WORK IN THE AGE OF DATA
The Causes and Consequences of Job Polarization, and Their Future Perspectives

Michael J. Böhm

Job polarization is a major trend that took place in advanced countries’ labor markets over the past several decades. This article uses administrative data as well as established sources from the literature to achieve three aims: first, it shows how the rise of high- and low-wage occupations, and the commensurate decline of traditional mid-wage occupations, has had adverse effects on the less-skilled share of the workforce. It then identifies the underlying driving forces of job polarization, which include biased technological changes, international trade and offshoring, and pervasive shifts of the industry structure, among others. Finally, the article provides an outlook of the trends to come, for example, whether in future some high-wage jobs may decline, and discusses the interaction with policy.

Job Polarization and Its Consequences for Workers

The distribution of jobs is one of the most important characteristics of a labor market. When employment in an economy is characterized by well-paying and secure jobs that give their holders purpose and a sense of producing something valuable, this can provide many wider benefits to the individuals, their families, and society at large. Changes of employment across jobs are also a driver of the rising inequality of wages and earnings in various countries (Acemoglu and Autor, 2011; Böhm, 2019; Böhm et al., 2019). Finally, the current debate about the changing nature of work, that is, because of smart robots or artificial intelligence, is mostly about which jobs will rise (be newly created) or decline (disappear).

The changing distribution of jobs could mean several things, including trends of employment or wages in occupations such as doctors, machine operators, and cleaners; or in industry sectors such as manufacturing and services. It could also imply a changing share of individuals in part-time as opposed to full-time work or temporary as opposed to permanent employment. When labor economists nowadays think about the changing distribution of jobs, most of them would have in mind the so-called trend of “job polarization.” In my view, this trend is rightly very prominent because job polarization is so forceful and pervasive that it decidedly altered the labor market composition of most advanced economies. In this article, I will discuss the effects that job polarization has had on workers, the causes that underlie it, and give an outlook on how these trends might evolve in the future. I begin by describing the facts.

Goos and Manning (2007) were among the first to show that over the preceding thirty years employment shares of the occupations with the highest and lowest (mean or median) wages had increased in the United Kingdom, whereas employment shares of middle-wage occupations had plummeted. Goos and Manning (2007) were also the first to coin the term “job polarization” in this context. Around the same time, Autor, Levy, and Murnane (2003) found that the employment share of codifiable routine occupations, which are often middle-wage jobs, had dropped in the United States, too. Spitz-Oener (2006) soon showed evidence along those lines for Germany; later came...

Figure 1 presents one way of depicting job polarization for Germany, using data from my ongoing cooperation with my colleagues Hans-Martin von Gaudecker and Felix Schran (2019). These data come from unique administrative records of the German unemployment insurance, containing individual-worker panel information and detailed occupations. I collapse the detailed occupations into four mutually exclusive and exhaustive groups, which include managers, professionals, and technical (Mgr-Prof-Tech); sales and office (Sales-Office); production, operator, and crafts (Prod-Op-Crafts); and services and care (Srvc-Care) occupations. This is similar to Acemoglu and Autor (2011)’s classification into four broad occupation groups for the US.

Panel A of fig. 1 shows that, even in Germany with its large and historically successful manufacturing sector, the employment share of Prod-Op-Crafts declined strongly during the three-and-a-half decades between 1975 and 2010, dropping from almost 55% to around 35–40%. At the same time, the employment shares of all other occupation groups increased. Panel B depicts annual full-time equivalent wages in the occupation groups, with earnings in Mgr-Prof-Tech substantially higher (55% on average) than in Prod-Op-Crafts (and in Sales-Office), which in turn are decidedly higher (33%) than in Srvc-Care. Therefore, jobs in Germany are clearly polarizing, too, in the sense that employment in middle-wage occupations is continuously declining whereas employment in high- as well as low-wage occupations is rising.

As mentioned above, job polarization is a transformative change of the economy because employment in high-wage occupations is rising, which should be a good thing. But employment is also rising in low-wage occupations.

Fig. 1. Employment and wages by broad occupation

SIAB 2% random sample of administrative social security records from 1975 to 2010 provided by the IAB institute. Sample restricted to West German males and females aged twenty-five to fifty-four (c. 450,000 unique individuals). Occupation groups are managers, professionals, and technical (Mgr-Prof-Tech); sales and office (Sales-Office); production, operator, and crafts (Prod-Op-Crafts); and services and care (Srvc-Care). Daily wages accumulated to annual full-time equivalent earnings (in 2010 euros).

Fig. 2. Employment and wages by broad industry sector

For data source, sample selection, and wage definitions see notes to fig. 1. Industry sectors are processing of primary materials, machinery and car production, and construction business (manufacturing); food, hospitality, repair services, wholesale trade, and retail trade (low-skill services); professional and related services, finance, insurance and real estate, transport and communications, utilities, education, and public administration (high-skill services).
Knowing the reasons for job polarization offers the opportunity to understand several key trends in the labor market over the past decades but also promises insights into what may happen in the future.

In Western countries, Prod-Op-Crafts jobs drastically declined, while Mgr-Prof-Tech and Srv-Care increased. In addition, wages in Mgr-Prof-Tech increased relative to the other occupations.

exactly because employment in high-wage occupations is rising, which should be a good thing. But employment is also rising in low-wage occupations, with many workers who previously (would) have done Prod-Op-Crafts jobs now employed in Srv-Care occupations. Sticking to my German example, Table 1 shows the employment of high-, medium-, and low-educated workers in the four broad occupations. We see that Prod-Op-Crafts have been by far the largest employer of low- and medium-educated workers with shares of 69 and 52%, respectively. However, these shares have declined substantially over time, dropping by seven percentage points each. Especially in the case of medium-educated workers, this drop has gone in hand with substantial occupational downgrading. That is, almost all of the decrease in Prod-Op-Crafts employment is accounted for by an increase of employment in low-wage Srv-Care occupations.

In contrast, Prod-Op-Crafts never played a particular role for highly educated workers and the decline of employment in it is almost negligible. Therefore, in the past Prod-Op-Crafts appears to have been a particularly attractive employment opportunity for medium- to low-educated workers (among them especially men). This has continuously diminished over time in Germany as well as in other Western countries such as the US or the UK. The decline of middle-wage Prod-Op-Crafts jobs is a reason for concern not only because of the lower wages that those medium- and low-educated workers are earning, who are now instead in low-wage Srv-Care occupations. It is also potentially problematic because further important job characteristics, such as union coverage, full-time and permanent contracts, health insurance and other benefits, as well as alternative work arrangements (one-hour contracts, pseudo self-employment, etc.), are substantially more advantageous in Prod-Op-Crafts than in Srv-Care and even than in some of the Mgr-Prof-Tech and Sales-Office occupations.

As an illustration of these differences with respect to additional dimensions of job quality, Table 2 reports the transition rates of the four occupation groups. We see that Srv-Care has by far the lowest rate of job stability with less than 85% of workers staying in the occupation group over a period of two years. That is, the turnover rate is almost 16%. In contrast, Prod-Op-Crafts features high job stability, or low turnover, almost at par with Mgr-Prof-Tech. Everything might be fine if many of the workers leaving Srv-Care were transitioning into higher-wage occupations. Unfortunately, this is not the case either: more than 9% of all Srv-Care workers are not in employment two years later; once again, much higher than in any of the other occupations. Therefore, Table 2 presents one illustration why also in non-wage dimensions the Prod-Op-Crafts occupations of the past have been very attractive jobs, and why the rise of Srv-Care may be problematic in these dimensions too.

The rest of this article will investigate in detail the reasons for these striking, and at least partly worrying, changes of the employment structure, for the German example shown here as well as advanced econ-

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Table 1: Occupational employment by level of education

<table>
<thead>
<tr>
<th>Occupation</th>
<th>Low</th>
<th>Change</th>
<th>Medium</th>
<th>Change</th>
<th>High</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mgr-Prof-Tech</td>
<td>3.7</td>
<td>+3.8</td>
<td>13.0</td>
<td>+0.0</td>
<td>77.4</td>
<td>-14.4</td>
</tr>
<tr>
<td>Sales-Office</td>
<td>12.4</td>
<td>+1.0</td>
<td>27.6</td>
<td>+1.2</td>
<td>14.7</td>
<td>+13.7</td>
</tr>
<tr>
<td>Prod-Op-Crafts</td>
<td>68.9</td>
<td>-7.0</td>
<td>51.9</td>
<td>-7.1</td>
<td>6.1</td>
<td>-1.4</td>
</tr>
<tr>
<td>Srv-Care</td>
<td>15.0</td>
<td>+2.3</td>
<td>7.5</td>
<td>+5.8</td>
<td>1.8</td>
<td>+2.1</td>
</tr>
</tbody>
</table>

Employment by education level (1975) and changes (2010–1975), in %

For data source, sample selection, and occupation definitions see notes to fig. 1. Low-education group are high-school graduates below Abitur with no apprenticeship training (i.e., no post-secondary education). Medium are Abitur holders or apprenticeship training. High are college graduates (general university or university of applied sciences). The columns sum to 100% (levels) and 0% (changes), respectively.

Table 2: Two-year transition rates by origin occupation

<table>
<thead>
<tr>
<th>Origin</th>
<th>Mgr-Prof-Tech</th>
<th>Sales-Office</th>
<th>Prod-Op-Crafts</th>
<th>Srv-Care</th>
<th>Non-Empl</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mgr-Prof-Tech</td>
<td>91.7</td>
<td>3.0</td>
<td>1.4</td>
<td>0.5</td>
<td>3.4</td>
</tr>
<tr>
<td>Sales-Office</td>
<td>2.4</td>
<td>89.9</td>
<td>1.4</td>
<td>0.7</td>
<td>5.6</td>
</tr>
<tr>
<td>Prod-Op-Crafts</td>
<td>13.0</td>
<td>1.3</td>
<td>91.3</td>
<td>0.9</td>
<td>5.3</td>
</tr>
<tr>
<td>Srv-Care</td>
<td>1.3</td>
<td>2.3</td>
<td>3.0</td>
<td>84.4</td>
<td>9.1</td>
</tr>
</tbody>
</table>

For data source, sample selection, and occupation definitions see notes to fig. 1. The Table shows percentage shares of destination occupations or non-employment in year t+2 for workers originating in one of the four origin occupations in t. Rows sum to 100%.
What Are the Underlying Causes of Job Polarization?

What are the drivers of transformative and long-running shifts of the distribution of jobs? Knowing the reasons for job polarization offers the opportunity to understand several key trends in the labor market over the past decades but also promises insights into what may happen in the future.

The most prominent explanation for polarization is routine-biased technical change, originally due to Autor, Levy, and Murnane (2003, henceforth ALM). ALM argued that in order to understand the impact of information and communication technology, especially computers and other programmable machines, on the labor market, one would have to focus on the tasks that they are good at performing. At the time of ALM’s writing and up until recently, these were the tasks that could be described by clear rules and procedures that a machine lacking flexibility and judgment can follow at each possible contingency. Computers and computerized machines have therefore been highly productive and reliable at performing tasks that programmers could codify; but also not very productive at anything else. The scientific literature has followed ALM thereafter and referred to these tasks as “routine,” in the sense that they are sufficiently well understood to be fully specified in a series of codes to be executed by a computer.

ALM then went on to show that occupations that contained many routine tasks as part of their job descriptions were often in middle-wage cognitive and manual occupations such as record-keeping and calculation; repetitive customer service; repetitive picking, sorting, and assembly; or monitoring jobs. Occupations that had a lot of such job content were therefore at risk of being disassembled into their constituent parts, with the routine tasks now carried out by computers, or outright replaced by programmable machines. These are approximately the Sales-Office and Prod-Op-Crafts occupations shown in fig. 1 above (see also discussion in Acemoglu and Autor, 2011, who use a similar broad occupation grouping).

At the other side of the spectrum, ALM argued, were jobs intensive in nonroutine problem-solving and complex communication tasks, which are characteristic of professional, managerial, technical, and creative occupations similar to the Mgr-Prof-Tech from above. These were at the top of organizational hierarchies or needed data and information as inputs and were thus complementary to routine tasks. When the overall amount of routine tasks rose, due to computers completing so many of them as humans would never be able to, the productivity and demand for nonroutine Mgr-Prof-Tech occupations rose. In addition, the relative demand for low-wage Srv-Care occupations has also risen, according to ALM, as tasks such as waiting tables or nursing elderly patients were still beyond the realm of what computers could do.

Is ALM’s routine-biased technical change hypothesis borne out in the data? We saw in fig. 1 that employment in Prod-Op-Crafts indeed drastically declined and that employment in Mgr-Prof-Tech as well as in Srv-Care increased. In addition, wages in Mgr-Prof-Tech increased relative to the other occupations. These facts persist in essentially all Western countries (Acemoglu and Autor, 2011; Goos, Manning, and Salomons, 2014). The employment shares of Sales-Office are, however, rising in Germany. Also in the US the corresponding occupations are more or less stable, at least when considering a longer time frame from the 1960s onward, and surely even over the last few decades Sales-Office are not declining as fast as Prod-Op-Crafts (Acemoglu and Autor, 2011, fig. 13).

It seems that routine-biased technical change describes the data over the past decades pretty well with a partial exception of not matching the much stronger decline of Prod-Op-Crafts compared to Sales-Office. But maybe this is not surprising given that other powerful factors than computers seem to have worked on the labor market. Out of those, the factor that has received most attention recently is international trade and offshoring, in particular in relation to China. Mediated by the fall of Socialism in Eastern Europe, trade policy (especially China’s joining of the WTO), as well as again information and communication technology, world trade has increased exponentially.
over the last twenty to thirty years. This is likely to have had an outsize impact on sectors and occupations producing tradable goods, many of which are in manufacturing industries and in Prod-Op-Crafts jobs. After somewhat of a hiatus, Autor, Dorn, and Hanson (2013) were among the first to revisit the role of trade for the decline of manufacturing jobs in the US economy (see also Ebenstein, Harrison et al., 2014). Autor, Dorn, and Hanson show that local regions which were exposed to import competition from China by virtue (actually misfortune) of their initial industry mix (i.e., import-competing manufacturing industries) experienced rising unemployment, lower labor force participation, and reduced wages. Aggregating this effect to the whole US economy, Autor, Dorn, and Hanson show that import competition accounts for one quarter of the decline in manufacturing employment during 1990–2007.

International trade and offshoring may therefore well explain why employment in Prod-Op-Crafts occupations dropped so much even conditional on routine-biased technical change. However, it is probably still not the whole story for why jobs have polarized. First, the impact of trade was much more benign for Germany, and potentially several other advanced countries, than it was for the US. This is shown by Dauth, Findeisen, and Suedekum (2014), who find that overall there were more export-oriented regions in Germany that benefited from trade than there were import-competing regions. Also, the benefits in Germany accrued largely from trade with Eastern Europe rather than with China.

Second, rising trade with either world region did not start to take off before the 1990s, whereas the decline of Prod-Op-Craft occupations began much before that in Germany (fig. 1 above) as well as the US (Acemoglu and Autor, 2011, fig. 13). Computerization rates reported by Spitz-Oener (2006) make it also unlikely that routine-biased technical change had a massive impact on the German labor market before the late 1970s. Therefore, another, complementary explanation is needed and it is provided by Bárány and Siegel (2018). First of all, Bárány and Siegel document that job polarization started as early as the 1950s in the United States. They then link job polarization to another key change of the employment structure, this time across industry sectors: structural transformation.

Structural transformation is characterized by the shift of employment and value added away from agriculture (earlier) and manufacturing (nowadays) toward services industries. The reasons for structural transformation itself are still under debate, as is the case for job polarization. Most of the academic literature explains structural transformation through a shift in consumption demands in response to technological change. These explanations are alternatively based on differential productivity growth across sectors or on non-homothetic preferences paired with growth in overall incomes. In the former case, uneven productivity growth induces changes in relative prices and, provided that sectoral outputs are complements in consumption, lead to a reallocation toward the sector experiencing lower productivity growth (Ngai and Pissarides, 2007). In the latter explanation (first formulated by Kongsamut, Rebelo, and Xie, 2001), any form of technological change reallocates consumption and thus overall output demands across sectors. Recent work by Boppart (2014) finds that both the consumption reallocations through price and through income effects explain about 50% each of structural transformation in the US.

Removing agriculture, Bárány and Siegel (2018) then split up the services industries into a high-skilled and a low-skilled sector based on consumption and average education considerations to show that employment in both of them have been increasing compared to manufacturing since the 1960s. As far as is possible, I replicate Bárány and Siegel’s US evidence for my German example in fig. 2a. Again, we see that manufacturing’s employment share has been declining continuously and quite steeply since 1975, while the employment share of high-skill services has risen sharply. Contrary to the US, low-skill services’ share has also declined but consistent with Bárány and Siegel it did rise relative to manufacturing.

In addition, panel B of fig. 2 depicts the average wages of each sector. In line with the corresponding evidence above, we see that manufacturing wages are quite high. In fact, they are the highest out of the three sectors and they seem to be rising somewhat further over time. This underscores the point made above that the long-run decline of Prod-Op-Crafts/manufacturing employment poses reasons for concern; even technological development and its adoption is endogenous to other market outcomes, government regulations and policies, and fundamental societal changes.

An important trend in which technology, policy, and general economic conditions have interacted is the rise of alternative work arrangements: temporary help agency workers, on-call workers, contract workers, and independent contractors or freelancers.

Google Vice President and General Manager Phil Harrison speaks on stage during the annual Game Developers Conference in San Francisco, California, in March, 2019.
in a country like Germany, which boasts a comparatively successful manufacturing sector, and, on balance, has not suffered from the expansion of international trade during the past decades.

I have argued that a combination of biased technological change, international trade and offshoring, and long-running changes of the industry structure can explain the broad historical changes of employment that are observed in Germany, the US, and most other Western countries over the past several decades. However, as readers might imagine by now, there exist further potential aspects to this, including the supply of skills (e.g., due to changes in the education system and population demographics), demand for low-skill services (Manning, 2004, Mazzolari and Ragusa, 2013), and the fact that recessions seem to accelerate job polarization (Jaimovich and Siu, forthcoming). These aspects may have worked in conjunction with the main driving factors to produce some of the differences in (the extent of) job polarization that can be observed across time periods and countries.

Future Perspectives and Interactions with Policy

Looking into the future is notoriously hard. Much of the research and policy debate focuses on the likely impact of rapid progress in artificial intelligence, digitization, and smart robots. One question is whether these technological advances will replace and therefore reduce an unprecedented amount of human labor or whether, in fact, a lot of new tasks for humans will open up in the ensuing economic transformation, and what the transition path and timing might look like (e.g., Acemoglu and Restrepo, 2018a). Equally important is the question of which tasks will be replaced that were up to now shielded from technology or trade, and whether job polarization will continue or jobs at the top or bottom end of the wage distribution will be more affected.

The current fundamental shift of technology is that codifiability and perfectly contingent rules and procedures are no longer necessary because—with vast amounts of data, computing power, and statistical procedures at hand—smart machines can learn to cope with a much expanded array of situations themselves. In this situation, Frey and Osborne (2017) use job characteristics derived from experts’ interviews to develop automation scenarios for detailed occupations in the US. Their striking finding is that almost half of jobs are at high risk of automation now. In addition, Blinder and Krueger (2013) find that 25% of jobs could be susceptible to further offshoring.

However, such scenarios may overestimate the share of jobs that will eventually be automated or offshored because, as argued by Arntz, Gregory, and Zierahn (2016, 2017), they neglect the substantial heterogeneity of tasks within occupations and the adaptability of workers and jobs in terms of tasks. Consistent with this, Graetz and Michaels (2018) find that, at least in the past, the adoption of industrial robots did not result in job losses but rather increased labor productivity and wages at the sector level. Therefore, it remains unclear to what extent automation will replace jobs (tasks), although a distinct possibility exists that the new technologies may have a large effect in the future.

There is an ongoing debate about what public policy may do in reaction to such changes. In terms of education policy, education systems need to be updated, providing training in some of the abstract (coding, data analysis) and manual skills (dexterity, flexibility) that are ever more important (Saunders, 2018b). In addition, interpersonal skills have become highly demanded (Deming, 2017). Life-long learning and retraining workers who have lost their jobs is another aspect of education and training, which Germany seems to manage better than the US (e.g., Battisti, 2017). Finally, labor market policy should adapt to the fact that working life will increasingly fragment and many employees may become contractors or gig workers (see also discussion further below). This includes portability and expansion of insurance programs, especially health, unemployment, and retirement benefits (Qureshi, 2018).

I will not delve into additional details of these (very sensible) general policy responses but refer to the existing literature (nicely summarized in an earlier book in the OpenMind series, The Age of Perplexity: Rethinking the World We Knew by Qureshi, 2018, and Saunders, 2018). The remainder of my article instead focuses on the interactions of policy with the trends themselves, also calling on some specific sectors of the economy for examples.

As in the historical case of job polarization, it is wrong to assume that technology and all the other factors work in isolation. In fact, technological development (e.g., Acemoglu, 1998) and its adoption (Beaudry and Green, 2002) is endogenous to other market outcomes, government regulations and policies, and fundamental societal changes. A recent paper by Graetz (2019) for example shows that, *ceteris paribus*, automation technology is adopted more intensely for tasks in which there are expensive training requirements for workers. Policy decisions and regulations therefore have an important role to play. For example, when unions insist on too high wages for Prod-Op-Crafts workers or when the minimum wage rises excessively, firms may respond with technology replacing relatively expensive jobs. Acemoglu and Restrepo (2018b) show that other societal changes, such as demographic aging, lead to faster automation adoption. Moreover, international trade policy (e.g., the US-Chinese trade war or Brexit) as well as changing terms of trade (especially rising wages in China, which squeeze firms’ profits from offshoring there) may actually turn around the impact of trade and offshoring.

Another important trend in which technology, policy, and general economic conditions have interacted is the rise of alternative work arrangements: temporary help agency workers, on-call workers, contract workers, and independent contractors or freelancers have become much more prevalent in countries such as the US (Katz and Krueger, 2019) and Germany (Böhm et al, 2019) since the early 1990s. This trend was most likely driven by a confluence of factors including weak demand (e.g., unemployment and the great recession), regulation (labor market liberalizations), and new technologies (Katz and Krueger, 2017). The flipside to it is the (domestic) outsourcing of many services activities from large firms to separate and specialized entities with lower wages and fewer other benefits, as studied for the case of food, cleaning, security, and logistics services by Goldschmidt and Schmieder (2017).

The role of regulations has been hotly debated at the lower end of the earnings distribution (e.g., distortionary versus inequality reducing effects of minimum wages). However, we often fail to recognize that
many high-wage occupations are among the most regulated. This is especially the case in sectors such as law, finance and insurance, and in health care, which exhibit some of the highest susceptibilities to the technologies that are now becoming available because they rely heavily on data collection and analysis. Many legal and financial-services related tasks, such as collecting sources and devising trading strategies, have already been automated. We are now in the process of seeing near-complete computerization of vast areas of the law (e.g., legal writing) and finance (payment services and personal accounts).

The sector where perhaps all these forces interact most interestingly is health care. Health care is the most regulated industry and this may also be the reason why automation technology has arguably made the least inroads. Medical spending is becoming an ever larger share of GDP everywhere and especially so in the US and Germany (OECD, 2017). The question is whether the financial pressures will eventually become so large—due to ever more demographic aging, expensive medical procedures, and perhaps mediated in a more general economic downturn—that savings will rise high on the political agenda. As examples out of many, artificial intelligence with access to vast medical databases can nowadays perform a lot of diagnoses and treatment tasks (identifying a common cold and prescribing medication; but also detecting much less common and obscure diseases) at least as well as a specialist with many years of training. At the same time, fast improvements are being made in the robotization of surgeries as well as nursing and care tasks.

One final big question is in how far, again via policies and regulations, our societies will be willing to transfer decision power from human experts to machines. Cases that are ambiguous and require (moral) judgment abound, not only in the medical field but also in the areas of self-driving cars, legal opinions, investment decisions, care and personal services, and others. Therefore, changes such as demography and political opinions will be

Changes such as demography and political opinions will be very important, by acting on the economy directly as well as by interacting with the new data-driven technology and the attitudes toward it.
very important, by acting on the economy directly as well as by interacting with the new data-driven technology and the attitudes toward it. Overall, in my view, it is quite conceivable that future changes of the job structure could be characterized by shrinking employment in some (formerly) high-wage as well as low-wage occupations compared to middle-wage occupations. That is, job polarization may in fact go into reverse at some point in the future, at least partially.

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Notes

1. On the other hand, detonation of employment opportunities—particularly severe for low- and medium-educated men—have been linked to societal trends of wider relevance. These include, among others, rising morbidity and mortality in midlife (Case and Deaton, 2015) as well as political polarization in various guises (Autor et al., 2016; Fettke forthcoming).

2. Sales-Office is a bit of a special case in Germany, with relatively high wages (as also noted by Cavaglia and Etheridge, 2019) and rising employment. But qualitatively the trends are consistent with those in the US, see discussion in the next section.

3. The movement of high-educated workers into Sales-Office is striking enough, potentially explaining both the rise in this occupation’s employment and wages in fig. 1. The level of education in middle-wage Prod-Op-Crafts is in fact not higher than in low-wage Srvc-Care; while the share of basic educated workers is about the same, the share of medium-educated workers is higher in Prod-Op-Crafts and the share of high-educated workers is higher in Srvc-Care.

4. Being able to compute transition matrices such as the one in Table 2 is a unique strength of having access to high-quality panel data. Also, the results were equally striking when I computed the transition matrix for males only or for one-year or five-year transitions (not shown for brevity).

5. Notable exceptions include Caselli and Coleman (2001) and Acemoglu and Guerrieri (2008) who point to differences in human or physical capital intensities across sectors, implying that accumulation of this production factor induces reallocations of activity across sectors.

6. These include workers in the (new) service and gig economy such as Uber drivers, Airbnb hosts, Task Rabbit taskers, or Deliveroo cyclists, as well as more manufacturing related jobs such as temp agencies hiring out “assistants” to industry firms for a limited amount of time.

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