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EXPLORING A SKILLS-BASED APPROACH TO OCCUPATIONAL MOBILITY

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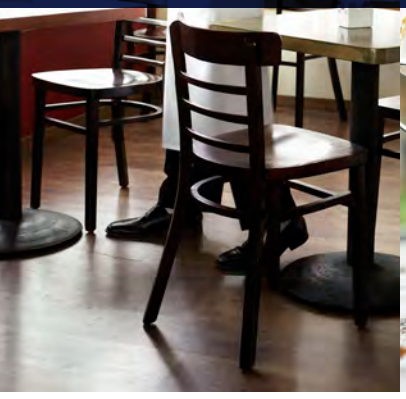

Key Findings

- In general, there is a high degree of similarity between the skills employers seek when filling lower-wage occupations and the skills demanded for opportunity occupations, defined as those that pay above the national annual median wage and that do not typically require a bachelor's degree.
- In the 33 metro areas analyzed, nearly half (49 percent) of lower-wage employment can be paired with at least one higher-paying occupation requiring similar skills.
- Transitions connecting the most similar occupations would represent an average annual increase in wages of nearly $15,000 (or 49 percent).
- Some of these transitions connect lower-wage occupations (7 percent) and opportunity occupations (33 percent) to other occupations often associated with a bachelor's degree.
- A substantial share of the most similar pairs connects lower-wage (30 percent) and opportunity occupation (42 percent) origins to destinations in different major occupational groups.

Introduction

Much has been written about the polarization of the U.S. economy in recent decades. Middle-wage jobs are scarcer than they once were (Autor, Katz, and Kearney 2006; Acemoglu and Autor 2011), and real wages are lower than they were 40 years ago for the typical worker lacking a bachelor's degree (Donovan and Bradley 2019). While individual workers at the lower end of the wage spectrum are often able to increase their take-home pay over time by accumulating skills, gaining experience, and sometimes changing career paths, some earn low wages indefinitely (Schultz 2019). At the same time, employer surveys indicate a shortage of qualified applicants, even during periods of high unemployment, suggesting that the often-discussed "skills gap" does not disappear in times of abundant labor (ManpowerGroup 2018).

In this report, we explore a skills-based approach to occupational mobility because it could both offer economic pathways out of lower-wage work for those without a bachelor's degree and inform a more efficient and equitable talent identification process for employers. The lessons from this analysis, based on the in-demand skills from nearly 60 million online job advertisements, resonate both in a tight labor market when open positions are difficult to fill and in times of economic recovery, as millions search for jobs that leverage and fully reward their experience and aptitude. We draw on a body of research that defines an occupation as a bundle of tasks, the successful completion of which requires a particular array of knowledge, skills, and abilities (hereafter referred to collectively as "skills"). We take our inspiration from recent studies that use a skills-based approach to detect similar occupations at the national level. For the 33 largest metro areas in the U.S., we use employer-demanded skills to identify potential bridges between lower-wage occupations and opportunity occupations, defined as occupations that do not typically require a bachelor's degree and that pay above the national annual median wage (adjusted for local cost-of-living differences).[2]

In this report, we apply a skills-based framework to exploring the potential for occupational mobility within local labor markets and answer the following research questions:

- How does the demand for skills vary by occupational education requirements and pay?
- What are the characteristics of transitions between the most similar origin and destination occupations?
- Which occupations and metro areas provide lower-wage workers with the greatest potential for occupational mobility?
- Which skills constitute the skills gap for transitions out of lower-wage work?

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[2] Prior research on opportunity occupations is available at www.clevelandfed.org/newsroom-and-events/publications/a-look-behind-the-numbers/albtn-opportunity-occupations.aspx.

Background

Our work is motivated by two concepts: first, that *economic* mobility could be improved by greater opportunities for *occupational* mobility, particularly out of lower-wage employment, and second, that a skills-based approach to occupational mobility could uncover potential transitions that may not be obvious when only considering more traditional qualifications such as years of directly relevant experience or higher levels of formal education.

While for many workers, a lower-wage job in retail or food service can act as a short-term introduction to the labor market, research suggests that a substantial share of workers find lower-wage employment to be more persistent than transitory (Schultz 2019; Gabe, Abel, and Florida 2019; Theodos and Bednarzik 2006; Boushey 2005; Andersson, Holzer, and Lane 2003; review by Kalleberg and Mouw 2018). In a recent study covering parts of six decades, the rate of mobility out of lower-wage work is found to have declined since the late 1990s and appears to be lower for those with less formal education, women, nonwhite workers, those experiencing longer spells of unemployment, and workers in low-end service occupations (Schultz 2019). Access to higher-wage firms (Andersson, Holzer, and Lane 2003) as well as union protections (Schultz 2019; Boushey 2005) are associated with higher rates of mobility, but impeding such progress could be a qualitative difference in the skills required for lower- and higher-wage occupations (Alabdulkareem et al. 2018).[3] Bringing the implications of limited economic mobility into stark relief, a recent study finds that workers in lower-wage occupations are much more likely to leave the labor force or become unemployed than to move up the job ladder over a one-year period (Gabe, Abel, and Florida 2019), and the upward mobility that occurs does so primarily between a limited number of occupations (Shearer and Shah 2018; Gabe, Abel, and Florida 2019). Nevertheless, switching occupations is one path to higher wages (Boushey 2005; Escobari, Seyal, and Meaney 2019).

Unpacking the skills an occupation requires — and the transferability of skills across occupations — could lead to greater levels of economic mobility. In the last decade, a substantial amount of academic attention has been leveled at developing a better, data-driven understanding of what, exactly, constitutes an *occupation*. To summarize succinctly, an occupation can be thought of as a bundle of tasks, for which workers need a particular skill set to complete (Yamaguchi 2012; Autor and Handel 2013). In essence, then, "skills define jobs" (Weise, Hanson, and Saleh 2019, p. 12) and what differentiates a given occupation from the rest is the combination and importance of the skills it requires.[4] Workers can transfer their skills from one job to another in order to accomplish occupation-specific tasks reliant on their skills (Yamaguchi 2012; Autor and Handel 2013; Gathmann and Schönberg 2010).

Research suggests that occupational mobility is generally (although not always) upward, allowing workers to better deploy the skills accumulated through prior work experience (Robinson 2018). Involuntary mobility caused by job loss, however, can be associated with a reduction in earnings, particularly when the new occupation requires different skills (Robinson 2018; Gathmann and Schönberg 2010). The negative effects of involuntary occupational mobility appear to be more severe for workers with skill sets that are less transferable within their local labor market (Macaluso 2019). Leveraging the transferability of skills and maximizing the positive potential of opportunistic occupational mobility, then, could benefit employed workers looking to take the next step in their careers, as well as the recently unemployed hoping to regain a firm foothold in the job market.

Recent research has begun to utilize the expanding frontier of labor market data to capitalize on this broader view of occupational mobility. Grounded in both empirical evidence (Gathmann and

[3] A declining rate of mobility out of lower-wage employment should not be confused with a declining rate of occupational mobility. In fact, Jarvis and Song (2017) find that overall rates of occupational mobility have been rising since the early 1990s, a trend consistent with employment instability stemming from "technological changes, de-unionization, and precarious employment practices that are loosening the bonds between employers and employees" (p. 592). In other words, some of the same structural trends leading to greater occupational mobility may also make it more difficult to transition out of lower-wage employment.

[4] This position is borrowed from Lazear's (2009) "skill-weights view of human capital," which applies similar logic to firms rather than occupations. Lazear also extends this concept to occupations by noting that "one way to define an industry or occupation is such that all individuals in the industry or occupation have identical skill-weights" (p. 932).

Schönberg 2010; Alabdulkareem et al. 2018; Poletaev and Robinson 2008; Geel and Backes-Gellner 2011) and intuition, this mostly applied research posits that workers are more likely to transition between occupations requiring similar skills than they are to switch between those requiring dissimilar skills. Efforts to distill jobs into their essential skills largely rely on national labor market surveys, extensive databases of online job advertisements and resumes, or both. In some instances, this information is used to create clusters of similar occupations, among which workers should find their skills most transferable (AlphaBeta 2017; Henry-Nickie and Sun 2019). More frequently, researchers use required skills and other occupational characteristics to identify specific job pairs that exhibit a high degree of similarity (World Economic Forum 2018, 2019; Blair et al. 2020; MaRS Discovery District 2018; Hegewisch et al. 2016; Lund et al. 2019).[5]

In a 2018 paper, the World Economic Forum examined the similarity of occupations nationally, noting future research should "help address the needs of local markets and consider the impact of mobility within and between geographies" (p. 18). We build upon this emerging body of research by exploring skills-based occupational transitions at the local level, relying on employer-demanded skills in the largest metro areas in the U.S. We believe that conducting this analysis at the regional economy level rather than at the national level acknowledges that even for the same occupation, employer-demanded skills can vary across metro areas (Deming and Kahn 2018). Focusing on local labor markets also allows us to incorporate regional differences in the mix of employers and industries that can affect occupational mobility (Kalleberg and Mouw 2018).

Data and Methods

In this analysis, we primarily rely on data from five sources. First, we use online job advertisements collected by Burning Glass Technologies between 2014 and 2018 from over 40,000 online sources, such as job boards and corporate websites. The data set includes the metro area and standard occupational classification (SOC) code of jobs posted online as well as the skills and educational requirements indicated in postings. Second, we use the 2018 Occupational Employment Statistics (OES) data set from the Bureau of Labor Statistics (BLS) to gather information on local employment and wage levels within metro areas. Third, we supplement the first two local data sets with national figures from the BLS's 2018–2028 Employment Projections program. This data set provides us with occupation-level information on both projected employment growth and typical entry-level education and experience. Fourth, to further corroborate the information on education requirements contained in the Burning Glass and BLS data sets, we incorporate national estimates of the educational requirements of occupations using the Department of Labor/Employment & Training Administration's (DOL/ETA) Occupational Information Network (O*NET) program. Fifth, we use the Current Population Survey (CPS) to observe occupational transitions made by workers to ground this theoretical exercise.

We begin our analysis by classifying occupations into three categories based on pay, education, and experience: lower-wage occupations, opportunity occupations, and occupations requiring extensive experience or a bachelor's degree. These classifications are adapted from previous research on opportunity occupations by Fee, Wardrip, and Nelson (2019). For the occupations generally paid on an annual basis (e.g., teachers), we use the annual median wages provided in the OES data set; for the remainder, we multiply the OES's hourly median wage by an estimate for the number of hours worked per week obtained from the 2013–2017 American Community Survey (ACS) national five-year sample.[6] We compare each occupation's annual median wages to the national annual median wage ($38,640) adjusted for metropolitan differences in cost of living. Those with annual median wages below the adjusted national estimate are categorized as lower-wage occupations. Among higher-paying

[5] A report by the Indiana Department of Workforce Development and Indiana Business Research Center (2011) provides a hybrid example of the cluster and job-pairs approaches, in that it first develops "pathway clusters" of similar occupations and then estimates the time it would take for displaced workers in specific occupations to adequately upskill for a transition to a number of very similar occupations.

[6] When calculating annual pay from hourly median wages, we assume a 52-week work year.

occupations, those classified as requiring extensive experience or a bachelor's degree meet at least one of the following criteria: more than 80 percent of job ads request a bachelor's or advanced degree, more than 90 percent of O*NET respondents indicate the occupation requires a bachelor's or advanced degree, or the BLS indicates the occupation typically requires graduate-level education or five or more years of experience for entry. The remaining occupations, which we call opportunity occupations, pay above the national annual median wage (adjusted for local cost-of-living differences) and represent viable destinations for workers who may lack a bachelor's degree and extensive experience but nevertheless may have many of the skills that hiring managers and employers are seeking in viable job candidates.

We focus our analysis on the 33 metro areas with at least 1 million jobs. Within these 33 metro areas, we find that half of employment is in lower-wage occupations (50 percent), and the remaining jobs are about evenly split between opportunity occupations (27 percent) and occupations requiring extensive experience or a bachelor's degree (23 percent).[7] Total employment in these 33 metro areas comprises half (50 percent) of U.S. employment overall.

We use Burning Glass job ads data to identify occupations in the same metro area requiring similar skills.[8] Because hundreds of unique skills can be requested for a single occupation when all local job ads are considered, we limit our analysis to the 25 skills with the highest skill intensity for a given occupation in each metro area; the skill intensity is simply the number of ads requesting the skill divided by the total number of ads listing at least one skill.[9] The collection of top-25 skills and their skill intensities for each occupation in each metro area reflects that local occupation's skill portfolio. Using the skill intensities for each occupation's skill portfolio, we calculate a similarity score for each possible pair of occupations within a metro area.[10] The score ranges from 0 to 1, with a higher similarity score indicating that the skill portfolio for one occupation (the origin) aligns closely with the skill portfolio of a second occupation (the destination).

Because we are interested in identifying opportunities for upward mobility that do not require extensive experience or a bachelor's degree, we ignore occupations in this category and identify transitions between and among the other two categories that meet our requirements for potential transitions. Potential transitions are those that originate in a lower-wage or opportunity occupation and result in at least a 10 percent pay increase. Potential transitions are further limited to job pairs for which the destination represents a meaningful number of local jobs and involves an occupation that is expected to grow or decline by less than five percent nationally in the coming decade.[11] Finally, we define a top transition as a potential transition that has a similarity score greater than 0.75.[12] We base our use of a 0.75 threshold on a supplementary analysis of occupational transitions made by workers between 2014 and 2018 as recorded in the CPS; we find that the average number of workers switching between an origin and a destination occupation is more than four times greater for transitions with a similarity score above the 0.75 threshold than for transitions with lower scores. For more detailed information on the data and methods, see Appendix 1.

It is important to consider the limitations of our analysis. First, our calculation of occupational similarity scores assumes that a worker currently

[7] Opportunity employment represents a greater share of total employment than in Fee, Wardrip, and Nelson (2019) because we take a more inclusive approach in this report. While we use three different data sets to carefully exclude occupations that overwhelmingly require a bachelor's degree or extensive experience, our expanded definition allows additional occupations to be considered as destinations in our skills-based analysis of occupational mobility.

[8] We do not assess the similarities of occupations across metro areas and recognize this as an avenue for future research.

[9] The median skill intensity of the first skill (53 percent) is substantially higher than that of the 25th skill (8 percent).

[10] We use cosine similarity to calculate this similarity score. See Appendix 1 for more information.

[11] We require destinations to represent at least one job for every 10,000 in a metro area, which sets the floor at approximately 100 jobs for the smallest metro areas analyzed. Of over 800 occupations, roughly 80 are projected to decline by less than five percent nationally, according to the BLS. Because we conduct our analysis at the metro area level, we include these occupations because it is unclear that such a marginal decline nationally would result in noticeably fewer jobs locally.

[12] Although each project varies in the methodological specifics, analyses by the World Economic Forum (2018, 2019), Blair et al. (2020), MaRS Discovery District (2018), and Hegewisch et al. (2016) also consider some combination of wage gains, employment projections, and the level of education and experience required in the identification of occupations with similar skills.

employed in an occupation possesses all the skills requested in the job ads for that occupation (World Economic Forum 2018; MaRS Discovery District 2018).[13] Second, our focus on skills explicitly mentioned in job ads could overlook skills that are omitted from such postings because candidates are assumed to have them (Weise, Hanson, and Saleh 2019; World Economic Forum 2018; Burning Glass Technologies 2015). Third, our skill intensity measure indicates the demand for skills within an occupation but not the level of skill mastery required for the occupation. Using more structured, national data sets (e.g., O*NET) could address several of these limitations. For example, O*NET's characterization of skill "levels" indicates the depth of skill proficiency needed for the occupation. However, working with a national data set such as O*NET would preclude us from incorporating regional differences in skill demands that are critical to this analysis (Deming and Kahn 2018).[14]

Two Illustrative Examples

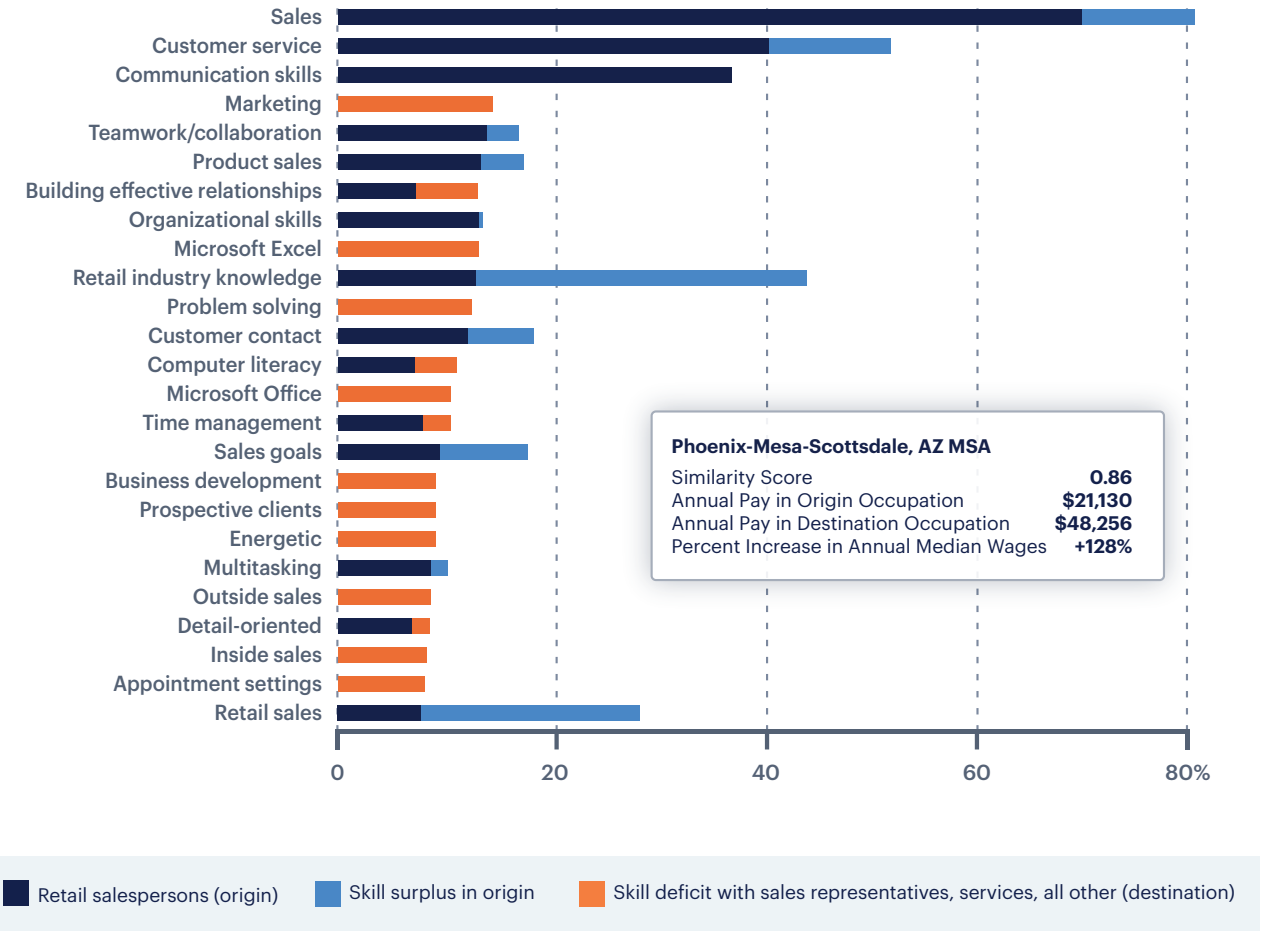
In this brief section, we illustrate our methodology by presenting two potential transitions with very different degrees of skills overlap. **Figure 1a**

[13] On the other hand, the skills captured in the job ads may not represent all the skills a worker may have developed from previous work, life, and volunteer experiences.

[14] In fact, a "Career Changers Matrix" is provided as part of the O*NET data offerings. For each occupation, it identifies related occupations based on skills and experience using national O*NET data. However, it does not consider local skill requirements, incorporate growth projections, or require a transition to result in higher wages for the typical worker as we do. More information is available in Allen et al. (2012) and at www.onetcenter.org/dictionary/24.2/excel/career_changers_matrix.html.

FIGURE 1A

Occupational Transition with a High Similarity Score



Sources: Authors' calculations using data from BLS Occupational Employment Statistics (May 2018), BLS Employment Projections (2018–2028), Burning Glass Technologies (2014–2018), USDOL/ETA O*NET 24.2 Database, BEA Regional Price Parities (2017), and American Community Survey Five-Year Public Use Microdata Sample (2013–2017)

compares the skill portfolios of two occupations — retail salespersons (the origin) and sales representatives, services, all other (the destination) — that have a high similarity score (0.86) in the Phoenix-Mesa-Scottsdale, AZ metro area. Skills in common (shown in dark blue) include sales, customer service, communication, teamwork/collaboration, product sales, and organization. For these shared skills, surpluses — or higher skill intensities for the origin than for the destination — such as for retail industry knowledge are indicated in light blue. Investments to overcome the modest skill deficits (shown in orange) — such as marketing, Microsoft Excel and Microsoft Office, and problem solving — could help to facilitate a transition that, on average, would represent a 128 percent increase in annual median wages. Because the similarity score exceeds 0.75, this example qualifies as a top transition in our analysis.

Conversely, there are occupations that have almost no top skills in common. For example, **Figure 1b** compares the skill portfolios of two occupations in the Dallas-Fort Worth-Arlington, TX metro area. Unsurprisingly, the similarity score of 0.26 indicates that, in this metro area, at least, there is relatively little overlap in the skill portfolios of fitness trainers (the origin) and paralegals (the destination). In fact, the two occupations have only seven of the top 25 skills in common, and these happen to be some of the most requested skills overall, as shown in

FIGURE 1B

Occupational Transition with a Low Similarity Score

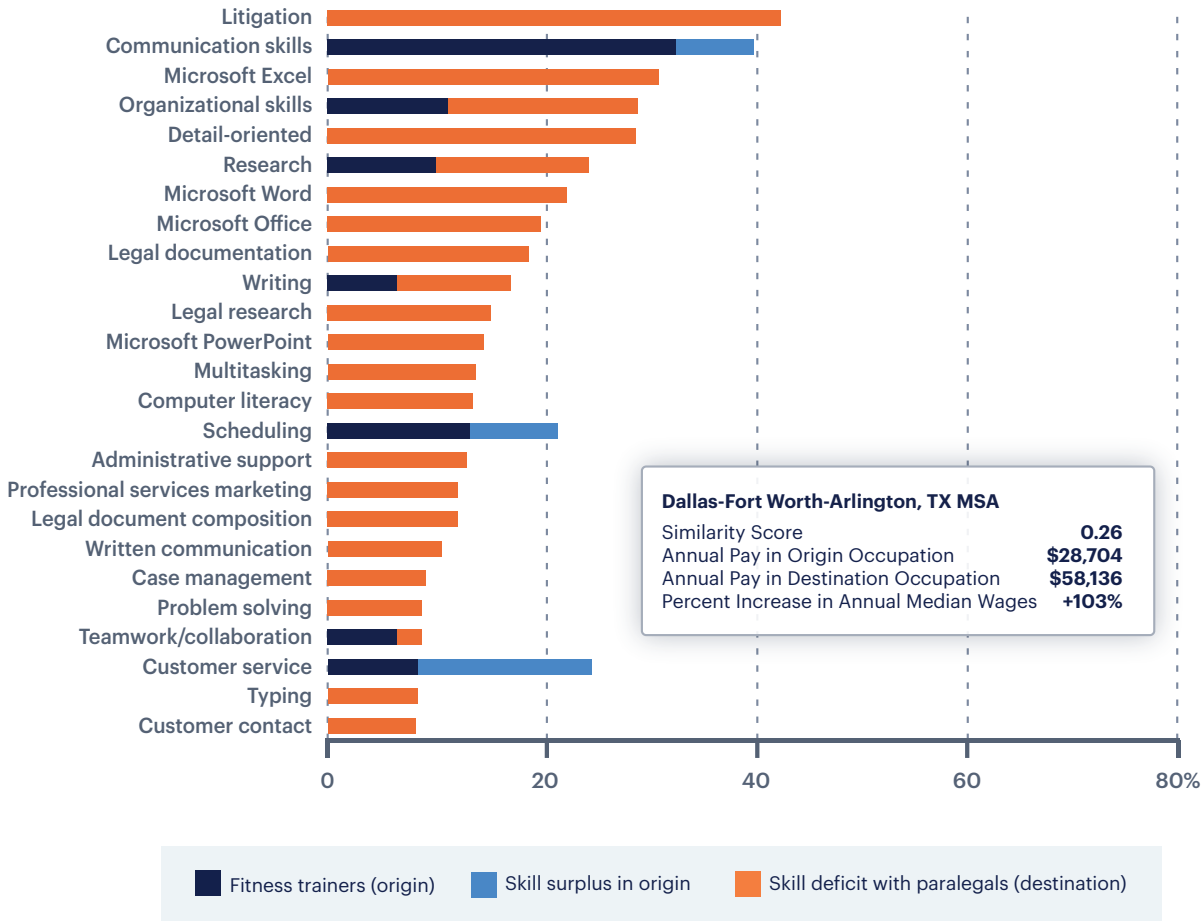


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Table 1. Despite these seven overlapping skills, it is clear that switching occupations from a fitness trainer to a paralegal would require a significant investment in developing skills to overcome the deficits.

Next, we explore the similarity of in-demand skills across the three broad categories of occupations described above and for some of the largest lower-wage and opportunity occupations. The remainder of the results section is dedicated to an analysis of the top transitions that — as illustrated in Figure 1a above — hint at the potential of skills-based occupational mobility in the largest labor markets in the U.S.

Results

How Does the Demand for Skills Vary by Occupational Education Requirements and Pay?

In this section, we take a two-pronged approach to evaluating whether the skills employers seek vary by occupational education requirements and pay. First, we analyze skill requirements for three broad categories of occupations, and then we report results for specific pairs of occupations. Regarding the former, we find that employers are seeking noticeably similar skills across our three occupational categories. **Table 1** ranks the 25 most requested skills nationally and within each respective occupational category. Some of the skills ranked highest overall (e.g., communication, organization, and teamwork/collaboration) also have high rankings in each of the occupational categories. Other high-ranking skills suggest similarity across two categories but divergence from the third. For example, customer service is ranked second for lower-wage occupations and third for opportunity occupations, but only 18th for occupations requiring extensive experience or a bachelor's degree. Microsoft Excel is highly ranked for the higher-wage occupational categories but not for lower-wage occupations.

Table 1 also offers evidence of a continuum across the three occupational categories. For example, planning goes from the 36th most requested skill in lower-wage occupations to the 14th for opportunity occupations and the fourth for occupations requiring extensive experience or a bachelor's degree; cleaning goes in the opposite direction, ranking much higher for lower-wage occupations (fifth) than for opportunity occupations (54th) and for occupations requiring extensive experience or a bachelor's degree (232nd). The notion of a continuum is reinforced by the correlations between the groups' rankings: The rankings for opportunity occupations are nearly equally correlated with those for lower-wage employment (0.698) and for occupations requiring extensive experience or a bachelor's degree (0.644), but these last two groups are not as strongly correlated with one another (0.542). Overall, Table 1 suggests that transitions across occupational groupings could be quite feasible, given the similarity of skills across occupational categories.

In **Table 2**, we assess the similarity of skills requested for specific lower-wage and opportunity occupations to identify potential transitions within and between these occupational categories. Because we are interested in transitions that appear feasible without extensive experience or a bachelor's degree, the following analyses ignore occupations that fall in this third category.

Table 2 presents the average similarity scores between the 10 largest lower-wage occupations and the 10 largest opportunity occupations across the 33 metro areas analyzed. Unlike the story of broad similarities told in Table 1, the relatively low similarity scores in Table 2 indicate that there is little skills overlap among the vast majority of these specific occupations. In fact, only one average similarity score, from retail salespersons to sales representatives, services, all other, meets our 0.75 threshold for top transitions (shaded dark orange in the table). Other lower-wage occupations, such as customer service representatives and office clerks, general, also have somewhat similar skill portfolios with opportunity occupations in sales and administrative work (shaded light orange). Conversely, personal care aides and janitors and cleaners have little in common with any of the largest opportunity occupations. Table 2 also suggests that significant reskilling would be required to transition workers from the largest lower-wage occupations into some of the largest

TABLE 1

Top-25 Skills Overall and Ranked Within Occupational Categories

		RANK			
Skill	**Overall intensity**	**Overall**	**Lower-wage occupations**	**Opportunity occupations**	**Extensive experience or bachelor's degree required**
Communication skills	26.9%	1	1	1	1
Customer service	17.7%	2	2	3	18
Physical abilities	14.3%	3	3	8	23
Organizational skills	13.1%	4	4	4	10
Teamwork/collaboration	11.8%	5	9	10	3
Scheduling	10.9%	6	7	6	12
Detail-oriented	10.2%	7	8	13	15
Sales	9.9%	8	6	9	27
Microsoft Excel	9.4%	9	16	5	6
Computer literacy	9.3%	10	11	7	19
Problem solving	8.8%	11	18	11	7
Writing	8.7%	12	14	15	8
Repair	8.4%	13	13	2	55
English	8.0%	14	10	21	21
Microsoft Office	7.7%	15	23	12	11
Planning	7.7%	16	36	14	4
Cleaning	7.0%	17	5	54	232
Building effective relationships	6.7%	18	19	17	16
Teaching	6.4%	19	30	64	2
Research	6.1%	20	47	19	5
Customer contact	6.1%	21	15	23	35
Multitasking	6.0%	22	17	22	26
Written communication	6.0%	23	28	18	17
Retail industry knowledge	5.9%	24	12	28	61
Budgeting	5.5%	25	62	20	9

Note: Skill intensities and ranks reflect national data rather than data for the 33 metro areas analyzed because, depending on local educational requirements and wage levels, the same occupation can fall into different categories from one metro area to another. Ranks ≤10 are shaded dark orange and ranks >30 are shaded light orange. Excludes occupations with fewer than 250 ads. Occupation-level skill intensities are aggregated to their respective category, weighting by the occupation's national employment.

Sources: Authors' calculations using data from BLS Occupational Employment Statistics (May 2018), BLS Employment Projections (2018–2028), Burning Glass Technologies (2014–2018), USDOL/ETA O*NET 24.2 Database, BEA Regional Price Parities (2017), and American Community Survey Five-Year Public Use Microdata Sample (2013–2017)

TABLE 2

Average Similarity Scores of Potential Transitions from the Largest Lower-Wage Occupations (in Rows) to the Largest Opportunity Occupations (in Columns)

	Registered nurses	Heavy and tractor-trailer truck drivers	Bookkeeping, accounting, and auditing clerks	First-line supervisors of office and administrative support workers
Retail salespersons	0.13	0.17	0.16	0.42
Combined food preparation and serving workers, including fast food	0.16	0.20	0.18	0.46
Cashiers	0.10	0.23	0.20	0.47
Office clerks, general	0.18	0.13	0.52	0.69
Laborers and freight, stock, and material movers, hand	0.14	0.27	0.18	0.30
Customer service representatives	0.17	0.22	0.38	0.74
Waiters and waitresses	0.21	0.22	0.22	0.43
Personal care aides	0.12	0.06	0.06	0.15
Secretaries and administrative assistants, except legal, medical, and executive	0.15	0.09	0.43	0.57
Janitors and cleaners, except maids and housekeeping cleaners	0.09	0.16	0.11	0.22

Note: Unrounded similarity scores higher than 0.50 but lower than or equal to 0.75 are shaded light orange; scores above 0.75 are shaded dark orange. Average similarity scores are weighted by the employment of the lower-wage occupations.

TABLE 2 *(continued)*

Average Similarity Scores of Potential Transitions from the Largest Lower-Wage Occupations (in Rows) to the Largest Opportunity Occupations (in Columns)

Sales representatives, wholesale and manufacturing, except technical and scientific products	First-line supervisors of retail sales workers	Business operations specialists, all other	Sales representatives, services, all other	Carpenters	Licensed practical and licensed vocational nurses
0.75	0.74	0.40	0.83	0.08	0.14
0.37	0.43	0.39	0.43	0.10	0.19
0.49	0.54	0.40	0.59	0.14	0.13
0.38	0.35	0.61	0.39	0.08	0.20
0.20	0.28	0.28	0.22	0.16	0.18
0.56	0.54	0.59	0.67	0.13	0.20
0.36	0.37	0.40	0.38	0.10	0.24
0.10	0.12	0.14	0.10	0.03	0.22
0.30	0.28	0.55	0.31	0.05	0.16
0.14	0.19	0.20	0.15	0.13	0.13

Sources: Authors' calculations using data from BLS Occupational Employment Statistics (May 2018), BLS Employment Projections (2018–2028), Burning Glass Technologies (2014–2018), USDOL/ETA O*NET 24.2 Database, BEA Regional Price Parities (2017), and American Community Survey Five-Year Public Use Microdata Sample (2013–2017)

opportunity occupations, such as registered nurses, heavy and tractor-trailer truck drivers, carpenters, and licensed practical and licensed vocational nurses.

What Are the Characteristics of Transitions Between the Most Similar Origin and Destination Occupations?

As the prior section makes perfectly clear, some occupations require very similar skill portfolios, while others share little in common. In this section and in the remainder of this report, we focus our analysis on top transitions, or those with a similarity score greater than 0.75. Of the nearly 685,000 potential transitions evaluated in this analysis, only 4,097 (0.6 percent) meet this high threshold. This number represents 880 unique origin and destination pairs across the 33 metro areas analyzed, suggesting that each pair represents a top transition in an average of roughly five metro areas. In fact, the majority are found in only one or two metro areas, but almost 50 are identified as top transitions in 20 metro areas or more.

By focusing on top transitions, we are neither implying that lower-scoring transitions are impossible to make nor suggesting that the full slate of top transitions represents likely opportunities for occupational mobility. In fact, our analysis of worker mobility recorded in the CPS suggests that most (60.7 percent) of the 880 unique top transitions identified in this analysis have been made by workers in recent years (**Table 3**) — much more than is the case for other unique potential transitions observed during the same period (31.8 percent). We draw the same conclusion when we compare actual worker mobility for all of the top and other potential transitions (which include those found in multiple metro areas).

As noted above and consistent with prior research (Macaluso 2019), we interpret these results as illustrative of a strong relationship between skill-based similarity scores and the observed occupational mobility of workers. Many of the top transitions we identify have been made by workers

TABLE 3
Share of Transitions Made by Workers (2014–2018)

	TOP TRANSITIONS (Similarity Score >0.75)		OTHER POTENTIAL TRANSITIONS (Similarity Score ≤0.75)	
	Number	Percent	Number	Percent
Unique	880	60.7%	70,731	31.8%
All	4,097	75.6%	680,617	42.0%

Note: In some cases, our analysis identifies potential transitions involving occupations with the same CPS occupational codes, despite having different finer-grained SOC codes. We do not count these as observed transitions in this table.

Sources: Authors' calculations using data from Current Population Survey (2014–2018 monthly sample), BLS Occupational Employment Statistics (May 2018), BLS Employment Projections (2018–2028), Burning Glass Technologies (2014–2018), USDOL/ETA O*NET 24.2 Database, BEA Regional Price Parities (2017), and American Community Survey Five-Year Public Use Microdata Sample (2013–2017)

in recent years, and this is particularly true for some of the most prevalent top transitions. Importantly, though, our analysis also suggests that there may be additional opportunities for occupational mobility that are not realized in the labor market. We offer some explanations and ideas for better realizing the potential of skills-based occupational mobility in the concluding section of this report.

For the 33 metro areas analyzed in this report, we find that nearly half (49 percent) of lower-wage employment is associated with at least one top transition (**Figure 3**). One-half of this 49 percent (one-quarter of all lower-wage employment) has a top transition only to another lower-wage occupation, albeit one with a meaningfully higher annual median wage. The remainder have at least one top transition with an opportunity occupation, suggesting the potential for an even greater wage increase. Just over half (51 percent) of lower-wage employment in these metro areas is associated with no top transition. Across the 33 metro areas, five occupations — janitors and cleaners; personal care aides; waiters and waitresses; cooks, restaurant; and nursing assistants — account for roughly one-quarter of all lower-wage employment with no top transition.[15]

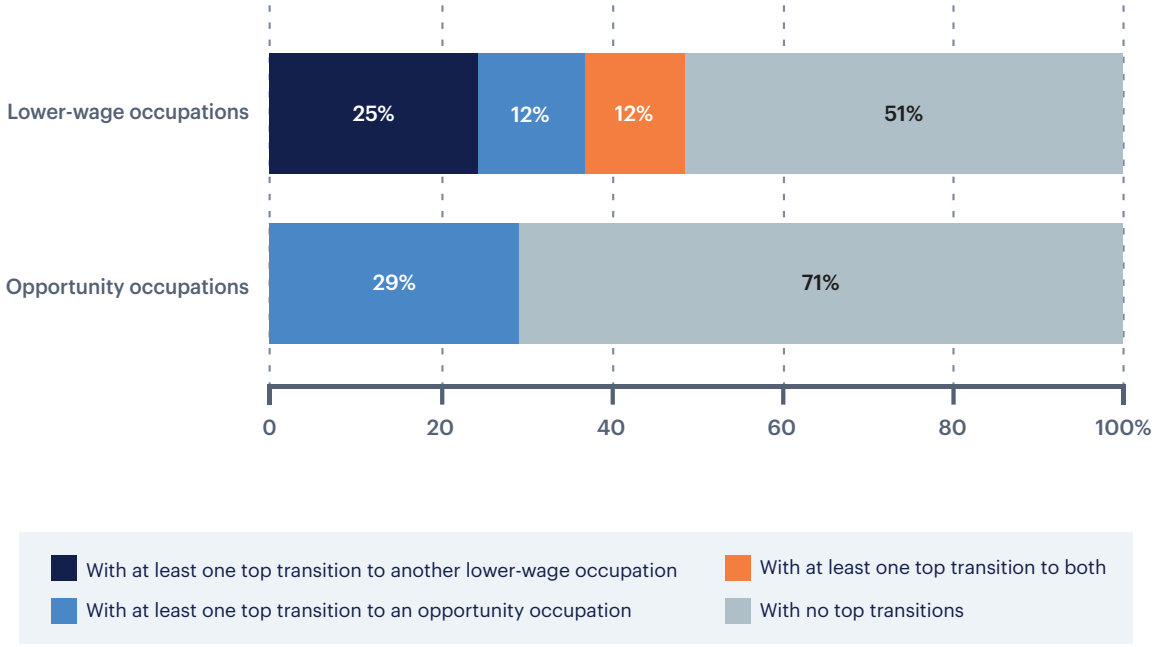
As Figure 3 indicates, even 29 percent of the jobs classified as opportunity occupations share a similar skill portfolio with another, even higher-paying occupation that does not typically require a bachelor's degree. In other words, even occupations already paying above the national annual median wage (adjusted for local cost-of-living differences) can serve as the origin for other opportunity occupations paying even higher wages.[16]

See Appendix 2 for summary statistics for each of the 33 metro areas analyzed in this report.

[15] While each of these five occupations has a top transition in at least one metro area, each occupation accounts for a substantial share of employment with no top transition across all 33 metro areas.

[16] For the highest-paying opportunity occupations in each metro area, a top transition is a mathematical impossibility because no other occupation not requiring a bachelor's degree would allow for a 10 percent increase in annual median wages.

FIGURE 3
Share of Employment by Type of Top Transition



Sources: Authors' calculations using data from BLS Occupational Employment Statistics (May 2018), BLS Employment Projections (2018–2028), Burning Glass Technologies (2014–2018), USDOL/ETA O*NET 24.2 Database, BEA Regional Price Parities (2017), and American Community Survey Five-Year Public Use Microdata Sample (2013–2017)

Figures 4a and **4b** shed additional light on the nature of these top transitions by exploring the typical entry-level education associated with the destination, as reported by the BLS, and whether the transition involves an origin and a destination in the same major occupational group.[17] As Figure 4a illustrates, the vast majority of transitions out of lower-wage occupations involve destinations that typically require no formal education or only a high school diploma. Although rare, there are instances in which a skills-based approach would suggest transitions between lower-wage occupations and occupations that typically require an associate's degree (8 percent) or bachelor's degree (7 percent) for entry.

The top transitions associated with opportunity occupations are more varied. Roughly 42 percent of top transitions out of an opportunity occupation origin are to a destination that typically requires a high school diploma, while the balance involve a destination requiring some level of postsecondary education. This includes the one-third of opportunity occupation employment associated with a top transition involving a destination that, according to the BLS, typically requires a bachelor's degree for entry. Our analysis classifies these destinations as opportunity occupations because at least 20 percent of the job openings are available to someone without a four-year degree, but the BLS's suggestion that a bachelor's degree is required perfectly illustrates how assessing occupational mobility using skills highlights transitions hidden by a reliance on educational credentials alone.

Figure 4b provides further evidence that a skills-based approach to occupational mobility identifies transitions that may not be readily apparent in the labor market. On an employment-weighted basis, we find that a substantial share of top transitions connects lower-wage (30 percent) and opportunity occupation (42 percent) origins to destinations in different major occupational groups. Some of these transitions connect lower-level positions with managerial roles in the same field (e.g., sales representatives and sales managers). When excluding transitions from non-managerial to managerial destinations, which the BLS classifies together in the same broad group, we find that 30 percent of top transitions from both lower-wage and opportunity occupations are to destinations in a different major occupational group. These findings suggest that occupations that may appear fairly dissimilar on the surface share commonalities in the skills they require.[18] Our analysis of worker mobility in the CPS provides some support for workers making top transitions outside their major occupational group, but they are less common, suggesting that a skills-based approach could be used to identify less obvious occupational transitions and, therefore, be viewed as a complement to the linear "career pathways" model that focuses on advancement within more narrowly defined fields.[19]

[17] The 23 major groups of occupations in the 2010 Standard Occupational Classification (SOC) system represent categories of broadly similar detailed occupations. More information is available at www.bls.gov/soc/2010/home.htm.

[18] This finding is not unique to our analysis, as Blair et al. (2020) and World Economic Forum (2018) also find skill similarities for occupations in different major occupational groups.

[19] Passed into law in 2014, the federal Workforce Innovation and Opportunity Act defines a career pathway as a combination of education, skills training, and supports for entering or advancing "within a specific occupation or occupational cluster." The full text is available at www.congress.gov/bill/113th-congress/house-bill/803.text.

FIGURE 4A

Share of Top Transitions by Bureau of Labor Statistics Entry-Level Education of the Destination

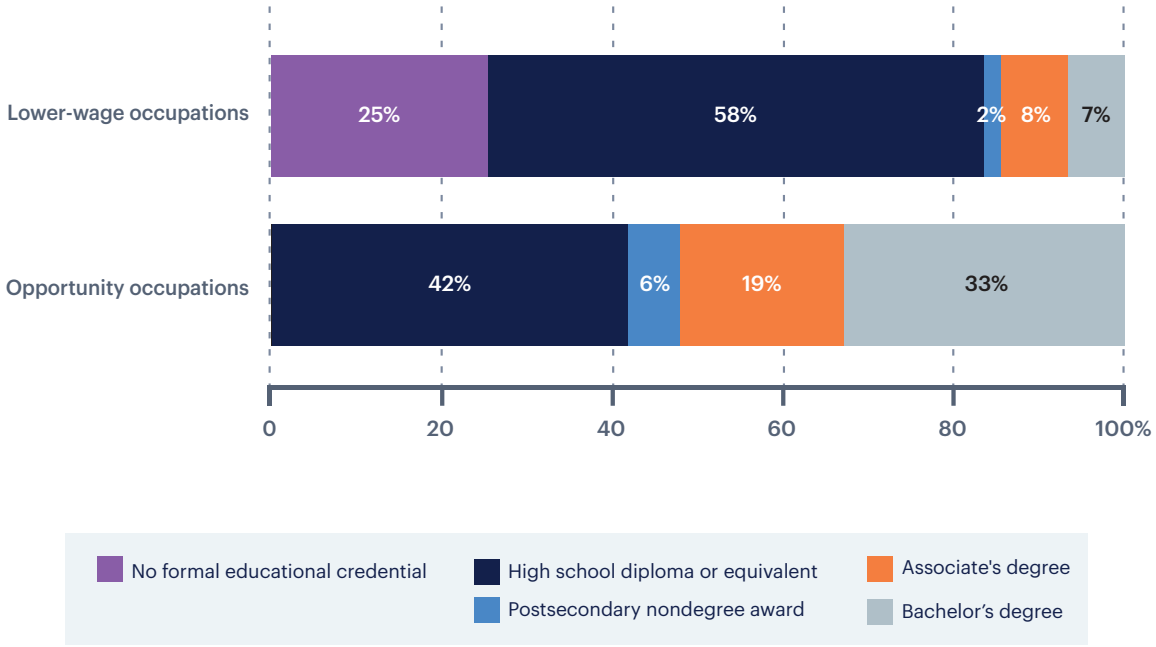
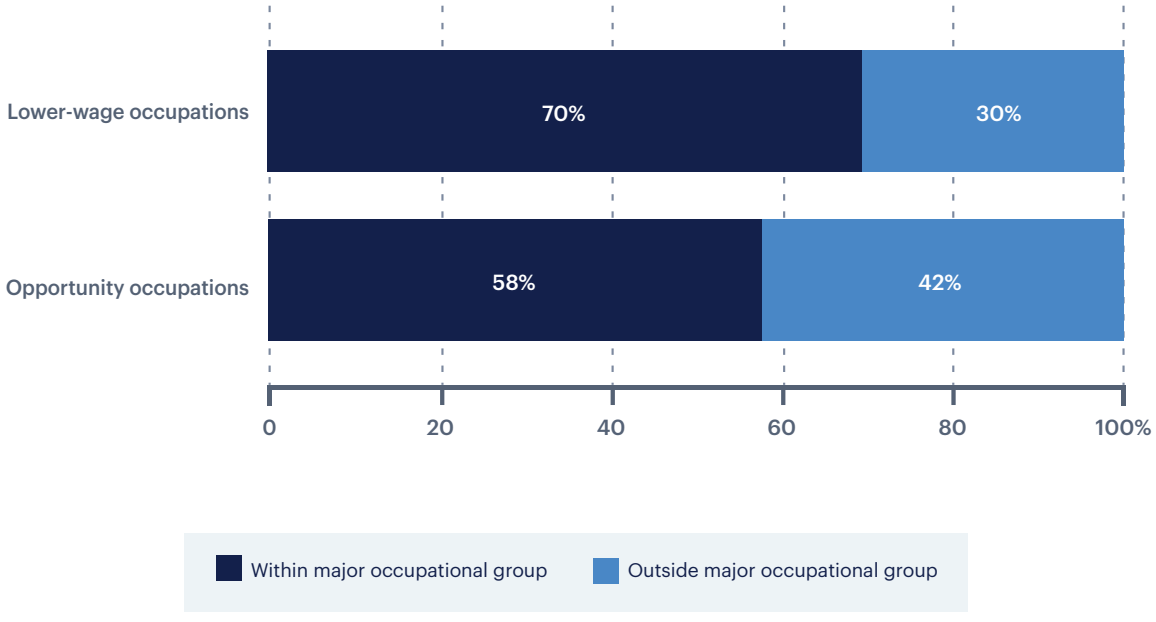


FIGURE 4B

Share of Top Transitions by Major Occupational Group



Note: Top transitions are weighted by the employment of the origin occupation.

Sources: Authors' calculations using data from BLS Occupational Employment Statistics (May 2018), BLS Employment Projections (2018–2028), Burning Glass Technologies (2014–2018), USDOL/ETA O*NET 24.2 Database, BEA Regional Price Parities (2017), and American Community Survey Five-Year Public Use Microdata Sample (2013–2017)

As **Table 4** indicates, the average increase in annual median wages is substantial for each transition type and is roughly $15,000 for all top transitions combined, representing an increase of 49 percent. While top transitions between lower-wage occupations represent a more modest increase of just under $7,000 (32 percent), increases are larger for the other two transition types — notably so for those connecting lower-wage and opportunity occupations (78 percent). Because they require the destination occupation's pay to exceed the national annual median wage adjusted for local cost-of-living differences, these top transitions offer the greatest potential to facilitate meaningful economic mobility for lower-wage workers.

Although the skill portfolio of a given occupation varies across metro areas, our analysis does identify some occupational transitions with consistently high similarity scores. **Table 5** lists the five most common for each type of transition. Note the importance of sales in the most common top transitions between lower-wage and opportunity occupations. Each of the five involves a transition from one sales occupation to another. The most common top transitions between lower-wage occupations are more varied, as are the most common transitions between opportunity occupations.

Highlighting the opportunities for mobility that can emerge when occupations are distilled down to their most essential skills, Table 5 also clearly illustrates that an occupation can play the role of both an origin and a destination in a given labor market. For example, three different lower-wage occupations routinely share similar skill portfolios with sales representatives, services, all other, which itself is an opportunity occupation that serves as an origin to the higher-paying first-line supervisors of non-retail sales workers.

TABLE 4

Wage Increases for Top Transitions

	AVERAGE ANNUAL MEDIAN WAGES			
Type of transition	**Origin occupations**	**Destination occupations**	**Increase**	**Percent increase**
Lower-wage occupation to lower-wage occupation	$21,508	$28,367	$6,859	32%
Lower-wage occupation to opportunity occupation	$28,547	$50,672	$22,125	78%
Opportunity occupation to opportunity occupation	$53,426	$76,128	$22,703	42%
Overall	**$30,100**	**$44,974**	**$14,873**	**49%**

Note: Where a single origin occupation is associated with more than one destination occupation, the average annual median wages of the transitions from the origin occupation are weighted by the employment of the destination occupations. Average annual median wages reported overall and for each type of transition are weighted by the employment of the origin occupations and adjusted for cost-of-living differences. The differences in average annual median wages are calculated on unrounded values.

Sources: Authors' calculations using data from BLS Occupational Employment Statistics (May 2018), BLS Employment Projections (2018–2028), Burning Glass Technologies (2014–2018), USDOL/ETA O*NET 24.2 Database, BEA Regional Price Parities (2017), and American Community Survey Five-Year Public Use Microdata Sample (2013–2017)

TABLE 5

Most Common Top Transitions Across Metro Areas by Type

Type of transition	Origin occupation	Destination occupation
Lower-wage occupation to lower-wage occupation	Retail salespersons	Counter and rental clerks
	Dining room and cafeteria attendants and bartender helpers	Dishwashers
	Locker room, coatroom, and dressing room attendants	Janitors and cleaners, except maids and housekeeping cleaners
	Hosts and hostesses, restaurant, lounge, and coffee shop	Waiters and waitresses
	Dining room and cafeteria attendants and bartender helpers	Waiters and waitresses
Lower-wage occupation to opportunity occupation	Retail salespersons	First-line supervisors of non-retail sales workers
	Retail salespersons	Sales representatives, services, all other
	Counter and rental clerks	Sales representatives, services, all other
	Sales and related workers, all other	Sales representatives, services, all other
	Sales and related workers, all other	Sales representatives, wholesale and manufacturing, except technical and scientific products
Opportunity occupation to opportunity occupation	First-line supervisors of office and administrative support workers	Administrative services managers
	Computer user support specialists	Computer network support specialists
	Sales representatives, services, all other	First-line supervisors of non-retail sales workers
	Sales representatives, wholesale and manufacturing, except technical and scientific products	First-line supervisors of non-retail sales workers
	Credit counselors	First-line supervisors of office and administrative support workers

Note: Each of these transitions is classified as a top transition in at least 22 of the 33 metro areas analyzed.

Sources: Authors' calculations using data from BLS Occupational Employment Statistics (May 2018), BLS Employment Projections (2018–2028), Burning Glass Technologies (2014–2018), USDOL/ETA O*NET 24.2 Database, BEA Regional Price Parities (2017), and American Community Survey Five-Year Public Use Microdata Sample (2013–2017)

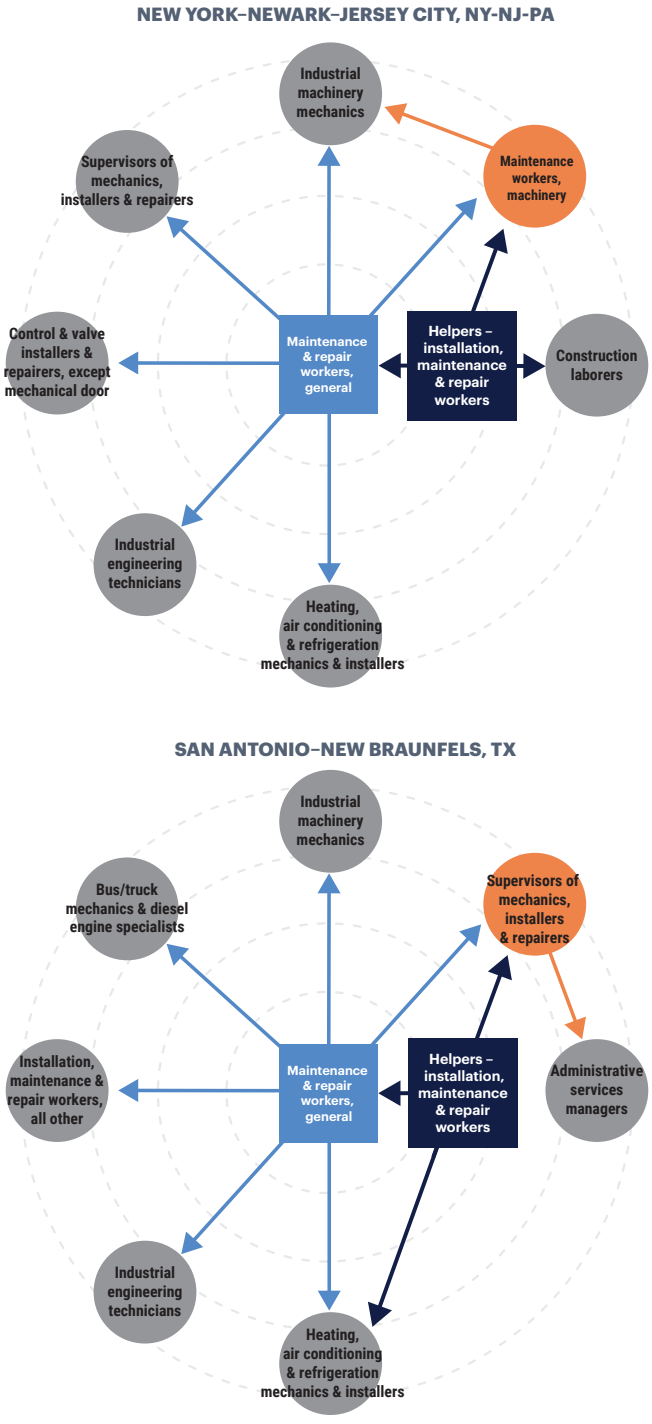
Figure 5 further explores these interconnections by focusing on a specific occupation in two labor markets: helpers – installation, maintenance, and repair workers in the New York and San Antonio metro areas. Three key points can be drawn from this example. First, a single occupation can be associated with multiple top transitions. In both metro areas, helpers – installation, maintenance, and repair workers have direct top transitions to one other lower-wage occupation and two opportunity occupations. The second point is that while there are some destinations in common across these two metro areas (e.g., industrial machinery mechanics), there is also regional variation (e.g., construction laborers in New York and bus and truck mechanics and diesel engine specialists in San Antonio). Last, in both metro areas, the top transition to maintenance and repair workers, general creates a bridge to a number of opportunity occupations that are not directly connected to helpers – installation, maintenance, and repair workers. The first transition to a better-paying occupation could open the door to additional career opportunities in the future.

Which Occupations and Metro Areas Provide Lower-Wage Workers with the Greatest Potential for Occupational Mobility?

Up to this point, we have largely focused on the occupations involved in top transitions and the skills requested by these occupations. However, as discussed in the previous section, the top transitions available to a lower-wage worker in one metro area may not be the same in another. In this section, we assess which occupations and which metro areas provide lower-wage workers the greatest potential for occupational mobility.

FIGURE 5

A Network of Top Transitions for Helpers – Installation, Maintenance, and Repair Workers in the New York and San Antonio Metro Areas



Note: Only direct and secondary top transitions from helpers – installation, maintenance, and repair workers are depicted.

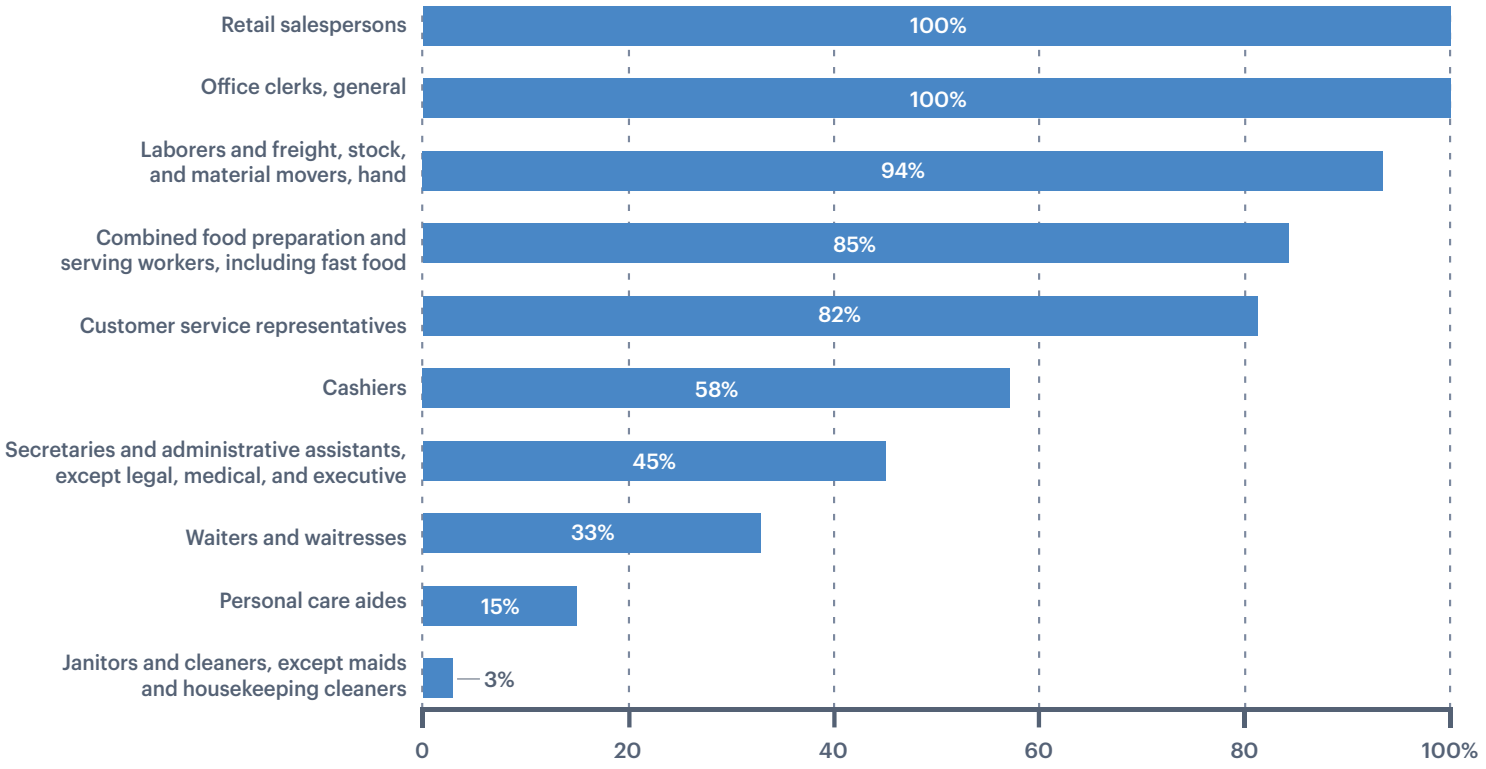
Sources: Authors' calculations using data from BLS Occupational Employment Statistics (May 2018), BLS Employment Projections (2018–2028), Burning Glass Technologies (2014–2018), USDOL/ETA O*NET 24.2 Database, BEA Regional Price Parities (2017), and American Community Survey Five-Year Public Use Microdata Sample (2013–2017)

Overall, the opportunity to transition to a higher-paying occupation requiring similar skills is more widely available for some occupations than others. **Figure 6** shows the share of metro areas in our study with at least one top transition from each of the 10 largest lower-wage occupations. A top transition exists for both retail salespersons and office clerks, general in all of the metro areas in our study. The same is true in the vast majority of these metro areas for several other occupations. For some, though, top transitions are not as abundant. For example, a top transition exists in just a handful of metro areas for personal care aides (15 percent) and in only one for janitors and cleaners (3 percent), suggesting that the skills gained through employment in some lower-wage occupations may not be as transferable as the skills gained in others.

Another metric for measuring the potential of occupational mobility is the average pay increase

FIGURE 6

Share of Metro Areas with a Top Transition Out of Lower-Wage Occupations



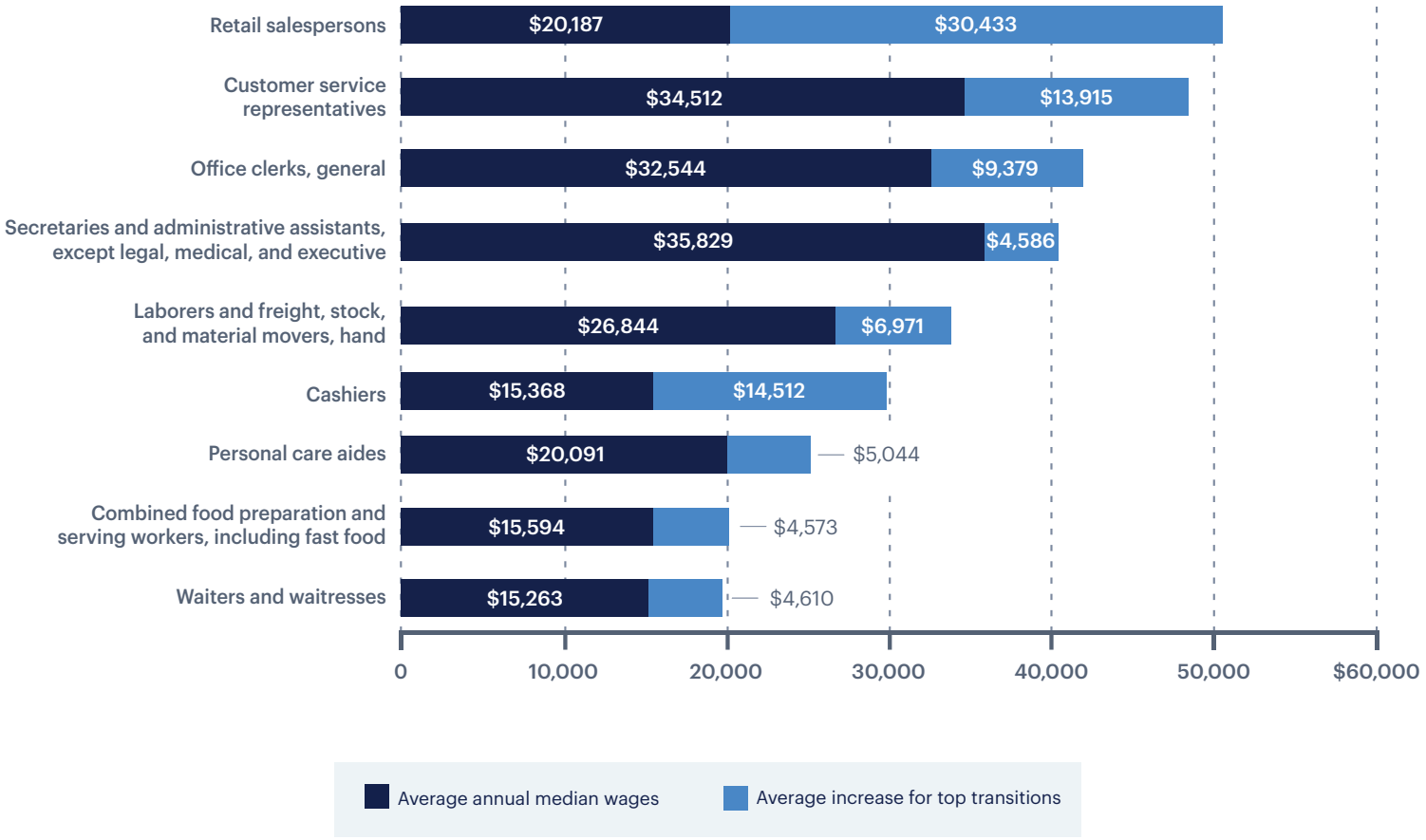
Sources: Authors' calculations using data from BLS Occupational Employment Statistics (May 2018), BLS Employment Projections (2018–2028), Burning Glass Technologies (2014–2018), USDOL/ETA O*NET 24.2 Database, BEA Regional Price Parities (2017), and American Community Survey Five-Year Public Use Microdata Sample (2013–2017)

for all top transitions from an occupation. **Figure 7** presents the average annual median wages of the largest lower-wage occupations in the metro areas analyzed and the average increase in annual median wages for all top transitions from these lower-wage occupations. The increase for top transitions from retail salespersons is so substantial that it more than doubles the original annual median wages from $20,187 to over $50,000, on average. Similarly, top transitions from work as a cashier result in annual wages that are nearly double the starting wage, from $15,368 to almost $30,000, on average. The increase is smaller for other occupations but still potentially meaningful, such as for secretaries and administrative assistants (13 percent) and personal care aides (25 percent).

The preceding figures illustrate two different but equally important components of occupational mobility: the prevalence of top transitions and the average increase in wages associated with those

FIGURE 7

Average Annual Median Wages for Top Transitions Out of Lower-Wage Occupations



Note: Where a single origin occupation is associated with more than one destination occupation, the average annual median wages of the transitions from the origin occupation are weighted by the employment of the destination occupations. Average annual median wages reported for these nine occupations are weighted by the employment in each metro area and adjusted for cost-of-living differences. We exclude janitors and cleaners because we identify only one top transition for this occupation in the metro areas analyzed.

Sources: Authors' calculations using data from BLS Occupational Employment Statistics (May 2018), BLS Employment Projections (2018–2028), Burning Glass Technologies (2014–2018), USDOL/ETA O*NET 24.2 Database, BEA Regional Price Parities (2017), and American Community Survey Five-Year Public Use Microdata Sample (2013–2017)

top transitions. **Figure 8** compares these two factors for the 33 metro areas analyzed. With the exception of a handful of metro areas, a top transition out of lower-wage employment is available for between 40 percent and 60 percent of lower-wage jobs, suggesting fairly minimal variation around the overall level of 49 percent reported in Figure 3.[20] The financial reward for making a top transition is greatest in metro areas such as New York, Kansas City, and Cleveland, where the increase in annual median wages is greater than $15,000, on average — much higher than in Riverside, CA, where it is closer to $10,000.

[20] Relative to their larger counterparts, smaller metro areas have fewer occupations with sufficient data to include in this analysis. This circumstance can reduce the number of destination occupations and thus lower the share of lower-wage employment associated with a top transition. For example, a comparison of the results for St. Louis and Minneapolis, outliers in Figure 8, suggest that their varying levels of lower-wage employment associated with a top transition are primarily explained by the similarity scores and wages of the occupations included in the analysis; however, some of the destinations in the Minneapolis metro area are excluded from St. Louis because of an insufficient number of job advertisements.

Some metro areas perform well on both metrics. In Charlotte, NC and Denver, a top transition is possible from more than half of lower-wage employment, and the average increase in annual median wages associated with a top transition exceeds $14,000.

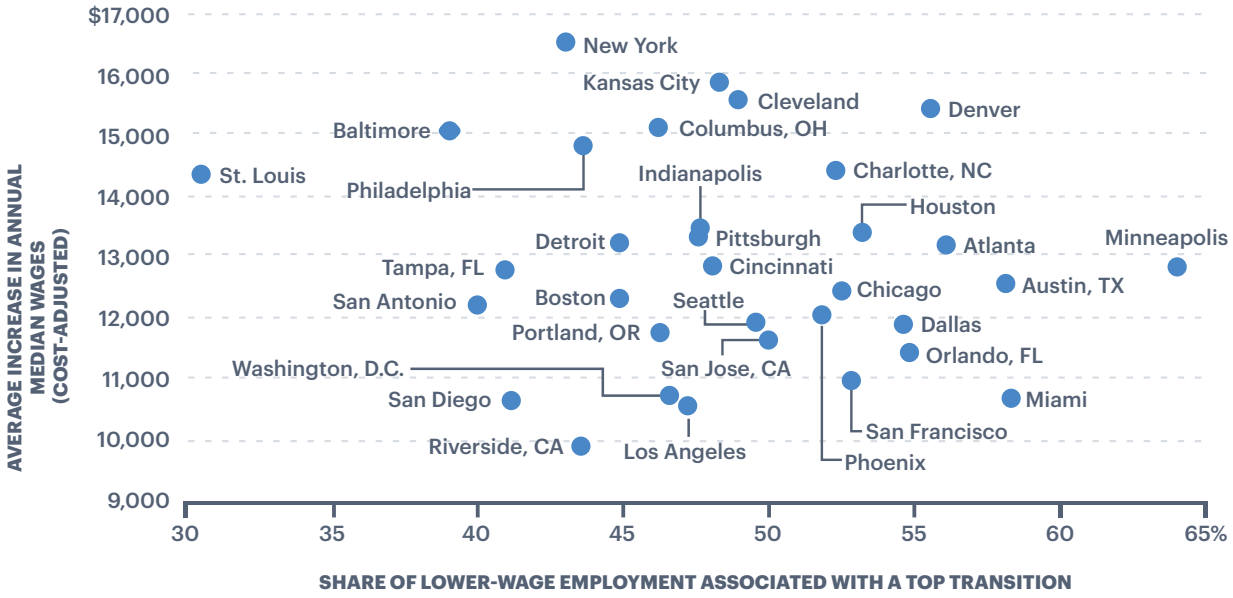
Which Skills Constitute the Skills Gap for Transitions Out of Lower-Wage Work?

The preceding analysis focuses on top transitions because, from the perspective of employer-required skills, they represent the most likely opportunities for mobility into better-paying occupations. Top transitions consist of pairs of occupations with very similar — but admittedly not identical — skill portfolios. The space between similar and identical can be explored to shed some light on the skills gap.

For the nearly 1,200 top transitions between lower-wage occupations (**Figure 9a**) and the more than 1,300 top transitions between lower-wage and opportunity occupations (**Figure 9b**), we identify

FIGURE 8

Lower-Wage Employment with a Top Transition and Average Increase in Annual Median Wages from Top Transitions by Metro Area



Note: Where a single origin occupation is associated with more than one destination occupation, the average annual median wages of the transitions from the origin occupation are weighted by the employment of the destination occupations. The average increase in annual median wages is weighted by the employment of the origin occupations in each metro area and adjusted for cost-of-living differences.

Sources: Authors' calculations using data from BLS Occupational Employment Statistics (May 2018), BLS Employment Projections (2018–2028), Burning Glass Technologies (2014–2018), USDOL/ETA O*NET 24.2 Database, BEA Regional Price Parities (2017), and American Community Survey Five-Year Public Use Microdata Sample (2013–2017)

FIGURE 9A

Skills Gaps for Top Transitions Between Lower-Wage Occupations

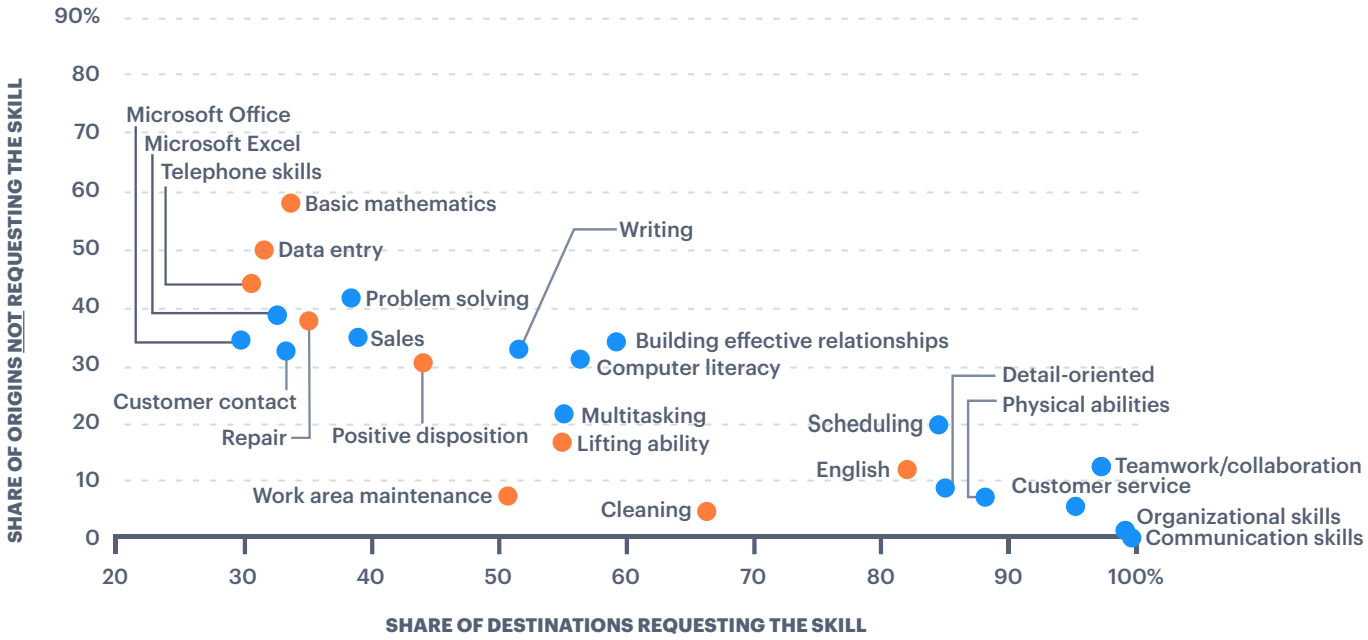
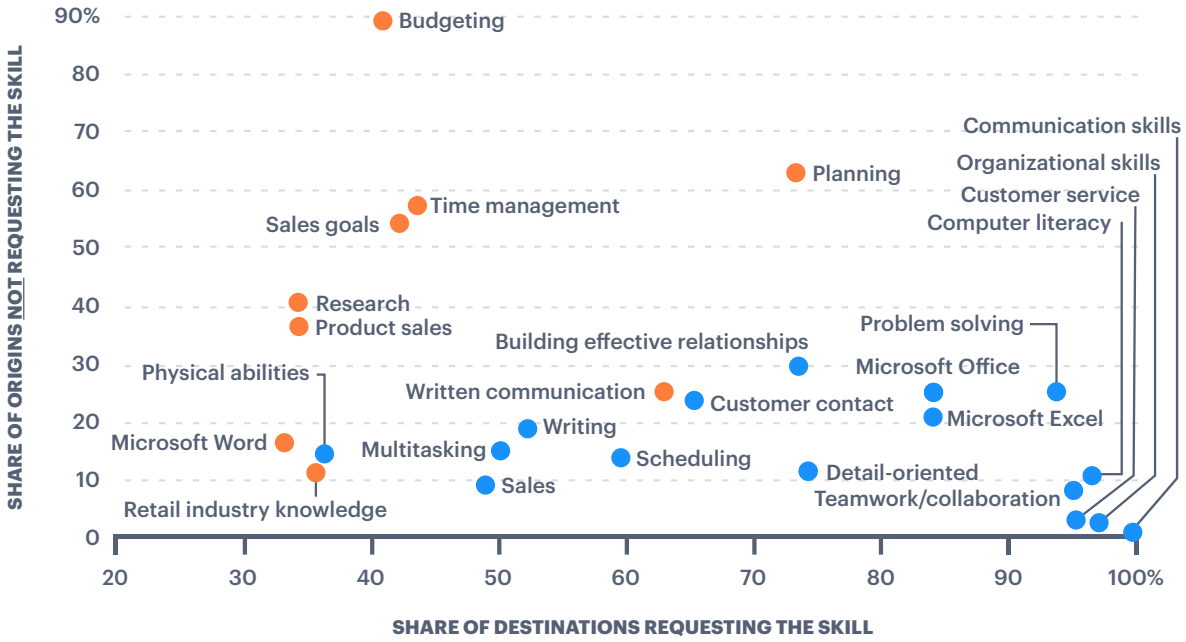


FIGURE 9B

Skills Gaps for Top Transitions from Lower-Wage to Opportunity Occupations



Note: The share of destinations requesting a skill is weighted by the employment of the destination occupations. The y-axis reflects the share of top transitions for which the skill ranks among the destination occupation's top 25 skills but not the origin's.

Sources: Authors' calculations using data from BLS Occupational Employment Statistics (May 2018), BLS Employment Projections (2018–2028), Burning Glass Technologies (2014–2018), USDOL/ETA O*NET 24.2 Database, BEA Regional Price Parities (2017), and American Community Survey Five-Year Public Use Microdata Sample (2013–2017)

the 25 most in-demand skills for the destination occupations. (Skills differentiating one figure from the other are highlighted in orange.) For each of those skills, we plot the share of destination occupations requesting the skill and, when it is requested, the share of origin occupations for which the skill is not among the top 25. Taken in the aggregate for these top transitions, the demand for a skill in the destination but not in the origin can be thought of as the skills gap. Skills with the largest gap represent both the greatest differences between these very similar occupational pairs and, quite possibly, the highest hurdles to occupational mobility.

As Figure 9a indicates, the most in-demand skills for top transitions between lower-wage occupations are commonly requested by the origin occupations and thus have minimal gaps. For example, communication, organization, and customer service are requested by nearly all the destinations, and in only a very few cases are these skills absent from the origins in these pairs. Requested by fewer destinations, skills such as basic mathematics, data entry, telephone skills, and problem solving tend to be less common in the origins; each has a gap exceeding 40 percent.

The skills gap identified for the top transitions between lower-wage and opportunity occupations takes a slightly different form (Figure 9b). Compared with Figure 9a, the gap for the commonly requested skills is typically (and somewhat surprisingly) lower across the board, with the vast majority falling below 30 percent. However, this analysis identifies four skills — budgeting, planning, time management, and sales goals — that are absent from the origin occupations in more than half of the cases in which the destination occupation requires them.

Finally, it is worth noting that while 16 of the 25 most in-demand skills for these top transitions are repeated across Figures 9a and 9b (shown in blue), nine are specific to the type of transition (shown in orange). Skills such as lifting ability, work area maintenance, and having a positive disposition may be important to facilitating mobility to better-paying — but still lower-wage — occupations, but these are qualitatively distinct from skills such as research, written communication, and product sales demanded by opportunity occupations. The suggestion is that while all these skills may be important for workers seeking higher wages, the return on investment may be greater for some skills than for others.

Discussion

Our analysis of nearly 60 million online job advertisements across 33 metro areas reveals broad similarities in the skills requested for lower-wage and opportunity occupations. By comparing the skill portfolios of individual occupations, we find that a top transition exists for nearly half (49 percent) of lower-wage employment, and pursuing a top transition from a lower-wage or an opportunity occupation would represent an average annual increase in wages of nearly $15,000. By revealing the skills that connect occupations in local labor markets, our analysis illustrates that a transition between lower-wage occupations could lead to a subsequent transition to an opportunity occupation. Information on potential and top transitions is vital to workers seeking to advance in their careers, as well as to those trying to reenter the workforce after a period of unemployment. For employers, considering the portability of skills from one occupation to another can expand the pool of viable candidates for open positions.

Our analysis of worker mobility in recent years suggests that workers have made more than half of the unique top transitions identified in this report. It is worth considering, then, the barriers that prevent the remainder from occurring. While our research cannot directly answer this question, we offer a few explanations. First, workers and employers alike may not be fully aware of the transferability of skills between lower-wage and better-paying occupations. Second, although skills shared by two occupations may lay the groundwork for a transition, workers may be lacking in key skills, sufficient skill mastery, or occupational licenses or credentials, all potentially requiring additional education or training inaccessible to workers with limited resources.

The broader adoption of hiring practices that emphasize the portability of skills is one of several approaches that could further expand occupational mobility and unlock the wealth of human capital held by workers without a bachelor's degree. Skills-based hiring practices are those that test applicants for the range of skills necessary to succeed in a role while deprioritizing formal educational credentials. In a study of 15 firms that incorporated a skills test into the review process for applicants to low-skill service jobs, researchers found that introducing testing increased employee tenure by about 25 percent (Hoffman, Kahn, and Li 2018). Some employers have made formal efforts to incorporate skills-based hiring into their human resources practices, and more are considering moving in that direction (Gallagher 2018).

Skills-based hiring is not a panacea, however, because while the top transitions identified in this report involve very similar occupations, they are not identical, and additional skills development could be required to actualize them. Therefore, strong collaboration is needed between employers, colleges and universities, and workforce development organizations to develop targeted training programs that can successfully facilitate the types of transitions discussed in this report (Burrowes et al. 2014). Such training could be situated within apprenticeship programs, public-private workforce development partnerships, or local hiring policies as part of economic development programs (Bartik et al. 2020).

In our comparison of the skill intensities for fitness trainers and paralegals, some of the largest gaps were for skills specific to the legal profession, such as litigation, legal documentation, and legal research, while other skills, such as communication, scheduling, and customer service, were shared. Short-term, low-cost, targeted training could facilitate occupational transitions for workers, and close collaboration with employers could ensure training satisfies the skills demanded in a given market. Skills-based occupational transitions have the potential to promote economic mobility for lower-wage workers without a bachelor's degree while helping to meet the talent needs of employers. Collaboration between employers and training providers hold the key to realizing this potential. ■

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APPENDIX 1 DETAILED DATA AND METHODS

Occupational Classifications

We classify the occupations within each metro area into three categories: lower-wage occupations, opportunity occupations, and occupations requiring extensive experience or a bachelor's degree. These classifications reflect differences in pay, education, and experience.

Pay

We begin with the 2018 Occupational Employment Statistics (OES) data set from the Bureau of Labor Statistics (BLS). This data set contains information on each occupation's employment, hourly median wage, and annual median salary. To determine annual median wages for each occupation, we rely on the BLS's annual median salary for occupations that are paid annual salaries. For occupations that are paid hourly, however, we multiply the hourly median wage by an estimate of hours worked per week and 52 weeks per year. We derive an estimate for the number of hours worked per week for each occupation from the 2013–2017 American Community Survey (ACS) Five-Year Public Use Microdata Sample (PUMS). We adjust the occupation's pay for differences in regional cost of living using the 2017 regional price parities (RPPs) produced by the Bureau of Economic Analysis (BEA). We compare the adjusted pay to the 2018 national annual median wage of $38,640 to determine if the occupation pays above or below the median.

Education and Experience

To determine the education and experience requirements for occupations, we use a combination of information from a database of online job ads acquired from Burning Glass Technologies (2014–2018), the BLS Employment Projections program (2018–2028), and the Department of Labor/Employment & Training Administration's Occupational Information Network (O*NET) program (24.2 database). First, for each occupation for which we have at least 100 job advertisements specifying the minimum level of education requested, we calculate the percent of each occupation's job ads requesting less than a bachelor's degree in each metro area (BGT Sub-BA share); we use the national share for occupations with an insufficient number of local job ads. We also use Table 1.7 from the BLS's Employment Projections program to understand the entry-level education required for occupations nationally. We supplement the information from these two sources with the percent of O*NET respondents indicating the occupation requires less than a bachelor's degree (O*NET Sub-BA share). We incorporate the O*NET data set because we notice that for several occupations (principally teaching and education administration occupations), the BGT Sub-BA share is higher than might be expected intuitively. Including the O*NET education information allows us to triangulate a reasonable estimate for the educational requirements of the occupations. To assess experience, we use the BLS Employment Projections program's measure of the years of related work experience typically required for the occupation.

Categorizing Occupations

Using these definitions of pay, education, and experience and the following rules, we categorize occupations in each metro area into lower-wage occupations, opportunity occupations, and occupations requiring extensive experience or a bachelor's degree. If the occupation pays less than the national annual median wage after adjusting for metropolitan differences in cost of living, then we categorize it as a lower-wage occupation. For the remaining higher-wage occupations, if the BGT Sub-BA share is less than 20 percent, if the O*NET Sub-BA share is less than 10 percent, if the BLS indicates the occupation requires graduate-level education, or if the occupation requires five or more years of experience, then we categorize the occupation as requiring extensive experience or a bachelor's degree. The remaining occupations pay above the national annual median wage (adjusted for local cost-of-living differences), are at least sometimes accessible to workers without a bachelor's degree, and do not require more than a few years of related work experience. We categorize these final occupations as opportunity occupations, adapting the definition from Fee, Wardrip, and Nelson (2019).

Identifying Occupational Transitions

To identify occupational transitions, we use a database of online job ads posted between 2014 and 2018 and acquired from Burning Glass Technologies.[21] The database includes the skills, education, and experience requirements extracted from job ads posted on over 40,000 online job boards and corporate websites. The Burning Glass skills taxonomy includes over 17,000 unique skills available at three levels of aggregation, and we work with the skills at the most disaggregate level (Burning Glass Technologies 2019). We begin by subsetting the data set to the 33 largest U.S. metro areas by employment, each including at least 1 million jobs in the 2018 OES data set. We require any occupation within a metro area to have at least 250 job ads with skills specified so that there are sufficient job ads to adequately describe the occupation's local skill portfolio; we drop occupations with fewer than 250 job ads. In addition, we exclude from the analysis ads for internships, ads with no associated skills, and ads missing a standard occupational classification (SOC) identifier. Even after dropping occupations with missing OES and insufficient Burning Glass data, we are able to analyze at least 85 percent of total employment in each of the 33 metro areas.

[21] More information on Burning Glass Technologies is available at www.burning-glass.com.

Hundreds of unique skills can be requested for a single occupation when all local job ads are considered. In order to work with a more concise selection of skills, we focus on the 25 skills with the highest skill intensities for each occupation in each metro area. The skill intensity is the percent of an occupation's job ads that request a particular skill. These top-25 skills and their associated skill intensities represent the skill portfolio for an occupation in a metro area.

To pursue our goal of identifying occupations with alike skill portfolios, we use a measure able to compare two objects with multiple attributes: cosine similarity. Cosine similarity is computed by measuring the cosine of the angle between two vectors, where each vector is defined by the skill intensities in an occupation's skill portfolio; it indicates the degree to which the two vectors are pointing in the same direction (Han, Kamber, and Pei 2012).[22] An important feature of cosine similarity is that two occupations with proportional but different skill intensity levels will have a similarity score of 1. As a result, the measure is not sensitive to absolute differences in the degree to which two occupations request skills. The formula for cosine similarity is presented below and is performed on the skill intensities of the top-25 skills for each occupation; where a skill exists in the top 25 for one occupation but not the other, we set the skill intensity to 0.

$$\frac{\sum_{i=1}^{25}(A_i \times B_i)}{\sqrt{\sum_{i=1}^{25}(A_i)^2} \times \sqrt{\sum_{i=1}^{25}(B_i)^2}}$$

Where A_i and B_i are the skill intensities for skill i in occupation A and occupation B, respectively.

A cosine similarity score is calculated for each pair of occupations in each metro area. The score ranges from 0 to 1, and the higher the score, the greater the alignment between the skills requested in one occupation (the origin) and the skills requested in a second occupation (the destination).

We use occupational characteristics to define what we call potential transitions. A potential transition originates from a lower-wage or opportunity occupation, entails at least a 10 percent increase in annual median wages between the origin and destination occupations, must be into an occupation that represents at least one out of every 10,000 jobs in a metro area as indicated by the BLS,[23] and must be projected to grow or decline by less than 5 percent nationally over the next 10 years according to the BLS's Employment Projections program. A top transition is a potential transition that has a cosine similarity score of greater than 0.75. We established a 0.75 threshold for top transitions after taking into consideration several factors. First, we manually reviewed the skill intensities of a random selection of job pairs with similarity scores between 0.5 and 0.8 and determined that potential transitions with scores below 0.75 appeared less realistic. Among potential transitions with a cosine similarity score greater than 0.75, 77 percent of the transitions involve an origin and destination that share 15 of their top-25 skills.

We also examined the frequency with which our transitions could be observed in the Current Population Survey (CPS). Using an IPUMS-CPS defined variable (CPSIDP), we linked monthly samples from 2014 to 2018 and identified unique individuals across time. This linked data set enabled us to observe the frequency of occupational transitions (Flood et al. 2020). We then matched these observed occupational transitions with our cosine similarity scores. Consistent with Macaluso (2019), we found a strong relationship between our skills-based similarity scores and observed worker mobility: As illustrated in Appendix Table 1, the average number of transitions occurring during this time period was markedly higher between occupations with a similarity score above 0.75 than it was between more dissimilar occupations.

APPENDIX TABLE 1

Similarity Scores for Potential Transitions and Observed Occupational Transitions

Similarity score of potential transition	Average number of transitions made by workers
Less than or equal to 0.75	6.0
Greater than 0.75	25.3

Note: Reported values are unweighted and exclude occupational pairs with no observed transitions. The relationship between the similarity score categories and the average number of transitions is preserved using weighted values.

Sources: Authors' calculations using data from Current Population Survey (2014–2018 monthly sample), BLS Occupational Employment Statistics (May 2018), BLS Employment Projections (2018–2028), Burning Glass Technologies (2014–2018), USDOL/ETA O*NET 24.2 Database, BEA Regional Price Parities (2017), and American Community Survey Five-Year Public Use Microdata Sample (2013–2017)

[22] Other studies have also used cosine similarity to compare the skill vectors of occupations (e.g., World Economic Forum 2018; Lima and Bakhshi 2018; and Djumalieva, Lima, and Sleeman 2018). Euclidean distance, which can be used to measure the magnitude of the distance between two skill vectors, is a common alternative to cosine similarity in studies such as ours (see Blair et al. 2020; World Economic Forum 2019; AlphaBeta 2017; Allen et al. 2012). We chose cosine similarity because it was better suited to the varying levels of the skill intensities calculated from the Burning Glass data set.

[23] This criterion ensures that we do not identify potential or top transitions into occupations that account for an insignificant level of local employment and sets the floor at roughly 100 jobs for the smallest metro areas analyzed.

APPENDIX 2 SHARE OF EMPLOYMENT ASSOCIATED WITH TOP TRANSITIONS FROM LOWER-WAGE AND OPPORTUNITY OCCUPATIONS BY METRO AREA

This table reports the share of employment in lower-wage and opportunity occupations from which at least one top transition exists. It includes the average annual median wages for origin and destination occupations involved in these transitions, as well as the percent increase in average annual median wages.

	LOWER-WAGE OCCUPATIONS			
		Average annual median wages		
	Share of employment associated with a top transition	Origin occupations	Destination occupations	Percent increase
Atlanta-Sandy Springs-Roswell, GA	56%	$22,318	$35,149	57%
Austin-Round Rock, TX	58%	$24,858	$37,530	51%
Baltimore-Columbia-Towson, MD	39%	$24,444	$40,662	66%
Boston-Cambridge-Nashua, MA-NH	45%	$29,174	$42,986	47%
Charlotte-Concord-Gastonia, NC-SC	52%	$22,199	$35,757	61%
Chicago-Naperville-Elgin, IL-IN-WI	53%	$25,603	$38,507	50%
Cincinnati, OH-KY-IN	48%	$24,063	$35,662	48%
Cleveland-Elyria, OH	49%	$23,346	$37,465	60%
Columbus, OH	46%	$23,294	$37,324	60%
Dallas-Fort Worth-Arlington, TX	55%	$25,754	$37,713	46%
Denver-Aurora-Lakewood, CO	56%	$26,786	$43,257	61%
Detroit-Warren-Dearborn, MI	45%	$24,137	$36,854	53%
Houston-The Woodlands-Sugar Land, TX	53%	$24,634	$38,316	56%
Indianapolis-Carmel-Anderson, IN	48%	$26,847	$39,283	46%
Kansas City, MO-KS	48%	$23,582	$38,429	63%
Los Angeles-Long Beach-Anaheim, CA	47%	$27,126	$39,510	46%
Miami-Fort Lauderdale-West Palm Beach, FL	58%	$25,200	$36,806	46%
Minneapolis-St. Paul-Bloomington, MN-WI	64%	$26,149	$39,291	50%
New York-Newark-Jersey City, NY-NJ-PA	43%	$28,150	$48,462	72%
Orlando-Kissimmee-Sanford, FL	55%	$22,782	$34,039	49%
Philadelphia-Camden-Wilmington, PA-NJ-DE-MD	44%	$26,647	$42,332	59%
Phoenix-Mesa-Scottsdale, AZ	52%	$26,901	$38,711	44%
Pittsburgh, PA	48%	$24,984	$37,552	50%
Portland-Vancouver-Hillsboro, OR-WA	46%	$27,635	$39,627	43%
Riverside-San Bernardino-Ontario, CA	44%	$25,178	$35,793	42%
San Antonio-New Braunfels, TX	40%	$24,744	$36,301	47%
San Diego-Carlsbad, CA	41%	$26,975	$39,321	46%
San Francisco-Oakland-Hayward, CA	53%	$28,486	$42,542	49%
San Jose-Sunnyvale-Santa Clara, CA	50%	$29,969	$45,232	51%
Seattle-Tacoma-Bellevue, WA	50%	$30,524	$43,888	44%
St. Louis, MO-IL	31%	$22,317	$35,494	59%
Tampa-St. Petersburg-Clearwater, FL	41%	$24,548	$37,238	52%
Washington-Arlington-Alexandria, DC-VA-MD-WV	47%	$26,294	$39,016	48%

Note: Where a single origin occupation is associated with more than one destination occupation, the average annual median wages of the transitions from the origin occupation are weighted by the employment of the destination occupations. Average annual median wages are weighted by the employment of the origin occupations associated with each type of transition in each metro area.

APPENDIX 2 SHARE OF EMPLOYMENT ASSOCIATED WITH TOP TRANSITIONS FROM LOWER-WAGE AND OPPORTUNITY OCCUPATIONS BY METRO AREA *(continued)*

	OPPORTUNITY OCCUPATIONS			
		Average annual median wages		
	Share of employment associated with a top transition	Origin occupations	Destination occupations	Percent increase
Atlanta-Sandy Springs-Roswell, GA	32%	$49,053	$69,290	41%
Austin-Round Rock, TX	26%	$50,358	$83,627	66%
Baltimore-Columbia-Towson, MD	22%	$58,459	$90,647	55%
Boston-Cambridge-Nashua, MA-NH	22%	$60,257	$80,185	33%
Charlotte-Concord-Gastonia, NC-SC	31%	$49,903	$69,243	39%
Chicago-Naperville-Elgin, IL-IN-WI	28%	$53,118	$69,034	30%
Cincinnati, OH-KY-IN	31%	$52,339	$76,101	45%
Cleveland-Elyria, OH	34%	$48,974	$67,107	37%
Columbus, OH	32%	$45,788	$59,192	29%
Dallas-Fort Worth-Arlington, TX	36%	$55,172	$80,528	46%
Denver-Aurora-Lakewood, CO	28%	$59,527	$77,120	30%
Detroit-Warren-Dearborn, MI	26%	$57,832	$74,042	28%
Houston-The Woodlands-Sugar Land, TX	34%	$57,585	$79,043	37%
Indianapolis-Carmel-Anderson, IN	27%	$51,227	$67,260	31%
Kansas City, MO-KS	31%	$52,140	$69,292	33%
Los Angeles-Long Beach-Anaheim, CA	26%	$61,500	$87,863	43%
Miami-Fort Lauderdale-West Palm Beach, FL	31%	$53,785	$83,857	56%
Minneapolis-St. Paul-Bloomington, MN-WI	27%	$53,256	$69,327	30%
New York-Newark-Jersey City, NY-NJ-PA	33%	$65,018	$106,229	63%
Orlando-Kissimmee-Sanford, FL	17%	$49,502	$74,402	50%
Philadelphia-Camden-Wilmington, PA-NJ-DE-MD	27%	$54,669	$77,234	41%
Phoenix-Mesa-Scottsdale, AZ	31%	$52,415	$70,671	35%
Pittsburgh, PA	29%	$51,002	$69,418	36%
Portland-Vancouver-Hillsboro, OR-WA	25%	$54,268	$71,686	32%
Riverside-San Bernardino-Ontario, CA	27%	$61,258	$90,720	48%
San Antonio-New Braunfels, TX	33%	$55,053	$83,885	52%
San Diego-Carlsbad, CA	22%	$56,920	$73,777	30%
San Francisco-Oakland-Hayward, CA	23%	$64,300	$93,181	45%
San Jose-Sunnyvale-Santa Clara, CA	18%	$65,591	$96,858	48%
Seattle-Tacoma-Bellevue, WA	33%	$60,116	$81,538	36%
St. Louis, MO-IL	29%	$46,302	$62,735	35%
Tampa-St. Petersburg-Clearwater, FL	36%	$51,656	$78,056	51%
Washington-Arlington-Alexandria, DC-VA-MD-WV	27%	$61,722	$87,856	42%

Sources: Authors' calculations using data from BLS Occupational Employment Statistics (May 2018), BLS Employment Projections (2018–2028), Burning Glass Technologies (2014–2018), USDOL/ETA O*NET 24.2 Database, BEA Regional Price Parities (2017), and American Community Survey Five-Year Public Use Microdata Sample (2013–2017)

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