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Computerization and wage inequality between and within German work establishments

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ABSTRACT

Recent evidence has revealed that a significant share of the rise in wage inequality has occurred at the establishment level, underscoring the importance of workplace-level analyses for understanding growing inequality. Using longitudinal matched employment data from Germany, we provide new insights into how investments in information and communication technologies (ICT) affect earnings inequality between and within establishments over time. Focusing on the mechanisms of inequality, cross-sectional estimates provide evidence of both skill- and class-biased technological change; however, establishment fixed effects models reveal that this relationship is driven by unobserved establishment heterogeneity. Despite a strong relationship between computerization and the rise in workplace heterogeneity, we find little evidence of a causal effect of computers on changes in establishment-level inequality. Rather, establishments that invest more greatly in ICT pay on average better wages and exhibit higher within-establishment inequality. These results challenge dominant explanations about the role of computerization in rising inequality, while also reinforcing the necessity of using organizational data to study inequality processes.

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The rise in wage inequality across many advanced societies has been dramatic, spurring considerable scholarly and public interest in its causes. Most existing studies have investigated rising inequality using individual-level data (e.g. Bound and Johnson, 1992; Juhn, Murphy, & Pierce, 1993; Katz and Murphy, 1992; Krueger, 1993; Western & Rosenfeld, 2011), industry-level data (e.g. Autor, Katz, & Krueger, 1998; Berman, Bound, & Griliches, 1994; Kristal, 2010, 2013; Lin & Tomaskovic-Devey, 2013), or occupational-level data (e.g. Firpo, Fortin, & Lemieux, 2011; Goos & Manning, 2007). Recently, Card, Heining, and Kline (2013) showed that establishments have also played an important role in rising wage inequality. Using West German administrative data, they demonstrated that a large proportion of growing earnings differentials across occupations, educational groups, and industries as well as the general increase in inequality is explained by rising establishment-specific wage premiums and increased worker sorting across workplaces. Given that considerable growth in inequality has transpired between workplaces, this suggests that establishment-level analyses may be particularly helpful in explaining rising inequality.

A leading explanation for growing inequality has been the spread of information and communication technologies (ICT). Although myriad studies report an association between ICT and inequality, the effect of computers on the wage structure remains elusive. According to the well-known skill-biased technological change hypothesis, spread of these technologies is believed to have increased demand for highly skilled workers and reduced demand for low-skilled workers, leading to skill-based inequality (Card & DiNardo, 2002; Morris & Western, 1999). Much of the rise in inequality along the skill gradient has been attributed to ICT enhancing demand for certain job tasks, while reducing demand and ultimately displacing other tasks through automation (Autor, Levy, & Murnane, 2003; Firpo et al., 2011; Goos & Manning, 2007; Spitz-Oener, 2006). Alternatively, in addition to this direct, skill-based channel, class-biased technological change (i.e. Kristal, 2013; Kristal & Cohen, 2015) contends that ICT investments contribute to inequality indirectly through furthering the decline in collective bargaining. Still others (e.g. Bresnahan, 1999; DiNardo & Pischke, 1997; Doms, Dunne, & Troske, 1997; Handel, 2007) argue that ICT has no influence on wages and that the observed relationship is driven by unobserved heterogeneity.

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To address these issues, we use highly detailed longitudinal matched employer-employee data from Germany to provide new insights into how ICT affects establishment wage inequality. Because ICT investments are made at the establishment level, rather than the industry or individual level, workplaces are the relevant unit of analysis for evaluating the link between computerization and rising inequality. Moreover, given that computer investments may not only increase differentials in average wages between establishments but also earnings dispersion within them, we use an innovative approach to differentiate between computerization's influence on between- and within-workplace inequality over time. To date, no study has considered the simultaneous impact of ICT on earnings inequality between and within establishments, meaning that it is unclear exactly how computers might shape total workplace inequality. Using a variance function regression with establishment fixed effects, we are able to provide insights into the sources of rising workplace heterogeneity (Card et al., 2013), while also offering one of the most rigorous investigations of how computerization influences inequality to date.

As the dominant European economy and fourth largest in the world, evidence from Germany is an important addition to the largely U.S.-based wage inequality debate. Despite being known for its comparably strong employment protection, collective bargaining institutions, and relatively modest wage inequality (DiPrete and McManus, 1996; OECD, 2011), earnings dispersion in Germany has increased significantly in recent decades, resembling U.S. trends (Dustmann, Ludsteck, & Schönberg, 2009). Understanding how computerization shapes inequality in a major economy such as Germany therefore not only provides a useful comparative example but also advances our knowledge regarding its link to larger patterns of inequality.

1. Computerization and the rise in inequality

Considerable research has found a strong relationship between the spread of information and communication technologies (ICT) and the growth in inequality. We focus particularly on skill-biased technological change, class-biased technological change, and unobserved establishment heterogeneity as the primary explanations for this relationship, which we extend to the establishment level.

1.1. Skill-biased technological change (SBTC)

A large body of predominantly economic literature has argued that ICT investments have a direct effect on wages through increasing skill-based inequality. Beginning with the earliest studies (e.g. Bound & Johnson, 1992; Juhn et al., 1993; Katz & Murphy, 1992; Levy and Murnane, 1992), scholars observed that much of the rise in inequality was between better- and lesser-skilled workers, although an even larger portion of the growth transpired within narrowly defined skill groups. Although these early studies were cautious about causation, economists largely agreed that computerization had likely driven much of the growth in inequality, yielding the theory of skill-biased technological change (Lemieux, 2008). The idea that technological change, particularly advancements in microcomputers, is skill-biased is derived from the notion that computer technology complements human capital. Consequently, the spread of this technology is thought to raise demand for highly-skilled workers and decrease demand for low-skilled workers, producing inequality (Acemoglu, 2002; Card & DiNardo, 2002).[1]

Research on computerization has repeatedly demonstrated that the spread of ICT is related to skilled workers. Krueger (1993) was among the first to empirically evaluate the relationship between computers and wages. Using CPS microdata between 1984 and 1989, he found that computer use predicts 10–15 percent higher wages on average. Further, as he discovered, better-educated workers are more likely to use computers at work. Others have found that ICT investments are also related to a rising share of college-educated workers over time using longitudinal industry data (e.g. Autor et al., 1998; Berman et al., 1994).

Establishment-level research also links computer investments and skill-based inequality. A wealth of studies has shown that ICT investments predict a higher proportion of skilled workers and a lower share of unskilled workers in establishments over time (Autor, Levy, & Murnane, 2002; Bresnahan, Brynjolfsson, & Hitt, 2002; Dunne and Schmitz, 1995; Siegel, 1998). Other research suggests that ICT investments increase within-establishment wage differentials. For example, Fernandez (2001) reports that retooling in one large manufacturing plant amplified earnings dispersion through the hiring of new, highly skilled workers that commanded real wage increases compared to wage stagnation among low-skill workers.

But how do computers exactly enhance demand for skill? Addressing one of the most glaring problems of the original SBTC hypothesis, Autor et al. (2003) propose a "task-based" version of SBTC, positing that tasks represent the missing causal mechanism behind computers' influence on the labor market.[2] As they assert, workplace activities comprise two general types of tasks: routine and non-routine. On the one hand, routine cognitive tasks (e.g., bookkeeping, cashiering, calculating) and routine manual tasks (e.g. picking, sorting, repetitive assembly) involve methodically repetitive procedures which are liable to computer substitution since they can be easily defined by explicit programmed rules. On the other, non-routine cognitive tasks (e.g. managing, problem solving, and advising) are computer-complementary as computers enhance the productivity of individuals completing these activities. By contrast, the impact of ICT on non-routine manual tasks (e.g. truck driving, cleaning, and servicing) remains ambiguous as computers neither strongly complement nor substitute for these activities. Consequently, the task-based approach identifies two potential channels through which computers affect wages. First, through shifting work toward non-routine cognitive tasks and automating cognitive and manual routine tasks, ICT is argued to increase demand for skilled workers to perform non-routine cognitive tasks. In turn, wage changes depend on whether the supply of skilled workers keeps pace with demand. Second, computerization may enhance the productivity (and therefore wages) of workers performing complementary tasks, contributing to inequality (Spitz-Oener, 2008).

In sum, skill-biased technological change predicts ICT investments increase the share of skilled workers in workplaces (Autor et al., 2002; Bresnahan et al., 2002; Dunne and Schmitz, 1995; Siegel, 1998) through task changes (Autor et al., 2003). Computer investments are also expected to amplify educational wage differentials by enhancing the relative productivity of individuals performing complementary tasks (Spitz-Oener, 2008). As a result, SBTC suggests that ICT investments increase between-establishment wage inequality through (1) heightening educational sorting across workplaces, and (2) increasing wage differences between high- and low-educated workers. These implications likewise apply to within-establishment inequality. ICT is not only related to the hiring of better-skilled workers on aver-

[1] In addition to the technology-induced rise in demand for skill, growing skill-based inequality in the U.S. may have been also fueled by a slowdown in the growth of highly-educated workers (Goldin and Katz, 2008).

[2] This is also called the "nuanced" SBTC hypothesis or in the context of job polarization the "routinization" hypothesis.

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