Centre for Research and Analysis of Migration

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Discussion Paper Series

CDP No 13/08

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Non-Technical Abstract

Economic debate about the consequences of immigration in the US has largely focused on how influxes of foreign-born labor with little educational attainment have affected similarly-educated native-born workers. Fewer studies analyze the effect of immigration within the market for highly-educated labor. We use O*NET data on job characteristics to assess whether native-born workers with graduate degrees respond to an increased presence of highly-educated foreign-born workers by choosing new occupations with different skill content. We find that immigrants with graduate degrees specialize in occupations demanding quantitative and analytical skills, whereas their native-born counterparts specialize in occupations requiring interactive and communication skills. When the foreign-born proportion of highly-educated employment within an occupation rises, native employees with graduate degrees choose new occupations with less analytical and more communicative content. For completeness, we also assess whether immigration causes highly-educated natives to lose their jobs or move across state boundaries. We find no evidence that either occurs.

Key Words: Immigration, Occupational Choice, Highly-Educated Workers, Communication Skills, Mathematical Skills.

JEL Codes: F22, J61, J31.

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November 2008

Abstract

Economic debate about the consequences of immigration in the US has largely focused on how influxes of foreign-born labor with little educational attainment have affected similarly-educated native-born workers. Fewer studies analyze the effect of immigration within the market for highly-educated labor. We use *O*NET* data on job characteristics to assess whether native-born workers with graduate degrees respond to an increased presence of highly-educated foreign-born workers by choosing new occupations with different skill content. We find that immigrants with graduate degrees specialize in occupations demanding quantitative and analytical skills, whereas their native-born counterparts specialize in occupations requiring interactive and communication skills. When the foreign-born porportion of highly-educated employment within an occupation rises, native employees with graduate degrees choose new occupations with less analytical and more communicative content. For completeness, we also assess whether immigration causes highly-educated natives to lose their jobs or move across state boundaries. We find no evidence that either occurs.

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1 Introduction

Between 1950 and 2007, the foreign-born share of employees in the US with a masters, professional, or doctorate degree rose from 5.9% to 18.1%. In light of this trend, which is quite similar to that of immigrants among workers with low education (see Figure 1), it is surprising that economists (with few exceptions) have paid relatively little attention to the effects of immigration within the market for highly-educated workers (those with graduate degrees).

Many analyses have attempted to establish the wage consequences of immigration for less-educated native-born workers. These effects in part depend upon the substitutability between US natives and immigrants within education levels. Borjas (2003, 2006) and Borjas and Katz (2005) argue that workers with identical educational attainment (and experience) are perfectly substitutable. In contrast, Manacorda et. al. (2006), Ottaviano and Peri (2008), and Peri and Sparber (2008b) argue that less-educated native and immigrant workers possess unique skills that lead them to specialize in different occupations. By specializing in occupations requiring tasks in which they have a comparative advantage, less-educated natives mitigate wage losses from immigration.

Although we do not estimate wage effects of immigration in this paper, it is reasonable to assume that such effects for highly-educated labor will also depend upon the substitutability of foreign and native-born workers. Thus, we analyze how native-born employees with graduate degrees change their occupations (and their associated skill content) in response to increases in the presence of a high proportion of similarly-educated foreign labor.

We begin by assuming that highly-educated native and foreign workers provide two general skills in their occupations: They are responsible for performing interactive (or communication) tasks such as talking with supervisors, subordinates, or customers, and also for quantitative (or analytical) tasks such as performing advanced mathematical analysis, designing new products using the principles of physics, and diagnosing ailments or diseases. Given that highly-educated immigrants, relative to native-born workers, will have imperfect language skills, knowledge of local networks, and familiarity with social norms, natives should have a comparative advantage in supplying communication skills, while highly-educated immigrants will have a comparative advantage in performing cognitive-quantitative and analytical tasks.

To assess the potential for specialization among highly-educated native and foreign-born workers, we merge data on occupational skills and abilities from the National Center for *O*NET* Development with individual-level Current Population Survey (CPS) data from 2003-2008. Together, this allows us to measure the skills that native-born workers with graduate degrees used in both their current occupation and the occupation they held in the previous year.

We then use the 1990 Census and 2002-2007 American Community Surveys (ACS) to construct the foreign-born share of highly-educated employment for each year and occupation. After merging this information with the individual-level CPS and skill data, we analyze whether the change in occupational skills used by a highly-educated native employee over the course of a year is related to the change, since 1990, in the share of highly-educated immigrants in the occupation he/she held in the previous year. We find that natives have responded to immigration by pursuing jobs requiring less quantitative and greater communicative skill. That is, we add to evidence from past studies by showing that native occupational adjustment in response to immigration occurs among highly-educated workers and occurs for those already employed.

For completeness, we also test two alternative ways in which highly-educated natives could respond to immigration. First,we test whether immigration and native unemployment are related. We find no evidence that highly-educated native employees in occupations with large increases in the proportion of similarly-educated immigrants are more likely to become unemployed or leave the labor force. Second, we use CPS data to determine if an increased presence of highly-educated immigrants is related to highly-educated natives' internal migration decisions. We find that Natives in *occupations* with high levels of immigration are no more or less likely to move across state borders.

2 Previous Literature

Many developed countries actively work to attract highly-educated immigrants.[1] It is easy to imagine that such workers generate aggregate gains.[2] Endogenous growth literature and its emphasis on human capital spillovers and scale effects in promoting technological development suggest high-education immigration could bolster GDP per capita growth.[3] A diversity of immigrant perspectives, experiences, and networks could spur idea generation, and trade.[4] Borjas (1999) argues that educated immigrants can improve fiscal conditions by increasing tax revenues without burdening social services. Such immigrants might also reduce short-run wage gaps across education levels by increasing the relative supply of highly productive workers.[5]

These aggregate benefits say little about the immediate consequences of highly-educated immigration on similarly-educated natives, however. The dearth of academic understanding of this topic is particularly surprising in light of US immigration law. Highly-educated non-resident immigrants wishing to work in the US usually require an H-1B visa. To obtain one, their employer must file a Labor Condition Application (LCA) stating that it will pay foreign workers wages comparable to those of similarly-educated natives, and that natives' working conditions will not be adversely affected.[6] According to Kapur and McHale (2005), the process is typically fast

[1] Kapur and McHale (2005) and Chiswick and Taengnoi (2007).

[2] Studies on the "brain drain" phenomenon and the potential for aggregate losses from emigration are not part of our analysis.

[3] See Romer (1986), Lucas (1988), Romer (1990), and Ciccone and Hall (1996).

[4] See Gould (1994), Rauch and Trindade (2002), Ottaviano and Peri (2005, 2006a), and Sparber (2008a, 2008b).

[5] Acemoglu (1998), however, notes that such an influx of highly-educated workers might serve to increase wage inequality in the long run.

[6] Other conditions also apply. The US Department of Labor provides detailed information at http://www.dol.gov/compliance/guide/h1b.htm. Additional rules for employers hiring a large proportion of foreign workers, including a condition that "the employer will not displace any similarly employed U.S. worker within 90 days before or after

(applications must be certified within seven days), and "the Department of Labor looks for obvious inaccuracies and incompleteness rather than substantially reviewing the employer's attestations." In other words, H-1B visas are granted without regard to empirical evidence on wage implications.

Much of the work on highly-educated migration to the US is descriptive and often focuses on the market for science and engineering (S&E) workers.[7] Black and Stephan (2007) note that between 1981 and 1999, "temporary residents accounted for more than 50% of the growth in Ph.D. production in the United States. Permanent residents provided for another 10%... Approximately one in three degrees in S&E was awarded to a student on a temporary visa."[8] Stephan and Levin (2007) go on to emphasize that individuals making exceptional contributions to US science and engineering in the recent past were disproportionately foreign-born. Hunt and Gauthier-Loiselle (2008) similarly argue that highly-educated immigrants contribute proportionally more than natives to patented innovations due to their larger specialization in science and engineering occupations.

Rather than focus exclusively on S&E, Groen and Rizzo (2007) show that the share of Ph.D.s granted to US citizens has declined in all fields between 1963 and 2000, though the trends are more pronounced in the sciences and have shown a small reversal in the 1990s. Much of this appears to be due to a decline in the propensity for native-born men to pursue graduate work after the end of the Vietnam War. The propensity for men to pursue professional degrees in law and medicine also declined, though the propensity to earn an MBA rose.

Some authors have focused on trends within occupations. Chiswick and Taengnoi (2007) find that immigrants with limited English proficiency or whose mother tongue is linguistically distant from English work in occupations in which English communication skills are not important. Levin et al. (2004) compare actual employment changes for native and immigrant S&E doctorates in occupational sectors with changes that would have occurred if employment in each sector had grown at the same rate of all S&E doctorates. They find that the share of native S&E doctorates employed in non-S&E positions (7.6%) was greater than the corresponding share among immigrants (4.2%). Moreover, the share of native Ph.D.s in non-S&E jobs after accounting for sectorial composition predicted by trends in native and immigrant S&E Ph.D. attainment (3.4%) is also higher than the figure associated with immigrants (1.6%).

How these trends and stylized facts affect occupational outcomes remains unclear. Levin et al. (2004), for example, explicitly state that the occupational effects they term "displacement effects" are not causal, while Stephan and Levin (2007) note that "the question of how immigrants affect employment outcomes in S&E has yet to be investigated."

George Borjas has done the most work trying to identify the consequences of immigration on natives within the market for highly-educated labor. He argues that, while likely to be beneficial to the US economy as a

applying for H-1B status," do not apply to employers seeking to hire only H-1B workers with graduate degrees.

[7] Many of the papers in this review can be found in *Science and the University* by Stephan and Ehrenberg (2007). Chapters also include contributions by Borjas (2007) and Freeman, Jin, and Shen (2007).

[8] Also see Stephan et al. (2002).

whole, immigration policies favouring highly educated are likely to be detrimental to highly-educated native workers.[9] In Borjas (2003), he finds that the immigration influx in the 1980s and 1990s caused wages to fall by 4.9% for college graduates. Similarly, Borjas (2006) argues that a 10% immigration-induced increase in the supply of S&E doctorates causes the wages paid to native S&E doctorates to decline by 3-4%.[10] Half of this wage effect can be explained by the proliferation of low-paying postdoc positions in the sciences – the same immigration shock causes the probability of a native worker being employed in a postdoc position by 4%, and the magnitude is much larger for younger workers.

To Borjas (2006), native and foreign-born doctorates are perfectly substitutable within "cohort by scientific field of study" groups. This is both because a science doctorate is a "highly specialized endeavor, requiring the investment of a great deal of time and effort, and the training is very specific," but also because he finds that native and foreign-born wages exhibit no statistically distinctive response to immigration. This result is echoed by Bound and Turner (2006), who argue that their "initial evidence on the relative wages of foreign and U.S. born Ph.D.s indicates near perfect substitutability."

The reality may be more nuanced, however. Chellaraj, Maskus, and Mattoo (2005) call perfect substitutability findings into question by citing Trends in International Mathematics and Science Study (TIMMS)[11] evidence that "among the major developed countries and the newly industrialized countries, the United States ranks near the bottom in mathematics and science achievement among eighth graders." Chiswick and Taengnoi (2007) and Levin et al. show that immigrants avoid jobs demanding high English skills, and that native-born S&E Ph.D.s are more likely to pursue non S&E jobs than foreign-born colleagues are. This may be driven by immigrant selection issues. Bhagwati and Rao (1999) claim that "the preponderance of foreign students get into technical and scientific programs because they (chiefly Asians) happen to be 'good at' mathematics and far less so at 'verbal' skills." Similarly, Chiswick (1999) explains the attraction of foreign students to US science by arguing that "science involves internationally transferable skills in contrast to the tendency for the humanities to be much more country specific."

Altogether, the literature suggests that a comparative advantage exists such that highly-educated natives choose communication-intensive jobs, while foreign-born workers are attracted to math, science, and engineering occupations. If highly-educated immigrants choose to specialize in scientific fields, it is worth asking how native employees with graduate degrees respond. Trends indicate that native workers are choosing alternatives to science and engineering at high rates. Levin et al. (2004) concede that "citizens may be more likely than their non-citizen counterparts to opt for better employment opportunities elsewhere in the economy." In our empirical analysis, we more formally assess how employed native-born workers with graduate degrees respond

[9] See Borjas (1999).

[10] Borjas (2005) provides a similar result in a more condensed version of Borjas (2006).

[11] See http://timss.bc.edu/timss2003.html.

to immigration through their choice of occupation and the skills those occupations require.

3 Data and Methodology

To ascertain how the occupational skills used by native-born workers change in response to immigration, we must develop a dataset that has individual-level demographic information, measures of occupational skill content, and foreign-born employment data across time. We achieve this by merging *O*NET* occupational characteristic information, individual-level CPS data from 2003-2008, and aggregated occupational employment data from the 1990 Census and 2002-2007 ACS surveys.

In 1998, the National Center for O*NET Development's *O*NET* database replaced the US Department of Labor's *Dictionary of Occupational Titles* (*DOT*) as the primary source of information about US job characteristics. Since then, *O*NET* has gathered information on hundreds of variables for more than 800 SOC-defined occupations. Prior to 2003, *O*NET* acquired its data from surveys administered to job analysts and experts. Beginning in 2003, however, information has come from job incumbent surveys. The database is updated twice a year, and its active "production database" is available for download.[12]

*O*NET* categorizes its variables into six distinct surveys, though we choose to select variables only from two – the Abilities and Activities surveys.[13] These surveys ask respondents to evaluate the importance of 52 particular abilities (skills) and 41 activities (tasks) required by his/her current job on a scale of 1 to 5.[14] In principle, this would allow us to assess workers' comparative advantage for 8,556 skill pairs. Instead, we are motivated by past literature and common practice to focus on the seven interactive (or communication) and five quantitative (or analytical) skills shown in Table 1.

Interactive skills include the ability to comprehend and express both oral and written material. They also include the importance of communicating with coworkers and people outside a person's workplace. Strictly speaking, quantitative and analytical skills are not synonymous. Lawyers, for example, require very little mathematical acumen but a high degree of inductive reasoning ability. Nonetheless, we treat quantitative and analytical skills as synonyms, so that the terms represent the importance of performing mathematical functions, analysis of data and information, and deductive and inductive reasoning tasks.[15]

The National Center for *O*NET* Development uses its surveys to assign an average level of importance for these skills to each SOC occupation. It also provides an SOC-to-Census 2000 Occupation Code crosswalk. This

[12] We use the *O*NET* 11.0 database, available at http://www.onetcenter.org/database.html.

[13] *O*NET* also provides worker Knowledge, Skills, Work Context (working conditions), and Work Styles surveys.

[14] Those who choose a score of 2 or higher are then asked to evaluate the level of each ability (or activity) needed to perform the job on a scale of 1 to 7. We do not use information from the "level" questions since they are conditioned upon previous survey responses.

[15] It is important to note that highly-educated workers use these skills extensively. Many of the omitted skill measures focus on manual tasks (which highly-educated workers do not often use) or on skills in which the comparative advantage is not immediately obvious (such as creativity or organizational ability). Exceptions to this rule exist, as Table 3 will make apparent, but it would be simple to incorporate additional skills into the analysis.

allows us to merge *O*NET* job characteristic information with individuals in the 2000 Census who hold those occupations.[16] The somewhat arbitrary scale of measurement of the original *O*NET* data motivates us to rescale the variables and assign percentile values for each job characteristic based upon wage earning employees between 18 and 65 years of age in the 1% sample of the 2000 Census.[17] Unfortunately, Census occupation codes are not constant throughout the time period of our analysis. To compensate, we then calculate occupation-specific skill values for the time-consistent IPUMS variable *occ1990* by taking the weighted average of skill values among the year-2000 occupations that comprise each *occ1990* code.[18]

In their analysis of the effects of immigration on workers with little educational attainment, Peri and Sparber (2008b) simply aggregate rescaled *O*NET* values to the state level. They then use variation across states over a long time horizon (1960-2000) to identify the effects of immigration on the skills used by less-educated natives. The methodology is appropriate since evidence suggests that markets for less-educated labor are local, and native-born workers without college experience do not respond to immigration by moving across state borders.[19] This assumption, however, may not be tenable for the highly-educated labor market which may be national in scope.[20] Thus, cross-state variation in immigration rates and skill use may be an inappropriate identification strategy.

Our analysis of the highly-educated labor market departs, methodologically, from Peri and Sparber (2008b) by instead analyzing the effect of immigration on employed individuals in a shorter and more recent time period. Specifically, we assess how the change in the foreign-born share of workers with a graduate degree in an occupation since 1990 subsequently affects the yearly change in occupational skills used by highly-educated native employees.[21]

The individuals in our analysis come from the CPS, which records both a respondent's occupation in the year of and prior to the survey. We focus on the post-9/11 period and merge *O*NET* occupational skill data to CPS individuals from 2003-2008.[22] In principle, immigration figures could also be constructed from CPS data. However, these aggregated values have a large potential for measurement error, since CPS surveys are relatively small in scale. Instead, we use the much larger 1990 Census and 2002-2007 ACS datasets. The foreign-born share of highly-educated employment in a 2003-2008 CPS individual's prior-year occupation is simply the share calculated from current-year 2002-2007 ACS occupation data. Changes an occupation's foreign-born share

[16] 2000 Census data comes from IPUMS (Ruggles et al. (2005)).

[17] Thus, for example, a Mathematical Reasoning ability value of 0.91 for Economists imply that Economists used more of these skills than 91% of the workforce in 2000.

[18] See Peri and Sparber (2008b). Autor, Levy, and Murnane (2003) employ a similar methodology using *DOT* data.

[19] See Card (2007), Card and Lewis (2007), Cortes (2008), Ottaviano and Peri (2007), or Peri and Sparber (2008a).

[20] Also see Borjas (2006).

[21] We use longer differences (between 1990 and year t) in measuring the inflow of foreign-born to allow for slow responses and reduce noise and measurement error in the explanatory variable.

[22] Ruggles et al. (2005) provides CPS data through IPUMS. We base the current-year occupation merge on the variable *occ1990*. The variable *occly* measures an individual's occupation in the prior-year. Using the IPUMS-provided occupation-to-*occ1990* crosswalk, we are able to construct an analogous *occ90ly* variable that provides time-consistent codes for an indivual's occupation in the prior year. We base the prior-year occupation merge on this variable.

simply measure the difference in this proportion between the 1990 Census and the relevant ACS year.[23]

Before turning to the empirical analysis, a few descriptive statistics, tables, and charts will be helpful. Over the survey period 6.2% of the 44,018 highly-educated native individuals in the sample have changed their occupation . Table 2 lists the proportion of highly-educated natives that chose new occupations over the course of a year, as well as the percentage-point change in the foreign-born share between 1990 and the 2002-2007 ACS samples, for occupations with more than 100 CPS observations. Turnover rates vary sizably. Around 10% of highly-educated natives in several management occupations changed their occupation in a year, about 1% of lawyers and architects did. Given that an individual's occupation in both the preceding and current year are recorded in the same survey, we believe that most of the observed changes reflect actual changes and not simple coding errors. The change in the foreign-born share also varies considerably – it declined for both Police Officers and Kindergarten Teachers, but rose by more than 20 percentage points for Electrical Engineers and Computer Software developers. Finally, the weighted correlation between the two variables is 0.14. This figure, however, does not provide information about the change in skill composition associated with occupational changes.

Table 3 lists the average occupational skill intensity among highly-educated employees between 2003-2008 for all skill measures, including those not used in the analysis. The value of 0.78 for Inductive Reasoning, for example, indicates that the average occupation chosen by workers with graduate degrees required more inductive reasoning skills than that used by 78% of the entire labor force. Note that all skill measures we use (Italicized in Table 3) have average values above 0.5, suggesting that these are skills often adopted by highly-educated workers.

Table 4 provides select skill values for occupations commonly employing highly-educated labor (more than 25% of the workers in each occupation hold a graduate degree). Column (1) lists the foreign-born share of highly-educated workers for each occupation in the table. Columns (2) and (4) provide the level of quantitative and interactive skills computed by averaging our four quantitative and seven interactive skills, respectively. The fourth column records the relative quantitative versus interactive value, and the final column converts this ratio into a percentile so that the occupation with the median value of quantitative versus interactive skill level (among all workers between age 18 and 65 in 2000) has a value of 0.5. Though far from a perfect one-to-one correspondence, the table demonstrates that foreign-born laborers disproportionately work in occupations demanding high quantitative versus interactive skills. Also, the occupational ordering of relative skill values appears to be reasonable. Musicians use fewer quantitative versus interactive skills than managers do, and managers use fewer of these relative skills than scientists do.

[23] Individual-level regressions in Section 4 include non-group quarter, wage-earning, civilian employees, 25 to 65 years old, with a masters, professional, or doctorate degree, who worked in defined states, industries, and occupations both in the year of and prior to the CPS survey (note that CPS data does not allow us to identify whether individuals aged 25 and older are enrolled in school).
Immigrant share estimates do not require that the individual is currently employed.
Skill percentiles are based upon non-group quarter, wage-earning, civilian employees, 18-65 years old, working in defined industries and occupations in the 1% 2000 Census, regardless of educational attainment and country of birth.

Figure 2 documents the trend in the average skill use of highly-educated native and foreign-born labor from 2003-2008. Though the trends themselves are quite stable in this short time horizon, the difference in occupation choice between native and immigrant workers is striking. Immigrants with graduate degrees choose occupations with quantitative versus interactive skills 4.8 percentiles above the median occupation. Highly-educated natives choose jobs 8 percentiles below the median.

Given the clear tendency of highly-educated natives to select occupations requiring communication skills at higher rates than immigrants choose those occupations, and the inclination for immigrants to choose jobs requiring quantitative skills more often than natives do, we believe an analysis of skill specialization remains appropriate.

4 Skill Response

Equation (1) presents our main empirical specification.

$$\begin{aligned} \Delta \left(\frac{Q}{I}\right)_{i,t}^{Native} &= \alpha + \beta \cdot \Delta FB_{i,t,occly} + \gamma \cdot X_{i,t} + FE_i + FE_t + \varepsilon_{i,t} \qquad (1) \\ \text{where } \Delta \left(\frac{Q}{I}\right)_{i,t}^{Native} &= \left(\frac{Q}{I}\right)_{i,t,occ}^{Native} - \left(\frac{Q}{I}\right)_{i,t,occly}^{Native} \\ \text{and } \Delta FB_{i,t,occly} &= FB_{i,t,occly} - FB_{i,1990,occly} \end{aligned}$$

The dependent variable is the change in the relative quantitative/interactive skills used by a native employee with a graduate degree between his/her current occupation (*occ*) and his occupation last year (*occly*), as recorded in the year t CPS survey. This value equals zero for all natives who did not change occupations in a given year. The variable $FB_{i,t,occly}$ is the foreign-born share among employees with a graduate degree in individual i's occupation in the year prior to the year t estimated from occupation data in year $t-1$ ACS surveys. Similarly, $FB_{i,1990,occly}$ is the same share in 1990 as estimated by the Census. The main regressor of interest, $\Delta FB_{i,t,occly}$, is simply the difference in these values. If increases in the proportion of highly-educated immigrants cause native employees with graduate degrees to move to occupations with lower quantitative/interactive content, β should be negative. As there are delays and persistence in the occupational response of natives we include the change of foreign-born share in the occupation during the whole period between year 1990 and year $t-1$.

The vector $X_{i,t}$ includes a number of demographic characteristics, including the individual's age and indicator variables for gender (male or female), educational attainment (masters, professional, or doctoral degree), and race (Asian, black, Hispanic, white, or multiple/other race). The regression includes a full set of fixed effects controlling for the year of the CPS survey, a person's state of residence both in the current and proceeding year, as well as the individual's industry of employment in both the current and preceding year.

As we are using variables in differences we do not include occupation fixed effects. We do, however, introduce variables measuring the highly-educated employment growth in the current and prior-year occupations since 1990 to control for occupational trends. We include fixed effects for state or residence in year t and $t-1$ and fixed effects for industry in year t and $t-1$.

Results for the baseline specification are in Table 5. All regressions are weighted by individual survey weights[24] and are clustered by the occupation of employment of the preceding year. Cells contain the estimate (and standard error) of the coefficient β for each possible combination of quantitative and interactive skill variables. Each of these 28 separate regressions has 44,018 observations, with R^2 values ranging from 0.19 to 0.37.

The regressions provide evidence that highly-educated natives respond to immigration by adopting occupations with less quantitative versus interactive content. Moreover we believe that the inclusion of an array of fixed effects and of individual and occupation- level controls, plus the fact that the dependent variable is an individual response and the explanatory variable an industry-level change allow us to interpret the coefficient estimates as causal. Each estimate of the coefficient on the immigrant share is negative, and 31 of the 35 values are significant. The magnitudes are reasonable. According to the estimate using Deductive Reasoning and Written Expression skills, for example, a ten percentage-point increase in the immigrant share of highly-educated workers induces natives with graduate degrees to choose occupations with 0.507 percentiles less quantitative versus interactive content. Depending upon the specification, the same shock is estimated to lead to a decline between 0.2 and 0.7 percentiles. Though not in Table 5, we also perform a regression in which Q and I are first constructed from an average of the relevant *O*NET* values and then converted into percentiles. This delivers a highly significant β estimate of -0.068 (standard error of 0.017) that is larger in magnitude than the estimates in Table 5.

The results are robust to the alternative measures of quantitative and interactive occupational skill content. It is worth noting, however, that the magnitudes are always smallest when the importance of Analyzing Data or Inductive Reasoning abilities are the proxies for analytical skills. The responses are greatest in regressions using Mathematical abilities or the importance of Estimating the Quantifiable Characteristics of Products. Thus, responses are stronger in regressions using variables more closely linked to quantitative (as opposed to analytical) skills. Among the interactive skills, the importance of Written Comprehension tends to deliver the lowest magnitudes, while the importance of Resolving Conflicts and Negotiating generates the largest.

One possible objection is that omitted variables might be correlated with both the immigrant share of an occupation and trends in occupational employment. Although the short panel and the rich set of fixed effects and covariates should mitigate this problem, further information can be gleaned by including foreign-born workers

[24]Weights (and averages) are hourly-adjusted so that they equal the IPUMS variable *perwt* multiplied by the individual's usual number of hours worked and by the number of weeks in the year the individual typically works.

in the model. The regressions in Table 6 introduce foreign-born workers with graduate degrees, an indicator variable for native workers, and a term interacting the native worker dummy with the change in the foreign-born share of workers. In each cell of the table, the first value represents the coefficient on the foreign-born share for all highly-educated workers. The second value (in bold) represents the differential effect experienced by natives.

The general effect is negative in all 35 specifications and significant in all but seven. Thus, all highly-educated workers with graduate degrees respond to a high presence of foreign labor by seeking occupations with less quantitative versus interactive content. More interesting, however, is that there is strong evidence that this effect is larger among native-born workers. The coefficient on the interaction term is negative in 27 of the specifications, significant in 14, and never positive and significant. Similar to the results in Table 5, this differential effect is least likely to be significantly negative when analytical skills are measured by the importance of Analysis of Data and Information or Inductive Reasoning, and when written comprehension proxies for communication skills. This finding confirms that native workers are more likely to shift occupation according to their comparative advantages (in communication skills) in response to a large inflow of educated foreign-born in the occupation.

Not only do highly-educated natives respond to immigration of foreign workers with graduate degrees, but more detailed analysis also reveals results that conform to findings from past studies. In their analysis of immigration and occupation choice, Chiswick and Taengnoi (2007) separately assess the behavior of immigrants from English speaking developed countries (the UK, Ireland, Australia, and New Zealand) since they should not have barriers to finding employment in occupations requiring English speaking ability. In other words, immigrants from these countries might have skills more substitutable with those of natives. We test this possibility by analyzing the native worker response to immigration from both English speaking developed countries (ESDC) and other source countries (see Table 7). The coefficient on the share of immigrants from non-English speaking countries remains negative and significant in 34 of the quantitative and interactive skill combinations. The coefficient on the share from ESDC countries is negative only once, and is actually positive and significant in ten specifications. Thus, native workers do seem to be responding to differences in the innate skills of foreign workers.

Borjas (2006) notes that the highly-specialized training in doctoral work could make workers with PH.D.s particularly immobile across occupations. Table 8 presents our assessment of how native workers with doctorate degrees respond to the foreign-born share of Ph.D.-recipients in an occupation.[25] Although the coefficient is negative in 29 specifications, it is significant in only 12. Thus, it does appear that the occupational skill response to immigration among native doctorates is small.

One might be concerned with lack of mobility among older workers as well. In fact, 6.7% of our sample's

[25] Only 4.9% of the 4,971 native-born workers with a PhD in the sample changed their occupation of employment.

22,208 young native workers (at or below the median age of 45) changed occupations, while only 5.6% of our remaining 21,810 old native workers did. The regressions in Table 9 separate the effects of immigration on these two groups by including an immigration interaction term for young workers (and by replacing the quantitative age control variable with a categorical young indicator). Despite the higher likelihood for young workers to change jobs, however, regressions offer relatively weak evidence for a differential effect of immigration on these two groups. The general impact is negative in each specification and significant in 25. The differential effect, while negative in 26 of the regressions, is significant in only seven.

We have also performed several robustness checks not presented here for space considerations. In one model, we estimate the effects conditional upon a native worker having changed occupations, by removing all natives who remained in a single occupation a given year. This alternative causes the magnitude of β estimates to increase roughly tenfold and remain highly significant. In other checks, we remove all state and industry fixed effects in the model. Conclusions from baseline, Ph.D., and young versus old regressions are quite similar. In regressions that identify the effect of immigration from ESDC countries, the coefficients are significantly negative in all but one specification. The most important differences come in regressions isolating the effect on native versus foreign-born workers. Models without state and industry indicators fail to find a differential effect on the two groups. Altogether, however, we believe that the regression results provide strong evidence that native-born employees with a graduate degree respond to immigration by choosing new occupations with more quantitative and less interactive content.

5 Employment

The skill response regressions in Section 4 only include native workers who were employed both in the year prior to and the year of the CPS survey. While those regressions imply that workers who remain employed in each year respond to immigration by changing the skill content of their occupations, they say nothing about those who have lost their jobs or have left the labor force. If highly-educated foreign-born workers increase the probability of natives leaving employment one needs to account for this effect too when evaluating labor market impact of highly educated immigrants. The linear probability model in Equation (2) explores how the labor force status of natives changes in response to immigration. The results are in Table 10. Each regression is weighted by individual survey weights and standard errors are clustered by the occupation of employment of the preceding year.

$$LFStatus_{i,t}^{Native} = \alpha^L + \beta^L \cdot \Delta FB_{i,t,occly} + \gamma^L \cdot X_{i,t} + FE_i^L + FE_t^L + \varepsilon_{i,t}^L \quad (2)$$

In Columns 1 and 2, the binary dependent variable equals one if the US-born individual who had been employed in the year prior to the CPS survey was currently unemployed. Of the 44,838 observations who had remained in the labor force, 586 (1.3%) were unemployed. The dependent variable in the second two regressions instead measures whether a highly-educated native had either become unemployed or left the labor force (4.3% of the sample of 44,252). Each specification measures $\Delta FB_{i,t,occly}$ as the change in the foreign-born share of highly educated workers in a native worker's occupation in the year prior to the survey (as described in Section 4). The vector $X_{i,t}$ retains the previously defined control variables, though it drops the growth rate of highly-educated employment in the individual's current occupation.[26] Columns 1 and 3 include fixed effects for the CPS year and the individual's current and prior-year state of residence and industry of most recent employment. Columns 2 and 4 also include prior-year occupation fixed effects.

The estimates in the first row of Table 10 show that highly-educated immigrants do not push similarly-educated natives out of employment. In fact, the estimates of β^L are two times positive and two times negative and never significant. Concerns that highly-educated native employees lose their jobs due to immigration seem unfounded. Instead, those employees often respond to immigration by choosing new jobs with less quantitative and more interactive skill content.

6 Internal Migration of Natives

While highly-educated natives respond to immigration through their occupational choices, it is possible that they respond in other ways as well. For example immigration may encourage natives to move across state boarders to flee from competition. If competition is genuinely national in the considered occupations, this would not protect native wages. However, competition may decrease with geographic distance. To explore the possibility for internal migration, we use the CPS datasets from 2003-2008 and the linear probability model in Equation (3).

$$Move_{i,t}^{Native} = \alpha^M + \beta^M \cdot \Delta FB_{i,t,occly} + \gamma^M \cdot X_{i,t} + FE_i^M + FE_t^M + \varepsilon_{i,t}^M \quad (3)$$

We examine three potential dependent variables: Indicator variables for whether or not an individual native with a graduate degree (i) moved across state borders, moved to a new state for work reasons, or moved to a new state with a lower proportion of immigrants between CPS years $t-1$ and t. Only 1,285 of the 46,163 natives (2.7%) in the sample did move; 753 (1.6%) moved for job reasons, while 764 (1.7%) moved to states with a lower proportion of immigrants.[27]

The vector $X_{i,t}$ includes the same variables as in the employment regression: An individual's age, the annual growth rate of his/her occupation in the year prior to the CPS survey, and indicators for gender, education

[26] The CPS records an individual's most recent occupation if he or she is currently unemployed. Individuals currently out of the labor force receive a separate (NA) occupation code.

[27] Note that the sample size is larger than for the skill regressions, as we no longer require individuals to be employed in the year of the CPS survey.

level, and race. The main explanatory variable of interest, $\Delta FB_{i,t,z}$, is the same as in previous regressions – the change in the foreign-born share of highly-educated workers in an individual's occupation in the year prior to the CPS survey. All regressions are weighted by individual survey weights and are clustered by the occupation of employment of the preceding year. Each also includes fixed effects for the year of observation, a person's state of residence in the current and proceeding year, and the individual's most recent and prior-year industries of employment. Columns 2, 4, and 6 also control for the individual's occupation in the prior year. In no specification do we find significant evidence that natives with graduate degrees respond to highly-educated immigration within their occupations by changing their state of residence.

7 Conclusion

Native and foreign-born workers with graduate degrees work in occupations requiring distinctively different tasks. Natives specialize in occupations demanding interactive or communication skills, while highly-educated immigrants disproportionately work in occupations requiring quantitative and analytical skills. As the foreign-born share of highly-educated employment rises, native-born employees respond by moving to jobs with less quantitative and more interactive content.

While highly-educated native-born employees respond to immigration by changing occupations, there is no evidence that immigration causes natives to become unemployed or leave the labor market altogether. There is also no evidence suggesting that native employees might migrate to states with lower proportions of immigrants. This last result is based upon data that observes very few natives who had moved over the course of a year. Instead, native-born occupational skill change appears to be the dominant consequence of highly-educated immigration.

The wage consequences of immigration were not examined in this paper, but they are likely to depend upon the degree of task reallocation experienced by native workers. If the evidence from the labor market for less-educated workers is an indication, the occupational skill response among highly-educated natives is likely to mitigate their potential wage loss from highly-educated immigration.

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Table 1
***O*NET* Skills, Variables, and Variable Descriptions**

Skill Type	O*NET Survey	Skill Variable Label	Skill Description
Interactive	Activities	Negotiate	Resolving Conflicts and Negotiating with Others
Communication	Activities	Comm In Org Comm Out Org	Communicating with Supervisors, Peers, or Subordinates Communicating with Persons Outside Organization
	Abilities	Oral Comp Writ Comp Oral Exp Writ Exp	Oral Comprehension Written Comprehension Oral Expression Written Expression
Analytical	Activities	Analyze	Analyze Data or Information
	Abilities	Deduce Induce	Deductive Reasoning Inductive Reasoning
Quantitative	Activities	Est Quant	Estimating the Quantifiable Characteristics of Products, Events, or Information
	Abilities	Math	Mathematical Reasoning

Note: The source of definitions is the O*NET Database provided by the National center for O*NET development.

Table 2

Percentage of Native Employees with Graduate Degrees Changing Occupations in a Year, by Prior Year Occupation

% Natives Who Change Occupations	%-Point Change in Foreign Share	Occupation	% Natives Who Change Occupations	%-Point Change in Foreign Share	Occupation
31.0	2.8	Salespersons, n.e.c.	5.9	1.2	Mechanical engineers
15.6	8.2	Industrial engineers	5.7	3.8	Vocational and educational counselors
14.0	11.3	Recreation workers	5.6	24.4	Computer software developers
13.9	6.0	Welfare service aides	5.1	1.2	Managers of medicine and health occupations
13.1	5.8	Editors and reporters	5.0	6.5	Other financial specialists
13.0	6.2	Customer srvc reps, investigators & adjusters, except insurance	5.0	0.1	Civil engineers
12.3	2.7	Secretaries	4.9	6.0	Supervisors and proprietors of sales jobs
11.6	9.8	Economists, market researchers, and survey researchers	4.8	1.8	Managers in education and related fields
11.2	8.4	Designers	4.6	11.6	Computer systems analysts and computer scientists
10.7	6.2	Managers and specialists in marketing, advertising, and PR	4.2	4.2	Registered nurses
10.2	1.5	Physical therapists	4.2	-0.1	Police, detectives, and private investigators
10.2	8.6	Management analysts	4.1	1.6	Psychologists
9.9	4.4	Purchasing managers, agents and buyers, n.e.c.	4.1	0.0	Kindergarten and earlier school teachers
9.9	8.1	Managers of properties and real estate	4.0	15.0	Chief executives and public administrators
9.8	7.7	Administrative support jobs, n.e.c.	3.9	7.1	Biological scientists
9.3	7.8	Human resources and labor relations managers	3.7	1.4	Speech therapists
9.1	4.0	Therapists, n.e.c.	3.7	6.0	Accountants and auditors
8.9	10.5	Not-elsewhere-classified engineers	3.4	2.5	Clergy and religious workers
8.2	7.9	Pharmacists	3.3	8.0	Subject instructors (HS/college)
7.8	7.3	Personnel, HR, training, and labor relations specialists	3.3	2.2	Secondary school teachers
7.8	3.3	Social workers	3.1	12.9	Dentists
7.5	1.1	Teachers , n.e.c.	2.9	6.3	Financial services sales occupations
7.4	1.6	Office supervisors	2.9	5.3	Geologists
7.0	3.0	Managers of service organizations, n.e.c.	2.9	1.7	Primary school teachers
6.9	18.9	Medical scientists	2.8	1.3	Librarians
6.8	20.1	Electrical engineer	2.8	6.3	Physicians
6.7	8.1	Managers and administrators, n.e.c.	2.6	0.4	Special education teachers
6.5	9.0	Real estate sales occupations	2.4	2.2	Other health and therapy
6.0	14.5	Chemists	1.2	1.9	Veterinarians
5.9	5.6	Financial managers	1.1	6.4	Architects
5.9	1.7	Farm workers	0.9	2.8	Lawyers

Note: Data sources: % Natives Who Change Occupations: Annual CPS Survey, 2003-2008. %-Point Change in Foreign Share: 1990 Census and Annual 2002-2007 ACS Survey. Table lists only occupations with 100 or more observed native workers with a graduate degree.

Table 3

Average Occupational Skill Intensity for Workers with Graduate Degrees, 2003-2008

Skill Average	Ability	Skill Average	Activity
0.32	Arm-Hand Steadiness	0.77	*Analyzing Data or Information*
0.54	Auditory Attention	0.59	Assisting and Caring for Others
0.71	Category Flexibility	0.67	Coaching and Developing Others
0.31	Control Precision	0.67	*Communicating with Persons Outside Organization*
0.76	*Deductive Reasoning*	0.67	*Communicating with Supervisors, Peers, or Subordinates*
0.43	Depth Perception	0.35	Controlling Machines and Processes
0.55	Dynamic Flexibility	0.67	Coordinating the Work and Activities of Others
0.43	Dynamic Strength	0.68	Developing and Building Teams
0.61	Explosive Strength	0.76	Developing Objectives and Strategies
0.33	Extent Flexibility	0.67	Documenting/Recording Information
0.54	Far Vision	0.45	Drafting… Technical Devices, Parts, and Equip.
0.40	Finger Dexterity	0.57	*Est. Quantifiable Characteristics of Products, Events, or Info.*
0.63	Flexibility of Closure	0.71	Establishing and Maintaining Interpersonal Relationships
0.73	Fluency of Ideas	0.70	Evaluating Info to Determine Compliance with Standards
0.53	Glare Sensitivity	0.71	Getting Information
0.38	Gross Body Coordination	0.69	Guiding, Directing, and Motivating Subordinates
0.45	Gross Body Equilibrium	0.31	Handling and Moving Objects
0.53	Hearing Sensitivity	0.69	Identifying Objects, Actions, and Events
0.78	*Inductive Reasoning*	0.38	Inspecting Equipment, Structures, or Material
0.63	Information Ordering	0.63	Interacting With Computers
0.28	Manual Dexterity	0.78	Interpreting the Meaning of Information for Others
0.61	*Mathematical Reasoning*	0.73	Judging the Qualities of Things, Services, or People
0.71	Memorization	0.75	Making Decisions and Solving Problems
0.32	Multilimb Coordination	0.59	Monitor Processes, Materials, or Surroundings
0.57	Near Vision	0.63	Monitoring and Controlling Resources
0.52	Night Vision	0.37	Operating Vehicles, Mechanized Devices, or Equipment
0.55	Number Facility	0.70	Organizing, Planning, and Prioritizing Work
0.72	*Oral Comprehension*	0.63	Performing Administrative Activities
0.74	*Oral Expression*	0.59	Performing for or Working Directly with the Public
0.75	Originality	0.33	Performing General Physical Activities
0.52	Perceptual Speed	0.68	Processing Information
0.52	Peripheral Vision	0.77	Provide Consultation and Advice to Others
0.68	Problem Sensitivity	0.41	Repairing and Maintaining Electronic Equipment
0.48	Rate Control	0.36	Repairing and Maintaining Mechanical Equipment
0.41	Reaction Time	0.69	*Resolving Conflicts and Negotiating with Others*
0.43	Response Orientation	0.69	Scheduling Work and Activities
0.61	Selective Attention	0.60	Selling or Influencing Others
0.47	Sound Localization	0.65	Staffing Organizational Units
0.44	Spatial Orientation	0.73	Thinking Creatively
0.75	Speech Clarity	0.66	Training and Teaching Others
0.68	Speech Recognition	0.76	Updating and Using Relevant Knowledge
0.66	Speed of Closure		
0.38	Speed of Limb Movement		
0.37	Stamina		
0.34	Static Strength		
0.54	Time Sharing		
0.34	Trunk Strength		
0.49	Visual Color		
0.49	Visualization		
0.32	Wrist-Finger Speed		
0.77	*Written Comprehension*		
0.77	*Written Expression*		

Note: *Skills used in data analysis italicized.*

Table 4
Quantitative and Interactive Skill Content of Selected Occupations

	(1)	(2)	(3)	(4)	(5)
Occupation	**Immigrant Share of Employees with Graduate Degrees, 2003-2008**	**Quantitative**	**Interactive**	**Quantitative / Interactive**	**Quantitative / Interactive Percentile**
Musician or composer	0.08	0.08	0.26	0.31	0.00
Vocational and educational counselors	0.06	0.50	0.81	0.61	0.11
Lawyers	0.05	0.63	0.81	0.78	0.20
Secondary school teachers	0.06	0.64	0.75	0.85	0.28
Managers of service organizations, n.e.c.	0.07	0.83	0.90	0.92	0.41
Management analysts	0.17	0.92	0.94	0.98	0.50
Managers of medicine and health occupations	0.09	0.95	0.86	1.10	0.60
Economists, market researchers, and survey researchers	0.26	0.88	0.69	1.27	0.69
Physicists and astronomers	0.25	0.98	0.65	1.51	0.81
Actuaries	0.13	0.97	0.49	1.99	0.91
Mathematicians and mathematical scientists	0.25	0.86	0.33	2.64	0.96

Note: Skill calculations are based upon *O*NET* task definitions, the 2000 Census and the IPUMS occ1990 occupation codes. Columns (2) and (4) represent skill intensity computed by averaging the five quantitative (and analytical) skill and seven interactive (and communication) skill measures described in Table 1. The occupations included are those near each decile of the 2000 distribution of workers' quantitative versus communication task intensity as shown in Column (5). The median worker had a Q/I percentile of 0.50 in 2000. More than 25% of employees in each listed occupation have a graduate degree.

Table 5

Native-Born Occupational Skill Response to Immigration

Dependent Variable: Change in Quantitative versus Interactive Occupational Skill Content (ΔQ/I) Used by Native-Born Workers with a Graduate Degree

Quantitative Skill Measure	Interactive Skill Measure: Negotiate	Comm In Org	Comm Out Org	Oral Comp	Writ Comp	Oral Exp	Writ Exp
Deduce	-0.0465 (0.0149)***	-0.0364 (0.0174)**	-0.0357 (0.0142)**	-0.0369 (0.0133)***	-0.0346 (0.0177)*	-0.0353 (0.0137)**	-0.0507 (0.0157)***
Induce	-0.0463 (0.0146)***	-0.0349 (0.0201)*	-0.0381 (0.0151)**	-0.0327 (0.0129)**	-0.0251 (0.0169)	-0.0305 (0.0137)**	-0.0367 (0.0181)**
Analyze	-0.0371 (0.0139)***	-0.0235 (0.0158)	-0.0270 (0.0174)	-0.0320 (0.0137)**	-0.0183 (0.0210)	-0.0301 (0.0132)**	-0.0332 (0.0123)***
Est Quant	-0.0657 (0.0160)***	-0.0597 (0.0178)***	-0.0621 (0.0186)***	-0.0512 (0.0142)***	-0.0440 (0.0172)**	-0.0529 (0.0143)***	-0.0508 (0.0151)***
Math	-0.0623 (0.0166)***	-0.0488 (0.0169)***	-0.0578 (0.0216)***	-0.0552 (0.0187)***	-0.0456 (0.0184)**	-0.0540 (0.0168)***	-0.0487 (0.0186)***

Note: Each cell contains estimates from a separate regression, and is defined by the different possible combinations of quantitative and interactive skill measures used in the dependent variable as indicated in the column and row headers. The explanatory variable is the change in the foreign-born share of workers with a graduate degree in the occupation since 1990.

Observations: 44,018 native-born workers with a graduate degree.

Individual Data Source: CPS, 2003-2008. Change in skill content determined by an individual's occupation in the year of and year prior to the CPS survey.

Other Controls: Age, growth rate of highly educated in the occupation, indicators for educational attainment, gender, and race.

Fixed Effects: Year of survey, state of residence in the year prior to the survey, state of residence in the survey year, industry of employment in the year previous to the survey and industry of employment in the survey year.

Regression Method: Least squares, with regressions weighted by CPS weights, adjusted for yearly hours worked. Standard errors (in parenthesis) are heteroskedasticity-robust and clustered by occupation of employment in the year prior to the survey.

*** indicates significance at the 1% level ** indicates significance at the 5% level * indicates significance at the 10% level

Table 6
Native and Foreign-Born Occupational Skill Response to Immigration

Quantitative Skill Measure		Dependent Variable: Change in Quantitative versus Interactive Occupational Skill Content (DQ/I) Used by Workers with a Graduate Degree — Interactive Skill Measure: Negotiate	Comm In Org	Comm Out Org	Oral Comp	Writ Comp	Oral Exp	Writ Exp
Deduce	General Effect	-0.0198 (0.0105)*	-0.0127 (0.0154)	-0.0181 (0.0126)	-0.0203 (0.0090)**	-0.0159 (0.0139)	-0.0255 (0.0118)**	-0.0230 (0.0136)*
	Differential Effect on Natives	**-0.0279 (0.0149)***	**-0.0247 (0.0166)**	**-0.0193 (0.0125)**	**-0.0189 (0.0128)**	**-0.0183 (0.0145)**	**-0.0111 (0.0141)**	**-0.0280 (0.0153)***
Induce	General Effect	-0.0286 (0.0121)**	-0.0181 (0.0168)	-0.0273 (0.0132)**	-0.0292 (0.0107)***	-0.0261 (0.0156)*	-0.0337 (0.0133)**	-0.0283 (0.0159)*
	Differential Effect on Natives	**-0.0189 (0.0138)**	**-0.0175 (0.0165)**	**-0.0124 (0.0128)**	**-0.0066 (0.0133)**	**0.0012 (0.0149)**	**0.0022 (0.0148)**	**-0.0083 (0.0159)**
Analyze	General Effect	-0.0331 (0.0115)***	-0.0354 (0.0122)***	-0.0363 (0.0126)***	-0.0372 (0.0107)***	-0.0469 (0.0144)***	-0.0377 (0.0112)***	-0.0434 (0.0136)***
	Differential Effect on Natives	**-0.0049 (0.0148)**	**0.0092 (0.0160)**	**0.0070 (0.0182)**	**0.0028 (0.0165)**	**0.0255 (0.0229)**	**0.0064 (0.0161)**	**0.0089 (0.0181)**
Est Quant	General Effect	-0.0282 (0.0099)***	-0.0202 (0.0122)*	-0.0244 (0.0108)**	-0.0208 (0.0088)**	-0.0183 (0.0107)*	-0.0198 (0.0086)**	-0.0204 (0.0094)**
	Differential Effect on Natives	**-0.0368 (0.0143)****	**-0.0374 (0.0152)****	**-0.0365 (0.0137)*****	**-0.0301 (0.0132)****	**-0.0243 (0.0145)***	**-0.0318 (0.0127)****	**-0.0291 (0.0135)****
Math	General Effect	-0.0257 (0.0132)*	-0.0214 (0.0152)	-0.0216 (0.0149)	-0.0290 (0.0134)**	-0.0210 (0.0138)	-0.0281 (0.0131)**	-0.0257 (0.0147)*
	Differential Effect on Natives	**-0.0366 (0.0145)****	**-0.0286 (0.0151)***	**-0.0366 (0.0149)****	**-0.0273 (0.0150)***	**-0.0232 (0.0152)**	**-0.0257 (0.0146)***	**-0.0230 (0.0157)**

Note: Each cell contains estimates from a separate regression, and is defined by the different possible combinations of quantitative and interactive skill measures used in the dependent variable as indicated in the column and row headers. The explanatory variables include the change in the foreign-born share of workers with a graduate (masters, professional, or doctoral) degree since 1990 ("General Effect" estimate) and the change in foreign-born share interacted with an indicator variable for native-born workers ("Differential Effect" estimate in bold).
Observations: 51,992 workers with a graduate degree.
Individual Data Source: CPS, 2003-2008. Change in skill content determined by an individual's occupation in the year of and prior to the CPS survey.
Other Controls: Age, occupational growth, indicators for educational attainment, gender, race, and nativity.
Fixed Effects: Year of survey, state of residence in the year prior to the survey, state of residence in the survey year, industry of employment in the year prior to the survey, and industry of employment in the survey year.
Regression Method: Least squares, with regressions weighted by CPS weights, adjusted for yearly hours worked. Standard errors (in parenthesis) are heteroskedasticity-robust and clustered by occupation of employment in the year prior to the survey.
*** indicates significance at the 1% level ** indicates significance at the 5% level * indicates significance at the 10% level

Table 7

Native Occupational Skill Response to Immigration from English Speaking Developed (ESDC) and Other Countries

		Dependent Variable: Change in Quantitative versus Interactive Occupational Skill Content (Q/I) Used by Native-Workers with a Graduate Degree						
		Interactive Skill Measure						
Quantitative Skill Measure		Negotiate	Comm In Org	Comm Out Org	Oral Comp	Writ Comp	Oral Exp	Writ Exp
Deduce	Share from ESDC	0.0293	0.0105	0.0851	0.1071	0.0509	0.0874	-0.0351
		(0.0562)	(0.0564)	(0.0511)*	(0.0515)**	(0.0461)	(0.0500)*	(0.0470)
	Share from Other Sources	-0.0500	-0.0385	-0.0413	-0.0435	-0.0385	-0.0410	-0.0514
		(0.0151)***	(0.0177)**	(0.0143)***	(0.0134)***	(0.0180)**	(0.0140)***	(0.0162)***
Induce	Share from ESDC	0.0578	0.0368	0.0842	0.1336	0.0613	0.1385	0.0016
		(0.0558)	(0.0576)	(0.0520)	(0.0548)**	(0.0462)	(0.0567)**	(0.0511)
	Share from Other Sources	-0.0511	-0.0382	-0.0438	-0.0404	-0.0291	-0.0383	-0.0385
		(0.0148)***	(0.0205)*	(0.0153)***	(0.0130)***	(0.0173)*	(0.0139)***	(0.0187)**
Analyze	Share from ESDC	0.0577	0.0709	0.1426	0.1187	0.1119	0.0940	0.0258
		(0.0514)	(0.0540)	(0.0525)***	(0.0483)**	(0.0494)**	(0.0460)**	(0.0442)
	Share from Other Sources	-0.0415	-0.0278	-0.0348	-0.0390	-0.0243	-0.0359	-0.0360
		(0.0143)***	(0.0162)*	(0.0176)**	(0.0140)***	(0.0213)	(0.0134)***	(0.0128)***
Est Quant	Share from ESDC	0.0189	0.0131	0.0462	0.0558	0.0281	0.0418	0.0010
		(0.0551)	(0.0465)	(0.0572)	(0.0440)	(0.0423)	(0.0471)	(0.0424)
	Share from Other Sources	-0.0696	-0.0631	-0.0671	-0.0561	-0.0473	-0.0572	-0.0532
		(0.0163)***	(0.0183)***	(0.0189)***	(0.0146)***	(0.0177)***	(0.0146)***	(0.0155)***
Math	Share from ESDC	0.0227	0.0058	0.0679	0.0894	0.0697	0.0765	0.0114
		(0.0627)	(0.0579)	(0.0631)	(0.0476)*	(0.0482)	(0.0469)	(0.0550)
	Share from Other Sources	-0.0663	-0.0513	-0.0637	-0.0619	-0.0510	-0.0600	-0.0514
		(0.0170)***	(0.0174)***	(0.0220)***	(0.0193)***	(0.0190)***	(0.0174)***	(0.0193)***

Note: Each cell contains estimates from a separate regression, and is defined by the different possible combinations of quantitative and interactive skill measures used in the dependent variable as indicated in the column and row headers. The explanatory variables include the change in the foreign-born share of workers with a graduate (masters, professional, or doctoral) degree from English Speaking Developed Countries (ESDC) or Other Sources since 1990.
Observations: 44,018 native-born workers with a graduate degree.
Individual Data Source: CPS, 2003-2008. Change in skill content determined by an individual's occupation in the year of and prior to the CPS survey.
Other Controls: Age, occupational growth, indicators for educational attainment, gender, and race.
Fixed Effects: Year of survey, state of residence in the year prior to the survey, state of residence in the survey year, industry of employment in the year prior to the survey, and industry of employment in the survey year.
Regression Method: Least squares, with regressions weighted by CPS weights, adjusted for yearly hours worked. Standard errors (in parenthesis) are heteroskedasticity-robust and clustered by occupation of employment in the year prior to the survey.
*** indicates significance at the 1% level ** indicates significance at the 5% level * indicates significance at the 10% level

Table 8
Native-Born Occupational Skill Response to Immigration, Doctorates

Dependent Variable: Change in Quantitative versus Interactive Occupational Skill Content (ΔQ/I) Used by Native-Born Workers with a Doctorate Degree

Quantitative Skill Measure	Interactive Skill Measure: Negotiate	Comm In Org	Comm Out Org	Oral Comp	Writ Comp	Oral Exp	Writ Exp
Deduce	-0.0356 (0.0141)**	-0.0247 (0.0172)	-0.0111 (0.0095)	-0.0216 (0.0106)**	0.0018 (0.0068)	-0.0087 (0.0091)	-0.0058 (0.0073)
Induce	-0.0409 (0.0133)***	-0.0258 (0.0159)	-0.0170 (0.0097)*	-0.0234 (0.0094)**	-0.0026 (0.0082)	-0.0120 (0.0091)	-0.0104 (0.0072)
Analyze	-0.0215 (0.0108)**	-0.0135 (0.0139)	-0.0082 (0.0094)	-0.0096 (0.0096)	0.0172 (0.0105)	0.0018 (0.0089)	0.0029 (0.0082)
Est Quant	-0.0369 (0.0138)***	-0.0310 (0.0130)**	-0.0228 (0.0113)**	-0.0234 (0.0112)**	-0.0121 (0.0096)	-0.0198 (0.0104)*	-0.0173 (0.0094)*
Math	-0.0297 (0.0123)**	-0.0115 (0.0106)	-0.0085 (0.0088)	-0.0140 (0.0094)	0.0012 (0.0081)	-0.0072 (0.0079)	0.0006 (0.0076)

Note: Each cell contains estimates from a separate regression, and is defined by the different possible combinations of quantitative and interactive skill measures used in the dependent variable as indicated in the column and row headers. The explanatory variable is the change in the foreign-born share of workers with a doctorate degree since 1990.
Observations: 4,971 native-born workers with a doctorate degree.
Individual Data Source: CPS, 2003-2008. Change in skill content determined by an individual's occupation in the year of and prior to the CPS survey.
Other Controls: Age, occupational growth, indicators for gender and race.
Fixed Effects: Year of survey, state of residence in the year prior to the survey, state of residence in the survey year, industry of employment in the year prior to the survey, and industry of employment in the survey year.
Regression Method: Least squares, with regressions weighted by CPS weights, adjusted for yearly hours worked. Standard errors (in parenthesis) are heteroskedasticity-robust and clustered by occupation of employment in the year prior to the survey.
*** indicates significance at the 1% level ** indicates significance at the 5% level * indicates significance at the 10% level

Table 9
Young and Old Native Occupational Skill Response to Immigration

Dependent Variable: Change in Quantitative versus Interactive Occupational Skill Content (ΔQ/I) Used by Native-Born Workers with a Graduate Degree

Quantitative Skill Measure		Interactive Skill Measure: Negotiate	Comm In Org	Comm Out Org	Oral Comp	Writ Comp	Oral Exp	Writ Exp
Deduce	General Effect	-0.0495 (0.0172)***	-0.0329 (0.0184)*	-0.0350 (0.0136)**	-0.0367 (0.0139)***	-0.0318 (0.0168)*	-0.0361 (0.0145)**	-0.0560 (0.0149)***
	Differential Effect on Young	0.0055 (0.0158)	-0.0063 (0.0145)	-0.0013 (0.0137)	-0.0003 (0.0153)	-0.0052 (0.0159)	0.0014 (0.0159)	0.0098 (0.0162)
Induce	General Effect	-0.0544 (0.0158)***	-0.0328 (0.0217)	-0.0394 (0.0141)***	-0.0359 (0.0141)**	-0.0298 (0.0180)*	-0.0387 (0.0144)***	-0.0443 (0.0194)**
	Differential Effect on Young	0.0148 (0.0157)	-0.0040 (0.0190)	0.0024 (0.0162)	0.0058 (0.0143)	0.0086 (0.0136)	0.0149 (0.0146)	0.0139 (0.0186)
Analyze	General Effect	-0.0327 (0.0164)**	-0.0030 (0.0173)	-0.0177 (0.0163)	-0.0154 (0.0150)	-0.0071 (0.0216)	-0.0158 (0.0149)	-0.0237 (0.0146)
	Differential Effect on Young	-0.0082 (0.0148)	-0.0376 (0.0184)**	-0.0170 (0.0178)	-0.0306 (0.0152)**	-0.0206 (0.0151)	-0.0263 (0.0143)*	-0.0176 (0.0142)
Est Quant	General Effect	-0.0554 (0.0167)***	-0.0485 (0.0187)**	-0.0515 (0.0172)***	-0.0421 (0.0144)***	-0.0357 (0.0186)*	-0.0446 (0.0147)***	-0.0441 (0.0155)***
	Differential Effect on Young	-0.0192 (0.0164)	-0.0207 (0.0154)	-0.0195 (0.0153)	-0.0167 (0.0134)	-0.0152 (0.0149)	-0.0152 (0.0137)	-0.0123 (0.0145)
Math	General Effect	-0.0546 (0.0183)***	-0.0343 (0.0192)*	-0.0473 (0.0232)**	-0.0341 (0.0215)	-0.0289 (0.0208)	-0.0342 (0.0203)*	-0.0313 (0.0203)
	Differential Effect on Young	-0.0143 (0.0187)	-0.0267 (0.0158)*	-0.0195 (0.0154)	-0.0388 (0.0177)**	-0.0307 (0.0179)*	-0.0364 (0.0205)*	-0.0320 (0.0209)

Note: Each cell contains estimates from a separate regression, and is defined by the different possible combinations of quantitative and interactive skill measures used in the dependent variable as indicated in the column and row headers. The explanatory variables include the change in the foreign-born share of workers with a graduate (masters, professional, or doctoral) degree since 1990 and the change in foreign-born share interacted with an indicator variable for "Young" workers age 45 or younger.
Observations: 44,018 native-born workers with a graduate degree.
Individual Data Source: CPS, 2003-2008. Change in skill content determined by an individual's occupation in the year of and prior to the CPS survey.
Other Controls: Occupational growth, indicators for educational attainment, gender, race, and young workers.
Fixed Effects: Year of survey, state of residence in the year prior to the survey, state of residence in the survey year, industry of employment in the year prior to the survey, and industry of employment in the survey year.
Regression Method: Least squares, with regressions weighted by CPS weights, adjusted for yearly hours worked. Standard errors (in parenthesis) are heteroskedasticity-robust and clustered by occupation of employment in the year prior to the survey.
*** indicates significance at the 1% level ** indicates significance at the 5% level * indicates significance at the 10% level

Table 10
Native Employment Response

	(1)	(2)	(3)	(4)
Dependent Variable:	**Unemployed**		**Unemployed or Not in Labor Force**	
Change in Foreign-Born Share of Last Year's Occupation	0.0108	-0.0216	0.0028	-0.0298
	(0.0149)	(0.0323)	(0.0154)	(0.0333)
Female Indicator	0.0017	0.0007	0.0016	0.0003
	(0.0015)	(0.0015)	(0.0016)	(0.0016)
Professional Degree Indicator	-0.0045	-0.0034	-0.0045	-0.0030
	(0.0017)***	(0.0021)	(0.0018)**	(0.0024)
Doctorate Degree Indicator	-0.0013	-0.0002	-0.0017	-0.0006
	(0.0018)	(0.0020)	(0.0019)	(0.0022)
Asian Indicator	-0.0069	-0.0065	-0.0055	-0.0052
	(0.0035)*	(0.0036)*	(0.0039)	(0.0040)
Black Indicator	0.0035	0.0030	0.0023	0.0018
	(0.0018)*	(0.0018)	(0.0020)	(0.0019)
Hispanic Indicator	-0.0005	-0.0005	-0.0010	-0.0011
	(0.0032)	(0.0031)	(0.0032)	(0.0032)
Other Race Indicator	0.0110	0.0114	0.0103	0.0106
	(0.0071)	(0.0070)	(0.0070)	(0.0069)
Age	0.0001	0.0001	0.0002	0.0002
	(0.0001)	(0.0001)	(0.0001)***	(0.0001)***
High-Education Growth of Last Year's Occupation	0.0001	-0.0011	0.0000	-0.0017
	0.0000	(0.0014)	0.0000	(0.0013)
Constant	-0.0300	0.0577	-0.0022	0.1084
	(0.0459)	(0.1120)	(0.1411)	(0.1104)
Year Fixed Effects?	Yes	Yes	Yes	Yes
Last Year State of Residence FE?	Yes	Yes	Yes	Yes
This Year State of Residence FE?	Yes	Yes	Yes	Yes
Last Year Industry FE?	Yes	Yes	Yes	Yes
This Year Industry FE?	Yes	Yes	Yes	Yes
Last Year Occupation FE?	No	Yes	No	Yes
This Year Occupation FE?	No	No	No	No
Observations	44838	44838	46163	46163
R-squared	0.04	0.06	0.51	0.52

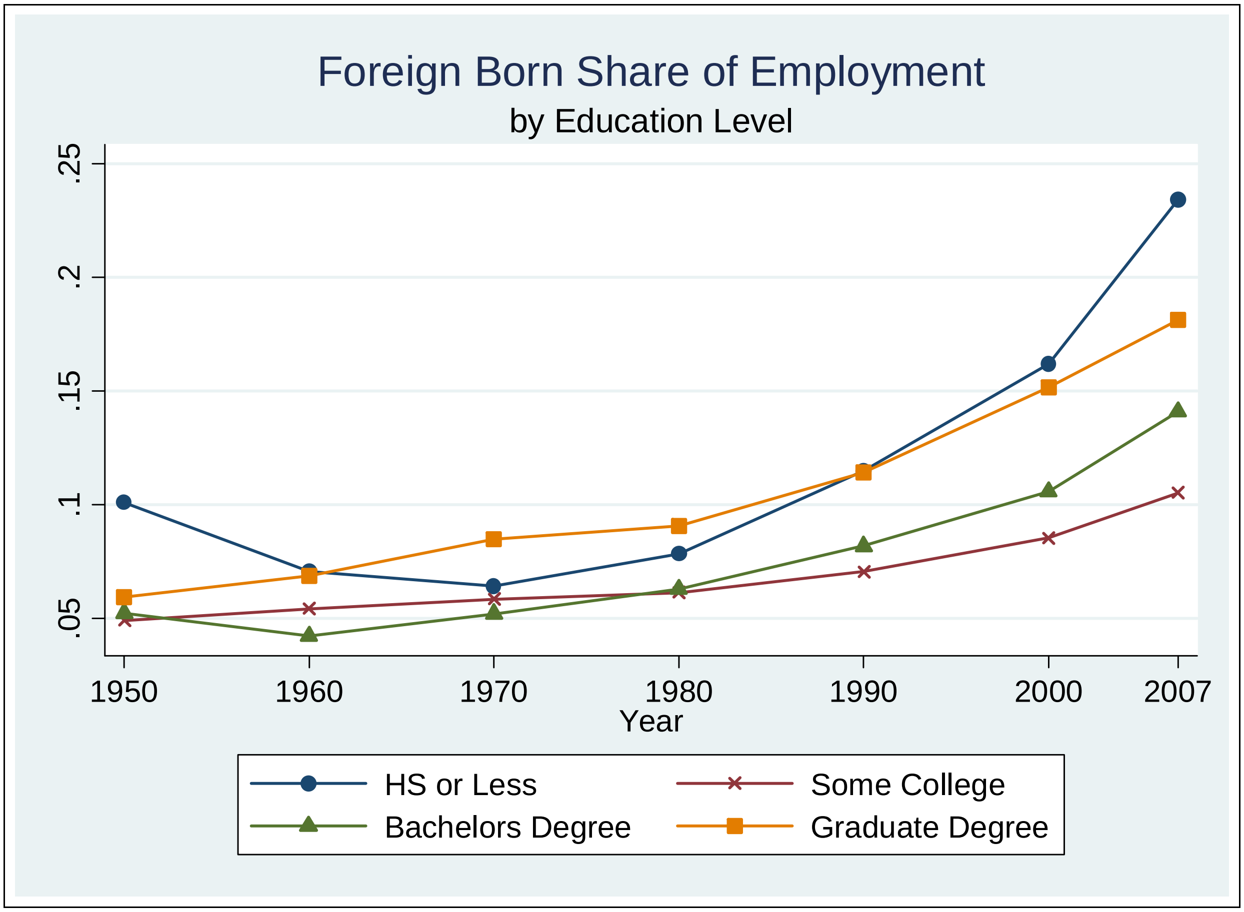
Individual Data Source: CPS, 2003-2008.
Regression Method: Linear probability model, with regressions weighted by CPS weights, adjusted for yearly hours worked. Standard errors (in parenthesis) are heteroskedasticity-robust and clustered by occupation of employment in the year prior to the survey.
*** indicates significance at the 1% level ** indicates significance at the 5% level * indicates significance at the 10% level

Table 11
Native Internal Migration Response to Occupation Immigration

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent Variable:	***Change State***		***Change State for Work***		***Change to State with Lower FB Share***	
Change in Foreign-Born Share of Last Year's Occupation	0.0071	0.0217	0.0096	0.0120	0.0070	0.0107
	(0.0178)	(0.0365)	(0.0150)	(0.0296)	(0.0106)	(0.0188)
Female Indicator	-0.0011	-0.0004	-0.0039	-0.0032	0.0010	0.0013
	(0.0018)	(0.0018)	(0.0014)***	(0.0015)**	(0.0010)	(0.0010)
Professional Degree Indicator	0.0045	0.0007	0.0032	0.0011	0.0041	0.0014
	(0.0030)	(0.0037)	(0.0030)	(0.0031)	(0.0017)**	(0.0019)
Doctorate Degree Indicator	0.0058	0.0037	0.0070	0.0059	0.0038	0.0022
	(0.0034)*	(0.0040)	(0.0032)**	(0.0035)*	(0.0016)**	(0.0021)
Asian Indicator	-0.0048	-0.0045	0.0033	0.0037	-0.0014	-0.0015
	(0.0051)	(0.0050)	(0.0052)	(0.0051)	(0.0035)	(0.0035)
Black Indicator	-0.0046	-0.0048	-0.0082	-0.0086	-0.0023	-0.0026
	(0.0027)*	(0.0027)*	(0.0026)***	(0.0026)***	(0.0015)	(0.0015)*
Hispanic Indicator	-0.0020	-0.0028	-0.0005	-0.0013	-0.0001	-0.0006
	(0.0052)	(0.0052)	(0.0054)	(0.0055)	(0.0030)	(0.0030)
Other Race Indicator	0.0003	0.0004	-0.0089	-0.0089	-0.0044	-0.0042
	(0.0094)	(0.0094)	(0.0054)	(0.0054)	(0.0040)	(0.0041)
Age	-0.0015	-0.0015	-0.0010	-0.0010	-0.0008	-0.0007
	(0.0002)***	(0.0002)***	(0.0001)***	(0.0001)***	(0.0001)***	(0.0001)***
High-Education Growth of Last Year's Occupation	0.0000	0.0007	0.0001	-0.0003	0.0000	-0.0004
	(0.0001)	(0.0013)	(0.0001)	(0.0011)	0.0000	(0.0006)
Constant	-0.5060	-0.2750	0.0705	-0.2106	-0.3568	-0.2117
	(0.3958)	(0.4034)	(0.3185)	(0.2493)	(0.1689)**	(0.1910)
Year Fixed Effects?	Yes	Yes	Yes	Yes	Yes	Yes
Last Year State of Residence FE?	Yes	Yes	Yes	Yes	Yes	Yes
This Year State of Residence FE?	Yes	Yes	Yes	Yes	Yes	Yes
Last Year Industry FE?	Yes	Yes	Yes	Yes	Yes	Yes
This Year Industry FE?	Yes	Yes	Yes	Yes	Yes	Yes
Last Year Occupation FE?	No	Yes	No	Yes	No	Yes
This Year Occupation FE?	No	No	No	No	No	No
Observations	46163	46163	46163	46163	46163	46163
R-squared	0.12	0.13	0.11	0.12	0.45	0.45

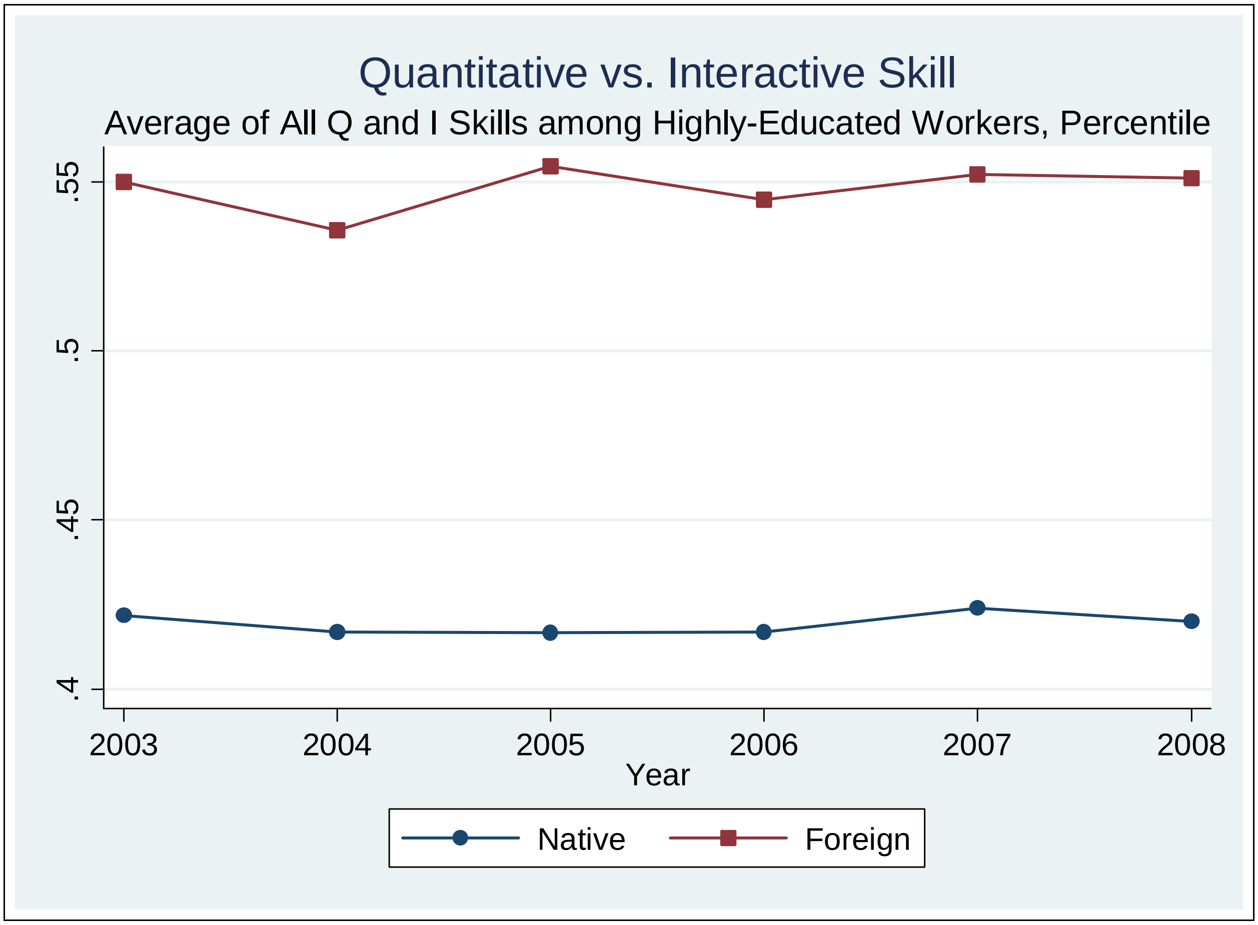
Individual Data Source: CPS, 2003-2008.
Regression Method: Linear probability model, with regressions weighted by CPS weights, adjusted for yearly hours worked. Standard errors (in parenthesis) are heteroskedasticity-robust and clustered by occupation of employment in the year prior to the survey.
*** indicates significance at the 1% level ** indicates significance at the 5% level * indicates significance at the 10% level

<u>Figure 1</u>
Foreign-Born Employment Share by Education Level



Data Source: US Census (1950-2000) and American Community Survey (2007). Sample includes non-group quarter, wage-earning, civilian employees, age 25-65, working in defined states, industries, and occupations, and with a defined birthplace. Prior to 1990, Graduate Degree holders are assumed to be those workers with five or more years of college experience.

Figure 2
Average Quantitative versus Interactive Skill Intensity among Native and Foreign-Born Workers with Graduate Degrees



Data Source: CPS (2003-2008) and *O*NET*. Sample includes non-group quarter, wage-earning, civilian employees, age 25-65, working in defined states, industries, and occupations in both the year of and prior to the survey year, with a defined birthplace, and have obtained a masters, professional, or graduate degree. Skill calculations are based upon *O*NET* task definitions, the 2000 Census and the IPUMS occ1990 occupation codes. Values represent skill intensity computed by averaging the five quantitative (and analytical) skill and seven interactive (and communication) skill measures described in Table 1, and then converting the Q/I ratio into percentiles. The median worker had a Q/I percentile of 0.50 in 2000.