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Closing the gap for racial minorities and immigrants through school-to-work linkages and occupational match

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Abstract

This study investigates the role of college major choices in labor market outcomes, with a focus on racial minorities and immigrants. Drawing upon research on school-to-work linkages, we examine two measures, *linkage*, the connection between college majors and specific occupations in the labor market, and *match*, the alignment of workers' occupations with their college majors. Analyzing data from the American Community Survey, 2013-2017, we show that linkage positively predicts earnings, particularly for workers in matched occupations, and negatively predicts unemployment. Notably, Black, Hispanic, and foreign-born workers in matched occupations benefit more from linkage strength than their White and U.S.-born counterparts. This advantage is more pronounced in states that are popular destinations for immigrants. Our findings suggest that earnings and unemployment disparities experienced among racial minorities and immigrants may diminish if they pursue majors closely tied to jobs in the labor market and secure jobs related to their college majors.

Keywords: school-to-work linkages, occupational match, college major choices, labor market outcomes, race and ethnicity, nativity

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1. Introduction

States have increasingly adopted policies to expand access to higher education, with the dual goal of enhancing labor market outcomes for degree holders and stimulating economic growth. For example, the Texas Higher Education Coordinating Board (THECB) released the *60×30TX* strategic plan to increase the share of individuals 25-34 years old with a postsecondary credential to 60 percent by 2030 and to ensure that college students graduate with skills valued in the labor market (Texas Higher Education Coordinating Board, 2015). Other states across the nation, including Arizona, California, Kentucky, Louisiana, Michigan, and South Carolina have implemented similar strategic plans.[1] Individuals who have earned bachelor's degrees are more likely to be employed and earn higher wages than those with lower levels of education (Ma & Pender, 2023). However, the benefits of a bachelor's degree are not evenly distributed. Not only is there significant variation in the earnings associated with particular college fields (Kim, Tamborini, & Sakamoto, 2015), but racial and ethnic minorities and immigrants are also often at a disadvantage in the labor force even after accounting for educational attainment (Cheng et al., 2019; Mora & Davila, 2018; Stewart & Dixon, 2010; U.S. Bureau of Labor Statistics, 2023a, 2023b; Wilson & Rodgers, 2016). This study investigates the role of college major choices in labor market outcomes and their implications for racial and ethnic minorities and immigrants.

One way of measuring whether students are graduating from college with marketable skills is to evaluate school-to-work linkage strength (DiPrete et al., 2017). *Linkage* is a characteristic of a society that measures the flow from specific college majors to specific occupations in the labor market. While a strong linkage between majors and occupations may be useful to understand and predict labor market outcomes, the rewards (or penalties) of linkage

[1] See Arizona Board of Regents (2016), Siqueiros et al. (2018), Kentucky Council on Postsecondary Education (2022), Louisiana Board of Regents (2019), State of Michigan (2020), and Robinson (2021) for more policy details.

may be reserved for those actually working in occupations tied to their majors. *Match* is another measure that examines whether an individual works in an occupation common among people with their college major (Bol et al., 2019). For example, for an architecture major, these occupations include architects and urban and regional planners. Together, these measures can be used to examine the extent to which college majors strongly connected to specific occupations in the labor market pay higher wages and have lower unemployment rates than college majors with weaker connections to specific occupations in the labor market.

In this study, we use data from the American Community Survey (ACS), 2013-2017, to examine school-to-work linkages among bachelor's degree holders in the United States. We calculate linkage strength scores for 36 college majors, with higher values corresponding to a stronger linkage between that major and specific jobs in the labor market, based on a multi-group segregation measure developed by DiPrete et al. (2017). In addition to linkage strength, we follow Bol et al. (2019) to generate an indicator of whether an individual was employed in a matched occupation. Using these linkage and match measures, we first examine to what extent individuals from different racial and ethnic backgrounds choose college majors that have strong school-to-work linkages using ordinary least squares (OLS) regression models and whether they work in a matched occupation using binary logistic regression models, both with state and year fixed effects. Second, we examine how linkage strength and match predict wages and employment for different racial and ethnic groups. As recommended by Bol et al. (2019), we interact linkage strength with match since the role of linkage may depend on whether an individual is working in an occupation aligned with their educational background. We further interact the linkage and match measures with an individual's foreign-born status to determine whether there are differences within race by nativity. Finally, we examine whether these

relationships vary across states categorized as established immigrant destinations, new immigrant destinations, and non-destinations.

Results show that workers who are Asian, Black, and foreign-born are more likely to complete a college major with stronger linkage than workers who are Hispanic, White, and U.S.-born. Workers who are Asian and U.S.-born are more likely to be employed in a matched occupation than workers who are Black and foreign-born. In line with previous work (Bol et al., 2019), we find that linkage positively predicts earnings and negatively predicts unemployment and that the earnings benefits from linkage are concentrated among individuals in matched occupations. More importantly, Black, Hispanic, and foreign-born workers in matched occupations appear to benefit more from linkage strength than White and U.S.-born workers in matched occupations. Finally, we find that the positive relationships between linkage, match, and labor market outcomes among racial minorities and immigrants are more prominent in states classified as established or new immigration destinations compared to non-destination states. This suggests that labor markets are more favorable to these groups in contexts with larger immigrant communities.

Students' major choices may indeed play a pivotal role in facilitating smooth and advantageous transitions into the labor force for college graduates. Our study results indicate that racial and ethnic minorities, as well as immigrants – groups historically underserved in the labor market – derive greater benefits from linkage and match than more privileged groups. While White, U.S.-born individuals maintain advantages in the workforce, these disparities may diminish if individuals pursue majors closely aligned with the job market and secure positions connected to their majors. Higher education policies, such as THECB's *60×30TX* strategic plan, hold the potential to encourage historically marginalized populations to major in fields strongly

tied to jobs in the labor market, thereby closing gaps in earnings and unemployment rates and fostering greater occupational equality.

2. Background

2.1. Why do school-to-work linkages and occupational match matter?

Human capital theory

Human capital theory and occupational closure theory offer insights into how linkage and match may relate to labor market outcomes. First, the human capital framework suggests that college majors serve as a means of signaling skills desirable for an occupation. Individuals with educational credentials are perceived by employers as having a desirable skill set and the capacity to learn on-the-job skills, which reflect their potential productivity as workers (Becker, 1964/1993). Within this framework, workers who have accumulated more human capital have lower chances of unemployment and greater chances of earning higher wages. For a worker's human capital to be best utilized, they must work in an occupation that is closely aligned with their degree (Robst, 2008). The skills from one field of study are generally not completely transferrable to another, which means that individuals who do not work in a position aligned with their degree have underutilized human capital. For instance, a worker with a degree in history could apply strong critical thinking and writing skills to a number of occupations, although the knowledge specific to their disciplinary background might not translate well to an occupation outside their field of study.

Since proficiency in language and culture can valued skills in the workforce, the human capital framework may explain how immigrants with lower English proficiency or familiarity with the host society may lie at a disadvantage in the labor market.[2] Park (1999) argues that

[2] Native-born racial and ethnic minorities earn lower wages than native-born Whites, and foreign-born minorities earn lower wages than foreign-born Whites (Stewart & Dixon, 2010).

among foreign-born workers, those who are native English speakers have a human capital advantage in the labor market over non-native English speakers because they can more easily transition into the U.S. labor market. Although limited English language ability does not bar an individual from participating in the labor market, immigrants who are less proficient in English may encounter narrower employment opportunities.

However, even among individuals with similar skills, including educational credentials and language proficiency, securing work closely aligned to one's degree can be more challenging for some groups compared to others, which challenges human capital theory (Bills, 2003). For example, racial and ethnic discrimination may undercut educational credentials in the job market, leaving highly skilled minority applicants unemployed and searching for work for longer periods (Pager & Shepherd, 2008), as well as earning lower wages throughout their careers compared to their White counterparts (Tomaskovic-Devey, Thomas, & Johnson, 2005). When focusing on early-stage careers, the earnings gap between White workers and Black and Hispanic workers is highest between those with the most education, further suggesting that educational credentials alone may not sufficiently explain earnings differences based on the human capital framework (Tomaskovic-Devey et al., 2005). These lingering gaps may be explained by occupational closure.

Occupational closure theory

Occupational closure theory may explain how college majors serve as a mechanism to uphold exclusivity within an occupation. The theory posits that social groups work to maintain their power and ranking in the social hierarchy by restricting access to their group (Weber, 1922; Weeden, 2002). Educational credentials and licenses may function as means of upholding group exclusivity and hoarding opportunities and rewards (Di Stasio & van de Werfhorst, 2016;

Redbird, 2017; Weeden, 2002). For example, lawyers must have a law degree, in addition to being licensed through bar associations, making the occupation closed to those without those college and work credentials. Closed groups that impose this kind of credentialing perpetuate perceptions that their work is high-quality and prestigious, mandating that they be rewarded with higher wages than less exclusive occupations (Bol & Weeden, 2015; Weeden, 2002). Of course, the degree of closure can vary by occupation, given that most occupations are generally not bound by law to hire applicants with specific degrees or licenses (Drange & Hellend, 2019; Weeden, 2002). However, in occupations without a licensure requirement, educational credentials like degrees and majors may provide workers with access to better pay and opportunities (Di Stasio & van de Werfhorst, 2016). For example, a worker may not need a degree in human resources to work in a related field, but it may help them secure the position and increase their starting salary.

Since social networks are generally homogeneous, historically privileged groups can benefit from social closure due to group bias (McDonald, 2011). Indeed, highly educated immigrant workers are less likely to be employed in a skill-matched position compared to native-born workers with the same level of education (Beckhusen et al., 2013) and may be at an earnings disadvantage (Tong, 2010; Zeng & Xie, 2010). This may be attributable to weak transferability of experience and educational credentials across borders, meaning that employers may devalue or underestimate the extent to which a job candidate's qualifications align with a particular job if they do not fully comprehend the candidates' educational and employment background (Beckhusen et al., 2013; Tong, 2010).

Both human capital and social occupational closure theory offer frameworks for understanding how majoring in fields closely linked to jobs, and subsequently working in an

occupation closely linked to one's major, can lead to improved labor market outcomes. These theories also provide explanations for why racial minorities and immigrants may face disadvantages. Racial minorities and immigrants are more likely to lack skills valued in the labor market, such as language proficiency (according to human capital theory), and they may encounter discrimination or possess skills less transferable to the domestic labor market (according to social closure theory). Indeed, data from the U.S. Bureau of Labor Statistics (2023b) shows that Hispanic and Black workers are overrepresented in low-wage positions and are surpassed by White and Asian workers in managerial and professional occupations, despite similar rates of workforce participation. Similarly, foreign-born workers constitute about 18 percent of the U.S. labor force but are concentrated in service sector jobs (U.S. Bureau of Labor Statistics, 2023a). Conversely, historically marginalized populations may experience more significant benefits from majoring in fields closely aligned with job opportunities, thereby narrowing existing gaps in the labor market.

2.2. Linkage and match by race, ethnicity, and immigration status

To understand who is most likely to benefit from school-to-work linkage, we must consider patterns in college major choice and the social processes that may influence these choices. While not directly observing the linkage strength of majors, prior research has shown clear racial and ethnic disparities in college major choice. Many studies suggest that racial and ethnic minorities are more inclined to choose vocationally oriented majors compared to their White peers, who tend to favor generally oriented majors like the social sciences and humanities. For example, Asian and Hispanic men are overrepresented among engineering and computer science graduates (Dickson, 2010; Leslie, McClure, & Oaxaca, 1998). Blacks and Hispanics are also shown to prefer vocational fields, such as business, education, engineering, law, medicine,

and architecture, over majors in the arts and sciences (Goyette & Mullen, 2006). Research also finds that Asian students, particularly women, are more likely than White students to select college majors in healthcare (Song & Glick, 2004).

As an exception, Simpson (2001) finds that Black and Hispanic high school students do not significantly differ in their college major choices from their White peers (there are, however, systematic differences between Asians and non-Asians). Nevertheless, this pattern may be explained by Black students entering college with a strong interest in science (Elliott et al., 1996) but experiencing high attrition rates from science majors (Adelman, 2006; Astin & Astin, 1992). These studies suggest that occupational closure may occur at the skill acquisition phase, in addition to the skill application phase, restricting access to education and certain majors (Bol & Weeden, 2015). In terms of immigration status, foreign-born students are more likely to select occupationally specific college majors than their native-born counterparts (Ma, 2009; Mullen, 2014; Nores, 2010). This may be a strategic choice by lower-resourced students to maximize their chances of upward mobility (Ma, 2009; Xie & Goyette, 2003). For instance, immigrant students whose first language is not English may be inclined to concentrate their studies on technical fields like math and science. These fields are less writing-intensive and may help offset their limited English proficiency upon entering the job market (Ma, 2009; Tseng, 2006). On the other hand, native-born students are more inclined to choose majors in the social sciences or humanities (Ma, 2009), which are more academically oriented and thus may not offer clear pathways to a particular set of occupations.

While there is consistent evidence that racial minorities and immigrants are more likely to pursue vocationally oriented majors, little is known about whether these choices correspond to stronger linkages to the labor market. A recent paper by Lu, Li, and Elbers (2024) is the only

study to our knowledge that has applied the linkage approach developed by DiPrete et al. (2017) to examine systematic differences by race and ethnicity (but not by nativity). Using ACS data and decomposition analyses, the authors find that Black graduates tend to choose fields of study with weaker linkages to the labor market, while White and Asian graduates choose fields with stronger linkages. However, their statistical models do not control for individual sociodemographic characteristics nor explore the intersection of race and nativity.

We plan to examine whether there are systematic differences in major choice and occupational match by race, ethnicity, and immigration status, controlling for a host of sociodemographic characteristics, and further explore whether these patterns are tied to labor market outcomes. We also determine whether the advantages (or disadvantages) of linkage and match in the labor market differ across states, focusing on variation by immigrant destination. States that are immigrant destinations, for example, may have labor markets in which minority workers are more (or less) likely to find jobs closely aligned with their degrees due to social networks, discrimination, and immigration policies. Established immigrant destinations may offer stronger networks among marginalized groups and work environments that are more receptive to immigrant workers. Conversely, labor markets in new and emerging immigrant destinations may perceive immigrants as an economic threat (De Jong et al., 2017). This suggests that immigrant workers in new and emerging destinations may face greater barriers in the labor market, even when selecting majors with strong linkages or working in matched occupations.

3. Data and sample

[Insert Table 1 here]

In this study, we use data from the 1% sample of the ACS spanning the years 2013 to 2017, which we downloaded from IPUMS (Ruggles et al., 2023). Our analyses focus on a

sample of individuals aged 25 to 64 whose highest educational credential was a bachelor's degree and who self-identified as White, Black, Hispanic, or Asian and Pacific Islander. Table 1 presents the means and standard deviations of variables in our main analytic sample, which comprises 1,414,588 individuals reporting positive earnings in the previous year. The mean annual earnings for our analytic sample amount to approximately $69,623.[3] Black and Hispanic workers report substantially lower annual earnings, falling below $55,000, while White workers have the highest annual earnings, averaging around $73,444. Standardized linkage strength exhibits systematic variation across race and ethnicity. On average, White and Hispanic workers tend to pursue degrees in lower-linkage majors, -0.015 and -0.005 standard deviations (SD) respectively, while Black and Asian workers tend to pursue degrees in higher-linkage majors, 0.021 and 0.132 SD, respectively. Despite these differences, the share of individuals working in matched occupations remains relatively consistent across race and ethnicity, ranging between 13.9 to 16.1 percent. A high percentage of Asian (76.9 percent) and Hispanic (39.5 percent) workers are foreign-born, while only 17.9 percent of Black and 5.8 percent of White workers are foreign-born.

We also use U.S. Decennial Census data from 1970, 1980, 1990, and 2000 and ACS data from 2008-2012 (corresponding to the year 2010) and 2013-2017 (corresponding to the year 2015) to classify states by immigration destination. Following Massey and Capoferro (2008, p. 34), we classify the "big five" immigration states – California, Florida, New York, Texas, and Illinois – as *established destinations*. Additionally, we include New Jersey as an established destination based on its immigrant population size. States receiving over one percent of a specific immigrant group (Mexican, Other Latin American, Asian, and Other) since the mid-

[3] When analyzing unemployment outcomes, we use a slightly different analytic sample, which is limited to individuals in the labor force who may or may not report earnings (N=1,391,564). The average unemployment rate is approximately 3.3 percent. For detailed summary statistics of this sample, please refer to Appendix Table A.1.

1990s are classified as *new destinations*.[4] While most of our new destinations align with those identified by Massey and Capoferro (2008), we add Alabama, New Mexico, Oklahoma, and South Carolina based on recent trends.[5] All other states are classified as *non-destinations*.

4. Method

4.1. Calculating linkage strength and match

In DiPrete et al. (2017), the authors advanced a new method to measure "the strength of linkages between educational credentials, including fields of study, and occupational positions" (p. 1869). Building off their work, we constructed a measure of *linkage* that quantifies the relationship between college majors and specific occupations in the labor market. It is important to clarify that linkage is a structural characteristic of a society's educational and occupational distributions rather than an individual characteristic. For example, nursing majors likely end up in a small set of occupations (i.e., working in nursing or related health fields). In contrast, history majors may spread across a multitude of occupations (e.g., most do not become historians, and many may work in fields ranging from law to business). DiPrete et al.'s (2017) linkage measure is based on multigroup segregation measures, specifically the Mutual Information Index (*M*). For this study, we adopt a slight alteration[6] of the DiPrete et al. measure:

$$M(ed)_g = \sum_j p_{j|g} log\left(\frac{p_{j|g}}{p_j}\right) \quad (1)$$

[4] The new destinations include AL, AZ, CO, CT, GA, HI, IN, LA, MD, MA, MI, MN, MO, NV, NC, OH, OK, OR, PA, SC, TN, UT, VA, WA, and WI.

[5] Kansas and Rhode Island are categorized as non-destinations, which contrasts with prior work. Massey and Capoferro's original classification (2008) excluded Washington, DC, while we do not, which affects calculations of immigrant inflow percentages.

[6] The DiPrete et al. (2017) study examined school-to-work linkages, accounting for the level of educational attainment. In the ACS data, majors are reported only for bachelor's degrees, so we restricted our analyses to individuals whose highest degree was a bachelor's. Because education is held constant, our linkage measure does not need to take educational attainment into account and, therefore, is a simplification of the DiPrete et al. (2017) approach.

where $p_{j|g}$ represents the conditional probability an individual who works in occupation j holds a bachelor's degree in college major g, while p_j represents the unconditional probability an individual works in occupation j. We calculated this measure among adults who were 25 to 64 years old, whose highest credential was a bachelor's degree, who were employed full-time, and who were not self-employed, in the armed forces, or attending school.[7]

In the end, we calculated linkage for 36 college majors. The measure itself lacks intuitive meaning except that higher values indicate that a college major is more closely tied to a small number of occupations in the labor market, while lower values indicate looser ties to the labor market. To ease interpretation, we standardized linkage scores to have a mean of 0 and a standard deviation of 1; these values are plotted in Figure A.1. The figure shows that majors like liberal arts, social science, and history have lower linkage scores than majors like electrical/mechanical repairs, cosmetology/culinary arts, and nuclear technologies.

Following Bol et al. (2019), we created a measure of *match*, which identified whether an individual was working in an occupation common among graduates with their college major. Although linkage – the connections between a college major and occupations in the labor market – may predict outcomes like earnings and unemployment, the rewards (or penalties) of linkage may be concentrated among individuals actually working in an occupation closely tied to their college major. While library science has a very high linkage score, the benefits that choosing that major bestows may transpire only for graduates who end up employed as librarians. For instance, libraries may regulate access to library jobs, recruit applicants with backgrounds in library science, and identify ways to retain employees and provide them with long-term job stability.

[7] These restrictions aligned with the DiPrete et al. (2017) approach. To ensure reliability, we decided to calculate linkage for college majors with 100 or more observations. Consequently, we excluded a small number of observations (N = 68), all from the military technologies major.

To measure match, we generated a binary variable that indicated whether an individual was employed in a matched occupation. Within each major, we sorted occupations by their actual frequency (called $ActualFreq$), the number of people in our dataset working in each occupation. Unsurprisingly, the most common occupation among library science majors was librarian (N = 4,331) while the least common occupation was clergy (N = 10). Next, within each major, we calculated the counterfactual frequency (called $CounterfactualFreq$), which assumed that majors and occupations were uncorrelated:

$$CounterfactualFreq = TotOcc\left(\frac{TotMaj}{Tot}\right) \quad (2)$$

where $TotOcc$ represents the number of people who work in each occupation[8], $TotMaj$ represents the number of people who major in each field, and Tot represents the total number of people in the dataset. We used this formula to calculate the number of individuals with a given occupation and major, assuming that the occupation distribution was proportional to the major distribution (i.e., occupations and majors were statistically independent).

Next, we calculated the ratio of the actual frequency to the counterfactual frequency:

$$Ratio = \frac{ActualFreq}{CounterfactualFreq} \quad (3)$$

For each college major, this value indicates how common (or uncommon) an occupation is in actuality compared to a hypothetical, counterfactual world in which people are randomly sorted into occupations. Higher ratio values mean that an occupation is more common than the counterfactual of random assignment, while lower ratio values indicate that an occupation is less common than the counterfactual of random assignment.

[8] Four-digit ACS occupation codes were used. Please visit the following webpage for details: https://usa.ipums.org/usa/volii/occ_acs.shtml.

Finally, we ranked occupations by their ratio values within each college major. Following the guidance provided by Bol et al. (2019), we defined the two occupations with the highest ratio values as matched occupations for a given major (see Table A.1 for a list of match occupations).

Again, we wish to clarify that linkage strength is not an individual characteristic but a characteristic of society; specifically, it represents the pathways from specific college majors to specific occupations in the labor market. Match, however, is an individual characteristic. It measures whether an individual is working in an occupation common among people with their given college major. Regardless of their differences, both linkage and match require a certain amount of individual decision-making: people must decide to major in a field with strong connections to specific occupations in the labor market and people must decide to work in an occupation common among people with their given college major.

4.2. Regression models

First, using our measures of linkage and match, we investigate whether individuals from different demographic backgrounds choose college majors with strong school-to-work linkages and end up working in matched occupations. We predict linkage using ordinary least squares regression and match using binary logistic regression among individuals who reported positive earnings. All models incorporate survey weights and include state and year fixed effects. The models control for sociodemographic characteristics, including age, age-squared, gender, native English speaker status, disability status, marital status, number of children, residency in a metro-nonmetro mix area, and residency in a nonmetro area. Additionally, we control for labor market participation characteristics like part-time employment, self-employment, and current school enrollment.

Next, we examine how linkage strength and match predict earnings and employment by racial and ethnic background, using separate subsamples for Whites, Blacks, Hispanics, and Asians. Earnings are normalized using the natural log. In addition to the main independent variables of interest, linkage and match, we introduce a linkage-by-match interaction term, following Bol et al. (2019), because the role of linkage may vary depending on whether an individual's occupation aligns with their educational background. To determine whether linkage and match exhibit stronger or weaker associations with labor market outcomes by nativity, we also incorporate a three-way interaction term (i.e., Linkage × Match × Foreign-born). All models incorporate survey weights, include state and year fixed effects, and control for sociodemographic and labor market participation characteristics. To predict unemployment, we use an analytic sample of individuals with employment data, including linkage strength in the model but not controlling for match, part-time employment, and self-employment, due to missing data on these variables among some unemployed individuals.

Finally, we determine how the relationships between labor market outcomes, linkage, match, race and ethnicity, and nativity vary among established, new, and non-destination states. This analysis enables us to explore differences across states in terms of their likelihood of having strong social networks for historically marginalized groups, racial and ethnic discrimination in the labor market, and immigrant-friendly policies and work environments.

5. Results

5.1. Relationship between linkage, match, race and ethnicity, and immigration status

[Insert Table 2 here]

Results from Table 2, Columns 1 and 3, reveal significant differences in linkage and match by race, ethnicity, and nativity. For instance, after adjusting for sociodemographic and

labor market participation characteristics, Black workers are more likely to select majors with strong linkages to the labor market but are less likely to work in a matched occupation than White workers. In contrast, Hispanics are less likely to choose a major with strong linkage and are also less likely to work in a matched occupation. Conversely, Asians are more likely to choose a major with strong linkage and work in a matched occupation. Notably, compared to U.S.-born workers, foreign-born workers tend to select strong-linkage majors but show reduced probabilities of working in matched occupations.

Table 2, Columns 2 and 4, illustrates that when race and ethnicity are interacted with foreign-born status, the pattern of Black workers favoring strong-linkage majors over White workers persists, with a notable intensification among Black immigrant workers. Critically, Black immigrants are more likely to work in matched occupations, whereas native-born Black workers are less likely to do so. This disparity may indicate evidence of discrimination against native-born Blacks in the labor market, where degrees in strong linkage majors do not translate to working in matched occupations. In contrast, among Hispanics, there are no systematic differences in major choices between U.S.-born individuals and immigrants, although immigrants are less likely to work in matched occupations. This lack of a disadvantage among native-born Hispanics contrasts with the findings for native-born Blacks. For Asians, the tendency to choose strong linkage majors and work in matched occupations appears to be driven by immigrants.

5.2. How are linkage and match associated with labor market outcomes?

[Insert Table 3 here]

Now, we examine whether linkage and match are associated with labor market outcomes. As shown in Table 3, we estimate earnings outcomes by race and ethnicity. First, we find that

while linkage appears to be positively correlated with earnings, point estimates are small and mostly statistically insignificant, except for Asians. In contrast, working in a matched occupation is strongly correlated with higher earnings across all racial and ethnic groups, with stronger correlations among racial minorities. While holding a degree in a strong-linkage major alone may not be significantly associated with earnings for most groups, the coefficients for the Linkage × Match interaction term suggest that strong-linkage majors may yield benefits in the labor market *if* individuals work in a matched occupation. Notably, these premiums are higher among racial and ethnic minorities than among White workers. For instance, among White individuals employed in a matched occupation, a one standard deviation increase in linkage is associated with 6 percent higher earnings; this premium is even larger for racial and ethnic minorities, ranging between 6.8 and 7.6 percent.

Foreign-born individuals lie at a disadvantage, with lower earnings than native-born individuals regardless of race. Interestingly, immigrants, particularly those from Black and Hispanic backgrounds, may further benefit from working in a matched occupation, as indicated by the coefficients for Match × Foreign-born. Additionally, we observe a small but significant three-way interaction term on Linkage × Match × Foreign-born among Asian individuals, which suggests a slight attenuation in the combined benefits of linkage and match among immigrants.

[Insert Table 4 here]

Unemployment outcomes, as depicted in Table 4, are based on models that use a slightly different analytical sample, which includes individuals without occupation outcomes. Consequently, match is not included as an explanatory variable in these models. Linkage is negatively related to unemployment, which means that workers with degrees in strong-linkage majors are less likely to be unemployed. Among most racial and ethnic groups, foreign-born

individuals face an employment disadvantage, generally experiencing higher incidences of unemployment, except for Black individuals. We do not find statistically significant coefficients for the Linkage × Foreign-born interaction terms except for some evidence that Black immigrants may benefit from choosing strong-linkage majors. Like the results for earnings, while foreign-born individuals lie at a disadvantage in the labor market, they are more likely to benefit from strong linkage (as well as match, with respect to earnings).

5.3. Subsample analyses by immigrant destination

[Insert Table 5 here]

Next, we determine whether the observed relationships between race, ethnicity, linkage, match, and labor market outcomes vary by state context. In Table 5, we divide the sample into three groups based on states' influx of immigrants – established immigrant destinations, new immigrant destinations, and non-destinations – following Massey and Capoferro (2008). We discover that in established states, Black and Asian individuals are more choose college majors with strong linkages to the labor market than their White counterparts. However, we find no significant differences among racial and ethnic groups in new destination states. In non-destination states, Blacks are less likely than Whites to choose majors with strong linkages. Across all three state contexts, immigrants are more likely to select strong-linkage majors than native-born individuals, although the difference in non-destination states fails to reach statistical significance. Turning to match, the results show that Blacks are less likely than Whites to work in a matched occupation in established, new, and non-destination states. In contrast, Hispanics and Asians are more likely to work in a matched occupation in an established destination state but are less likely to do so in a non-destination state. The observed patterns for Black workers

may reflect discrimination against native-born Black Americans, while the patterns for Hispanics and Asians may reflect different attitudes toward these groups in more and less diverse contexts.

When considering the interaction terms between race and foreign-born status, Black and Asian immigrants in established and new immigrant destinations are more inclined to choose majors with stronger linkages and work in matched occupations. In contrast, Hispanic immigrants in established destinations and, to an extent, new destinations are less likely to choose strong-linkage majors or work in matched occupations than White immigrants. It is worth noting that when adding all foreign-born coefficients for each racial and ethnic group, immigrants from all backgrounds seem more inclined than native-born individuals to choose strong-linkage majors in both established and new destinations. Regarding match, we find more variation, with Black immigrants more likely to work in a matched occupation in established and new destinations, while Hispanic immigrants are less likely to do so in these state contexts.

[Insert Tables 6 and 7 here]

Turning to earnings outcomes, as shown in Table 6, while foreign-born workers of all races face a disadvantage in both established and new immigrant destinations, this relationship does not hold in non-destination states for Whites, Blacks, and Asians. An exception is Hispanic foreign-born workers, who experience an earnings disadvantage in all states, including non-destinations. However, the benefits of working in a matched occupation for foreign-born workers are often large enough to offset such disadvantages in established and new immigrant destinations. For instance, Black immigrants in established immigrant states, on average, earn 7.9 percent less than Black native-born workers (see Column 4); however, when these immigrants work in a matched occupation, their earnings are approximately 8.5 percent higher than those of Black native-born workers also in a matched occupation (as indicated by the

coefficient for Match × Foreign-born of 0.164). In other words, the advantage of match counterbalances the disadvantage of being a foreign-born worker. Similar patterns are observed for White and Black immigrants in established and new destinations, Hispanic immigrants in new destinations, and Asians in established destinations. However, there is more limited evidence that strong-linkage majors provide an earnings premium for foreign-born workers, except for Asian immigrants.

In terms of unemployment, as shown in Table 7, White individuals majoring in a field characterized by strong linkage have a lower likelihood of being unemployed across all states. However, this relationship only persists in established and new destination states for Blacks and Hispanics, and solely in established destinations for Asians. Stated differently, majors with strong linkages may not help racial and ethnic minorities in non-destination states. Additionally, foreign-born individuals tend to have higher unemployment rates than their native-born counterparts in new or established destinations. Yet, the benefit of choosing strong-linkage majors does not appear to offset the disadvantage of being foreign-born, except for Black immigrants.

5.4. Subsample analyses by gender

Finally, we investigate whether the relationships between labor market outcomes, linkage, match, race, ethnicity, and nativity differ by gender. To accomplish this, we conduct subsample analyses, replicating the models presented in Table 2 separately for each gender in Table A.3. Generally, the coefficients exhibit consistent trends across female and male subsamples, except for Hispanic and Asian native-born individuals, for whom females are less likely than males to choose strong-linkage majors and less likely to work in matched occupations.

Despite native-born Hispanic and Asian females showing lower tendencies to choose strong-linkage majors or work in matched occupations, the results in Table A.4 demonstrate that females benefit more from linkage and match regardless of race and nativity. Almost all coefficients for match and the interactions between match and linkage are larger in magnitude and statistically significant for females. Turning to unemployment outcomes in Table A.5., we observe similar patterns for Whites and Blacks, whereas Hispanic and Asian females do not seem to benefit from stronger linkage. These results echo the analyses presented in Bol et al. (2019), which identified stronger effects of linkage strength on unemployment than on earnings for men.

6. Discussion

National statistics indicate that White, native-born individuals tend to experience greater advantages in the workforce compared to racial and ethnic minorities and immigrants, evidenced by their higher average earnings and lower unemployment rates (U.S. Bureau of Labor Statistics, 2023a, 2023b). However, our findings suggest that these gaps may narrow if individuals major in fields with strong connections to the labor market and if they work in occupations closely tied to their college majors (and even more so if both conditions are satisfied). While previous studies have consistently documented systematic differences in college major choices across race and nativity, it has remained unclear whether these major choices are in fields with strong linkages to the labor market or lead to a good occupational match. We find that immigrants are more likely to complete a college major with stronger linkages than native-born individuals but are less likely to work in a matched occupation. In terms of race and ethnicity, Hispanics are less likely to choose majors with strong linkages and work in matched occupations. However, Black, Hispanic, and foreign-born workers in matched occupations seem to benefit more from linkage

strength than White, U.S.-born workers in matched occupations. Additionally, state analyses reveal that the earning premiums among immigrants and racial and ethnic minorities are stronger in established and new immigrant destinations than in non-destinations. This observation may reflect the presence of stronger networks among immigrants and racial and ethnic minorities, or it may be tied to state policies that encourage historically marginalized populations to pursue college majors closely aligned to jobs in the labor market or to work in fields related to their majors.

Going forward, policymakers and researchers ought to explore why college students major in fields tightly or loosely connected to the job market and why some students end up working in a matched occupation, while others do not. As we have shown, these choices differ by demographic group. Regardless of the reason why, practitioners at colleges and universities, in collaboration with employers, may wish to use this information to develop novel strategies that can help students learn more about the career pathways of different college majors and how they connect to jobs. Moreover, college career placement offices, as well as academic department staff, can work with employers to assist students, particularly those from historically marginalized backgrounds, acquire positions in occupations related to their college majors.

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Table 1. Summary statistics, earnings sample

	White (1)	Black (2)	Hispanic (3)	Asian (4)	All (5)
Wage*	73,444.83 (76,168.98)	53,205.73 (44,284.87)	54,781.30 (52,467.81)	68,622.11 (63473.9)	69,623.80 (71,402.57)
Unemployment		-		-	-
z-Linkage strength*	-0.015 (0.996)	0.021 (1.041)	-0.005 (1.001)	0.132 (1.044)	0.002 (1.006)
Match	0.161 (0.367)	0.142 (0.349)	0.139 (0.346)	0.152 (0.359)	0.156 (0.363)
Age	42.79 (11.42)	41.55 (10.90)	39.81 (10.42)	40.81 (10.72)	42.24 (11.27)
Female	0.493 (0.499)	0.576 (0.494)	0.523 (0.499)	0.507 (0.499)	0.504 (0.499)
White	1.000	-	-	-	0.736 (0.440)
Black	-	1.000	-	-	0.085 (0.279)
Hispanic	-	-	1.000	-	0.089 (0.285)
Asian	-	-	-	1.000	0.088 (0.283)
Foreign born	0.058 (0.234)	0.179 (0.383)	0.395 (0.489)	0.769 (0.421)	0.161 (0.368)
Non-English-speaking	0.056 (0.230)	0.124 (0.330)	0.674 (0.468)	0.745 (0.435)	0.178 (0.382)
Married	0.651 (0.476)	0.464 (0.498)	0.565 (0.495)	0.670 (0.469)	0.629 (0.482)
N children	0.852 (1.107)	0.822 (1.088)	0.913 (1.119)	0.849 (1.028)	0.854 (1.100)
Disability	0.037 (0.189)	0.043 (0.204)	0.036 (0.186)	0.020 (0.141)	0.036 (0.186)
Part-time	0.149 (0.356)	0.119 (0.324)	0.142 (0.349)	0.136 (0.343)	0.145 (0.352)
Self-employed	0.102 (0.303)	0.052 (0.224)	0.085 (0.280)	0.084 (0.278)	0.095 (0.294)
In-school	0.060 (0.237)	0.119 (0.324)	0.095 (0.293)	0.072 (0.258)	0.069 (0.254)
Metro	0.826 (0.378)	0.926 (0.260)	0.942 (0.233)	0.968 (0.174)	0.858 (0.348)
Metro mix	0.111 (0.314)	0.051 (0.220)	0.036 (0.186)	0.021 (0.146)	0.091 (0.288)
Non-metro	0.062 (0.241)	0.021 (0.146)	0.021 (0.145)	0.009 (0.098)	0.050 (0.218)
N	1,093,251	93,101	109,386	118,850	1,414,588

Notes: The mean of total personal earned income in 2017 dollars is shown as wage, but in regression models, the natural log of wages is used. All means are weighted by survey weights. The earnings sample includes individuals who are working and have positive earnings. The employment sample includes individuals who are working or not working, including individuals with negative or zero earnings (see Table A.1).

Table 2. Regression results for background characteristics on linkage strength and match

	z-Linkage (1)	z-Linkage (2)	Match (3)	Match (4)
Black	0.032***	0.012**	-0.162***	-0.266***
	(0.005)	(0.005)	(0.013)	(0.014)
Hispanic	-0.022***	-0.004	-0.074***	0.019
	(0.005)	(0.006)	(0.014)	(0.015)
Asian	0.094***	0.010	0.107***	0.009
	(0.005)	(0.008)	(0.014)	(0.023)
Foreign-born	0.126***	0.086***	-0.084***	-0.170***
	(0.004)	(0.006)	(0.013)	(0.017)
Black × Foreign-born		0.133***		0.614***
		(0.014)		(0.035)
Hispanic × Foreign-born		-0.013		-0.180***
		(0.010)		(0.029)
Asian × Foreign-born		0.145***		0.212***
		(0.010)		(0.030)
Constant	0.271***	0.280***	-1.190***	-1.177***
	(0.022)	(0.022)	(0.058)	(0.058)
N	1,414,588	1,414,588	1,414,588	1,414,588

Notes: Standard errors are shown in parentheses (*** p<0.01, ** p<0.05, * p<0.1). All regression models use the earnings sample and are weighted by survey weights. The reference group for race is White and for foreign-born is native-born. All models include year and state fixed effects, as well as controls for age, age-squared, gender, native English speaker status, disability status, marital status, number of children, residency in a metro-nonmetro mix area, residency in a nonmetro area, part-time employment, self-employment, and current school enrollment.

Table 3. Regression results for linkage strength and match on earnings by race

	White	Black	Hispanic	Asian
	(1)	(2)	(3)	(4)
Linkage	0.001	0.002	0.005	0.022***
	(0.001)	(0.004)	(0.005)	(0.008)
Match	0.086***	0.129***	0.096***	0.169***
	(0.003)	(0.009)	(0.011)	(0.016)
Linkage × Match	0.060***	0.073***	0.076***	0.068***
	(0.002)	(0.008)	(0.009)	(0.013)
Foreign-born	-0.028***	-0.098***	-0.223***	-0.077***
	(0.006)	(0.013)	(0.008)	(0.010)
Linkage × Foreign-born	0.000	0.011	-0.018**	0.050***
	(0.006)	(0.012)	(0.007)	(0.009)
Match × Foreign-born	0.080***	0.155***	0.216***	0.069***
	(0.014)	(0.024)	(0.019)	(0.019)
Linkage × Match × Foreign-born	0.000	0.012	-0.011	-0.025*
	(0.011)	(0.019)	(0.016)	(0.015)
Constant	8.990***	8.869***	9.067***	8.805***
	(0.019)	(0.060)	(0.111)	(0.083)
N	1,093,251	93,101	109,386	118,850

Notes: Standard errors are shown in parentheses (*** p<0.01, ** p<0.05, * p<0.1). All models are weighted by survey weights. The reference group for foreign-born is native-born. All models include year and state fixed effects, as well as controls for sociodemographic and labor market characteristics.

Table 4. Regression results for linkage strength on unemployment by race

	White	Black	Hispanic	Asian
	(1)	(2)	(3)	(4)
Linkage	-0.123***	-0.106***	-0.095***	-0.134***
	(0.008)	(0.022)	(0.027)	(0.044)
Foreign-born	0.224***	0.079	0.158***	0.122**
	(0.031)	(0.060)	(0.043)	(0.053)
Linkage × Foreign-born	0.015	-0.135***	0.050	-0.068
	(0.029)	(0.045)	(0.039)	(0.049)
Constant	-3.733***	-1.492***	-2.292***	-2.756***
	(0.146)	(0.329)	(0.488)	(0.565)
N	1,071,494	93,252	108,731	117,825

Notes: Standard errors are shown in parentheses (*** p<0.01, ** p<0.05, * p<0.1). All models are weighted by survey weights. The reference group for foreign-born is native-born. All models include year and state fixed effects, as well as controls for sociodemographic and labor market characteristics.

Table 5. Regression results for background characteristics on linkage strength and match by immigrant destination

	z-Linkage:			Match:		
	Established (1)	New (2)	Non-dest. (3)	Established (4)	New (5)	Non-dest. (6)
Black	0.049***	-0.006	-0.033*	-0.203***	-0.297***	-0.308***
	(0.008)	(0.007)	(0.020)	(0.023)	(0.019)	(0.054)
Hispanic	0.009	-0.004	-0.050	0.073***	-0.024	-0.224**
	(0.007)	(0.010)	(0.034)	(0.019)	(0.028)	(0.091)
Asian	0.037***	-0.020	-0.015	0.098***	-0.067	-0.554***
	(0.009)	(0.014)	(0.060)	(0.028)	(0.042)	(0.182)
Foreign-born	0.106***	0.075***	0.028	-0.151***	-0.146***	-0.270***
	(0.008)	(0.009)	(0.026)	(0.024)	(0.026)	(0.076)
Black	0.113***	0.139***	0.170**	0.633***	0.576***	0.192
× Foreign-born	(0.019)	(0.021)	(0.068)	(0.047)	(0.056)	(0.194)
Hispanic	-0.032***	-0.024	0.048	-0.210***	-0.204***	-0.237
× Foreign-born	(0.012)	(0.018)	(0.057)	(0.036)	(0.056)	(0.183)
Asian	0.135***	0.140***	0.102	0.234***	0.073	0.355*
× Foreign-born	(0.013)	(0.018)	(0.069)	(0.037)	(0.053)	(0.215)
Constant	-0.037	0.362***	0.362***	-1.841***	-0.968***	-0.958***
	(0.029)	(0.029)	(0.073)	(0.082)	(0.076)	(0.186)
N	583,870	704,836	125,882	583,870	704,836	125,882

Notes: Standard errors are shown in parentheses (*** p<0.01, ** p<0.05, * p<0.1). All models are weighted by survey weights. The reference group for foreign-born is native-born. All models include year and state fixed effects, as well as controls for sociodemographic and labor market characteristics.

Table 6. Regression results for linkage strength and match on earnings by immigrant destination

Panel A:	White:			Black:		
	Established	New	Non-dest.	Established	New	Non-dest.
	(1)	(2)	(3)	(4)	(5)	(6)
Linkage	-0.011***	0.007***	0.009**	0.003	0.002	-0.008
	(0.002)	(0.002)	(0.004)	(0.008)	(0.005)	(0.017)
Match	0.085***	0.085***	0.085***	0.113***	0.137***	0.160***
	(0.005)	(0.004)	(0.009)	(0.016)	(0.012)	(0.037)
Linkage × Match	0.043***	0.066***	0.066***	0.079***	0.066***	0.108***
	(0.004)	(0.003)	(0.006)	(0.013)	(0.011)	(0.029)
Foreign-born	-0.017**	-0.038***	-0.045	-0.079***	-0.122***	-0.064
	(0.008)	(0.009)	(0.028)	(0.017)	(0.021)	(0.065)
Linkage × Foreign-born	0.003	0.007	0.003	0.012	0.011	0.006
	(0.008)	(0.009)	(0.029)	(0.020)	(0.015)	(0.049)
Match × Foreign-born	0.103***	0.045**	0.063	0.164***	0.169***	-0.149
	(0.018)	(0.023)	(0.064)	(0.033)	(0.036)	(0.172)
Linkage × Match × Foreign-born	-0.005	0.026	-0.008	-0.004	0.020	0.186*
	(0.014)	(0.017)	(0.049)	(0.027)	(0.027)	(0.105)
Constant	9.235***	9.012***	9.190***	9.082***	8.942***	9.050***
	(0.030)	(0.025)	(0.060)	(0.090)	(0.079)	(0.291)
N	387,069	591,864	114,318	37,482	49,660	5,959
Panel B:	Hispanic:			Asian:		
	Established	New	Non-dest.	Established	New	Non-dest.
	(1)	(2)	(3)	(4)	(5)	(6)
Linkage	0.005	0.006	-0.017	0.020**	0.033**	-0.030
	(0.006)	(0.009)	(0.029)	(0.010)	(0.013)	(0.045)
Match	0.101***	0.107***	-0.139	0.146***	0.215***	0.312***
	(0.013)	(0.021)	(0.091)	(0.020)	(0.027)	(0.117)
Linkage × Match	0.079***	0.060***	0.195***	0.072***	0.056**	-0.001
	(0.011)	(0.017)	(0.061)	(0.016)	(0.024)	(0.114)
Foreign-born	-0.225***	-0.211***	-0.272***	-0.083***	-0.076***	0.080
	(0.009)	(0.017)	(0.047)	(0.012)	(0.017)	(0.064)
Linkage × Foreign-born	-0.026***	0.003	0.036	0.043***	0.056***	0.096*
	(0.009)	(0.015)	(0.047)	(0.011)	(0.015)	(0.053)
Match × Foreign-born	0.200***	0.236***	0.532***	0.108***	-0.023	-0.073
	(0.022)	(0.038)	(0.141)	(0.023)	(0.034)	(0.136)
Linkage × Match × Foreign-born	-0.003	-0.025	-0.152	-0.024	-0.027	0.043
	(0.019)	(0.033)	(0.094)	(0.018)	(0.028)	(0.125)
Constant	9.184***	9.255***	9.237***	9.068***	8.742***	9.571***
	(0.064)	(0.156)	(0.353)	(0.069)	(0.123)	(0.364)
N	79,070	27,444	2,872	80,249	35,868	2,733

Notes: Standard errors are shown in parentheses (*** p<0.01, ** p<0.05, * p<0.1). All models are weighted by survey weights. The reference group for foreign-born is native-born. All models include year and state fixed effects, as well as controls for sociodemographic and labor market characteristics.

Table 7. Regression results for linkage strength on unemployment by immigrant destination

Panel A:	White:			Black:		
	Established	New	Non-dest.	Established	New	Non-dest.
	(1)	(2)	(3)	(4)	(5)	(6)
Linkage	-0.131***	-0.127***	-0.062*	-0.107***	-0.102***	-0.132
	(0.013)	(0.012)	(0.032)	(0.033)	(0.030)	(0.083)
Foreign-born	0.129***	0.341***	0.321**	-0.005	0.191**	-0.069
	(0.042)	(0.048)	(0.157)	(0.078)	(0.097)	(0.279)
Linkage × Foreign-born	0.029	0.008	-0.091	-0.195***	-0.046	-0.438*
	(0.038)	(0.048)	(0.175)	(0.064)	(0.065)	(0.249)
Constant	-3.529***	-3.651***	-3.049***	-0.949**	-1.481***	-1.920
	(0.190)	(0.194)	(0.511)	(0.456)	(0.458)	(1.498)
N	380,422	579,535	111,537	37,817	49,567	5,868
Panel B:	Hispanic:			Asian:		
	Established	New	Hispanic	Established	New	Non-dest.
	(1)	(2)	(3)	(4)	(5)	(6)
Linkage	-0.076**	-0.155**	0.006	-0.151***	-0.089	-0.506
	(0.030)	(0.061)	(0.148)	(0.053)	(0.079)	(0.565)
Foreign-born	0.145***	0.171*	0.426	0.140**	0.067	0.748
	(0.050)	(0.092)	(0.259)	(0.061)	(0.106)	(0.505)
Linkage × Foreign-born	0.033	0.126	-0.235	-0.071	-0.064	0.523
	(0.044)	(0.086)	(0.269)	(0.058)	(0.090)	(0.587)
Constant	-2.030***	-2.249***	-2.312	-1.937***	-2.867***	-4.193*
	(0.353)	(0.792)	(2.398)	(0.384)	(0.795)	(2.332)
N	78,807	27,233	2,691	79,911	35,292	2,622

Notes: Standard errors are shown in parentheses (*** p<0.01, ** p<0.05, * p<0.1). All models are weighted by survey weights. The reference group for foreign-born is native-born. All models include year and state fixed effects, as well as controls for sociodemographic and labor market characteristics.

Appendix

Figure A.1. Standardized linkage strength of each college major

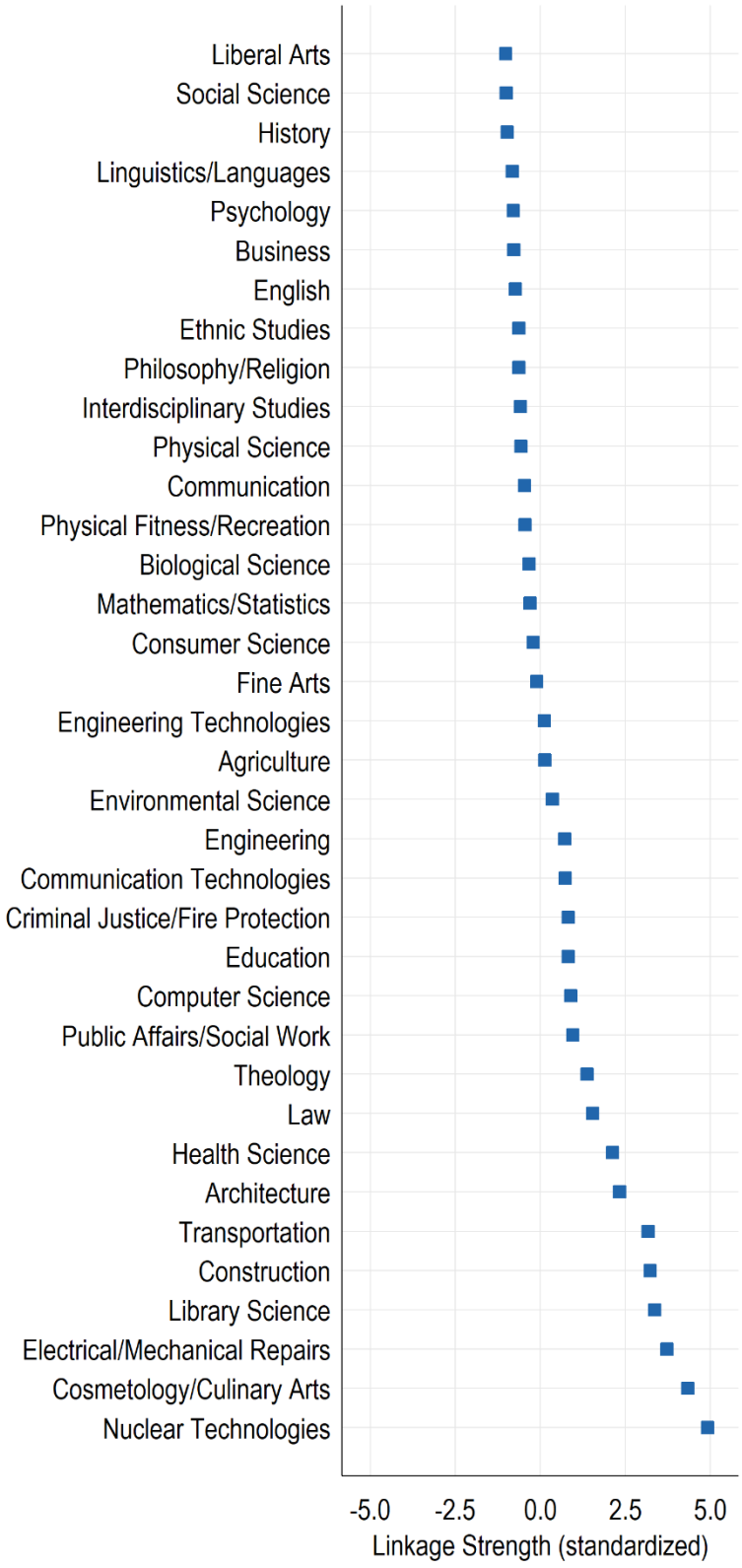

Table A.1. Match occupations by major

Major	Most Common Occupation	Second Most Common Occupation
Agriculture	Farmers, ranchers, & other agricultural managers	Miscellaneous agricultural workers
Architecture	Architects	Urban & regional planners
Biological Science	Biological scientists	Physical scientists
Business	Accountants & auditors	Financial managers
Communication	Producers & directors	Editors
Communication Technologies	Artists	Broadcast/sound engineering technicians & radio operators
Computer Science	Computer programmers	Computer network architects
Construction	Construction managers	Cost estimators
Consumer Science	Preschool & kindergarten teachers	Childcare workers
Cosmetology/Culinary Arts	Morticians, undertakers, & funeral directors	Chefs & head cooks
Criminal Justice/Fire Protection	First-line supervisors of police and detectives	Probation officers & correctional treatment specialists
Education	Elementary & middle school teachers	Special education teachers
Electrical/Mechanical Repairs	Welding, soldering, & brazing workers	Bus/truck mechanics & diesel engine specialists
Engineering	Civil engineers	Mechanical engineers
Engineering Technologies	Industrial engineers	Mechanical engineers
English	Editors	Writers & authors
Environment Science	Conservation scientists & foresters	Environmental scientists & geoscientists
Ethnic Studies	Secretaries & administrative assistants	Human resource workers
Fine Arts	Artists	Designers
Health Science	Registered nurses	Pharmacists
History	Secondary school teachers	First-line supervisors of retail sales workers
Interdisciplinary Studies	Dieticians & nutritionists	Social workers
Law	Paralegals & legal assistants	Miscellaneous legal support workers
Liberal Arts	Secretaries & administrative assistants	Elementary & middle school teachers
Library Science	Librarians	Library assistants
Linguistic/Languages	Secondary school teachers	Secretaries & administrative assistants
Mathematics/Statistics	Actuaries	Computer programmers
Nuclear Technologies	Radiation therapists	Diagnostic related technologists & technicians
Philosophy/Religion	Clergy	Retail salespersons
Physical Fitness/Recreation	Recreation & fitness workers	Athletes, coaches, & umpires
Physical Science	Chemists & materials scientists	Environmental scientists & geoscientists
Psychology	Counselors	Social workers
Public Affairs/Social Work	Social workers	Counselors
Social Science	Social workers	Chief executives & legislators
Theology	Clergy	Religious workers
Transportation	Air traffic controllers & airfield operations specialists	Aircraft pilots & flight engineers

Table A.2. Summary statistics, employment sample

	(1)
Wage*	-
Unemployment	0.033 (0.179)
z-Linkage strength*	0.001 (1.007)
Match	0.156 (0.363)
Age	42.16 (11.21)
Female	0.499 (0.499)
White	0.733 (0.441)
Black	0.086 (0.281)
Hispanic	0.090 (0.286)
Asian	0.089 (0.284)
Foreign born	0.163 (0.369)
Non-English-speaking	0.179 (0.384)
Married	0.626 (0.483)
N children	0.854 (1.099)
Disability	0.035 (0.185)
Part-time	0.133 (0.340)
Self-employed	0.093 (0.291)
In-school	0.067 (0.251)
Metro	0.859 (0.347)
Metro mix	0.090 (0.287)
Non-metro	0.049 (0.217)
N	1,391,564

Table A.3. Regression results for background characteristics on linkage strength and match by gender

	z-Linkage (1)	z-Linkage (2)	Match (3)	Match (4)
Panel A: Male				
Black	0.018***	0.024***	-0.211***	-0.290***
	(0.006)	(0.007)	(0.024)	(0.027)
Hispanic	0.011	0.019**	-0.011	0.051**
	(0.007)	(0.008)	(0.022)	(0.025)
Asian	0.104***	0.044***	0.074***	0.113***
	(0.007)	(0.010)	(0.023)	(0.035)
Foreign-born	0.160***	0.152***	-0.104***	-0.101***
	(0.006)	(0.007)	(0.021)	(0.026)
Black × Foreign-born		-0.023		0.365***
		(0.018)		(0.060)
Hispanic × Foreign-born		-0.014		-0.166***
		(0.013)		(0.047)
Asian × Foreign-born		0.086***		-0.051
		(0.013)		(0.046)
Constant	-0.078***	-0.074**	-1.196***	-1.195***
	(0.029)	(0.029)	(0.095)	(0.095)
N	693,310	693,310	693,310	693,310
Panel B: Female				
Black	0.037***	-0.004	-0.146***	-0.263***
	(0.007)	(0.007)	(0.015)	(0.017)
Hispanic	-0.050***	-0.024***	-0.112***	-0.005
	(0.007)	(0.008)	(0.017)	(0.019)
Asian	0.088***	-0.024**	0.122***	-0.066**
	(0.008)	(0.012)	(0.018)	(0.030)
Foreign-born	0.087***	0.007	-0.071***	-0.221***
	(0.007)	(0.009)	(0.016)	(0.022)
Black × Foreign-born		0.302***		0.776***
		(0.021)		(0.043)
Hispanic × Foreign-born		-0.005		-0.177***
		(0.014)		(0.036)
Asian × Foreign-born		0.215***		0.380***
		(0.015)		(0.038)
Constant	0.838***	0.850***	-0.297***	-0.276***
	(0.032)	(0.032)	(0.072)	(0.072)
N	721,278	721,278	721,278	721,278

Notes: Standard errors are shown in parentheses (*** p<0.01, ** p<0.05, * p<0.1). All regression models use the earnings sample and are weighted by survey weights. The reference group for race is White and for foreign-born is native-born. All models include year and state fixed effects, as well as controls for age, age-squared, native English speaker status, disability status, marital status, number of children, residency in a metro-nonmetro mix area, residency in a nonmetro area, part-time employment, self-employment, and current school enrollment.

Table A.4. Regression results for linkage strength and match on earnings by race and gender

	White (1)	White (2)	Black (3)	Black (4)	Hispanic (5)	Hispanic (6)	Asian (7)	Asian (8)
Panel A: Male								
Linkage	0.007***	0.007***	0.007	0.003	0.005	0.017**	0.077***	0.046***
	(0.002)	(0.002)	(0.007)	(0.007)	(0.005)	(0.007)	(0.006)	(0.011)
Match	0.077***	0.073***	0.133***	0.080***	0.160***	0.089***	0.157***	0.134***
	(0.004)	(0.004)	(0.016)	(0.018)	(0.015)	(0.018)	(0.013)	(0.024)
Linkage × Match	-0.013***	-0.014***	0.026*	0.013	0.018	0.009	-0.027**	-0.003
	(0.003)	(0.004)	(0.016)	(0.018)	(0.013)	(0.015)	(0.011)	(0.022)
Foreign-born	0.002	-0.005	-0.094***	-0.116***	-0.203***	-0.222***	-0.024*	-0.026*
	(0.007)	(0.008)	(0.018)	(0.019)	(0.011)	(0.012)	(0.013)	(0.013)
Linkage × Foreign-born		-0.002		0.019		-0.024**		0.040***
		(0.008)		(0.021)		(0.011)		(0.013)
Match × Foreign-born		0.073***		0.238***		0.200***		0.036
		(0.020)		(0.038)		(0.031)		(0.028)
Linkage × Match × Foreign-born		0.016		-0.006		0.017		-0.034
		(0.016)		(0.036)		(0.027)		(0.025)
Constant	8.899***	8.900***	8.768***	8.772***	9.039***	9.040***	8.806***	8.808***
	(0.027)	(0.027)	(0.104)	(0.103)	(0.115)	(0.115)	(0.120)	(0.120)
N	547,603	547,603	37,866	37,866	50,391	50,391	57,450	5,7450
Panel B: Female								
Linkage	-0.001	-0.001	0.000	0.000	-0.014***	-0.006	0.041***	0.003
	(0.002)	(0.002)	(0.005)	(0.005)	(0.005)	(0.006)	(0.005)	(0.011)
Match	0.100***	0.095***	0.164***	0.148***	0.181***	0.102***	0.267***	0.179***
	(0.004)	(0.004)	(0.011)	(0.011)	(0.012)	(0.014)	(0.011)	(0.022)
Linkage × Match	0.095***	0.095***	0.103***	0.086***	0.105***	0.114***	0.088***	0.099***
	(0.003)	(0.003)	(0.009)	(0.010)	(0.010)	(0.012)	(0.008)	(0.018)
Foreign-born	-0.045***	-0.064***	-0.050***	-0.084***	-0.186***	-0.223***	-0.122***	-0.137***
	(0.008)	(0.009)	(0.016)	(0.018)	(0.010)	(0.011)	(0.013)	(0.014)
Linkage × Foreign-born		-0.006		0.004		-0.016		0.048***
		(0.008)		(0.014)		(0.011)		(0.013)
Match × Foreign-born		0.103***		0.099***		0.232***		0.116***
		(0.019)		(0.032)		(0.024)		(0.026)
Linkage × Match × Foreign-born		0.007		0.042*		-0.019		-0.019
		(0.014)		(0.022)		(0.020)		(0.020)
Constant	8.612***	8.614***	8.755***	8.769***	8.719***	8.734***	8.584***	8.606***
	(0.027)	(0.027)	(0.075)	(0.075)	(0.186)	(0.186)	(0.117)	(0.117)
N	545,648	545,648	55,235	55,235	58,995	58,995	61,400	61,400

Notes: Standard errors are shown in parentheses (*** p<0.01, ** p<0.05, * p<0.1). All models are weighted by survey weights. The reference group for foreign-born is native-born. All models include year and state fixed effects, as well as controls for sociodemographic and labor market characteristics.

Table A.5 Regression results for linkage strength on unemployment by race and gender

	White (1)	White (2)	Black (3)	Black (4)	Hispanic (5)	Hispanic (6)	Asian (7)	Asian (8)
Panel A: Male								
Linkage	-0.105***	-0.104***	-0.088***	-0.050	-0.107***	-0.143***	-0.164***	-0.126*
	(0.012)	(0.013)	(0.033)	(0.037)	(0.031)	(0.041)	(0.035)	(0.069)
Foreign-born	0.144***	0.144***	0.052	0.036	0.000	0.007	0.000	0.007
	(0.045)	(0.045)	(0.094)	(0.095)	(0.068)	(0.069)	(0.068)	(0.069)
Linkage × Foreign-born		-0.006		-0.150*		0.084		0.084
		(0.047)		(0.079)		(0.062)		(0.062)
Constant	-3.050***	-3.050***	-1.595***	-1.582***	-1.115	-1.122	-1.115	-1.122
	(0.198)	(0.198)	(0.531)	(0.531)	(0.701)	(0.700)	(0.701)	(0.700)
N	544,047	544,047	37,996	37,996	50,553	50,553	50,553	50,553
Panel B: Female								
Linkage	-0.136***	-0.140***	-0.168***	-0.134***	-0.041	-0.057	-0.041	-0.057
	(0.011)	(0.011)	(0.024)	(0.028)	(0.026)	(0.036)	(0.026)	(0.036)
Foreign-born	0.299***	0.303***	0.129	0.125	0.274***	0.275***	0.274***	0.275***
	(0.045)	(0.045)	(0.080)	(0.080)	(0.057)	(0.057)	(0.057)	(0.057)
Linkage × Foreign-born		0.041		-0.147***		0.034		0.034
		(0.037)		(0.056)		(0.051)		(0.051)
Constant	-4.568***	-4.566***	-1.388***	-1.396***	-3.291***	-3.291***	-3.291***	-3.291***
	(0.212)	(0.212)	(0.430)	(0.430)	(0.665)	(0.665)	(0.665)	(0.665)
N	527,447	527,447	55,106	55,106	58,127	58,127	58,127	58,127

Notes: Standard errors are shown in parentheses (*** p<0.01, ** p<0.05, * p<0.1). All models are weighted by survey weights. The reference group for foreign-born is native-born. All models include year and state fixed effects, as well as controls for sociodemographic and labor market characteristics.