Unraveling the German Jobs Miracle in the Great Recession: A Stochastic Dominance Approach

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ABSTRACT

This paper contributes to the unraveling of the German jobs miracle. A model that is capable to explain the enormous absorption capacity of the labor market in the Great Recession is developed. The referring adjustment system simultaneously addresses (i) the firm level as the crucial locus of adjustment decisions and (ii) the intensive margin of labor as a crucial adjustment channel during crisis. Intuitively spoken, a generalized system of work sharing covering sharing coefficients beyond one results. Since employment stabilization requires balancing of counterparting risks, this system will be organized as a renegotiation proof system of time banking, namely working time accounts.

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1. Motivation and Introduction

The starting point of this paper is the amazing stylized fact that despite being more severely affected by the global economic downturn than most other OECD countries, Germany exhibits a rather mild rise in the national unemployment rate (e.g. OECD (2010a, b), OECD 2009)[2]. So far, the discussion concerning the determinants has not reached a conclusion (cf. Bell/Blanchflower 2009). Insofar, the following research issues are important to be addressed: Which mechanisms have cushioned the German labor market? How can these mechanisms be institutionalized successfully, e.g. in national, collective or firm-level settlements? Further, as a perspective for upswings, future recessions, and for countries that did not technically entered a recession since 2008, it might be worthwhile to inspect whether crucial elements of this particular adjustment system indicate forward-looking ingredients for a jobs oriented labor market policy, especially for globally integrated nations.

This paper contributes to the unraveling of Germany's jobs miracle by developing a theoretical model that is capable to explain the enormous absorption capacity of the German labor market that has been continuously observed in the Great Recession and during the current upswing. The model is based on a stochastic dominance approach and provides a general and globally applicable means of adjustment. In a first step, we derive a firm level mechanism of labor market adjustment, and prove its rather natural shock absorption capacity. In a second step, those institutional settings are discussed that are essential for the countercyclical requirements of this flexibility scheme concerning labor market stability, i.e. to achieve substantial immunization of employees against job losses during crisis and immunization of firms against loss of knowledge capital during upswing. Finally, prospects for a global penetration are given.[3]

One strand of the related literature stresses the importance of automatic stabilizers to mitigate adverse effects of cyclical variation. Automatic stabilizers as social protection or

[2] As OP-ED columnist in the NY Times, Paul Krugman introduced the term "Germany's jobs miracle" to recognize the success of respective labor market policy to avoiding mass job losses resulting in only modest rises in the unemployment rate (Krugman 2009).

[3] This paper concentrates on genuine labor market policy and does, therefore, not address potential stimulus packages and related consumption effects. A combined analysis of internal work adjustment systems and stimulus will be an interesting issue for future research.

(partial) unemployment benefit schemes dampen the impact of economic shocks and are intended to improve labor market conditions. For example, Stiglitz (2009) drives the hypothesis that restrictive labor market legislation and employment protection regulation in Germany, in fact, operated as an automatic stabilizer on the labor market with positive long-run effects, since firms were almost obliged to maintain human capital, irrespective their preferences.

Despite being intuitively attractive, this argument is weakened by recent empirical work based on OECD data. In a related study, Möller (2010) contradicts the hypothesis that firms have been reluctant to dismiss people owing to labor market regulations. Precisely, he points out that the data neither disclose a causal relation between employment protection legislation and job stabilization effects nor show any correlation between employment protection indices and unemployment rate changes across countries. To put it differently, countries with similar employment protection regulations experienced diverging changes in unemployment levels and vice versa.

A plausible interpretation of these results is that firms in Germany played an active role in the decision on labor hoarding, i.e. that they voluntarily refrained from layoffs, if applicable, backed up by collective agreements. Insofar, the German jobs miracle is not disentangled by the above legislation hypotheses. Obviously, alternative adjustment patterns are effective and need to be identified in order to elucidate the remarkable job market performance which looks like a reversion of the classical eurosclerosis pattern.

Consequently, a second strand of the related literature emphasizes the protective and buffering effect of short-time work schemes in the world recession (Verick/Islam 2010, Cazes et al. 2009). Legislation on short-time work (stw) reflects a jobs oriented economic strategy and has - in the face of crisis - been introduced, modified or extended in many OECD countries except Australia, Greece, Portugal, Spain, Sweden, UK, and the United States. In principle, stw programs have been well established since decades and share the common objective of encouraging labor hoarding (retention of specific human capital) by subsidizing wage payments and/or social security contributions of firms (e.g. OECD 2009, 2010b). Since many OECD countries are operating such programs and, in addition, any of those countries lacking support for stw can be matched to a counterpart stw-supporting country with the matching variable equivalent unemployment change, either institutional differences in the stw programs

might be responsible for recent differences in labor market dynamics, or alternative institutions and adjustment channels account for country-specific variations in unemployment patterns.

This paper contributes by justifying such an alternative institution of labor market adjustment that resolves Germany's jobs miracle. We aim to close the existing research gap in the context of the astonishing labor market performance that has become evident in the Great Recression. We introduce a model that simultaneously addresses (i) the firm level as the crucial locus of adjustment decisions and (ii) the intensive margin of labor as the crucial adjustment channel during the recent crisis. A stochastic dominance approach is developed to formalize important ad-hoc hypotheses that have been stated recently in the context of Germany's labor market dynamics (e.g. Möller 2010, Crimmann et al. 2010).

Intuitively spoken, we derive a generalized system of work sharing that covers sharing coefficients exceeding 100 percent, hence, integrates non-payed overtime work and fully-compensated short-time work into one comprehensive framework of flexible working hours. It shows that an appropriate set-up of this comprehensive system as a firm-level institution is not trivial, since the intended employment stabilizing capacity crucially depends on the integration of counterparting risks and on the self-enforceability of contracts.

In order to balance the counterparting risks, the generalized work sharing system will be organized in an accounting or banking system for worked hours, so called "working hours accounts" or, equivalently, "working time accounts". Like ordinary banking accounts, working time accounts trace transactions by the individual, but transactions refer to hours instead of money. In particular, hours deviations from contracted standard working hours are traced over the period under consideration, e.g. the time-span until compulsory settlement of accounts which might range from a couple of months to decades. There is a one-to-one mapping of a working hours account to an individual employee within a firm, hence each worker has his/her separate working time account. In sum, working time accounts reflect a low cost alternative accomodating changes in labor demand at the intensive adjustment margin.

The key role of internal adjustment of average hours worked in limiting unemployment increases has attracted much attention in the current discussion (cf. Arpaia/Curci 2010). To continue this argument, the broad and well-institutionalized dissemination of working time accounts in Germany might be presumably the key to its jobs miracle. This paper shows that working time accounts that not only render cyclical sensitivity of per capita hours worked, but

also have been enacted beforehand crisis and comprise a form of job security, e.g. a "no-layoff clause" or voluntary job guarantee are, in fact, renegotiation proof and, furthermore, can be expected to exhibit favorable patterns of adjustment costs including recruitment and training expenditures in the aftermath of the great recession. Given these characteristics, other countries might consider the working-hours-accounts-system approach as a reasonable strategy to initialize similar schemes in the aftermath of the world recession, preferably during upswing. Those countries might then be able to fully exploit the buffering capacity of this labor market adjustment instrument in future cycles.[4]

The paper is organized as follows. The next section presents related literature. Section 3 summarizes important stylized facts and provides some recent and influential hypotheses. Section 4 derives the model that unravels the German jobs miracle. Section 5 discusses crucial properties of the solution as renegotiation-proofness, links the model results to empirical evidence, and concludes. The main conclusion is that working time accounts establish a generalized institution which is likely to be applicable for a variety of OECD countries, provided that aspects of industrial and labor relations are adequately taken care of.

2. Related Literature

This paper is located within the triangle of (i) empirical literature with focus on labor market and cycle research, (ii) theoretical contributions to contract theory and risk theory, and - as we motivate the discussion by elaborating a country-specific example - (iii) research that in fact focuses on the German labor market in a globalized world.

In general, this paper is related to research that deals with the Great Recession and discusses the interplay of GDP growth, employment and unemployment dynamics, adjustment dynamics, and legislation. Specifically, the argumentation is based on insights from overviews and survey papers in the style of Bell/Blanchflower (2009), ILO (2011, 2009), OECD (2010a, 2010b, 2009). Moreover, quantitative empirical contributions to the analysis of appropriate labor market policies during crisis that explicitly focus on short time work are related to this paper, especially Cahuc/Carcillo (2011) and Hijzen/Venn (2011). We use their results and

[4] Notice that circumvention of future scarcity of qualified labor and establishing work-life-balanced distributions of working time are further candidates which are supported by coverage within a working hours accounts system.

remarks on potential drawbacks as a focus point in our discussion and argue that the working time accounts approach is likely to solve most drawbacks.

The work on intensive margin adjustment of labor vs. extensive margin adjustment is also related to our research (for an overview cf. Haskel et al. 1997), since this paper contributes to the development of appropriate means of labor market adjustment at the intensive margin and proves their favorability. Nickel (1978) relates to our paper through his discussion of evolving adjustment patterns over (life) cycles. The discussion of Abraham/Houseman (1994) relates to our approach, as it shows that job security need not to prevent adequate hours flexibility.

The theoretical literature in line with the approach presented here is twofold. On the one hand, the contributions made by Rothschild/Stiglitz (1970) and by Rasmusen/Petrakis (1992) to research on risky prospects and stochastic dominance are relevant for the set-up of the theoretical model. Their findings on probability mass shifts are the key to the proofs in section 4. where we show that working time accounts establish a firm-level adjustment institution capable of providing mutually beneficial insurance. Since mutually beneficial effects rely on renegotiation-proofness of the underlying institution "working time account", on the other hand, the literature on self-enforceability, renegotiation-proofness, and spot-implementable contracts is extremely relevant. Fortunately, the major results from Chiappiori et al. (1994) instantaneously apply to our results, thus the requested proof is straightforward.

Last not least, from a legal-institutional perspective related studies on working time and working time flexibility, including time banking systems, as well as country-related studies referring to the German economy in world and EU context are relevant, namely EIRO-surveys (European Foundation for the Improvement of Living and Working Conditions), IAB located descriptive documents for working time accounts in Germany (e.g. Zapf/Brehmer 2010), and quantitative research addressing the German jobs miracle (e.g. Möller 2010).

The next section continues with stylized facts, drawn from the sources just cited.

3. Stylized Facts

The recent world recession and subsequent unemployment growth have been driven by a global collapse of demand. In contrast to past recessions the timing of the Great Recession is characterized by a rather simultaneous entry of the world economy into a sharp drop of GDP

growth with negative rates in almost all OECD countries, and a massive slow down in fast growing countries like China and India to expansion rates in the corridor of 5 and 9 percent (cf. ILO 2011). Likewise, the development of employment and unemployment in affected countries contradicts former patterns.

On the first sight, those economies with more restrictive employment protection legislation seemed to have performed relatively better, but related estimates reveal no significant relation between the level of OECD employment protection indices and growth in unemployment rates (e.g. Möller 2010). However, in European countries evidence for labor hoarding is striking. Labor hoarding represents labor adjustment at the intensive margin and aims to stabilize permanent employment and to moderate rises in unemployment (Arpaia/Curci 2010, OECD 2009, OECD 2010b).[5] The most acknowledged measure within the class of labor hoarding instruments is definitely short-time work (stw). Federal government initiated labor market legislation has put emphasize on short-time work schemes and allowances (cf. Cazes/Verick/Heuer 2009).

Recent empirical evidence suggests that the use of short-time work programs indeed had beneficial effects in preserving permanent jobs during the crisis, but also addresses the open questions of free-riding as well as post-crisis adjustment capability of existing schemes (e.g. Cahuc/Carcillo 2011, Hijzen/Venn 2011). Although the scientific community has directed much interest to short-time work, alternative measures of intensive margin adjustment of labor are practiced. In Germany, for example, working time banking systems and temporary work-sharing arrangements at the establishment level plus further training are observed (cf. Crimmann et al. 2010).

Table 1 illustrates why it might be fruitful to analyze such alternative measures as well:

[5] In general, adjustment patterns of production with impact on labor input can be categorized into two sets (cf. Haskel/Kersley/Martin 1997): First adjustment at the extensive margin covers per capita adjustment, i.e. exit and entry of employees with potential consequences for unemployment levels. Job destruction and job creation refer to extensive margin adjustment. Second adjustment at the intensive margin denotes variation of working hours, hence reflects fluctuation in the worked time per capita. Adjustable work sharing schemes, including short-time work, working time accounts, but also overtime work, and temporary work-sharing arrangements reflect intensive margin adjustments of labor. With extensive margin adjustment of labor reallocative shocks and cyclical variation are directly transmitted to employees. In contrast, intensive margin adjustments internalize part of either shock, thereby downsizing employment variation and supporting the retention of human capital.

Table 1: Alternative measures of labor hoarding in Germany

Labor market adjustment at the intensive margin

Adjustment Practice	Relative contribution*
Short-time work (stw)	**35.7**
Inter-temporal hours transfer	**51.2**
Hours-withdrawal from working time accounts (wta)	21.5
Reduction of overtime	29.7
Other (e.g. temporary work-sharing agreements)	**13.1**

*: In 2009 short time work has been responsible for 35.7 % of measured labor hoarding.

Note: data rely on calculations by the Institute for Employment Research (IAB) of the Federal Employment Agency (BA). They are subject to minor routine revisions. Thus depending on retrieval date and/or specific IAB-reference the relative contribution of stw, wta, ovt, and residual instruments may vary within a 2-3 percentage point range. As the contribution of stw never exceeds 37 %, the discussion in this paper refers to the table above. Source: IAB (2010), Average working time in Germany and its components, http://doku.iab.de/grauepap/2010/tab-az09en.pdf, accessed 15. January 2011, own calculations.

Table 1 shows that short-time work in fact contributed less than 4 out of 10 hours to the reduction in annual working hours, whereas the withdrawal of employee's hours deposits in working time accounts, i.e. the reduction of credit hours, taken together with their technical equivalent of overtime hours reduction capture more than half of the labor hoarding capacity. Consequently, in Germany major part of potential labor market stabilization in the Great Recession accrues to inter-temporal hours transfer, either institutionalized in working time accounts or as part of shrinking overtime work schedules. Given this information, it is worthwhile to study employment retention from the working hours transfer perspective.

Technically spoken, working time accounts internalize allocative shocks, e.g. random drops and peaks in demand, thereby counter-balancing cyclical variation up to a certain limit. Any working time account is attached to an individual employee within a given firm. It traces hours worked by this employee over the cycle in a time banking system, and enables to accumulate individual hours credits (deficits, respectively) when actual hours exceed (fall short of, respectively) standard hours. Provided that contracted normal hours in general depict market conditions over the cycle, the expected value of an account equals zero. Spells of positive account balances might occur if labor is scarce, in initial phases of a product life cycle,

or during extended upturns. As in 2009, spells of negative balances are characterized by consecutive withdrawal of hours credits, or accumulation of hours deficits. Such spells are likely to occur during downturn, and presumably in matured phases of product cycles.

Table 2 points out the increasing incidence of working time accounts in Germany in the last decades,[6] informs about typical constitutional characteristics and highlights the adjustment potential that took place in the Great Recession.

Table 2: Working time accounts and LM flexibility in Germany

Incidence, characteristics, and absorption capacity

Increasing WTA coverage (1999 - 2009)		
1999		
Percentage of firms		21
Percentage of employees		35
2009		
Percentage of firms		35
Percentage of employees		51
WTA: Institutional Arrangements		
Average allowance of hours transfers (upper bounds)		
Hours credits (worked hours > normal hours)		69
Hours debits (worked hours < normal hours)		39
Average duration until mandatory settlement of balance		30 weeks
Yearly adjustment capacity of WTA during GR		
Re-balancing to tackle crisis	(% of firms)	46
Average number of hours that have been withdrawn	(-h)	45
Macro-level adjustment via labor hoarding		
Average annual hours reduction	(-h)	44

Sources: Zapf/Brehmer (2010), http://doku.iab.de/kurzber/2010/kb2210.pdf, accessed 14 December 2010. Möller (2010). Data are based on the IAB Establishment Panel, and WSI Betriebsrätebefragung 2009: Beschäftigungssicherung, yearly values refer to 2009/crisis spell 08q3-09q3, own calculations.

Note: Hours and duration figures in the institutional arrangements column are averages and do not at all reflect the great variety of practiced institutional settings. In Germany, working time accounts often appear as firm-specific settlements (see also section 4.2.1 $\Delta \mathbf{h}_t, T_{ref}$)

[6] For an overview over different types of working time flexibility, including working time accounts, in the EU see European Foundation for the Improvement of Living and Working Conditions (2010).

Table 2 reveals some interesting insights. First the incidence of working time accounts and coverage of employees is growing. Within one decade, the number of employees who operate there working time schedule under a working time accounts scheme has risen by almost 50 percent. Moreover, these schemes seem to be well established from an Industrial Relations and Labor Relations perspective (see also Groß/Schwarz 2006). Second there is a nice congruence between the reduction in average annual working time of almost 44 hours that took place in 2009 compared to 2008 (calculated for the base of all employees, IAB 2010) and the dis-saving of, on average, 45 annual hours in response to crisis that took place correspondingly in working time accounts. In other words, the average contribution to downward adjustment of annual working hours through working time accounts has virtually matched the average contribution which has been observed at the macro level. Notice that in practice, withdrawal of hours credits in firms with respective time banking systems can take place rather frictionless. Third employees did enter the recession with a substantial stock of hours credits, and apparently the German labor market did benefit from this buffer. Tentative interpretation could be as follows: Synchronization of the overall labor hoarding effect and the re-balancing impact on working time accounts might indicate that time banking systems prevent firms and employees from free-riding with federal government initiated schemes, eventually decreasing risks of inefficient reduction or working time through, e.g., excessive usage of short-time work, as suspected in the literature.[7] Indeed the subsequent section shows that working time accounts can be enacted as renegotiation-proof institutions. A fact which might explain the counter-intuitive evidence on international labor markets.

The leading hypothesis in this paper is that exactly these working time accounts are relevant and even crucial for the amazing performance of the German labor market and the cited jobs miracle. Despite their important interplay with other forms of working time flexibility working time accounts can be interpreted as the key success factor to employment retaining and productivity recovery in the aftermath of crisis. Although working time accounts

[7] For 2010, recent statistics (IAB 2011) report again an accumulation of hours credits in working time accounts at a macro-level mean of 3.7 hours along with strong employment growth and remarkable reduction of unemployment. At this first sight, the critique of jobless growth as one potential drawback of labor adjustment at the intensive margin does not apply. This issue will be an interesting topic for future analysis.

denote a well-established labor market policy practice in Germany, they are only little known in many OECD countries as well as in the newly industrialized Asian economies. Indeed, the model developed in the next section suggest that economies which do not practice working time banking systems such as working time accounts are very likely to benefit from their introduction.

4. The Model

As stated in the introduction our model aims to balance counterparting risks. Thus we apply stochastic concepts to rank risky prospects in order to show that working time accounts establish a mutual insurance device between firms and employees which dominates working arrangement without this form of working time flexibility from a stochastic dominance perspective. We also show that appropriate institutional arrangements are required, including transparency of balances and periods of compulsory settlements.

The main advantage of our approach is the general applicability plus the clear intuition which is given by moving probability mass within risky prospects. The model aims to improve the understanding of the interplay of re-allocative shocks, economic downturn, remuneration and labor adjustment. Since the model relies on only weak assumptions, applicability in other economies is given. Moreover, settings that include an efficiency wage mechanism like a binding threshold on productivity or knowledge capital can easily be integrated.

4.1. Comparing Risks with Probability Mass Shifts

4.1.1. The Idea

Although the probability mass shift approach is applicable to any arbitrary probability distribution function, let us first illustrate the underlying idea with help of the familiar standard normal distribution $f(X) = (2\pi)^{-0.5} \cdot e^{-0.5x^2}$. Let us further depict a) probability density as well as b) the value of the cumulative density function for the realizations -2, -1, 1, and 2 of random variable X. The probability density for values -2, and 2 is given by $f(-2) = f(2) = 0.054$. The respective probability density for realizations -1 or 1 is $f(-1) = f(1) = 0.242$.

Cumulative densities amount to $F(-2) = 0.023$, $F(-1) = 0.159$, $F(1) = 0.841$ as well as $F(2) = 0.977$. The probability mass covered by the interval $[-2,-1]$ equals the probability mass covered by the interval $[1,2]$, and comprises 13.6 percent of the overall probability mass.

The idea of comparing risks by probability mass shifts is as follows: Let us at a time shift e.g. those 13.6 percent of probability mass without affecting the first moment of the distribution, i.e. preserving the mean. Now consider an outward shift which generates a new random variable Y with more weight in the tails of the distribution. In our example, Y might be generated by shifting both probability mass areas to -2 and 2, respectively, thereby increasing the corresponding probability density to 0.19. Of course, these shifts imply a probability density of 0 in the interval $(-2,-1]$, and $[1,2)$, respectively. Next consider an inward shift which puts more weight to the center of the distribution. In this case, the above probability mass might be shifted to -1 and 1, implementing probability densities of $f(-1) = f(1) = 0.378$ as well as zero density in the intervals of shifted probability mass.

In other words, shifting probability mass to the tails of a distribution increases dispersion and therefore risk, whereas shifting probability mass to the center of a distribution decreases dispersion and therefore risk. For any two distributions with identical expected value, the well-known notion of second-order stochastic dominance is equivalent to the notion of probability mass shift to the center. Referring again to the discussed (mutual) insurance problem on the labor market, the task will be to identify instruments of labor adjustment that imply a shift of probability mass to the center which rather automatically integrates counterparting risks.[8]

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[8] In economic theory, the concept of defining variability under only weak assumptions and – based thereon – the comparison of risky prospects has been first addressed by Rothschild/Stiglitz (1970) who prove the equivalence of the following definitions of "increasing risk": On the one hand, random variable *Y* is more risky than random variable *X* if

- every risk averter prefers *X* to *Y*,
- *Y* is generated from X by adding a random variable *Z* with $E[Z|X] = 0$,
- *Y* has more weight in the tails.

On the other hand, let *F(x)* and *G(y)* be the respective cumulative probability functions of *X* and *Y*. *G(y)* is second-order stochastically dominated by *F(x)*, iff (integral condition):

Shifting probability mass while keeping the mean of pre- and post-shift distributions constant is equivalent to mean preserving manipulations of random variables, and is typically discussed in conjunction with symmetric distributions, as e.g. captured by cyclical variation. In contrast, mean altering shifts of probability mass essentially apply to half-sided or censored distributions. The Great Recession, for example, and temporary demand shifts for non-storable production or services reflect half-sided distributions, and will be studied in this paper in the light of mean altering shifts of probability mass.

Let us continue with the definitions of mean preserving spread (DEFINITION 1), mean preserving contraction or shrink, respectively (DEFINITION 2), as well as mean augmenting contraction or shrink, respectively (DEFINITION 3).[9]

4.1.2. Mean Preserving Shifts

The first definition below comprises the rather common notion of mean preserving spread as a general concept to rank risky prospects.

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

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

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

- $\int_{-\infty}^{t} [G(z) - F(z)]dz \geq 0$, for all *t*, with strict inequality for some (non-zero) interval of values of *z*.

[9] For an overview of mean preserving spreads, probability mass shifts, stochastic dominance, and a critique of Rothschild/Stiglitz (1970) see Rasmusen/Petrakis (1992).

DEFINITION 2 for mean preserving contraction (mean preserving shrink, equivalently) writes as

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

For the treatment of potential adjustment inertia, non-symmetrically distributed random variables or insufficient time-intervals to counter-balance it is useful to define effects of probability mass shifts that do not preserve the mean. The latter property can be utilized for a better understanding of the role of working time accounts in the Great Recession, and helps to unravel the cited jobs miracle.

4.1.3. Mean Altering Shifts

A direct implication of massive economic crisis and of temporary demand cuts in the service sector is that, on average, shocks and temporary shifts do not set off. Therefore, DEFINITION 3 defines as an analog to DEFINITION 2 the mean augmenting contraction (mac), and – equivalently – mean augmenting shrink (mash).

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

There are two stages inherent to DEFINITION 3. At a first stage, the shift of probability mass from the tail to the censoring point unequivocally increases the expected value, i.e. $\mathrm{E}[X] > \mathrm{E}[Y]$ (*mean augmenting property*). Consequently, X first-order stochastically

dominates Y (X fsd Y). At a second stage, the shift generates a random distribution that second-order stochastically dominates the unmodified distribution (*contracting property*).

Whereas the mean augmenting property is evident, the contracting property is worth to be further explored. Since the overall probability distribution function of any half-sided distributed or right censored random variable z is a combination of (i) the mode or a spike at α and (ii) a continuous probability density function for values $z < \alpha$, the right shift of probability mass either transfers cumulated density from the continuous part (ii) to the censoring point or decreases the incidence of realizations in the interval $\left[z_{y_0}, z_{y_1} \right]$ while simultaneously increasing the frequency of realizations in a successive interval $\left[z_{x_0}, z_{x_1} \right]$, where $G(z_{y1}) - G(z_{y0}) = F(z_{x1}) - F(z_{x0})$ identifies the area of the shifted probability mass, and with $-\infty < z_{y0} \leq z_{y1} < z_{x0} \leq z_{x1} \leq \alpha$. Then, cumulative density $G(Y)$ strictly exceeds $F(X)$ in the interval $\left[z_{y_0}, z_{x_1} \right]$ and at least equals $F(X)$, otherwise. Thus, the integral condition is satisfied, and the contracting property is established.

Working time accounts apply under either concept. Thus they can be integrated in the model of probability mass shift irrespective of whether the condition of a mean preserving contraction/shrink (mpc/mpsh) holds, or the concept of mean augmenting contraction/shrink (mac/mash) is satisfied. The next subsection proves that working time accounts generate benefits to both firms and employees (and federal governments). They also provide scope for mutual insurance, while not violating crucial incentive devices.

4.2. Working Time Accounts and Counter-Balancing of Labor Market Risks

4.2.1. Institutional Settings

The unique property of time banking is to formally trace worked hours in a statement of account. In general, working time accounts are determined by (i) remuneration, (ii) standard hours, (iii) distribution of working time, i.e. total hours including upper and lower limits of hours worked, i.e. allowance of hours deviation, and (iv) a reference period over which worked hours have to be averaged. Working time accounts as an insurance device, in addition,

encompass an element of (v) job security and are best interpreted in the context of implicit contracts or efficiency wage mechanisms.[10]

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

$$\text{wta} := \left\{ \mathbf{w},\ \mathbf{h_{\mu}},\ \mathbf{\Delta h_t},\ T_{ref},\ 1_{\text{jsec}} \right\}.$$

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

Given the massive amount of labor hoarding in the Great Recession, in DEFINITION 4, we explicitly define working time accounts as a mutual insurance device. Mutual insurance is captured by the job security element (jsec) and also integrates the knowledge that firms in general benefit from inter-temporal transfer of worked hours (as e.g. from exemption from overtime pay). In our context proper incentives are likely to be a prerequisite for the insurance mechanism. We will cover this circumstance in the payment vector: $\mathbf{w} = \left[w_{eff}, 1_{\text{ibp}} \right]$.

In fact, working time accounts as a mutual insurance device address the most common type of working time accounts in the German labor market practice. A corresponding general definition is given:

DEFINITION 5 (INTENSIVE MARGIN ADJUSTMENT: WORKING TIME ACCOUNTS AS MUTUAL INSURANCE DEVICE): *If working time accounts explicitly insure employees against unemployment from shocks in random job destruction, then employment security* jsec *is effective. Working time accounts as a mutual insurance device* wta_mi *write as*

[10] Property (v) relates to the "no-layoff clause" mentioned in the introduction.

$$\text{wta\_mi} := \left\{ \begin{pmatrix} w_{eff} \\ 1_{\text{ibp}} \end{pmatrix}, \mathbf{h_\mu}, \mathbf{\Delta h_t}, T_{ref}, \text{ jsec} \right\}$$

with incentive compatible wage w_{eff} *representing the appropriate incentive device to e.g. meet effort standards. The indicator variable* 1_{ibp} *takes value 1 if informal bonus payments arrangements are in place. Technically spoken, informal bonus payments* ibp *allow firms in principle to add further stochastic performance related components to the basic incentive device* w_{eff} *, for example, in order to control for idiosyncratic worker characteristics.*

Expected working time $\mathbf{h_\mu}$ captures component (ii) and is related to the expected profit maximizing output level. Further, the maximum limit of hours credits/debits[11] $\mathbf{\Delta h_t} > 0$ can be accumulated on a daily, weekly or alternatively defined basis and coincides with component (iii). Of course, $\mathbf{\Delta h_t}$ might be restricted by law. With h_t as realized worked hours in a given period, the actual amount of hours transfer δh_t either matches the desired value or is identical to the contracted limit $\mathbf{\Delta h_t}$. Formally, δh_t is given by $\delta h_t = \min\left[\Delta h_t, \left|h_t - h_\mu\right|\right]$.

Component (iv) is specified by the time horizon T_{ref} over which positive and negative hours transfers balance on a mandatory basis. Reference periods may vary from a few months up to several years. For example, annualized hours contracts comprise a reference period of 12 months. Explicit settlement of a reference period assures enforceability of the insurance device. Moreover, re-adjustment for systematic changes in underlying variables is not ruled out a priori. Finally, employers commit to a "no-layoffs" clause in response to temporary negative demand shifts or comparable shocks, where jsec represents the obligation of providing employment security, an obligation that is usually settled in collective agreements.[12] We will see that this combination of (random) transfer of worked hours and job security is crucial for the success of mutual insurance in the labor market.

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[11] As long as random separation will be symmetrically distributed, the limits for hours credits and debits will coincide.

[12] Chung et al. (2007) and Kouzis/Kretsos (2003) give overviews. Case studies of the negotiation of *Collective Agreements on Employment Security and Working Time Accounts* can be found in Croucher/Singe (2004).

4.2.2. Adjustment Potential of Working Time Accounts

Let random demand shocks drive adjustment needs of firms. Let us further focus on the following two polar cases of potential adjustment: As polar case one, consider instantaneous adjustment of production (cf. capability of costless buffering or quantity imitating price adjustments) which is discussed in this subsection. As polar case two consider the case of binding adjustment inertia of production (cf. economic crisis or binding non-storability with price-rigidity apply). The latter case will be discussed in the subsequent subsection.

In principle, polar case one addresses an adjustment context corresponding to a white noise random job destruction shock. Using the concept of mean preserving shrink, we obtain

PROPOSITION 1 (INSTANTANEOUS ADJUSTMENT): *When costless buffering or perfect price adjustment are feasible, contracts comprising working time accounts second-order stochastically dominate their counterparts without time banking systems.*

PROOF: As working time accounts reverse any temporary demand shift up to the bound $\Delta h_t > 0$, employment contracts comprising working time accounts definitely alter the shape of the related profit distribution. Inter-temporal transfer of worked hours shifts probability mass from the tails to the center of the uninsured distribution (the olive area in Figure 1b depicts the corresponding probability mass that will be shifted to the mean). Statistically speaking, compared to the baseline scenario in Figure 1a, the frequency of the mean is boosted, while expected profits do not alter – eventually implying a less risky distribution of profits. Figure 1b also informs about the composition of the *new* probability density at the mean. □

4.2.3. Economic Crisis and Working Time Accounts: Superior Adjustment Potential

Let us now integrate the world crisis. The impact of the Great Recession might be reflected by a half-normally distributed disturbance term $\upsilon_t \sim \mathrm{N}^{+}\left(0, \sigma_{\upsilon}^{2}\right)$. Hence, the first two moments (in absolute terms) are given by $E(\upsilon_t) = \sqrt{2/\pi} \cdot \sigma_{\upsilon_t}$, and $V(\upsilon_t) = \left(\pi - 2/\pi\right) \cdot \sigma_{\upsilon_t}$. With this, we can derive

PROPOSITION 2 (NON-STORABLE GOOD): *During economic crisis or when buffering or price adjustments are ruled out (e.g. because of quality standards), any working contract comprising working time accounts first-order stochastically dominates the counterpart contract without inter-temporal hours transfers. Firms have strict incentives for the introduction of working time accounts as a mutual insurance device.*

PROOF: In polar case two, a transfer of worked hours modifies shape and expected value of the related profit distribution, thereby introducing a mean augmenting shrink (DEFINITION 3). Probability mass (compare the olive area in Figure 1d) is shifted from the tail to the censoring point of the uninsured distribution, and frequency of the censoring point increases. In Figure 1d this is labelled by "with wta" Thus, with binding adjustment inertia as in the Great Recession, working time accounts as mutual insurance device raise expected profits and first-order dominate alternative adjustment measures (baseline scenario is depicted by Figure 1c). □

Since the two discussed polar cases treat the upper and lower bound of adjustment capabilities, the dominance of risk sharing in working time accounts is proven.

5. Discussion and Conclusion

Labor adjustment at the intensive margin inaugurates the scope for mutual unemployment and surplus insurance at the firm level. If the adjustment pattern of hours is traced in individual working time accounts and, in addition, employment guarantees with respect to demand driven allocative shocks are given, this firm-level instrument of labor market policy establishes a self-enforcing institution of mutual insurance, even capable to tackle crisis.

Mutual insurance refined contracts comprising working time accounts are self-enforcing, since for firms and workers the respective hours transfers are just mirror inverted, and, by construction, working time accounts imply integration of counter-balancing risks. In fact, a reciprocal threat position is assembled, and breaching of contracts would be meaningless, since the benefits that have been proven in the Propositions rely on a bilateral functioning of the transfer mechanism. The related formal proof of renegotiation-proofness and spot-implementability is derived by Chiappiori et al. (1994). The authors discussed motivation and double-sided commitment under repeated moral hazard, and have shown that renegotiation-

proof and self-enforcing employment relations that provide long-term incentives are enacted if remuneration of employees is characterized by random savings in termination contracts.

As the magnitude of hours that are saved (i.e. hours credits provided by an employee) or are invested (i.e. hours debits/withdrawal by an employee) is random according to random shocks and turbulence, the "calculated" hourly wage varies with every movement in the working time account. The deviation between "normal" hourly wages and "calculated" hourly wages in working time accounts is equivalent to employees random savings in a given period as developed in Chiappiori et al. (1994). As necessary and sufficient for renegotiation-proofness, this deviation constitutes a random variable.

To conclude, there seems to be reasonable evidence that the well-established presence of the labor market institution *working time accounts* in Germany substantially contributed to the emergence of the jobs miracle in the Great Recession.

Let us consider whether working time accounts as an LM adjustment institution with mutual insurance are also capable to fix major drawbacks of short time work schemes. In principle, there are two major critiques: (i) inefficient reduction of working hours during crisis and free-riding application for subsidies, and (ii) insider power combined with jobless growth. With hours flexibility in working time accounts, critique (i) is ruled out by construction. Here, table 2 provides further empirical evidence for co-existence. Critique (ii) is relevant, since job-reallocation is smoothened by working time accounts. But this potentially negative effect might be offset by frictionless adjustment in combination with maintenance of knowledge capital and efficient recruitment. Future empirical work on the relative growth-employment-dynamic paths of firms with and without working time accounts will provide further evidence. First anecdotal evidence is in favor of a job-creation recovery hypothesis within the working time accounts regime, since employment and hours balances in respective accounts have regained momentum and growth from 2009 to 2010, indicating a sustained jobs miracle in the aftermath of crisis.

Last not least, in contrast to most of the OECD countries, and also in contrast to fast growing economies youth unemployment in Germany also decreased and the relative rate of youth and adult unemployment is the most favorable among OECD and G20 members.

Future research will integrate the working time accounts approach with the stimulus and asset accumulation approach in order to identify potential complementarities or trade-offs.

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Appendix

Figure 1: Labor market adjustment at the intensive margin:
Two-sided buffering of labor market risks through probability mass shifts
-- pdf of the deviation π between expected profits and realized profits --

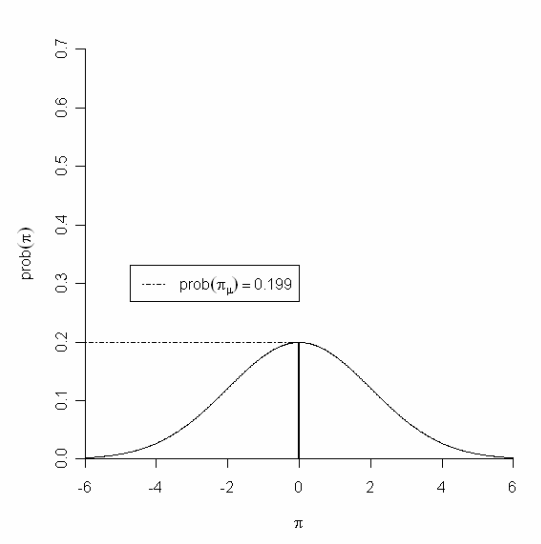

Fig. 1a –Baseline scenario *perfect adjustment*:
Deviation π of feasible profit
from deterministic profit maximum

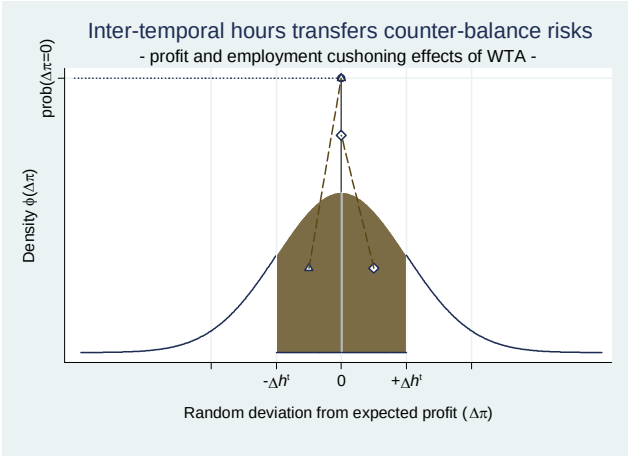

Fig. 1b –Working time accounts (WTA) *second order* stochastically dominate reference contracts
– proof: mean preserving contraction –

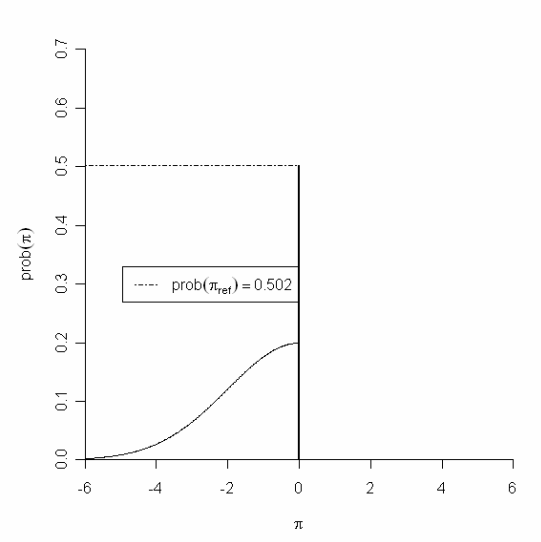

Fig. 1c –Baseline scenario *adjustment inertia*:
Deviation π of feasible profit
from deterministic profit maximum

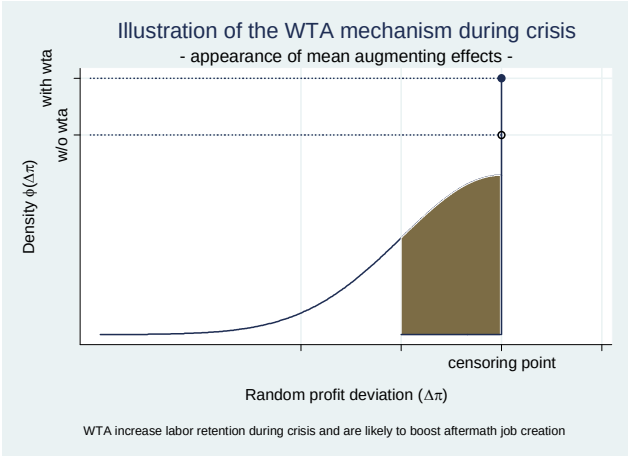

Fig. 1d –Impact of crisis & Great Recession:
WTA *first order* stochastically dominate
alternative adjustment measures
– proof: mean preserving contraction –