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Abstract

The distributional consequences of the recent economic crisis are still broadly unknown. While it is possible to speculate which groups are likely to be hardest-hit, detailed distributional studies are still largely backward-looking due to a lack of real-time microdata. This paper studies the distributional and fiscal implications of output changes in Germany 2008-09, using data available prior to the economic downturn. We first estimate labor demand on 12 years of detailed, administrative matched employer-employee data. The distributional analysis is then conducted by transposing predicted employment effects of actual output shocks to household-level microdata. A scenario in which labor demand adjustments occur at the intensive margin (hour changes), close to the German experience, shows less severe effects on income distribution compared to a situation where adjustments take place through massive layoffs. Adjustments at the intensive margin are also preferable from a fiscal point of view. In this context we discuss the cushioning effect of the tax-benefit system and the conditions under which German-style work-sharing policies can be successful in other countries.

JEL-Code: D580, J230, H240, H600.

Keywords: labor demand, output shock, tax-benefit system, crisis, income distribution.

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1 Introduction

The 2008-09 economic downturn has led to a broad discussion, both in the public and academic arena, on the likely distributional and fiscal consequences of the crisis and on which policy might be most effective at mitigating the adverse labor market and welfare consequences of the downturn. In fact, policy efforts to minimize welfare losses were seriously hampered by how little was known about the distribution of changes in employment and incomes and about the capacity of existing redistribution systems to soften the negative impacts of job and earnings losses. In this context the German experience is particularly interesting. While Germany has suffered a substantial drop in GDP (around 5 percent on average—an even larger slump than in the United States), employment levels and unemployment rates were unusually resilient as most of labor adjustments occurred at the intensive margin (working hours). This is in contrast to many other Western countries, which experienced far greater levels of layoff. While many analysts and policy makers have focused on Germany's employment effects and its work-sharing policies (see, e.g., Hijzen & Venn (2011), Cahuc & Carcillo (2011)), much less is known about precise distributional and fiscal consequences of alternative labor market adjustments.

We investigate this question, focusing on the German situation for the years 2008-09. While it is possible to speculate about which groups are likely to be hardest-hit, detailed distributional studies are usually not available until the crisis is long over and decisions have already been made. For that reason we develop a straightforward approach to gauge the distributional and fiscal implications of large output changes at an early stage, i.e., without having the appropriate microdata. We first estimate labor demand on 12 years of high-quality, micro-level administrative employer-employee data (LIAB). The estimates are used to predict labor-demand effects of the output shocks observed during the downturn at a disaggregated level (by industry and for labor inputs detailed by age, skill and contract type). Interestingly, we are able to transpose these labor market changes to household-level microdata commonly used for distributional analyses (the German Socio-Economic Panel, SOEP).[1]

Using this combined approach we can analyze the first-round consequences of the recession for income changes at the household level. We suggest two contrasting scenarios

[1] To the best of our knowledge, this is the first empirical study linking output changes to distributional and fiscal consequences using a detailed micro model of labor-demand responses. The approach is conceptually related to the literature on linking micro and macro models (see, e.g., Bourguignon et al. (2003) or Peichl (2009) for a survey, and Bourguignon et al. (2008), Hérault (2010), Ahmed & O'Donoghue (2010), Ferreira et al. (2008) and Robilliard et al. (2008) for distributional and crisis-related analyses). In particular, our method is closer to the "top-down"approach which aims to approximate the effect of macro changes on income distribution. Further differences with approaches are discussed in the following sections.

when translating labor-demand reactions to earnings losses at the household level. The first polar case (*intensive scenario)* allows only for adjustments of employees' working hours rather than staff levels. Although being stylized, this scenario comes close to the observed German situation and also to that of other countries where much of the reductions in total working hours occurred at the intensive margin (e.g., Austria, Belgium, the Czech Republic, the Slovak Republic). The second polar case (*extensive scenario*) shows what happens if the same overall adjustment in total working hours occurs exclusively via layoffs and hires—a scenario more in line with the situation experienced in the United States, Greece, Ireland, Spain or the UK (OECD (2010)).[2]

Our results show that low-skilled and non-standard workers faced above-average risks of earnings losses. An examination of the resulting income losses shows, however, that automatic stabilization by the tax-benefit system is effective in cushioning a significant share of the gross-income losses. Moreover, we find that the margin of adjustments does indeed matter. Given the likely pattern of job losses among different groups of workers, adjustments at the extensive margin result in a sizable widening of the income distribution, increasing inequality and a rise in the number of poor people by more than 10 percent. In the intensive scenario poverty headcounts rise by under 4 percent, while most inequality measures are predicted to change little. Importantly, adjustments at the intensive margin are also preferable from a fiscal point of view—at least in the short-term. We discuss the limits of our analysis, notably the fact that the hour-adjustment would be even more favorable in countries with less generous unemployment insurance. However, it is less effective if the economic structure encourages temporary work or does not provide incentives for firms to retain workers.

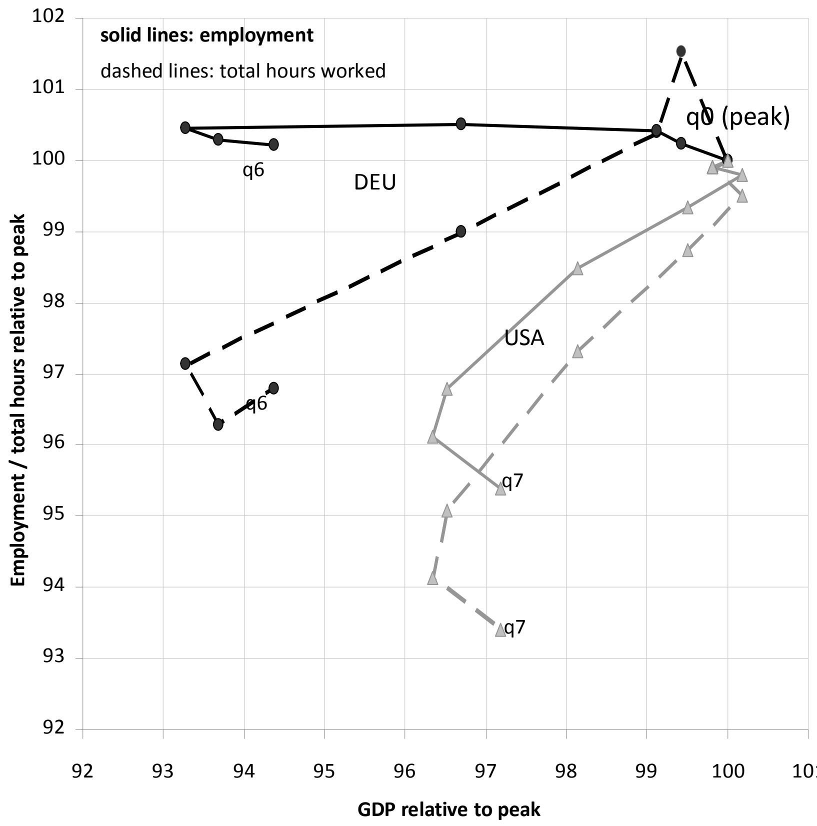
The remainder of the paper is structured as follows. Section 2 briefly summarizes the labor market changes in Germany during the crisis and contrasts them with the US experience. In Section 3 we lay out our empirical approach, present the data and the estimation of the labor-demand model. In Section 4we predict the first-round effect of output shocks on the demand for different labor inputs, compare them to observed labor market trends, and analyze the distributional consequences of labor market adjustments at the household level. Finally, we derive and discuss the fiscal consequences of working-hour reductions versus layoffs. Section 5 concludes.

[2]Our demand model, specified on total hours (rather than employment levels), captures the actual total labor demand adjustment (comprising both margins) reasonably well. In fact, we show that the German labor market performance was very much in line with past reaction to output changes as far as changes in total hours worked are concerned.

2 The German Labor Market during the Crisis

The German labor market performance has received considerable attention since the onset of the 2008-09 economic crisis. Figure 1 illustrates the unique adjustment patterns in Germany by contrasting the evolution of output and employment against those observed in the United States.

Figure 1: Labor market adjustments: Germany vs. US



Source: OECD National Accounts database and Eurostat labor market statistics. Notes: Q0 is the quarter when GDP peaked (2007Q4 for US and 2008Q1 for Germany), and each data point refers to consecutive quarters since then.

During the recent economic crisis, Germany suffered particularly sizable output losses of almost 7 percent since GDP peaked in 2008Q1. Yet employment levels, as shown by the black solid line, remained practically unchanged, suggesting an unusually low Okun's coefficient value. Nonetheless, Figure 1 shows that the crisis did have a significant effect on the German labor market. Up until 2009Q2, hours worked per employee (as well as total working hours in the economy) had declined by 4 percent (black dashed line).

Hence, on aggregate, the adjustments materialized exclusively at the intensive margin (the difference between the solid and the dashed lines). In contrast to the German situation, US employment dropped by almost 5 percent despite a smaller drop in GDP (grey solid line). Most of the adjustment happened along the extensive margin, whereas working-hour reductions along the intensive margin accounted for only around one third of the drop in total hours worked (grey dashed line).

The specific adjustment witnessed in Figure 1 is partly the result of possibilities and constraints induced by labor market conditions and institutions (see, e.g., Möller (2010), Eichhorst et al. (2010), OECD (2010)). In the German context the government-supported short-time working scheme (*Kurzarbeit*) has tended to receive most of the attention. Yet while a substantial share (around 25 percent) of working-time reductions during the crisis to date can indeed be directly attributed to this programme, other factors were more important on aggregate. The greatest reductions, accounting for more than one third of recorded changes in total hours worked, were due to opening clauses in collective agreements, which allowed temporary reductions in weekly working hours (and earnings), or to so-called "pacts for employment and competitiveness" between employers and employees (Bellmann et al. (2008)). In addition, working-time accounts or "time banks", as well as substantially reduced overtime, account for around 20 percent each (Bach & Spitznagel (2009)).

In our analysis we set up a framework which is general enough to comprise both the intensive and extensive margin. This allows us to simulate two polar scenarios of adjustment which come close to the contrasted situations depicted in Figure 1. This will be described in the following section.

3 Empirical Approach

To study the short-term effects of a large output shock on employment and income, we derive the likely patterns of demand-side adjustments using own labor-demand estimations. We assume a "right-to-manage" setting, with employment and hours chosen by the firm. Wages are fixed in the short term and labor inputs are the only margins of adjustment for firms (capital is constant). The labor-demand model is estimated on matched employer-employee data for Germany. In a second step the demand-side model is linked to household-level data, and tax/benefit simulations are conducted in order to derive the distributional consequences. In our approach the macro level output shocks are not derived from a stylized CGE-type of model but correspond directly to the observed changes per industry for the years 2008-09.[3] We ignore longer-term changes in prices and wages, which is justified in the German case, since wage adjustments were not a primary channel for reducing labor costs during the downturn (Collective Agreement Archive (2009), Bellmann & Gerner (2011)). Instead we focus on short-term labor-demand adjustments, which are the most immediate driver of household income losses during a labor market downturn. Before proceeding with the distributional analysis in Section 4, this section presents details on data sources and labor-demand estimations.

3.1 Data

The demand model relies on a high-quality linked employer-employee dataset (LIAB) from the Institute for Employment Research (IAB) in Nuremberg, Germany, (see Alda et al. (2005) for more information on the dataset and von Wachter & Bender (2006) for a recent application). The firm component of the LIAB is the IAB Establishment Panel (Kölling (2000)). The term "establishment" refers to the fact that the observation unit is the individual plant, not the firm. The Establishment Panel is a representative, stratified, random sample including establishments with at least one worker for whom social contributions were paid. Information on employment levels and changes, staff qualifications, investment as well as industry affiliation and output are used.

The employee data correspond to the employment statistics of the German Federal Employment Agency (*Bundesagentur für Arbeit*) and are drawn from administrative records comprising all employees paying social security taxes or receiving unemployment benefits (see, e.g., Bender et al. (2000)). The dataset covers about 80 percent of German employees in the private sector. The entire public sector is excluded, as civil servants are not observed in the social security data. Information recorded in the data include employees' histories on daily wages, age, seniority, schooling, training, occupation, employment type (full-time, part-time or irregular employment), industry and region.

Data from the employee history are linked with the establishment sample year-by-year using a plant identifier. Since the unified sample for East and West Germany exists only since 1996, we focus on the period 1996-2007. We select establishments with at least 10 employees, in order to be able to identify substitution patterns between different types of workers. In total our resulting sample consists of $37,958$ establishment-year observations. The number of establishment-years is $19,520$ in manufacturing (51 percent of the total), $5,035$ in construction (13 percent), $1,847$ in transport and communications (5 percent), $10,956$ in services (29 percent) and 600 in financial services (2 percent).

[3] The method we suggest is rather general. It can also be applied as a tool for ex ante policy response analyses if one uses projections of output changes (instead of actual ones) in order to analyze forward-looking counterfactual scenarios.

For the distributional analysis we use the German Socio-Economic Panel (SOEP), a representative survey of the entire German population with around 25,000 sample individuals living in more than 10,000 households per cross-section (see Wagner et al. (2007)). For the present paper we utilize information on labor market status, gross wage, job type, benefits, industry, working time, household composition, age, education levels and housing costs. We use the 2008 wave, which contains labor market information for the year 2007, in particular hours worked and wages.[4] In order to make the information consistent with the distributional analysis using policy parameters as of January 1, 2009, we use a static ageing technique, which allows us to control for changes in global structural variables as well as income adjustments that differentiate by income components (see Gupta & Kapur (2000)). We restrict the sample to the same industries as in the LIAB, but include the unemployed. This yields 5,532 households and 9,218 individuals.

To calculate net incomes and fiscal effects, we link the data to the tax and benefit simulation model of the Institute for the Study of Labor, IZAΨMOD (see Peichl et al. (2010)). IZAΨMOD contains a tax-benefit calculator comprising all relevant features of the German tax and benefit system, such as income taxation and social insurance contribution rules, as well as unemployment, housing and child benefits.[5] We make use of the population weights available in SOEP. The results are therefore representative of the German population. Using the simulated tax and benefit payments, we can compute disposable income for each household.

3.2 Labor-demand Model

We estimate a structural labor-demand model on the LIAB data. For our purposes it is essential to adopt a micro rather than a macro approach for mainly two reasons. Firstly, the explicit goal of our contribution is to assess the consequences of output changes on the demand for narrowly defined groups of workers. This implies that we have to account for substitution patterns between different labor inputs at the firm level. Secondly, macro models of labor demand produce unbiased results only under quite restrictive assumptions with regard to employment adjustments (see Bresson et al. (1992)).

Following standard practice, we adopt the dual approach by assuming a constant output, specifying a cost function and using Shephard's lemma to derive the labor-demand functions (Hamermesh (1986, 1993) and Bond & Van Reenen (2007)). We opt for a Generalized Leontief specification as proposed by Diewert (1971), which is a linear second-

[4] As explained in the introduction, it is precisely the lack of rapid microdata production that justifies our approach.

[5] Note that IZAΨMOD also has a behavioral module allowing for the simulation of labor supply reactions, which is not used in this application.

order approximation to any arbitrary cost function. Importantly, it does not restrict the substitution elasticities of input factors. We follow the specification of Diewert & Wales (1987) and take a short-term perspective, assuming capital to be fixed (or perfectly separable from labor inputs). We also allow for non-constant returns to scale, which is important in the context of our study, since the output elasticities are not restricted to equal unity.

For a given firm there are $i = 1, ..., I$ labor inputs corresponding to the cells we define below. We ignore firm and time indices to clarify notations. We write C, the short-term labor costs of a firm, as follows:

$$C = \sum_i \alpha_i w_i + \sum_i \sum_j \alpha_{ij} w_j^{0.5} w_j^{0.5} Y + \sum_i (\beta_{YYi} w_i) Y^2, \tag{1}$$

with Y the firm-specific output and w_i the wage of labor group iThe symmetry condition $\alpha_{ij} = \alpha_{ji}$, $\forall i, j$, is the only restriction imposed on the coefficients. Differentiating C with respect to wages w_i yields the factor demands X_i, and dividing by Y gives the input-output ratio:

$$X_i/Y = \alpha_{ii} + \sum_{j \neq i} \alpha_{ij} \left(\frac{w_j}{w_i} \right)^{0.5} + \alpha_i \frac{1}{Y} + \beta_{YYi} Y, \tag{2}$$

which is the basis of our labor-demand estimation. Since we are analyzing the comparative-static effect of output shocks, our main measure of interest is the output elasticity of input (labor) demand, which is written as:

$$\epsilon_{iY} = \frac{\partial X_i}{\partial Y} \frac{Y}{X_i} = 1 - \frac{\alpha_i}{X_i} \tag{3}$$

3.3 Estimation

The detailed administrative data allow us to distinguish $I = 12$ labor inputs per industry. We differentiate between two skill/education levels, three age groups and two categories of employment contract. Skilled workers hold a university, polytechnical or college degree or have completed vocational training. Age groups are defined as 15-29 (young), 30-54 (middle-age) and 55-64 (old). We differentiate between full-time workers and a "non-standard" employment type category comprising both part-timers and irregular employment (short-term employment, temporary workers and those in marginal employment referred to as *Mini/Midijob* in Germany). We estimate input-output ratios separately for the five industries (manufacturing, construction, trade and communications, services and financial sector), which gives $5 \times 12 = 60$ different cells for the distributional analysis.

There is clearly no complete congruence, and possibly a trade-off, between the definition of labor inputs used for the purpose of labor-demand estimation on one hand and a disaggregated cell definition for precise distributional analyses on the other. We feel that the choice made here presents a reasonable balance. In particular, skill and age/experience groups constitute different types of productive factors for firms and also correspond to groups exposed to different risks of unemployment or working-time adjustments during a labor market downturn. One may wish more disaggregation for the distributional analysis (e.g., gender, migrants) but this would be more difficult to justify in terms of labor-input differentiation. The output variable used for estimating the model is defined as business volume excluding intermediate inputs. For the financial sector we instead measure "output" as balance sheet total (banking) and total premiums paid (insurances).

We specify our labor-demand model with respect to total working hours—exploiting establishment level working-time information. This setup therefore captures changes in both employment (heads) and work intensity (hours) and implicitly assumes perfect substitutability between the two adjustment margins. To the best of our knowledge, an hours specification at the micro level is unique. Most of the related studies estimating demand systems rely on the textbook head-count specification. A few other papers specify their model in terms of hours by appending working-hours measures to the data (see Hamermesh (1993)), but due to a lack of firm-level information, such working-hours measures normally rely on semi-aggregate averages (in most cases at the industry level) at a given point in time (see Freier & Steiner (2010) for a recent example). Our micro approach is set up as follows: we first extract average full-time working hours at the establishment level directly from LIAB data. At this point we only have information on average full-time hours for a specific establishment in a certain year. We then extract mean working hours for each cell from the SOEP data. After which, we retrieve SOEP information on average full-time hours by industry and year, mirroring the available LIAB data. In a fourth step we calculate ratio of SOEP cell-specific working hours and SOEP industry-year full-time averages, which we finally apply to the LIAB data to construct a finely grained working hours distribution across our labor-demand cells in each establishment and year.

For the estimation we add two linear terms to the equations (2). We include time dummies to capture time trends as well as potential policy or business-cycle effects, and add disturbance terms ε_i for the $i = 1, .., 12$ inputs in each industry. The disturbance vector $\{\varepsilon_1, ..., \varepsilon_{12}\}$ is assumed to be multivariate and normally distributed, with mean vector zero and constant covariance matrix Ω. The system of 12 equations per industry is estimated using the Seemingly Unrelated Regression (SUR) proposed by Zellner (1962).

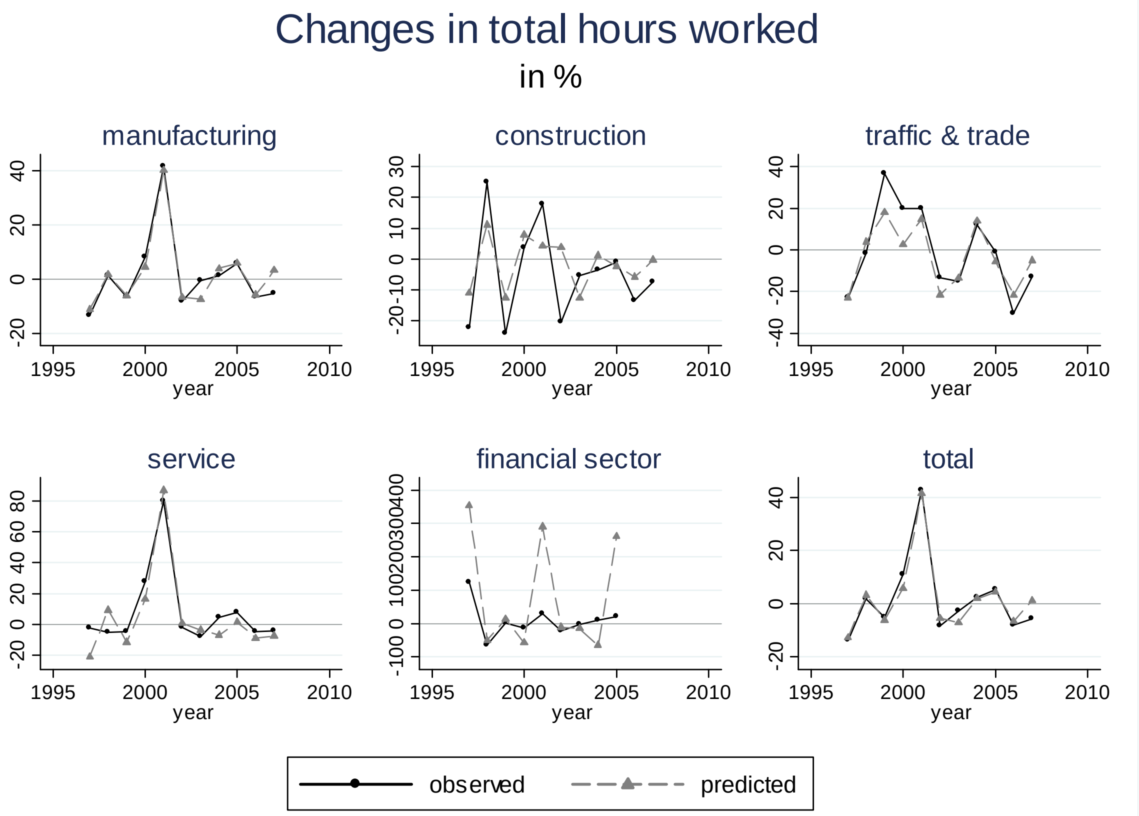
SUR first employs equation-by-equation OLS to obtain the covariance matrix of the error terms, Ω. A Feasible Generalized Least Squares estimation on the full system, conditional on Ω, is then conducted. Thus, SUR allows error terms to be contemporaneously correlated across regressions and is more efficient than separate OLS estimations.

It is useful to check the predictive power of the model. In Figure 2 we plot yearly relative changes in total hours worked as reported in the LIAB data against changes as predicted by the model for each industry over the period 1996-2007.[6] Predicted changes in working hours are derived by multiplying the industries' output elasticities by the industry-specific aggregate output change. With the exception of the financial sector, the graphs show the predictions to be rather accurate. This is reassuring with regards to the estimated model and provides confidence that using employment reaction to output changes over the entire period results in good approximations of employment changes in specific time periods.

Table 1 presents output elasticities of labor demand. For readability we present average elasticities for broader input groups in this table. Complete results for all 60 cells are reported in Table 8 in the appendix. All group elasticities are positive—as predicted by theory. The average output elasticity across all cells is 0.64, which is well in line with other studies determining employment reactions to output shocks (normally output elasticities lie in $[0.5, 0.9]$, see e.g., Brechling & O'Brien (1967), Fay & Medoff (1985) or Card (1986)). The results suggest that across all sectors unskilled employees are hired more quickly in a boom and fired faster during a recession. Output elasticities of young and, especially, older workers are also above average. As expected, those on non-standard employment contracts are more likely to be affected by output changes than regular ("full-time") employees.

[6] Note that we could not use any observations for the financial sector for the years 2006 and 2007 because the LIAB output measure for these industries changed as of 2006.

Figure 2: Predictive power



Source: Observed hours form the LIAB, predicted hours calculated using LIAB output data and estimated elasticities.

Table 1: Output elasticities

Group	Man	Con	Tra	Ser	Fin	**Total**
Skilled	0.57	0.45	0.79	0.62	0.94	**0.59**
Unskilled	1.05	0.5	1.02	0.99	1.02	**0.96**
Young	0.74	0.55	0.02	0.72	0.87	**0.68**
Middle-age	0.62	0.41	0.92	0.61	0.96	**0.61**
Old	0.75	0.61	1.04	0.99	0.94	**0.82**
Full-time	0.65	0.43	0.80	0.63	0.95	**0.63**
Non-standard	0.68	0.93	1.23	0.97	0.92	**0.83**
Total	**0.65**	**0.46**	**0.83**	**0.67**	**0.94**	**0.64**

Source: Own calculations using the LIAB. Notes: All numbers are averages weighted by the number of total hours in the respective cells. Man = Manufacturing, Con = Construction, Tra = Transport & Communications, Ser = Services, Fin = Financial Services.

4 Employment and Distributional Effects

We now model the impact of the crisis, first on employment using the labor-demand model, then on household income distribution by feeding the predicted employment effects into the SOEP data. Our reference period for the output shock (and subsequent employment/distributional changes) is the period 2008-09, which corresponds to the recent downturn period in Germany.

4.1 Output Shocks and Predicted Employment Effects

Results are summarized in Table 2. The top panel reports changes in official output aggregates and employment by industry over the crisis period. Output, as measured by value added for each industry from German national accounts, dropped in all of the shown industries. Overall, the German economy shrunk by 5 percent over this period. In the selected sample of industries, value added declined by even more (8 percent).[7] In particular, the decline in manufacturing output, a slump of 18 percent, is noteworthy.

Employment changes are shown in headcounts (employment levels) as well as total hours worked, accounting for adjustments along both the extensive and intensive margin. It is evident that the output shock did result in sizable labor-demand effects overall. Yet there is a considerable difference between the margins of adjustment. While changes in employment levels are minimal, total hours worked dropped substantially over a relatively short period of time, with a very large drop of about 10 percent in the manufacturing sector.

The bottom panel of Table 2 shows changes in total hours worked across industries and for different groups of workers as predicted by the labor-demand model. For the prediction we multiplied reported industry output changes with the corresponding output elasticities of labor demand in each of the 60 cells. As we have chosen a "total hours" specification, our predictions are conceptually comparable to the official changes in total working hours shown in the top part of the table. Our predictions capture the overall changes well—both quantitatively and qualitatively. This match is reassuring in terms of the external validity of the estimated model and validates our implicit assumption that past elasticities provide a good approximation of present labor market responses. The correspondence between predicted and observed working-hours changes is also an important finding: it suggests that, despite its magnitude, the downturn in Germany has not resulted in a structural break of firm behavior. Only in the transport and communications sector do we overestimate the labor-demand reaction (possibly explained in part by stimulus spending

[7] The difference is mostly due to the public sector, where value added actually increased during the crisis period.

Table 2: Output shocks and actual vs. predicted hours adjustments

	Man	Con	Tra	Ser	Fin	Total
	Official statistics					
	Output (value added, price adjusted)					
2008	496.4	78.8	130.5	949.6	76.1	1731.3
2009	406.2	77.7	119.2	917.6	74.9	1595.6
% change	-18	-1	-9	-3	-2	-8
	Employment levels (in 1000 workers)					
2008	7352	1741	2079	12420	1045	24637
2009	7163	1746	2067	12415	1042	24433
% change	-3	0	-1	0	0	-1
	Total hours worked (in millions)					
2008	10383	2680	3015	15827	1483	33387
2009	9352	2630	2915	15401	1457	31754
% change	-10	-2	-3	-3	-2	-5
	Predictions					
	Total hours worked (% change)					
Total	-12	-1	-7	-2	-2	-7
Skilled	-10	-1	-7	-2	-2	-6
Unskilled	-19	-1	-9	-3	-2	-11
Young	-14	-1	0	-2	-1	-8
Middle-age	-11	-1	-8	-2	-2	-7
Old	-14	-1	-9	-3	-2	-9
Full-time	-12	-1	-7	-2	-2	-7
Non-standard	-12	-1	-11	-3	-1	-8

Sources: Value added from the German National Accounts (constant prices, chain-linked index, 2000 = 100). Official employment statistics from the Institute for Employment Research. Predictions are based on the LIAB. Notes: Man = Manufacturing, Con = Construction, Tra = Transport & Communications, Ser = Services, Fin = Financial Services.

benefiting this sector). Moreover, the table suggests that different types of workers are affected differently, with old, unskilled and non-standard workers suffering the most.

4.2 Cell Identification and Shock Scenarios

We now feed the predicted employment shocks for each cell into the SOEP, a representative micro dataset often used for distributional analyses. The SOEP is informationally rich and allows us to differentiate by skill, age, employment group and industry, just as we did in the linked employer-employee data. Table 3 provides an overview of selected worker characteristics for both the LIAB and SOEP datasets. The table reveals that although general socio-demographic characteristics such as gender or nationality differ, the two datasets compare well as far as the dimensions of our cells are concerned. In particular, the age and employment-type distributions are almost identical.

Table 3: Worker characteristics, wave 2007

General	LIAB	SOEP
Observations (persons)	1,828,126	9,218
Share of women	38.3	44.4
Share of foreigners	5.4	16.0
Share of working in East	20.6	16.2
Skill distribution		
Share of skilled	85.9	91.0
Share of unskilled	14.1	9.0
Age distribution		
Share of young	17.9	18.4
Share of medium-aged	67	68.2
Share of old	15.1	13.4
Mean age	41.8	41.6
Job distribution		
Share of full-timers	73.4	72.9
Share of part-timers	26.6	27.1

Source: Own calculations using the LIAB and the SOEP.

The labor-demand model is specified in terms of total hours and hence accounts for adjustments at both the extensive and intensive margin. Yet the model cannot predict which margin is used by a particular firm or sector. Thus, we must suggest concrete scenarios of labor market adjustments to translate total hour changes into income changes at the cell level. Since actual labor-input adjustments during the 2008-09 crisis were mainly along the intensive margin in Germany, we first suggest a scenario where adjustments exclusively materialize as a change in worked hours (e.g., a switch from full-time to part-time employment). We simply change working hours proportionally in line with the total change in labor demand at the cell level, holding employment levels constant.

In a second polar case we suggest a scenario where the same total hours adjustments only occur at the extensive margin through layoffs. That is, adjustments consist in changes in employment rates at the cell level. If the predicted change in labor demand for a given cell is $-X\%$, we randomly draw $X\%$ of workers within the SOEP cell and make them unemployed. This second scenario is closer to the adjustment pattern seen in countries where layoffs were more important than changes in average hours worked.

We feel that these two scenarios provide interesting counterfactuals for the distributional and fiscal impact of the labor market downturn, which highlight the role of the adjustment margin in shaping distributional outcomes and correspond reasonably well to the adjustment patterns observed in Germany and the United States. It is likely, however, that the differences between the distributional effects of our stylized scenarios provide upper bound estimates. First, adjustments will generally take place along both the intensive and the extensive margins. On a more technical level, we abstract from the facts that working-hours reductions will not be uniform within each cell and that unemployment risks within cells will not be evenly distributed. However, in the context of our distributional analysis, the random draw will have no noticeable impact as cell definitions are already disaggregated.[8]

4.3 Distributional and Fiscal Impacts

The distributional analysis is based on SOEP data before and after the two scenarios of labor-demand adjustment. We denote by "Base" the pre-crisis (baseline) situation, by "Intensive" the post-crisis scenario resulting from adjustments along the intensive margin only, and by "Extensive" the post-crisis scenario resulting from extensive-margin adjustments. Income distribution measures are based on household total income equivalized using the "modified OECD" scale. Capturing the household context (family size and composition) is of course a principal reason for performing the distributional analysis on SOEP-type data rather than using the worker-based LIAB directly.

Income and hours changes. We examine the distributions of both gross and net incomes in order to capture the cushioning effect of the tax-benefit system. We assume policy parameters as of January 1, 2009.[9] Table 4 shows large working-hours changes for workers in the manufacturing industry mirroring the predicted labor-input adjustments reported in Table 2.[10] Gross earnings follow changes in total working hours. They are

[8] For instance, in the case of the extensive scenario, any non-random modeling attempt would, in fact, run into difficulties, as it would have to utilize characteristics (such as age, education) that are similar to the ones used to distinguish cells. Also note that some intermediary scenarios based on more realistic combinations of the intensive and extensive margins could be suggested but would require additional assumptions. We keep this work for future research.

[9] It is important to note that net income calculations do not account for benefits (*Kurzarbeitergeld*) paid through the short-time working programme (*Kurzarbeit*), as our data do not allow us to identify the likely recipients of these benefits. This is relevant when considering the distributional effects reported for the "intensive"scenario below. While this provides a lower-bound for the incomes of many of the workers affected by reduced working hours, recall that the large majority of working-hour reductions in 2009 (75 percent) were not on account of *Kurzarbeit.*

[10] Note that because the sampling frames for the SOEP and LIAB data are different and predictions from the demand model have been applied cell-by-cell to the SOEP, total working-hour changes by industry do not match exactly.

not the same, however, since working hours are shown at the individual level, whereas incomes are measured on an "equivalized" household basis and, hence, are also affected by the incomes of other family members. This is also why incomes can change for the non-employed and why relative changes in (household) earnings can exceed changes in (individual) working-hours reductions. Across industries it is, in particular, unskilled workers who are found to suffer the greatest earnings losses. The net incomes of young individuals also decline sharply. Average losses are even larger than for the older age-group, despite the earlier finding in Table 2 that older workers are somewhat more likely to face job loss or working-time reductions than young workers. One reason is that older workers are more likely to be living with a partner whose income partly shields them from a drop in household incomes.

It is striking that the net income effects are more sizable in the intensive scenario. This is because hours in the intensive scenario are equally reduced for everybody who is working in a specific cell. Hence, every worker in this cell suffers an equal, but relatively small, income losses. Tax burdens also decline for these workers, which is why income losses are smaller on a net basis than before taxes. In the extensive scenario certain workers are laid off—resulting in a sharp drop of their gross income. On top of reduced tax burdens, a considerable part of the earnings loss tends to be offset by an entitlement to unemployment benefits. Consequently, the income cushioning effect of the tax-benefit system is larger than under the intensive scenario, and the difference between net and gross income changes is more sizable as a result. Note that these effects also operate for non-employed individuals, who can be sharing a household with job losers entitled to unemployment benefits.

Comparing changes in gross and net income gives some indication of the effectiveness of social safety nets at absorbing some of the income loss. The income of low-skilled workers is likely to be relatively close to the level of minimum-income benefits. Safety-net benefits, therefore, absorb a large part of their earnings losses on average resulting in large differences between gross and net earnings changes. Reflecting the 400/800 euro ceiling on monthly earnings in the German Mini/Midijob programme, the wages of many workers in the "non-standard" category are also especially low. However, these jobs are particularly attractive for second earners. Because of their higher-earning partners, they are then less likely to receive means-tested benefits when losing all or part of their own earnings.

Income distribution. Table 5 presents changes of incomes and working hours by decile groups. Interestingly, relative net income losses in the "intensive" scenario are very similar from deciles 4 to 10. Perhaps even more strikingly, the lowest two decile groups

Table 4: Relative change in earnings and hours for working-age individuals and family members (by group, in %)

	Intensive			Extensive		
	Gross	Net	Hours	Gross	Net	Hours
Skilled	-3.6	-2.4	-3.3	-3.6	-2.2	-3.3
Unskilled	-6.6	-3.4	-6.3	-6.6	-2.7	-6.3
Young	-3.6	-2.7	-3.6	-3.6	-2.4	-3.6
Middle-age	-3.8	-2.2	-3.0	-3.9	-2.0	-3.1
Old	-3.5	-1.8	-3.3	-3.6	-1.7	-3.4
Full-time	-3.6	-2.6	-3.4	-3.6	-2.3	-3.4
Non-standard	-4.7	-2.7	-4.6	-4.7	-2.4	-4.6
Non-employed	-4.3	-1.7	.	-4.2	-1.2	.
Manufacturing	-9.4	-7.0	-11.2	-9.2	-6.2	-11.2
Construction	-1.3	-0.9	-0.7	-1.3	-0.8	-0.8
Transport-Comm	-6.3	-4.2	-7.0	-6.4	-3.8	-7.1
Services	-2.8	-1.8	-2.2	-3.0	-1.8	-2.3
Financial	-2.4	-1.8	-1.5	-2.4	-1.5	-1.5
Total	**-3.7**	**-2.5**	**-3.5**	**-3.7**	**-2.2**	**-3.5**

Source: Own calculations using the SOEP and IZAΨMOD. Notes: Incomes are equivalized (modified OECD scale), working hours are shown on an individual basis.

experience the smallest net income changes—showing the effectiveness of the benefit system. A somewhat similar picture emerges if labor-demand adjustments take place entirely through layoffs. Once again, net income losses tend to be less severe than in the intensive scenario. This is not the case, however, for the first two decile groups. The reason is that those at the bottom of the income distribution tend to be entitled to means-tested benefits, which ensure that net incomes at the very bottom change very little in both the intensive and extensive scenarios. As a result, whether or not those affected by earnings losses are entitled to unemployment benefits makes little difference, and net income changes for the two scenarios are more similar for the bottom two deciles than for middle-class households.

Distributional measures. Table 6 reports a range of global distribution measures (Gini, General Entropy, inter-decile ratio), as well as absolute and relative poverty headcount (Foster-Greer-Thorbecke: FGT0) and poverty intensity (FGT1, FGT2). As customary the poverty line is defined as the 60 percent of median income. Consistent with the results by income deciles, overall inequality is reduced in the "intensive" scenario. The income distribution is compressed, as parts of the working population suffer income losses, while the net incomes of the non-employed change less. In the "extensive"

Table 5: Relative change in earnings and hours by income decile (in %)

	Intensive			Extensive		
	Gross	Net	Hours	Gross	Net	Hours
1	-3.7	-0.3	-3.2	-4.1	-0.6	-3.1
2	-3.8	-0.6	-3.8	-3.8	-0.7	-3.7
3	-3.9	-2.0	-3.8	-3.7	-1.2	-3.6
4	-3.8	-2.7	-3.5	-3.7	-1.7	-3.5
5	-3.8	-2.9	-3.5	-4.0	-2.2	-3.7
6	-4.3	-3.0	-3.9	-4.2	-2.5	-3.8
7	-3.6	-2.6	-3.5	-3.7	-2.5	-3.7
8	-3.7	-2.8	-3.4	-3.6	-2.6	-3.4
9	-3.4	-2.5	-3.1	-3.2	-2.3	-3.1
10	-3.8	-2.5	-3.3	-3.9	-2.5	-3.4
Total	**-3.7**	**-2.5**	**-3.5**	**-3.7**	**-2.2**	**-3.5**

Source: Own calculations using the SOEP and IZAΨMOD. Notes: Incomes are equivalized (modified OECD scale), working hours are shown on an individual basis. Decile groups are for the selected sample only (working-age individuals and household members) and are based on the "pre-crisis" baseline.

scenario, however, inequality rises, as some workers are laid off while others are not affected by the crisis at all. Because the incidence of job losses is particularly high for some groups who tend to have low incomes even prior to unemployment (e.g., young and low-skilled workers), this additional unemployment yields a further dispersion of the income distribution. The difference between the inequality measures in the two scenarios illustrates that facilitating working-hours adjustments can play an important role in limiting the growth of income disparities during a downturn.

This can also be seen when looking at poverty measures. In the intensive scenario the share of the poor as indicated by the headcount ratio using a constant poverty line (FGT0) increases only slightly, while we see a substantial rise of more than 10 percent in the extensive case. Other poverty indicators arrive at quantitatively similar results. But interestingly, with a variable poverty line (FGT0v), the number of poor in the intensive scenario actually goes down, since median income (and hence the poverty threshold) drops more strongly than incomes at the very bottom of the distribution. These results underline the importance of evaluating relative poverty measures alongside absolute changes in income levels—especially when assessing the distributional consequences of rapid economic changes.

Fiscal effects. Finally, we shed some light on the role of the margin of adjustment for government budgets. Table 7 shows the fiscal effects of the two scenarios relative to the baseline case, i.e., the German tax benefit system as of January 1, 2009, without any

Table 6: Inequality and poverty measures and relative change

	Base	Intensive		Extensive	
	Net	Net	Δ (in%)	Net	Δ (in%)
Gini	0.324	0.323	-0.385	0.330	1.637
GE0	0.176	0.174	-1.193	0.181	2.972
GE1	0.197	0.197	-0.161	0.203	3.079
P9010	4.251	4.175	-1.807	4.307	1.304
FGT0	0.205	0.213	3.588	0.229	11.653
FGT1	0.048	0.050	2.142	0.054	12.388
FGT2	0.019	0.020	4.289	0.023	19.085
FGT0v	0.205	0.195	-5.067	0.214	4.516

Source: Own calculations using the SOEP and IZAΨMOD. Notes: Measures are based on equivalized disposable incomes (modified OECD scale) and refer to the selected sample only (working-age individuals and household members). The poverty line is set at 60 percent of median income (of the total population) and is either constant, using the baseline median (FGT0, FGT1, FGT2), or varies, using the median of each scenario (FGT0v).

crisis-related employment changes. As one would expect, both scenarios result in a highly negative effect on the government budget. Tax revenue and social insurance contributions (SIC) decrease, as labor earnings drop for those employees affected by the crisis. It is interesting to note the differences between the two scenarios in terms of taxes and SIC. In the intensive case the proportional reduction in combination with the progressive income taxation and regressive SIC yields higher relative tax revenue reductions. In the extensive scenario employment reductions are highest in the middle part of the income distribution (cf. Table 5), where SIC payments are higher than tax liabilities. As the highly progressive German income tax is concentrated at the top (with the top 10 percent paying more than 55 percent of the income tax revenue), the reduction in tax revenue is relatively lower than the decrease in SIC. Due to higher benefit expenditures, the fiscal consequences of the extensive scenario are, however, substantially more severe (benefit payments increase by 6 percent). In total, the government's budget decreases by 7 percent in this case. This yields an eventual shortfall which is approximately 3 billion euros higher than in the intensive scenario, given our considered population sample.[11]

[11] In a back-of-the-envelope calculation one could argue that the German short-term working scheme was an efficient investment for the initial phase of the crisis—costing a similar amount (3 billion euros per year)—encouraging reductions in total working hours and thus keeping many employees in the workforce.

Table 7: Fiscal effect

Changes	Intensive in billion euros	in %	Extensive in billion euros	in %
Tax revenue	-5.6	-4.2	-3.0	-2.3
Social insurance contributions	-5.4	-3.2	-6.3	-3.8
Benefit payments	-1.0	1.1	-5.3	5.9
Total budget effect	-11.9	-5.7	-14.6	-7.0

Source: Own calculations using the SOEP and IZAΨMOD. Notes: Percentage changes refer to each category (ex: tax revenue goes down by 4.2 percent in intensive scenario)

Discussion. A principal result of the analysis is that sharing earnings losses in a downturn among larger groups of workers can produce less inequality—and lower immediate fiscal costs—than widespread layoffs. In general, the distributional advantages of achieving capacity adjustments through working-hours reductions, rather than layoffs, are greater in countries with lower automatic stabilizers, i.e., with less generous unemployment benefits and lower average tax burdens than Germany. In this respect, our results confirm the claim that the distributional distortions of the US labor market—experiencing massive layoffs while having a much less redistributive tax and benefit system—have been particularly severe.

Yet the question remains whether countries should adopt a strategy of working-time reductions to minimize layoffs. The answer depends largely on the nature of the labor market downturn and on the specific initial conditions (such as the structure of the economy or labor market institutions) in each country. In Germany conditions for working-hours reductions were, in many respects, ideal. First, the greatest output losses were suffered in the export-oriented manufacturing industry. Firms in this sector had both the motivation and the financial resources to retain valuable skilled workers during a temporary period of severely reduced output demand. Second, the output shock was indeed temporary: external demand for German manufacturing goods recovered; and the jobs of workers with reduced hours therefore remained viable after the downturn. Third, and as discussed in Section 2, policy developments prior to the downturn (especially working-time accounts and specific provisions in collective agreements), as well as policy responses to the crisis (e.g., the short-time working scheme, *Kurzarbeit*), had strongly facilitated working-hours adjustments.

On the other hand, this type of measure, which protects existing jobs, tends to reinforce employer incentives to hoard highly educated or experienced workers, while less attractive jobs may be cut more quickly (Hijzen & Venn (2011), Cahuc & Carcillo (2011)). In other words, working-hours adjustments may in fact worsen the relative position of poorly protected low-skilled and non-standard workers, who were shown to be particularly likely to suffer earnings losses in a downturn. This is likely to be a concern in highly segmented labor markets, e.g., in Spain (but also in Germany, where non-standard forms of employment have become more common).

The specificity of the output shock also has to be borne in mind, when assessing the merits of exporting certain national policies to other countries. If the sectoral incidence of output shock is different, labor hoarding might be much less beneficial for firms, and hence less widespread as a result. If, for instance, firms in the affected sector are severely credit-constrained, they may have little choice but to lay off workers. More importantly, lower output demand may not be temporary as recessions are frequently accompanied by structural changes. Policies that actively encourage firms to delay layoffs in these cases can be an obstacle to a necessary restructuring process and, hence, hold back economic recovery.

5 Conclusion

In this paper we analyze the distributional and fiscal impact of the 2008-09 crisis in Germany. We base our analysis on a disaggregated labor-demand model, which is justified by the fact that labor-demand changes are the principal driving factor of household income losses in the early phase of a labor market downturn. The predicted adjustments are then combined with detailed household microdata to translate changes in individual earnings into income changes at the household level. Thus, the method can be used before detailed income data become available and can therefore aid timely policy responses to output shocks.

The choice of Germany is interesting, since, on the one hand, it suffered from a severe output drop, which translated into a substantial labor market downturn—like many other Western countries. However, on the other hand, the adjustments occurred almost exclusively at the intensive margin, with employment levels and unemployment rates remaining unusually stable. This reflects in part Germany's policy measures before and during the crisis—facilitating labor-cost adjustments via working-hours reductions rather than layoffs.

Our labor-demand model is flexible enough to capture the real-world demand reactions following the German recession well. At the same time, the approach enables us to assess the distributional and fiscal consequences—in particular with respect to the margin of adjustment. More precisely, we propose two polar cases to assess the importance of the different margins. The first scenario, close to the German experience, assumes that all employment adjustments take place via such working-hour reductions. The second one better reflects the situation in countries such as the United States, Greece and Spain, where adjustments of employment levels were far greater.

Our results show that low-skilled and non-standard workers faced above-average risks of earnings losses, in particular if they worked in the manufacturing sector where output reductions were very large. When examining the resulting income losses, it transpires, however, that automatic stabilization by the tax-benefit system is effective in cushioning a significant share of the gross-income losses—especially among low-income groups (cf. also Dolls et al. (2010)). As far as the margin of adjustment is concerned, we show that while promoting working-hour adjustments through work-sharing and other measures cannot prevent significant income losses, it can be highly effective in avoiding very large increases in income poverty and fiscal costs. In those two dimensions the German policy responses to the crisis were successful.

Nevertheless, the conditions for working-hours reductions in Germany were ideal, as the output drop mostly occurred in the export-oriented sectors, where motivation to hoard skilled labor was high and firms had the necessary financial resources to do so. We, therefore, argue that whether the German policy can be successful in other countries crucially depends on initial conditions (especially the structure of the economy and labor market institutions) as well as the specificities of the output shocks.

From a methodological point of view, we use recent historical data to make inference about the effects of the current labor market downturn. The demand model provides an interesting "average" approximation of short-term effects of output shocks. Yet institutional changes over recent years may have affected the demand for different groups of workers in complicated ways, and the policies put in place during the crisis had their own specific effects. Hence, an important, but challenging, improvement would consist in explicitly modeling policy institutions (such as *Kurzarbeit*) in the labor-demand estimation. Another obvious limitation is that the adopted short-term horizon goes along with the assumption of constant wage levels. Although it would be worthwhile to model wage variations by interacting labor demand and supply iteratively in order to attain equilibrium (see e.g., Peichl & Siegloch (2010)), we have argued that this assumption is not too restrictive in the context of our study, as wage reductions were not a primary response to the labor market downturn in Germany.

A Appendix

Table 8: Output elasticities per cell

Cell values	Man	Con	Tra	Ser	Fin
Sk/You/FT	0.67	0.42	-0.09	0.63	0.88
Sk/You/PT	0.96	-0.29	0.78	0.94	0.76
Sk/Mid/FT	0.53	0.45	0.85	0.52	0.96
Sk/Mid/PT	0.50	2.10	1.21	0.97	0.95
Sk/Old/FT	0.77	0.40	0.99	0.98	0.93
Sk/Old/PT	0.62	0.29	2.22	1.00	0.97
USk/You/FT	0.95	1.17	-0.20	0.99	1.10
USk/You/PT	0.99	0.89	0.95	0.96	0.95
USk/Mid/FT	1.15	-0.35	1.30	0.99	1.04
USk/Mid/PT	0.41	-0.32	1.26	0.99	1.00
USk/Old/FT	0.89	3.09	0.74	1.04	1.00
USk/Old/PT	0.25	0.36	-0.33	0.99	0.96

Source: Own calculations using the LIAB. Notes: (U)Sk = (Un)skilled, You=Young, Mid= Middle-age, FT = full-time, PT = Part-timer and irregular employees.

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