
Firms and the Economics of Skilled Immigration

Sari Pekkala Kerr, *Wellesley College*

William R. Kerr, *Harvard University and NBER*

William F. Lincoln, *Johns Hopkins University*

Executive Summary

Firms play a central role in the selection, sponsorship, and employment of skilled immigrants entering the United States for work through programs like the H-1B visa. This role has not been widely recognized in the literature, and the data to better understand it have only recently become available. This chapter discusses the evidence that has been assembled to date in understanding the impact of high-skilled immigration from the perspective of the firm and the open areas that call for more research. Since much of the US immigration process for skilled workers rests in the hands of employer firms, a stronger understanding of these implications is essential for future policy analysis, particularly for issues relating to fostering innovation.

I. Introduction

Listening to the public discourse on skilled immigration, one might reasonably expect that economists who are studying the issue would be highly focused on the role of firms. For example, Bill Gates has framed his push for more H-1B worker visas (the largest visa program for skilled immigration to the United States, described further below) in terms of his experiences at Microsoft. In 2007 Congressional testimony, he noted “I personally witness the ill effects of these (H-1B) policies on an almost daily basis at Microsoft.” Gates has further stated that Microsoft hires four additional employees to support each H-1B worker hired. Policy briefs like those of the National Foundation for American Policy (2008, 2010) suggest even higher levels of job creation. Over the

last year, Mark Zuckerberg of Facebook and other high-tech executives have strongly advocated for higher admissions of skilled immigrants by arguing that these workers are essential for the competitiveness, growth, and innovation of their firms. These advocates have even gone so far as to use the phrase “national suicide” to describe the United States’ limited admission of skilled migrants.

Critics of skilled immigration come to a very different policy conclusion, but they also often present their arguments in the context of firms. Matloff (2003) argues that the principal use of the H-1B program by high-tech companies is to minimize their internal labor costs. He argues that these businesses hire skilled immigrants to displace older citizen workers with high salaries and presents case studies about displacement within individual firms. Hira (2010) decries instances where Americans are tasked with training the H-1B workers who will be taking over their own jobs. A popular press commentary from Milton Friedman, winner of the 1976 Nobel Prize in economics, similarly notes the role of firms: “There is no doubt that the (H-1B) program is a benefit to their employers, enabling them to get workers at a lower wage, and to that extent, it is a subsidy” (*Computerworld* 2002).

To date, economists have paid little attention to the role of firms in understanding the impacts of skilled immigration. As we describe below, the prior literature has traditionally studied these issues using frameworks and empirical approaches that were developed for general migration. These borrowed approaches were conceived, however, for settings quite different from those of skilled immigration. In particular, firms play a central role in the immigration of skilled workers to the United States. For firm-sponsored programs like the H-1B visa, it is essential that we trace through firms’ role in each step: lobbying about the number of visas to be granted, identifying which firms pursue visas and for what occupations, the employment and wage conditions of skilled migrants in these firms, how this resource affects other employment relationships within the firm and the innovation outcomes of firms, and similar questions.

This chapter reviews the progress that has been made so far on understanding the impacts of high-skilled immigration from the perspective of the firm. The next section reviews some of the most important programs for these workers that involve firms. The admission of these workers is of deep importance to the United States, particularly with respect to fostering innovation. In 2008, immigrants represented 16% of the US workforce with a bachelor’s education and they accounted for

29% of the growth of this group during the 1995–2008 period. In occupations closely linked to innovation and technology commercialization, the share of immigrants is even higher at almost 24%. At the PhD level, the shares hover at 50%. Firms, especially large and high-tech firms, have played a central role in this growth through their sponsorship of visas and effective selection of foreign workers. In fact, the structure of one of the most important skilled immigration programs is designed to allow firms to select the workers that they want to hire, rather than having these employees selected by the US government.

Section III discusses in greater detail why an understanding of the economics of the firm is important. We start by describing how many of the traditional approaches for quantifying immigration's consequences (e.g., local area studies) can fail to capture the decision making of businesses (e.g., Microsoft makes employment decisions over many local areas, and even countries, at once). We emphasize the important degree to which firms internalize substitutions and complementarities over different worker groups and occupations. In fact, some of the key arguments made about skilled immigration cannot be analyzed without departing from traditional frameworks of labor markets and focusing instead more specifically on firms. We further describe how the nature of the employer-employee relationship within firms can impact decisions.

Section IV surveys recent academic work about firms and skilled immigration. This section is unfortunately small relative to its importance. We are able to note several key features on the work that has been done to date, however. First, growth in the employment of skilled immigrants is connected with greater overall firm employment. This growth, however, differs across worker groups in important ways (e.g., favoring younger natives over older natives, favoring complementary occupations). Technological development increases as the firms employ more workers undertaking invention. Subsequently, these migrants influence the global operations of their employers (e.g., shifting foreign direct investment toward their home countries). Not surprisingly, firms seek to influence these admissions through lobbying efforts. As discussed below in section IV, however, entry costs into lobbying mean that the lobbying firms only imperfectly represent the full preferences of firms.

Sections V and VI then describe important areas for future research from both microeconomic and macroeconomic perspectives, respectively. On the micro side, we highlight the need for greater clarity in understanding the heterogeneity in firm employment choices (e.g., team composition, occupational distributions), a more comprehensive

depiction of global human resources (HR) practices of firms, increased inquiry into the implications of tied employee-employer relationships (e.g., wages, training, project staffing choices), and a better understanding of how variation across institutions in visa access influences collaboration (e.g., firm-university, large-small firm). From a macroeconomic perspective, we describe the need for richer general equilibrium models that embed firm choices and dynamics. Such models will provide better guidance on the growth implications of skilled immigration to the United States and the possible impacts from alternative policies (e.g., adjusting the H-1B cap, auctioning off visas). In addition, we discuss the need for a better understanding of how immigration affects reallocation across firms and its related contribution to aggregate productivity growth.

The final section concludes with a review of the current state of research in this area and examples of where data development is most needed. We encourage work on several steps—from the simple merger of public data onto internal government research databases to the more complex collection and integration of better data on the H-1B visa program into employer-employee files. Recent research has made progress on some of these questions, but we have only begun to develop our understanding of the answers.

II. US Skilled Immigration Programs and Firms

This section first describes some of the major visa programs that involve firms. We then discuss the disproportionate influence of large firms in employing these immigrants. We close with a discussion of foreign firms and their use of the visas.

A. Overview of H-1B and L-1 Visas and the Role of Firms

Several programs for skilled immigrants directly involve firms. For much of the chapter we will focus on the H-1B visa, which is used for most temporary admissions of science, technology, engineering, and mathematics (STEM) workers. It allows companies in the United States to seek short-term help from employees in “specialty occupations,” that is, positions that require specialized knowledge like engineering or accounting. Almost all holders of this visa have a college degree and typically about half have completed a graduate degree. Many also work in information technology and STEM, which accounted for over 70% of all successful visa applications in the 2012 fiscal year. India and China

accounted for over 70% of recipients for the 2012 fiscal year.¹ This share has increased since a decade ago, when the figure was closer to 50%.

Firms are central to the employment of H-1B workers. They must apply for a particular individual and these employees are tied to the company for the length of their visa. The initial length of the visa is for three years and it can be extended for another three years, for a total of six years altogether. In some cases, an application by the firm for the permanent residency of its employee further lengthens the time duration. Legal and application fees are substantial; for a firm with 26 or more full-time employees in 2008 the application fee alone was \$2,320. It is important to note that there is no pricing mechanism that allocates visas over firms, but they are instead distributed in a first-come-first-served fashion up to the regulated cap or by lottery in special cases.

Firms are required by law to pay H-1B workers the higher of two different wage levels: (a) the “prevailing wage” in the company for the particular job in question or (b) the prevailing wage for the occupation in the geographic region where the person is employed. The rationale often given for these restrictions is that they are intended to help protect domestic worker wages and discourage employers from abusing their relationships with foreign workers. Additionally, if a certain proportion of a firm’s workforce is comprised of H-1B visa holders (15% for firms with 50 or more employees), the firm must make a good faith effort to hire a US citizen worker for the position and must not displace Americans who are similarly employed.

The H-1B has also been one of the most controversial immigration programs for firms. There has been an annual limit for the number of H-1B visas that can be allotted to private sector businesses since the Immigration Act of 1990. Notably, family members of the worker can immigrate with her or him and do not count against the cap. Visa renewals after three years also do not count against the cap. Although the policies surrounding the program have not changed significantly since this time, one thing that has changed is this limit. The cap is fixed through a political bargaining process and set by Congress and the president. Visas are allocated until the cap runs out, and there are neither market prices nor an auction system to determine which firms get to hire skilled workers under a work visa if demand outstrips supply.

Figure 1a plots the trajectory of the limit using data from the United States Citizenship and Immigration Service (USCIS). The initial level was set at 65,000 visas and stayed there for much of the 1990s, when the cap was rarely reached. The cap was increased by the American Competitiveness and Workforce Improvement Act of 1998 and the American

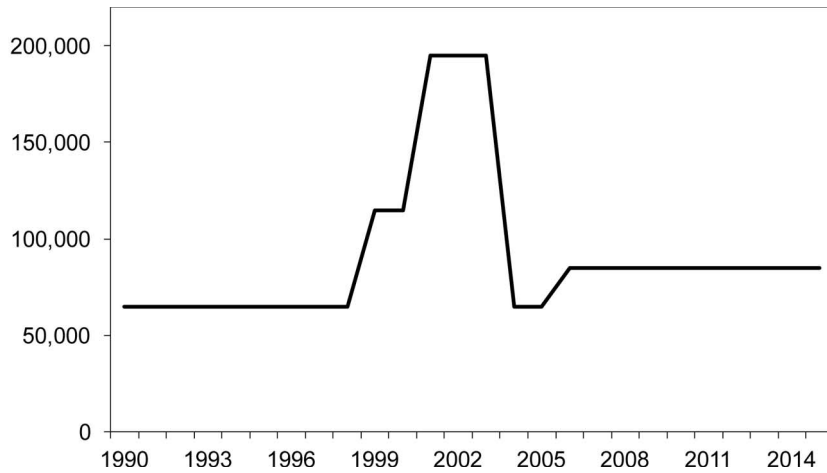


Fig. 1a. Evolution of H-1B visa cap

Notes: Figure plots the cap on the number of H-1B visas that can be issued by fiscal year. The cap was reached in every fiscal year since 1997 except 2002 and 2003.

Competitiveness in the Twenty-First Century Act of 2000, up to a maximum of 195,000 visas. In the wake of a downturn in the information technology sector early in the twenty-first century and the events of September 11, 2001, however, these short-term increases were allowed to expire in 2004. The limit reverted back to its initial level of 65,000 visas. It was subsequently raised by 20,000 through an advanced degree exemption in 2006, but has not been changed since despite demand far exceeding supply in many years.

Figure 1b plots the number of months taken to reach the H-1B cap for fiscal years since 2000. The cap was reached in every fiscal year since 1997 except 2002 and 2003. In some years, the cap is reached very rapidly once the government begins accepting applications. In other years, 10 or more months pass before the cap is reached. This speed to reaching the cap is the best proxy for the demand for the visas relative to the regulated supply and the fluctuations in this balance over time. (Exact demand is otherwise unknown given that applications for the visas are not accepted after the cap is reached and firms wait for the next fiscal year.)

The history of legislation behind changes in the cap is informative about the political economy of skilled immigration and its relationship to that of low-skilled immigration (Kerr, Lincoln, and Mishra, forthcoming). From the program's creation in 1990 to the expiration of legislation

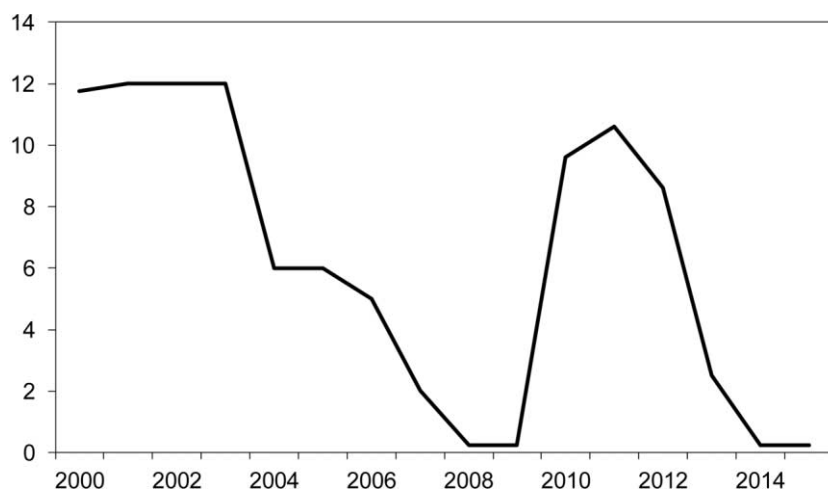


Fig. 1b. Months to reach H-1B visa cap

Notes: Figure plots the number of months taken to reach the H-1B cap. The cap was reached in every fiscal year since 1997 except 2002 and 2003.

in 2004, firms had been quite successful in their prior lobbying efforts. The cap was not binding until 1997 and within the first year that demand hit this limit it was doubled by legislation that passed with more than two-thirds support from both houses of Congress. The next bill to raise the limit followed two years later and was passed on a 96-1 tally in the Senate and a voice vote in the House of Representatives. Crucially, however, these pieces of legislation did not significantly change policy with respect to low-skilled immigration.

Although advocates of high admissions levels did manage to pass the H-1B Reform Act in 2004, reform efforts since have not gained significant traction. This has partly been the result of the fact that leaders in Congress began to bundle legislation on skilled immigration with that on low-skilled immigration into comprehensive immigration reform. This political situation was unexpected in 2003 when visa demand failed to reach the cap, but it has caused significant controversy since. The cap has been binding in every year since 2004. In some recent years (including the 2014 and 2015 fiscal years), the visa demand exceeded the annual supply in the first week that the visas were available. In these cases, a lottery system is used to allocate the visas to firms.

While its provisions about the maximum number of visas allotted have expired, one important provision of the American Competitive-

ness in the Twenty-First Century Act of 2000 that has remained in effect is that it exempted universities, government research labs, and certain nonprofits from the cap altogether. This exemption has been a significant piece of innovation policy and has only become more important since 2004 as the overall cap has been reached regularly. Recent policy proposals have followed in this vein. For example, the immigration reform proposal unveiled by the Obama administration in 2013 called for “stapling” green cards to the diplomas of foreign students graduating with master’s and PhD degrees from American universities. This type of reform has been a part of other policy proposals as well.

Although arguably not as important, a few other visas are used by firms to hire skilled immigrants as well. One is the L-1 visa, which is used by multinationals to transfer their employees to the United States from foreign divisions. Holders of this visa must have worked for the firm abroad for at least one year and typically hold a college degree or the equivalent. Canadian and Mexican citizens may come to the United States on the TN visa, which was created under the North American Free Trade Agreement. These workers must have a job offer with a firm in the United States before applying and are restricted to working in a certain set of occupations that typically require a bachelor’s degree. The O visa for workers of extraordinary ability is used even less often than either of these visas, but given its nature also likely has had significant impacts on firm performance and technological development. Hunt (2011) provides a useful extended discussion of the different kinds of visa categories and their characteristics.

Firms play a significant role in sponsoring permanent residency in the United States for their employees once they have come on a temporary visa. The H-1B, L-1, and O visas are all “dual intent” in that workers can use them both as a means of obtaining short-term employment in the United States while also intending to ultimately immigrate permanently. This feature accounts for part of the significant attractiveness of these visas, particularly the H-1B. The TN visa is not a dual intent visa, meaning that holders must show at the time of initial application and at each visa renewal that they do not intend to immigrate to the United States.

B. Large Firms and Their Disproportionate Share of Skilled Immigration

While the figures released by the USCIS on the employment of skilled immigrants by particular firms are very limited, we do have some sense

of the role of particular firms in employing H-1B workers. The Department of Labor (DOL) makes microrecords on all Labor Condition Applications (LCAs) publicly available starting in 2001. These applications are a first step toward obtaining an H-1B and are intended to show that the potential worker will be employed in a manner following US law. If this application is approved the final step is to file a petition with the USCIS, which makes the ultimate determination on the application. Microrecords on LCAs received by the DOL include fields such as firm name and proposed location of employment.

One of the most notable features of these data is the large skewness in the demand for visas across firms. A large and growing literature has focused on the skewness of the firm size distribution and its consequences for business cycle fluctuations and the international transmission of shocks (e.g., Axtell 2001; Gabaix 2011; di Giovanni and Levchenko 2012). Analyses of the distribution of demand for skilled immigrants across firms, however, have largely been lacking in the literature. This skewness has the potential to be of significant importance in how fluctuations in the stock of skilled immigrants affect firms and aggregate outcomes. It is also the case that shocks to a relatively small subset of firms could disproportionately affect visa demand. Indeed, this is what happened in the early twenty-first century when the information technology sector went through difficult times and demand for H-1B visas did not reach the cap.

One of the challenges in working with the LCA data is that there are no consistent firm identifiers in the records; information must be paired with other firm outcomes using name-matching approaches. In order to make some progress in understanding these issues, we developed a panel of 171 firms over 2001–2006. Our criteria for including firms includes being publicly traded, appearing in the Compustat database in all six years, being headquartered in the United States, and accounting for at least 0.05% of all US patents developed domestically. Consistent with the literature on firm size distribution, this panel accounts for more than \$3 trillion in annual revenues. Kerr, Lincoln, and Mishra (forthcoming) provide greater details on the construction of this sample.

Table 1 lists the top 12 firms in the sample in terms of the sum of their LCAs in 2001–2006 as well as the same list in terms of H-1B approvals for 2012, obtained from *Computerworld* magazine (Thibodeau and Machlis 2013). High-tech firms dominate the first list, with Microsoft, IBM, and Oracle accounting for the largest number of applications.

Table 1
Top Firms By H-1B Demand

Rank	Company Name	Total LCA Applications 2001–2006	Company Name	2012 H-1B Visa Approvals
1	Microsoft	13,523	Cognizant	9,281
2	IBM	7,594	Tata	7,469
3	Oracle	6,755	Infosys	5,600
4	Intel	3,995	Wipro	4,304
5	Motorola	3,747	Accenture	4,037
6	General Electric	3,593	HCL America	2,070
7	Cisco Systems	3,344	Mahindra Group	1,963
8	Sun Microsystems	2,552	IBM	1,846
9	Hewlett Packard	2,492	Larsen & Toubro	1,832
10	Qualcomm	2,362	Deloitte	1,668
11	Sprint	2,280	Microsoft	1,497
12	Schlumberger	1,937	Patni Americas	1,260

Source: This list comes from *Computerworld* magazine (Thibodeau and Machlis 2013) and includes non-US companies that use the H-1B visa.

Notes: The left columns list the top 12 firms in our sample of 171 firms in terms of their Labor Condition Applications (LCAs) between 2001 and 2006. This sample is restricted to public companies with headquarters in the United States. The LCAs are a first step toward obtaining an H-1B visa for a worker. The right columns list the top 12 companies in 2012 in terms of H-1B visa approvals.

Microsoft's large role mirrors that found in Kerr, Lincoln, and Mishra (forthcoming) in terms of the skewness of lobbying expenditures across firms. Some firms outside of the information technology sector also appear on the list, including General Electric and Motorola. These 12 firms accounted for 56% of all LCA applications in our sample of 171 firms. Looking at this list across years, there is some shuffling but there is generally stability in the set of top firms. Considering the within-firm correlation in LCAs across years for the whole sample, the correlation is 88%. The second list also exhibits skewness in visa demand. The shift toward companies from India is immediately apparent, while the information technology sector still clearly plays an important role.

In order to get a larger picture of firm visa demand, in figure 2 we plot the entire distribution of LCAs applied for over 2001–2006 across the firms in our sample. The skewness of the distribution is immediately apparent. This is true even despite the fact that our sample is concentrated among some of the largest firms in the US economy in terms of sales, suggesting that the larger distribution across all firms is even more skewed than that depicted here. Each observation represents the total applications over the sample period for a given firm, which is in-

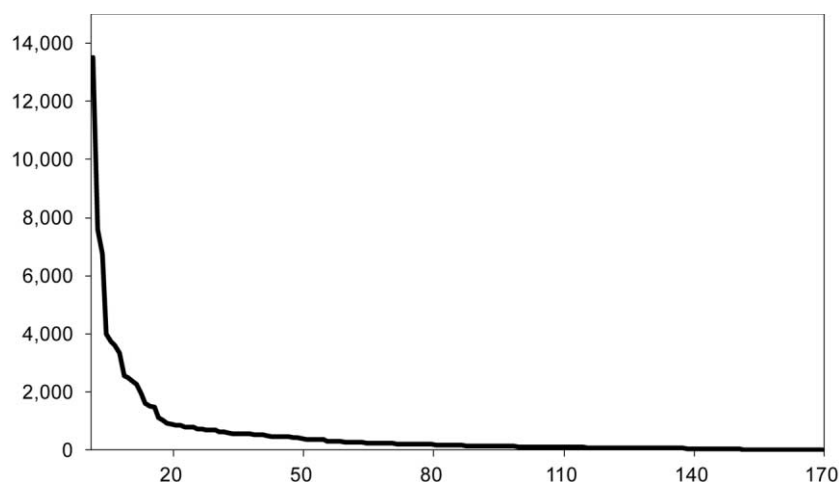


Fig. 2. Distribution of firm LCAs

Notes: Figure plots each firm's total number of Labor Condition Applications 2001–2006 (y axis) against its rank in terms of LCAs (x axis). Firms are ordered by their LCA demand, with lower numbers on the horizontal axis being the largest users of the program.

indicated on the vertical axis. Firms in the first column of table 1 account for the top end of the distribution and there is a long tail of firms that have relatively little visa demand.

A natural question is how this skewness in the distribution of demand for skilled workers relates to the firm size distribution. Although there is significant variation in this relationship, we find a close association between the demand for foreign workers and firm size. In figure 3 we plot the logarithm of total LCA applications against the logarithm of firm average sales over 2001–2006. Each point represents an observation for each firm LCA-sales pair. For the two firms in the sample with no LCAs, we add one to the total, so that the logarithm is zero. There is a clear positive relationship between the two measures; a simple regression yields a slope coefficient of 0.43 with a standard error of 0.05.

C. Indian Firms and the H-1B Visa

One of the most notable differences between the two lists in table 1 is the increasing importance in recent years of firms from India such as Tata, Infosys, and Wipro. Although based in New Jersey, Cognizant also has strong ties to India. Citizens from India account for more H-1B visas than any other country by a significant margin (64% of new issuances in

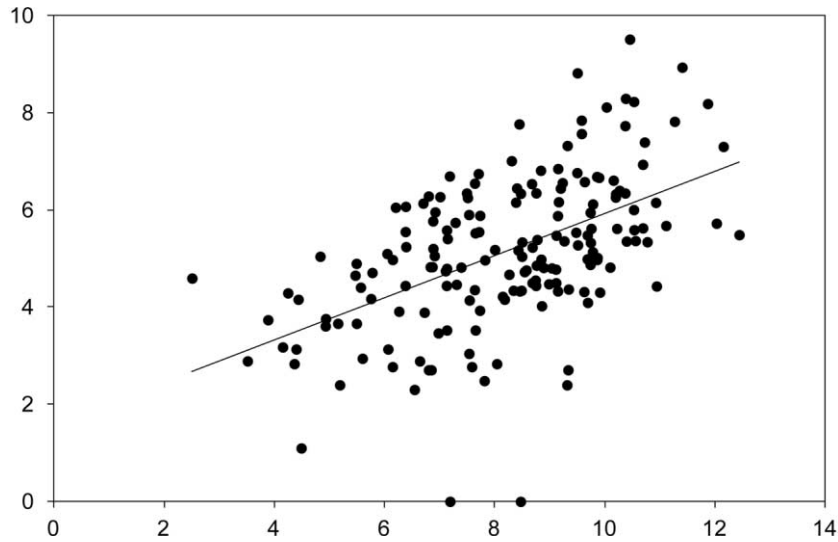


Fig. 3. Firm LCAs relative to sales

Notes: Figure plots the logarithm of each firm's total LCA applications 2001–2006 (y axis) against the logarithm of its average level of sales over the time period (x axis).

fiscal year 2012) and this share has grown in recent years. Several high-profile Indian firms have used it to facilitate their work in outsourcing. This has led to significant criticism of the program in the public debate, especially since it was not tied to the original intent of the program.

Clemens (2013) studies the wages of workers who obtain H-1B visas within one particular large Indian multinational in the software industry. He exploits the lottery system that was established by the USCIS to allocate visas to workers when the number of applications rapidly exceeds the cap. The study then follows the winners and losers of the visa lottery in the personnel records of the firm. The setting is attractive in that there are very low barriers to trade and technology transfer across countries in the sector that the firm belongs to. The results are striking, indicating that moving to the United States leads to a sixfold increase in wages for workers who received the visa relative to those who did not.

The phenomenon of foreign firms and their use of immigration visas is worthy of further research and policy consideration given how the US immigration process allows foreign firms to use access to visas as a business model, and we hope that work continues in this vein. The core issues that we discuss in the remaining sections, however, are focused exclusively on US firms and their relationships to the skilled immigra-

tion process. Independent of policy considerations with respect to foreign firms, the central role of US firms in skilled immigration deserves direct attention.

III. Introducing the Firm

As explained above, this chapter focuses on how the hiring of skilled immigrants affects firms, and what role the firms have in determining who will migrate into the United States. This focus on individual producers, while rare, is very important as there are many reasons why the economics of the firm could (and do) matter in the case of skilled immigration. Moreover, the efficiency of firms in production is a central element of social welfare calculations. Here we contrast the firm-based research approach with the existing academic literature and point out areas where further knowledge on the role of firms would be crucial in deriving novel conclusions.

In the academic literature there is very little tradition for considering the role of firms in analyses of immigration. Instead, economists have approached the study of the issue through the framework of shifts in the supply of workers to a labor market. Firms provide the underlying demand for workers in traditional labor supply and demand analysis, but the approach abstracts from the role of firms in the selection of immigrants. The most important question in the traditional approach is typically related to what constitutes the appropriate labor market. Below we explain the common approaches that prior empirical work has taken for defining the labor market, highlight certain skilled immigration studies that follow each approach, and describe how the perspective of a firm may be captured or not.

Many seminal studies defined labor markets as local areas such as cities or states (e.g., Card 2001). The idea is that immigrants enter a local labor market and compete with natives and prior immigrants for job opportunities. Firms may react to the potentially increased labor supply by adjusting wages and/or employment levels. Empirical research then seeks to measure the average effects across all workers or some specific population groups like the native workers. Kerr and Lincoln (2010), Hunt and Gauthier-Loiselle (2010), and Peri, Shih, and Sparber (2013) are recent examples of this approach with respect to skilled immigration. To the extent that a firm makes employment choices within a single local area, either because the firm is relatively small or because its local units are operating autonomously, then the behavior of the city

at large may be reflective of the underlying firms. The fact that large firms typically extend across multiple geographic areas and that firms operating in a labor market are usually rather heterogeneous are complications that the local area studies cannot address. The global nature of the employment decisions for the large firms exacerbates the issue.

Another approach uses a national labor market among workers with similar education and age/experience profiles, and implicitly assumes that firms may recruit workers from a broader area (e.g., Borjas 2003). This approach would suggest that the employment opportunities for a 25-year-old American with a bachelor's degree in Boston depend most upon immigration of other 25-year-olds with bachelor's degrees, regardless of where they are located in the United States, rather than other age or education groups within Boston itself. While it is plausible that the labor market for skilled workers is national in spatial scope, this approach has not been used for analyzing skilled immigration. The reason is that the highest education group in the age-education framework is typically a bachelor's degree or greater—a level that most skilled immigration studies would take as the minimum requirement for defining skilled workers. The age-education framework also does not capture elements of firm-level hiring decisions given that firms optimize over their entire wage bill, internalizing any potential complementarities across worker groups.

A related approach, which is more specific to a particular institutional setting but also important for the analysis of skilled immigration, considers labor markets to be highly specialized fields of study or expertise (e.g., Friedberg 2001). Recent examples related to skilled immigration include Borjas and Doran's (2012) study of the migration of Russian mathematicians following the Soviet Union's collapse and Moser, Voena, and Waldinger's (forthcoming) study of Jewish scientists expelled from Nazi Germany. While these studies partially capture some elements of the economics of firms, there are also important differences with firm-level analyses. For example, the Borjas and Doran (2012) study takes place within the math departments of US universities that have more limited scope for overall personnel growth (unlike firms) and mostly lack complementary inputs. Large US firms engaged in global competition frequently suggest that the skilled immigrants they seek to hire are a necessary input required to grow the firm. This view suggests that skilled immigrants possess complementarities with domestic workers that can unlock greater growth opportunities. Moreover, firms tend to have greater flexibility than public or other institu-

tions in the speed with which they can adjust their scale of operation and their worker composition, suggesting that their responses to the increased supply of skilled labor may be very different from those observed across typical university departments.

While the approach based upon labor markets and labor supply is a useful framework for low-skilled immigration, it seems rather incomplete for skilled immigration. First, the structure of many skilled immigrant admissions (e.g., the H-1B visa) is designed in part to allow companies to select the skilled workers that they wish to hire, rather than migrants being selected by the US government based on a points system or similar approach. Indeed, in order to hire a worker with an H-1B visa, a firm has to first locate that worker (abroad or already in the United States on another visa), file the LCA with the DOL, file for the actual H-1B visa with the USCIS, pay for associated filing and legal fees, and similar tasks.

Thus, firms play a central role when the annual admissions of skilled immigrants into the United States are determined. Without firm-level data it is impossible to disentangle the role of firms in determining these admissions or the effect of the admissions on the businesses themselves. A firm-level analysis also allows us to account for other kinds of heterogeneity that are not captured with other approaches. This is especially important since firms hold specific assets that are often instrumental in determining employment outcomes and their organizational structures more generally. When there are complementary inputs (as might be the case with, for example, skilled and low-skilled labor), firms will be able to internalize these complementarities and capture opportunities for enhanced productivity, learning, and the development of entirely new capabilities.

The US visa system for skilled immigrants also possesses certain non-market features that make a firm-level analysis more interesting and appropriate. Examples noted above are the nonpriced nature of the visas, the allocation on a first-come-first-served basis, and the regulated cap. Second, immigrant workers sponsored on an H-1B visa are effectively tied to the firm that employs them. The visa is granted for employment by a specific worker at a particular company and location. This structure provides some compensation to the firm for having identified and recruited the worker. The structure additionally creates an asymmetry in the bargaining power between the company and the worker, as the employee cannot easily leave the firm during the 3 + 3 year duration of the visa. Firms can also sponsor permanent residency (a green card)

for their H-1B workers, which can further tie employees and firms together. The green card process can take up to 10 years depending on the person's country of origin, although there have been recent legislative efforts to reduce this imbalance across worker nationalities. It has often been argued that firms may utilize this asymmetry by employing the H-1B workers at a lower wage than they would pay comparable native workers. We discuss empirical work on this issue below.

The outcome of these and other features of the visa system is to place firms in the center of the skilled immigration process. At many points, the economics of firms can dramatically shape the structure of US immigration (and indeed the system is partly designed to have this characteristic). As an example, the bullets below provide some assembled data on the share of new H-1B visa issuances going to workers from India or computer-related occupations (India accounts for the lion's share of this type of worker):

- 1995: India ~20%, computer 25%
- 1998: India ~45%, computer 57%
- 2002: India 28%, computer 28%
- 2008: India 57%, computer 53%
- 2012: India 64%, computer 70+%

There is an exceptional set of fluctuations in terms of the H-1B program's composition. These shares for computer-related occupations increased during the information technology boom of the 1990s, only to retract during the tech recession in 2002. The shares then expanded back in 2008 and have further strengthened in recent years. This flexibility has its advantages and potential drawbacks that we discuss later, but the key point to make here is its dependency on firm demand. Temporal shifts in firm and industry demands affected over 25%–30% of the visa allocation in terms of countries of origin and occupation. A system of allocating visas on a first-come-first-served basis without restrictions regarding the composition of visas to be distributed will always possess these characteristics.

IV. Existing Literature

This section describes some of the recent empirical work regarding firms and skilled immigration. Most of the focus is on the United States, although some complementary work outside of the United States is

mentioned. These studies represent only the beginning of what we think has the potential to be a fruitful line of research.

A. Employment Structures of Firms

The introduction to this chapter describes several arguments that have been made about how firms utilize skilled immigration. One recent study that looks at the role of specific firms and evaluates the effects of skilled immigration on those firms is the study of Kerr, Kerr, and Lincoln (forthcoming). This paper uses quarterly employee-level data from the largest US employers and patenting firms derived from a large administrative government database (the Longitudinal Employer Household Database [LEHD]). The study finds rising overall employment of all skilled workers with increased skilled immigrant employment by the firm. In other words, increasing the number of skilled immigrants appears to lead to an increase in the overall size of the firm, even after accounting for endogeneity and other concerns.

Beyond this general increase, the empirical results show substantial differences across different types of workers. Employment expansion following young skilled immigration into the firm is greater for young natives than their older counterparts. Employment of older natives does not decline in absolute number, but the associated growth of this group is substantially smaller compared to other employment categories. The study also looks at employee departures from firms to evaluate whether there is evidence for worker displacement. It finds that departure rates for older workers relative to younger workers are the highest for those in STEM occupations. The study argues that these occupations are especially prone to this age-related effect due to the higher rates of substitution over age categories possible in these professions. That is, it is easier for firms to switch between computer programmers of different ages than among managers of different ages. This can be due to diverse factors ranging from types of education to occupational structures (e.g., occupations with strong union membership have lower substitution capacity over ages). Kerr and Kerr (2013) further examine what happens to the STEM workers that leave firms when the skilled immigrant worker pool is expanding and show that these domestic workers leaving tend to fare worse in terms of their future employment and earnings than do those who leave under different conditions.

A recent set of papers have begun to focus on the employee characteristics of firms and where immigrants tend to work. Using the LEHD

employer-employee data from the US Census, Andersson et al. (2010) find that, relative to natives, immigrants are more likely to have coworkers that are immigrants. This is particularly true in terms of having coworkers from their countries of origin, and language considerations seem to play a large role. Using data from Sweden, Åslund, Hensvik, and Skans (2012) similarly find that managers who are immigrants tend to hire immigrants more relative to native managers.

B. Wage Rates Paid to Immigrants

Beyond employment outcomes, wage conditions are also of central concern. This is true for the immigrants themselves given the tied employer-employee relationship under the H-1B visa. The worry here is that the wages of migrants will be squeezed due to the asymmetric bargaining power of the firm compared to the worker. Concern also exists about guarding against the hiring of immigrants being used to suppress the wages paid to American workers. The H-1B program in particular features the “prevailing wage requirement” discussed above. The efficacy of this requirement is often debated (e.g., firms could classify a superstar programmer as a “software programmer” and thereby pay a lower effective wage), but the intent behind it is clear.

Several studies estimate the potential H-1B pay differential by comparing the wages of H-1B workers to comparable natives and attempting to control for the traits of the workers.² These studies provide a range of estimates from a 20% underpayment of H-1B workers to an overpayment of several percentage points. It is quite hard to rationalize why H-1B workers would be compensated more than comparable natives, but one could also view these latter studies as finding no wage gaps. A rough reading of this work might suggest a 5% differential is the central tendency of the estimates. Regardless, these comparisons across groups face a range of difficult econometric concerns: differing sample compositions, unobserved attributes of workers such as non-cognitive skills, incomplete compensation information, and similar. As such, they are informative, especially taken as a whole to observe the range of outcomes estimated, but not conclusive.

A related approach attempts to estimate pay differentials by comparing the wages of immigrant workers with and without permanent residency. If permanent residency affords migrants unrestricted job mobility and removes asymmetric bargaining power, wage adjustments around the event can quantify any underpayment for the migrants. As a recent example, Mukhopadhyay and Oxborrow (2012) use the New Im-

migrant Survey and compare immigrants who arrive with a green card to those who upon arrival were waiting to have their status adjusted to permanent residency. Using a differences-in-differences matching approach, they find a wage increase of about 25% (or just under \$12,000 per year) attributable to arriving with a green card. The small sample size of the survey makes these conclusions tentative, but they are stronger than cross-sectional comparisons. This paper additionally provides references to earlier work in this vein. Chi and Drewianka (2014) also compare immigrants from Mexico and Puerto Rico who marry a US citizen born on the mainland to measure the change in their earnings when they become eligible for a green card. They find green card earnings premiums of 30%–100%, depending on the time since arrival. While interesting in its approach, it is unclear how well these results extrapolate to countries that send the largest numbers of skilled immigrants into the United States, such as China and India.

These analyses get us closer to the conceptually best experiment of randomly providing permanent residency to immigrant workers and observing wage changes. Analysis of wage changes as workers obtain permanent residency is slightly less attractive, as it mainly reveals potential underpayment for workers at this margin compared to the overall skilled migrant population on a temporary visa, but these estimates are nevertheless very useful. Studies utilizing larger administrative data sets and richer comparison pools will continue to strengthen our quantitative understanding of these issues.

A third approach considers wage adjustments in local areas as immigration fluctuations occur. Empirical evidence on this issue has been mixed and, given the unique institutional aspects of the program such as the prevailing wage requirement, it is unclear that the same conclusions would hold here as in the literature on general immigration. Kerr and Lincoln (2010) and Peri, Shih, and Sparber (2013) find limited or positive effects on wages from higher levels of H-1B admissions, consistent with positive productivity effects on firms. Bound et al. (forthcoming), on the other hand, find negative effects on wages in a calibrated model discussed later. These studies do not consider firm-level data but attempt to inform this debate.

Also using the LEHD, Rho (2013) studies the earnings assimilation of immigrants in the United States. She finds that skilled immigrants do not experience relative increases in their earnings as they live longer in the United States. Unskilled immigrants, in contrast, have lower earnings relative to comparable natives when they arrive in the United States. Over the course of her sample period, however, these individu-

als see significant gains, with increases in job tenure being the most important factor.

C. Innovation Outcomes of Firms

The recent literature has also begun to focus on the impact that skilled immigration has on firm innovation and productivity. This link may initially seem tenuous, but immigrant STEM workers play a significant role in technological development and commercialization in the United States. We earlier noted the high shares of immigrants in STEM fields. This pattern is growing, with Kerr and Lincoln (2010) finding that 67% of the total increases in STEM workers from 1995 to 2008 were accounted for by immigrants.

Much of the work around innovation has considered institutions other than firms. We begin by discussing some of this background. Kerr and Lincoln (2010), Hunt and Gauthier-Loiselle (2010), Peri (2012), and Peri, Shih, and Sparber (2013) provide evidence of the positive connections between skilled immigration in a local area (either a city or state) and the innovation/productivity outcomes of those regions. Chellaraj, Maskus, and Mattoo (2008), Stuen, Mobarak, and Maskus (2012), and Gaule and Piacentini (2013) document the disproportionate contributions of foreign graduate students on innovation in the United States by field. Moser, Voena, and Waldinger (forthcoming) similarly find that the large inflow of Jewish German scientists who fled the Nazi regime around 1933 had significant impacts on US patenting in chemistry, and they discuss how many of these scientists were employed in US firms.

Turning to studies using firm-level data, Kerr and Lincoln (2010) find that firms that employ many H-1B workers show higher rates of innovation when the program is expanded and lower rates when it is contracted. Their estimates suggest that a 10% increase in H-1B admissions is associated with a 3% higher growth in firm invention for each standard deviation increase in dependency on H-1B workers. The effects are found to be especially large in the computer sector, which accounts for a large portion of all H-1B admissions. This study utilizes indirect inference in that it connects firm innovation outcomes and patenting to H-1B dependency, but it does not observe the quantities of immigrants employed in the firm.

In ongoing work Kerr, Kerr, and Lincoln (2014) use the LEHD to further investigate this relationship. They focus on a sample of 129 top

patenting firms that are most affected by immigration policy. They find that a 10% growth of firm employment of skilled immigrants is associated with a 1%–2% increase in total firm patenting. This growth is consistent with ethnic innovation—for example, firms undergoing large increases in employment of Chinese immigrants exhibit disproportionate growth in US patenting by inventors with Chinese ethnic names. There is little evidence of crowding out of domestic inventors, and the estimates point to the fact that the increases in patenting are primarily driven by the immigrants themselves. These findings are consistent with those of Kerr and Lincoln (2010), who did not have as detailed data on employee characteristics. In both of these studies, the margin of impact is on the quantity of innovation work conducted, rather than quality differences between immigrants and natives. Hunt (2011, forthcoming) and Kerr (2013) further discuss this distinction.³

D. Global Connections of Firms

The academic literature on global business exchanges has long noted the role of ethnic networks in trade patterns (e.g., Rauch and Trindade 2002). Rauch (2001) and Keller (2004) provide important reviews of this work. Migrants often retain an affinity for their home countries and possess skills and knowledge that can be useful for conducting business in these places. Recent research traces out how migrants can shape the economic activity of their employer firms as part of this process.

Saxenian, Motoyama, and Quan (2002) provide an influential survey of immigrant scientists and engineers living in Silicon Valley, the majority of whom were employed in large firms. These surveys, while not representative for all immigrants (or even for STEM immigrants in Silicon Valley), offer some sense of the relative forms of these contributions. Over 80% of Chinese and Indian immigrant STEM workers report exchanging technical information with their respective nations, about 50% of immigrants in this survey report aiding the development of contracts or business relationships between the United States and their home countries, and 18% report investing in overseas business partnerships. These connections happen both within and outside of firms. This study likely overstates the home-country exchanges of all immigrants, but subsequent work has more systematically documented the qualitative findings with respect to technology transfer (e.g., Kerr 2008; Agrawal et al. 2011; Oettl and Agrawal 2008).⁴

Perhaps the best-documented evidence regarding within-firm effects

pertains to how immigrants shape the foreign direct investment (FDI) activities of their employer firms. Foley and Kerr (2013) document this pattern with respect to ethnic inventors using firm-level data from the Bureau of Economic Analysis. Their work emphasizes the role of ethnic inventors in the United States for helping their employers develop R&D-based work abroad and enter into foreign countries without the support of local joint venture partners. This is perhaps due to better knowledge of the home country. Foley and Kerr (2013) also provide a more extensive literature set on both the trade and FDI channels. Kugler and Rapoport (2011) discuss the joint margins of trade and FDI, and Saxenian (2006) provides case studies.

Beyond trade and FDI, additional work considers the role of immigrants in the outsourcing of work. One way that diasporas are thought to connect with their home country is by facilitating these activities (with special emphasis often given to India). It is argued, for example, that the US-based members of an ethnic group can provide knowledge about opportunities to their home countries, serve as reputational intermediaries, facilitate contracts, and the like. Hira (2010) argues that this relationship is true, and moreover that the H-1B visa is particularly used as a vehicle for outsourcing by bringing immigrants to the United States for training in the jobs to be conducted overseas. There appears to be some truth to this claim, as the top three H-1B applicants in 2013 for H-1B visas were Indian outsourcing firms, with Infosys (no. 1) applying for three times more visas than Microsoft (no. 6). Beyond this high-profile approach of dedicated outsourcing firms, the relationship becomes less clear. Using data from oDesk, the world's largest online platform for outsourcing, Ghani, Kerr, and Stanton (forthcoming) find evidence of ethnic Indians being more likely to send work to India when outsourcing jobs. These authors also suggest, however, that the Indian diaspora's role was likely modest in the overall rise of India as the top outsourcing destination on oDesk.

E. Firm Lobbying for Immigration Policy

While there is a significant literature on the political economy of immigration, there has been little empirical work on the role of firms in lobbying for immigration. Direct measures of political involvement by firms used to be primarily confined to information on firm or sector contributions to Political Action Committees (PACs). These groups could be organized by firms, but they necessarily had to raise their

funds from voluntary donations from individuals. It is often difficult to identify the issues these organizations tried to promote. Until recently, contributions to PACs were also an order of magnitude smaller than the amounts that firms spent on lobbying.

With the Lobbying Disclosure Act of 1996, however, researchers now have had access to direct measures of annual firm lobbying expenses and information on the issues for which they lobbied. Kerr, Lincoln, and Mishra (forthcoming) use these data to investigate the role of barriers to entry in shaping firms' lobbying efforts over time. After developing and estimating a model of firm lobbying behavior that indicates the importance of barriers to entry in determining the dynamics of firms' lobbying efforts, they turn to analyzing a particular episode in immigration policy—the 2004 expiration of legislation that dramatically decreased the number of available H-1B visas to firms.

They begin by documenting a positive relationship between whether the firm lobbied for H-1B legislation and two key firm traits: (a) the number of a firm's patents that were developed by Chinese or Indian inventors, and (b) the number of LCAs that the firm applied for. The authors find that lobbying activity is concentrated only among a relatively small set of very large firms. Lobbying for skilled immigration is even rarer, being driven by a handful of key players such as Microsoft. The study then finds a large shift toward lobbying for immigration once the cap falls significantly in 2004. Crucially, however, this shift occurs almost entirely among firms that were previously lobbying rather than new firms that entered the political process. The work argues that barriers to entry in the political process explain why so few firms lobby, and why the mix of firms lobbying with regard to skilled immigration does not fully reflect all of the firms impacted by the issue.

Facchini, Mayda, and Mishra (2011) have also investigated firms' efforts to affect immigration policies through lobbying. Combining sectoral information on expenditures on lobbying for immigration with information on the number of temporary work visas awarded by the US government, they find that firms both favoring and opposing high levels of admissions shape US immigration policy. In sectors where business groups favoring immigration incur greater lobbying expenditures, barriers to immigration are lower. The opposite turns out to be true where labor unions play a larger role. While these two studies represent a start on studying the political economy of firms and skilled immigration, much more could be done to deepen our understanding of these issues.

F. Skilled Immigration and Entrepreneurship

With respect to entrepreneurship, the contributions of immigrants are similarly large, although exact estimates remain elusive. Saxenian (1999) finds that 24% of ventures in Silicon Valley during the 1980s and 1990s were run by Chinese or Indian bosses. In a follow-up piece, Wadhwa et al. (2007) find that immigrants started 25% of new high-tech companies with more than one million dollars in sales in 2006. Some of the survey methodologies in these studies have been criticized, but their results should remain roughly correct. A more important fact to bear in mind is that these figures are calculated across companies where at least one immigrant played a key role. Thus, by definition, the total contribution of immigrants is less than 25%. These contributions are particularly strong in high-tech fields. In an advocacy piece, Anderson and Platzer (2006) similarly find that immigrants represent 25% of founders of recent publicly listed, venture-capital-backed companies in the United States.

These studies shine the spotlight on high-growth entrepreneurship. For many this focus is appropriate, given the policy concern around fostering these entrepreneurs in particular. An example of this is the Start-Up Visa Act currently being discussed in the United States to provide easier admissions to immigrant entrepreneurs who are starting companies with high growth potential. By contrast, adjustments in the H-1B program would likely have their greatest impact on entrepreneurship in the medium-run as immigrants obtain permanent residency and leave sponsoring firms to start their own companies. The extensive sample selection for these studies, however, makes it harder to gauge the overall contributions of immigrants. Fairlee (2008) considers a broader landscape by returning to nationally representative survey databases like the Current Population Survey and the decennial census. Fairlee finds that immigrants are about 30% more likely to start a business than nonimmigrants, and their share of current business ownership is on par with their population shares at 12%–13%. Equally important, Fairlee's work describes the extensive range of immigrant contributions. They play equally important roles in low- and high-skill sectors, reflective of the great range of immigrants admitted to the United States. More generally, many of the questions surrounding how skilled immigration affects entrepreneurship can only be addressed using the lens of the firm.

V. Open Areas of Inquiry—Microeconomic Effects

There are many open questions in this field of research, so we provide in this section some thoughts about issues worthy of attention. We begin by focusing on microeconomic analyses before turning to macroeconomic perspectives.

A. *Heterogeneity in Firm Employment Choices*

The study of Kerr, Kerr, and Lincoln (forthcoming) provides some initial comparisons across worker groups (young vs. old, immigrant vs. native), but it is fairly coarse in its distinctions. Moreover, their study does not have access to occupational-level data for many workers. This could be improved upon in two complementary ways. First, ongoing data development by the US Census Bureau is linking the decennial Census of Populations into the LEHD records. This will provide a substantially richer set of information on worker traits for perhaps 15% of the sample, enabling many new analyses. Second, some firms are beginning to open up their employment records for researchers. Such information may provide a wealth of data that will never be available with administrative records (e.g., reporting relationships). We hope that several such studies emerge to let us see both the internal pictures of individual companies and the larger patterns across the firms.

Several issues are important for further study. First, Peri and Sparber (2011) consider the potential shift of native educated workers across occupations in response to immigration inflows. The authors find that immigrants with graduate degrees specialize in occupations demanding quantitative and analytical skills, while native workers move into 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. In a quite different context, Borjas and Doran (forthcoming) also consider native mobility across mathematical subfields in response to the Soviet influx. They demonstrate how native mathematicians shifted into fields where the Soviet mathematicians were less active before the influx, especially those mathematicians that were not superstars.

Tracing out these potential complementarities and shifts across occupations within and across firms is important for understanding the con-

sequences of skilled immigration. Likewise, it is intriguing to consider differences across skill levels and ethnic groups. For example, does an influx of Hispanic skilled immigrants into a firm help low-skilled Hispanic immigrants already in the firm? Does it lead to greater future hiring of low-skilled Hispanics?

Given that the largest employers of skilled immigrants have multiple facilities, future work on the expansion and contraction over locations within a firm is important. Several studies particularly note the role of immigration in smoothing spatial differences or needs (e.g., Borjas 2001; Kerr 2010; Ruiz, Wilson, and Choudhury 2012). One line of work could consider the role of skilled immigration in firm staffing versus drawing from local areas. Are they complements or substitutes? A second line could consider the firm's activities over locations—for example, in periods of strong visa access, do firms systematically shift activity toward locations that immigrants find most attractive for work?

B. Global HR Practices

The above observations segue into a broader and important area of future inquiry. Many immigrants are employed by large multinational organizations that have operations in many countries. For these firms, the domestic and local considerations noted above are just one part of the overall staffing choices made. It is essential that we begin to understand better the degree to which the labor choices made by these global companies connect across countries. Such inquiries could evaluate first whether the hiring of immigrants inside the United States is connected to changes in foreign employment levels (and vice versa). Second, it would be beneficial to understand better the internal labor markets within these firms across countries (e.g., Choudhury 2010). Programs like the H-1B and L-1 visas are used for intracompany transfers; thus, how these decisions are embedded within the firm's organization is important.

A second area of interest relates to firm incentives to discover talent. Tervio (2009) describes a dynamic inefficiency in the discovery of talent that can occur when competition for workers reduces the benefits that firms can receive from new employment relationships. These lower benefits in turn lead to less investment in finding new talent than what is socially optimal. Guaranteed contract length in professional sports is one example of an effort to address this issue. The tied employer-employee relationships embedded in the H-1B program can also be

seen in this light, as compensating firms for the costs incurred in the identification of a foreign worker to bring to the United States by allowing a protected employment spell. This feature can be controversial, however, and legislators have modified the rules governing visa portability over time. By looking inside of firms, progress can be made toward understanding how important these incentives for talent discovery are. Understanding this saliency would help guide policymakers contemplating adjustments of this feature.

C. Implications of Tied Employer Relationships

The previous section described research on whether tied employer-employee relationships influence wages paid to immigrants by firms. Future work needs to consider other outcomes that lock-in effects might influence. A first example is project selection for immigrants. Many firms struggle when workers quit during the middle of an important project, disrupting the workflow and developed tacit knowledge base of the project team. The tied employer-employee relationship makes it far more difficult for a worker on an H-1B visa to switch firms. This greater worker stability can be very valuable to the firm, perhaps leading to the use of certain immigrant groups on long-duration projects where this stability is an asset. This issue could be ideally studied using project-level data with information on the success of the project and the turnover of the team.

A second example is training and worker investment. The literature on firm-sponsored on-the-job training emphasizes that greater mobility of workers reduces the incentives of firms to invest in their skills due to a lower expected return. Tied employer-employee relationships again provide some stronger assurances to firms of the time horizons over which they could benefit from trained workers. If it is also true that wages for immigrants on temporary visas adjust imperfectly, the productivity gains to firms could easily outpace wage growth. Information on firm-sponsored training across worker groups would allow investigation of this proposition.

Within these and related questions, the way that the United States grants permanent residency for employment-based applications provides a particularly advantageous way to quantify effects. Limits exist for the number of employment-based green cards that go to a single country in a given year. Most countries are well below these limits, while they are binding for large countries like China, India, and the

Philippines. As a consequence, the time required for a temporary immigrant to obtain permanent residency can be several years longer for immigrants from these large countries than for those from smaller countries. Recent legislation intends to correct this imbalance going forward, but the past variation could be very useful for teasing out these lock-in effects on various margins as long as information on country-of-origin is available.

D. Variation across Institutions in Visa Access

A final area of microeconomic interest is to consider whether the differential access of various institutions to immigration visas impacts the types of collaborations in the economy and related industrial organization. The most prominent candidate is university-firm collaboration. Since the H-1B visa reforms circa 2000, universities and nonprofits have been exempt from the H-1B visa cap on new issuances, unlike firms. It is an open question whether this differential access has a material effect on the rate and types of collaborations formed when visa access is restricted for firms (e.g., life sciences firms sponsoring postdoctoral research in nearby universities).⁵ Likewise, several features of the immigration process lead to larger firms employing disproportionate shares of temporary immigrants (e.g., returns to scale in visa applications, greater stability in the employer-employee relationship). It is possible that such features influence the local industrial organization and large-small firm dynamics.

VI. Open Areas of Inquiry—Macroeconomic Effects

Beyond these analyses, we need to increasingly develop a better understanding of the general equilibrium effects of skilled immigration, with firms as a central element in this model. We describe here a few particular potential research areas, among many other possibilities.

A. Visa Structure and Economic Outcomes

Bound et al. (forthcoming) provide a rare example of an equilibrium model of the skilled immigration process. They use their calibrated model to analyze the employment and wage adjustments of computer scientists across two tech booms. Their results suggest that the substantial increase in immigration during the period of growth of the late

1990s, which was much larger in magnitude compared to the 1980s boom, led to less wage growth than what would have otherwise occurred. This study provides one of the first integrated models to consider the impact of skilled immigration on the economy. As the results of these types of calibrated frameworks depend significantly upon the specified structure of the model, future researchers may naturally want to adjust some aspects of their framework.

In particular, we hope that future researchers build equilibrium models that include the choices of firms. What appears especially relevant is the endogenous visa demand by different types of businesses and the first-come-first-served basis of the program. A fleshed-out model could provide a basis for understanding such diverse facts as the heavy uptake of the visa by high-tech companies for STEM occupations, the differences across worker ages and occupations in terms of impacts, and similar. Such a model could also allow for a comparison of alternative allocation schemes (e.g., quotas on occupations or countries of origin, a pricing mechanism for visas). These models would also begin to show the micro-macro connections of firm growth and aggregate growth with, for example, potential emphasis on understanding innovation channels.

B. Competition over Countries for Skilled Immigrants

The above model could just consider the United States economy by specifying for simplicity an outside supply of immigrant workers for hire. The international competition for talent would be beyond the scope of such a framework. Freeman (2006) discusses the worldwide nature of these labor flows, and Stephan, Franzoni, and Scellato (2013) provide recent evidence on academic location choices. We hope macroeconomic work begins in this global direction too, although such a model would be very complicated (e.g., including game theoretic considerations for firms). One potential element for such a model would be the choices by multinationals of where to locate facilities. The developing microeconomic literature can provide some foundation for an accurate portrayal of this dimension.

C. Immigration and Firm Reallocation

One of the central ways in which the literature on international trade has benefited from a closer examination of the role of firms is in look-

ing at how exports and imports affect reallocation within an economy. This work was given theoretical foundations by the pioneering models of Melitz (2003) and Bernard et al. (2003). For example, Pavcnik (2002) finds evidence of gains in aggregate productivity from reallocation in response to greater exposure to import competition that came from trade liberalization in Chile. The existing literature on skilled immigration discussed above has made some progress in understanding how immigration affects innovation and productivity at the city and state levels or for a select group of firms. With more comprehensive information on firms in an economy, a fruitful line of research would be to better understand how greater inflows of skilled immigrants affect firm market shares and aggregate productivity. This could be through the entry of new firms or the exit of lower-productivity firms (e.g., Acemoglu et al. 2013). If skilled immigration does indeed have impacts on firm innovation and the largest and most productive firms in the economy gain disproportionately from these inflows (as would be suggested by the evidence above), this selection effect in particular has the potential to be large. This would be another way in which skilled immigration could affect aggregate productivity. That is, it could have an impact not only on within-firm outcomes but also on aggregate outcomes due to reallocation effects. An investigation of such issues is only possible with an approach that focuses squarely on the firm.

VII. Conclusions

Economists tend to pay close attention to the quantitative tools and empirical approaches that they use for studying the economic impacts of policy choices. Over the last three decades an important literature has developed a toolkit for considering the economic consequences of immigration. Conflict and disagreements remain about which methodology should be applied for studying a given circumstance or policy, but it is clear that these disagreements are conducted with a well-developed understanding of the potential pitfalls and advantages of each approach. A common language and frame of reference has been developed for these discussions, with most of the disagreement focused on discerning the traits of the problem at hand as a guide to selecting the right tool.

As research on skilled immigration grew over the last decade, a natural starting point was to utilize the existing methodologies that were developed for general immigration studies. The major theme of this

chapter is that this borrowed approach should not be the end point. Unlike the study of migration more broadly, firms play an essential and active role in the skilled immigration process. In fact, the structure of the most important skilled immigration program allows firms to first choose the worker that they want to hire. The same is true for universities and students, who often become the workers later hired by firms (e.g., Stephan and Levin 2001; Stephan 2010). Given this policy framework, it will be particularly valuable to understand exactly how these institutions choose to be a part of the immigration process, the role of the immigrants in their sponsoring institutions, how these initial conditions persist for future assimilation of the immigrant, and so on.

Over the past decade, the academic literature on international trade has benefited deeply from a greater consideration of the role of the firm—for example, understanding the role of fixed costs and productivity thresholds for the firms choosing to engage in foreign exports (e.g., Melitz 2003), evaluating the link of internal resources and personnel for the firm to the export destinations selected, and similar. These developments have enabled stronger economic evaluations and policy counsel. Our hope is that the literature on skilled immigration can take a similar step forward. Indeed, our conclusion is that greater adoption of recent tools from other literatures that have considered firms in greater depth would be more valuable as a step forward for the literature than further refinements of the toolkit used for broader migration studies.

To facilitate this work, a great deal of firm-level information is essential—the appropriate data and computing power needed to study these issues are orders of magnitude more complex than those required to conduct a local area study. The development of new employer-employee data offers great promise for expanding our understanding of the impacts of immigration from both empirical and theoretical perspectives. Data sets like the LEHD from the US Census Bureau that indicate the immigration status of workers constitute powerful new platforms. Access to these data sets is important for continued research, especially as we consider whether and how to reform the US immigration system. It is especially crucial that the existing citizenship and country-of-origin information in these data sets are maintained and that links to the decennial census data on occupations and family structures are improved.

Enormous investments have been placed into the development of these resources, and we are just starting to see the returns from an academic perspective, with hopefully greater returns with respect to policy

to follow shortly. But we hope too that these current data development efforts are expanded upon. Some important progress can be made with appropriate authorizations. For example, linking LEHD employees to inventor records in the United States Patent and Trademark database would provide a stronger foundation for studies of skilled immigration and innovation.

Another item that would be useful for empirical work involves linking existing data together across government entities, which is admittedly difficult. For example, pilot studies have shown the capabilities of linking the Census Bureau's family of data sets with the foreign affiliate records of the Bureau of Economic Analysis. Such a link would provide a better picture of aggregate firms and employment decisions. Multinational companies are the leading employers of skilled migrants, and these firms often have a majority of their employees and operations outside of the United States. To better understand the economics of the firm, we need to understand this global footprint. This goes to such fundamental questions as whether greater visa access leads multinational firms to keep more jobs in the United States. Recent high-profile cases have suggested that this may indeed be an important consequence of restricting skilled immigration flows, such as the founding of a new Microsoft R&D center in Vancouver, Canada. Using resources like Compustat to obtain worldwide sales on public firms offers a less-than-ideal alternative in the short term. As we have already collected much of the needed information to do a comprehensive analysis, the fact that this has remained unfinished has hampered research progress.

The frontier for future research is the collection and integration of new sources of information for research purposes, some of which is being currently collected for nonresearch needs. These have the potential to be informative for important policy considerations, but we are very far from this point today. For example, many policymakers want to know what the impact of the H-1B visa program is on various aspects of the economy—the cap on H-1B issuances is a specific policy variable that is frequently debated. It is difficult, however, to get information on present and past H-1B holders. Multiple studies, including our own, would have benefited from this type of information. As in the movie *Field of Dreams*, “if you build it, they will come.” A coordinated effort to link past H-1B data to workers in the LEHD would be extremely valuable and may serve to attract new economists to the study of these issues going forward. Further inclusion of information on other visas (e.g., F-1, L), permanent residency, citizenship changes, and so on

would continue to expand and enrich the potential for research in this area. These improvements would not simply be improvements in degree, but would constitute large steps forward in what is possible. For example, using the lottery feature of the H-1B visa allocation in recent years for causal inference would be a major step forward.

With this call for additional research, we would like to close on a note of optimism. Economists have made tremendous strides over the past decade in identifying important unanswered questions about the impacts of skilled immigration, assembling and utilizing existing data resources, and making early traction on empirical work. This research area is exciting, productive, and becoming ever more so. It is also an area where policy choices are being actively made, and economists can provide important inputs into these decisions. Existing studies provide some guidance in current policy choices, and introducing this conceptual framework into the literature in moving forward may be even more important.

Endnotes

This paper is a revised version of a review prepared for the Innovation Policy and the Economy Forum, April 2014. Comments are appreciated and can be sent to wkerr@hbs.edu. We especially thank Daniel Goroff and the Sloan Foundation for financial support for this project. We are also grateful to Ed Egan and Rosana Lee for very helpful comments on the draft. The authors were paid an honorarium by the NBER for the writing of this review. For acknowledgments, sources of research support, and disclosure of the authors' material financial relationships, if any, please see <http://www.nber.org/chapters/c13404.ack>.

1. See the publications submitted annually by the United States Citizenship and Immigration Services (USCIS) to Congress, "Characteristics of Specialty Occupation Workers."

2. Studies of the impact of H-1Bs on wages include Lowell (2001), Zavodny (2003), Matloff (2003, 2004), Kirkegaard (2005), Miano (2005), Lowell and Salzman (2007), Tambe and Hitt (2009), Mithas and Lucas (2010), Hunt (2011), and Lofstrom and Hayes (2011).

3. Related work has been done outside of the United States. Similar conclusions are drawn for the Netherlands (Parrotta, Pozzoli, and Pytlikova 2014; Ozgen, Nijkamp, and Poot 2011) and the United Kingdom (Nathan, forthcoming). Studies using cross-country variations in diversity and innovation include Alesina, Harnoss, and Rapoport (2013) and Ashraf and Galor (2011).

4. Hovhannisyan and Keller (2010) look at specific business-related travel, and Docquier and Rapoport (2012) provide a broad review of these issues.

5. On a similar note, Massachusetts Governor Deval Patrick recently announced a plan to use this differential to create avenues for bringing H-1B workers to the state, "Massachusetts' Clever Immigration Reform Workaround," <http://management.fortune.cnn.com/2014/04/14/massachusetts-visas-immigration/>. Accessed April 15, 2014.

References

Acemoglu, Daron, Ufuk Akcigit, Nicholas Bloom, and William R. Kerr. 2013. "Innovation, Reallocation, and Growth." Working Paper no. 18993, NBER, Cambridge, MA.

- Agrawal, Ajay, Devesh Kapur, John McHale, and Alexander Oettl. 2011. "Brain Drain or Brain Bank? The Impact of Skilled Emigration on Poor-Country Innovation." *Journal of Urban Economics* 69:43–55.
- Alesina, Alberto, Johann Harnoss, and Hillel Rapoport. 2013. "Birthplace Diversity and Economic Prosperity." Working Paper no. w18699, NBER, Cambridge, MA.
- Anderson, Stuart, and Machaela Platzer. 2006. "American Made: The Impact of Immigrant Entrepreneurs and Professionals on US Competitiveness." National Venture Capital Associate Report, Arlington, VA.
- Andersson, Fredrik, Monica Garcia-Perez, John C. Haltiwanger, Kristin McCue, and Seth Sanders. 2010. "Workplace Concentration of Immigrants." Working Paper no. 16544, NBER, Cambridge, MA.
- Åslund, Olof, Lena Hensvik, and Oskar Skans. 2012. "Seeking Similarity: How Immigrants and Natives Manage in the Labor Market." Working Paper, World Bank. http://siteresources.worldbank.org/EXTLACOFFICEOFCE/Resources/870892-1265238560114/SeekingSimilarity_WBpaper.pdf.
- Ashraf, Quamrul, and Oded Galor. 2011. "The 'Out of Africa' Hypothesis, Human Genetic Diversity, and Comparative Economic Development." Working Paper no. w17216, NBER, Cambridge, MA.
- Axtell, Robert. 2001. "Zipf Distribution of US Firm Sizes." *Science* 293:1818–20.
- Bernard, Andrew, Jonathan Eaton, J. Bradford Jensen, and Samuel Kortum. 2003. "Plants and Productivity in International Trade." *American Economic Review* 93 (4): 1268–90.
- Borjas, George. 2001. "Does Immigration Grease the Wheels of the Labor Market?" *Brookings Papers on Economic Activity* 2001 (1): 69–119.
- . 2003. "The Labor Demand Curve Is Downward Sloping: Reexamining the Impact of Immigration on the Labor Market." *Quarterly Journal of Economics* 118 (4): 1335–74.
- Borjas, George, and Kirk Doran. 2012. "The Collapse of the Soviet Union and the Productivity of American Mathematicians." *Quarterly Journal of Economics* 127 (3): 1143–203.
- . Forthcoming. "Intellectual Mobility: Native Responses to Supply Shocks in the Space of Ideas." *Journal of Labor Economics*.
- Bound, John, Breno Braga, Joseph Golden, and Gaurav Khanna. Forthcoming. "Recruitment of Foreigners in the Market for Computer Scientists in the US." *Journal of Labor Economics*.
- Card, David. 2001. "Immigrant Inflows, Native Outflows, and the Local Labor Market Impacts of Higher Immigration." *Journal of Labor Economics* 19 (1): 22–64.
- Chellaraj, Gnanaraj, Keith Maskus, and Aaditya Mattoo. 2008. "The Contribution of Skilled Immigration and International Graduate Students to US Innovation." *Review of International Economics* 16 (3): 444–62.
- Chi, Miao, and Scott Drewianka. 2014. "How Much is a Green Card Worth? Evidence from Mexican and Puerto Rican Men Who Marry Women Born in the US" *Labor Economics* 31:103–16.
- Choudhury, Prithwiraj. 2010. "Return Migration and Distributed R&D in Multinationals—A Study Using Micro Data." Working Paper, Harvard Business School, Harvard University.
- Clemens, Michael. 2013. "Why Do Programmers Earn More in Houston than Hyderabad? Evidence from Randomized Processing of US Visas." *American Economic Review Papers & Proceedings* 10 (3): 198–202.

- di Giovanni, Julian, and Andrei A. Levchenko. 2012. "Country Size, International Trade, and Aggregate Fluctuations in Granular Economies." *Journal of Political Economy* 120 (6): 1083–132.
- Docquier, Frederic, and Hillel Rapoport. 2012. "Globalization, Brain Drain, and Development." *Journal of Economic Literature* 50 (3): 681–730.
- Donnelly, Paul. 2002. "H-1B Is Just Another Gov't. Subsidy." *Computerworld*, July 22. <http://www.computerworld.com/article/2576945/it-careers/h-1b-is-just-another-gov-t-subsidy.html>.
- Facchini, Giovanni, Anna Maria Mayda, and Prachi Mishra. 2011. "Do Interest Groups Affect Immigration Policy?" *Journal of International Economics* 85 (1): 114–28.
- Fairlee, Robert. 2008. "Estimating the Contribution of Immigrant Business Owners to the US Economy." Small Business Administration, Office of Advocacy Report.
- Foley, Fritz, and William Kerr. 2013. "Ethnic Innovation and US Multinational Firm Activity." *Management Science* 59 (7): 1529–44.
- Freeman, Richard. 2006. "People Flows in Globalization." *Journal of Economic Perspectives* 20 (2): 145–70.
- Friedberg, Rachel. 2001. "The Impact of Mass Migration on the Israeli Labor Market." *Quarterly Journal of Economics* 116 (4): 1373–408.
- Gabaix, Xavier. 2011. "The Granular Origins of Aggregate Fluctuations." *Econometrica* 79 (3): 733–72.
- Gaule, Patrick, and Mario Piacentini. 2013. "Chinese Graduate Students and US Scientific Productivity." *Review of Economics and Statistics* 95 (2): 698–701.
- Ghani, Ejaz, William Kerr, and Christopher Stanton. Forthcoming. "Diasporas and Outsourcing: Evidence from oDesk and India." *Management Science*.
- Hira, Ron. 2010. "The H-1B and L-1 Visa Programs: Out of Control." EPI Policy Paper, Economic Policy Institute. <http://www.epi.org/publication/bp280/>.
- Hovhannisyan, Nune, and Wolfgang Keller. 2010. "International Business Travel: An Engine of Innovation?" CEPR Discussion Paper no. 7829, Centre for Economic Policy Research.
- Hunt, Jennifer. 2011. "Which Immigrants are Most Innovative and Entrepreneurial? Distinctions by Entry Visa." *Journal of Labor Economics* 29 (3): 417–57.
- . Forthcoming. "Does the United States Admit the Best and Brightest Computer and Engineering Workers?" *Journal of Labor Economics*.
- Hunt, Jennifer, and Marjolaine Gauthier-Loiselle. 2010. "How Much Does Immigration Boost Innovation?" *American Economic Journal: Macroeconomics* 2 (2): 31–56.
- Keller, Wolfgang. 2004. "International Technology Diffusion." *Journal of Economic Literature* 42 (3): 752–82.
- Kerr, Sari Pekkala, and William Kerr. 2013. "Immigration and Employer Transitions for STEM Workers." *American Economic Review Papers and Proceedings* 103 (3): 193–7.
- Kerr, Sari Pekkala, William Kerr, and William Lincoln. Forthcoming. "Skilled Immigration and the Employment Structures of US Firms." *Journal of Labor Economics*.
- . 2014. "Skilled Immigration and the Innovation of US Firms." Working Paper, Harvard Business School, Harvard University.
- Kerr, William. 2008. "Ethnic Scientific Communities and International Technology Diffusion." *Review of Economics and Statistics* 90 (3): 518–37.

- . 2010. "Breakthrough Inventions and Migrating Clusters of Innovation." *Journal of Urban Economics* 67 (1): 46–60.
- . 2013. "US High-Skilled Immigration, Innovation, and Entrepreneurship: Empirical Approaches and Evidence." Working Paper no. 19377, NBER, Cambridge, MA.
- Kerr, William, and William Lincoln. 2010. "The Supply Side of Innovation: H-1B Visa Reforms and US Ethnic Invention." *Journal of Labor Economics* 28 (3): 473–508.
- Kerr, William, William Lincoln, and Prachi Mishra. Forthcoming. "The Dynamics of Firm Lobbying." *American Economic Journal: Economic Policy*.
- Kirkegaard, Jacob. 2005. "Outsourcing and Skill Imports: Foreign High-Skilled Workers on H-1B and L-1 Visas in the United States." Working Paper no 05-15, Washington, DC, Peterson Institute for International Economics.
- Kugler, Maurice, and Hillel Rapoport. 2011. "Migration, FDI and the Margins of Trade." CID Working Paper no. 222, Center for International Development, Harvard University.
- Lofstrom, Magnus, and Joseph Hayes. 2011. "H-1Bs: How Do They Stack Up to US Born Workers?" IZA Working Paper no. 6259, Institute for the Study of Labor.
- Lowell, B. Lindsay. 2001. "Skilled Temporary and Permanent Immigrants in the United States." *Population Research and Policy Review* 20:1–2.
- Lowell, B. Lindsay, and Hal Salzman. 2007. "Into the Eye of the Storm: Assessing the Evidence on Science and Engineering Education, Quality, and Workforce Demand." Working Paper, Georgetown University and the Urban Institute.
- Matloff, Norman. 2003. "On the Need for Reform of the H-1B Non-Immigrant Work Visa in Computer-Related Occupations." *University of Michigan Journal of Law Reform* 36 (4): 815–914.
- . 2004. "Needed Reform for the H-1B and L-1 Work Visas (and Relation to Offshoring)." Working Paper, Department of Computer Science, University of California, Davis.
- Melitz, Marc. 2003. "The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity." *Econometrica* 71 (6): 1695–1725.
- Miano, John. 2005. "The Bottom of the Pay Scale: Wages for H-1B Computer Programmers." CIS Background, Center for Immigration Studies. <http://www.cis.org/PayScale-H1BWages>.
- Mithas, Sunil, and Henry Lucas. 2010. "Are Foreign IT Workers Cheaper? US Visa Policies and Compensation of Information Technology Professionals." *Management Science* 56:745–65.
- Moser, Petra, Alessandra Voena, and Fabian Waldinger. Forthcoming. "German Jewish Émigrés and US Invention." *American Economic Review*.
- Mukhopadhyay, Sankar, and David Oxborrow. 2012. "The Value of an Employment-Based Green Card." *Demography* 49:219–37.
- Nathan, Max. Forthcoming. "Ethnic Inventors, Diversity and Innovation in the UK: Evidence from Patents Microdata." *Journal of Economic Geography*.
- National Foundation for American Policy. 2008. "H-1B Visas and Job Creation." Policy Brief. <http://nfap.com/>.
- . 2010. "H-1B Visas by the Numbers: 2010 and Beyond." Policy Brief. <http://nfap.com/>.
- Oettl, Alexander, and Ajay Agrawal. 2008. "International Labor Mobility and Knowledge Flow Externalities." *Journal of International Business Studies* 39 (8): 1242–60.

- Ozgen, Ceren, Peter Nijkamp, and Jacques Poot. 2011. "Immigration and Innovation in European Regions." IZA Working Paper no. 5676, Institute for the Study of Labor.
- Parrotta, Pierpaolo, Dario Pozzoli, and Mariola Pytlikova. 2014. "The Nexus between Labor Diversity and Firm's Innovation." *Journal of Population Economics* 27 (2): 303–64.
- Pavcnik, Nina. 2002. "Trade Liberalization, Exit, and Productivity Improvements: Evidence from Chilean Plants." *Review of Economic Studies* 69 (1): 245–76.
- Peri, Giovanni. 2012. "The Effect of Immigration on Productivity: Evidence from US States." *Review of Economics and Statistics* 94 (1): 348–58.
- Peri, Giovanni, Kevin Shih, and Chad Sparber. 2013. "STEM Workers, H-1B Visas and Productivity in US Cities." Working Paper, University of California, Davis and Colgate University.
- Peri, Giovanni, and Chad Sparber. 2011. "Highly-Educated Immigrants and Native Occupational Choice." *Industrial Relations* 50 (3): 385–411.
- Rauch, James. 2001. "Business and Social Networks in International Trade." *Journal of Economic Literature* 39 (4): 1177–203.
- Rauch, James, and Vitor Trindade. 2002. "Ethnic Chinese Networks in International Trade." *Review of Economics and Statistics* 84 (1): 116–30.
- Rho, Deborah. 2013. "Immigrant Earnings Assimilation: The Role of the Firm." Working Paper, Duke University.
- Ruiz, Neil, Jill Wilson, and Shyamali Choudhury. 2012. "Geography of H-1B Workers: Demand for High-Skilled Foreign Labor in US Metropolitan Areas." Brookings Report, Metropolitan Policy Program at Brookings. <http://www.brookings.edu/~media/research/files/reports/2012/7/18%20h1b%20visas%20labor%20immigration/18%20h1b%20visas%20labor%20immigration.pdf>.
- Saxenian, AnnaLee. 1999. *Silicon Valley's New Immigrant Entrepreneurs*. San Francisco: Public Policy Institute of California.
- . 2006. *The New Argonauts*. Cambridge, MA: Harvard University Press.
- Saxenian, AnnaLee, with Yasuyuki Motoyama and Xiaohong Quan. 2002. *Local and Global Networks of Immigrant Professionals in Silicon Valley*. San Francisco: Public Policy Institute of California.
- Stephan, Paula. 2010. "The I's Have It: Immigration and Innovation, the Perspective from Academe." In *Innovation Policy and the Economy*, vol. 10, edited by Josh Lerner and Scott Stern. Chicago: University of Chicago Press.
- Stephan, Paula, Chiara Franzoni, and Giuseppe Scellato. 2013. "The Comings of the Foreign-Born for PhD and Postdoctoral Study: A Sixteen Country Perspective." Working Paper no. 18809, NBER, Cambridge, MA.
- Stephan, Paula, and Sharon Levin. 2001. "Exceptional Contributions to US Science by the Foreign-Born and Foreign-Educated." *Population Research and Policy Review* 20 (1): 59–79.
- Stuen, Eric, Ahmed Mobarak, and Keith Maskus. 2012. "Skilled Immigration and Innovation: Evidence from Enrollment Fluctuations in US Doctoral Programs." *Economic Journal* 12(565): 1143–76.
- Tambe, Prassana, and Lorin Hitt. 2009. "H-1B Visas, Offshoring, and the Wage of US Information Technology Workers." Working Paper, New York University and University of Pennsylvania.
- Tervio, Marko. 2009. "Superstars and Mediocrities: Market Failure in the Discovery of Talent." *Review of Economic Studies* 76 (2): 829–50.

- Thibodeau, Patrick, and Sharon Machlis. 2013. "The Data Shows: Top H-1B Users Are Offshore Outsourcers." *ComputerWorld*, February 14. <http://www.computerworld.com/article/2494926/technology-law-regulation-the-data-shows-top-h-1b-users-are-offshore-outsourcers.html>.
- Wadhwa, Vivek, AnnaLee Saxenian, Ben Rissing, and Gary Gereffi. 2007. "America's New Immigrant Entrepreneurs." Kauffman Foundation Report.
- Zavadny, Madeline. 2003. "The H-1B Program and its Effects on Information Technology Workers." *Federal Reserve Bank of Atlanta Economic Review* 88 (3). <http://www.intellectualltakeout.org/library/research-analysis-reports/h-1b-program-and-its-effects-information-technology-workers>.