The Organizational Production of Earnings Inequalities in Germany, 1994-2010

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Abstract

What drives workplace inequality levels and trends? We investigate this question with 1994-2010 German private sector linked employer-employee panel data. We find that between workplace inequalities have risen faster than reported in previous work. Similar to studies in Sweden and the U.S. we find that most earnings inequalities are within workplaces, but much of the growth in earnings inequalities is between workplaces. Fixed effect models suggest that mean workplace wages – the between workplace component of growing national inequality -- are primarily driven by changes in the skill composition of the workplace, although the rise of part-time employment has increased the aggregate wages of full-time workers and increased female employment depresses mean workplace wages. Within workplace inequality estimates highlight the central role of categorical distinctions – e.g. gender, education, part-time composition, and skill variance- in driving within workplace inequalities. Within workplace inequality is rising steeply in low wage workplaces. Gender heterogeneity and gender segregation are both associated with higher within workplace inequality, although these mechanisms seem to be weakening over time. Both high skill and part-time intensive workplaces generate high within workplace inequality, suggesting that high inequality is consistent with both low and high road production strategies.

Keywords: inequality, organizations, Germany, Relational Inequality Theory, Human Capital Theory

JEL Codes: C55, D22, D31, J31

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Rising income inequality in high income countries is now recognized as a widespread social and political problem (Stiglitz 2012) and influential commentators warn that it will only increase (Piketty 2014). Policy debates about inequality primarily focus on government redistribution at the national level, often ignoring that income distributions have become more unequal because of shifts in workplace compensation practices. Shifts in income from labor to capital, and among employees from lower to higher skill workers are well documented. But there has been less linkage of workplace level distributional trends to national inequality dynamics. Importantly, we believe that a better understanding and documenting of how and why some firms produce more or less inequality than others will provide a powerful counter-narrative to the simplistic idea that inequality is a naturally occurring process.

Empirically we take advantage of fifteen years of German administrative data on private sector workplaces and their employees. German full-time earnings inequality rose a remarkable 31% during this period. Theoretically, we supplement standard human capital theory with sociological relational inequality theory (e.g. Avent-Holt and Tomaskovic-Devey 2010, 2014), which provides insights into those components of distributional processes beyond those simply tied to individual skill levels. Most importantly, we bring workplaces into the center of the analysis of national inequality levels and trajectories.

Rising national inequality reflects a series of firm level decisions around the make versus buy decision, investment, compensation and income distributions. We demonstrate that national trends are the product of workplace and firm dynamics in the relative ability of organizations to accumulate resources and of actors to make claims on those resources. This paper stresses that the bifurcation of organizations into low and high wage workplaces is a fundamental driver of rising inequality in Germany. Outsourcing and the birth of new organizations characterized by high and low wage production strategies are likely fundamental to this polarization.

The paper begins with introductions to Linked-Employer-Employee Panel data and to relational inequality theory. We then provide a descriptive analysis, finding that contemporary inequality levels are higher and trends steeper than recent reports, documenting a rapid convergence in inequality levels between the low inequality East and high inequality West Germany, and decomposing inequality trends into between and within workplace components. Both components are rising, but the between organization components is rising most rapidly. We go on to identify organizational factors influencing both the mean wage of workplaces (the between component) and the standard deviation of logged earnings (the within component). These factors include human capital attributes of workers, but also the skills embedded in organizational divisions of labor. We find the latter are particularly important in predicting mean workplace pay. Skill and demographic heterogeneity, as well as job segregation along multiple status dimensions are particularly strong drivers of within workplace inequality. We conclude with some reflections on the theory and policy implications of these analyses.

Background

Until the advent of Linked Employer-Employee Panel (LEEP) data it was impossible to tie shifts in earnings distributions back to their source in production. Scholars relied on data on individual or family income, abstracted from the organizations that actually generate and distributed income.
An increasing number of countries are now producing LEEP data and making them available to the research community, making it possible to advance this long recognized limitation.

Early LEEP studies across multiple countries found that 40 percent or more of the total national variation in wages were attributable to similarly skilled workers (measured as both observed traits and individual fixed effects) working in different firms (see review in Abowd and Kramarz 1999). These findings strongly violated human capital theory based expectations that wages are primarily linked to the productivity of individuals. Descriptive studies of eight countries (United States, Belgium, Denmark, Netherlands, Finland, Sweden, Germany, France, and Norway) are reported in Lazear and Shaw (2009a). Across these countries within workplace earnings inequalities averaged between 60 and 80 percent of country wide variance. Mirroring national aggregate inequality patterns, wage variance within firms was highest in the United States, followed by the Netherlands, Germany and France, and relatively low in the Nordic countries (Lazear and Shaw 2009b). In all countries examined there is almost as much social space to bargain over wages within workplaces as there is in the labor market overall. Previous research in economics using LEEP data tend to conclude by pointing to the need to study workplace wage setting in its own right (e.g. Abowd et al. 2006; Lazear and Shaw 2009).

LEEP researchers have also reported firm heterogeneity in the impact of individual traits on wages. Cardoso (1999) showed a wide dispersion of human capital and gender coefficients across medium sized Portuguese workplaces. Abowd, Kramarz and Roux (2006) looking at medium and large workplaces in France find great heterogeneity in wage growth across workplaces, with education, tenure, and maleness showing positive, negative and no earnings returns within workplaces net of starting wage. In an application of RIT to LEEP data, Tomaskovic-Devey, Hällsten and Avent-Holt (2015) show that non-western immigrant-native Swede wage gaps vary dramatically across workplaces. A notable aspect of this paper is that workplaces with higher levels of inequality consistently increase the inequality associated with all individual status characteristics. Wage returns to education, occupational skill, and even individual fixed effects all rise with the level of workplace inequality. Observing German workplaces Antonczyk, Bernd and Sommerfeld (2010) show a similar link between workplace inequality and gender pay gaps. In France, where rising inequalities have been at the very top of the wage distribution, Jellal, Nordman, and Wolff (2008) show that workplace gender wage gaps rise at the top as well. The notion that wages are set more or less homogenously in labor markets is directly challenged by these empirical results.

Human capital theory provides some clear direction into how these inequalities might be generated. From a human capital perspective the aggregate workplace wage bill should mirror the skills deployed in production and within workplace inequalities should track heterogeneities in the workplace skill distributions. We begin with this expectation as well.

Relational inequality theory (RIT) was developed to explain the substantial pay inequalities that remain net of conventional human capital models. These variations include well known gender and other demographic pay inequalities, but also the high level of organizational variation in wage

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2 RIT is in many ways a contemporary version of the “new structuralism” and “dual economy” theories of the 1970s and 1980s. They key difference is that RIT begins with interaction within organizations as the process generating inequality, rather than deviations from single national labor market models into dual or multi-sector models (see the discussion in Tomaskovic-Devey et al. 2015)
rates and wage setting processes that have been identified in previous research in economics (e.g. Abowd et al. 2006; Bhaskar, Manning and To 2002; Cardoso 1999).

RIT identifies the social and technical relations within workplaces as generating within organizational inequalities (see reviews in Avent-Holt and Tomaskovic-Devey 2014; Roscigno and Wilson 2013; Wilson and Roscigno 2013). In contrast to the standard human capital models, core mechanisms in RIT are located inside the workplace, not in external labor market processes. Consistent with human capital theory RIT sees organizational product markets as the limiting condition on the total wage bill to be distributed to employees, but emphasizes the relative power of actors to bargain over the distribution of available resources within and between workplaces.

In RIT workplaces accumulate resources through the production and sale of products and services, various stakeholders make claims on those resources, sometimes as individuals, but often collectively mobilizing occupation, skill, unionization and other institutional resources. In this model categorical distinctions – employer-employee, manager-worker, male-female, citizen-non-citizen, degree-no degree – are used to both distribute and legitimate inequalities. Such distinctions become part of identities and are used to make the in-group/out-group distinctions that produce status expectations for legitimating claims on organizational resources (Ridgeway 1997).

From human capital theory RIT retains production generated income as the limiting condition on aggregate organizational wage bills, as well as the human capital focus on individual productivity as both a source of skill in production and a fundamental claims making resource. The level of workplace income available to be distributed should be expected to reflect to some extent aggregate internal productivity. Unlike human capital theory, RIT conceptualizes internal productivity as rising not simply with average individual skill, but also with the task complementarities and efficiencies that arise from workplace divisions of labor and the quality of social relationships in workplaces (Hodson 2001, for a similar view in economics see Bender et al. 2016). RIT also recognizes that organizational income can arise from external organizational power in political and product markets (Tomaskovic-Devey 2014). Thus from a RIT perspective the level of resources available for distribution will reflect some mix of internal production efficiencies and external market power. The distribution of those resources, however, will reflect the relative bargaining power of actors with claims on organizational income.

The most basic source of both workplace productivity and distributional inequalities lies in the technical division of labor. Within workplace inequality should rise with the degree of occupational skill variability at the workplace level. Between workplace inequality should vary as a function of the average skill level of workplaces and perhaps the skill complementarities produced by complex divisions of labor. This view is consistent with studies that explain rising inequality in terms of the shifts in the skill composition of production (Autor, Katz, and Kearney, 2006). Comparative work using industry-occupation, rather than LEEP, data supports the hypothesis that the hollowing-out of the skill distribution is associated with rising within industry inequality in Germany (Fernandez-Macias, Hurley and Stone, 2012). What is unclear in this research is whether this skill polarization happened within or between workplaces. In this study we find that most of this skill polarization is happening between workplace, in the founding or evolution of increasingly skill segregated workplaces.
The observation that actors create and use categorical distinctions to pursue individual and collective agendas to (re)produce inequality is widespread in social theory: see Tilly (1998) on categorical claims, Bourdieu (Bourdieu and Wacquant 1992) on classification struggles; Abbott (2005) on jurisdictional claims; Lamont and Fournier (1992) on moral boundary work; and Ridgeway (2011) on categorical status expectations. Salient social distinctions are the lens through which we observe moral worthiness and thus legitimate distributional mechanisms of exploitation and exclusion (Schwalbe et al. 2000). Both routine interaction and collective struggles draw on these identities.

A key prediction from RIT is that more categorically heterogenous workplaces will have higher levels of inequality. All of the few studies that have looked at workplace earnings inequalities in the past have found that employee gender and human capital heterogeneity are associated with higher earnings inequalities (Barth et al. 2012; Hedström 1991; Kalleberg and van Buren 1994; Shin 2009). Here we explore the impact of workplace heterogeneity along occupation, education, sex, citizenship, and tenure lines.

Following Tilly (1998) another expectation of RIT is that when multiple salient categorical distinctions reinforce each other (e.g. low education worker facing credentialed manager), distributional inequalities will be exaggerated. Importantly, because each workplace has a more or less unique intersection of categorical distinctions, inequality regimes are at least partially, often largely, produced locally (Acker 2006). The intersection of jobs in workplace divisions of labor with other locally salient categorical distinctions such as education, gender, immigrant status or authority will produce local status hierarchies and as a result variation across workplaces in inequality regimes (Tomaskovic-Devey 2014). We will explore the impact of workplace occupational segregation along education, sex, citizenship, and tenure lines upon workplace mean earnings and inequality levels.

**German Inequality Trends**

Earnings inequalities in Germany have risen dramatically since the mid-1980s. Market earnings inequalities in German are now marginally higher than in the U.S. (Solt 2009). Figure 1 displays these trends for all full-time Germany employees for our observation period. There is a considerable flattening of the distribution, with increased employment in higher and lower wage jobs. Most of the rise in higher wage jobs happened before 2002, while the rise in low wage jobs accelerated afterwards.
Card, Heining, and Kline (2013) have done the most careful and detailed analysis of the organizational basis of rising German earnings inequalities. Limiting their analysis to men and West Germany, they find that increased between workplace earnings inequalities produced about one-quarter of growing inequality in Germany. Three quarters were produced by growing within workplace inequalities. In contrast, recent results for Sweden (Skans, Edin and Holmlund 2009) and the U.S. (Song et al. 2016) concluded that two-thirds of the recent growth in those nation’s earnings inequalities stemmed from increased variance in between workplace mean earnings. In these countries the process seems to be driven primarily by the creation of more homogeneously high wage and low wage workplaces, rather than widespread income redistributions within workplaces. Song et al. (2016) find that rising within firm wage inequality in the U.S. is primarily driven by the 50 or so highest paid workers in the very largest (10,000 employees or more) firms.

Card et al. (2013) connect the rise in within workplace wage inequalities in Germany to increasing within workplace educational and occupational skill dispersions. Interestingly, none of the rise in within workplace inequality was associated with increased returns to individual education, rather it is the skill level of the workplace that produced the well-known increased returns to more educated workers. Workplaces, particularly newly founded workplaces, have simplified their divisions of labor yielding increasing proportions of high skill and low skill workplaces. This change in the organization of work is also associated with the birth of new, non-union low wage workplaces. Card et al. (2013) find that firms born after 1996 show particularly high levels of
between firm wage dispersion, thus confirming that between workplace inequalities in Germany are growing through the birth of new skill segregated firms. In addition, since 1996 German firms have had more latitude to offer fixed-term, rather than permanent, contracts to their employees. They suggest that labor outsourcing and the creation of low wage “mini-jobs” may have further contributed to the expansion of between workplace inequalities as well.3

Because Card et al. (2013) focus on only men and only West Germany their conclusions must be taken with a grain of salt. If high versus low road employment strategies are associated with East versus West German workplaces, the dominant between workplace-growing inequality pattern found in the US and Sweden may be in play in Germany as well. Similarly, excluding women even as they become a higher proportion of the labor force may obscure both within and between workplace inequality trends associated with sex segregation in employment and production roles.4

**Analytic Choices**

We use German administrative data, linking all employees in a workplace to their employer over time. These data are of very high quality as they are used to track income and employment for social security and tax purposes. Thus they have very little measurement error, particularly in comparison to standard survey data. Most importantly they allow analysts to focus on the workplace context in which wages are earned and paid. We focus our analyses on the wages of full-time employees and almost all workplace characteristics are calculated on full-time workers only. The one exception is the workplace distribution of part-time employees which is calculated from all employees. Thus while we focus on earnings inequality levels and trends for full-time employees, we allow the growth of part-time employment to influence these trends. All analyses are based on all employees in all workplaces with 20 or more employees. As is common in LEEP analyses we do not focus on statistical significance, but rather explained variance and the magnitude of coefficients.

We depart from Card et al.’s (2013) analysis on a number of critical dimensions. First, we include the entire German private-sector economy, including full-time employed women and everyone who works in East Germany to investigate how inequality develops in the entire German economy over time. Consistently we begin our analyses in 1994 after German unification. At this point the administrative data from the West and East had been combined and data quality were equally high in both parts of the country.5 Most importantly, we proceed from an organizational, rather than individual, model of wage setting. Card et al. (2013) follow the analytic pattern in previous LEEP studies in focusing on the relative contribution of individual and workplace wage setting. We,

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3 Prior to 1985 fixed term contracts, except for probationary employees and apprenticeships were prohibited in Germany when no permanent position was available. In 1996 even these restrictions were removed and an employee could be hired up to three times on time limited (typically 24 months) fixed term contracts. This policy changed somewhat in 2001, when follow-up temporary contracts were forbidden if there was a previous temporary contract with the same employer (Gebel 2010).

4 Card et al. (2013) use the female wage distribution as a robustness check comparison to their male only results. One problem with this approach is that it artificially splits all workplaces into male-only and female-only workplaces.

5 Although national data are available starting in 1991, the East German administrative data only become reliable in 1993 and we limit our analytic sample to 1994 and later. The period of great growth in German earnings inequality happens within our observation period.
however, treat all wage setting as organizational, focusing on the impact of structural shifts in the population of organizations and internal shifts in skill composition and heterogeneity as the primary explanations of between workplace wage setting and organizational skill and demographic composition as producing within workplace inequalities.

Card et al. (2013), Tomaskovic-Devey et al. (2015) and other studies using LEEP data have typically estimated models at the individual level, building off familiar individual level earnings models and, in order to control for the sorting of high skilled workers into high income workplaces, using an individual fixed effect strategy to control for unobserved worker skill heterogeneity. But one of the remarkable lessons from early LEEP studies is that such selection processes are remarkably weak (see the multi-country discussion in Lazear and Shaw 2009). Abowd et al. (2009) show for firms in a sample of US states that the correlation between workplace and individual fixed effects was only .07. For West Germany, Card et al. (2014) show a similar low selection estimated correlation of .097 in the early nineties, rising to .249 in the later 2000s. While selection is growing (a result also reported for Sweden by Skans et al. 2009) in Germany, it is driven by organizational, rather than individual level processes, associated with outsourcing and the evolution of more skill homogenous labor processes (Card et al. 2013). Thus, we feel that our strategy of estimating models at the organizational level is appropriate both theoretically and empirically.

Workplaces are observed via an establishment ID and are for the most part unique stand-alone workplaces. When a firm owns two or more workplaces operating in the same industry in the same municipality they will be reported under the same ID. We think it reasonable to assume that such workplaces shares similar divisions of labor, skill and employment practices. When a workplace is sold to another firm, it will get a new ID. We think treating such workplaces as new establishments is appropriate, as did Card et al. (2013). We also limit our analyses to all workplaces with at least 20 full-time employees to produce more stable measures of organizational traits.

In the analyses that follow we first decompose German full-time employment inequality trends into between and within workplace components. In a second step, we focus on the role of East German unification and industrial shifts for producing the observed between workplace rise in inequality. In these analyses we examine the deviation of individual wages from the mean wage of the workplace. We then shift to human capital and relational inequality explanatory models to estimate the influence of workplace division of labor and employment composition, modeling both between and within workplace variation in organizational earnings inequalities. We use workplace fixed effect models to explore the causes of changes in workplace mean log earnings and the workplace standard deviation of log earnings.

Both RIT and human capital approaches suggest that productivity related resources (occupational skill, education, tenure, and experience) should influence workplace mean earnings. Human capital theory sees internal wage distributions as a function of individual skill levels. RIT suggests three general processes that might be expected to generate within organizational wage inequality.

The first process includes organizational policies or practices that may enable or retard the ability to make social distinctions among employees. Large German workplaces almost universally have collective bargaining agreements. In addition, workplaces with more than 250 employees are
mandated to have work councils with labor as well as managerial representation. Both forms of worker representation are likely to lead to reduced inequalities. The administrative data do not provide a measure of collective bargaining coverage, so we simply use a measure of size to proxy for both of these processes.

The second process includes routine social distinctions in production and among employees that facilitate both productivity and status based claims on the pool of available income. We focus on both the levels and overall variability in status characteristics, with the basic prediction that socially salient status characteristics act as legitimate bases for making income distinctions and that variance in status characteristics produce the bargaining space for higher status groups to make stronger claims on resources. From a human capital point of view the salient status characteristics should include education, tenure, and experience, and perhaps occupational skill levels as an indicator of task specific skills. From an RIT perspective occupational skill is assumed to be the dominant claims making resource since it will typically be institutionalized in organizational divisions of labor and pay schedules. For human capital variables RIT describes the proximate mechanism generating earnings, not as productivity, but as wage claims. These can be productivity linked claims, but also may reflect credentialism, organizational citizenship rights, and seniority based claims. RIT additionally, predicts that other forms of organizational citizenship, gender and immigrant status may operate similarly to human capital, influencing the ability of actors to make claims on organizational resources.

The third inequality generating process is the intersection between status characteristics imported from the society more generally and production roles within the workplace. Tilly (1998) emphasized this process as both distributing inequalities through segregation and cementing status distinctions in interaction. Ridgeway’s (2012) model of gender status hierarchy similarly stresses that the intersection of jobs and gender generates gender based status expectations. The well-known tendency for female dominated jobs to pay lower wages is the most familiar example of this segregation process (see Ludsteck 2014 for evidence on Germany using LEEP data). There are quite a few RIT linked papers that have found that these processes exaggerate status inequalities (see the review in Tomaskovic-Devey 2014), but to our knowledge no one has yet applied this insight to explain overall workplace inequality.

Observing Earnings Inequalities

Analytically we disaggregate shifts in total logged earnings inequality into between and within workplace components. We first focusing on total, regional and industry disaggregation, followed by fixed effect modeling of workplace variation in both inequality components. Table 1 presents these shifts. Mean workplace private sector earnings in Germany changed little over the period. This reflects the combination of German export policy which encouraged both unions and management to keep wages low and the rising capital share of income in the German economy (Card et al. 2013; Kristal 2010). The dramatic inequality increase is between German workplaces. The standard deviation of mean earnings grew from .26 to .35, or 35.6%. The larger contribution is the increased between workplace dispersion associated with the rise of high wage and low wage workplaces.
Within workplace inequalities rose as well. In the average workplace pay inequality grew by 12%. At the same time there was increased across workplace inequality variation which grew 20% from a fairly low base in 1995. In 2010 most inequality was produced within workplaces 
\((.42 = .32 + .11)\), but between workplace inequality was fast converging (.35). This is a striking pattern of increased pay segregation across workplaces, coupled with slow growth in within workplace inequality as well. See Table 1 for descriptive statistics.

**Explanatory Models**

In the remainder of this paper we explore these shifts in between and within workplace inequality.

Our first analysis decomposes individual income for each year into between and within workplace components. This is done with a simple workplace fixed effect for each year.

Our second analysis, gauges the degree to which increased between workplace mean wage inequalities simply reflect the incorporation of low productivity East German workplaces or shifts in the German industrial structure. In this analysis the dependent variable is workplace mean wage and again we simply estimate yearly fixed effects for East Germany, all German states, and three digit industry codes. Because outsourcing and various other mechanisms to externalize labor costs are understood to be a prime cause of increased between workplace inequality, the industry analysis helps us establish the degree to which this process is a reasonable explanation.

Our third and fourth analyses model the influence of workplace composition on respectively mean workplace earnings inequality and within workplace inequality (measured as the standard deviation of workplace logged earnings). Both of our dependent variables are aggregate versions of the log of real daily earnings. This variable include all earnings from the focal employer in the year, divided by days worked. We only have a crude measure of hours worked (full-time, long part-time, and short part-time) so a measure of hourly wage is not possible. It is for this reason that we limit our analyses to full-time employees. For most employees this is a very high quality measure with relatively little error, especially compared to self-report data. The key limitation of this measure is that it is top-coded at the maximum income subject to German social security withholding. Card et al. (2013) developed an imputation strategy that used workplace as well as individual level data to impute the income of higher earners. We have improved on their imputation strategy by making better use of both workplace and individual information. See Appendix 1 for details of our imputation strategy. Because of the lagged imputation strategy our analyses begin in 1995.

Explanatory variables focus on skill and status levels, heterogeneity, and segregation. We also explore the impact of organizational size, a key variable in prior literature on organizational wage variation. For within workplace inequality we also examine the influence of mean workplace wage to gauge the degree to which between organizational inequality growth has implications for within organizational inequality patterns. We present both OLS and workplace fixed effect estimates. FE models can be considered rough proxies for contemporary causal process in wage setting. We also report OLS models which can be thought of as representing the organizational accretion of historical processes.
We observe continuous status characteristics in terms of both organizational means and their standard deviations. These include occupational rank, employee age and workplace tenure. Occupational rank is a measure of three digit occupations ranked in terms of national percentiles of the income distribution. We interpret this as a summary measure of job skill levels.\(^6\) Card et al. (2013) find that increased workplace inequality is associated with occupational, but not individual skill, shifts among males in West Germany. We treat occupational rank, age, and tenure means and standard deviations as rough proxies for skill levels and skill variance in production. Table 1 shows that while average occupational skill did not change, between workplace skill variance went up 15%. Mean age and tenure both increased as the German labor market aged. The variation in mean age declined. Between and within workplace tenure variance grew strongly, while between workplace variance in age and occupational rank grew modestly. Overall the most striking pattern is the growing between workplace skill and tenure segregation. Germany has seen a growth in both high skill-high tenure and low skill-low tenure workplaces.

We approach categorical characteristics in terms of both employment shares and their heterogeneity. These include part versus full-time (percent less than 18 hours/week, percent 18 -39 hours week, 40+ hours/week is the reference category), educational degrees (percent low education, percent medium education, percent tertiary education is the reference category), percent male, percent German citizen, and percent in credentialed positions. Heterogeneity in categorical composition is observed with the Gibbs-Martin index of heterogeneity for each of these distinctions.\(^7\) We treat these categorical divisions as the bases for claims making on organizational resources. Educational composition, of course, can also be interpreted as an additional productivity related trait. In human capital theory productivity claims are enforced by market processes. In RIT the same claims need only be persuasive to be enforceable. Card et al. (2013) report that individual education has no impact on organizational inequality shifts net of occupational skill and its variance for West German men. One striking shift in German employment is the growth of part-time employment and it’s increased between workplace variance.

Table 1 provides ample evidence that the German labor market is increasingly polarized between firms providing high skill, secure, full-time work and those specializing in low road production.

**Table 1 Establishment descriptive statistics for first and last year, 1995 and 2010**

|            | 1995 | 2010 | SD |
|------------|------|------|----|

\(^6\) This is consistent with standard practice in labor economics. In sociology similar measures have been described as measures of socioeconomic status, but there is substantial conceptual ambiguity in this literature. Recently sociologists LeGrand and Tählin (2013) have shown across multiple countries that the consistent underlying dimension associated with occupational socioeconomic status is skill in production. We adopt this interpretation as well.

\(^7\) The formula for the Gibbs-Martin index of heterogeneity is:

\[
H = 1 - \sum_{\text{0}=1}^{n} p_0^2
\]

where \(p_0\) is the proportion of employees in an establishment within a category and \(n\) is the number of categories (e.g. two for sex, three for education).
|                                | Mean | SD  | Mean | SD  | Mean % Change | % Change |
|--------------------------------|------|-----|------|-----|--------------|---------|
| Mean Log Earnings              | 4.54 | 0.261 | 4.576 | 0.354 | 0.79 | 35.63 |
| Standard Deviation of Logged   | 0.286 | 0.084 | 0.32 | 0.101 | 11.89 | 20.24 |
| Earnings                       |      |      |      |      |      |   |
| Log Establishment Employment   | 0.448 | 1.26 | 0.411 | 1.319 | -1.56 | 4.68 |
| Mean Occupational Skill        | 0.595 | 0.176 | 0.594 | 0.203 | -0.17 | 15.34 |
| Mean Age                       | 38.82 | 4.385 | 41.97 | 3.791 | 8.12 | -13.55 |
| Mean Tenure                    | 6.243 | 3.739 | 8.788 | 4.851 | 40.77 | 29.74 |
| SD Occupational Skill          | 0.2 | 0.072 | 0.196 | 0.08 | -2.00 | 11.11 |
| SD Age                         | 9.994 | 1.254 | 9.67 | 1.386 | -3.24 | 10.53 |
| SD Tenure                      | 4.456 | 2.572 | 5.935 | 3.111 | 33.19 | 20.92 |
| % PT Less than 18 hours        | 0.012 | 0.035 | 0.026 | 0.05 | 118.33 | 40.85 |
| % PT Greater than 18 hours     | 0.101 | 0.138 | 0.156 | 0.177 | 54.46 | 28.26 |
| % Low Education                | 0.21 | 0.221 | 0.215 | 0.251 | 2.38 | 13.57 |
| % Medium Education             | 0.694 | 0.225 | 0.648 | 0.251 | -6.63 | 11.56 |
| % Male                         | 0.643 | 0.256 | 0.653 | 0.239 | 1.56 | -6.64 |
| % German                       | 0.922 | 0.11 | 0.937 | 0.089 | 1.63 | -19.09 |
| % Credentialed Positions       | 0.427 | 0.295 | 0.494 | 0.323 | 15.69 | 9.49 |
| Gibbs-Martin Index of          |      |      |      |      |      |   |
| Heterogeneity                  |      |      |      |      |      |   |
| Part/Full Time                 | 0.159 | 0.173 | 0.232 | 0.198 | 45.91 | 14.45 |
| Educational Degrees            | 0.344 | 0.165 | 0.358 | 0.165 | 4.07 | 0.00 |
| Gender                         | 0.327 | 0.148 | 0.339 | 0.144 | 3.67 | -2.70 |
| German Citizen/Non-Citizen     | 0.118 | 0.133 | 0.102 | 0.113 | -13.56 | -15.04 |
| Credentialed positions         | 0.315 | 0.148 | 0.291 | 0.161 | -7.62 | 8.78 |
| Segregation as Correlation     |      |      |      |      |      |   |
| Between:                       |      |      |      |      |      |   |
| Occupational Skill, Male       | -0.053 | 0.272 | -0.065 | 0.258 | 22.64 | -5.15 |
| Occupational Skill, German     | 0.088 | 0.153 | 0.054 | 0.143 | -38.64 | -6.54 |
| Occupational Skill, White      | 0.725 | 0.227 | 0.688 | 0.253 | -5.10 | 11.45 |
| Collar                         |      |      |      |      |      |   |
| Occupational Skill, High       | 0.245 | 0.217 | 0.244 | 0.23 | -0.41 | 5.99 |
| Education                      |      |      |      |      |      |   |

Since we see heterogeneities as claims making resources on available resources they should not be strongly tied to mean workplace earnings, except in so far as they shift the relative power of capital, customers, or labor. We do not observe capital’s share of income or the price paid by consumers for production, so we cannot directly observe the distinction between market power, class power, and productivity. To the extent that we observe large impacts of non-productivity
related status characteristics on mean earnings, we will interpret them as consistent with these unobserved processes.

The final set of variables focuses on the intersection of claims making resources and positions in the division of labor. Segregation on status dimensions is hypothesized in RIT to exaggerate the inequalities that either production or social roles would produce on their own. We observe this segregation as the workplace level correlation between occupational rank and male, German citizen, professional/managerial class and tertiary education. We include indicator control variables for workplaces where particular status characteristics are missing. The correlation is set to zero for these workplaces. The low means for gender and citizenship segregation reflect these zero scores in workplaces that are entirely sex or citizen homogeneous. The influence of segregation is hypothesized to be primarily internal to organizational wage bargains.

We do not have a measure of collective bargaining coverage. The rise of new, non-unionized firms, is linked by Card et al. (2013) to rising between workplace inequalities. This omitted variable is effectively controlled in the fixed effects models specification, but it does limit our ability to comment on the magnitude of this effect. We also lack a measure of fixed versus permanent contract frequency in the workplace. In Germany, collective agreements do not allow for unequal pay for fixed-term and permanent-contract workers, although in practice temporary workers’ occupational positions may be downgraded to allow for lower payments (Gebel 2010). Fixed contracts are a practice that has been growing in Germany and so leaves our statistical models open to omitted variable bias. Since legally it cannot influence wages, but socially it might influence the mean occupational skill of a workplace, this source of bias in the models can be expected to be absorbed by the estimated influence of changes in skill composition upon earnings.

**First Results: Rising German Inequality**

We begin our analyses in 1995, four years after German reunification, decomposing rising inequality into within and between workplace components. This is done for each year partitioning individual log wage variance into between and within workplace components.

Figure 2 displays the results. Total inequality rises 12.1 log points, or 31% over its level in 1993. Within workplace wage dispersion rises 4.5 log points (15%), while between workplace wage dispersions increases 7.5 log points (75%). Sixty-three percent of increased total inequality in Germany is associated with changes in mean wages within workplaces. This is in contrast with Card et al. (2013) who found only about a quarter of increased German inequality was associated with shifts in workplace mean wage. The Card et al. (2013) sample excluded all East German

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8 This is the approach advocated by Blau (1977) and followed recently by Tomaskovic-Devey et al. (2015). Categorical approaches to segregation (e.g. Duncan dissimilarity index of Grusky’s A) become unstable in the small cell size world of jobs within workplaces (see discussion in Tomaskovic-Devey et al. 2015).

9 In 1998 firms began reporting data on marginally employed mini-jobs. It appears that some of these were misclassified as full-time in that year, temporarily increasing the estimate of within workplace inequality. In the models that follow we use year fixed effects so this source of measurement error is effectively controlled by design.
employment and all women, essentially half of full-time German employees. It is not surprising then to find much higher between-firm components in Germany’s rising wage inequality in our result.

Figure 2. Trends in German daily earnings inequality; total, within and between workplace components, 1995-2010 all employees in workplaces with at least 20 employees.

Second Results: Structural Change and Rising Workplace Inequality

The simplest explanation for the rapid rise in between workplace inequality are the dynamics of East and West German unification and shifts in the industrial structure of the German economy. Reflecting its socialist past East Germany initially has much lower earnings inequalities than West Germany. Unification, however, brought profound changes to East Germany. Many firms were not competitive and closed. West German firms established new branches in the east, sometimes closing unionized shops and replacing them with non-union workplaces. The changes in industrial structure are less dramatic, but there is a gradual rise in service sector employment in Germany as elsewhere. The literature on outsourcing and skill segregation between workplaces points to industrial shifts as a likely source of rising between workplace inequalities.
For this analysis we focus on just the between workplace variance in mean earnings, estimating yearly fixed effects for East and West Germany, all German States, three digit industries and finally States and Industries together. We report only the total explained variance for each mode for each year in Table 2.

In 1995 19% of between workplace wage dispersion was produced by the lower wages in East Germany inherited from the socialist period. Further distinctions among German states add little additional information. Geographical distinctions in inequality levels decline strongly across the observation period as total employment in East Germany declines and wage levels in East Germany become more similar to those in the West.

| Year | Employees     | Between Variance | East/West | Explained Variance | Both States/Industries |
|------|---------------|------------------|-----------|--------------------|------------------------|
| 1995 | 15,385,454    | 0.263            | 0.189     | 0.238              | 0.464                  |
| 1996 | 15,050,954    | 0.266            | 0.158     | 0.205              | 0.476                  |
| 1997 | 14,498,751    | 0.274            | 0.149     | 0.190              | 0.500                  |
| 1998 | 14,267,101    | 0.298            | 0.132     | 0.168              | 0.486                  |
| 1999 | 14,210,004    | 0.293            | 0.121     | 0.155              | 0.490                  |
| 2000 | 14,369,638    | 0.297            | 0.107     | 0.135              | 0.497                  |
| 2001 | 14,342,992    | 0.300            | 0.088     | 0.120              | 0.475                  |
| 2002 | 13,876,790    | 0.308            | 0.070     | 0.102              | 0.505                  |
| 2003 | 13,539,284    | 0.313            | 0.081     | 0.108              | 0.510                  |
| 2004 | 13,203,413    | 0.334            | 0.080     | 0.106              | 0.517                  |
| 2005 | 12,906,135    | 0.339            | 0.078     | 0.103              | 0.526                  |
| 2006 | 13,043,704    | 0.365            | 0.082     | 0.101              | 0.535                  |
| 2007 | 13,349,214    | 0.373            | 0.079     | 0.100              | 0.556                  |
| 2008 | 13,617,768    | 0.384            | 0.078     | 0.094              | 0.557                  |
| 2009 | 13,121,793    | 0.373            | 0.078     | 0.095              | 0.536                  |
| 2010 | 13,297,233    | 0.386            | 0.071     | 0.090              | 0.549                  |

Note: Lines represent changes in the German industrial classification system

Industry distinctions produced 46% of between workplace inequalities in 1995, rising to 55% by 2010. By 2010 regional differences in wages explain an additional 5% of between workplace inequalities. The rapid rise in between workplace inequality is primarily a function of employment shifts toward both low and high wage industries as suggested by the literature on outsourcing and between workplace skill segregation. The convergence of East and West German earnings actually led to decreased between establishment inequalities.
Third Result: Explaining Between Workplace Inequality Levels and Trends

We next estimate a series of models predicting first the levels (Table 3 OLS) and then change (Table 4 FE) in workplace mean wage. Industry and region are effectively absorbed by the workplace fixed effects in Table 4. We report nested models to highlight the influence of theoretically distinct groups of variables. We begin with a simple time trend (OLS1 and FE1), followed by the impact of organizational size (OLS2 and FE2). There is a long history of research finding higher wages in larger organizations. The mechanisms have tended, however, to be unclear with higher productivity reflecting more complex divisions of labor or market power being the most prominent explanations. This is followed by a model that includes productivity related measures (mean occupational skill levels, age, and tenure) and their within workplace variance (OLS3 and FE3). Occupational variance reflects the complexity of divisions of labor and should be associated with higher productivity through this classic organizational mechanism. We have no expectations for the impact of tenure and age variance on mean organizational earnings.\(^{10}\)

Mean wage is traditionally seen as a measure of overall productivity. From an RIT perspective that value is likely to be produced by some combination of internal production efficiencies and external market power. In addition, in an RIT model mean wages reflects both internal productivity and the relative strength of capital and labor to make claims on income as profits and earnings.

OLS4 and FE4 explore the impact of categorical distinctions around education, gender, citizenship, and managerial/professional occupations. We treat all of these as describing the composition of employment and have no position on their connection to productivity, but each may change the relative power of labor to bargain over collective wages. Unfortunately, we do not have a measure of union coverage. Card et al. (2013) suggest that declining union coverage is a major contributor to rising inequality in Germany. It may be reasonable to speculate that the categorical distinctions we do measure will become more influential in wage bargains between capital and labor in the absence of collective bargaining (see Kristal 2013). If this is the case their influence might be expected to strengthen in the fixed effect models relative to OLS estimates.

OLS5 and FE5 explore the impact of heterogeneity in these categorical status distinctions. OLS6 and FE6 add the impact of education, sex, immigrant, credentialed occupation segregation on

\(^{10}\) In terms of omitted variables the models lack measures of managerial practices and their potential complementarities with employee’s skill levels (Hodson 2001; Bender et al. 2016). Also missing are indicators of market power relative to customers and suppliers which is also a potential driver of organizational income. Both sets of unobserved processes are probably partially controlled in the fixed effect specification.
changes in mean wages. Both sets of variables are hypothesized to impact within workplace inequality, but should have only modest effects on mean earnings via their influence on the collective wage bargain between capital and labor earnings. We primarily focus on the final models, when discussing historical (OLS) and contemporary (FE7) causal impacts. The usual missing variable and model adequacy caveats apply.
Table 2. OLS regression of mean workplace earnings on employment size, continuous, categorical and intersectional bases for inequality, 1995-2010 pooled German private sector workplaces with 20 or more employees.

| Variable                      | Variable                      | Variable                      | Variable                      | Variable                      | Variable                      | Variable                      | Variable                      |
|-------------------------------|-------------------------------|-------------------------------|-------------------------------|-------------------------------|-------------------------------|-------------------------------|-------------------------------|
|                               | e1po                          | e2po                          | e3po                          | e4po                          | e5po                          | e6po                          | e7po                          |
| year                          |                               |                               |                               |                               |                               |                               |                               |
| 1996                          | 0.004                         | 0.005                         | -0.008**                      | 0.003                         | 0.008*                        | -0.004**                      |                                 |
| 1997                          | -0.001                        | 0.001                         | -0.028***                     | -0.010***                     | 0.002                         | 0.003                         | -0.022***                     |
| 1998                          | 0.031***                      | 0.033***                      | -0.006                        | 0.012***                      | 0.027***                      | 0.033***                      | 0.001                         |
| 1999                          | 0.038***                      | 0.043***                      | -0.007**                      | 0.013***                      | 0.033***                      | 0.042***                      | 0.002                         |
| 2000                          | 0.043***                      | 0.048***                      | -0.005                        | 0.016***                      | 0.037***                      | 0.046***                      | 0.002                         |
| 2001                          | 0.045***                      | 0.051***                      | -0.010***                     | 0.013***                      | 0.038***                      | 0.044***                      | -0.005***                     |
| 2002                          | 0.056***                      | 0.063***                      | -0.008**                      | 0.017***                      | 0.048***                      | 0.055***                      | -0.004***                     |
| 2003                          | 0.058***                      | 0.064***                      | -0.018***                     | 0.014***                      | 0.047***                      | 0.054***                      | -0.014***                     |
| 2004                          | 0.049***                      | 0.056***                      | -0.027***                     | 0.002                         | 0.037***                      | 0.045***                      | -0.025***                     |
| 2005                          | 0.049***                      | 0.055***                      | -0.035***                     | -0.004                        | 0.035***                      | 0.044***                      | -0.034***                     |
| 2006                          | 0.036***                      | 0.043***                      | -0.043***                     | -0.018***                     | 0.024***                      | 0.031***                      | -0.044***                     |
| 2007                          | 0.023***                      | 0.031***                      | -0.046***                     | -0.031***                     | 0.010*                        | 0.017***                      | -0.052***                     |
| 2008                          | 0.016**                       | 0.024***                      | -0.049***                     | -0.041***                     | 0.001                         | 0.009*                        | -0.058***                     |
| 2009                          | 0.031***                      | 0.039***                      | -0.047***                     | -0.036***                     | 0.012**                       | 0.024***                      | -0.055***                     |
| 2010                          | 0.028***                      | 0.037***                      | -0.040***                     | -0.038***                     | 0.009*                        | 0.021***                      | -0.052***                     |
| Emp.size total               | 0.054***                      |                               |                               |                               |                               |                               |                               |
| c.emp_tot#c.emp_tot           |                               | -0.001***                     |                               |                               | -0.000***                     |
| Mean occ. rank                |                               |                               | 1.097***                      |                               | 0.651***                      |
| Mean age                      |                               |                               |                               | 0.005***                      |                               | 0.007***                      |
| Mean tenure                   |                               |                               |                               | 0.013***                      |                               | 0.006***                      |
| SD occ.rank                   |                               |                               |                               | 0.194***                      |                               | -0.075***                     |
| SD age                        |                               |                               |                               | -0.037***                     |                               | -0.025***                     |
| SD tenure                     |                               |                               |                               | 0.013***                      |                               | 0.009***                      |
| Share part-time <18 hours     |                               |                               |                               | 0.392***                      |                               | -0.118***                     |
| Share part-time >=18 hours    |                               |                               |                               | 0.138***                      |                               | -0.147***                     |
| Share low educ                |                               |                               |                               | -0.572***                     |                               | -0.332***                     |
|                                |        |        |
|--------------------------------|--------|--------|
| Share med educ | -0.394*** | -0.228*** |
| Share male | 0.698*** | 0.455*** |
| Share German | -0.335*** | 0.200*** |
| Share managers/profs | 0.603*** | 0.205*** |
| Gibbs-Martin working hours | 0.245*** | 0.256*** |
| Gibbs-Martin educ | 0.708*** | 0.139*** |
| Gibbs-Martin sex | -0.329*** | -0.109*** |
| Gibbs-Martin German | -0.239*** | 0.280*** |
| Gibbs-Martin managers/profs | 0.178*** | 0.118*** |
| Corr occ. rank male | 0.150*** | 0.096*** |
| Corr occ. rank male miss | 0.008*** | 0.006*** |
| Corr occ. rank German | -0.029*** | 0.055*** |
| Corr occ. rank German miss | -0.155*** | -0.093*** |
| Corr occ. rank managers/profs | -0.280*** | -0.051*** |
| Corr occ. rank managers/profs miss | -0.191*** | -0.066*** |
| Corr occ. rank high educ | 0.151*** | -0.108*** |
| Corr occ. rank high educ miss | -0.237*** | -0.023*** |
| Constant | 4.564*** | 4.510*** |
| N | 2509936 | 2509936 |

|        |        |        |        |        |
|--------|--------|--------|--------|--------|
| r2 | 0.003 | 0.109 | 0.568 | 0.511 | 0.143 | 0.249 | 0.714 |
| N | 2509936 | 2509936 | 2509525 | 2509929 | 2509929 | 2509936 | 2509525 |

legend: * p<0.05; ** p<0.01; *** p<0.001
Table 3. FE regression of mean workplace earnings on employment size, continuous, categorical and intersectional bases for inequality, 1995-2010 pooled German private sector workplaces with 20 or more employees.

| Variable                  | FE1  | FE2  | FE3  | FE4  | FE5  | FE6  | FE7  |
|---------------------------|------|------|------|------|------|------|------|
| 1996                      | 0.003*** | 0.003*** | -0.003*** | 0.003*** | 0.002*** | 0.004*** | -0.002*** |
| 1997                      | -0.003*** | -0.004*** | -0.016*** | -0.008*** | 0.022*** | 0.027*** | 0.003*** |
| 1998                      | 0.027*** | 0.026*** | 0.010*** | 0.014*** | 0.033*** | 0.040*** | 0.007*** |
| 1999                      | 0.040*** | 0.039*** | 0.016*** | 0.023*** | 0.038*** | 0.046*** | 0.009*** |
| 2000                      | 0.046*** | 0.045*** | 0.020*** | 0.027*** | 0.038*** | 0.046*** | 0.009*** |
| 2001                      | 0.046*** | 0.045*** | 0.015*** | 0.025*** | 0.036*** | 0.045*** | 0.004*** |
| 2002                      | 0.055*** | 0.054*** | 0.020*** | 0.029*** | 0.044*** | 0.054*** | 0.006*** |
| 2003                      | 0.058*** | 0.057*** | 0.016*** | 0.029*** | 0.045*** | 0.058*** | -0.000 |
| 2004                      | 0.056*** | 0.056*** | 0.012*** | 0.023*** | 0.042*** | 0.055*** | -0.008*** |
| 2005                      | 0.057*** | 0.056*** | 0.007*** | 0.019*** | 0.041*** | 0.056*** | -0.015*** |
| 2006                      | 0.057*** | 0.056*** | 0.005* | 0.016*** | 0.040*** | 0.056*** | -0.020*** |
| 2007                      | 0.055*** | 0.054*** | 0.002 | 0.012*** | 0.037*** | 0.054*** | -0.026*** |
| 2008                      | 0.052*** | 0.051*** | -0.002 | 0.008*** | 0.033*** | 0.051*** | -0.031*** |
| 2009                      | 0.057*** | 0.056*** | -0.001 | 0.009*** | 0.037*** | 0.056*** | -0.032*** |
| 2010                      | 0.070*** | 0.069*** | 0.011*** | 0.019*** | 0.049*** | 0.069*** | -0.024*** |

Emp.size total | 0.003*** | 0.003*** | 0.012*** | 0.019*** | 0.049*** | 0.069*** | -0.024*** |
Emp.size squared | 0.000* | 0.000 |
Mean occ. rank | 0.682*** | 0.520*** |
Mean age | 0.006*** | 0.006*** |
Mean tenure | 0.000 | 0.002*** |
SD occ.rank | -0.055*** | 0.054*** |
SD age | -0.010*** | -0.006*** |
SD tenure | 0.005*** | 0.004*** |
Share part-time <18 hours | 0.170*** | 0.064*** |
Share part-time >=18 hours | 0.155*** | 0.080*** |
Share low educ | -0.401*** | -0.381*** |
Share med educ | -0.329*** | -0.340*** |
Share male | 0.334*** | 0.291*** |
| Variable                  | Coefficient 1 | Coefficient 2 | Coefficient 3 | Coefficient 4 | Coefficient 5 | Coefficient 6 |
|--------------------------|---------------|---------------|---------------|---------------|---------------|---------------|
| Share German             | 0.086***      | 0.030         |               |               |               |               |
| Share managers/profs     | 0.297***      | 0.065***      |               |               |               |               |
| Gibbs-Martin working hours | 0.193***      | 0.084***      |               |               |               |               |
| Gibbs-Martin educ        | 0.051***      | -0.013**      |               |               |               |               |
| Gibbs-Martin sex         | -0.044***     | -0.006        |               |               |               |               |
| Gibbs-Martin German      | -0.200***     | -0.023        |               |               |               |               |
| Gibbs-Martin managers/profs | -0.084***     | -0.074***     |               |               |               |               |
| Corr occ. rank male      | 0.024***      | 0.007***      |               |               |               |               |
| Corr occ. rank male miss | 0.005         | -0.001        |               |               |               |               |
| Corr occ. rank German    | -0.032***     | 0.001         |               |               |               |               |
| Corr occ. rank German miss | 0.010***     | -0.001*       |               |               |               |               |
| Corr occ. rank managers/profs | -0.050***     | -0.009***     |               |               |               |               |
| Corr occ. rank managers/profs miss | -0.023***     | -0.009***     |               |               |               |               |
| Corr occ. rank high educ | 0.037***      | -0.017***     |               |               |               |               |
| Corr occ. rank high educ miss | 0.003**      | 0.003***      |               |               |               |               |
| Constant                 | 4.557***      | 4.572***      | 4.003***      | 4.429***      | 4.582***      | 4.585***      |

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**Legend:** * p<0.05; ** p<0.01; *** p<0.001
In general the OLS models explain more of the variance than the fixed effect models. This suggests that the variables in our models have been more influential historically than they are more recently. It also suggests that the increased between workplace variance in mean wages is not only tied to the variables in these models, but reflect some other time varying processes within workplaces. The most likely candidates include changes in managerial practices, collective bargaining strength and firm market power.

Looking first across models it is apparent that the traditional indicators of potential productivity (occupational skill, tenure, and age as a proxy for experience) are particularly influential in generating both the levels and changes in mean earnings, explaining about 58% of between workplace earnings variation (Table 2 OLS3) and 48% of change in the fixed effect (Table 3 FE3) specification. Workforce composition, (Table 2 OLS4 and Table 3 FE4) categorical heterogeneity (OLS5 and FE5) and segregation (OLS6 and FE6) are collectively less powerful correlates of the level of mean earnings or within workplace change. As we will see in the next section, they are considerably more influential in producing within workplace inequality than they are in generating the total resources available to be distributed.

Larger workplaces display, as expected, higher mean earnings (Table 2 OLS2), but this effect is much reduced in the full model (Table 2 OLS6). In the first fixed effect specification (Table 3 FE2) size is negatively related to mean workplace earnings, suggesting that larger firms are more likely to produce declining earnings in the contemporary period. This effect is essentially zero in the final model (FE6), suggesting that larger firms have eroded their wage advantage via changes in the organization of the labor process and composition of their workforces. We do not pursue the exact mechanisms mediating this relationship in this paper, but it might be of interest to future researchers.

OLS6 (Table 2) makes clear that the skill level of the occupational structure is an important correlate of mean wages and that the upskilling or deskilling of the occupational structure is as well (Table 3 FE6). In addition, net of all other variables more complex divisions of labor (SD occ.rank) are associated with lower levels of mean earnings (OLS6) but growing workplace earnings in the fixed effect specification (FE6). This is an interesting result, which we return to later in the paper.

Longer and more heterogeneous tenure workforces have small positive effects on mean earnings in both the OLS and FE final models. Experience (age) levels are also positive, but experience heterogeneity has a negative influence on earnings levels. This is the case in both the OLS and FE estimations.

More part-time workers are associated with lower mean earnings among full-time workers in the OLS models, but higher earnings in the FE models. This suggests that low wage workplaces are expanding their part-time labor forces, but also that there is an internal transfer of income from marginal part-time employees to core full-time workers in these low wage workplaces.
More educated workers are associated with higher (OLS6) and rising (FE6) mean wages, and this effect holds even in the final model with controls for occupational skill and skill heterogeneity. This could reflect higher productivity among educated workers, even net of occupational skill levels and divisions of labor or higher bargaining power relative to employers when workers can make educational claims (Lin and Tomaskovic-Devey 2013 produce evidence for the latter interpretation in the U.S.).

Male workforces are associated with much high earnings (OLS6) as are rising shares of males in the workforce, and these are true even after controls for workplace human capital and occupational skill composition. This is not the case for German citizenship. German citizens are more likely to be employed in lower wage workplaces (OLS4), although net of skill and other composition variables more German citizens are associated with higher average earnings (OLS6). In the wage change models German citizenship is only marginally associated with higher mean earnings in the initial model (FE4), and this small effect does not hold in the final model (FE7). The advantage of German citizenship is to be sorted into more highly skilled jobs in lower wage workplaces, but this advantage appears to be more historical than a contemporary causal influence. More male workplaces appear to be either higher productivity, perhaps through higher employer investments in production or in male firm specific human capital, and/or produces higher bargaining power for labor relative to capital.

A comparison of the OLS and FE coefficients allows us to gauge which causal processes are strengthening or weakening in the current period. We focus on the final models in this comparison. It is important to recognize that the FE models produce lower explained variance than the OLS models. This is an unusual result, since FE models are typically preferred to account for unmeasured, but consequential time stable processes. Not surprisingly given the relative weakness of the FE prediction models, we find that most FE coefficients are substantially smaller than the OLS estimates, suggesting a weakening of their causal influence in the contemporary period. In supplementary calculations we estimated a predicted change in mean wages based on the FE coefficients and changes in model variables. This exercise leads to a predicted rise in mean wages of 6.5%, mostly driven by the increased age, tenure, and education in the German labor force. But the real change was only 2.4%, suggesting that unmodeled dynamics within firms and in the birth and death of firms are quite important in producing downward wage pressures. We see the most likely candidates to be the German government’s normative pressure to keep wages low in export markets, the rise of new non-union workplaces, and outsourcing processes. All of these processes are implied by the rapid growth of the influence of the industry fixed effect documented in the preceding section.
Fourth Result: Explaining Within Workplace Inequality Levels and Trends

Table 4 reports the regression of workplace inequality upon time (OLS1), resources (OLS2), and then continuous (OLS3), categorical (OLS 4 and OLS5) and intersectional (OLS6) sources of inequality. OLS7, the final model, estimates the contributions of all variables net of all others. The final model explains 35% of inequality variation across German workplaces in the 1995-2010 period. Since these models pool all organizations across the observation period, estimates describe the current covariation of inequality with organizational resources, skill and categorical composition, and segregation. Model 1 shows a similar rise of 4 logged points in within workplace inequality to that reported in Figure 2.

Model 2 explores the impact of organizational size and mean wages on organizational inequality. Larger more complex organizations were hypothesized to have more social room to make distinctions. Organizations with more resources to distribute were hypothesized to be more unequal as well. Neither hypothesis is supported. Net of financial resources, size is essentially unrelated to organizational inequality. This is not the case for resources. High wage organizations tend to be more equal than low wage organizations. This effect is curvilinear, turning essentially flat once the average daily wage rises to about €100/day (based on OLS7). Thus the evidence suggests that inequality is highest in low wage workplaces, with yearly average earnings below about €30,000. This result is more consistent with a classic Marxian exploitation model, than it is with RIT’s focus on total resources producing an interactional space for social distinctions.

OLS3 explores the impact of productivity related composition variables and their variance on workplace inequality. High skilled workplaces tend to also be high inequality. The reverse holds for high levels of age and tenure. On the other hand variance in skill, age, and tenure are all associated with higher levels of inequality. This model explains a substantial 20% of the variation in organizational inequality. Based on the results in OLS7, where all variables are in the model simultaneously, one standard deviation rise in occupational skill is associated with 1.6 log points higher inequality. The effect of age is half as large at .5 log points, but the impact of tenure is 50% larger at 2.1 log inequality points.

OLS4 looks at the employment shares associated with categorical distinctions among employees. Larger shares of very short hour employment are associated with increased inequality among full-time workers. Higher shares of tertiary employment (the reference category) are associated with higher workplace inequalities, although this effect seems most pronounced relative to secondary education shares. More women, immigrants and secondary sector workers are all associated with higher workplace inequalities.

OLS5 explores the impact of heterogeneity in categorical distinctions. The logic of this measurement is that claims by advantaged groups are strengthened in the presence of lower status actors. With the exception of work hours, more socially heterogeneous workplaces all
display higher levels of internal inequality. Explained variance is the highest of all preliminary models, suggesting that categorical heterogeneity is the most powerful source of workplace inequality.

OLS 6 explores the impact of the intersection of categorical distinctions with skilled roles in the workplace division of labor. One of the most interesting predictions from RIT is that the matching of status characteristics to internal divisions of labor will produce higher levels of inequality than either would alone (Tilly 2008). These correlations range from -1 to 1, and there is substantial variation across German workplaces in the degree of rank segregation. In all cases as the correlation between occupational rank and status advantages strengthens inequality rises in the initial model. In the final model, there is no additional impact of managerial/professional rank segregation on inequality, net of the control for managerial/professional heterogeneity. On the other hand, a rise of one standard deviation in gender and tertiary education rank segregation are associated (in the OLS7 model) with an additional 1 unit standard deviation rise in workplace inequality. The impact of immigrant segregation is much weaker with a .2 unit increase in segregation associated with a standard deviation increase in workplace citizen/immigrant rank segregation.

Table 5 produces fixed effects estimates for the same set of nested models. The estimates are thus purged of stable unobserved workplace influences and interpretable in terms of the impact of change in X on change in Y. In general the fixed effects results are broadly similar to the OLS estimates. There are a few notable exceptions. Changes in mean age and tenure are not associated with changes in inequality in the FE models. Nor are part/full time shares and heterogeneity associated with shifts in earnings inequality among full-time workers in the FE models. German/immigrant heterogeneity and segregation are also not associated with rising shifts in workplace inequality in the final FE models.

Some coefficients are substantially larger in the fixed effect specification, suggesting that their associated mechanisms are stronger in the current period than they were historically. One of the most striking is mean wage. The fixed effect specification suggests strongly that dropping mean wages are associated with strongly rising inequality. The magnitude of this effect is quite a bit stronger than the OLS results, suggesting that contemporary Germany workplaces that pursue a low-road, low wage labor process strategy are contributing to rising within workplace inequality. Since these are estimates of within workplace inequality shifts this literally means that low wage production strategies directly benefit higher wage workers in the same workplace. While capital or customers may also benefit from low wage strategies, so to do more advantaged workers.
Table 4. OLS regression of workplace inequality (SD logged daily earnings) on resource, continuous, categorical and intersectional bases for inequality, 1995-2010 pooled German private sector workplaces with 20 or more employees.

| Variable                  | OLS1   | OLS2   | OLS3   | OLS4   | OLS5   | OLS6   | OLS7   |
|---------------------------|--------|--------|--------|--------|--------|--------|--------|
| year                      |        |        |        |        |        |        |        |
| 1996                      | -0.008*** | -0.008*** | -0.004 | -0.007*** | -0.006*** | -0.007*** | -0.003* |
| 1997                      | -0.004 | -0.004* | 0.001  | -0.003 | -0.002 | -0.001 | 0.001  |
| 1998                      | 0.055*** | 0.052*** | 0.059*** | 0.055*** | 0.055*** | 0.058*** | 0.059*** |
| 1999                      | 0.022*** | 0.019*** | 0.028*** | 0.021*** | 0.022*** | 0.024*** | 0.026*** |
| 2000                      | 0.021*** | 0.017*** | 0.027*** | 0.019*** | 0.021*** | 0.022*** | 0.024*** |
| 2001                      | 0.027*** | 0.023*** | 0.031*** | 0.024*** | 0.028*** | 0.029*** | 0.029*** |
| 2002                      | 0.027*** | 0.022*** | 0.030*** | 0.023*** | 0.027*** | 0.028*** | 0.028*** |
| 2003                      | 0.022*** | 0.016*** | 0.026*** | 0.018*** | 0.023*** | 0.024*** | 0.025*** |
| 2004                      | 0.022*** | 0.016*** | 0.029*** | 0.019*** | 0.024*** | 0.025*** | 0.026*** |
| 2005                      | 0.023*** | 0.017*** | 0.031*** | 0.019*** | 0.025*** | 0.026*** | 0.027*** |
| 2006                      | 0.031*** | 0.023*** | 0.040*** | 0.026*** | 0.033*** | 0.033*** | 0.034*** |
| 2007                      | 0.033*** | 0.025*** | 0.043*** | 0.028*** | 0.035*** | 0.036*** | 0.036*** |
| 2008                      | 0.039*** | 0.031*** | 0.047*** | 0.034*** | 0.041*** | 0.041*** | 0.039*** |
| 2009                      | 0.038*** | 0.030*** | 0.048*** | 0.031*** | 0.040*** | 0.041*** | 0.040*** |
| 2010                      | 0.041*** | 0.032*** | 0.052*** | 0.034*** | 0.043*** | 0.044*** | 0.042*** |

| Emp.size total | 0.001** |        |        |        |        |        |        |
| Emp.size squared | -0.000 |        |        |        |        |        |        |
| Mean wage | -0.837*** |        |        |        |        |        |        |
| Mean wage squared | 0.097*** |        |        |        |        |        |        |
| Mean occ. rank | 0.195*** |        |        |        |        |        |        |
| Mean age | -0.004*** |        |        |        |        |        |        |
| Mean tenure | -0.007*** |        |        |        |        |        |        |
| SD occ.rank | 0.391*** |        |        |        |        |        |        |
| SD age | 0.003*** |        |        |        |        |        |        |
| SD tenure | 0.010*** |        |        |        |        |        |        |
| Share part-time <18 hours | 0.162*** | 0.195*** |        |        |        |        |        |
| Share part-time >=18 hours | -0.073*** | -0.004 |        |        |        |        |        |
| Variable                        | FE1            | FE2            | FE3            | FE4            | FE5            | FE6            | FE7            |
|--------------------------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|
| Share low educ                 | -0.071***      |                | -0.006         |                |                |                |                |
| Share med educ                 | -0.118***      |                | -0.043***      |                |                |                |                |
| Share male                     | -0.070***      |                | -0.015***      |                |                |                |                |
| Share German                   | -0.064***      | 0.036***       |                |                |                |                |                |
| Share managers/profs           | 0.053***       | 0.053***       |                |                |                |                |                |
| Gibbs-Martin working hours     | -0.030***      | -0.068***      |                |                |                |                |                |
| Gibbs-Martin educ              | 0.107***       | 0.035***       |                |                |                |                |                |
| Gibbs-Martin sex               | 0.223***       | 0.104***       |                |                |                |                |                |
| Gibbs-Martin German            | 0.039***       | 0.032***       |                |                |                |                |                |
| Gibbs-Martin managers/profs    | 0.091***       | 0.079***       |                |                |                |                |                |
| Corr occ. rank male            | 0.105***       | 0.053***       |                |                |                |                |                |
| Corr occ. rank male miss       | -0.105***      | -0.025***      |                |                |                |                |                |
| Corr occ. rank German          | 0.028***       | 0.017***       |                |                |                |                |                |
| Corr occ. rank German miss     | -0.023***      | -0.014***      |                |                |                |                |                |
| Corr occ. rank managers/profs  | 0.013***       | -0.003         |                |                |                |                |                |
| Corr occ. rank managers/profs miss | -0.004 | 0.009*                     |                |                |                |                |                |
| Corr occ. rank high educ       | 0.039***       | 0.048***       |                |                |                |                |                |
| Corr occ. rank high educ miss  | -0.002         | 0.018***       |                |                |                |                |                |
| Constant                       | 0.283***       | 2.076***       | 0.194***       | 0.468***       | 0.145***       | 0.272***       | 1.762***       |

| Year                           | FE1            | FE2            | FE3            | FE4            | FE5            | FE6            | FE7            |
|--------------------------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|
| 1996                           | -0.007***      | -0.006***      | -0.005***      | -0.006***      | -0.006***      | -0.006***      | -0.005***      |

Table 5. FE regression of workplace inequality (SD logged daily earnings) on resource, continuous, categorical and intersectional bases for inequality, 1995-2010 pooled German private sector workplaces with 20 or more employees.

Legend: * p<0.05; ** p<0.01; *** p<0.001
|      |       |       |       |       |       |       |       |       |       |       |       |       |
|------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
|      |       |       |       |       |       |       |       |       |       |       |       |-------|
|      |       |       |       |       |       |       |       |       |       |       |       |-------|
| 1997 | -0.004*** | -0.005*** | -0.003* | -0.004*** | -0.003* | -0.004*** | -0.006*** |       |       |       |       |       |
| 1998 | 0.053*** | 0.056*** | 0.055*** | 0.053*** | 0.055*** | 0.054*** | 0.053*** |       |       |       |       |       |
| 1999 | 0.019*** | 0.024*** | 0.021*** | 0.019*** | 0.021*** | 0.020*** | 0.021*** |       |       |       |       |       |
| 2000 | 0.016*** | 0.022*** | 0.018*** | 0.016*** | 0.018*** | 0.016*** | 0.018*** |       |       |       |       |       |
| 2001 | 0.022*** | 0.028*** | 0.022*** | 0.021*** | 0.024*** | 0.022*** | 0.021*** |       |       |       |       |       |
| 2002 | 0.020*** | 0.027*** | 0.020*** | 0.020*** | 0.023*** | 0.020*** | 0.019*** |       |       |       |       |       |
| 2003 | 0.015*** | 0.023*** | 0.014*** | 0.015*** | 0.018*** | 0.015*** | 0.013*** |       |       |       |       |       |
| 2004 | 0.014*** | 0.021*** | 0.013*** | 0.014*** | 0.017*** | 0.015*** | 0.009*** |       |       |       |       |       |
| 2005 | 0.015*** | 0.021*** | 0.013*** | 0.014*** | 0.018*** | 0.015*** | 0.007*  |       |       |       |       |       |
| 2006 | 0.021*** | 0.027*** | 0.019*** | 0.020*** | 0.025*** | 0.022*** | 0.011*** |       |       |       |       |       |
| 2007 | 0.024*** | 0.029*** | 0.020*** | 0.023*** | 0.028*** | 0.025*** | 0.012*** |       |       |       |       |       |
| 2008 | 0.029*** | 0.034*** | 0.024*** | 0.028*** | 0.033*** | 0.030*** | 0.012*** |       |       |       |       |       |
| 2009 | 0.028*** | 0.034*** | 0.023*** | 0.027*** | 0.032*** | 0.029*** | 0.012*** |       |       |       |       |       |
| 2010 | 0.033*** | 0.041*** | 0.027*** | 0.032*** | 0.037*** | 0.034*** | 0.018*** |       |       |       |       |       |

Emp.size total | 0.001
Emp.size squared | -0.000
Mean wage | 0.000
Mean_wage squared | -1.289***
Mean occ. rank | 0.104***
Mean age | 0.092***
Mean tenure | 0.000
SD occ.rank | 0.001
SD age | 0.134***
SD tenure | 0.000
Share part-time <18 hours | 0.006***
Share part-time >=18 hours | -0.065*
Share low educ | -0.042***
Share med educ | 0.040
Share male | -0.068***
Share German | -0.042***
Share managers/profs | 0.026
Gibbs-Martin working hours | -0.119***
Gibbs-Martin educ | -0.120***
Share male | -0.087***
Gibbs-Martin working hours | 0.038**
Share German | 0.005***
Share managers/profs | 0.064*
Gibbs-Martin working hours | 0.044***
Gibbs-Martin educ | 0.057***
Share male | 0.054***
Gibbs-Martin working hours | -0.027
Gibbs-Martin educ | 0.094***
Share German | 0.052***
|                                   |          |          |
|-----------------------------------|----------|----------|
| Gibbs-Martin sex                  | 0.197*** | 0.135*** |
| Gibbs-Martin German               | 0.004    | 0.029    |
| Gibbs-Martin managers/prof        | 0.106*** | 0.063*** |
| Corr occ. rank male               | 0.027*** | 0.024*** |
| Corr occ. rank male miss          | -0.029***| -0.006   |
| Corr occ. rank German             |          |          |
| Corr occ. rank German miss        | -0.006** | -0.004*  |
| Corr occ. rank managers/prof      | 0.022*** | -0.003   |
| Corr occ. rank managers/prof miss |          |          |
| Corr occ. rank high educ          | 0.040*** | 0.033*** |
| Corr occ. rank high educ miss     | -0.002   | 0.005*   |
| Constant                          | 0.287*** | 3.226*** |
|                                   | 0.117*** | 0.400*** |
|                                   | 0.165*** | 0.263*** |
|                                   | 3.454*** |

|                     | r2_w     |          |          |          |          |          |          |
|---------------------|----------|----------|----------|----------|----------|----------|----------|
|                     | 0.054    | 0.100    | 0.080    | 0.068    | 0.090    | 0.064    | 0.169    |
|                     | r2_b     | 0.023    | 0.001    | 0.142    | 0.159    | 0.221    | 0.149    | 0.136    |
|                     | r2_o     | 0.020    | 0.000    | 0.120    | 0.114    | 0.174    | 0.107    | 0.143    |
|                     | N        | 60247    | 60247    | 60237    | 60247    | 60247    | 60247    |

legend: * p<0.05; ** p<0.01; *** p<0.001
Other notable shifts relative to the OLS models involve occupational skill and segregation processes. The inequality exaggerating impact of mean workplace skill is quite a bite higher (.134 vs. .070) in the fixed effect specification, suggesting a contemporary strengthening of the bargaining power of the high skilled. There is no similar increase for variance in occupational skill. This suggests that on average during this period the increased bargaining power of high skilled workers is relative to employers, rather than relative to other employees. Among the segregation variables there is a small decline in the impact of tertiary education segregation (from .048 to .033), but large decline for sex (.053 to .024) segregation. Of course, these results may reflect unmeasured variables in the OLS specification, but they suggest that it is plausible that both low wage and high skill labor processes are associated with increased inequality and that the historical influence of at least sex segregation on within workplace wage inequality is waning.

**Conclusions**

We follow Card et al.’s (2013) investigation of rising German earnings inequalities. We depart from their work in two fundamental ways. First we foreground workplaces as the sites of income pooling and distribution, including all full-time employees in workplaces in our analyses. We also examine the entire German economy, including East Germany. These more inclusive sampling decisions led us to identify higher levels of earnings inequalities and more rapid growth in inequality than in their analyses. While we replicated their finding that growing between workplace inequalities were produced by occupational skill polarization, we also found that human capital levels were associated with change in workplace mean earnings. The contrast in results primarily reflects the lower education levels of the East German labor force and the shorter tenure of women in gender integrated workplaces.

Substantively, we document rapid convergence of between workplace inequality in East and West Germany and rising between industry differences in mean wages. Many East German firms failed
after reunification and West German capital moved into the East spreading West German investment and human resource practices. The rising importance of industrial mean wage variance probably is a result of firm level skill specialization processes. When a manufacturing firm sheds non-core production as a cost saving measure the tasks that are spun off migrate into other industries. For example when a machine tool company retains their machinists and engineers, but sub-contracts payroll, building maintenance and cafeteria services, that work even though it is largely performed in the same building is now organized by new firms in three lower wage service industries. It is low wage firm growth that generate much of the increased inequality in Germany, both within and between workplaces.

We use human capital and relational inequality theories to explain variation in workplace mean wages and within workplace inequality. In general, and consistent with human capital theory, average workplace wages are strongly tied to productivity related characteristics. The distribution of wages within workplaces is more strongly conditioned by categorical status distinctions among employees, the central prediction from relational inequality theory. Since human capital theory was originally developed to explain aggregate productivity trends (Becker 1957) and relational inequality theory to explain within workplace income distributions (Avent-Holt and Tomaskovic-Devey 2014) these results should not be surprising.

In addition, mean wages rise with more skill complexity in the division of labor. In classical economic theory more complex divisions of labor are thought to increase overall productivity through skill and technological specialization (e.g. Smith 1776). This classical insight is supported in our analyses, workplaces with higher occupational variance pay higher average wages. Since the trend is toward the creation of firms with less specialized divisions of labor in order to externalize non-core production, this may be one explanation of the rising share of income going to capital. By creating simpler firm specific divisions of labor, less rent sharing with non-core labor is possible, leading to higher capital shares of income.

We did not have expectations that relational inequality processes would strongly impact mean wages. We found, however, two robust effects. Larger part-time labor forces were associated with higher mean wages among full-time employees. This suggests income transfers from part-time to full-time workers. Full-time workers are expected to have stronger legitimacy in their claims on organizational resources than part-time workers. Results are consistent with this expectation. The second strong result has to do with the gender composition of the workforce. Higher female employment is associated with lower wages, net of individual and occupational skill levels. This strongly suggests that capital’s share of income increases when the wage bargain is with female employees. Part-time employment is growing rapidly in Germany and benefits full-time workers by strengthening their claims over organizational resources. The declining influence of gender heterogeneity and segregation on mean wages, is probably off-set at the individual level by the tendency for women to fill these part-time jobs.

Relational inequality predictions were more strongly supported in the analyses of within workplace inequality. In both OLS and FE estimations explained variance was most strongly tied to categorical heterogeneity. Gender, educational, and part-time heterogeneity expand the space for claims making over organizational resources. Segregation was relatively weakly associated with workplace inequality and only gender segregation predicted increased inequality in the fixed effect.
specification. Inequality was particularly high in low average wage workplaces, suggesting an exploitation of low power employees by higher status employees in these workplaces. Since we do not observe capital earnings we cannot comment on whether this exploitation extends to capital as well. Conversely, high occupational skill workplaces are also high inequality workplaces. Schweicker and Groß (2016) also looking at growing workplace earnings inequality in Germany, find that bonus payments have grown rapidly in high skill workplaces, especially at the top of the skill distribution. Thus the adoption of performance pay schemes targeted at the top of the skill/authority distribution is likely to produce the rising within workplace inequality in high skill workplaces that we observe here. Again, capital income is not observed, but we would not be surprised to find capital income reduced when capital confronts highly skilled workers central to the labor process.

One limitation of LEEP data is that we do not observe specific organizational practices. Other papers with more refined measures have also stressed the relative power of actors (workers, capital, managers) over the distribution of surplus. They have identified union power and investment strategies (e.g. computerization, financialization) as potential sources and indicators of the relative power of actors (Kristal 2013; Lin and Tomaskovic-Devey 2013; Tomaskovic-Devey, Lin and Meyers, 2015). There are also a series of papers confirming that when firms introduce performance pay practices, which are typically targeted at high earners, the wages of high earners rise, often at the expense of lower wage earners in the firm (Barth et al. 2012 in Norway; Fabling, Grimes, and Maré 2012 in New Zealand; Hanley 2010b in the U.S; Somerfeld 2013 in Germany). Barth et al. (2012) find that this performance pay effect is absent in unionized Norwegian firms. Shin (2009) also exploring management practices finds that job rotation, which is often associated in the US context with increased effort exploitation, is associated with higher workplace inequality, but cooperative self-managed teams are associated with lower inequality. Bender et al. (2016) show that firms with advanced management practices and high skilled labor forces have higher productivity. Investment decisions and market power, worker organization, and human resource practices are likely to be the proximate mechanisms producing the within and between workplace inequality patterns documented in this paper.

We hope that a fundamental contribution of this paper is to redirect research on growing national inequalities towards observing the firm level processes that generate market income distributions. We document for Germany that about 2/3s of the rapid growth in income inequality was produced by increased variance in mean workplace wages. This strongly suggests a bifurcation in organization production into high road and low road production strategies. Since high road strategies are often accomplished by externalizing lower skilled work to subcontract firms, this process marks a pattern in which the resources acquired in high value added firms are decreasingly shared with all workers involved in production. The same pattern is happening internally in which part-time employees are increasingly supporting the wages of full-time employees. This disturbing pattern is not confined to Germany. Barth et al. (2014) also explore the contribution of within versus between workplace wage inequality to US inequality trends, in this case limited to nine states with LEEP data for 1992 and 2007. Similar to our results for Germany they find that two-thirds of the growth in US earnings inequality happened between workplaces and about half of that was associated with industrial changes. Contrary to technological change explanations (Autor, Katz, and Kearney 2006) these shifts were not associated with workplace changes in mean skill or skill variance, but were more simply associated with rising earnings for the top 5% of earners.
within workplaces, which in turn increased the mean wage of establishments that contained these top earners. In a similar paper, with more complete LEEP data over a longer period, Song et al. (2015) also find that about 2/3 of the rise in US inequality happens between firms, with within firm income growth only in the top 50 positions in the very largest firms. In the US increased earnings heterogeneity across workplaces was produced by some firms raising the wages of their highest earners. Skans, Edin and Holmlund (2009) report that growth in Sweden’s between workplace wage inequality accounts for practically the entire increase in Swedish wage inequality since the mid-1980s. In contrast to our results for Germany, they find that this increased inequality was not a result of industrial shifts. They speculate that this may reflect increased skill sorting brought about by the institutional transition to local wage negotiations in Sweden after 1980.

These three sets of results are not completely comparable, but do suggest that connecting national inequality trends to workplace income dynamics will be fruitful research foci. These comparisons suggests that there may be processes, particularly the firm segregation in skill and worker power associated with the founding of increasingly specialized firms, outsourcing by established firms, and declining union coverage, that are widespread across high wage capitalist firms as well as those that are nationally specific.

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Appendix 1. Imputation strategy for top coded income

In the German social security records wages are censored at the social contribution limit which differs by year and in East and West Germany. The wage information stated in the social security notification is sum of wages related to the employment episode. The daily wage is the episode wage divided by number of calendar days, i.e. it is the average wage for this period. Wages are deflated by the CPI, base year is 2010. We consider all daily wages as censored that are larger than the contribution limit minus 3 € in order to account for rounding errors.

1 Imputation methods

1.1 Simple
A simple approach to top-coding is to use individual information only to impute missing earnings for top coded cases. Tobit regressions by year, East/West Germany, gender, education and age groups. This is the most common approach in the literature that developed out of top coded survey data. Since much wage variation is associated with employment organization this is not a satisfying approach for LEEP data.

1.2 Card/Heining/Kline
Card, Heining and Kline (2013) include in their imputation equations using German LEEP data the leave-one-out mean workplace and mean individual wage and workplace shares of censored observations in their imputation equations to improve top-code estimates. In our replication of their imputation model we discovered that their method produces too few jobs immediately to the right of the censoring limit and too few cases in the far tails of the distribution.

1.3 The lagged wage alternative
Rather than focusing on the mean individual and workplace wage prior to the observation year we utilize information on lagged wages in our prediction equation. [When the lagged wage for persons is missing this must be imputed in an earlier stage.] We reason that the censored wage is more strongly influenced by the most recent wage than by mean wages over longer periods.

1.3.1 Individual Variables
Individual variables are used in the imputation models to stratify the sample. Thus each imputation is based on a prediction equation that contains lagged wage plus a series of organizational characteristics. Since censored wages are likely to be censored in prior years we utilize an iterative solution.

Step 1: independent imputation models by year, age (4 categories) education (five categories), sex and east/west Germany

\[ \log w_{it} = \gamma * x_{it} + \epsilon_{it} \quad t \in [1994 \ldots 2010] \]
Predict $\log w_{it}^{\text{ind}}$

Step 2: include lagged variables in order to account for correlation over time

$$
\log w_{it} = \alpha \cdot \log w_{it-1}^{\text{type}} + \beta \cdot (\log w_{it-2}^{\text{type}} - \log w_{it-1}^{\text{type}}) + \gamma x_{it} + \epsilon_{it}
$$

$t \in [1996 \ldots 2010]$

type = \{\text{org, ind, lag, mean}\}$

If person in sample in $t-1$
- org = observed uncensored wage
- ind = imputed wage from regression in $t-1$ without lag variables
- lag = imputed wage from regression in $t-1$ with lag variables

If person is not in sample in $t-1$ $log w_{it-1}$ is replaced by the person mean estimated:

$$
\log w_{it-1}^{\text{mean}} = \log w_{it}^{\text{org,ind}} - \text{mean}(\log w_{it}^{\text{org,ind}} - \log w_{it-1}^{\text{org,ind}})
$$

i.e. current wage – average change

$$
(\log w_{it-2}^{\text{type}} - \log w_{it-1}^{\text{type}}) = \text{mean}(\log w_{it-2}^{\text{org,ind}} - \log w_{it-1}^{\text{org,ind}})
$$

i.e. average change

$=>$ close to 0

If person is not in sample in $t-2$ $log w_{it-1}$ is replaced by mean

$$
\log w_{it-1}^{\text{mean}} = \log w_{it}^{\text{org,ind}} - \text{mean}(\log w_{it}^{\text{org,ind}} - \log w_{it-1}^{\text{org,ind}})
$$
i.e. current wage – average change

\[
\left( \log w_{it-2}^{type} - \log w_{it-1}^{type} \right) = \text{mean} \left( \log w_{it-2}^{org,ind} - \log w_{it-1}^{org,ind} \right)
\]

i.e. average change

=> close to 0

1.3.2 Firm variables
We include the following workplace level variables in the imputation equations: fraction of workers with university degree, mean years of schooling of firm by gender, log firm size, full-time employees, log firm size squared, full-time employees, dummy for firm size > 10, full-time employees, mean log real daily wage of co-workers, fraction of co-workers with censored wage, dummy firm has only 1 worker in current year.

2 STATA CODE

/*
Workplace Inequalities

Purpose: impute wages above the contribution limit

Input: core data for all obs and samples
Output: year wage wage_imp censd

*/

version 13.1

clear
set varabbrev off
set type double
set more off

global date 2015-05-26
global yearlist "1993/2010"
*global samplist "lin10t3 lin10t5 lin50t3 lin50t5 all"
global samplist "all"

cd M:\Quickablage\Peter\_Projekte\workplaceInequalities

cap log close
log using 3log/3b_wage_imp_${date}.log, replace

* Calculate censoring limits as mode of wages by east/west
foreach year of numlist $yearlist
    { use plow_west dwage using 2datatemp/3a_coredata`year'_all, clear
        sort plow_west
        by plow_west: egen climrd = mode(dwage)
        by plow_west: keep if _n==1
        gen year = `year'
        drop dwage
        compress
        save 2datatemp/3_cens`year', replace
    }
clear
foreach year of numlist $yearlist
    { append using 2datatemp/3_cens`year'
    }
gen climrm = round(climrd * 365/12 ,1) if !inlist(year,1996,2000,2004,2008,2012)
replace climrm = round(climrd * 366/12 ,1) if inlist(year,1996,2000,2004,2008,2012)
drop climrm
sort plow_west year
list
save 2datatemp/3b_censoring, replace
*/

* Compute additional variables
* mean log(wage) of person in all other periods
* fraction of other years that wage is censored
* missing if observed once + dummy in model
* comments:
* - mean wages are higher if person is observed in later years due to real wage growth
* - mean of sample is computed later based on strata
* mean log(wage) of firm except person
* fraction of other employees in form whose wage is censored
* - missing if one employee + dummy in model
* - comment: separately by gender

* partition data into subsamples
foreach sampsize in $samplist {

    * create a subsample-ids for individuals
    clear
    foreach year of numlist $yearlist {
        append using 2datatemp/3a_coredata`year'_`sampsize', keep(persid)
    }
    bysort persid: keep if _n==1
    gen byte smp = int( (_n-1)/_N *5) + 1
    tab smp, mis
    save 2datatemp/3_persid_smp_`sampsize', replace

    * create a panel of key variables with subsample-ids
    foreach sampsize in $samplist {
        clear
        foreach year of numlist $yearlist {
            append using 2datatemp/3a_coredata`year'_`sampsize', keep(persid firmid plow_west sex dwage)
            if `year'==1993 gen int year = `year'
            else replace year = `year' if missing(year)
        }
        merge m:1 persid using 2datatemp/3_persid_smp_`sampsize'
        assert _merge==3
        drop _merge
        sum
        compress
        save 2datatemp/3_coredata_wagepan_smpf_`sampsize', replace
    }

    * create mean wage and censoring data for individuals
    foreach sampsize in $samplist {
        foreach smp of numlist 1/5 {
            use if smp==`smp' using 2datatemp/3_coredata_wagepan_smpf_`sampsize', clear
            assert !missing(dwage)

            * mark censored wages
merge m:1 year plow_west using 2datatemp/3b_censoring
assert _merge~=1
drop if _merge==2
drop _merge plow_west

replace climrd = climrd - 3 // to account for rounding errors, the
censoring limit is reduced by 3 euro

gen byte censd = dwage > climrd
replace dwage = climrd if censd==1

* deflation by cpi
merge m:1 year using 1dataorig/cpi_1991_2013
assert _merge~=1
drop if _merge==2
drop _merge

gen lrdwage = log(dwage /(cpi/100)) // log real daily wage
gen lrdclim = log(climrd /(cpi/100)) // log real censoring limit

drop cpi dwage climrd

* means by person
sort persid year
    by persid: gen long pers_N = _N
    by persid: egen mlop_lrdwage = mean(lrdwage)
    replace mlop_lrdwage = (mlop_lrdwage * pers_N - lrdwage) / (pers_N-1)
    // leave-one-out adjustment of mean
    
    by persid: egen mlop_censd = mean(censd)
    replace mlop_censd = (mlop_censd * pers_N - censd) / (pers_N-1)

list persid year lrdwage mlop_lrdwage censd mlop_censd pers_N in 1/200

gen byte dpers1 = pers_N==1

keep persid year lrdwage lrdclim censd mlop_lrdwage mlop_censd dpers1
order persid year lrdwage lrdclim censd mlop_lrdwage mlop_censd dpers1
compress
sum
save 2datatemp/_temp_`sampsize'_`smp', replace // panel data by sample

}
}

* separate samples by year and join the parts to get complete yearly data
foreach sampsize in $samplist {

merge m:1 year plow_west using 2datatemp/3b_censoring
assert _merge~=1
drop if _merge==2
drop _merge plow_west

replace climrd = climrd - 3 // to account for rounding errors, the
censoring limit is reduced by 3 euro


foreach year of numlist $yearlist  
  foreach smp of numlist 1/5 { 
    use if year==`year' using 2datatemp/_temp_`sampsize'_`smp', clear//
    separate by year
    drop year
    save 2datatemp/_temp_`smp'_`year', replace
  }
  clear
  foreach smp of numlist 1/5 { // join
    by subsample
    append using 2datatemp/_temp_`smp'_`year'
    erase 2datatemp/_temp_`smp'_`year'.dta
  }
isid persid

lab var lrdwage          "log real daily wage, in prices of 2010"
lab var lrdclim          "log real censoring limit"
lab var censd            "dummy wage is censored"
lab var mlop_lrdwage     "mean log real daily wage of person in other years"
lab var mlop_censd       "fraction of person's other wage obs censored"
lab var dpers1           "dummy person observed in 1 year only"

assert missing(mlop_lrdwage, mlop_censd) if dpers1==1  
assert !missing(mlop_lrdwage, mlop_censd) if dpers1==0

compress
sum
save 2datatemp/3_coredata_wagepers_`sampsize'`year', replace
}
erase 2datatemp/_temp_`sampsize'_1.dta
erase 2datatemp/_temp_`sampsize'_2.dta
erase 2datatemp/_temp_`sampsize'_3.dta
erase 2datatemp/_temp_`sampsize'_4.dta
erase 2datatemp/_temp_`sampsize'_5.dta
}

* Prepare regression data

foreach sampsize in $samplist  
  foreach year of numlist $yearlist  
    use if year==`year' using 2datatemp/_temp_`sampsize'_`smp', clear//
    separate by year
    drop year
    save 2datatemp/_temp_`smp'_`year', replace
  }
  clear
  foreach smp of numlist 1/5 { // join
    by subsample
    append using 2datatemp/_temp_`smp'_`year'
    erase 2datatemp/_temp_`smp'_`year'.dta
  }
  *
use persid firmid age sex educ german plow_west using 2datatemp/3a_coredata`year'`sampsize', clear
merge 1:1 persid using 2datatemp/3_coredata_wagepers`year'`sampsize' _merge==3
drop _merge

* data on individuals
replace age = age/10
lab var age "age/10"
gen agec = floor(age) // 4 age categories for strata
replace agec = 5 if age==6
lab def agec 2 "20-29" 3 "30-39" 4 "40-49" 5 "50-60"
lab val agec agec
tab educ, miss
replace educ = 10 if missing(educ)
replace educ = 10 if educ==0
gen byte educ5 = educ // 5 educ classes for strata
replace educ5 = 1 if educ==3 // no vocational training
replace educ5 = 2 if educ==4 // with vocational training
lab def educ5 1 "novoc" 2 "vocat" 5 "appco" 6 "uni" 10 "miss"
lab val educ5 educ5
gen byte yoschool = . // years of schooling
replace yoschool = 9 if inlist(educ,1)
replace yoschool = 13 if inlist(educ,2,3)
replace yoschool = 15 if inlist(educ,4)
replace yoschool = 16 if inlist(educ,5)
replace yoschool = 18 if inlist(educ,6)
egen yoschool_mean = mean(yoschool), by(sex german plow_west)
replace yoschool = yoschool_mean if missing(yoschool)
assert !missing(yoschool)
tab yoschool, miss

* firm variables
sort firmid
by firmid: egen frac_uni_f = mean(educ==6)
by firmid: egen yoschool_f = mean(yoschool)
by firmid: gen lfsize = log(_N)
by firmid: gen fs11 = _N>10
gen lfsize2 = lfsize^2

* mean wages and censoring by firm
by firmid: gen long firm_N = _N
by firmid: egen mlof_lrwdwage = mean(lrdwage)
replace mlof_lrwdwage = (mlof_lrwdwage * firm_N - lrdwage) / (firm_N-1)

by firmid: egen mlof_censd = mean(censd)
replace mlof_censd = (mlof_censd * firm_N - censd) / (firm_N-1)

* replace missings by means for fraction-censored and mean-wage variables
gen byte dfirm1 = firm_N==1
assert missing(mlof_lrwdwage, mlof_censd) if dfirm1==1
assert !missing(mlof_lrwdwage, mlof_censd) if dfirm1==0

sum mlof_lrwdwage if inrange(firm_N,2,5)  // mean of firm wage of small firms
replace mlof_lrwdwage = r(mean) if dfirm1==1
sum mlof_censd if inrange(firm_N,2,5)       // mean of share censored wage of
small firms
replace mlof_censd = r(mean) if dfirm1==1

gen mlof_censd_lrwdwage = mlof_censd * mlof_lrwdwage  // Interaction
list firmid sex lrdwage mlof_lrwdwage censd mlof_censd firm_N in 1/100
drop firm_N yoschool_mean yoschool
lab var frac_uni_f  "fraction of workers with university degree"
lab var yoschool_f  "mean years of schooling of firm by gender"
lab var lfsize      "log firm size, full-time employees"
lab var lfsize2     "log firm size squared, full-time employees"
lab var fsize11     "dummy for firm size>10, full-time employees"
lab var mlof_lrwdwage "mean log real daily wage of co-workers"
lab var mlof_censd  "fraction of co-workers with censored wage"
lab var dfirm1      "dummy firm has 1 worker in current year"

* strata
*keep if sex==1 & plow_west==1
egen strata = group(sex agec educ5 plow_west), label lname(strata) truncate(6)
tab strata, miss
drop sex a
gec educ5 plow_west
numlabel strata, add

* If 1 obs per person: mean of other persons, contrary to Card by Strata
sort strata
foreach var of varlist mlof_lrwdwage mlof_censd {
    by strata: egen `var' = mean(`var')
}
replace mlop_lrdwage = _ml mlop_lrdwage if dpers1==1
replace mlop_censd = _ml mlop_censd if dpers1==1
drop _ml mlop_lrdwage _ml mlop_censd

g gen mlop_censd_lrdwage = mlop_censd * mlop_lrdwage // Interaction
*drop mlop_lrdwage mlop_censd dpers1
sum
save 2datatemp/3_coredata_reg`year'`sampsize', replace

* Step 1: compute imputations from independent regressions
foreach sampsize in $samplist {
    foreach year of numlist $yearlist {
        use 2datatemp/3_coredata_reg`year'`sampsize', clear
* List of rhs-variables
* global exvar //
*     age mlop_censd mlop_lrdwage mlop_censd_lrdwage ///
*     fsize11 lfsize lfsize2 frac_uni_f yoschool_f mlof_censd mlof_lrdwage mlof_censd_lrdwage ///
*     dpers1 dfirm1 ///
*     german

global exvar //
    age german ///
    fsize11 lfsize lfsize2 frac_uni_f yoschool_f

* Check variables
keep persid strata lrdwage lrdclim censd ${exvar}
foreach var of varlist _all {
    assert !missing(`var')
}
}
sum

* imputation routine
gen lrdwage_imp = lrdwage if censd==0
gen byte converged = .
gen uniform = uniform()
gen k =.
gen draw =.
gen sigma =.
gen xb =.

levelsof strata, local(stratval)
foreach stratum of numlist `stratval' {

tab strata if strata == `stratum' // just do display the current stratum

cap cnreg lrdwage ${exvar} if strata==`stratum', censored(censd) //
iterate(200)
dis e(converged)
replace converged = e(converged) if strata==`stratum'
if e(converged)==1 {
   cnreg // display regression results
cap drop _xb
predict _xb if strata==`stratum', xb
local sigma = _b[ sigma:_cons]
replace k = normal((lrdclim - _xb)/`sigma') if censd==1 & strata==`stratum'
replace draw = k + uniform * (1-k) if censd==1 & strata==`stratum'
replace draw = 1-1e-16 if draw>1-1e-16 & draw<. & censd==1 & strata==`stratum'
// artificial censoring due to limited computer accuracy
   replace lrdwage_imp = _xb+ sigma!*invnorm(draw) if censd==1 & strata==`stratum'
   replace sigma = `sigma' if strata==`stratum'
   replace xb = _xb if strata==`stratum'
}
}

* checks
compare lrdclim lrdwage_imp if censd==1
compare lrdclim lrdwage_imp if censd==1 & draw == 1-1e-16
count if draw == 1-1e-16 // number of artificially censored cases
replace lrdwage_imp = lrdclim if lrdclim > lrdwage_imp & censd==1 & draw == 1-1e-16 // ensure that imp wages are >= cens limit
replace lrdwage_imp = lrdclim if lrdclim > lrdwage_imp & censd==1 // should occur in very rare cases

tab converged, miss
assert lrdclim <= lrdwage_imp + .001 if censd==1  // imputed wage is >= censoring limit if observed wage censored, +.001 due to rounding errors
assert lrdwage <= lrdwage_imp + .001 if censd==1  // imputed wage is >= observed wage if obs wage censored, +.001 due to rounding errors
assert lrdwage == lrdwage_imp if censd==0  // exact equality

* save real actual and imputed wages
keep persid lrdwage lrdwage_imp cens converged sigma xb uniform lrdclim compress sum

save 2datatemp/3b_coredata_impwage_`year'_`sampsize'_oloo, replace
}
}
* Imputation with lagged variables
foreach sampsize in $samplist {
    foreach year of numlist 1995(1)2010 {
        foreach year of numlist 1996(1)2010 {
            use 2datatemp/3_coredata_reg`year'`sampsize', clear
            *merge imputations from independent and lagged regressions
            merge 1:1 persid using 2datatemp/3b_coredata_impwage_`year'`sampsize'_oloo, keepusing(lrdwage_imp)
            assert _merge==3
drop _merge
            ren lrdwage_imp lrdwage_imp_lag0  //current

            local l2 = `year' - 2
            local l1 = `year' - 1
            if `year'==1995 {
                merge 1:1 persid using 2datatemp/3b_coredata_impwage_`l2'_`sampsize'_oloo, keepusing(lrdwage_imp)
                drop if _merge==2
                drop _merge
                ren lrdwage_imp lrdwage_imp_lag2
            } else if `year'==1996 {
                merge 1:1 persid using 2datatemp/3b_coredata_impwage_`l1'_`sampsize'_oloo, keepusing(lrdwage_imp)
                drop if _merge==2
                drop _merge
                ren lrdwage_imp lrdwage_imp_lag1
            }
        }
    }
}

if `year'==1996 {

}
merge 1:1 persid using 
2datatemp/3b_coredata_impwage_`l2'`sampsize'_oolo, keepusing(lrdwage_imp)
    drop if _merge==2
    drop _merge
    ren lrdwage_imp lrdwage_imp_lag2
merge 1:1 persid using 
2datatemp/3b_coredata_impwage_`l1'`sampsize'_lag, keepusing(lrdwage_imp)
    drop if _merge==2
    drop _merge
    ren lrdwage_imp lrdwage_imp_lag1
}
if `year'>1996 {
merge 1:1 persid using 
2datatemp/3b_coredata_impwage_`l2'`sampsize'_lag, keepusing(lrdwage_imp)
    drop if _merge==2
    drop _merge
    ren lrdwage_imp lrdwage_imp_lag2
merge 1:1 persid using 
2datatemp/3b_coredata_impwage_`l1'`sampsize'_lag, keepusing(lrdwage_imp)
    drop if _merge==2
    drop _merge
    ren lrdwage_imp lrdwage_imp_lag1
}

* wage differences
gen lrdwage_imp_dlag21 = lrdwage_imp_lag1 - lrdwage_imp_lag2
gen lrdwage_imp_dlag10 = lrdwage_imp_lag0 - lrdwage_imp_lag1

* averages of observed differences (downbias because inclusion of independent imputations? use truncated wage)
sort strata
foreach var of varlist lrdwage_imp_dlag10 lrdwage_imp_dlag21 {
    by strata: egen _`var' = mean(`var')
}
gen gap_lag1_d = missing(lrdwage_imp_lag1)
gen gap_lag2_d = missing(lrdwage_imp_lag2)
gen gap_lag1_lag2_d = missing(lrdwage_imp_lag1) &
missing(lrdwage_imp_lag2)

gen lrdwage_imp_lag1_m = 0
replace lrdwage_imp_lag1_m = lrdwage_imp_lag0 - _lrdwage_imp_dlag10 if
missing(lrdwage_imp_lag1)
replace lrdwage_imp_lag1 = 0 if missing(lrdwage_imp_lag1)

sum lrdwage_imp_lag1* if lrdwage_imp_lag1==0
sum lrdwage_imp_lag1* if lrdwage_imp_lag1~0
gen lrdwage_imp_dlag21_m = 0
replace lrdwage_imp_dlag21_m = _lrdwage_imp_dlag21 if missing(lrdwage_imp_dlag21)
replace lrdwage_imp_dlag21 = 0 if missing(lrdwage_imp_dlag21)
sum lrdwage_imp_dlag21* if lrdwage_imp_dlag21==0
sum lrdwage_imp_dlag21* if lrdwage_imp_dlag21==0

* loo firm wage based on imputed wage from step 1
sort firmid
by firmid: egen mlof_lrdwage_imp = mean(lrdwage_imp_lag0)
by firmid: gen long firm_N = _N
replace mlof_lrdwage_imp = (mlof_lrdwage_imp * firm_N - lrdwage_imp_lag0) / (firm_N - 1)
sum mlof_lrdwage_imp if inrange(firm_N,2,5) // mean of firm wage of small firms
replace mlof_lrdwage_imp = r(mean) if dfirm1==1
gen mlof_censd_lrdwage_imp = mlof_censd * mlof_lrdwage_imp // Interaction
drop lrdwage_imp_lag0 lrdwage_imp_lag2 lrdwage_imp_dlag10 _lrdwage_imp_dlag21 _lrdwage_imp_dlag21

* List of rhs-variables
*global exvar ///
*    age mlop_censd mlop_lrdwage ///
*    fsize11 lfsize lfsize2 frac_uni_f yoschool_f mlof_censd mlof_lrdwage mlof_censd_lrdwage ///
*    dpers1 dfirm1 ///
*    german

global exvar ///
    age german ///
    gap_lag1_d gap_lag2_d gap_lag1_lag2_d ///
    lrdwage_imp_lag1 lrdwage_imp_lag1_m ///
    lrdwage_imp_dlag21 lrdwage_imp_dlag21_m ///
    fsize11 lfsize lfsize2 frac_uni_f yoschool_f ///
    mlof_censd mlof_lrdwage_imp mlof_censd_lrdwage_imp

* Check variables
keep persid strata lrdwage lrdclim censd ${exvar}
foreach var of varlist _all {
    *assert !missing(`var')
count if missing(`var')
}
sum

* imputation routine
gen lrdwage_imp = lrdwage if censd==0
gen byte converged = .
gen uniform = uniform()
gen k = .
gen draw = .
gen sigma = .
gen xb = .

levelsof strata, local(stratval)
foreach stratum of numlist `stratval' {

tab strata if strata == `stratum' // just do display the current stratum

cap cnreg lrdwage ${exvar} if strata==`stratum', censored(censd) //
iterate(200)
dis e(converged)
replace converged = e(converged) if strata==`stratum'
if e(converged)==1 {  // display regression results
    cnreg
    predict _xb if strata==`stratum', xb
    local sigma = _b[sigma:_cons]
    replace k = normal((lrdclim-_xb)/`sigma') if censd==1 & strata==`stratum'
    replace draw = k + uniform * (1-k) if censd==1 & strata==`stratum'
    replace draw = 1-1e-16 if draw>1-1e-16 & draw<. & censd==1 & strata==`stratum'

    // artificial censoring due to limited computer accuracy
    replace lrdwage_imp = _xb+`sigma'*invnorm(draw) if censd==1 & strata==`stratum'
    replace sigma = `sigma' if strata==`stratum'
    replace xb = _xb if strata==`stratum'
}
}

* checks
compare lrdclim lrdwage_imp if censd==1
compare lrdclim lrdwage_imp if censd==1 & draw == 1-1e-16
count if draw == 1e-16  // number of artificially censored cases
replace lrdwage_imp = lrdclim if lrdclim > lrdwage_imp & censd==1 & draw == 1e-16  // ensure that imp wages are >= cens limit
replace lrdwage_imp = lrdclim if lrdclim > lrdwage_imp & censd==1
    // should occur in very rare cases

tab converged, miss

assert lrdclim <= lrdwage_imp + .001 if censd==1  // imputed wage is >= censoring limit if observed wage censored, +.001 due to rounding errors
assert lrdwage <= lrdwage_imp + .001 if censd==1  // imputed wage is >= observed wage if obs wage censored, +.001 due to rounding errors
assert lrdwage == lrdwage_imp    if censd==0  // exact equality

* save real actual and imputed wages
keep persid lrdwage lrdwage_imp censd converged sigma xb uniform lrdclim
compress

save 2datatemp/3b_coredata_impwage_`year'_`sampsize'_lag, replace
}
}
clear

* Graph earnings distributions

*local sampsize 50000
foreach sampsize in $samplist {
    foreach version in lag oloo {
        foreach year of numlist 1995(2)2010 {
            use persid sex plow_west if sex==1 & plow_west==1 using 2datatemp/3a_coredata`year'_`sampsize', clear
            merge 1:1 persid using 2datatemp/3b_coredata_impwage_`year'_`sampsize'_`version'
            assert _merge==1
            keep if _merge==3
            drop _merge
            foreach region of numlist 1 {
                sum lrdwage if plow_west==region
                global clim = r(max)
            }
        }
    }
}

53
histogram lrdwage_imp if plow_west==`region' &
inrange(lrdwage_imp,3,6) , xline(${clim}) title("wage_i - `year' - west`region'")
saving(3log/imp_`version'`region'_`year'_`sampsize', replace)

histogram lrdwage_imp if plow_west==`region' &
inrange(lrdwage_imp,${clim}-.6,${clim}+.6), xline(${clim})
title("wage_i - `year' - west`region'") saving(3log/impc_`version'`region'_`year'_`sampsize', replace)

histogram xb if plow_west==`region' & inrange(xb,3,6)
, xline(${clim})

title("xb - `year' - west`region'")
saving(3log/xb_`version'`region'_`year'_`sampsize', replace)

histogram xb if plow_west==`region' & inrange(xb,3,6) &
censd==0, xline(${clim})
title("xb not cens - `year' - west`region'")
saving(3log/xb_`version'_c0_`region'_`year'_`sampsize', replace)

histogram xb if plow_west==`region' & inrange(xb,3,6) &
censd==1, xline(${clim})
title("xb censored - `year' - west`region'")
saving(3log/xb_`version'_c1_`region'_`year'_`sampsize', replace)

graph combine
3log/imp_`version'`region'_`year'_`sampsize'.gph
3log/impc_`version'`region'_`year'_`sampsize'.gph

3log/xb_`version'_c0_`region'_`year'_`sampsize'.gph
3log/xb_`version'_c1_`region'_`year'_`sampsize'.gph

3log/xb_`version'_`region'_`year'_`sampsize'.gph 
graph combine
, scale(.6) cols(2) ycommon

graph combine
, scale(.6) cols(2) ycommon

3log/imp_`version'_xb_west`region'_`year'_`sampsize'.png, replace