterized by payments for *wasted time*, e.g. full compensation despite spare capacity. The offsetting profile of adjustment is carried into effect by deposits of working hours.

If firms opt for working time accounts for reasons of adjustment, respective marginal costs keep unchanged, are therefore unaffected by fluctuations in demand. Moreover, they yield the same optimum strategy as under certainty. Altogether, working time accounts are superior to alternative adjustment strategies under benefit-cost analysis (an outline of the main results is given in Section 2.2.

A definition of, respectively, *working time accounts* and the equivalent *windows of working time* is straightforward. By construction they integrate firm specific circumstances as well as employees' preferences, since the constituting elements entail idiosyncratic specifications.

Definition 1 (wta) *A working time account* $\mathbf{wta} = \{h_\mu, \min[\,|h_t - h_\mu|, \Delta h_\mu\,], \Delta t, w, Ⓢ\}$ *is specified by the following five elements:*
(a) standard working hours h_μ*,*
(b) maximum of hours deviation $\Delta h_\mu = \max|h_t - h_\mu|$*,*
(c) account's time horizon Δt*, i.e. maximum period of time in order to balance,*
(d) constant time wage w *that participating employees receive, and*
(e) commited insurance Ⓢ*, i.e. firms cover participants from dismissal risks caused by transitory demand shifts.*

As already mentioned, standard hours in (a) coincide with expected hours h_μ. A measure can be stipulated legally, in collective agreements or in firmlevel agreements, depending on the specificity of product markets and on the information generating capacity of firms. With Δh_μ in (b) an idiosyncratic supremum for periodwise differences between current and expected number of hours that meet the no–shirking condition is defined, i.e. the maximum amount that h_t may exceed (fall short of) h_μ is stated. Definition 1 introduces symmetric cases for (b)[7]:

$$\{\Delta h_\mu \in \mathbb{R} \quad : \quad \max_{h_t > h_\mu} |h_t - h_\mu| = \underset{\Delta > 0}{\Delta} h_\mu = \underset{\Delta < 0}{\Delta} h_\mu = \max_{h_t < h_\mu} |h_t - h_\mu|\} \quad . \tag{12}$$

Notice that it is not the firm's objective to contract the adjustment potential Δh_μ as large as possible, since the incentive constraint in **A7** in combination with payment of constant time wages restricts feasible variations in derived hourly wages ω_t and consequently Δh_μ. Empirically, either the numbers of hours is realized, which is sufficient to produce an output level that imitates the

[7]Basically, the integration of diverging limits for hours credits and debts is straightforward, but identificaton of **wta** as a reasonable instrument and insurance device is not affected by the symmetry assumption.

analogue on the shifted demand curve, or the bound Δh_μ becomes effective. If the latter occurs too often, despite the no–shirking condition is effective, it is more than likely that (a) will be renegotiated or per capita adjustments and job reallocation will occur.

The purpose of (c) quite similar. The choice of an adequate spell to obligatory settle the working time account is not a trivial problem. First, the period of time, in which working hours credits and debts are forced to have offset, should be long enough concerning a problem, which relates to something like 'small–sample shortcomings' regarding the number of periods. Second, for reasons of practicability, it is sensible to agree a priorily to renew **wta** in regular intervals, and if necessary modify, since eventualities as non–transitory shocks or additional risks may become valid. Thus, (c) defines a compulsory expiration date, whose existence becomes crucial, if production risks are substantial, innovation and/ or global markets are of major importance and when employer's honesty is to be assessed.

From the employees' point of view there exists exactly one reason to support the described credit market for working time: job security motives. Thus, they will agree to **wta**, if and only if the employment insurance argument as provided in (e) is prevalent. In other words, if demand variation is significant or if cumulated market risks introduce ex–post employment lotteries with sufficient low expected utility, it is fairly reasonable for employees to participate in contracts on working time accounts. Thus, efficient risk allocation can be achieved via **wta** as well as profit stabilizing effects. The present situation on labor markets and growing incidence of working time accounts, too, underline the presumption, that both, employees and employers in fact benefit from inherent insurance. The major benefit for firms stems from the variable risk premiums that insured employees pay, since these premiums generate — up to a certain extent — cost neutrality of **wta** with regard to variable costs, as (d) points out.

From the preceding arguments it is evident that industrial relations play a crucial role for the success of working time accounts, since a coordinated approach of management and employees (their representatives) in design, implementation and execution enhances Pareto improving effects. The respective costs, i.e costs of installation and maintenance, are primarily fixed costs, as they can be assigned to the area of information and communication. Compared to alternative flexibility strategies working time accounts come along with a lot of cost advantages. E.g. contribution margins are usually lowered in periods of underutilization of production capacity due to continuous compensation of workforce or short–time. Otherwise typical increases in marginal costs due to longer working hours and overtime premiums are cut off in working time accounts. A similar argument applies to recruitment costs and costs of (temporary) separations or (re–) employment, as the case may be. Insofar working time accounts represent a worthwhile adjustment strategy, which in addition yields continuous employment for incumbents.

The following section treats working time accounts from an employer's perspectiv. Their relative advantages are discussed with attention drawn to the objective of job security, where **wta** handle the latter within the two–sided implicit insurance framework. Hence, is likely that employers as well as employees endorse this adjustment strategy, whenever those guarantees can be verified (e.g. by worker representatives). If a firm reneges, i.e. arguable dismissals occur, employees withdraw agreement to future **wta** schedules and compulsory expiration dates become valid.

2.2 Alternative Adjustment Strategies

Working time accounts delineate one possible strategy to cope with short–run demand fluctuations. Though this instrument is appealing owing to its capability to adequately handle positive as well as negative shocks, alternative instruments exist, which cope for at least one the two directions of deviation. These alternative strategies differ mainly according to their intrinsic cost profiles and they diverge concerning the degree of reversibility.

The following pages provide a short discussion of the different cost profiles as an outcome of utilization and retraction of single instruments. The instruments included predominantly aim at temporary fluctuations, thus should be reactive and invertible. Overtime work, extra shifts, postponement of holidays, placement of orders with external firms, temporary work, and (fixed–term) contracts are possible means of managing excess demand. If current demand falls short of expected demand, cutback of overtime working, short–time work, reduction of working hours, drop of shifts, retraction of orders with external firms, phasing out fixed–term contracts, non–replacement of personnel fluctuation, contracted separations, and lay offs can be taken into consideration.

Whilst the imitation of temporary fluctuations in product demand via working time accounts takes place without any additional compensation, one–time costs of negotiation and initiation as well as expenditures for documentation and maintenance of an account system emerge. System maintenance is necessary, since working time accounts regulate the intertemporal allocation of working time within the firm. Altogether **wta**s induce fixed costs.

Overtime hours that are always counterbalanced with leisure are equivalent to hours credits in working time accounts. But the bulk of *overtime hours* is compensated with overtime premiums. Moreover, timing and implementation of overtime work suffer from uncertainties, which are best depicted by institutional inertia. Thus — a priori — the adjustment potential of overtime work is restricted substantially. The legislation on *short–time* work is restrictive. For instance, in Germany the following holds: On the whole, short–time working benefits are restricted to employees in firms, where at least one third of the workforce is affected by a relative income loss exceeding 10%, and the shortfall must be conditional on unforeseen lack of demand or shortage of intermediate products. Entitled firms are obliged to approach the regional employment office with a written application for short–time and under submission of a set of supplementing documents (German Employment Office (2001)). Thus, short–time work under German legislation comes along with non neglectable transaction costs. If firm level institutions already exist, which can be interpreted as hours flexibility instruments, then short–time work cannot be implemented, unless the adjustment potential of such instruments is completely exhausted. This further limits short–time as an adjustment instrument.

The transaction costs argument also applies, if it comes to the assessment of the instrument *disentanglement of working hours and operation time*: Set–up and cutback of shifts cause per capita costs on the one hand. On the other hand expenses for maintenance and repair increase. At times it is argued that *part–time work* holds a remarkable capability for flexibility (e.g. OECD (1995)). Contributions that properly provide theoretical or empirical evidence are hardly available. Thus, hypotheses as "part–time contracts more often (i) agree on hours corridors or (ii) implicitly use working time flexibility than their full–time counterparts" still lack analytical verification. The strategy to absorb risks on product markets via 'smart' *combinations of external and internal labor markets* proves to be myopic, since recent experiences in industrial relations reveal large

transaction and bargaining costs, when it comes to the decision of either to enforce the expiration date of a fixed–term contract or to convert it into a permanent contract.

The primary focus of agreements on *early retirement* is rather on permanent demand shifts than on short–termed deviations. The corresponding procedures are extremely time–consuming and evaluations should pay attention to the fact that social costs of early retirement will always exceed firm specific costs by considerable amounts, since prevailing schemes are characterized by take-up of subsidies and use of unemployment benefits through integration of long–term unemployment for former incumbents. Moreover, per capita adjustment is not attained, since legislation prescribes to fill in the vacant slot immediately with an outsider. Thus, early retirements primarily entail qualification flexibility, i.e. adjustment of human capital profils.

To conclude, working time accounts are superior to alternative adjustment instruments with respect to adjustment costs. In addition they imply ex–post congruence of demanded and realized output. Correspondingly **wta** can be interpreted as 'natural' occurrence of strategies, which obtain ex–post efficiency for spot–contract sequences in renegotiation games, thus generating renegotiation–proofness. Moreover, they guarantee implementability of the long–run optimum by spot contracts as defined in Chiappori et al. (1994) (see also 2.3). Correctly designed, working time accounts are capable to (almost) offset reduction in profits, which are induced by product market uncertainty[8]

Thus, a hierarchy of adaption seems plausible, which links single instruments to the expected duration of demand deviation. Fluctuations, which mainly represent white–noise errors are regulated completely via working time accounts. Non–transitory deviations or longer termed shifts of the demand curve to the northeast correspond e.g. with a well–designed (consistent) timing of, first, credits of working time, (ii) overtime hours, and (iii) recontracting of elements in **wta** as well as hiring. Reversed trends could be accompanied by cutback of overtime work, reductions in standard hours, non–replacement of exits, and separations. The relative weights of individual instruments in a period specific basket depend on the length of Δt, i.e. the account's time horizon, on the degree of product market uncertainty, and on the relative frequency of permanent shocks.

The model so far leads to the conclusion that employers are able to credibly commit to insure their (high effort) employees against the loss of jobs as stated in Definition 1, where the risk of unemployment is induced by demand fluctuations. Credibility is given, because employees hedge employers against demand fluctuations, if working time accounts are effective, thus generating mutual dependence. Similar properties could be reached via inventories, as they provide capacities for intertemporal production buffers. For storable goods the same results are attained as under working time accounts, but with large investments. Thus, inventories raise considerable 'adjustment' costs and are inferior to working hours buffers as ruled in working time accounts.

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[8] If the shape of demand fluctuation permits stipulation of fairly narrow windows around standard working hours (see (b) in Definition 1), the threat of deviations from optimal output decision diminishes. Otherwise, since the shape of the firm's production function influences the marginal–costs—marginal–revenue—differential, alternating output levels cause inefficiencies. I.e. intertemporal transfer of production drives the firm to deviate from the short–run optima, which can be calculated with the usual microeconomic tools. For output Q_t in period t marginal revenue exceeds marginal costs under negative demand shifts, whereas the difference between marginal costs and marginal revenue is positive in cases, where the realization of demand is larger than expected demand. The latter argument demonstrates that complementary instruments, as for example marketing activities, can be sensible, since they serve to lower the variance of demand.

Altogether the latter are consistent with recent time management, whereas the former are not.

Several strategies are a priori not restricted to be just a substitute for working time accounts. Wage cuts, price policy and multiskilling may be practised complementarily to working hours transfers. Let's consider wage cuts first. Within the efficiency wage framework reductions in wages cannot be promising, since the no–shirking condition is violated. Thus, wage cuts are not a suitable adjustment strategy, unless employees voluntarily offer. But such behavior does not seem very likely at all.

Price policy subsumes the following proceeding: The firm sets the profit maximizing price p under the optimal output decision Q^*. If product demand Q_M, revealed at p, deviates from Q^* then the firm deduces the current demand function $P(Q+\Delta Q)$ from the realization (see figure 1, $\Delta Q \neq 0$). This function advises how to adequately adjust price to $p^{pp}|_{Q_M} \gtrless p$, i.e. the market clearing price for hitherto excess demand or excess supply, respectively.

Note that under price policy the denoted price increase $p^{pp} - p$ at Q^* in case of excess demand depicts a suboptimal choice, since optimal output will no longer be at Q^*. Thus, the firm's output decision will be also adjusted. Price policy introduces a second stage optimization, which refers to the ex–post demand curve and leads to altered output decisions, i.e. to production extension in the short run. Consequently, it is more than likely that overtime hours (and/ or temporary work) are required. To summarize, the model predicts complementarity of price policy and overtime work, with the first instrument related to marketing policy and the second instrument related to personnel policy.

Expected values of revenue and costs of a price adjustment policy can be split up into partial expected values, each corresponding to one the three possible forms of realization (excess demand, excess supply, no deviation from expected demand). The potential success of price policy varies with the generic shape of demand according to **A5**, with the dispersion of this function, and with the shape of marginal costs.

The sign of the profit differential between the two adjustment strategies *price policy* and *working hours flexibility* is not unequivocally predictable, since it is determined by several, sometimes related factors. Working time accounts are c.p. the more favorable the higher the degree of uncertainty, the larger overtime premiums, and the higher per capita recruitment costs. Here further research, mainly empirically, promises interesting new insights. E.g. the pairwise consistent combinations (i) price policy/ overtime work and (ii) **wta/** firm level communication system could be subsystems of a higher ordered conjoint supermodular system, or they could stem from diverging (sub) systems of entrepreneural activities. The latter would predict diverging equilibria. The former predicts multiple equilibria, which describe increasing sets. Translated into empirical framework of cross–section and panel data that property implies interactions between variables.

Whether price policy is suitable in rent sharing environments (Slichter (1950), Carruth/ Oswald (1989)), is ambiguous, since elaborated motivational aspects and industrial relations gain weight. It is not unreasonable to argue that alternative instruments, particularly marketing related activities are preferred, e.g. maintenance of customer relations, service strategies, quality management or time management. The desirability of price policy as an adjustment instrument depends on relative weight of equilibrium unemployment, demand driven unemployment risks, prediction over chances of re–employment, and on the underlying product market structure. Decisive is whether major contribution in the determination of unemployment comes from incentive arguments or from market uncertainty. Related work on the wage curve portrays important properties (cf. Blanchflower/ Oswald (1994)).

Multiskilling comprises efficient allocation of the different single skills, i.e. efficient assignment of several tasks in a multitasking environment. Thus, dependent on demand fluctuations, employees could redistribute the share of e.g. production activity j, production activity k, different maintenance activities, quality assurance, further training, etc. But adaption via flexibility in qualifications causes expenditures for further training on the one hand (Carstensen (1999)) and may induce short–termed productivity leakages due to learning curves on the other (Pil/MacDuffie (1996)). From this point of view one should expect the presence of interdependencies (complementarities) between **wta** and multiskilling or skill upgrading.

To summarize, successfully practised working time accounts cover employees fully from labor market related consequences, as long as temporary fluctuations are considered. The presented model assumes intertemporal transferability of working time within firms in contrast to non–storable goods or prohibitive costs of inventories. The idiosyncratic supremum of hours transfers arises from efficiency wage arguments, which are integral part of the model. Consequently, employees base their effort decision on standard hours. Altogether the combination of incentive theoretic and insurance arguments results in a (at least) pairwise interlocking of periods via hours transfers and moreover in long–term employment relations.

Initiation and implementation of working time accounts are potentially surrounded by institutional restraints. Precise examinations of the empirical incidence and evolution of this particular insurance device are reserved for future research. An interesting aspect will be credibility: Can firms in fact credibly commit not to renege the implicit contract, or are incentives to lower standard hourly wages via pseudo–balancing dominating, i.e. skimming of cost advantages from lacking overtime premiums occurs without respective hours cutback in opposite periods. The latter behavior might occur, if firms assess contracted standard hours as suboptimal (resp. too low).

Even if credibility is given and employees have agreed, the contribution of this model to research in labor economics is restricted to the environment of temporary shifts of the demand curve and depends on firm's predictive ability. In addition suitable institutions, which regulate negotiation and renegotiation of working time accounts or single elements in **wta**, should be installed as e.g. well designed routines for the bargaining process, in which the works council participates and that are effective prior to schedule's enactment.

2.3 Renegotiation–proofness of Working Time Accounts

As the model is designed as a sequence of spot contracts, the solutions form also a spot sequence. Thus, it is necessary to deal with ex–post efficiency of contracts under insufficient commitment possibilities (spot implementability) and to apply the results to the specific case of working time accounts. Renegotiation–proofness as a neccessary condition for optimal long–term contracts to be implementable via spot contracts is of interest, too[9]. The contemplation of renegotiations is

[9]The optimal long–term contract is renegotiation–proof (ex–post efficient). Spot contracts are ex–ante efficient, but usually lack ex–post efficiency, since in general they are not renegotiation–proof (as defined in the game–theoretic framework, see Dewatripont (1988), Fudenberg/Holmstrom/Milgrom (1990)). The contract's capability for memory is crucial: If the optimal long–term contract exhibits e.g. memory of wages, which means past wage levels affect current wages, the spot sequence is Pareto–dominated by the optimal long–term contract. This result can be altered, if well defined credit market conditions apply, which translate into specific constraints for credit access. Thus, spot implementability can be generated

crucial for various reasons, e.g. if integration of persistent shocks is needed[10].

First, it has to be verified, whether the T–period working time model in the just discussed manner can adequately catch the economic problem of demand uncertainty or whether alternative approaches are needed to meet the requirements of the multi–period economic environment. The second question deals with moral hazard, primarily on the employer's side. In the stability analysis it is of significant interest, in which circumstances incentives emerge to lie, when announcing the necessity of adjusted hours, and how these incentives depend on expectations of future developments, e.g. legal regulation.

The labor contract derived in Section 2.1 is covered by **wta** in Definition 1, since (constant) compensation per period is included. The following arguments will prove that well defined parallels exist between the **wta**–approach and well–known contract– or game–theoretic approaches, which trace back to hours components of the acccounts. Since current working hours h_t do not always coincide with standard working hours h_μ, limited commitment introduces into the presented model. In a slightly different economic context Chiappori et al. (1994), hereafter CH94, develop an integrated multi–period principal–agent–model, which deals with the same problem. The following considerations use their results on spot implementability to prove sequences of **wta**s to be optimal in the long run.

Given limited commitment and lack of memory in spot contracts, the corresponding sequence of spot contracts (the periodwise chain) usually generates solutions, which are suboptimal in the long run, i.e. diverge from that solution, the optimal long–term contract generates. Thus, with only a few exceptions, the long–run optimum is not renegotiation–proof, and that effect not spot implementable. Since long–term contracts inherently produce memory, they internalize negative externalities resp. enable efficient risk allocation by intertemporal smoothing, a task which iterated spot contracts cannot accomplish. However, important exceptions exist. Trivially, any spot sequence which imitates a memoryless long–term contract is ex–post efficient, where the sequence is the T–times repetition of the optimal static contract. More exciting, ex–post efficiency can likewise be achieved, if one successfully implants memory in a spot sequence, for example via specific credit contracts.

Keeping the latter in mind the above authors prove that the following two cases generate renegotiation–proofness and in fact spot implementability: (a) Agent's savings are observable and can be controlled/ monitored by the principal, (b) randomized savings.

They model the firm's decision problem over wage contracts in a multi–period principal–agent–setting, which explicitly integrates credit market access. Thus (employee–) agent's period income and period consumption no longer coincide by definition. The control of credit market access as mentioned in (a) allows the (employer–) principal to endow spot contracts with memory, although they originally were memoryless. In this regard, the agent is offered a well defined compensation package, which combines period consum and period savings subject to all the period specific participation constraints (employee's reservation utilities profile). In doing so, the

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via optimizing over the choice of savings, where the following definition applies: A "long–term contract is spot implementable if and only if there exists a perfect Bayesian equilibrium of the spot contract game" (Chiappori et al. (1994), see also Rey/ Salanie (1990)) that replicates the outcome of the long–term contract.

[10]Fudenberg/ Tirole (1991) discuss the replacement of one (long–term) contract by another subject to parameter changes as a second alternative under the topic *renegotiation–proofness*.

long–run optimum can be attained in a sequence of spot contracts by solving the optimal choice of incentives. CH94 do not miss to indicate lack of empirical relevance and transferability of their theoretically appealing results. This is not surprising at all, since usually the agent's consumption is not — as claimed in (a) — observable by the principal, the credit market cannot be restricted to the two participants principal and agent, respectively.

Fortunately, these shortcomings does not apply to the presented **wta**–model. Therefore, working time accounts are a suitable example for a chain of iterated spot contracts being renegotiation–proof and for spot implementability of the long–run optimum à la CH94. Accordingly, case (a) is transferred onto the working time account approach. Spot efficiency is proven under controlled savings, although, interestingly, the design of **wta** also reproduces case (b)[11].

If the expected value of the random variable *product demand* is time invariant as postulated in **A5**, then the implementation of **wta** is identical to controlled savings (for a more detailed description see Chiappori et al. (1994)), with the principal monitoring agent's credit market access, thus determining the agent's savings–path. The solution of the optimization problem shows the following typical properties: The generated sequence of single–period contracts is renegotiation–proof and, moreover, the so defined employment relation is spot implementable. The demand function provides enough (sufficient) memory as it has constant expected shape and mean demand, i.e. uncertainty pertains the parameter with an expected value of zero.

To elucidate and in order to provide evidence for the complementary approach (see Topkis (1998)), let us consider the scene from alternative perspectives: Scenario ① and scenario ② cover exactly the same economic situation but utilize different vocabulary, i.e. role reversal of principal and agent. This procedure affords interesting interpretations and new insights on the intrafirm credit market for hours deposits, which trades hours credits and hours debts: Scenario ① is formulated analogously to CH94, with the employer–principal and an employee–agent. This assignment of roles is feasible, though an intuitive approach would be of reversed direction: Since employees own the input factor labor, they also execute saving and borrowing of working hours, which puts them into lender's position and the firm into borrower's position. The following result from CH94 illustrates that the role assignment in Scenario ① does not contradict the credit market.

A situation that endows at least one of the parties (for example exclusively the agent) with access to a perfect credit market, but where, additionally, the agents's borrowing and saving can be monitored by the principal, is equivalent to exclusive credit access for the principal. Since in our model the employer–principal determines current hours h_t, he indeed monitors the employee–agent's savings by controlling the difference $h_t - h_\mu$. Thus, the problem at hand is equivalent to the situation *credit market access for the principal, no access for the agent*, which fits scenario ①. Hence, the retention of principal and agent as in CH94 and the intuitive approach are equivalent.

[11] Applicability of CH94 necessitates the validity of a few (weak) conditions, which are fullfilled in the presented model. Critical is the constraint that interfirm transfers of working hours do not occur. This becomes plausible when discussed in a manner similar to non–transferability of specific human capital. Were accumulated human capital unequivocally separable into general and specific components, the latter would depreciate completely in case of interfirm mobility. This result might change, however, if non–separabilities exist (for diverging predictions see e.g. Acemoglu/Pischke (1999)). Since hours worked in firm i in our model are not affected by non–separabilities, it is reasonable that time deposits are not interchangeable between different firms. Furthermore, under the assumption that employees value continuous employment, the model predicts non–transferability as mobility does not occur.

Scenario ①: the employer–principal controls the employee–agent's savings by varying the relative wights of 'artifical' components within the compensation package. To elucidate, split up the constant time wage, i.e. the *constant period income* $w = \omega \cdot h_\mu$ to reveal information on the two periodic specific summands (i) *demand–adjusted earnings* and (ii) *compulsory savings*, both time–variant:

$$w \quad = \quad w \cdot \frac{h_\mu}{h_t} + \tilde{s}_t h_\mu \quad , \tag{13}$$

with $\tilde{s}_t \sim N\left(0, \sigma^2_{\tilde{s}}(\sigma_M)\right)$. Current levels of lending and borrowing $\tilde{s}_t \cdot h_\mu$ are enforced via the working time account, with actual size of $\tilde{s}_t$ determined by the employer and depending on the ratio of standard hours to realized hours. Period savings are zero, if h_μ and h_t coincide and decrease with the ratio (h_μ/h_t). Thus, transitory excess demand augments the fictitious share of savings in constant time wages, which is equivalent to borrowing working hours by employers.

Working time accounts are in fact characterized by variation in hourly earnings. This becomes evident, if equation (13) is converted to hourly levels, where $\tilde{\omega}_t \sim N\left(\omega, \sigma^2_\omega(\sigma_M)\right)$:

☛ decomposition of *artificial* hourly wages ω:

reference value		period specific		at employer's discretion	
$\frac{w}{h_\mu}$	=	$\frac{w}{h_t}$	+	$\tilde{s}_t$	resp.
ω	=	$\tilde{\omega}_t$	+	$\tilde{s}_t$	➟
constant hourly earnings	=	*variable hourly earnings*	+	*compulsory savings*	.

It is evident that the random variables $\tilde{\omega}_t$ and $\tilde{s}_t$ both have constant expected values, thus implementing memory in the iterated spot game: In each period the specific hourly earnings are expected to be at ω and the predicted amount of period savings ($E(\tilde{s}_t)$) is 0. The following conclusions can be drawn: The sequence of spot contracts **wta** is renegotiation–proof and implies the long–run optimum. As a result annualized hours contracts as an insurance device generate a long–term employment relation, the bilateral insurance model works.

Scenario ② is logically equivalent, thus leads to the same conclusion, but reversely defines the roles of principal and agent. Based on an intuitive approach to the inner firm credit market for working time, the employee (resp. his representatives) is denoted as the principal who constraints credits, whereas the employer is stated to be the agent, whose hours savings are monitored by the principal. This definition leads to very interesting implications and facilitates conclusions on economies of scope between well defined instruments of personnel policy, particularly between *working time flexibility* and *elaborated information channels*.

In a world with working time accounts employees act as a banking house[12]. Thus they should be able to verify the actual borrowing of the firm, which is $h_t - h_\mu$, at least when the firm is after the stability of working time accounts as a favorable adjustment strategy.

Empirical implications are straightforward: Employees or their representatives in firms with **wta** schedules should be granted substantial information rights, since they have to be sufficiently knowledgeable about the firm's situation. Otherwise long–term efficiency is hardly achievable for the inner firm credit market, since efficiency of the (spot–) **wta**–sequence depends on employees' ability to control the firm's credit access, represented by actual hours requirement. By definition employees are aware of e.g. how an ordinary range for Δh_μ would look like. The term *employee–principal monitored credit access of the employer–agent* measures the following: The buffer defined in **wta** (Δh_μ: permitted hours credits or hours debts per period, Δt: maximum period of time to settle the account) is controlled by employees.

In other words, the primarily better informed party has to reveal respective demand figures. Thus, stability of working time accounts as a personnel instrument benefits from activities, which inform employees on quantity of sales orders, on market appraisal and market forecast or alternative short–run indicators. Moreover, it is sensible to raise firm level institutions, that regulate the flow of information as e.g. well defined channels or chains of communication.

Consequently, employees should be able to estimate and evaluate h_μ (resp. the requested level of s_t) in any period. If unforeseen deviations out of the ordinary occur, thus necessitating changes in "contracted" elements in **wta**, then employees, too, should participate in decision making on modifications of **wta**. Furthermore, due to efficiency wage arguments, the intertemporal transfer of working hours is restricted a priori to levels that do not violate the *no–shirking condition* for incentive compatible compensation levels. Thus, a well defined supremum for Δh_μ exists, such that employees' contribution at the design phase, e.g. when fixing the several elements of **wta** prior to their enactment, is more than sensible.

The just derived properties of spot implementability and renegotiation–proofness rely on the assumption of time invariant expected demand. As mentioned in case of durable demand shifts the respective elements in the firm's working time account have to be adjusted, i.e. contract renewal requires alteration. Persistent excess demand carries the risk of moral hazard, as firms have an incentive to execute concealed reductions in standard hourly earnings ($\tilde{\omega}_t$), at least at first sight. If the above discussed firm level institution *information system* exists, however, such behavior is myopic and is seems very unlikely that firms take this strategy seriously into consideration, because employees would try to enforce the alteration of single elements in **wta** or abolish the account system at all. Alternatively, they could try to enforce hiring.

Altogether, **wta**–models can be interpreted as a variant of two–sided principal–agent–models, in which roles are reversed more than once (see Bull (1983)). Working time accounts are part of implicit contracts, in which the parties postulate distributions over future states (Hart/ Holmstrom (1987)). The moments of the underlying distribution may change, or outcomes may be observed, which are not in the event set. If unforeseen contingencies occur, incomplete contracts utilize mechanisms for adaption or rules that enable exactly one party to choose adequate instruments for

[12]Here, the assumptions that interest rates on hours credits balance (unobservable) risk premiums of firm provided employment insurance and that preferences for intertemporal smoothing of hours supply are negligible simplify matters.

adjustment (MacLeod (2000)), but usually recontraction and ex post hold–up are a problem (cf Maskin/ Tirole (1999)).

In our context, the recontraction game implies that neither party will insist on enforcement of (unchanged) **wta**s that lack efficiency nor will they omit adjustment strategies that entail job stability and promote profits. To conclude, from the employer's point of view working time flexibility is a suitable means to strengthen profits, whereas from the employee's point of view this adjustment stategy is worthwhile, if employment guarantees are sufficiently credible.

2.4 Integrating Complementarities: Coherent Incentive Systems including Hours Deposits

The necessity of workers' control capacity in order to generate renegotiation–proof solutions points out that working time accounts (**wta**) show complementarities to intrafirm information and communication systems (**inco**). In the context so far, information means reporting the firm's situation on product markets on a regular basis and evaluation of additional variables, on which success depends, such as revenue, labor productivity or prediction of future markets. Empirically one should interpret (**inco**) as including the bargaining process on the design of working time accounts.

Under Definition 1 and the constraint of regularity, it is reasonable to use modern IT–facilities (**it**) as well: Documentation, execution and maintenance of the accounts system simplify. Thus **it** forms another element of the complementary system, to which **wta** belongs. As the feasibility of modern IT–facilities depends on certain conditions on human capital, further training (**tra**), particularly firm provided training, is another candidate. In addition, it is well–known that modern modes of operation and flexible production technologies (**mot**) together with team work (**team**) and decentralized/ job–related decision making (**ei**) form a complementary sub–system with **tra** (Lindbeck/ Snower (2000), Ichniowski et al. (1996), Pil/ MacDuffie (1996)).

Thus working time accounts, institutionalized information, and employee involvement in decision making, IT–facilities and computerization, versatile production equipment, teamwork, firm supported/ supplied training, and efficiency wages constitute a coherent system of complementary instruments. Consequently, an analysis of simultaneous variation of these instruments is needed to identify system effects. The theory of supermodular optimization (spmo) proves quite useful in this regard (Milgrom/ Roberts (1994), Topkis (1978, 1995, 1998)). The charme of spmo as an analytical tool results from several characteristics. First optimal allocation of single instruments to well–balanced packages in optimal solutions is derived, where changes of variables and parameters of contrary direction orientation can be integrated in a conclusive framework (Holmstrom/ Milgrom (1994)). Second, and more important, the results do not depend on differentiability. Thus, the theory of supermodular optimization provides monotone comparative statics to predict spillover effects. This property is very useful in contract theory and in personnel economics, since they often deal with problems incorporatin discrete variable variation, i.e. with issues that typically lack differentiability of the objective function (Milgrom/ Shannon (1994), Milgrom/ Roberts (1995a)).

Under the derived hypothesis on complementarity comparative statics for working time flexibility, e.g., predict that profit mazimizing firms, which lack a suitable base for implementation of **it**, may fail when introducing just **wta** or **team**, though the latter instruments both promise positive effects. In other words, if success crucially depends on introduction and stability of working time accounts (and/ or team work), firms should also invest in an intrafirm system of information

and communication. The hypothesis that those working time accounts lack continuous presence, which are effective in firms, who refrain from systematic information dispersion, and moreover determine elements of **wta** without employee involvement in decision making, follows from a strict interpretation of scenario ②. In this context alternative patterns of **wta**–emergence may be observed, in which periods of a) existence, b) planning, and c) abolishment alternate repeatedly.

Analytically, a firm opts for an idiosyncratic equilibrium, when choosing its well–balanced combination of single instruments under firm specific restrictions. The different equilibria emerging on an aggregate level describe a partially ordered set, whose greatest element corresponds to the full complementary system, including **wta**, **inco**, **it**, **ei**, **tra**, **mot**, and **team**. This maximum element dominates all other (HRM–system) equilibria, which use just one single instrument or any subsystem, since marginal benefits from introduction of the complete system exceed the sum of marginal benefits due to isolated variation of each single instrument.

In the initiation phase, however, the coordinated approach is more time–consuming than strategies, which concentrate on specific personnel instruments. Coordination efforts and time lags prior to initiation increase, though (mid– and long–run) forecasts are much better. The role of time as a key success factor should not be underestimated, thus limiting facilities to introduce comprehensive coherent systems in one step, particularly when adaption to shocks is needed. Shocks may require instantaneous reactions, thereby increasing the probability for *instrumentwise* introduction of HRM–systems. At first, those instruments with largest predicted isolated effects will be installed. Anyhow, under such behavior firms face a lock–in to specific routes of HRM–systems.

If introduction of working time accounts takes place as in scenario ②, then addition of strategies seems reasonable, which e.g. aim at the limitation of demand fluctuation. Imaginable is that measures as *concentration on specific customer groups* or *specialization to high quality production* accompany the complementary HRM–system. Future research should investigate the practical impact of complementarities by integrating **wta** arrangements in panel data analysis. If possibilities for complete systems lack, such data may hopefully give hints on sensible orders of introduction. Furthermore, they can be exploited to identify suboptimal behavior and to draw appropriate recommendations for personnel policy.

2.5 Critical Remarks

Long–term employment was established by intertemporal transfers of working time. Corresponding Pareto improving effects of working time accounts result from diverging risk attitudes of workers and firms. This section discusses important implications of the moedel and contains a couple of remarks, which facilitate a judgement of the results and typical shortcomings of the model. Hints for analytical extensions and empirical research follow. Any general classification should not ignore the fact that we constructed a pure micro model. Thus, well–known characteristics of partial models apply.

Given the environment of our insurance model, expected value of per period hours deposits is zero. Empirical evidence seems to differ[13]: Often, persistent and positive working hours credits exist, thus predicting inhonest behavior of firms. That this need not be true, may be elucidated by the following hypothesis. Whereas we restricted ourselves to output market risks, companies are

[13]Experiences with working time accounts — compared to experiences with overtime work — are still rare. Hence, interpretation of apparent stylized facts should be cautious.

exposed to additional sources of uncertainty, e.g. at the production level. Models with production risks show similarities with truncated models, X–inefficiencies and frontier analysis applies. Usual interpretation of production level risks, however, changes dramatically, if working time accounts are effective, as they enable frictionsless (counter)imitation of materialized uncertainty. As a result, the production function under certainty is imitated at the expense of hours credits. Thus, expected balance of working time accounts is non–zero.

It is not beyond dispute, whether the maxime *providing job stability* should be pursued unconditionally, since efficient separations are prevented (bad matches keep valid). Inefficient quits, however, do not occur (e.g. in economic downturns, see den Haan et al. (1999)). It is widely recognized that long–term employment interacts with technological progress, promotion policy and human capital accumulation. The issue is, whether "obligatory" tenure has similar effects. One hypothesis for future research states that the simultaneous investment in firm level training towards multiskilling as well as in flexible processes and the use of strategies integrating customer's feedback result in more versatile job and task assignment opportunities for workers (cf. Lindbeck/ Snower 2000) and help to decrease the spread of demand. To summarize, clear cut matches are not required anymore.

The restriction to changes in net employment neglects the phenomenon of churning, thus leaving realized separations and recruitment aside. Part of the job turnover is not considered (e.g. Davis/ Haltiwanger (1992)). The model contains no predictions for the sign of changes in job turnover due to existence of working time accounts, although an intuitive hypothesis would c.p. suppose a decreased job turnover rate. Hence, attractive research perspectives arise. Arguments, why firms do not change output via (temporary) per capita variation appear in 2.2. Most important are (i) institutional inertia, (ii) fixed and quasi–fixed costs of employment and (iii) convex adjustment costs.

The discussion so far has not disclosed information on an appropriate confidence interval for demand uncertainties. But since large levels of demand shocks may crucially threat the firm's existence, it has to be examined, whether a critical value for the probability density of expected demand Q^* exists. The following scenario with negative demand shocks may illustrate: Let the firm exit the market for reasons of insolvency, if realized demand is at least $\gamma-$percent below expected demand. With increasing variance the probability of falling below the critical demand level also increases. Thus, an upper bound for dispersion exists, which determines the critical value for credibility of employment guarantees, beyond which a firm can no longer credibly commit not to dismiss insiders (shut down threat).

In conjunction with the credibility argument it follows that contracting and enforcement of **wta**–arrangements depend on the employees' ability to estimate such bounds and to evaluate the character of large–valued shocks as temporary or permanent. Notice that the risk of bankruptcy is usuallly not ruled in working time accounts. In case of liquidation working time credits and debts expire. In case of a persistent shift of the demand curve corresponding alterations in the expected value will become apparent only with large delays, since working time accounts allow for short–run window–dressing as do inventories. Both arguments elucidate that supplementary profit stabilizing activities are sensible. Working time accounts, which integrate opportunities to convert *persistent* hours credits into stock market equivalents represent a reasonable means to strengthen the firms credibility at the tails of the demand distribution.

For myopic employers moral hazard may be appealing. The strategy to conceal persistent demand increases is an example: saving of recruitment costs is combined with lowering of average

hourly earnings. Sufficiently large fixed recruitment costs (Oi (1962), Hart (1988)) or suboptimal number of standard hours may cause such behavior. However, job security and long–term employment relationships encourage reputation and similar firm level institutions, such that potential benefits are just short–termed, whereas employees' penalization lasts longer. Thus the insurance property of **wta**s erodes attractiveness of moral hazard. System effects, particularly with intrafirm channels of information and communication (**inco**), underscore.

3. Concluding Remarks

Product market risks in fact alter the optimization behavior of risk neutral firms. Given that inventory buffers are not costless, adjustment strategies become necessary. In detail, we considered working time deposits. If efficiency wage arguments are valid, then working hours schedules, which explicitly enable innerfirm hours credits and debts (denoted as *working time accounts*), are superior to alternative adjustment strategies as e.g. overtime work and short–time work, or temporary employment or cycles of separation and re–employment.

Risk averse employees also prefer working time accounts, since, in exchange for time variing working hours, they are covered from unemployment risks due to sales risks. Thus, working time accounts establish reciprocal insurance. The favorability of such working hours contracts is not merely based on cost advantages and efficient risk allocation. The above discussion has proven the solutions to be renegotiation–proof and the long–run optimum to be implementable via the sequence of spot contracts, if firms introduce systems of information and communication. Correspondingly, working time accounts and inner firm information systems build a coherent subsystem of the same complementary incentive system. Plausibility arguments show that the latter includes additional incentive instruments as support of training, multiskilling and team work. Synergies with computerization and flexible production equipment also exist.

Although the focus was on product market uncertainty, additional sources may cause deviations between expected and realized demand. As a first extension fluctuations at the production level were considered. Things simplify, if risks from different domains are uncorrelated, since their variances just add up. The critical limit, however is reached sooner, thus necessitating supplementary measures to shrink dispersions (marketing policy, quality control, purchase policy). But if interdependences exist e.g. between output market and input market, additional interaction terms have to be included. In addition, if firms are exposed to risks, which relate to X–inefficiencies and refer to frontier analysis, working time accounts possess non–zero expected values by inherently imitating production functions under certainty. Thus positive balances of accounts are more than likely to emerge.

Empirically, we expect that flexibility strategies are not restricted to the adjustment of the production factor labor, but that well–defined bundles of reinforcing instruments are exploited, which aim at both levels, a priori minimization of uncertainty and ex–post adjustment in case of ocurrence (see Milgrom/ Roberts 1995b). Analyses of enterprise level panel data will give further insights into the insurance generating capacities of employment–relations and, hopefully, show whether the postulated instruments in fact constitute a complementary system, which additional instruments enhance productivity and profit effects, and which instruments contradict the inner firm credit market for working hours. Interesting tasks for future theoretical and empirical research are the integration of correlated risks as well as the analyses of firms with multiple output markets, which differ geographically and with respect to price setting behavior.

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