Great Recession and labor market anomalies: The German labor market miracle revisited from a decision under risk perspective

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ABSTRACT

The phenomenon of the so-called German labor market miracle is the point of departure for our analysis. Yet a consistent theoretical explanation of jobs safeguarding during the Great Recession is lacking, important ad-hoc hypotheses exist. For example, Burda/Hunt (2011) are intuitively convinced that using labor adjustment along the intensive margin through working time accounts is a key element in the puzzle.

The major objective of this paper is to close this research gap. Therefore, we introduce a formal model of adjustment practice *working time accounts as a mutual insurance device* in the context of – compensated – work sharing. As an extension and generalization of the quite well-known labor market practice of work sharing, working time accounts enable adjustable sharing coefficients, while holding remuneration constant, irrespective actual working time positively or negatively deviates from standard contracted hours. Such generalized work sharing is achieved via intertemporal shifting of hours worked by an employee, with every single transfer being recorded in a time banking system as either a time credit granted by the employee (sharing coefficient greater 1) or as an accumulated deficit hour the employee owes to the firm (sharing coefficient below 1). In industrial and workplace relations practice, intertemporal shifting of working hours in working time accounts systems often interferes with its technical equivalent of transitory overtime work with compensatory time-off in lieu.

This paper contributes to theoretically resolving the remaining jobs safeguarding puzzle and derives a model of labor adjustment based on well-defined probability mass shifts and application of stochastic dominance rules. The associated solution is characterized by features of a silver bullet for employment. This paper aims to extend analysis of the insightful article by Burda/Hunt (2011). In sum, our model not only explains the remaining puzzle of missing employment decline in the Great Recession, but also helps to fill the research gap on missing employment increases due to reluctant hiring behavior in the preceding expansion. Consequently, we link different phases of the business cycle and explicitly relate them to working time accounts driven labor market effects. In fact, working time accounts are capable to eliminate antipodal labor market risks. Moreover, when facing unprecedented downturn they even impose a mean increasing decrease in risk. Therefore, we conclude that there are lessons to be learnt from German labor market practices and industrial relations.

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I. INTRODUCTION

The global financial and economic crisis 2008-09 hit economies almost simultaneously with severe impact on output ranging from strong negative growth in most OECD countries to substantial slowdown in the BRICS countries (Brazil, Russia, India, China, South Africa) and has been accordingly recognized as the Great Recession. This paper contributes by utilizing the fact that the worldwide occurrence of a sharp drop in demand did implement a natural experiment on labor markets, where we attribute treatment assignment to heterogeneity of countries concerning their labor market institutions. Despite not directly referring to the treatment assignment character, recent OECD research also emphasizes a likely key role of institutions for cross-country differences in labor market dynamics in response to the world crisis (OECD (2012a) and Gal et al. 2012).

In fact, this paper's analysis is motivated by unprecedented labor adjustment evidence, in particular by the phenomenon of massive labor hoarding during crisis with retaining of job slots in firms and sustaining of household's disposable income. The alleviated transmission of the massive global downturn to labor input, measured by responsiveness of employment and unemployment to output shocks, was not expected by economists. The muted responsiveness phenomenon challenges both economic theory and so far undisputed empirical principles like Okun's law (Okun (1962), Cazes/Verick 2011). The lack of layoffs has been enormous, and the corresponding jobs retention effect has attracted much interest in the scientific discussion as well as in the political debate. Various empirical papers aim to identify reliable driving forces for the amazing labor market performance (Islam/Verick (2011a), Elsby et al. (2010), CESifo (2010), Arpaia/Curci (2010), Cahuc/Carcillo (2011), Bell/Blanchflower (2011, 2009), Boeri/Brueckner (2011), Hijzen/Venn (2011), Burda/Hunt (2011), Gal et al. 2012). In sum, research is still inconclusive with respect to explanatory factors, though consensus is reached concerning the fact that crucial parts of the cushioning mechanism remain unclear. In terms of the strength of jobs safeguarding effects cross-country differences have become evident, definitely pointing to an exceptional outcome in the German labor market that virtually absorbed the negative output shock (Burda/Hunt (2011), ILO (2011b), OECD (2010a, 2012a), Boysen-Hogrefe/Groll (2010), Bellmann/Gerner 2012), raising the question of what has motivated firms to retain workers.

With the natural experiment character of the Great Recession and initial recovery as our point of departure, our objective is to develop a consistent model of crucial determinants of the above labor market anomaly, which has been subsequently denoted as the labor market miracle or jobs miracle (introduced by Krugman (2009) and Möller 2010). Based on the overwhelming extend of the muted response in Germany, we suspect the idiosyncratic industrial and workplace relations context as a candidate of being a driving force of labor market adjustment dynamics. In particular, we raise the question whether Germany's unique pattern of the social partners matters in disentangling the employment dynamics puzzle.

This paper's results show that the key to unraveling the jobs miracle is embodied in disentangling that mechanism, which enables disposable income to remain almost stable over a number of periods, thus weathering shocks affecting output and demand. According analysis integrates preceding expansions for a more comprehensive picture of intensive margin adjustment versus extensive margin adjustment and provides new insights on jobs oriented strategies versus growth oriented strategies of economic policy. In this context, we connote with adjustment dynamics industry- and company-level adjustment behavior as well as related aggregates referring first to the pre-crisis time span, second to initial response during crisis and third to subsequent recovery periods.

This paper adds theoretically with a stochastic approach. In this approach we disclose a mechanism that turns out to be fundamental in the menu of instruments for labor market cushioning and safeguarding of jobs. We introduce a probability mass shift model that clarifies that a particular option from the toolkit for flexible working hours arrangements imposes a mean preserving decrease in risk on disposable income and employment (relations) over the business cycle. This particular option has been assigned the identifying term *working time accounts.* Interchangeably used are expressions like *working hours accounts* or *time-saving accounts* (Carstensen (2001), OECD 2012a). Our results suggest that important lessons might be learnt from the natural experiment approach and its outcomes, since working time accounts obviously point to a more general mechanism responsible for above average labor market performance during crisis and recovery, eventually mitigating business cycle impacts.

In labor market practice this option "allows employers the freedom to increase hours above standard hours with no immediate payment, as long as hours are deduced at some future time with no cut in take-home pay, leaving hours at the standard when averaged over a window of

time. The number of hours the employer owes the worker, which may be negative, is tracked in the worker's working time account." (Burda/Hunt 2011, 299). The term working time account (Arbeitszeitkonto) refers to the distinguishing feature of tracking individual hours deviations in an employee-unique account. The phrase *Arbeitzeitkonto* was originally assigned to some pilot arrangements in Germany in the early 1990s, which extended flexitime schemes beyond daily flexibility. Subsequently, the EIRO network of the European Union adopted the term and initially located working time accounts in the annualized hours sphere (Schulten (1998), Kouzis/Kretsos (2003a), Eurofound 2012).

As a labor market institution of adjustment along the intensive margin a given working time accounts system determines the rules for intertemporal shifting of worked hours.[1] The German experience with working time accounts shows that associated arrangements are typically negotiated between management and employee representatives at the company-level or covered by collective agreements as are potential accompanying measures, among them employment security commitments (e.g. Seifert/Massa-Wirth (2005), Zapf 2012). This paper shows that working time accounts that have been institutionalized by the social partners as a mutual insurance device, effectively establish mutually beneficial effects of intertemporal shifting of working hours, among them internal labor market cushioning with human capital maintenance and profit smoothing. Moreover, such mutual insurance devices exhibit the property of being invulnerable to renegotiation. Renegotiation-proofness of working time accounts is a critical success factor if intertemporal shift of working hours is practiced in environments where an efficiency wage mechanism is effective.

Despite the Great recession has motivated an extensive debate on supporting factors of recent labor market evidence and numerous empirical papers on labor markets during crisis and recovery have been written, analysis of theory-developing approaches is almost absent and usually confined to proposing ad-hoc hypotheses. For example, Burda/Hunt (2011) are intuitively convinced that the use of labor adjustment at the intensive margin through working time accounts might constitute an important element in the puzzle: "The missing employment increase in the boom accounts for 41 percent of the missing employment decline in the recession, and … Although we cannot account for about 40 percent of the missing decline in

[1] Throughout the paper we use the terms *intertemporal shifting* and *intertemporal transfer* interchangeable.

employment, we believe that a personnel management tool known as working time accounts, which became increasingly common in labor union contracts over time, played a role in moderating the labor market downturn." (Burda/Hunt (2011, 275; 277)).

Altogether, a theoretical explanation of the observed labor market miracle is still lacking. Similarly, a formal model of working time accounts as an adjustment institution is missing. The major objective of this paper is to close this research gap. Our solution will be located in the broader context of – generalized – work sharing. As an extension of the well-known labor market practice of (temporary) work sharing with proportional remuneration change, working time accounts contracts extend to flexible sharing coefficients, while holding remuneration constant. Flexible work sharing coefficients cover values less than one as well as values greater than one. In other words, while worked hours vary with the cycle, disposable income is stable. Hence, every single deviation between an individual employee's current and standard working hours is recorded as a time transfer in a time banking system as either a credit hour or a deficit hour, depending on whether the sharing coefficient is chosen above or below one. Any time transaction captures a one-to-one match between a worker and his or her working time account. Notice that transitory overtime work with contracted entitlement to compensatory time-off in lieu is in fact equivalent to intertemporal transfer of hours in working time accounts.

This paper contributes to theoretically resolving the remaining puzzle and derives a model of labor adjustment based on well-defined probability mass shifts and application of stochastic dominance rules. The associated solution is characterized by features of a silver bullet for employment. Basically, this paper can be interpreted as a formal extension of the insightful article by Burda/Hunt (2011). In this context, our model not only explains the remaining puzzle of missing employment decline during crisis, but also helps to fill the research gap on missing employment increase due to reluctant hiring behavior in the preceding expansion, even independently from pessimistic expectations. Our approach links different phases of the business cycle and explicitly relates them to working time accounts driven effects. In fact, working time accounts eliminate considerable amount of labor market risk. Moreover, when facing unprecedented downward shocks they even impose a mean increasing decrease in risk.

Corresponding research questions are: 1. Which mechanisms have cushioned the German labor market during the Great Recession? 2. Which adjustment measures have been rather unique to Germany? 3. Are they mutually beneficial to firms and employees (and to the society

at all)? 4. If so, what can be said about enforceability and renegotiation-proofness, i.e. how can we implement such mechanisms in appropriate national, collective or firm-level settlements? Further, as a perspective for future expansion and contraction as well as for economies that did not technically enter a recession since 2008, it might be fruitful to inspect potential lessons to be learnt from German experiences. In fact, general applicability is an issue in order to identify forward-looking instruments supportive of jobs oriented policy-making that in turn is increasingly recognized as a potential key success factor for globally integrated economies.

The remainder of this paper is organized as follows. The next section presents related literature. Section III. summarizes important stylized facts, introduces a new taxonomy of adjustment practices, and discusses some recent and influential hypotheses. Section IV. derives the stochastic model to disentangle the German labor market miracle. Section V. introduces the institutional perspective of working time accounts and discusses crucial properties of the solution like renegotiation-proofness. It links the model results to empirical evidence and assesses the explanatory power of working time accounts in the labor market miracle context. Section VI. summarizes and concludes. The main conclusion will be that working time accounts establish a promising adjustment institution that is likely to be applicable in various economies, provided that aspects of industrial and workplace relations are taken care of.

II. Related Literature

This paper is located in the triangle of (i) empirical literature with focus on labor markets and cycle research including the work that particularly addresses global employment dynamics in the Great Recession and beyond, (ii) theoretical contributions from contract theory and risk theory, and - as we motivate the discussion by elaborating a country-specific example - (iii) research that explicitly addresses the German labor market in a globalized world, including survey results on working time accounts practice. Moreover, the general context of new institutional economics applies, since working time accounts systems interfere with incentive devices, which originate in asymmetric information and repeated moral hazard.

This paper is first related to research that deals with the Great Recession in general and discusses the relationship between GDP growth, employment and unemployment dynamics, labor market resilience, and suspected deviations from Okun's Law (Elsby et al. (2010), Katz (2010), Cazes/Verick (2011), IMF (2010), OECD 2012b). Further, findings on adjustment

dynamics and policy options from well-received series or overview papers, from specific volumes of periodicals as well as from economic outlooks provide important background information and points of departure for our study: Bell/Blanchflower (2009), CESifo (2010), ILO (2012, 2011a, 2011b, 2009), Islam/Verick (2011a), the special topical issue "Labour Market Consequences of the Economic Crisis" of the Nordic Economic Policy Review (2011), and OECD (2012a, 2010a, 2010b, 2009).

Since this paper contributes to the development of appropriate means for labor market adjustment along the intensive margin and intends to prove the superiority of intensive margin adjustment in order to internalize risk, work on intensive margin adjustment of labor vs. extensive margin adjustment relates to our research (for an overview cf. Haskel et al. 1997). Nickell (1978) is related to our paper through his discussion of evolving adjustment patterns over (product life) cycles. The study of Abraham/Houseman (1994) relates to our approach, as it shows that job security need not to undermine adequate hours flexibility.

Policy circles – especially in Germany – sometimes favor the use of short-time work as explaining the emergence of a jobs miracle. In fact, legislation on short-time work confirms a jobs oriented strategy of politics. In the face of crisis, short-time compensation has been introduced, modified, or extended in many OECD countries with only a few exceptions like Australia or Sweden (Islam/Verick 2011b, Cazes et al. 2011). Basically, such programs have a long tradition and share the common objective of encouraging labor hoarding, i.e. retention of specific human capital, by subsidizing wage payments and/or social security contributions (e.g. OECD 2009, 2010b). One strand of recent research on short-time work confronts this rather speculative hypothesis with empirical evidence with less satisfactory results: Boeri/Brueckner (2011), Cahuc/Carcillo (2011) and Hijzen/Venn (2011) find evidence that short-time work contributed to safeguarding permanent employment but also point out embedded shortcomings like free-riding or reallocation inertia. Since short-time work schemes have been supported by a large number of OECD governments, their impact is far from being exclusive to Germany. Moreover, while being inherent part of the political debate on a silver bullet for employment, there is no evidence that utilization of short-time work in Germany in the Great Recession deviated from respective usage patterns in prior recessions (Boysen-Hogrefe/Groll (2010), Burda/Hunt (2011), Haltiwanger 2011). Taken together, short-time work use and

corresponding legislation changes do not satisfactorily clarify the employment puzzle, leaving the question open of what explains the German labor market miracle.

Other related work is concerned with international differences in employment protection legislation and stresses the linkage to automatic stabilizers that generally mitigate adverse effects of cyclical variation. For example, Stiglitz (2009) proposes the hypothesis that restrictive labor market legislation and employment protection regulation in Germany could have operated as an automatic stabilizer on labor markets with positive long-run effects, since firms were almost obliged to maintain human capital, irrespective of their preferences. Despite intuitively appealing, empirical work with OECD employment protection indices weakens this argument (Möller (2010), Gal et al. 2012). Eventually, the authors point out that differences in employment protection legislation hardly account for differences in employment dynamics at the extensive margin and conclude that employment protection legislation neither resolves the observed labor market miracle. Subsequent studies emphasize the relevance of institutional specificities, and also examine the interplay of labor demand and labor supply in industrial and workplace relations (Bellmann/Gerner (2012), OECD 2012a). Admittedly, firms and the so called social partners (unions, works councils) actively favored the decision for employment retention. According to anecdotal and descriptive evidence, firms voluntarily refrained from layoffs, often backed up by multifaceted collective agreements (pacts for employment and competiveness, e.g. Seifert/Massa-Wirth 2005).

The literature on risk, insurance and contract theory that is relevant for the approach presented here is twofold. First, the set-up of the theoretical model is rooted in the seminal contributions to analyses of risky prospects and stochastic dominance by Hadar/Russel (1969), Hanoch/Levy (1969), and Rothschild/Stiglitz (1970) as well as in surveying work by Levy (1992, 2006) and Eeckhoudt/Gollier/Schlesinger (2005). Their insights on probability mass shifts are the key to the proofs in section IV and V, where we show that intensive margin adjustment of employment contractually settled in working time accounts eliminates antipodal risks (Proposition 2, Definition 4). We also show that working time accounts establish a firm-level adjustment institution that provides mutually beneficial insurance between firms and employees (Proposition 4, Definition 5). With Levy (2006) as point of departure, we further show that withdrawal of surplus hours from working time accounts in response to the rather unpredicted drop in demand in the Great Recession, imposed a mean increasing decrease in

risk to which we can apply the first order stochastic dominance rule (Propositions 3 and 4). Second, work on self-enforceability and renegotiation-proofness of contracts is related to our approach, since mutuality of benefits requires renegotiation-proofness of associated contracts. Here, an article by Chiappori et al. (1994) is closely related, as their crucial results on constrained savings directly apply, making the respective proof for working time accounts as a renegotiation-proof institution of mutual insurance between firms and workers straightforward (Proposition 4).

Despite the discussion in this paper concentrates on the labor market cushioning, i.e. jobs and disposable income safeguarding, effects of intertemporal transfer of working hours in working time accounts, we also consider important context factors. Whereas subsidies like short-time compensation in principle lower labor costs, our model explicitly addresses the value of continuing the employment relation, e.g. benefits from maintaining specific human capital or sufficient levels of motivation. Here, our work is related to findings from labor discipline and implicit contract models. Correspondingly, our institutional set up of working time accounts integrates an efficiency wage mechanism vector in the style of Shapiro/Stiglitz (1984), augmented by insights from MacLeod/Malcomson (1989) and Lemieux et al. (2009) on idiosyncratic bonuses that account for interpersonal heterogeneity.[2]

From a legal-institutional perspective, recent survey studies on working time and working time flexibility, among them time banking systems, are related to our work (Chung/Tijdens (2012) Chung et al. (2007), Kerkhofs et al. 2008), as well as country-specific studies referring to the German economy in a global context, including EIRO-surveys (European Foundation for the Improvement of Living and Working Conditions: Eurofound (2012, 2010)). Also related to our study is empirical work that treats the institutions and the firm level as key elements in the German labor market puzzle (Reisenbichler/Morgan (2011), Möller (2010), and Crimmann et al. 2010). Seifert (2004), Seifert/Massa-Wirth (2005), Groß (2010), and Groß/Schwarz (2007, 2010) are highly relevant as they thoroughly study institutional details and dynamics of

[2] While being well beyond the scope of this paper, it can be shown that working time accounts, indeed, provide incentives for private unemployment insurance in the shirking model, and therefore address major critique of the Shapiro-Stiglitz approach (cf. Bull 1985).

working time accounts arrangements, including their role in the German industrial and workplace relations system.

The research most relevant to our contribution is recent analyses by Michael Burda and Jennifer Hunt who explicitly address the research gap our paper intends to fill (Burda/Hunt (2011), including the comments by Elsby (2011) and Haltiwanger 2011). Here, we add with a theoretical model that moderates the pace of job creation and job destruction, irrespective of factors like pessimistic expectations or lack of confidence. The explanation developed in this paper simultaneously covers weak hiring behavior during expansion as well as unprecedented employment retention during crisis.

The next section continues with stylized facts, drawn from IAB-, WSI-, ISO/sfs-, OECD-, ILO-, and IMF-sources.[3] The stochastic model will be developed in section IV, while section V links working time accounts as a firm-level institution of mutual insurance to the German labor market miracle, eventually integrating the fact that this labor market practice is privately negotiated and contracted between the social partners.

III. STYLIZED FACTS

This section looks at employment adjustment along the intensive margin in more detail. On a descriptive basis, we motivate our fundamental proposition, namely that working time accounts played a key role in the German menu of labor adjustment practices during the Great Recession and its aftermath through their inherent capability of reciprocally insuring employees and employers against unemployment and vacant job slots. Taken together, we will argue along the first three research questions stated in the introduction: Which mechanisms cushioned labor markets in the Great Recession? Which mechanisms are rather unique to the German labor market? What can be said about mutual benefits for employers and employees?

The section is organized as follows: Subsection III.A. summarizes insights from existing studies on labor market dynamics during crisis. Since the cushioning role of short-time work is

[3] The stylized facts on annual working time dynamics, description of methodology, and important descriptive information on working time accounts schedules are retrieved from the following data sources and documents: IAB Establishment Panel Survey, IAB working time and volume of work tables, ISO/sfs Employer Survey on Operating Hours, WSI Works Council Survey; OECD (2012b), Zapf/Brehmer (2010), Fuchs et al. (2012), Zapf (2012), Zapf/Herzog-Stein (2011), Bach/Koch (2003).

likely overemphasized in the political debate, we also report crucial contradictory econometric evidence. Subsequent subsection III.B. provides a system to categorize labor market dynamics. In Table 1 we display a brief description of the main channels of labor adjustment to external shocks and then focus on the variation-of-hours channel, hence, intensive margin adjustment, while further distinguishing between intensive margin adjustment for purposes of absorbing shock or muting cycles, on the one hand, and structural reallocation of working time as e.g. implemented by increasing share of part-time jobs, on the other hand (Table 2). As revealed by calculations according to the IAB working time and volume of work measurement concept (Bach/Koch 2003), hours changes for muting purposes accounted for about 96 percent of total decline in hours per employee from 2008 to 2009 in Germany (cf. Fuchs et al. 2012). Using this insight, we introduce a new taxonomy of adjustment instruments for the shocks mitigating regime (Table 3). Subsection III.C. turns to German adjustment practice. Using the taxonomy from Table 3, Table 4 captures corresponding empirical evidence; it decomposes the change in annual hours per worker and documents the relative contribution of the associated adjustment practices defined in the taxonomy. Table 4 covers both labor hoarding in the Great Recession (2008-2009) and increases in hours per worker in the aftermath of recession (2009-2010). Since data are supportive of the key role conjecture of – reversible – intertemporal shifting of working hours, subsection III.D. informs about coverage of working time account schemes in Germany, crucial institutional characteristics, and per-account cushioning effect during crisis. The section concludes with some remarks bridging to the major contribution of this paper, hence, the probability mass shift model of labor adjustment.

III.A. Intensive margin adjustment during the Great Recession

The Great Recession and subsequent labor market dynamics have been driven by a global collapse in demand. In contrast to past recessions the timing of downturn initiated a rather simultaneous entry of the world economy into a sharp drop of GDP growth with negative rates in almost all OECD countries, and substantial slow-down in BRIC countries, like China and India, where expansion rates drop to a corridor between five and nine percent (ILO 2011a). Observed patterns of employment adjustment and unemployment dynamics seem to deviate from former arrangements and outcomes.

With respect to cyclicality of labor markets, Okun's Law has long been confirmed as a fundamental empirical relationship pointing out that changes in unemployment accompany changes in output, potentially with a lag (Okun 1962). The Great Recession, however, reported remarkable deviations from rather stable Okun coefficients, ranging from no longer detecting the statistical relationship to exceeding familiar confidence intervals and even sign reversal (Elsby et al. (2010), Katz (2010), IMF (2010), Cazes/Verick (2011), OECD 2012a). Moreover, in response to the negative shock, European economies practiced labor hoarding to a large extend compared to e.g. the U.S. economy.[4] Labor hoarding represents downward adjustment of labor along the intensive margin with the objective to stabilize existing jobs and to moderate rises in unemployment (Arpaia/Curci (2010), OECD (2009, 2010b), Dietz et al. 2011).[5] It comes at the price of decreases in productivity.

Figure 1 plots the percentage point change in unemployment rate against real GDP growth across OECD countries, thereby elucidating the particular position of the German labor market (OECD 2012a,b). The figure reflects the broad evidence for muted labor market response but also the existence of cross-country differences in average adjustment behavior. With the exception of Spain, evidence is supportive of labor hoarding.

INSERT FIGURE 1 ABOUT HERE

As can be seen in the left part of the figure, during crisis the enormous loss in real GDP was accompanied by just moderate increases in unemployment (left y-axis, orange bullets). As can be depicted from the right part of the figure, initial recovery is accompanied by muted –

[4] According to Hamermesh (1993, 205), labor hoarding "... can be defined as a less than proportionate decrease in worker-hours in response to a negative demand shock.", and further: "... hoarding labor, as it adjusts to negative shocks and 'sweating labor,' deriving extra output from its work force, as it adjusts to positive shocks" (p. 212). Responsible for the fact that firms tend to adjust hours before they adjust employment are (quasi-) fixed adjustment costs of employment like recruiting, training, and separation (Oi 1962).

[5] In general, adjustment patterns of production with impact on labor input can be categorized into two sets (cf. Haskel et al. 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.

and potentially lagged – reduction of unemployment (right y-axis, blue bullets). The horizontal dash-dot line denotes the respective OECD-average of unemployment rate change during crisis and initial recovery, thus the right axis has been rescaled for a visual match of OECD-averages of labor market dynamics (sharing one horizontal line). Notice that the mean percentage point increase in unemployment during crisis amounts to 2.3, whereas during initial recovery it is given by 0.6. Correspondingly, the vertical dash-dot lines denote crisis and initial recovery averages in real GDP growth: output decline of about 6.4 percent in crisis and growth of about 5.9 percent with recovery.

The distinctive role of the German labor market during both crisis and recovery becomes evident if we compare the D bullets with corresponding OECD-averages. While being more severely affected by the decline in real GDP, the German labor market more than absorbed the output shock: Over the four quarters of the duration of crisis and in contrast to all other countries, Germany's unemployment rate slightly decreases, contradicting Okun's Law. In 2009, Paul Krugman introduced the term "Germany's jobs miracle" in his role as OP-ED columnist in the NY Times to recognizing the success of accompanying jobs oriented labor market policies (Krugman 2009). The picture persists during recovery with recognizable levels of job generation. In sum, the German labor market miracle seems to be relevant and a better understanding of the underlying factors is expected to provide important insights for potential lessons in the context of quality of labor and maintenance of human capital.[6]

Especially in the political debate on jobs safeguarding evidence, short-time work has attracted much interest as a well-appropriate labor hoarding practice, and quite a few politicians are convinced that short-time work programs have acted as a silver bullet for employment. In line with this, labor market legislation has put some emphasis on short-time work schemes and allowances during crisis, and in some cases these have been supplemented by extended unemployment benefit programs (cf. Cazes et al. 2011).

Despite the use of short-time work programs in fact helped to preserve permanent jobs, recent empirical evidence also reveals severe shortcomings like incentives for free-riding and

[6] Further, evidence of decreased long-term unemployment in Germany and declining youth unemployment rates associated with falling per adult ratios of youth unemployment is worth to be mentioned (Scarpetta et al. (2010), Bell/Blanchflower (2011), Bell/Blanchflower 2009).

inferior post-crisis adjustment (e.g. Cahuc/Carcillo 2011, Hijzen/Venn 2011). According to Boeri/Brueckner (2011), short-time work programs as a means to adjust labor along the intensive margin is not as supportive as broadly recommended. Their data show considerable deadweight costs of short-time work usage, including weak jobs safeguarding performance, crucial dependence on institutional framing, and vulnerability to free-riding. To summarize, likely drawbacks of programs to encourage use of short-time work schedules in order to stabilize employment are as follows: First, they provide incentives to apply for short-time work subsidies also for such job slots that would have been preserved anyway. Second, as any subsidy, short-time allowances tend to initiate counter-productive effects, thus distorting pressure for efficient reallocation of tasks, in the worst case implementing jobless recovery. In addition, usage of short-time work programs in the Great Recession in Germany has been very similar to prior recessions (Boysen-Hogrefe/Groll (2010), Burda/Hunt (2011), Haltiwanger 2011). To conclude, the explanatory power of short-time work for emergence of the German labor market miracle a la Krugman (2009) is definitely overstated.

With respect to reported differences in the adjustment behavior of labor input, chapter 2 of the 2012 OECD Employment Outlook emphasizes the importance of response heterogeneity with a distinctive role of institutions and coordinated bargaining (OECD 2012a,b). In fact, competing instruments of intensive margin adjustment have been practiced during crisis, presumably as a substitute for short-time work (Zapf/Herzog-Stein (2011), Fuchs et al. 2012). In particular, working time banking systems and temporary work-sharing arrangements at the establishment level contributed to labor hoarding in Germany and substituted short-time compensation programs (Crimmann et al. 2010). Further, according to the European Company Survey 2009 (Eurofound 2010), Germany is rather unique in the dissemination of working time banking systems as well as in the length of experience with working time accounts as a labor market practice (cf. Groß/Schwarz 2010 and Table 5 for an elementary description).

With the objective of an intuitive access to the interplay of several adjustment mechanisms as well as to elucidate their comparative relevance, we continue by categorizing labor market dynamics into its major channels, followed by some structuring remarks, eventually providing a breakdown of labor hoarding in Germany into its main components. As core content of the subsequent subsection we develop a taxonomy of intensive margin adjustment practices that share the objective of muting cyclical variation and shocks: the shocks mitigating regime.

III.B. Taxonomy of labor market dynamics: The shocks mitigating regime

With the unexpected drop in demand as our point of departure let us look at Table 1 that addresses labor demand dynamics in a stochastic environment. Technically speaking, the value of the marginal product of labor (VMPL) varies with related shocks and over the cycle. In principle, two channels of labor adjustment are relevant. Either wages could adapt to changing VMPL by accordingly adjusting wages, or labor utilization could be altered via quantitative adjustment. Whenever an efficiency wage mechanism is effective, however, adjustment of wages causes counter-productive effects. In other words, we expect downward wage rigidity to prevail and empirical evidence is in fact supportive (e.g. Campbell/Kamlami (1997), Bewley (1999, 2007)). Therefore, we do no longer treat the price adjustment channel and consequently skip the grey-colored right hand side branch of Table 1.

INSERT TABLE 1 ABOUT HERE

The left branch in Table 1 denotes the quantitative adjustment channel and covers two sub-channels: (i) labor adjustment along the intensive margin (variation of hours), and (ii) labor adjustment along the extensive margin (separation and hiring of employees). Regarding the jobs oriented strategy inherent in the German labor market miracle (e.g. ILO 2011b), our focus is on the bold faced bottom left decision node (i) intensive margin adjustment of labor. Accordingly, Table 2 focuses on changes in working hours and provides a broad classification of respective measures.

INSERT TABLE 2 ABOUT HERE

Given the issue of absorption capability, we broadly classify labor adjustment along the intensive margin into such hours variations that are intended to (a) mute cyclical variation or to mitigating shocks and into such changes in annual hours per worker that can be traced to (b) structural developments, e.g. reallocation in the composition of full-time and part-time job slots. Empirical evidence for Germany in the Great Recession shows that the part-time work contribution to decline in total hours per worker was almost negligible (cf. Fuchs et al. (2012), Brautzsch 2011). Therefore, branch (b) of structural changes of contracted working hours from Table 2 is not a candidate to explaining the unprecedented absorption capacity of the German labor market. Stylized facts rather point to class (a) of intensive margin adjustment practices. Let us, for simplicity, denote (a) as “shocks mitigating regime”, which is characterized by

internal flexibility and reversibility of adaption, hosting adjustment practices like short-time work, overtime work, or work sharing as reflected by temporary arrangements and generalized in working time accounts.

In Table 3 we introduce our taxonomy of adjustment practices for the shocks mitigating regime. The taxonomy organizes instruments by their a priori impact of hours adjustment on earnings: We denote subregime E in the top panel of Table 3 and subregime NE in the bottom panel, where E stands for "effect existent" and NE abbreviates "no effect". Thus, subregime E reports the submenu of practices whose usage directly changes regular earnings and related social security contributions. In comparison, subregime NE covers such instruments that have no impact on regular earnings. For example, generalized work sharing through working time accounts is part of NE, whereas temporary work sharing through reduced standard weekly hours accompanied by proportional payment decline is located in subregime E. The reason for introducing the distinction between E and NE is to simplify interpretation of crucial insights from subsequent analysis of stochastic models, namely in face of the probability mass shift approach (to be introduced in modeling section IV.) that refers to NE as an application.

INSERT TABLE 3 ABOUT HERE

A brief description of the taxonomy is as follows: The three practices a) paid overtime work (PAID-OVT), b) short-time work (STW), and c) temporary work sharing with proportional hours and remuneration changes (TWSH), respectively, reflect the most important instruments in subregime E of labor adjustment. With PAID-OVT effective, employees work excess hours, where additional hours compared to contractual standard are compensated with an overtime premium, e.g. at 120% of regular hourly earnings. As an industrial and labor relations issue, associated enactment and ceasing of overtime are typically negotiated between management and labor representatives. Use of STW in addition involves the employment agency (if applying for short-time allowance, short-time compensation, or according benefits). In contrast, TWSH introduces reduced standard weekly hours covered by fixed-term agreements at corporate or establishment level. Enactment of TWSH imposes a proportional earnings reduction, with remuneration returning to prior level by termination of TWSH.

The three basic instruments in subregime NE of compensation-preserving labor adjustment along the intensive margin are d) working time accounts (Arbeitszeitkonten, WTA), e) working

transitory overtime with compensation for additional hours in the form of time-off in lieu (TOIL-OVT), and f) between-years transfer of annual leave entitlements (PAID-VAC). From an employee's perspective, labor adjustment in WTA implies accumulation of surplus hours, thus, collecting of credit hours in times of upward adjustment as well as accumulation of deficit hours such as withdrawal of surpluses or accumulation of negative hours in case of downward adjustment. With TOIL-OVT effective, an employee works excess hours, but total earnings and average working hours of this employee stay constant, since any excess hour is rewarded with equalizing time-off in lieu. Like paid overtime, practicing TOIL-OVT involves labor-management negotiations. Use of PAID-VAC represents a supplementary kind of time banking such that employees adapt their annual leave entitlements according to firm-specific requirements through carrying over or taking in advance of paid vacation days. Recognizable variation in aggregate annual per capita hours, despite often of minor quantitative importance, accrues from g) inter-annual deviation in short-term absenteeism of employees (ABS). In fact, absenteeism varies with the cycle, where the associated role as a leading economic indicator is increasingly acknowledged in the political debate.

III.C. German labor market practice: Shocks mitigating evidence

Using the taxonomy defined in Table 3, Table 4 reports corresponding data for decline in average annual working hours (2008-2009) and for increase in average annual working hours (2009-2010), as available from IAB working time and volume of work data resource.[7] Cell entries respectively display the relative contribution of an adjustment instrument, as percentage share of total change in annual hours. Extending the content of Table 3, item RESID informs about the proportion of hours changes that is not explained by the shocks mitigating regime, adjusted for variation in absenteeism. On a 100-point scale, the value (100 − RESID) basically depicts the taxonomy's relevance in Germany's intensive margin flexibility of the labor market in the Great Recession and first year aftermath. Eventually, the three bottom rows report total

[7] Notice that Table 4 does not include separate data for transitory overtime with compensatory time-off in lieu (TOIL-OVT), since we adopted the existing IAB methodology and thus adapted the taxonomy. By construction, IAB working time and volume of work measurement concept (Bach/Koch 2003) estimates WTA effects inclusive TOIL-OVT information, since institutional practice in Germany typically embodies entitlements to time-off from TOIL-OVT schedules into corresponding WTA arrangements (Bauer et al. 2002). According to Seifert (2004, 3), in working time accounts in "private companies, overtime is the most frequent source (86%) of time credits".

change (i) in per capita annual hours, (ii) in employment, and (iii) in employment subject to social security payments.

INSERT TABLE 4 ABOUT HERE

In line with existing work, evidence for labor hoarding is striking, as can be seen from the bottom rows. Whereas annual hours per worker declined by almost 44 hours from 2008-09, employment was remarkably stable (the number of persons in employment increased from 40.345 million in 2008 to 40.362 million in 2009; the number of employees ins jobs subject to social security payment increased from 35.866 million to 35.894 million, representing a change of less than 0.1%). Recovery, in turn, started very early and occurred on a moderate-level job generating path. Within just on year, from 2009-10, about two thirds of preceding downward adjustment of hours was reverted, while employment further increased to 40.553 million, with employment in jobs subject to social security contributions rising to 36.065 million, indicating growth rates of almost 0.5%.

The joint, adjusted for absenteeism, effect of the four major adjustment practices WTA, STW, PAID-OVT, and TWSH amounts to about 96% of the absorption capacity of the German labor market in the Great Recession, as reported by $(100 - \text{RESID})$. While variation in the use of WTA, STW, and PAID-OVT over the business cycle refers to long existing regulations and practical experiences in Germany, TWSH is rather introduced as a subordinated instrument, typically succeeding adjustment via working time accounts and blurring contracted transfer limits. In the 2009-10 recovery, the joint effect of adapting WTA, TWSH, STW, and PAID-OVT accounted for more than 97% of upward adjustment capacity, again adjusted for variation in absenteeism.[8] Addressing research question 1, the stylized descriptive approach in Table 4 discloses temporary work sharing, (extended use of) short-time work, (reduction of) overtime work, and generalized work sharing via working time accounts as those mechanisms that have cushioned the labor market. Any of these instruments aims at maintaining knowledge capital and employment during downturn and at mitigating matching frictions during expansion.

[8] At first sight, increases in 2009-10 absenteeism seem to be inverted by opposite movements on working time accounts. While being well beyond the scope of this paper, this argument will be addressed in future research.

Let us turn to the decomposition of annual changes in hours in detail. If treated separately, WTA is responsible for about one fifth of the labor hoarding effect in the Great Recession and, further, for nearly every second hour of upward adjustment of per capita working time during recovery 2009-10. Net of rising absenteeism, the upward adjusting effect of WTA still exceeds 30%. In comparison, one third of labor hoarding results from implementing TWSH, while approximately one fifth of the above upward adjustment effect is due to expiry or early termination of TSWH arrangements. Since temporary work sharing as a labor market adjustment practice is not continuously in use and tends to interfere with generalized work sharing in working time accounts, respective firms typically implemented packages of balanced TWSH schedules to reduce standard weekly hours in response to challenged confidence due to the financial crisis. A balanced TWSH schedule, for example, comprises a stepwise use of available time-off entitlements, succeeded by further hours reductions during downturn and options of early ending of reduced hours, succeeded by accumulation of compensatory time-off entitlements during recovery.[9] Given the balanced package property, it is reasonable to also calculate a cumulated effect of WTA and TWSH, which we denote as *joint contribution of work sharing*. With a joint contribution of approximately 51% to 2008-09 cutback and of about 67% to the 2009-10 increase in average working time (50% in case of absenteeism adjusted WTA), Table 4 shows that generalized work sharing in WTA together with temporary work sharing TWSH drives the bulk of total change in annual working time over the recent cycle (sum of rows II.c. and III.d.). Therefore, working time accounts are definitely a candidate for solving research question 2 (adjustment measures unique to Germany), occasionally accompanied by temporary work sharing packages.

The picture that Table 4 points out for the two classical adjustment practices PAID-OVT and STW is also interesting. In general, the fours cells i) ΔPAID-OVT_2008-09 (19.5%), ii) ΔPAID-OVT_2009-10 (25.7%), iii) ΔSTW_2008-09 (25.0%), iv) ΔSTW_2009-10 (21.4%) describe the following adjustment patterns: Δ#imp#_200y-yy denotes the relative hours effect resulting from variation of adjustment practice #imp# within period 200y-20yy, in percent.

[9] According to reports from business press (Autonews, Bloomberg, Wallstreet-online), which we consider as supplementary anecdotal evidence, a concentration of TWSH agreements occurred in the automotive industry, with recognizable interference with existing working time banking systems.

Thus, ΔSTW_2008-09 = 25% displays the percentage share of labor hoarding from increased use of short-time work, indicating that every fourth hour of labor hording in 2009 accrues to short-time work. Note that cells ii) and iii) depict cycle-conform adjustment practices, while cells i) and iv) point to opposite-sense combinations of cycle phase and adjustment practice. As expected, data do support the cyclicality of STW and PAID-OVT, with rising volumes of overtime work related to expansion, on the one hand, and extended use of short-time work correlating with recession, on the other hand. Reported effects of STW and PAID-OVT, respectively, are larger during cycle-conformity of intended sense of direction of the associated instrument. Impact of STW extension during downturn (25%) rather matches impact of rising use of PAID-OVT during expansion (25.7%), indicating that cycle-conform effects fairly coincide in size. Reported counter-cycle impacts of changes in STW and changes in PAID-OVT, 21% and 19.5%, are also quite similar.

Table 4, moreover, confirms some unexpected but striking congruence between counter-cyclical adjustment through overtime and working time accounts, on the one hand, and through short-time work and temporary work sharing, on the other hand. Like phasing down WTA, cutback of PAID-OVT accounts for approximately one fifth of labor hoarding during the Great Recession. Likewise, during recovery 2009-10 phasing out of STW is responsible for slightly more than one fifth of upward adjustment of labor at the intensive margin, which is roughly equal to the hours increasing effect resulting from terminating TWSH. Thus, suspending or phasing down of any of the four major adjustment practices accounts for about 20% of total absorption capacity.[10] The corresponding joint contribution to overall downward flexibility resulting from downsizing overtime work and reducing time balances in working time accounts summarizes to about 40%. Likewise, joint contribution to overall upward flexibility resulting from suspending short-time work and terminating temporary work sharing schedules adds up to 40%. Embodied in these results is a valuable information, possibly identifying another statistical relationship for the shocks mitigating regime. At the intensive margin, business cycle conform adjustment practices are responsible for roughly 60% of cushioning capacity, while about 40% of observed flexibility is jointly implemented by such adjustment instruments that

[10] Further research should inspect whether this finding addresses a well-defined relation in balanced adjustment packages or whether it materialized randomly.

have been designed for opposite stages of the cycle. In other words, adjustment practices whose original use is intended for recovery and expansion, contribute about 40% to muting slowdown and recession, and vice versa.

In sum, the decomposition of aggregate hours effects for the shocks mitigating regime has shown that the four intensive margin adjustment practices WTA, TWSH, PAID-OVT, and STW account for over 96% of the absorption capacity of the German labor market during the Great Recession. Moreover, the cushioning effect of STW seems to be clearly overstated, despite being a favorite in the political debate. Even if taken together with its sister instrument PAID-OVT, cumulated contribution of short-time and overtime work to downward labor flexibility at the intensive margin never exceeds 47%, while more than 51% of labor hoarding capacity is due to adjusting hours via working time banking at the company level, including coordinated use of temporary work sharing arrangements. Consequently, the next subsection inspects institutional characteristics and adaption capacity of generalized work sharing in WTA, thereby enabling an intuitive approach to this papers solution for research question 3 (identifying a labor market adjustment device providing mutual benefits for both employers and employees).

III.D. WTA as a labor market institution and conclusions for theory formation

With the potential key importance of WTA in the Great Recession, the identifying structural characteristics of working time accounts systems and their dynamics are of interest as is the adjustment effect of WTA during the Great Recession in comparison to aggregate adjustment. From previous work it is known that intertemporal transfer of hours in WTA is an important part of labor market practice and industrial relations in Germany and, moreover, it is well institutionalized in mutual contracts between management and labor representatives that provide reciprocal insurance of firms and employees against shocks and cyclical variation (Seifert/Massa-Wirth 2005, Groß/Schwarz 2007).

In this sense, Table 5 summarizes dissemination, key characteristics, and the recent shocks mitigating effect of working time accounts systems in Germany. The upper part of Table 5 stresses the profound experience with WTA in Germany in terms of coverage. The center part of the table captures the typical institutional arrangement of WTA in terms of three constituting parameters: i) upper bound for hour surpluses, ii) lower bound for deficits hours, and iii)

window of time over which de facto worked hours and standard hours obligatory equalize. It also informs, in percent, iv) to which extent existing arrangements are well-defined according to the three identifying parameters.[11] The bottom third of Table 5 refers to the shock absorbing capacity of intertemporal shifting of hours per worker in WTA as observed during crisis in terms of average v) pre-crisis per-account time buffer, vi) per-account amount of surplus withdrawal or deficit accumulation to tackle crisis, and vii) percentage share of manufacturing firms that explicitly initialized hours movements on WTA in response to crisis with the objective of safeguarding employment. Documented data source from IAB Establishment Panel Survey, ISO/sfs Employer Survey on Operating Hours, WSI Works Council Survey (2009, 2010), and IAB Working Time Calculation.

INSERT TABLE 5 ABOUT HERE

Table 5 first points out the continuously increasing use of working time accounts. Starting with just a few pilot systems in the early 1990s, in less than one decade, the ratio of employees covered by WTA schemes grew to 35% in 1999. By 2003 WTA coverage was 41%, while in 2007 already 47% of employees owned a personal time account. In 2009, eventually, coverage amounted to 51%. Thus, during crisis more than every second employee was in general eligible to shock absorbing benefits from rebalancing working time accounts. In firms, incidence of WTA schemes also increased from 21% in 1999 to almost one third in 2009.

Table 5 also shows that, in Germany, WTA schemes are well established as a labor market institution: From industrial and workplace relations perspective, over three quarters of existing arrangements are classified as sophisticated.[12] Under this contractual frame, WTA schemes provide a great variety of upper and lower limits of feasible transfer volume, and also the

[11] According to Groß/Schwarz (2007), a WTA arrangement is called sophisticated if elements i), ii), and iii) are explicitly defined in the contract. While Seifert (2004) denotes the window of time as *time account compensation period*, we prefer the term *settlement period*. A WTA balance equal to zero we denote as "settlement of accounts". Notice that upper bounds will reappear in Definition 4 (section V.) as $\boldsymbol{\Delta}_{\boldsymbol{t}}^{+}$, lower bounds as $\boldsymbol{\Delta}_{\boldsymbol{t}}^{-}$, standard hours as $\boldsymbol{h}_{\boldsymbol{st}}$, and de facto hours as $\boldsymbol{h}_{\boldsymbol{t}}$, whereas the term T_{ref} will refer to the settlement period.

[12] 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 (Eurofound 2010), Chung (2009), and Kerkhof et al (2008). Reisenbichler/Morgan (2011) provide a detailed review of working time accounts as a general labor market practice within the "flexible working-time toolkit" (page 11), including a discussion of existing institutional arrangements and changes related to the robustness of German labor market in the Great Recession.

windows of time for processing the stipulated zero-balance of an account differ. In principle, scope for flexibility rises with firm size and if a firm belongs to the industry sector (Groß/Schwarz 2007, Groß 2010). In 2007, on average, WTA contracts limited surpluses to 103 hours per account, whereas potential WTA deficits were limited to 63 hours per account. The mean settlement period, which denotes the expected window of time to average de facto and standard working hours, encompasses 38 weeks. Like coverage of WTA, absorption capacity and scope for flexibility substantially grew over time: Average allowance of surplus hours rose from 75 hours (2001) to 96 hours (2005) to the 103 hours peak (2007) that appears in Table 5. Average scope for time deficits increased from 50 hours in 2001 to 53 hours in 2005 to 63 hours in 2007. The settlement period show the following development pattern: A 32 weeks window in 2001 rises to 42 weeks in 2005, declining again to 38 weeks in 2007.[13]

Employees went into crisis with a stock of surpluses – on average 72 hours – per working time account, indicating a substantial absorption buffer available in the German labor market. Virtually no negative WTA balances are documented for 2008q2, and almost half of the firms reported to have utilized downward adjustment on working time accounts to cope with crisis, such as surplus withdrawal or deficit accumulation. The size of the pre-crisis buffer on working time accounts is remarkable. In this context, Burda/Hunt (2011) argue that any surplus hour that has been accumulated by an employee in the past will increase future separation costs for firms if not taken as compensatory time-off, thereby facilitating employment protection. Note that this argument also holds if no job security guarantees have been contracted. In contrast to the separation cost argument, we prefer to argue that this 72 hours buffer immediately affects the value of continuing an employment relation. This value generally rises with a growing balance on a working time account.[14]

On average, a downward shift of 45 hours materialized. In other words, in response to crisis employees, on average, withdrew 45 hours from their WTA balance. For example, an intertemporal transfer of 45 hours of actual working time into future periods might have

[13] Notice that the limits of 69 surplus hours, 39 deficit hours, and settlement period of 30 weeks, as reported in Zapf/Brehmer (2010), refer to first comprehensive results from 2005 ISO/sfs Employer Survey on Operating Hours (Groß/Schwarz 2007). Some results were updated in Groß (2010). This paper uses the updated version.

[14] Related proofs can be developed by using corresponding findings from MacLeod/Malcomson (1989).

occurred, or a representative employee might have taken 45 hours of time-off in lieu to compensate for excess hours from past periods. Individual adjustment patterns were, of course, heterogeneous. Recall that according to IAB working time and volume of work calculations the mean decrease in annual working time amounted to about 44 hours (Table 4). From labor market flexibility perspective, this congruence between the mean dissaving effect on WTA and the aggregate decline in average annual working hours is quite interesting, as it indicates that, during crisis, the mean downward adjustment effect due to WTA has fairly matched the aggregated effect of downward adjustment along the intensive margin. Despite being purely anecdotal evidence, this similarity is noteworthy.

In sum, although almost macabre, our hypothesis related to employment safeguarding is that the natural experiment, implemented by the Great Recession, revealed the enormous capacity of WTA as both a mutual unemployment insurance device and a labor market practice that generates significant benefits from retaining an employment relationship over the cycle.

As reported in Tables 4 and 5, during recession working time has been transferred to future periods and accumulated surpluses from the past have been drawn down, indicating a phase-down of accounts and overtime schedules. During recovery at least part of the transferred working time was retrieved and withdrawal of hours has been reversed. In principle, such a procedure points to intertemporal reallocation of working time, ultimately internalizing deviations. Due to its institutional settings, WTA adjustment in fact implies mutual elimination of antipodal risks for employer and employees, thereby linking crisis and aftermath, recession and recovery, or, more generally, different stages of the business cycle.[15] Technically speaking, working time accounts internalize allocative shocks, e.g. random drops and peaks in demand, within the given limits of transfer volume, thereby counter-balancing and cushioning cyclical

[15] Consistent with additional information on part-time work and full-time work volume over time, we suspect a job generating effect, even pronounced in the full-time work segment. Hence, both, part-time work volume as well as full-time work volume have returned to their formerly increasing paths, but part-time work is located below its long-run trend, whereas full-time work has returned to some point above the path before 2009 (Fuchs et al. 2012). Using insights from Burda/Hunt (2011) this finding leads to a hypothesis of hiring behavior reversal: Under the impression of a fast recovery the pessimistic and reluctant hiring behavior of firms that prevailed during pre-crisis expansion might have been inverted, eventually implementing a more optimistic and courageous hiring policy of firms in the aftermath of the world crisis. First anecdotal evidence supports this argument, since registered jobs vacancies increased by more than a quarter, likewise implementing an extension of annual working hours in complementary job slots (IAB 2011).

variation. An adequate theoretical framing for well-defined intertemporal shifting of hours in WTA is thus the stochastic environment of mean preserving decreases in risk and, more generally, of probability mass shifts.

As any working time account is attached to an individual employee, this account tracks hours worked by that employee over the cycle within a time banking system, and thus enables individuals to accumulate personal time credits (time deficits, respectively) whenever actual hours exceed standard hours (are below standard hours, respectively). Provided that contracted standard hours in general depict market conditions, the expected value of a working time account balance over the cycle equals zero. Temporary spells of positive account balances might occur when labor is scarce, in initial phases of product life-cycles, or at the beginning of upturns. As in 2008-09, temporary spells of negative balances are characterized by consecutive withdrawal of surplus hours and accumulation of deficit hours. Such spells are likely to occur during downturn, and presumably in matured phases of product cycles. Alternative sources for non-zero WTA balances are periods of lack of confidence or deteriorating expectations. For associated sequences of shock internalization accompanied by temporary non-zero WTA balances the adequate model frame is characterized by mean altering probability mass shifts, which in turn point to first order stochastic dominance rules.

The core hypothesis of this paper is then that well-institutionalized working time accounts schemes in Germany are relevant and even crucial for the amazing labor market performance and, in fact, constitute the missing element to unravel the German labor market miracle. Notwithstanding important interplay with other forms of time flexibility and comprehensive labor market reforms in Germany, WTA are more than likely the key success factor to jobs safeguarding during crisis and productivity recovery in the aftermath. The appropriate model to prove this statement will be developed in subsequent sections IV. and V.

Whereas working time accounts denote a well-established labor market policy practice in Germany, they are fairly little known in many OECD countries as well as in most non-OECD economies. Indeed, the model we introduce in the next two sections suggests that economies, which do not practice working time banking systems in the style of WTA, will very likely benefit from their introduction.

IV. THE BASIC MODEL

Given the stochastic environment of employment decisions, any observed adjustment of labor with potential impact on organization of work schedules displays an outcome of decision-making under risk. This section treats such decision problems from a stochastic dominance perspective and, thus, develops our labor market model of well-defined probability mass shifts resulting in equalizing deviations and yielding unique comparative statics of risk. Overall, the results enable us to assess working time accounts in the menu of labor market adjustment practices. Further, the global financial crisis challenged confidence, basically resulting in a strong negative impact on expectations for real economy's development. Stochastically, such distorted expectations induce a skewed distribution over associated objective functions. We take this into account by introducing a variation of the probability mass shift model that extends to non-symmetrical environments. The extended model implies – in addition to uniqueness of comparative statics of risk – first order stochastic dominance of the post-shift distribution, thereby increasing the expected value of the related objective function. In sum, these findings are of great importance for explaining the German labor market miracle.

While from a formal point of view firms and workers face decision problems under risk, such decision problems typically address complex settings, and often a consistent derivation of results requires strong assumptions, accordingly limiting interpretation and applicability of conclusions. Fortunately, many decision problems simplify by applying concepts of probability mass shifts and subsequently evaluating the alternatives using stochastic dominance rules. Then, the risky prospects under consideration can be ranked without imposing e.g. restrictive assumptions on functional shape. The trick of such simplifications is that they enable decision makers to discriminate between any pair of risky prospects or random variables by attributing their difference to a well-defined transfer of probability mass. In other words, random variables under comparison capture exactly the pre-shift distribution and the post-shift distribution. For example, internal flexibility might correspond to a post-shift distribution, whereas external flexibility might reflect a pre-shift distribution of adjustment. On the partial ordering of random variables with equal means, a probability mass shift from the tails to the center of the associated probability distribution e.g. imposes a decrease in dispersion from pre-shift to post-shift, thus comes along with a lower risk being implemented in the post-shift distribution.

Our labor market dynamics application exploits the explanatory power of the probability mass shift approach: Here, we take advantage of the fact that alternative adjustment practices determine alternative one-to-one matchings with specific transformations of risk, each rooting in the same originating random distribution of potential outcomes. Suppose, for example, employment adjustment to be the random variable that depicts product demand driven labor market risks, and let shock-absorbing intertemporal transfer of working hours be the dispersion decreasing transformation to probability mass. Then we can easily demonstrate that the labor market practice that is operated in Germany since the early 1990s as a firm-level employer-employee-agreement with continuously increasing incidence, and that has been termed as working time accounts (Arbeitszeitkonten, WTA), in fact plays a crucial role as a built-in stabilizer of cyclical variation on the labor market. The core characteristic of WTA is the intertemporal transfer of working time and this transfer generates the well-defined transfer of probability mass to the center of the employment adjustment distribution.

The remainder of this section first introduces a basic example to intuitively motivate the idea of systematically manipulating risk by transferring of probability mass. It then reports crucial definitions, sets up the model, denotes related stochastic dominance rules, and closes with the main result of comparative statics of risk, thus our proof of the risk mitigating capacity of well-defined probability mass shifts as implemented by working time accounts.

IV.A. The idea: Increasing and decreasing risk by transfer of probability mass

One of the surprising stylized facts in the Great Recession is the incidence of rather similar GDP growth rates among major OECD countries, but sharply diverging employment and unemployment dynamics. Concerning the labor market, some authors even discuss a tale of two recessions. Taking similar shocks on GDP or demand as point of departure, we start with a basic example on the partial ordering of risky prospects whose expected values coincide.

For ease of exposition, we illustrate the transfer of probability mass using discrete distributions. Certainly, any argument can be reformulated for continuous random variables. Consider the following three risky prospects RP_1, RP_2, RP_3, distributed as:

$$RP_1 \sim \left((\mu - 2\sigma), \tfrac{1}{5};\ (\mu - \sigma), \tfrac{1}{5};\ \mu, \tfrac{1}{5};\ (\mu + \sigma), \tfrac{1}{5};\ (\mu + 2\sigma), \tfrac{1}{5}\right),$$

$$RP_2 \sim \left((\mu - 2\sigma), \frac{2}{5};\ \mu, \frac{1}{5};\ (\mu + 2\sigma), \frac{2}{5}\right),$$

$$RP_3 \sim \left((\mu - 2\sigma), \frac{1}{5};\ \mu, \frac{3}{5};\ (\mu + 2\sigma), \frac{1}{5}\right),$$

where $RP_i \sim (y_{i1},\ p_{i1}\ ;\ y_{i2},\ p_{i2}\ ;\ \ldots)$ denotes the outcome-probability distribution, with p_{ij} as the probability of outcome y_{ij}. Corresponding expected values are calculated as $E(RP_i) = \sum_{j=1}^{m} p_{ij} \cdot y_{ij}$, with m denoting the number of different outcomes or states. We briefly approve the equal-mean property for RP_1 , RP_2 , and RP_3:

$$E(RP_1) = \frac{1}{5} \cdot (\mu - 2\sigma + \mu - \sigma + \mu + \mu + \sigma + \mu + 2\sigma) = \mu$$

$$= \frac{2}{5} \cdot (\mu - 2\sigma + \mu + 2\sigma) + \frac{1}{5} \cdot \mu = E(RP_2) = E(RP_3) = \frac{1}{5} \cdot (\mu - 2\sigma + \mu + 2\sigma) + \frac{3}{5} \cdot \mu = \mu\,.$$

The dispersion, of course, differs between the prospects. Before inspecting this in more detail, let us show that RP_2 as well as RP_3 can be unambiguously generated from RP_1 by a predefined transfer of probability mass. Thus, the distributions of RP_2 and RP_3 are respectively defined by adding a probability mass shift to the distribution of RP_1 . Strictly speaking, RP_2 shifts the associated probability mass at $y = \mu - \sigma$ to outcome $y = \mu - 2\sigma$ and the probability mass at $y = \mu + \sigma$ to $y = \mu + 2\sigma$. Likewise, RP_3 shifts the respective 20% probability mass from points $\mu - \sigma$ and $\mu + \sigma$ to the mean μ.

Figure 2 demonstrates that shifting probability mass to the tails of RP_1 yields RP_2 , whereas shifting probability mass to the center yields RP_3 .

Figure 2 here

We can easily see that the stone-colored reference distribution RP_1 is less dispersed than maroon-colored RP_2 , but has larger dispersion than blue-colored RP_3 . In terms of comparative risk it is said that RP_2 , while putting relatively more weight in the tails of the distribution with respect to RP_1 , is an increase in dispersion and, consequently, an increase in risk. Vice versa, RP_3 that puts relatively more weight to the center region represents a decrease in dispersion and, consequently, a decrease in risk. In other words, risky prospect RP_3 is less risky than RP_1 , which is less risky than RP_2 . It is straightforward that RP_3 is also less risky than RP_2 .

Overall, whenever a decision maker is able to reduce the deviation between risky prospects to differences in the location of probability mass over the range of the associated distribution, he/she is also able to rank these prospects in terms of risk and therefore to reliably solve the underlying decision problem.

IV.B. Relevant definitions and stochastic dominance rules

The elementary definitions for probability mass transformations of risky prospects and concerning stochastic dominance rules are well-known in economic literature.[16] Thus, the subsequent set of definitions and the relevant rules of stochastic dominance are selected with the aim to standardize notation as well as to facilitate comprehension and assessment of the mechanism of mitigating cyclical labor market risks, since the latter is crucial to the practical relevance and explanatory power of our model.

In regard of our labor market application plus the objective of an intuitive interpretation of the model conclusions, we follow Wolfstetter (2002) who formulates the ranking on a set of alternatives or random variables rather than on the set of associated distribution functions, despite the latter dominates in the literature. In this sense, we say that one random variable or risky prospect dominates another random variable or risky prospect. Let us consider random variables X and Y. Denote the corresponding distribution functions as $F(X)$ and $G(Y)$, and write the associated probability density of realization x, y as $f(x)$ and $g(y)$. Without loss of

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[16] Related work originates from mathematics and game theory (cf. Hardy/Littlewood/Polya (1934) and Blackwell/Girshick 1954). In economics, general interest in stochastic dominance relations and in potential simplification of solutions to decision problems has been initiated by parallel work of Hadar/Russel (1969) and Hanoch/Levy (1969). Crucial concepts and important criteria have also been developed in the seminal article of Rothschild and Stiglitz (1970) who directed attention toward the second order stochastic dominance relation. In the literature, the terms comparing risk or comparative risk are used in parallel to notions like (Rothschild-Stiglitz) increase in risk, second-degree/second order stochastic dominance.

These ideas and decision rules framed in incomlete knowledge on utility functions have been further elaborated in numerous papers, including Rothschild/Stiglitz (1972), Diamond/Stiglitz (1974), Meyer (1975), Ekern (1980), Menezes/Geiss/Tressler (1980), Whitmore (1980), Meyer/Ormiston (1989), Landsberger/Meilijson (1990), Rasmusem/Petrakis (1992), Eeckhoudt/Gollier/Schlesinger (1996), Leshno et al. (1997), Machina/Pratt (1997), Müller (1998), Eeckhoudt/Schlesinger/Tsetlin (2009). Surveys are provided by Levy (1992), Levy (2006).

The essence of a jobs miracle in the context of cyclical variation and, consequently, the study of employment cushioning effects of intertemporal transfer of working hours in working time accounts is definitely located in a Rothschild-Stiglitz world of comparative risk.

generality let us normalize the range of X, Y to the closed interval $Z := [z_{min}, z_{max}] \subset \mathbb{R}$, with $z_{min} < z_{max}$.

DEFINITION 1 (probability mass shift). A transfer of probability mass from one region or outcome of a distribution to another region or outcome of that distribution is called a probability mass shift (PMS).

(a) Any probability mass shift alters the shape of both, the probability density function (pdf) and the cumulative distribution function (cdf) of the random variable under analysis.

(b) A probability mass shift to the center lowers probability density in the tails of a distribution and increases probability density in the center region of that distribution, thereby reducing dispersion.

(c) A probability mass shift to the tails lowers probability density in the center region of a distribution and increases probability density in the tails of that distribution, thereby increasing dispersion.

Graphically, a probability mass shift from subinterval A on the range of a risky prospect to another subinterval B on that range cuts (part of) the area under the corresponding probability density function in interval A and additively relocates this area to interval B. If such relocation imposes no effect on the mean we use the term *mean preserving shift of probability mass*. Definition 2 treats corresponding impacts on dispersion.

DEFINITION 2 (mean preserving change in risk). A probability mass shift on the partial ordering of equal-mean distributions generates a mean-preserving transformation of the underlying random variables. Correspondingly, mean preserving changes in risk are introduced.

(a) Y is said to be a mean preserving spread (MPS) of X, if:

1. $E(X) = E(Y)$, and
2. Y differs from X by a probability mass shift from the center region of X to its tails, where the center region is captured by closed interval $I := [z_0, z_1] \in Z$, and $z_{min} < z_0 \leq z_1 < z_{max}$, such that

$$g(t)\begin{cases} \geq f(t) & \text{if} \quad z_{min} \leq t \leq z_0 \\ \leq f(t) & \text{if} \quad z_0 \leq t \leq z_1 \\ \geq f(t) & \text{if} \quad z_1 \leq t \leq z_{max} \end{cases},$$

with strict inequality for at least one $t \in I$.

(b) X is said to be a mean preserving contraction (MPC) of Y, if:

1. $E(X) = E(Y)$, and
2. X has been generated from Y by a probability mass shift from the tails of Y to its center region, which is captured by closed interval $I := [z_0, z_1] \in Z$, and $z_{min} < z_0 \leq z_1 < z_{max}$, such that

$$f(t)\begin{cases} \leq g(t) & \text{if} \quad z_{min} \leq t \leq z_0 \\ \geq g(t) & \text{if} \quad z_0 \leq t \leq z_1 \\ \leq g(t) & \text{if} \quad z_1 \leq t \leq z_{max} \end{cases},$$

with strict inequality for at least one $t \in I$.

(c) Any (sequence of) mean preserving spread(s) defines a mean preserving increase in risk (MPIR), whereas any (sequence of) mean preserving contraction(s) defines a mean preserving decrease in risk (MPDR).

It is easy to verify that mean preserving spread (MPS) and mean preserving contraction (MPC) denote inverse operations. The concept of increase or decrease in risk is closely related to the more general concept of second order stochastic dominance and to the so called integral condition(s). On the partial ordering of risky options with identical expected value, both concepts are equivalent. In fact, mean preserving increase in risk (MPIR) addresses a special case of second order stochastic dominance (SSD). The corresponding general definition in terms of stochastic dominance rules is as follows:

DEFINITION 3 (stochastic dominance). For any two random variables X and Y with associated distribution functions $F(x)$ and $G(y)$ we say that X stochastically dominates Y

(a) in the first order sense, written as $X \succ_{FSD} Y$, iff

1. $F(t) \leq G(t)$, for all $t \in Z$ and
2. strict inequality holds for at least one t.

(b) in the second order sense, written as $X \succ_{SSD} Y$, iff

1. $\int_{z_{min}}^{z} [G(t) - F(t)]dt \geq 0$, for all $z \in Z$ and
2. strict inequality holds for at least one z.

It is worthwhile stressing that first order stochastic dominance (FSD) is the weakest condition to define an unambiguous ranking of risky prospects, i.e. without imposing any restriction on preferences except the monotonicity axiom. On the other hand, second order stochastic dominance (SSD) maps to unambiguous preference rankings for risk-averse agents. Further, FSD implies SSD. For respective proofs see Hadar/Russel (1969), Rothschild/Stiglitz (1970), and Levy (1992, 2006).[17]

Taken together, 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 thus risk. For any two distributions with identical expected value, a sequence of probability mass shifts to the center (MPDR) imposes the well-known rule of second order stochastic dominance.

The subsequent section addresses the comparative statics of risk, resulting from flexible hours in working time accounts, pointing to one crucial insight of this paper, which we will derive in the context of well-defined probability mass shifts.

IV.C. Key result: Internalization of antipodal risks and even more

To achieve the central objective of this paper, namely to develop a consistent theory of cushioning effects in the German labor market, the following five steps are left: First, we show that associated adjustment practices impose a contracting probability mass shift. Second, we apply corresponding stochastic dominance rules to labor market dynamics over the business

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[17] Technically, the major insight from Rothschild/Stiglitz (1970) is that for the partial ordering of distributions with the same mean notions (i)-(iii) of increasing risk are equivalent, and *Y* is said to be more risky than *X* if

(i) any risk averse individual prefers *X* to *Y*,

(ii) *Y* is generated from *X* by adding a random variable Ω, with $E\left[\Omega \mid X\right] = 0$, and

(iii) *Y* has more weight in the tails of its distribution than *X*.

Associated proofs revealed as necessary and sufficient condition an important statement (iv) that is well-known as the integral condition. With *F(x)* and *G(y)* as cumulative probability functions of *X* and *Y*, the integral condition of (second order) stochastic dominance (IC) writes as

(iv) $\int_{-\infty}^{z}\left[G\left(t\right)-F\left(t\right)\right]dt \geq 0$, $\forall z$, with strict inequality for some (non-zero) interval. Since we compare pairs of equal-means distributions, $\int_{-\infty}^{\infty}\left[G\left(t\right)-F\left(t\right)\right]dt = 0$ holds as well.

cycle in order to, third, identify such labor market practices and institutions with built-in capacity to generate decreases in risk. If in addition, a first order stochastic dominant solution is detected, a superior adjustment instrument has been identified. Finally, enforceability and renegotiation-proofness of associated adjustment practices should be analyzed.

First, we make use of the fact that working time accounts provide the necessary stochastic properties by construction, given they are well-defined and adequately set up as a firm-level institution. Such working time accounts then automatically internalize reallocative shocks, thereby reversing adverse effects of e.g. demand shocks. In section V.B., we will further argue that for renegotiation-proofness to hold mutual agreements between employers and employees are necessary, thereby imposing reliability and enforceability of cushioning effects.[18]

In terms of stochastic dominance rules, Propositions 1 and 2 reinforce the capability of probability mass shifts to eliminate antipodal risks. If, for example, the conditions denoted in Proposition 2 are satisfied, then most decision-makers, and definitely any risk-averse decision-maker will strictly prefer prospect X to prospect Y.

PROPOSITION 1 (risk absorption). Suppose that a symmetrically distributed random variable X second order stochastically dominates another symmetrically distributed random variable Y, written as $X \succ_{SSD} Y$. Suppose further that X has been yielded from Y be a mean preserving decrease in risk (MPDR). Then X absorbs some risk from Y.

PROPOSITION 2 (internalization of antipodal risks). Fix symmetric random variable X that second order stochastically dominates another symmetric random variable Y: $X \succ_{SSD} Y$, and let X have been generated from Y be a mean preserving decrease in risk (MPDR). Let the associated center region of the probability mass shift collapse to interval $I = \{E[Y]\}$. Further, let the corresponding tail regions within which associated probability mass is eliminated be $T_l := [E[Y] - \delta_1, E[Y] - \delta_0] \in Z$ as well as $T_r := [E[Y] + \delta_0, E[Y] + \delta_1] \in Z$, with $\delta_0 \geq 0$ and $\delta_1 > 0$. Then X internalizes antipodal risk from Y and will be preferred by all risk-averse agents.

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[18] Recall that in Germany, working time accounts agreements are typically negotiated between the social partners either at collective bargaining level or in decentralized bargaining at the enterprise level.

Proof. By definition a MPDR moves probability mass to the center, thus Proposition 1 is straightforward. The choice between X and Y will depend on the risk attitude of participating agents. Jensen's inequality provides the basis for the conclusion that agents with a concave utility function will prefer the risk absorbing option X to the alternative Y. Proposition 2 characterizes a probability mass shift that implies a mean preserving decrease in risk around the expected value, since the set of temporary shocks falling into interval T_l will be exactly offset by the set of antipodal shocks falling into interval T_r, with both probability masses being transferred to the mean, thereby imposing a rising probability of the expected outcome. Thus, opposite risks are counter-balanced and, consequently, eliminated. □

For the conclusions that will be drawn in terms of shocks mitigation for the German labor market miracle, Proposition 2 is crucial. Figure 3 visualizes the corresponding key message for the familiar standard normal distribution with following subdomain parameters: $\delta_0 = 0$ and $\delta_1 = \sigma$. Corresponding empirical operationalizations of X and Y in the given labor market context might be employment or employment adjustment, in general, and operating profits or workers' current pay, from contract partners' specific perspective. For example, it is quite obvious that workers will prefer salary spells associated to X (blue-colored cdf, Figure 3) to spells that are connected to Y (maroon-colored cdf, Figure 3), since X internalizes risk from Y.

Figure 3 here

Figure 3 reveals an important aspect that leads to the context of first order stochastic-dominance. Let us, for identification purposes, denote such a specific transfer of probability mass shift for generating $F(X)$ out of $G(Y)$ as *collapse-to-the-mean PMS*. It is evident that the collapse-to-the-mean PMS naturally decomposes the range of risky prospect X and Y into two subdomains (Z_l, Z_r): closed interval $Z_l := [z_{min}, E[Y]]$, on the one hand, and open interval $Z_r := (E[Y], z_{max}]$, on the other hand.

It is easy to verify that on the subdomain Z_l random variable X first order stochastically dominates random variable Y, since $F(t) \leq G(t)$ for $t \leq E[Y]$, with strict inequality for $E[Y] - \delta_1 \leq t < E[Y]$. Equivalently, we write $X \succ_{FSD} Y$ on Z_l. This subdomain becomes relevant in face of asymmetric risks, along with unexpected shocks or perishable goods. Such asymmetric developments are treated in Proposition 3, which extends the PMS approach to non-symmetrical contexts. It is important to capture unprecedented developments and distorted

expectations like those in the Great Recession in a separate approach, because symmetric noise or equalizing risks models insufficiently address this matter. In other words, the setup of the stochastic environment changes with challenged economic confidence. For such a reformulated model we expect the mechanism, so far responsible for antipodal risks internalization (Proposition 2), to then imposing a mean altering shift of probability mass, eventually implementing first order stochastic dominance (Proposition 3).

The framing of Proposition 3 is as follows: The associated stochastic environment will be negatively skewed. Let the right tail of the random variables under analysis to be completely eliminated. To simplify notation, we write $Y_{sk.}$ for the skewed variable and Y_{sym} for the corresponding symmetric variable, where we refer to the symmetric distribution as the source or reference from which our skewed environment emerges. In particular, we study two cases of $Y_{sk.}$: Let the first case attribute to circumstances where any deviation from a given target value $E[Y_{sym}]$ confirms a negative shock. Graphically, the right tail of the originating distribution Y_{sym} is eliminated and the remaining part is reweighted (folded over). Proposition 3 denotes this as case (1), with the associated skewed random variable written as Y_{skf}, where f indicates that we study a folded distribution. The second case attributes to an environment where positive deviations from an expected value do not realize as positive shocks, but as the expected value $E[Y_{sym}] = \mu_{sym}$.[19] Evidence in the Great Recession rather points to the latter definition, as do binding adjustment inertia and production of non-sustainable goods or services. Graphically again, the right tail of the originating distribution Y_{sym} is eliminated and completely collapsed to its mean, i.e. kinked at μ_{sym}. Proposition 3 addresses this as case (2), with Y_{skc} denoting the respective skewed distribution, where the c indicates collapse of the right tail to point $E[Y_{sym}] = \mu_{sym}$. Let us term Y_{skc} as the collapsed-to-the-mean distribution. The term collapsed refers to the fact that the set of realizations of a risky prospect is just bounded from above as distinguished from a setting where positive shocks are folded over, i.e. where the absolute value of a residual matters.

Proposition 3 characterizes the mean altering effect of a probability mass shift to the center, with the center being attributed to the symmetrical source of our non-symmetric

[19] Of course, we mean the expected value of the symmetric source distribution Y_{sym}.

context. Thus, in case (1) the folding point corresponds to the center, while in case (2) the truncation or collapse point corresponds to the center.[20]

PROPOSITION 3 (FSD imposing probability mass shift). Let $\left[z_{min}, E\left[Y_{sym}\right]\right]$ denote the range of half-sided distributed random variable $Y_{sk\cdot}$ whose symmetric counterpart is given by Y_{sym}, with range $[z_{min}, z_{max}]$. Assume $Y_{sk\cdot}$ to be either (1) the folded distribution Y_{skf}, where the fold occurs at $E\left[Y_{sym}\right]$ or (2) the collapsed-to-the-mean distribution Y_{skc}, where the right tail of Y_{sym} has not been folded over across the $y = E[Y_{sym}]$-axis, but is completely re-weighted to the mean.

Now consider random variable X_{skj} that differs from Y_{skj} by a probability mass shift from the – remaining – left tail of Y_{skj} to the center, with $j = f, c$. Suppose that this tail to center transfer of probability mass starts at point $t_0 := E\left[Y_{sym}\right] - \delta_i$, with $\delta_i > 0$, and covers the whole area under the associated pdf on interval $\left[E\left[Y_{sym}\right] - \delta_i, E\left[Y_{sym}\right]\right)$. Further, let the affected probability mass to be shifted exactly to the folding point or to the collapse point of Y_{skj}, respectively, i.e. to $E\left[Y_{sym}\right]$.

Then X_{skj} is a mean increasing contraction (MIC) of Y_{skj} and first order stochastically dominates Y_{skj}, $j = f, c$. Consequently, every agent prefers X_{skj} to Y_{skj} unless a violation of the monotonicity axiom. For the regimes of (1) folded distribution, one the one hand, and (2) collapsed-to-the-mean distribution, on the other hand, we write:

(1) $X_{skf} \succ_{FSD} Y_{skf}$ in case (1),

(2) $X_{skc} \succ_{FSD} Y_{skc}$ in case (2).

Proof. Recall the definition of first order stochastic dominance (Definition 3), namely that $F(t) \leq G(t)$, for all t in the range of the distribution and with strict inequality for at least one t within that range. We will prove that in case (1) the difference between cdf of Y_{skf} and cdf of X_{skf} is non-negative over the entire range and strictly positive on interval $\left(t_0, E\left[Y_{sym}\right]\right)$. For

[20] Extensive formal analysis of non-sustainability and lacking recovery in aftermath of crisis are beyond the scope of the current paper, which aims to explain the interplay of reluctant hiring behavior of German firms before crisis in combination with the jobs safeguarding effect during crisis.

case (2) we prove that the first order stochastic dominance condition holds for random variable X_{skc} over random variable Y_{skc}.

For (piecewise) construction of Y_{skf} and X_{skf} we can use insights from Levy (2006) who developed a general notation for the cdf of any non-symmetrically truncated random variable as a piecewise function that embodies the cdf of the symmetric counterpart. Maintaining the distinguishing notations and, for simplicity, working with the normal distribution we yield:

$$G(t)\text{: cdf of } Y_{sym}\,, \quad F(t)\text{: cdf of } X_{sym}\,, \quad \text{and} \quad \Delta(t) := G(t) - F(t)\,,$$

$$G_f(t)\text{: cdf of } Y_{skf}\,, \quad F_f(t)\text{: cdf of } X_{skf}\,, \quad \text{and} \quad \Delta_f(t) := G_f(t) - F_f(t)\,,$$

$$G_c(t)\text{: cdf of } Y_{skc}\,, \quad F_c(t)\text{: cdf of } X_{skc}\,, \quad \text{and} \quad \Delta_c(t) := G_c(t) - F_c(t)\,.$$

For the folded case (1) first order stochastic dominance (FSD) is proven, since:

$$\Delta_f(t) = \begin{cases} 0 & \text{if} \quad t < t_0 \\ 2 \cdot \big(G(t) - G(t_0)\big) & \text{if} \quad t_0 \le t < E\big[Y_{sym}\big] \\ 0 & \text{if} \quad t \ge E\big[Y_{sym}\big] \end{cases} .$$

Likewise, for the collapsed case (2) FSD is shown by:

$$\Delta_c(t) = \begin{cases} 0 & \text{if} \quad t < t_0 \\ G(t) - G(t_0) & \text{if} \quad t_0 \le t < E\big[Y_{sym}\big] \\ 0 & \text{if} \quad t \ge E\big[Y_{sym}\big] \end{cases} .$$

Both expressions $\Delta_f(t)$ as well as $\Delta_c(t)$ are non-negative over their entire range and strictly positive on interval $\big(t_0, E\big[Y_{sym}\big]\big)$, since any cumulative distribution function is non-decreasing and $G(t)$ is strictly increasing. Thus, FSD is proven: $X_{skf} \succ_{FSD} Y_{skf}$ and $X_{skc} \succ_{FSD} Y_{skc}$ hold. □

Figures 3a and 3b summarize the contribution of Proposition 3 for the folded distribution and the collapsed distribution. The PMS to the center imposes a MIC, thereby implementing FSD of distribution F over G. As can be seen in the proof of Proposition 3, FSD of X_{skf} is ensured by $\Delta_f(t) > 0$, for $t_0 < t < \mu_{sym}$. In Figure 4a, the green dash-dot line displays the values of $\Delta_f(t)$. Similarly, FSD of X_{skc} results from $\Delta_c(t) > 0$, for $t_0 < t < \mu_{sym}$. Associated values $\Delta_c(t)$ are plotted as green dash-dot line in Figure 4b.

Figures 4a and 4b here

Since the financial crisis expectations for labor market dynamics increasingly point to negatively skewed distributions and thus the above feature of FSD becomes highly relevant. Because – if applied to negatively skewed distributions – a probability mass shift to the center generates first order stochastic dominance, one can consequently prove that any adjustment practice that differs by exactly a probability mass shift to the center from another adjustment practice Pareto dominates the latter.

Along with declining confidence of economic actors anecdotal evidence indicates that modern globalized economies are increasingly confronted with unprecedented incidents, decelerated development, and thus eroding expectations. Among others, long standing statistical relations like Okun's Law seem to no longer hold, rebalancing of opposite risks during cycles seems to be increasingly impeded, with so far recognized time horizons being gradually violated (Cazes/Verick 2011). For the Great Recession and its aftermath we conclude from Proposition 3 and the associated proof that the outcome of the natural experiment in 2008-09 is supportive of the first order stochastic dominance hypothesis referring to the use of working time accounts in Germany. Subsequently, we derive the explanatory power of such accounts to filling the research gap of the German labor market miracle.

V. Explaining the Miracle: Lessons from Great Recession as a Natural Experiment

This section applies the probability mass shift approach to working time accounts in the Great Recession. The objective is twofold. First, we use Proposition 2 and, in particular, Proposition 3 to close the gap in explaining the German labor market miracle. We introduce institutional details of working time accounts as a reciprocal insurance device that provides mutual benefits for firm and workers (Definitions 4 and 5, contributing to research question 3). Second, we show that these sophisticated working time accounts establish an institution of reciprocal commitment, since they embody consumption smoothing and intertemporal memory of contracts, thus implementing renegotiation-proofness and enforceability (resolving research question 4). For this proof we use insights from Chiappori et al. (1994).

The European Foundation for the Improvement of Living and Working Conditions writes in a recent study “Flexitime schemes with the possibility to bank hours – so-called ‘working time accounts’ – are considered to be a form of flexibility that can meet the interest of both

employers and employees.", and further: "working time accounts are generally still not commonly used. In the EU 27, only 6% of companies offer such … time accounts." (Eurofound 2012, 10). In comparison to weak penetration rates of working time accounts in Europe and worldwide, respective coverage in Germany is remarkably high, with almost one third of firms practicing working time accounts and over 50% of employees being covered (cf. Table 5). Moreover, from existing work we know that about 77% of WTA schemes in Germany offer a high degree of contractual sophistication and reliability (Groß/Schwarz 2007).

Intuitively speaking, the fact that the German labor market was capable to instantaneously exploiting the shock absorbing capacity of working time accounts in the Great Recession is not really surprising, given their long-standing experience in Germany, the degree of sophistication of institutional arrangements between the social partners, accompanying legislation, and the content of court judgments concerning the, in fact, rare disputes.[21] In terms of commitment and renegotiation-proofness, the well-established industrial relations system in Germany admittedly facilitated pre-crisis accumulation of reputation and mutual confidence similar to behavioral mechanisms revealed in gift exchange and fair-wage effort models of efficiency wages.

One major constituting element of working time accounts is that they adjust labor at the intensive margin, thus worked hours vary with the cycle. Within pre-specified limits – the scope for flexibility –, the according adjustment mechanism ensures that working time per worker tends to exceed standard hours during expansion and tends to fall short of standard hours during downturn. Correspondingly, workers accumulate surplus hours in their accounts in expansion and with positive demand shocks, while they accumulate deficit hours or draw down surpluses during recession and with negative demand shocks. Overall, the mechanism embodies properties similar to those of automatic stabilizers.

V.A. Internalizing risk in practice: Intensive margin adjustment through WTA

In labor market practice, intertemporal shifting of working time transforms employment adjustment into adjustment of hours or, in other words, converts labor adjustment along the

[21] For example, by decision of the Federal Labor Court (BAG) employers are obligated to either buy-out existing surpluses or to draw down hours credits of employees until the account's balance equals to zero. Moreover, it is illegal to charge employees for hours deficits in case of dismissal. Statutory insolvency protection for long-term accounts is required by law (Flexi II, cf. Bundesgesetzblatt 2008).

extensive margin into adjustment along the intensive margin without affecting remuneration. Since wages of workers are insensitive to the variation of hours within the limits of the account's scope for flexibility, adjustment in working time accounts substitutes extensive margin adjustment at zero adjustment costs. Overall, working time accounts provide disincentives to hiring in expansion as well as disincentives to layoff in recession. This corresponds to findings in Burda/Hunt (2011) who detect missing recruitment in the preceding expansion as well as missing employment decline in the Great Recession.[22]

The unique property of time banking is to formally track worked hours in a statement of account. Such a working time account identifies the name of the employee to whom it belongs and includes following constituting elements: a) remuneration ($\boldsymbol{w}$); b) standard hours ($\boldsymbol{h_{st}}$); c) the window of time over which worked hours are required to average standard hours (T_{ref}), equivalently denoted as settlement period; d) the set of permissible distribution of working time deviations ($\boldsymbol{\Delta_t^-}, \boldsymbol{\Delta_t^+}$), including upper and lower limits of actual working hours and a bound for cumulated differences between realized and standard hours; and e) the current WTA balance (aba) that calculates net surplus or net deficit accumulated by an individual employee since the most recent zero balance in his/her WTA. As movements of hours on an account are formulated from the employee's perspective, a one-to-one correspondence is generated between the employee and his/her working time account within the firm. Any surplus on such an account documents a time credit granted by an employee to the firm, while a deficit shows that the worker owes working time to the employer. Most constituting elements cannot be treated isolated. The settlement period T_{ref}, for example, interferes with the account's balance aba: T_{ref} determines the maximum duration for WTA surpluses and deficits to cancel out each other, with a reset of elapsed time to value zero each time the current WTA balance aba equals zero. Notice that as a synonym for $\mathrm{aba} = 0$ we use the expression "settlement of accounts". The vectors of standard hours and of feasible hour deviations are also interdependent and, moreover, might be limited by legislation or judgment.

Given these preliminaries, let us now define WTA as a practice of internalizing antipodal market risks through intensive margin adjustment of labor. Definition 4 is then as follows:

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[22] The authors also discuss a potential regime shift at the institutional level, ultimately stressing the quasi-fixity of input factor labor for firms.

DEFINITION 4 (WORKING TIME ACCOUNTS). A working time account wta is attached to an individual employee in a given firm and formally tracks the deviation of worked hours from contracted standard hours over time. A working time account adjusts labor at the intensive margin without imposing any effect on salaries. Institutional arrangements are privately negotiated and settled in individual or collective agreements. Formally, we write:

$$\text{wta} := \{\boldsymbol{w},\ \boldsymbol{h_{st}}, T_{\text{ref}}, \boldsymbol{\Delta_t^-}, \boldsymbol{\Delta_t^+}, \text{aba}\},$$

with a) remuneration package $\boldsymbol{w} = \binom{w_f}{w_v}$;

with b) standard hours vector $\boldsymbol{h_{st}} = \begin{pmatrix} h_{st}^d \\ h_{st}^w \\ h_{st}^m \\ h_{st}^a \\ \dots \end{pmatrix}$; with c) settlement period T_{ref} in weeks;

with d_1) the vector of realized hours deficits $\boldsymbol{\Delta_t^-}$ displaying downward adjustment:

$$\boldsymbol{\Delta_t^-} := \begin{pmatrix} \Delta_{t,d}^- \\ \Delta_{t,w}^- \\ \Delta_{t,m}^- \\ \Delta_{t,a}^- \\ \cdots \\ \Delta_{t,\Sigma}^- \end{pmatrix} = \begin{pmatrix} \min\{h_t^d - h_{st}^d, \Delta_{max,d}^-\} \\ \min\{h_t^w - h_{st}^w, \Delta_{max,w}^-\} \\ \min\{h_t^m - h_{st}^m, \Delta_{max,m}^-\} \\ \min\{h_t^a - h_{st}^a,\ \Delta_{max,a}^-\} \\ \cdots \\ \min\{\sum_{i=0}^t \Delta_{i,d}^-\ ,\ \Delta_{MAX}^-\} \end{pmatrix},\ i = 0, 1, \dots, t\ ;$$

with d_2) corresponding vector of realized surpluses $\boldsymbol{\Delta_t^+}$ reporting upward adjustment:

$$\boldsymbol{\Delta_t^+} := \begin{pmatrix} \Delta_{t,d}^+ \\ \Delta_{t,w}^+ \\ \Delta_{t,m}^+ \\ \Delta_{t,a}^+ \\ \cdots \\ \Delta_{t,\Sigma}^+ \end{pmatrix} = \begin{pmatrix} \min\{h_t^d - h_{st}^d,\ \Delta_{max,d}^+\} \\ \min\{h_t^w - h_{st}^w,\ \Delta_{max,w}^+\} \\ \min\{h_t^m - h_{st}^m,\ \Delta_{max,m}^+\} \\ \min\{h_t^a - h_{st}^a,\ \Delta_{max,a}^+\} \\ \cdots \\ \min\{\sum_{i=0}^{t} \Delta_{i,d}^+ ,\ \Delta_{MAX}^+\} \end{pmatrix},\ i = 0, 1, \dots, t\ ;$$

and with e) the current WTA balance $\text{aba} = \Delta_{t,\Sigma}^+ + \Delta_{t,\Sigma}^-$.

First, superscript "$-$" indicates downward adjustment along the intensive margin of labor, while superscript "$+$" indicates upward adjustment along the intensive margin. Notice that suffix st always stands for the contracted standard, thus, regular working time, while t stands for the present period, thus, depicts actual working time figures. Associated upper and lower limit for deviations, i.e. the maximum permissible transfer volume, is indexed with the max-subscript. Corresponding reference spells are indicated by comma-separated suffixes, following the t- or max-subscript: Here, index d stands for daily values, while w depicts weekly values, m denotes monthly values, and a stands for annual values. These spell identifiers also appear as exponential terms in expressions h_{st} and h_t. The three dots below the annual values rows of the deviations vector respectively reflect that contracting parties might have agreed upon longer-termed accounts. Moreover, there exists a strictly binding bound for the overall capacity level of accumulated hours transfers in either direction. Given upward adjustment, this bound is the maximum allowance of surplus hours Δ_{MAX}^+ (see also the empirical average of 103 hours, documented in Table 5). For downward adjustment, the lower bound is given by the scope for time deficits Δ_{MAX}^- (cf. the 63 hours cell in Table 5). Finally, current index i always runs over values $0, 1, \dots, t$ and is used for summation of all surplus and deficit hours over time. Notice that with each settlement of accounts $\Delta_{t,\Sigma}^+ = \left|\Delta_{t,\Sigma}^-\right|$ is satisfied and, consequently, elapsed time pointer s within the window of time T_{ref} is reset to $s = 0$, with $\text{s} \in [0, T_{\text{ref}}]_{\mathbb{N}}$.

Definition 4 characterizes the elements a) to e) in some detail, basically as a checklist. Let us inspect them with respect to their role within the WTA adjustment system. Remuneration (package) $\mathbf{w}$ is an important element in the system. Since the idiosyncratic intensive margin adjustment mechanism of working time accounts is based on insensitivity of compensation to working hours variation, we include two distinctive forms of remuneration in the definition: fixed salary w_f and variable components w_v. If no variable components are negotiated then w_v assumes a zero vector. The partition into fixed and variable contents enables us to include incentivizing effects of efficiency wage mechanisms and to simultaneously impose some risk-taking on (groups of) employees. Notice that the variability of w_v depends on pre-defined performance criteria such as performance ratings, stock values, or skill acquisition, while it is independent from flexible working hours resulting from the WTA system.

The vector of standard hours $\boldsymbol{h_{st}}$ informs about the amounts of contracted daily, weekly, monthly, annual etc. working time. Transfer(able) volume of hours appears in the definition as elements d_1) and d_2), which in fact denote probability mass shift vectors. In particular, the two deviations vectors $\boldsymbol{\Delta_t^-}$ and $\boldsymbol{\Delta_t^+}$ formalize three contents: (i) the transfer frame of working time, (ii) the maximum feasible transfer volume measured in hours, and (iii) reported deviation of hours. Surplus hours are banked in the $\boldsymbol{\Delta_t^+}$ sub-account, whereas any deficit hour or withdrawal of surplus is recorded in the $\boldsymbol{\Delta_t^-}$ sub-account. Both sub-accounts are updated on a daily basis. By design, the WTA system distinguishes the scope for intertemporal flexibility, depending on whether time deficits or time credits are considered and on the time horizon. With $\Delta_{max,j}^-$ and $\Delta_{max,j}^+$, $j = \{d, w, m, a, \dots\}$, the maximum transfer volume is first allowed to vary with the time horizon under control, and second to be specific to the characteristic of denoting a surplus or a deficit as compared to standard hours. The scope for upward flexibility or for time deficits, respectively, becomes effective if the magnitude of currently required hours deviation $\left|h_t^j - h_{st}^j\right|$ exceeds the contracted limit $\left|\Delta_{max,j}\right|$. The magnitude of total net surplus and deficit, respectively, is restricted by cumulative capacity of WTA, hence, by Δ_{MAX}^+ and Δ_{MAX}^-.

The action space for standard hours might be narrowed by legal requirements due to Hours of Work Acts or corresponding legislation. Similarly, feasible scope for flexibility might be restricted. In the recent past, for example, the maximum window of time for worked hours and standard hours to equalize, i.e. the length of T_{ref}, has been addressed by labor courts in context

of decisions concerning long-term security and early-retirement compatibility of surpluses (cf. Bundesgesetzblatt 2008). Finally, the actual value aba of the working time account balance is common knowledge to the contract parties and informs about total net surplus or net deficit in terms of hours.

Let us elucidate with a numerical example: Suppose that contracted standard hours amount to 7 hours per day, 35 hours per week, and that monthly and annual values amount to their adjusted for paid vacancy days values. Then $h_{st}^{d} = 7$, $h_{st}^{w} = 35$ etc.. Suppose further that regular surplus and regular deficit buffers have been negotiated at the same magnitude, e.g. at 2 hours per working day and 10 hours per week. Let the maximum number of surpluses be limited to 80 hours and the maximum number of deficits be restricted to 60 hours. Assume the window of time for matching standard hours is settled at 78 weeks, representing a settlement period of about one year and six months. The associated elements in Definition 4 then write as $\Delta_{max,d}^{-} = -2$, $\Delta_{max,w}^{-} = -10$, $\Delta_{max,d}^{-} = 2$, $\Delta_{max,w}^{+} = 10$, $\Delta_{MAX}^{-} = -60$, $\Delta_{MAX}^{+} = 80$, and $T_{\mathrm{ref}} = 78$. Within these limits, employers have the freedom to adjust working time free of charge. Let $\mathrm{aba} = -60$ and $s = 46$, then 32 weeks remain to settle the account.

Widely used in Germany's labor market practice is an elaborated version of this basic working time account system. Because such accounts integrate employment or job guarantees for respective employees, we introduce the term *working time accounts as a mutual insurance device* for this elaborated version of WTA systems (see Seifert/Massa-Wirth (2005) for a study of associated no-layoff clauses in pacts for employment and competitiveness). In the next subsection, we first introduce working time accounts as a mutual insurance device in a further definition and second prove that this device in fact establishes a renegotiation-proof institution of internal labor market flexibility, while providing private unemployment insurance.

V.B. Mutually beneficial insurance in practice: WTA as a renegotiation-proof institution

The mutual insurance device version of working time accounts is outlined in Definition 5. It describes the most common type of intertemporal shifting of hours in working time accounts in Germany. Subsequently, we will use insights from Chiappori et al. (1994) to show that such working time accounts are not only preferable from a stochastic point of view, but are also self-enforcing and do establish a renegotiation-proof labor market adjustment institution.

DEFINITION 5 (WORKING TIME ACCOUNTS AS MUTUAL INSURANCE DEVICE). Fix the WTA from Definition 4 and add the following two elements: (i) Working time accounts as a mutual insurance device (wta_mi) explicitely insure the employee against unemployment resulting from shocks in random job destruction. No participating firm will lay off any worker due to operational reasons. (ii) Working time accounts as a mutual insurance device (wta_mi) integrate a refined efficiency wage mechanism to ensuring insensitivity of wages to internal intertemporal flexibility of hours whilst enabling the scope for compensating bonus differentials to account for worker idiosyncrasies by individualizing informal bonus payments. Then

$$\text{wta\_mi} := \{\text{wta}, \text{jsec}\},$$

$$\text{with wta as in Definition 4, except } \boldsymbol{w} = \begin{pmatrix} w_{\text{eff}} \\ \mathbf{1}_{\text{ibp}} \\ w_v \end{pmatrix}, \text{ and with}$$

$$\text{jsec} = \text{"retain employment obligation"}.$$

Refined compensation package writes as $\boldsymbol{w}$. Here, incentive compatible fixed wage w_{eff} captures the appropriate incentive device necessary to satisfy effort standards requirements and in line with collective bargaining solutions. If informal bonus payments arrangements are in place indicator vector $\mathbf{1}_{\text{ibp}}$ assumes value 1. The informal bonus is at discretion of employers based on their subjective assessment of worker performance, with the objective to rewarding idiosyncratic jobs characteristics and also heterogeneity of workers. Again, variable payment w_v covers performance related pay based on objective performance measures. The mutual insurance mechanism is completed by employment safeguarding guarantee, denominated as jsec. By inclusion of jsec employers commit to a jobs safeguarding strategy, meaning that dismissal due to operational reasons will not be executed. When practiced in conjunction, intertemporal flexibility through working hours variation $(\boldsymbol{\Delta_t^-}, \boldsymbol{\Delta_t^+})$ and jobs safeguarding (jsec) define a reciprocal insurance device against unemployment and negative consequences of demand fluctuation.

It is straightforward that w_{eff} in general entails income smoothing and therefore enables intertemporal smoothing of consumption. The option of accounting for worker and job slots

heterogeneity by informal bonus payments ibp is specified, since the value of an employment relation varies with such heterogeneity. Moreover, in the context of unfilled vacancies informal bonuses enable firms to retain contract specific surpluses and to voluntarily share profits.[23]

Further, the joint use of (random) transfer of worked hours ($\boldsymbol{\Delta_t^-, \Delta_t^+}$) and job security (jsec) is crucial in respect of renegotiation-proofness of such private insurance arrangements on the labor market as well as for mutual credibility of commitment by employer and employee. Appropriate proofs of renegotiation-proofness of employment safeguarding strategies point to consumption smoothing with random savings, as developed in Chiappori et al. (1994) who address the issue of motivation and two-sided commitment in the context of repeated moral hazard. We draw directly on the authors' results regarding controlled savings and borrowing, though most empirical applications will violate circumstances where agent's savings can be monitored by the principal.

A crucial insight in Chiappori et al. (1994, 1549) is that *"optimal contracts will therefore always exhibit memory of consumption whenever technically possible"*. The result is based on the general desirability of intertemporal smoothing, which in fact corresponds with the second order stochastic dominance rule we discussed in Definition 2 and Proposition 2. Consequently, optimal long-term employment relations will internalize this need and will be invulnerable to renegotiation. A straightforward conclusion is that in such cases intertemporal smoothing derives independently from incentive constraints. In other words, whenever employer and employee are able to contract upon the amount of intertemporal hours movements, then the following argument applies: *"(c) When the principal can monitor the access of the agent to credit markets, then he has the best of both worlds. Since no incentive constraints need to be considered for savings, the optimal long-term contract is sequentially efficient; moreover, contractual savings allow the principal to adjust the agents's reservation utility level along the optimal sequence of spot contracts, which thus achieves long run efficiency."* (p. 1550). If, however, an employer is restricted in monitoring the employee's saving then intertemporal

[23] A model of self-enforcing informal bonus contracts in the face of non-verifiable performance (assessment) is introduced by MacLeod/Malcomson (1989) who also address the choice between incentivization through labor discipline device contracts and discretionary bonus contracts, depending on regional labor market conditions and behavioral factors like economic beliefs. Idiosyncratic bonuses are further analyzed in Lemieux et al. (2009). Empirical analysis in Lemieux et al. (2012) reveals that introducing bonus pay might mute inefficient separation and significantly contributes to sustaining volume of work.

consumption smoothing, sequential efficiency, and therefore renegotiation-proofness will fail (except for special case of CARA preferences). Thus, the authors resume: *"Of course, case c) may seem to have limited empirical relevance."* (p. 1550) and *"there are many reasons why the agent might be prevented from borrowing as much as he likes, but it is more difficult to imagine how the principal could constrain the agent's savings. … Apart from these special cases, however, the constrained savings result appears to lead … to a dead end."* (p. 1540).

Nevertheless, our working time accounts as a mutual insurance device frame immediately establishes the constraint savings context: wta_mi definitely satisfy the associated conditions, since hours surpluses denote states where realized working time exceeds standard working hours (matching constrained saving), while hours deficits denote states where realized working time falls short of contracted expected working time (indicating constrained borrowing). Equivalently, the realized hourly wage of an employee, i.e. in purely arithmetical terms, varies with any activity on his/her working time account: Hence, $\boldsymbol{\Delta_t^-}$ points to t in Chiappori et al. (1994, 1537), while $\boldsymbol{\Delta_t^+}$ points to s, with s denoting saving by the employee and t denoting employer's saving.

While adjusting an employee's realized working hours over the cycle, an employer automatically controls the employee's access to the credit market for hours. Then, by controlling the worker's access to time credits and time deficits, the employer monitors the realized hourly wage $\frac{w}{h_t}$ and, simultaneously, the difference between the actual value of hourly wages, i.e. $\frac{w}{h_t}$, and the expected value of hourly wages, i.e. the contracted standard $\frac{w}{h_{st}}$. Let us write such a difference as $-\rho_t$ in case of employee's saving or as τ_t in case of employee's borrowing. Overall, the employer-principal constrains the employee-agent's current saving and borrowing through intertemporal transfers on working time accounts.

A more formal illustration of smoothed consumption, fluctuating actual hourly wages, and controlled savings and borrowing in working time accounts as a mutual insurance device is as follows: For simplicity of exposition, let us assume monthly income w_{eff} to be consumed, thus consumption is smoothed at level w_{eff}.[24] Notice, however, that the associated hourly wage,

[24] Recall that discretionary bonus payments ibp are controlled by employers and are thus consistent with the constrained savings environment.

which an employee actually receives, varies with the number of hours that he/she worked in that month. In the preceding paragraph, we denoted the corresponding value as actual or realized hourly wage. Since the magnitude of intertemporal shifting of working time is determined by the employer in line with the rules of the working time accounts arrangement, it is exactly this employer who has an impact on actual hourly wages and, consequently, controls the associated deviation between actual and expected hourly wages. Such deviation, in turn, equals the amount of worker's saving or borrowing, respectively. Therefore, we can say that the employer effectively controls and monitors the employee's access to the credit market as proposed in case (c) by Chiappori et al. (1994).

A negative deviation is imposed whenever actual, i.e. realized, hourly wage is below the reference value that always refers to standard working time h_{st}. A negative deviation thus indicates controlled savings ρ_t. A realized hourly wage exceeding the contracted reference points in turn points to constrained borrowing τ_t by an employee. Notice that savings and borrowing are written in monetary terms, not as time credits or deficits: Savings and borrowing depict the pecuniary equivalents of intertemporal time transfers, from a worker's perspective.

For a negative deviation between realized and regular hourly wage, the decomposition of actual hourly wage $\frac{w_{\text{eff}}}{h_t^m}$ into expected hourly wage $\frac{w_{\text{eff}}}{h_{st}^m}$ and random hourly savings ρ_t yields the constrained savings case:

(1a) $$\underbrace{\frac{w_{\text{eff}}}{h_{st}^m+\Delta_{t,m}^+}}_{\substack{\text{actual hourly wage} \\ \text{(less than usual)}}} = \underbrace{\frac{w_{\text{eff}}}{h_{st}^m}}_{\substack{\text{expected hourly wage} \\ \text{(reference point)}}} - \underbrace{\rho_t}_{\substack{\text{random hourly savings} \\ \text{(controlled by the employer)}}} ,$$

(1b) $$\rho_t = \frac{\Delta_{t,m}^+ \cdot w_{\text{eff}}}{(h_{st}^m+\Delta_{t,m}^+)\cdot h_{st}^m} = \frac{\Delta_{t,m}^+}{h_t^m} \cdot \frac{w_{\text{eff}}}{h_{st}^m} ,$$

with actual working time h_t^m denoted as $h_t^m = h_{st}^m + \Delta_{t,m}^+ > h_{st}^m$.

The equations can be interpreted as follows: By using the option to transitorily increase working time in response to market fluctuation the employer influences realized hourly wages

of an employee. In particular, the decision of upward adjustment of labor along the intensive margin imposes a mandatory, thus constrained, savings component on monthly average earnings. In mathematical terms, a ratio equal to $\frac{\Delta_{t,m}^{+}}{h_t^m}$ of standard hourly earnings is converted into temporary savings by that employee.

We elucidate with a numerical example: Suppose monthly salary of $w_{\text{eff}} = 3200$, monthly standard hours of $h_{st}^m = 160$ as well as realized hours increase of $\Delta_{t,m}^{+} = 5$. The employee then receives an actual hourly wage of $\frac{w_{\text{eff}}}{h_t^m} = 19.4$. By comparison with expected hourly wage $\frac{w_{\text{eff}}}{h_{st}^m} = 20$ we infer that 3% of the contracted hourly wage is converted into temporary savings.

Let us proceed with the counterpart of constrained borrowing. In such cases a positive deviation between current hourly wage and standard hourly wage realizes, driven by downward flexibility of working time. Here, we decompose actual hourly wage $\frac{w_{\text{eff}}}{h_t^m}$ into expected hourly wage $\frac{w_{\text{eff}}}{h_{st}^m}$ plus random hourly borrowing τ_t:

(2a) $$\underbrace{\frac{w_{\text{eff}}}{h_{st}^m + \Delta_{t,m}^{-}}}_{\substack{\text{actual hourly wage} \\ \text{(more than usual)}}} = \underbrace{\frac{w_{\text{eff}}}{h_{st}^m}}_{\substack{\text{expected hourly wage} \\ \text{(reference point)}}} + \underbrace{\tau_t}_{\substack{\text{random hourly borrowing} \\ \text{(controlled by the employer)}}} ,$$

(2b) $$\tau_t = \frac{-\Delta_{t,m}^{-} \cdot w_{\text{eff}}}{(h_{st}^m + \Delta_{t,m}^{-}) \cdot h_{st}^m} = \frac{-\Delta_{t,m}^{-}}{h_t^m} \cdot \frac{w_{\text{eff}}}{h_{st}^m} ,$$

with actual working time h_t^m denoted as $h_t^m = h_{st}^m + \Delta_{t,m}^{-} < h_{st}^m$.

Again, our numerical example illustrates: All other things equal, suppose that a 5 hours activity on the working time account during the month under consideration comes as a drawing down of surpluses. Thus, the level of monthly deficit hours is equal to $\Delta_{t,m}^{-} = -5$. Further, actual hourly wage amounts to $\frac{w_{\text{eff}}}{h_t^m} = \frac{3200}{155} = 20.65$, which exceeds the reference value of 20

monetary units. Overall, this implies a constrained borrowing rate of 3.25% referred to the contracted standard of 20.

Taken together, working time accounts as a mutual insurance device yield the "constrained access case" a la Chiappori et al. (1994), and wta_mi establish a long-term efficient and renegotiation-proof labor market institution operating at the firm-level with the objective to adjusting random labor market dynamics, thereby providing incentives for private unemployment insurance, eventually implementing a pattern of intensive vs. extensive margin adjustment that fairly captures recent evidence of muted labor market response in Germany.

In addition, Germany's collective bargaining practice supports mutual credibility: The obligation of employers to no-layoffs clauses jsec is covered by the same agreement as is the WTA system, including the scope for flexibility $\boldsymbol{\Delta_t^-, \Delta_t^+}$. Consequently, within the negotiated duration of the agreement employers mandatorily comply with associated jobs safeguarding rules over the cycle – and this is exactly what happened during the world crisis.[25]

Proposition 4 summarizes the major contribution of this paper for solving the remaining part of the German labor market miracle.

PROPOSITION 4 (explaining the German labor market miracle). *Working time accounts as a mutual insurance device* (wta_mi) are well-established as a labor market practice in Germany. They display an integral part of sophisticated industrial and workplace relations and are typically settled in collective agreements or in individual company contracts.

(1) If intertemporal shifting of working time through individualized banking of hours is tracked in such reciprocal schemes, then wta_mi internalize antipodal employment risks, thus stochastically dominate competing labor adjustment practices, which imply variable adjustment costs, such as extensive margin adjustment or intensive margin adjustment through paid overtime and short-time work.

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[25]Chung et al. (2007) and Kouzis/Kretsos (2003b) give overviews for contractual arrangements. Case studies on negotiation of *Collective Agreements on Employment Security and Working Time Accounts* can be found in Croucher/Singe (2004). Seifert/Massa-Wirth (2005) do embed their literature review on *pacts for employment and competiveness* in Germany in a discussion of the decentralization of industrial relations responsibilities and, moreover, contribute with content analyses of such pacts, including employer guarantees like guarantees against involuntary layoff. The enabling property of gradually increasing decentralization of collective bargaining, accompanied by instruments of internal flexibility of labor, is further stressed by Reisenbichler/Morgan (2011).

(2) Internalizing reallocative labor market risks by intertemporal shifting of working time introduces consumption smoothing and smoothing of operating profits. Therefore, wta_mi are renegotiation-proof and, further, imply long-term efficiency of associated contracts, since the embodied smoothing effect automatically imposes the constrained savings case a la Chiappori et al. (1994). While intertemporal flexibility in working time accounts retains employment and keeps monthly salary unchanged, realized hourly wages of an employee vary randomly. Any hours movement documented on a working time account immediately affects realized hourly wage: Time deficits arithmetically increase hourly wages in comparison to contracted standard (imposing random borrowing), whereas time credits arithmetically decrease realized hourly wages (imposing random savings). With the level of savings and borrowing at discretion of the employer in response to market developments, but known to both parties, wta_mi establish a renegotiation-proof firm-level labor market practice.

(3) Given a context of negatively skewed distributions, use of wta_mi generates a mean increasing contraction on employment and on income paths. Such a negatively skewed stochastic environment has been imposed by the Great Recession as a natural experiment on labor markets; accordingly agents' expectations over the business cycle did reshape, eventually deteriorating confidence in economic development, pointing to distribution $G_{sk}(t)$ of random job destruction. Thus, cutback of (surplus) hours in wta_mi during the Great Recession created truncated distribution $F_{sk}(t)$ by implementing a probability mass shift on – also truncated – random job destruction $G_{sk}(t)$. Then, distribution $F_{sk}(t)$ first order stochastically dominates its untransformed reference $G_{sk}(t)$. Relevant shift of probability mass within the distribution of employment adjustment materializes through intertemporal shifting of worked hours on corresponding working time accounts. Truncated reference distribution G, for example, attributes to practices in the shocks mitigating regime like sequences of incompletely compensated short-time work, and even dismissal policies.

In sum, during crisis the renegotiation-proof option working time accounts as a mutual insurance device immediately implemented employment and human capital safeguarding, contributed to income maintenance, and to employee well-being in Germany. The decision under risk approach of employment dynamics as outlined in Propositions 2 and 3 revealed

superior shocks mitigating properties of practiced working time accounts schemes and, therefore, their key importance in resolving the German labor market (dynamics) puzzle.

Proof. Corresponding proofs are straightforward. First, in case of e.g. transitory demand shocks Proposition 2 and Figure 3 apply, thus proving the second order stochastic dominance property of working time accounts as a mutual insurance device. Second, renegotiation-proofness immediately follows from equations (1b) and (2b) in combination with Chiappori et al. (1994). Third, with principally pessimistic expectations associated to the Great Recession, Proposition 3 applies (illustrated in Figures 3a and 3b), thus establishing first order stochastic dominance of working time accounts as a mutual insurance device. □

To summarize, from a stochastic dominance approach perspective, the renegotiation-proof institution of mutually beneficial insurance between firms and workers, namely working time accounts as prevailing in Germany, crucially contributes to filling the explanation gap of the German labor market miracle. In contrast to intuitive approaches in the literature, we are now able to formally prove the capacity of such accounts as an adjustment method of choice with characteristics of a silver bullet for employment. Stochastically speaking, adjustment in working time accounts differs by a sequence of at least mean preserving decreases in risk from competing adjustment measures. Further, under well-defined circumstances like deteriorated expectations, working time accounts imply a sequence of mean increasing reductions in risk.

V.C. Discussion

We are now able to fill the research gap on sources of the German labor market miracle. By applying the probability mass shift approach of internalizing reallocative risks to internal flexibility in working time accounts, we have shown that the widespread use of intertemporal shifting of working hours in working time accounts is first particular to Germany (contributing to research question 2) and, second, also points to an adjustment practice that is mutually beneficial to firms and workers (positively answering question 3). Intertemporal flexibility in working time accounts as mutual insurance device exhibits second order stochastic dominance and might, depending on challenges on economic confidence, generate first order stochastic dominance within the shocks mitigating regime's taxonomy.

Mutually beneficial effects result, since within the scope for flexibility, i.e. within limits $\boldsymbol{\Delta_t^-, \Delta_t^+}$, working time accounts cushion and reverse any temporary demand shift. Stochastically

speaking, the transfer of worked hours between periods unambiguously shifts the associated probability mass of the probability density function to the center, with the density function corresponding to firm's and employee's objective function, respectively. Thus, working time accounts second order stochastically dominate (SSD) competing labor adjustment practices such as hiring-and-dismissal patterns or well-known sequences of overtime-/short-time use. The intuition behind SSD is that every risk averse employee strictly prefers the smoothed income path to more risky prospects of unemployment(-benefits)-employment spells, including varying remuneration, and also to random sequences of short-time compensation and paid overtime. Analogously, firms prefer continuous availability of human capital to random sequences of recruiting and layoff. In comparison to intertemporal flexibility in working time accounts, extensive margin adjustment involves separation costs, recruitment costs, loss of income and human capital, and search costs. Although a balanced combination of the more traditional instruments within subregime E from the shocks mitigating regime (Table 3) might in principle achieve similar results in terms of probability mass shift on employment, such combinations will be dominated by incentive compatible intertemporal shifting of hours in working time accounts in terms of disposable earnings and variable adjustment costs.

Regarding principal applicability of working time accounts recall that our results on stochastic dominance are not independent from quasi-fixed costs of labor or entitlement to overtime payment. Potential benefits are, moreover, reinforced by significance of specific human capital and the presence of some efficiency wage mechanism. In terms of potential adoption of a system of working time accounts as a mutual insurance device, we expect firms to self-select along well-defined productivity-threshold patterns. Similarly, industrial relations climate, reputation, and commitment in workplace relations are expected to further encourage the settlement of working time accounts as mutual insurance device in collective contracts.

Of course, the probability mass shift approach applies to non-symmetrical errors and cycle-related anomalies as well. In terms of behavioral economics, the world crisis caused massive turbulences on economic confidence, eventually implementing truncated expectations. Given such downward distorted expectations, we then verified the property of first order stochastic dominance (FSD) to be embodied in intertemporal hours flexibility in working time accounts. With the dramatic events at the end of 2008, the majority of economic actors interpreted the Financial Crisis as an exogenous shock being accompanied by rebooting the whole economic

system and also by a generally deteriorating effect on future economic development. In terms of random variables, we thus modelled labor market adjustment paths during crisis and early post-crisis as truncated distributions. In particular, we added with analyses of collapsed-to-the-mean and folded distributions, respectively. The extended model could reveal that the German system of reversible labor adjustment along the intensive margin – as operated and tracked in working time accounts as a mutual insurance device – implemented such a probability mass shift on the distribution of random job destruction that created a mean increasing contraction of employment. Overall, first order stochastic dominance of working time accounts within the shocks mitigating regime resulted.

Thus, in the Great Recession working time accounts as established in Germany's industrial or workplace relations imposed a mean increasing contraction on employment. Therefore, with lack of economic confidence and cycle-related anomalies, working time accounts as a mutual insurance device will be preferred by all agents for whom the monotonicity axiom holds.

In the German system of collective and decentralized bargaining, working time accounts are of increasing importance, almost pari passu with key factors like wage development or transition from temporary to permanent employment. In Definitions 4 (and 5) we defined the constituting elements of working time accounts (as a mutual insurance device). From existing studies we know that the great majority of existing working time accounts arrangements is sophisticated in terms of explicitly stipulating the constituting elements that are outlined in the above definitions (Groß (2010), Groß/Schwarz 2007), where the representative working time account scheme is covered by a collective agreement or a company-level/plant-level contract that operates the mutual insurance device. Due to the obligation of unambiguous employment safeguarding, such contracts are typically denoted as pacts for employment (Tarifvertrag zur Beschäftigungssicherung).[26] The expiration date of contracted employment guarantees is part of such agreements, and often duration of no-layoff clauses considerably exceeds the duration of the accompanying collective agreement itself. A time horizon for jobs safeguarding of five

[26] In the design of our study, we took into account the fact that the majority of institutional arrangements in Germany encompasses a binding commitment of the employer to a jobs safeguarding strategy. So called "no-layoff due to operational reasons" clauses are explicitly included in the agreements and third party enforcement in case of dispute is ensured by existing court decisions, which in fact encourage reputation, while substantially punishing reneging behavior.

to ten years is fairly standard, in fact implementing long-term employment relations. Further, regular renewal of such pacts is common practice.

Overall, the typical German working time accounts system satisfies Definition 5 and, thus, renegotiation-proofness holds (solving research question 4): Given such employment relations, intertemporal flexibility in working time accounts randomizes current hourly wages, while leaving monthly salary unchanged. Technically, this randomization decomposes the realized hourly wage into either (i) expected hourly wage plus random borrowing (shifting working time to future periods) or (ii) expected hourly wage minus random savings (working excess hours with time-off entitlement in future periods). By construction, workers' access to savings and borrowing in working time accounts is controlled by the employer who adjusts working hours to product demand shocks. With this controlled access property, a rarely satisfied but strong result from Chiappori et al. (1994) holds: Working time accounts as mutual insurance device establish a renegotiation-proof institution of labor market adjustment.

To summarize, as a labor market practice mutual insurance device working time accounts in fact contribute to explaining the German labor market miracle. Renegotiation-proofness is relevant in order to allow for assessing working time accounts as an adequate and key instrument in the jobs oriented adjustment menu. With the probability mass shift approach as point of departure for our explanatory model, the unprecedented performance of the German labor market no longer comes as a surprise, and even the jobs generating and profit enhancing recovery path is fairly plausible when taking quasi-fixed labor costs and effort standards into consideration. Such standards are e.g. common in German export industry.

VI. SUMMARY AND CONCLUSIONS

The objective of this paper has been to fill the remaining research gap on explanatory factors of the German labor market miracle. The existence of a non-negligible labor market miracle has become evident during the Great Recession, which in fact has imposed a natural experiment on labor markets and economic development. The term miracle has been addressed because of the stylized fact that the German labor market – in contrast to many other economies – virtually absorbed the GDP shock, despite being at least as much affected by the sharp drop in world demand. The employment safeguarding performance of the German labor market during the world crisis as well as the still lasting job generating capacity during

recovery are also in contrast with former patterns of jobless growth in Germany and contradict predictions at early stages of the world crisis, where the majority of politicians and economists had, in fact, expected considerable downward adjustment of employment accompanied by unemployment growth rather than the observed stability of employment relations, falling youth unemployment and the reduction of long-term unemployment.

The German labor market miracle has been the point of departure for our analysis. We started with a classification of the main channels of labor adjustment to external shocks, and further concentrated on labor adjustment along the intensive margin, given the jobs oriented approach in Germany. We introduced the distinction between intensive margin adjustment for muting cycles and shocks mitigation purposes, on the one hand, and structural reallocation of working time through a rising share of part-time jobs, on the other hand, since the latter had driven before crisis evolution of aggregate per capita working hours. But during crisis and recovery the part-time effect has been remarkably absent, thus we finally focused on the shocks mitigating regime, for which we introduced a new taxonomy of intensive margin adjustment practices. This taxonomy first includes traditional instruments like paid overtime work and short-time work, both imposing disproportional remuneration changes. Second, it integrates temporary work sharing with respective effects on earnings. In comparison to conventional work sharing, temporary work sharing is reversible and comes with a contracted expiry date. While conventional work sharing has not obtained much popularity as a reliable adjustment or jobs oriented practice, temporary work sharing is definitely relevant in case of shutdown risk. Third, intertemporal shifting of working hours in working time accounts enters the taxonomy, pointing to an adjustment practice whose utilization maintains salaries unchanged. Fourth, overtime work with entitlement to compensatory time-off in lieu – a technical equivalent to accumulation of surpluses on working time accounts – is incorporated. Moreover, for the sake of completeness, the hours effects of inter-annual shifting of paid vacancy days and also of inter-annual changes of reported short-term absenteeism are included.

We then filled the taxonomy with corresponding data, where operationalization of the shocks mitigating regime is based on working time and volume of work tables (Federal Employment Agency), supplemented by representative survey data on operating hours and workplace relations. The descriptive study addressed labor market dynamics in response to the financial crisis and also during recovery, with available information included for employment,

contracted working hours, and decomposition of labor adjustment practices along the intensive margin. Results revealed a remarkable labor hoarding effect with rather stable employment from 2008-09 and a modest jobs generating path at the beginning of recovery from 2009-10. In contrast to the preceding development, reallocation of working time due to extension of the part-time and secondary work segment has been negligible. Indeed, descriptive evidence shows that the dynamics of the four core instruments from our taxonomy, namely short-time work, paid overtime work, temporary work sharing, and working time accounts accounted for about 96 % of total decline in hours per employee from 2008 to 2009 in Germany. In the 2009-10 expansion, they accounted for more than 97 % of upward adjustment capacity.[27]

The joint contribution of short-time work (introduction or extension) plus cutback of paid overtime work to job retention 2008-09 was less than 45 percent. The seemingly key success factor short-time work accounted for merely one out of four hours of shock absorbing annual working time reduction, while every fifth hour of upward adjustment was due to phasing out of short-time work from 2009 to 2010. Therefore, we preliminarily concluded that short-time work is far from being able to explaining the miracle, and that it seems to be very reasonable to further inspect intertemporal shifting of working time in working time accounts as a candidate to filling the research gap, not at least because Germany is rather unique in dissemination and length of experience with working time accounts as a labor market practice. Corresponding joint contribution to the labor market cushioning capacity of generalized work sharing through working time accounts plus the particular temporary work sharing type as defined in the taxonomy definitely exceeded 50 percent. Taking into consideration that about half of the workforce was eligible to time transfers in working time accounts, we interpreted the isolated contribution of working time accounts of almost one fifth to total downward cushioning and of more than 30 percent to (net of rising absenteeism) upward cushioning as remarkable. We also recognized the nearly coincidence of conditional absorption by withdrawal of 45 hours from existing accounts and the about 44 hours aggregate decline in hours per worker from 2008-09.

[27] Reported values are net of – obviously cycle-sensitive – changes in short-term absenteeism. While beyond the scope of this paper, future research on shock-mitigating practices and automatic stabilizers should address determinants and consequences of such sick days. At first sight, it appears that increases in aggregate absenteeism that accompany expansion are neutralized by upward adjustment on working time accounts, and vice versa.

In the succeeding approach, we further integrated insights from existing studies on short-time work, including drawbacks, ambiguous findings, and critical judgment concerning use and extended legislation on short-time compensation in the Great Recession. Overall, negative externalities dominated. We also included findings that differences in employment protection legislation did not add to unraveling the miracle and that the contribution of wage moderation in the preceding decade to the employment retention effect, despite being existent, was rather small. Therefore, as a starting point for our formal analysis, we built on important hypotheses, mainly from the insightful article by Burda/Hunt (2011) who intuitively suspect the use of working time accounts as an instrument to adjust labor along the intensive margin to providing the missing piece in the labor market puzzle.[28]

This paper then added with a decision under risk approach proving this suspicion, based on proofs of stochastic dominance (first and second order). In methodological terms, intertemporal shifting of hours in working time accounts defines a generalized form of work sharing, which mandatorily integrates accumulation of surplus hours during spells of working time extension and accumulation of time deficits in periods of reduced hours under one roof over the cycle. Formally, such transfers are equivalent to probability mass shifts on a random variable, since random drops and peaks in demand determine the associated hours transactions, and thus stochastic dominance rules do apply. By proving stochastic dominance, the model revealed that the refined version of working time accounts that has been widely used in Germany since the late 1990s in fact resolves the German labor market miracle. With respect to a mechanism of employment cushioning inherent in such systems we introduced the term *working time accounts as a mutual insurance device*. Employment contracts that rule working time accounts as a mutual insurance device incorporate employment guarantees or jobs safeguarding, e.g. no-layoff clauses. By construction, such contracts internalize antipodal risks via adjusting labor along the intensive margin, thus stochastically dominate alternative adjustment mechanisms and schedules. Moreover, they are self-enforcing and renegotiation-proof.

[28] Recall that associated adjustment of hours along the intensive margin of labor is tracked in a time banking system, which has become known as working time accounts and denotes a well-institutionalized labor market practice in Germany.

Renegotiation-proofness could be proven, because transactions on mutual insurance device working time accounts counter-act realizations of a random variable, thereby establishing the constrained savings and borrowing case, as introduced by Chiappori et al. (1994). Realized hourly wages vary with any activity on a working time account, since surplus hours point to states where realized working time exceeds standard working hours and hours deficits attribute to states with realized working time less than expected working time. While adjusting realized working time, an employer automatically controls the employee's access to both the credit market for hours and to the value of actual hourly wages. As the magnitude of intertemporal shifting of working time is determined by the employer in accordance with the rules of the working time accounts arrangement, this employer has an impact on actual hourly wages and therefore controls the associated deviation between actual and expected hourly wages. Here, a negative deviation indicates controlled savings and is imposed if the arithmetical hourly wage is lower than the reference value (the latter depicting standard hourly wage, given standard working time). With a realized hourly wage exceeding the contracted reference standard, associated deviation is positive, thus indicating constrained borrowing. Hence, we denoted savings and borrowing in monetary terms rather than as number of time credits or deficits. From a worker's perspective, saving and borrowing reflect the random pecuniary equivalent of an intertemporal time transfer. This paper has shown that constraining current savings and borrowing in long-term employment relations through intertemporal transactions on working time accounts ensures renegotiation-proof adjustment along the intensive margin, thus establishes a labor market institution that provides mutually beneficial private unemployment insurance.

Altogether, there is reasonable evidence that the labor market institution working time accounts as a mutual insurance device that is well-established in Germany's industrial relations landscape significantly contributed to the emergence of the jobs miracle in the Great Recession. Consistent with recent insights on weak hiring behavior during the preceding expansion, employees entered recession with notable positive balances on their working hours accounts. Extending previous research, the decision under risk approach developed in this paper is capable to simultaneously close the explanation gap regarding employment retention during crisis as well as the co-existing research gap regarding reluctant pre-crisis hiring behavior of firms. According to Burda/Hunt (2011), 40 percent of the jobs safeguarding effect

in the Great Recession are not yet explained, while almost 20 percent of muted hiring activity of firms in the preceding expansion could not be disentangled, even if pre-crisis pessimistic economic expectations are accounted for. Confirming the authors' intuition, our model is able to derive why working time accounts as a mutual insurance device yield the missing piece in the employment puzzle, thereby interrelating different phases of the business cycle.[29]

In an environment of negative expectations as in the context of the Financial Crisis, which we integrated as a natural experiment, working time accounts in fact impose a mean increasing contraction on the objective functions of firms and employees, and will be thus preferred by all participating agents for whom the monotonicity axiom holds.

Our analysis extends previous research with a formal approach that relies on only weak assumptions and is generally applicable under various legal settings. Nevertheless, any working time accounts scheme must be properly institutionalized and communicated, since – within the limits of the hours flexibility – deviation from axiom-like rules as overtime pay or short-time compensation is involved. Intuitively, working time accounts integrate non-paid/time-off in lieu overtime work and fully-compensated short-time work into one comprehensive framework of flexible working hours. The set-up of the comprehensive framework as a firm-level institution is not trivial, since the intended employment stabilizing capacity crucially depends on the intertemporal integration of antipodal risks and on enforceability. Here, this paper contributed with a detailed definition of working time accounts, including the constituting elements and procedural rules, with the objective to provide sufficient information for potential lessons from the miracle, thereby emphasizing the importance of transparency within this labor market practice. The definition for working time accounts as a mutual insurance device is intended to serve as a first guideline for potential future users. In terms of potential benefits from the adoption of such an accounts system, we expect firms to pre- or self-select based on well-defined productivity-threshold patterns and the existence of an efficiency wage mechanism.

We believe that our stochastic model of probability mass shift identifies a general principle lying behind exceptional labor market performance from which crucial lessons might be learnt

[29] This paper treated genuine labor market policies, thus stimulus packages and potential consumption effects will be addressed in future analysis.

to tackle unemployment, while preserving incentives. Moreover, if practiced beforehand, intertemporal shifting of working time in general mutes external labor market shocks, thus provides smoothing of excessive or at least rushed hiring and dismissal. Given timing and significance of the world crisis, we treated the Great Recession and its aftermath as a natural experiment on labor markets and recovery paths, that as a byproduct enabled us to reveal important insights on jobs oriented strategies versus growth oriented strategies of economic policy and on potential interdependences. Overall, working time accounts as a mutually beneficial adjustment and insurance practice contribute to a more comprehensive picture of shocks mitigating, thereby circumventing major drawbacks and negative externalities of short-time work. The latter insight is relevant, since in policy discussion the misconception of associating short-time work as causal to the German labor market miracle is still widespread, even though use of short-time work has been very similar to previous recessions.

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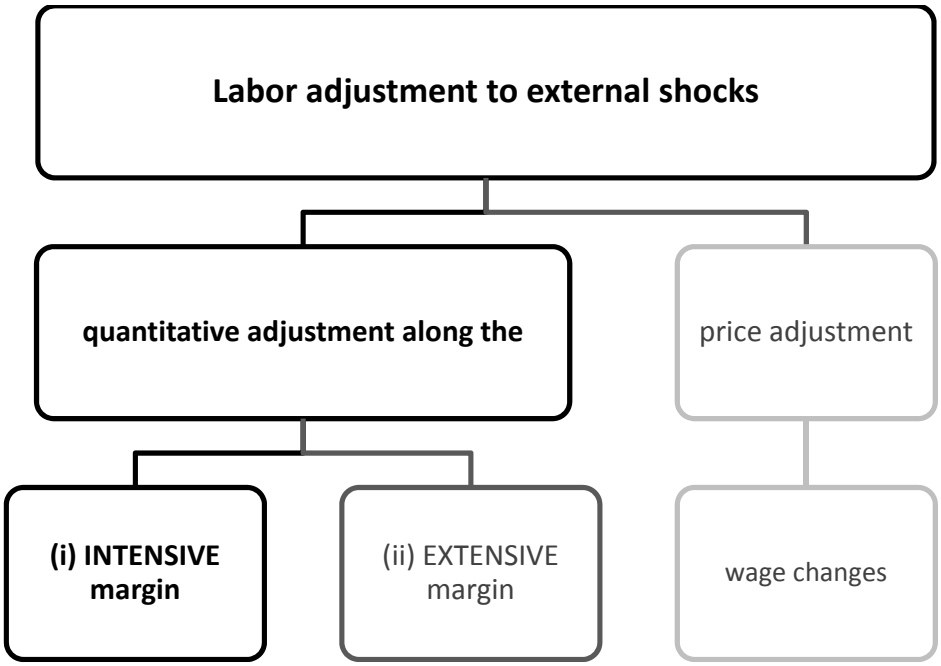
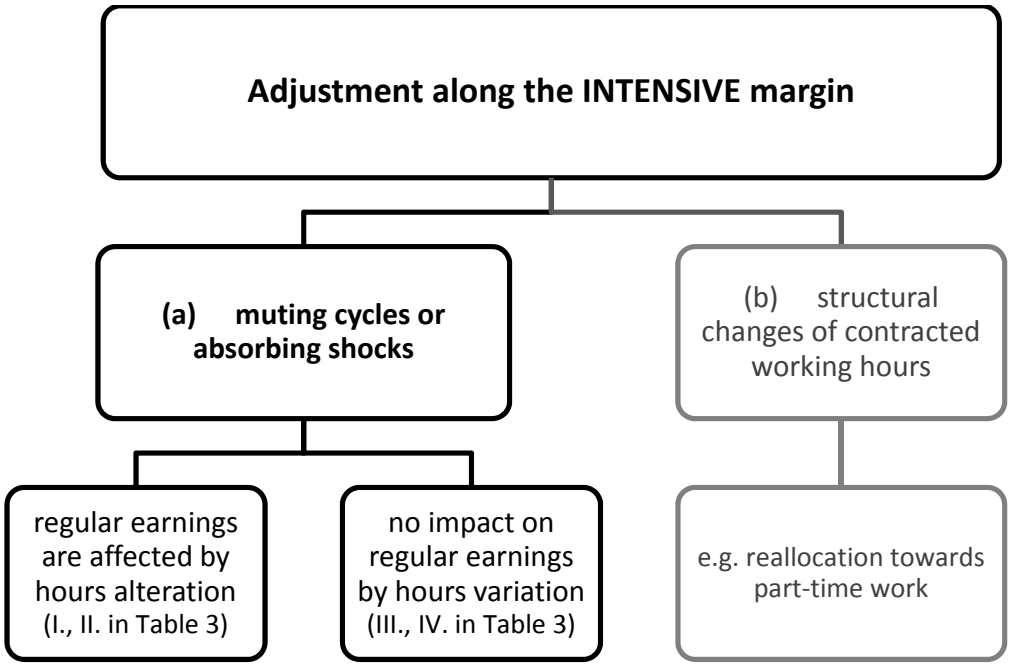
Appendix

Table 1: Main channels of labor adjustment to external shocks



Note: Subsequent Table 2 will focus on labor adjustment along the intensive margin, denoted by adjustment channel (i).

Table 2: A broad classification of intensive margin labor adjustment



Note: Subsequent Table 3 will focus on intensive margin adjustment for purposes of muting cycles and absorbing shocks, denoted by the set of strategies in branch (a): Shocks mitigating regime.

Table 3: Shocks mitigating regime – Taxonomy of intensive margin adjustment practices, by impact on regular earnings

Subregime E	**Regular earnings are affected by hours alteration**

I. Hours adjustment entitles to compensatory pay/earnings replacement

One-sided deviation from contracted regular working hours, including:

a. working excess hours with compensatory overtime payment or premium: **PAID-OVT**
b. working less hours covered by a short-time work scheme: **STW**

II. Downward adjustment of hours proportionally decreases monthly earnings

Cutback of standard weekly hours with contracted expiry date (fixed term):

c. temporary work sharing arrangement (enactment/ceasing): **TWSH**

Subregime NE	**Regular earnings are not affected by hours change**

III. Intertemporal shifting of working time: Compensation-preserving

d. hours accumulation and hours withdrawal in working time accounts: **WTA**
e. working longer hours with entitlement to compensatory time off in lieu: **TOIL-OVT**
f. inter-annual shifting of annual leave entitlements: **PAID-VAC**

IV. Other cyclically sensitive changes in annual working hours

g. variation in short-term absenteeism: **ABS**

Note: Corresponding labor market data in Germany appear in subsequent Table 4

Table 4: Decomposition of aggregate decline in hours per worker (2008-09) and of total increase in hours per worker (2009-10)

As percentage share of total change in annual hours per worker

		2008-09	2009-10
E.	**Regular earnings are affected by hours alteration**		
I.	Hours adjustment entitles to compensatory pay/earnings replacement		
a.	PAID-OVT	19.5	25.7
b.	STW	25.0	21.4
II.	Downward adjustment of hours proportionally decreases monthly earnings		
c.	**TWSH**	**33.3**	**19.9**
NE.	**Regular earnings are not affected by hours change**		
III.	Intertemporal shifting of working time: Compensation-preserving		
d.	**WTA**	**18.1**	**46.7**
e.	TOIL-OVT*		
f.	PAID-VAC: included in V. (RESID), due to non-synchronized reference spells		
IV.	Other cyclically sensitive changes in annual working hours		
g.	ABS	-0.2	-16.3
V.	Other, incl. reallocation in composition of part-time and full-time jobs		
	RESID	4.3	2.6
	Total change in annual hours per worker and in employment		
		-43.6	27.6 (hours)
		17,000	191,000 (persons in employment,
		28,000	171,000 … subject to social security)

Data sources: Fuchs et al. (2012), for methodology cf. Bach/Koch (2003), own calculations.

* No entry, since IAB measurement concept essentially includes TOIL-OVT in the WTA estimates. With the company employment safeguarding programs being launched in the Great Recession and reverted in the aftermath, TOIL-OVT might also contribute, to some extent, to TWSH (due to work-hour reduction packages in response to weak demand using up accrued time off; due to early end of reduced hours in response to recovery). To some extent, TWSH schedules have been transformed into WTA schemes during recovery. For exemplary reporting in business and engineering newspapers: http://www.wallstreet-online.de/ _print/nachricht/2944675-daimler-beendet-arbeitszeitverkuerzung-einen-monat-frueher; http://europe.autonews.com/section/BREAKING?profile=&date=20100510&d=1.

Table 5: WTA and labor market flexibility in Germany

Incidence, characteristics, and absorption capacity

Increasing WTA coverage and long experience [a)]

	1999	**2009**
% of **firms** covered	21	32
% of **employees** covered	35	51

WTA: Prevailing institutional arrangements [b)]

	Hours
Average allowance of hours transfers (upper bounds)	
i) **Maximum** number of hour **surpluses** (i.e. limit of worked hours exceeding regular hours)	103
ii) Maximum number of hour deficits (i.e. limit of regular hours exceeding worked hours)	63
Average duration until mandatory WTA settlement	**Weeks**
iii) **Window of time to average** de facto worked hours to regular hours	38
Degree of sophistication and experience	**Percent**
iv) **Ratio of well-ruled** and well-institutionalized WTA	77

Adjustment capacity from WTA during Great Recession [c)]

v) **Documented surpluses** on existing accounts (i.e. average WTA balance as by 2008q2)	72 hours
vi) **Average number** of hours **withdrawn** from WTA (i.e. downward adjustment per account 2008q3-2009q3)	45 hours
vii) **Share of firms** with movements on WTA to **tackle crisis** (i.e. realized hours shift is reported to be driven by GR)	48 percent

Aggregate adjustment of annual working hours 2008-09 [d)]

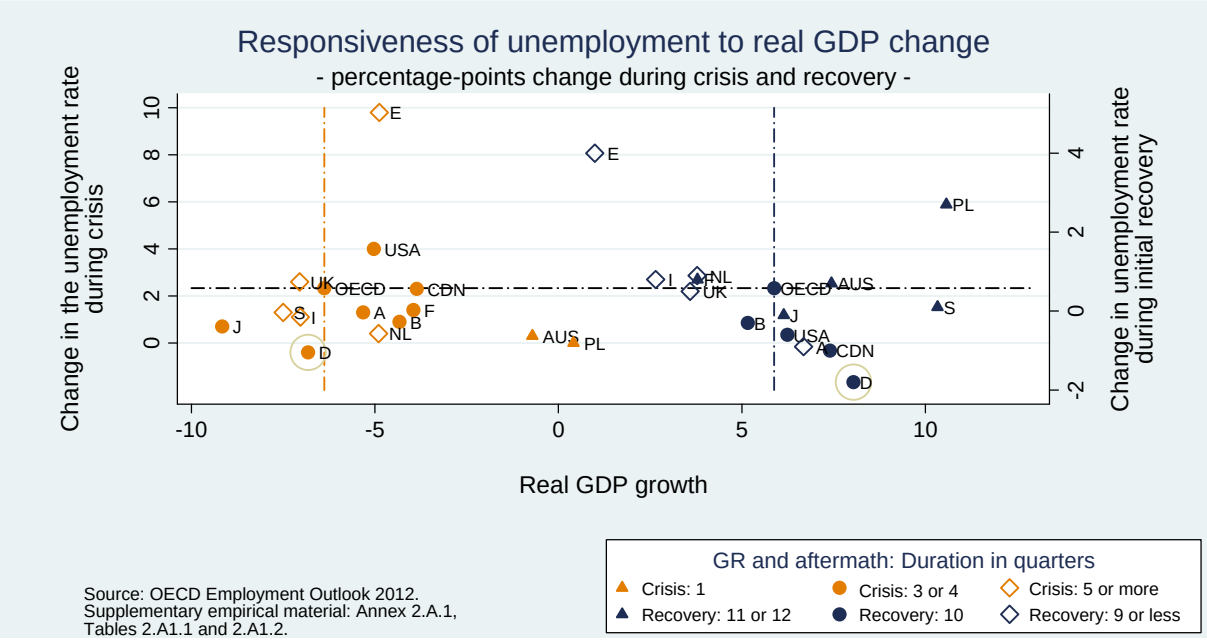
Decline in de facto **working time** per capita	44 hours

a) Sources: IAB Establishment Panel Survey and 2009 WSI Works Council Survey (WSI WC S); Zapf (2012), Möller (2010), Zapf/Brehmer (2010). Notice that ISO/sfs Employer Survey reports 37% coverage for employees subject to social security in 1999, increasing to 41% in 2003, and further up to 47% in 2007 (Bauer/Munz (2005), Groß/Schwarz 2010).

b) Sources: ISO/sfs Employer Survey on Operating Hours 2007; Groß (2010), Groß/Schwarz (2010). Note that WTA are typically settled as firm-specific or collective agreements, often in so called PECs (pacts for employment and competitiveness, Seifert/Massa-Wirth 2005). Thus, reported averages of flexibility capacity do not capture existing variety of institutional settings (Groß/Schwarz (2007) for a comprehensive overview).

c) Sources: 2009 and 2010 WSI WC S; Zapf/Brehmer (2010), Zapf/Herzog-Stein (2011).

d) Taken from Table 4.



Source: OECD Employment Outlook 2012.
Supplementary empirical material: Annex 2.A.1, Tables 2.A1.1 and 2.A1.2.

Figure 1: Labor Markets and the Great Recession: General Evidence for a Miracle

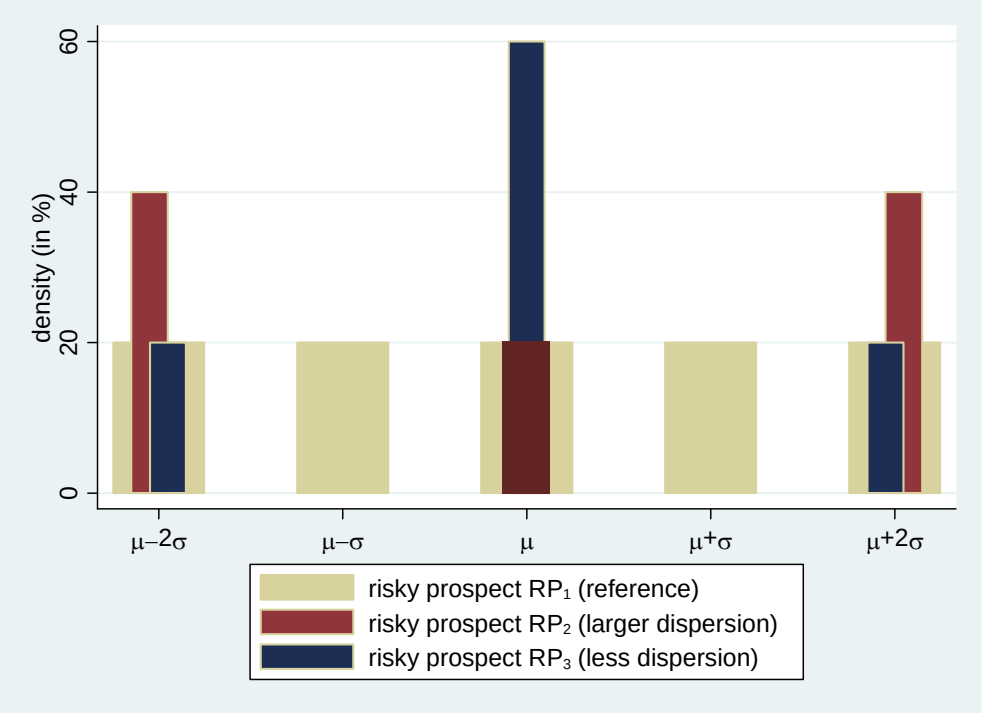
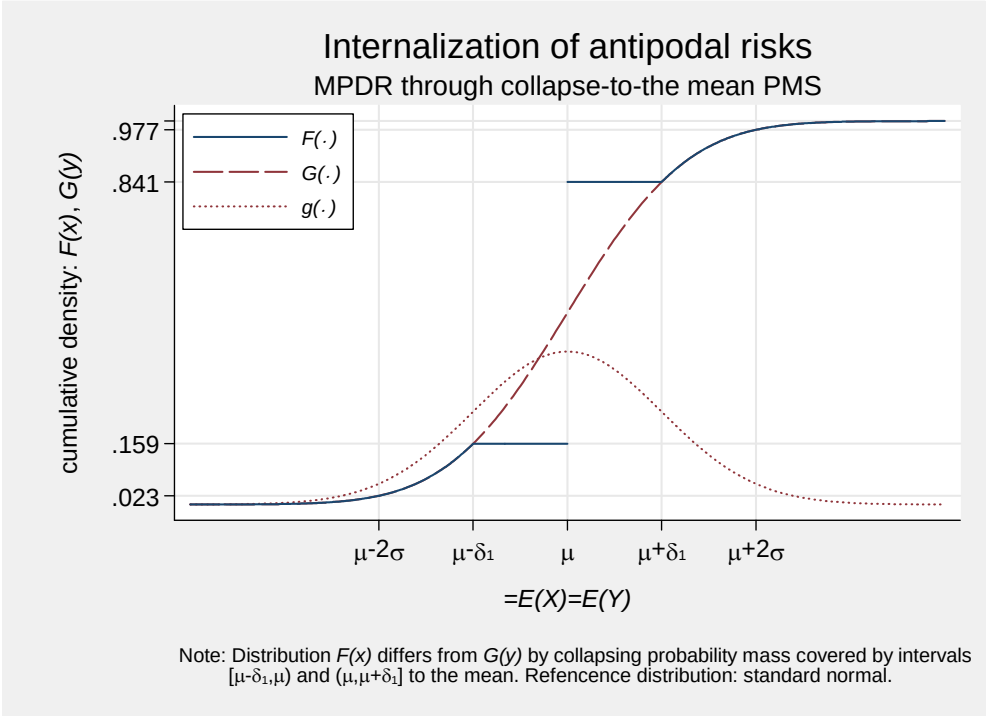


Figure 2: The impact of a probability mass shift on dispersion



Note: Distribution *F(x)* differs from *G(y)* by collapsing probability mass covered by intervals $[\mu-\delta_1,\mu)$ and $(\mu,\mu+\delta_1]$ to the mean. Refencence distribution: standard normal.

Figure 3: The risk elimination potential of a probability mass shift to the center

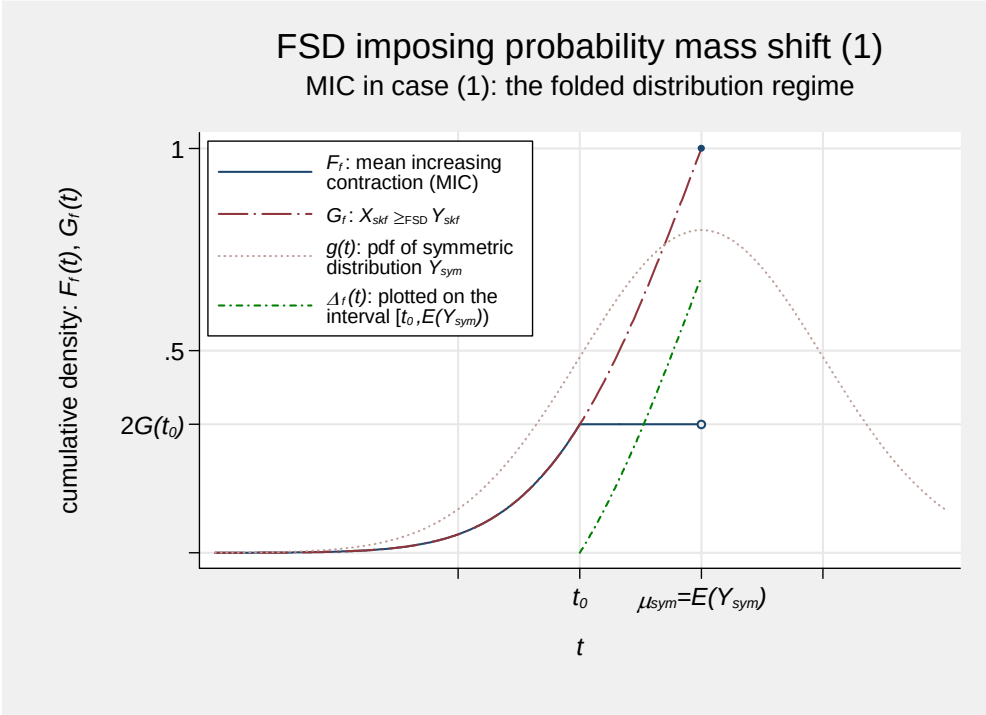


Figure 4a: The essence of Proposition 3 in the skewed environment, case (1)

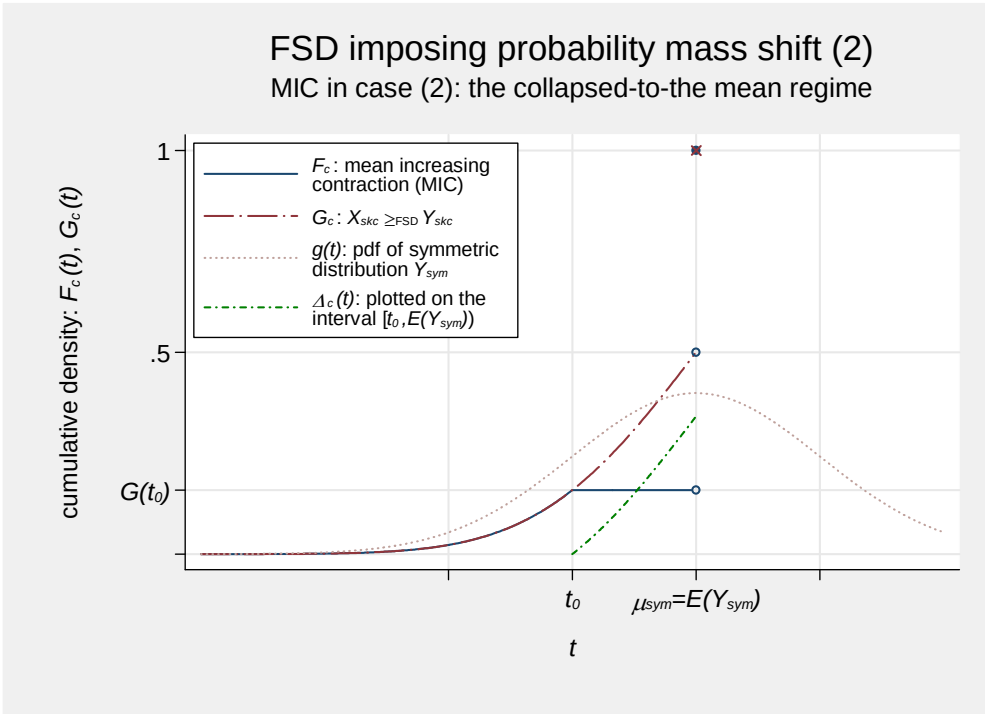


Figure 4b: The essence of Proposition 3 in the skewed environment, case (2)