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Chapter Author(s): Stephen Ross Yeaple

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The Innovation Activities of Multinational Enterprises and the Demand for Skilled-Worker, Nonimmigrant Visas

Stephen Ross Yeaple

Multinational enterprises, those firms that operate productive facilities in multiple countries, engage in the lion's share of both international commerce and formal innovative activities such as research and development (R&D). An almost universally held view is that the nature of knowledge creation and its usage leads to the development of these firms (e.g., Helpman 1984; Markusen 1984). Knowledge is a public good that can be used in many places by many people simultaneously, and so the firms that create knowledge have difficulty extracting rents from it. These market imperfections give rise to multinationals.

While the use of existing technology has been integrated into the theory of the multinational enterprise, the international flows of labor that facilitate its creation have received less attention. The development and management of new technologies within the firm require the most highly trained and capable minds. Moreover, while the world has seen the rapid fragmentation of production processes, which have allowed individual countries to specialize in particular stages of the physical production process, the fragmentation of the production of technology remains limited. Despite some diffusion in recent years, most formal R&D remains highly concentrated in a few firms' headquarters that are located in even fewer countries. Yet, it is likely that raw intellectual talent is not nearly as concentrated globally as the location of multinationals' headquarters.

A growing literature (e.g., Kerr and Kerr 2015) suggests that there are substantial frictions to international collaboration that can only be fully

Stephen Ross Yeaple is professor of economics at Pennsylvania State University and a research associate of the National Bureau of Economic Research.

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overcome by allowing researchers to work in close physical proximity for an extended period of time. Hence, international relocation costs, many of which are driven by government policies, that impede the flow of the world's most talented workers from low- to high-innovation locations may have substantial negative consequences for global welfare. Indeed, in testimony before Congress, Bill Gates has argued that US limits on skilled-worker inflows could lead to innovative activities moving out of the United States to places where there is less competition for the most highly skilled workers.

The United States accommodates some of this need for labor movements within firms through its H-1B and L-1 nonimmigrant visa programs. The H-1B program is highly visible and so is well known. Every year the US Citizen and Immigration service accepts applications by US-based firms for temporary work visas that number 65,000 for workers with specialized skills and an additional 20,000 visas for recent graduates of American universities.[1] The annual number of petitions for these visas usually exceeds the allowed number of visas, so that the cap is binding.

The L-1 visa program, which came into being in the 1970 amendments of the Immigration and Nationality Act, is less well known. It has two components. The L-1A program is designed to offer temporary work visas with a typical duration of three years for the managers and executives that are being transferred within the firm, but across the border. The L-1B program is designed for workers being transferred within the firm, but across the border, who have specialized knowledge of the company's products/services, research, systems, proprietary techniques, management, or procedures. Both cases are relevant for the international movement of the labor to develop and to manage new technology.

This chapter presents an analysis of the industrial structure of international labor flows that are made possible by the L-1 and H-1B visa programs. We begin by providing a simple model of firm sourcing of skilled labor based on recent advances in the quantitative literature on differentiated intermediate input sourcing (e.g., Antras, Fort, and Tintelnot 2017). In the model the welfare effects of temporary work visas may be much like the welfare effects of sourcing intermediate inputs: they lead to increased innovative activities at the firm level and an expansion of the domestic workforce at those firms that actually use foreign workers. According to this framework, it may be the firms that do not use temporary skilled foreign workers who suffer the most and whose contraction may adversely affect the welfare of domestic US workers. Further, it is shown that under reasonable parameter values skilled US workers may benefit from the existence of these programs!

1. Many more are given without restriction to university professors and employees of nonprofits. Surely without this exception, US universities would be hard pressed to maintain their world-leading reputation for research!

We then turn to data on L-1 and H-1B visa programs to assess whether the qualitative implications of our model are consistent with the facts. As our model points to a complementarity between multinational production and worker visa usage, we focus on the role played by multinational enterprises in these flows. Using firm-level data of the users of these programs, we show that it is the most R&D-intensive firms in the most R&D-intensive industries that rely most heavily on temporary visas. Our results provide support for the hypothesis that international flows of specialized workers are important because these workers are highly complementary to the use and to the development of innovative technologies.

Going further, we demonstrate that the structure of sourcing of labor across the types of visas differs dramatically across industries and countries. For instance, H-1B visas are fairly evenly distributed over high-tech industries while L-1 visas and all temporary work visas are more skewed toward the industries in which US multinationals operate the most aggressively abroad. This suggests that the L-1 visa program plays the role of a substitute for the H-1B program. Supporting this hypothesis is the observation that after controlling for the relevant firm-level characteristics, multinational firms are still granted a large number of temporary work visas than nonmultinational firms. This suggests that these firms are better able to overcome the frictions, both driven by US policies and by the natural difficulties associated with identifying and acquiring the proper skills in distant labor markets.

Temporary work visas are the source of much controversy in the United States. As noted above, employers in high-tech areas argue that the program is too restrictive and so reduces the size of the high-tech sector in the United States to the ultimate detriment of all. Others argue that despite its relatively small size, both programs allow US firms to substitute lower-cost workers from abroad for comparable workers in the United States. Further, assert many critics, the program facilitates the offshoring of skilled activities as foreign workers can be efficiently "trained" in the United States. In an analysis of the L-1 program, the Department of Homeland Security describes the controversy: "Opponents of the L-1 visa program feel that it drives down salaries, reduces employment opportunities for domestic technology workers, and allows unscrupulous petitioners to exploit foreign beneficiaries. However, proponents of the L-1 visa argue that this program allows US firms to remain innovative and to recruit and to retain the 'best and brightest'" (Office of the Inspector General 2013, 5).

Within the vast academic literature on immigration, the role played by temporary work visas for skilled labor has received less attention. To the extent that it has, the key questions have been (a) whether the expansion of H-1B visa programs has had the effect of increasing or decreasing demand for competing American workers, and (b) has the program had the effect of spurring additional innovation (see, e.g., Kerr and Lincoln 2010; Kerr, Kerr, and Lincoln 2015). Our contribution is to look at the cross-firm structure of skilled-labor temporary work visa usage by individual firms for patterns

that shed light on precisely these issues. We provide a portrait of which industries use these visas intensively, which firms within industries use these visas most, and which countries are the sources of these workers. We show that the foreign investment activities of US firms predict much of the variation in these sourcing patterns. This suggests that the expansion of multinational enterprises may lead to greater integration of the labor markets for high-skilled labor.

The conceptual framework that we believe is most appropriate for analyzing the welfare consequences of temporary work visas is the import-sourcing work of Antras, Fort, and Tintelnot (2017), who analyze the firm-level decisions to import differentiated intermediate inputs. In the activities associated with the development and management of new technologies, sourcing individual talents may be even more critical than sourcing individual components. Human specialization in high-technology industries is perhaps greater than in any other activity associated with mass production as there may only be a handful of candidates who are truly qualified for particular jobs. Further, given the nature of the activities involved, actual worker mobility, rather than remote communication, may be critical.[2]

In the context of sourcing foreign inputs, multinationals are important for two reasons. The first reason is that the L-1 visa program makes it possible for these firms to avoid the H-1B visa cap. This is a source of a competitive advantage of multinationals that has not been considered in the literature. It is still true, however, that this advantage is limited to sourcing workers only from countries in which it has affiliates, and so represents only a partial solution to sourcing problems. Second, because workers are, in large part, experience goods, multinationals may have a sourcing advantage in identifying, obtaining, and nurturing qualified workers relative to firms with no facilities on the ground.[3]

The remainder of the chapter is organized into six sections. In the next section we briefly describe the L-1 visa program, as it is relatively unfamiliar in the literature. In section 2.2, we provide a model of the international sourcing of skilled labor by firms engaged in innovation. In the model, firms gain from access to foreign workers for two reasons: they may be able to pay a low wage and they benefit from a diversity of skills from different locations. In sourcing such labor, multinationals have improved access because of their proximity to foreign labor markets. We also show how this framework can be used to measure the welfare impact of foreign investment and the availability of temporary work visas.

2. See Keller and Nune Hovhannisyan (2015) for the role of businessman mobility in the related context of international trade.

3. It may be the case that workers and firms need to make relationship-specific investments in order for the worker to be able to adequately implement an important task. In this context, L-1 intracompany transfer visas and H-1B visas may then be different animals for different firms depending on which type of investment is most important. In this case, Antras (2003, 2005) becomes relevant.

In section 2.3, we describe the data. In section 2.4, we provide simple econometric analyses. We first describe the cross-industry structure of temporary visa usage pointing out the similarities and differences between the usage of L-1 and H-1B programs. We then conduct a firm-level analysis in order to understand which firm characteristics are most associated with temporary visa usage. Finally, we look at the cross-country pattern in the origin of temporary visa usages. We argue that the results suggest that our model would be worth calibrating as its first-order implications are consistent with the data. Section 2.5 provides additional detail on what data would allow the full model to be estimated and used to do policy analyses were employer-employee visa data to be merged with data on the activities of US multinationals. The final section concludes.

2.1 The L-1 Program

Like the H-1B visa program, the L-1A visa and L-1B visa programs allow firms to sponsor specific workers for specific jobs for a temporary period of time. The L-1A visa covers workers who enter the United States in order to provide service in an executive or managerial capacity for an American branch, subsidiary, affiliate, or office of the same employer. An executive capacity refers to the employee's ability to make decisions of wide latitude and autonomy, while managerial capacity refers to the ability of the employee to supervise and control the work of professional employees and to manage the organization or a department, subdivision, function, or component of the organization.[4] The L-1B visa covers workers who have a specialized knowledge of a company's product, service, research, equipment, techniques, management, or other interests and its application in international markets, or an advanced level of knowledge or expertise in the organization's processes and procedures.

To qualify for an L-1 visa a worker must have been working for a qualifying organization abroad for one continuous year within the three years immediately preceding his or her admission to the United States. Qualified employees entering the United States to establish a new office will be allowed a maximum initial stay of one year. All other qualified employees will be allowed a maximum initial stay of three years. For all L-1B employees, requests for extension of stay may be granted in increments of up to an additional two years, until the employee has reached the maximum limit of five years. For all L-1A employees, requests for extension of stay may be granted in increments of up to an additional two years, until the employee has reached the maximum limit of seven years.

To obtain a visa for a qualified employee, an employer must file a Form I-129, Petition for a Nonimmigrant Worker, and pay a fee. Certain organi-

4. In the absence of an existing affiliate, a firm may use this visa program to send a worker to the United States to open a new affiliate.

zations may establish the required intracompany relationship in advance of filing individual L-1 petitions by filing a blanket petition. Eligibility for blanket L certification may be established if: (a) the petitioner and each of the qualifying organizations are engaged in commercial trade or services; (b) the petitioner has an office in the United States that has been doing business for one year or more; (c) the petitioner has three or more domestic and foreign branches, subsidiaries, and affiliates and the petitioner, along with the other qualifying organizations, meet one of the following criteria: have obtained at least ten L-1 approvals during the previous twelve-month period; have US subsidiaries or affiliates with combined annual sales of at least $25 million; or (d) have a US workforce of at least 1,000 employees. Blanket petitions offer employers the flexibility to transfer eligible employees to the United States quickly and with short notice without having to file an individual petition with the United States Citizenship and Immigration Service.

Aside from offering access to skilled foreign workers to US employers, the L-1 program has other features in common with the better-known H-1B program. In terms of its scope, the L-1 program is smaller but of a similar order of magnitude as the H-1B program. According to the Department of Homeland Security, the number of L-1 visa petitions approved or renewed in 2015 stood at 78,537 compared with 172, 748 for the H-1B program. Both programs are dual-intent programs that can act as a stepping-stone to a green card.[5]

In other respects, the visas offered by the two programs are not perfect substitutes. First, the ability of heavy users of the program to file blanket petitions and the lack of a cap on the number of employees that could be hired makes the L-1 program relatively more flexible so that firms can better smooth demand shocks than with the H-1B program. Furthermore, because H-1B visas may be denied due to the cap in such a way that specific skills cannot be prioritized, the L-1 program eliminates another source of uncertainty facing the firm. Yet another advantage of the program is that it gives firms better incentives to make long-term investments in the skills of their employees. A weakness of the program, however, is that unlike the H-1B program, the L-1 program does not provide firms the ability to recruit new graduates.[6]

2.2 Visas, Multinationals, and Innovation in General Equilibrium

In this section, we provide a simple model to analyze the effect of temporary visa programs on the innovation activities of firms. The key idea

5. The data can be found at https://travel.state.gov/content/visas/en/law-and-policy/statistics/non-immigrant-visas.html.

6. Another subtle difference between H-1B and L-1 programs is that most spouses of workers with an L-1 visa will qualify for an L-2 visa that allows the spouse to work in the United States. In 2015, the number of L-2 visas was over 86,000.

is that the high-skilled labor that is necessary to provide advertising and R&D services and to manage complex corporations labor inputs are at least as highly differentiated as intermediate inputs. Nevertheless, laborers from given countries will have some common features such as cultural and educational background and industrial experience. Multinational firms will have lower cost of hiring foreign workers than firms without global operations because they are more likely to be able to identify, to train, and to attract talented individuals abroad.

We show how the model could be estimated using data that exists, but is not readily available. We also show how the elasticities to be estimated determine the welfare implications of temporary visa programs. For instance, under reasonable parameter values, the elimination of skilled-worker temporary visa programs would have a negative impact on the relative wage of skilled labor as it would shrink research-intensive activities.

2.2.1 Assumptions

Consider a world in which there are I countries that are indexed by i and j. These countries are endowed with skilled (L_i^s) and unskilled labor (L_i^u). In each country, there is a representative consumer with preferences defined over a differentiated good (X) and a homogeneous good (Y). These preferences are given by

$$U_i = \frac{\sigma}{\sigma - 1} X_i^{(\sigma-1)/\sigma} + Y_i, \sigma > 1, \tag{1}$$

where σ is the elasticity of substitution across goods, the aggregator of varieties of the differentiated good is constant elasticity of substitution (CES),

$$X_i = \left(\int_{\omega \in \Omega_i} x(\omega)^{(\varepsilon-1)/\varepsilon} d\omega \right)^{\varepsilon/(\varepsilon-1)}, \tag{2}$$

$\varepsilon > \sigma$ is the elasticity of substitution across varieties of the differentiated good, and Ω_i is the set of available varieties in country i. We assume that good Y is freely traded between countries, produced using exclusively unskilled labor, and is the numeraire. Assuming that Y is produced everywhere, the wage of unskilled labor (not our interest in this chapter) is the same everywhere, and we choose units so that its price is one.

Consumer maximization of equations (1) and (2) yield demand for variety ω in country i of

$$x_i(\omega) = (P_i)^{\varepsilon-\sigma} p_i^{-\varepsilon}(\omega), \tag{3}$$

where p_i is the price in i, and the price index of differentiated goods in country i is

$$P_i^{1-\varepsilon} = \int_{\omega' \in \Omega_i} p_i(\omega')^{1-\varepsilon} d\omega'.$$

Note that because $\varepsilon > \sigma$ an increase in the aggregate price index for the differentiated good raises demand for an individual variety but lowers aggregate demand for the composite differentiated good.

Differentiated goods are not traded and their production requires both skilled and unskilled labor. Skilled labor is used in management and innovation functions to lower marginal costs of production, while unskilled labor physically creates output. In country i there is a measure of N_i firms indexed by ω. Each firm produces a distinct variety of the differentiated good according to a firm-specific production function given by

$$x_i(\omega) = \varphi(\omega) r_i(\omega) l_i^u(\omega), \tag{4}$$

where $\varphi(\omega)$ is the inherent productivity of the firm and $l_i^u(\omega)$ is the quantity of unskilled labor employed by the firm in country i and $r_i(\omega)$ is an endogenous component of firm productivity that is due to the firm's conscious R&D effort. Firms are heterogeneous in their inherent productivity φ, which is distributed according to the cumulative distribution function G. Firms from country i are also heterogeneously endowed with foreign affiliates with firm ω assumed to own an affiliate in set $J(\omega)$ of countries.[7] These firms may produce in any country in which they have an affiliate, but more importantly, as we describe below, they are better able to access skilled-labor markets from countries in which they own an affiliate.[8]

The endogenous component of firm ω's productivity in country i, $r_i(\omega)$, depends on management and R&D services provided by the firm at that location. These services take the form of a bundle of tasks that require skilled labor such as managers, marketing professionals, computer programmers, and scientists. These tasks lie on the unit interval and have an elasticity of substitution between them of ρ. Formally, the production function for this bundle of tasks is

$$M_i = \left(\int_0^1 s_i(t)^\rho \, dt \right)^{1/\rho},$$

where $s_i(t)$ is the effective quantity of labor services of task t provided in country i. Crucially, we assume that all workers contributing to the production of this bundle must share the same location. Finally, in order for a firm with inherent productivity φ to obtain a productivity level of φr requires the firm to produce fr^ϕ units of these bundles, where $\phi > \varepsilon - 1$ guarantees an interior solution to R&D.

Skilled workers in country i have productivities, z, across tasks that are drawn independently from the Fréchet distribution,

$$\Pr(Z < z) = \exp\left(-T_i z^{-\theta}\right),$$

where the parameter $\theta > \rho - 1 > 0$ captures the extent of skilled task comparative advantage across countries, and the parameter T_i captures the general quality of education, and hence skilled-labor capability, in country i. The endogenous wage of skilled labor in country j is given by w_j^s.

7. We choose not to endogenize the location choice of firms given the lack of data and the complexity involved. This is an area where further work would be desirable.

8. We are not taking any stand in the model on asymmetries between a firm's headquarters and its various plants.

Moving workers across countries is costly. This is either because the workers do not have experience with the workings of the particular firm, because cultural differences make workers less effective abroad, or simply because compensating differentials must be paid to induce labor to move to unfamiliar and isolated environments. We assume that the size of these moving costs depends on whether the firm owns an affiliate in the worker's country. If the firm owns an affiliate in country j, then it faces iceberg-type costs $\tau_{ji} \geq 1$ that vary across country pairs so that the realized cost of employing l_j^s skilled workers from country j for an operation in country i incurs the cost $w_j^s \tau_{ji} l_j^s$.[9] If a firm does not operate an affiliate in country j, then it has a higher cost of obtaining labor from that country and it faces the additional cost of sourcing labor $\delta_{ji} \geq 1$ so that its cost of sourcing labor is given by $\delta_{ji}\tau_{ji}$.[10]

The market structure is perfect competition in the labor markets for skilled and unskilled labor and for the homogeneous good industry. The market structure in the differentiated good industry is one of monopolistic competition.

The timing is as follows. First, firms hire skilled workers globally. Next, the firms engage in innovation and marketing efforts. Finally, the firm hires unskilled labor locally, produces, and sells its product in the local market.

2.2.2 Firm-Level Implications

In this subsection we solve for firms' innovation decisions (R&D and skilled-labor sourcing) as a function of the firms' productivity φ and set of affiliate locations J. We focus on a firm of arbitrary characteristics from a single country and characterize how variation in firm characteristics in this country gives rise to different behavior in sourcing of skilled labor and in total innovation effort.

We solve the model backward. We first derive the variable profit associated with production at a given level of productivity. Second, we determine the optimal level of productivity chosen by the firm given the cost of management and innovation. Finally, we derive the optimal sourcing of workers internationally.

The profit associated with our representative firm of inherent productivity φ that is located in country i, that is associated with an affiliate network J, that charges price p, and that implements innovation effort r is

$$\Pi_i(\varphi, J) = \max_{p,r} \left\{ \left(p - \frac{1}{\varphi_i r} \right) x_i(p) - C_i(J) f r^{\phi} \right\}, \tag{5}$$

where demand $x_i(p)$ is given by equation (3) and $C_i(J)$ is the cost of a bundle of managerial and R&D inputs in country i for a firm with affiliate network

9. For simplicity, we assume that there are no fixed costs associated with sourcing labor from abroad. This has the unrealistic implication that a firm sources workers from every country. We leave this extension to future work.

10. For evidence that the internal labor markets of large firms may be more efficient at matching workers and tasks, see Papageorgiou (2016).

J. The first-order condition for profit maximization with respect to the price of output has the solution

$$p(\varphi, r_i) = \frac{\varepsilon}{\varepsilon - 1} \frac{1}{\varphi r_i(\varphi, J)}, \tag{6}$$

which together with the first-order condition for the optimal choice of productivity in country i yields the optimal productivity level of

$$r_i(\varphi, J) = \left(\frac{B_i \varphi}{f C_i(J)} \right)^{1/(\phi - \varepsilon + 1)}, \tag{7}$$

where

$$B_i = \frac{1}{\phi} \left(\frac{\varepsilon}{\varepsilon - 1} \right)^{-\varepsilon} (P_i)^{\varepsilon - \sigma} \tag{8}$$

is the markup adjusted demand level in country i. It is immediately clear from equation (7) that a firm's choice of innovation intensity is increasing in the size of the market that it serves, is increasing in inherent productivity, and is decreasing in the cost of a bundle of management tasks. Equation (7) further implies that the total spending on skilled labor by the firm in country i is

$$S_i(\varphi_i, J) = \left(f C_i(J) \right)^{-(\varepsilon - 1)/(\phi - \varepsilon + 1)} \left(B_i \varphi \right)^{\phi/(\phi - \varepsilon + 1)}. \tag{9}$$

We now turn to the cost minimization problem of the firm with respect to its sourcing of skilled labor. For a given task, the firm will employ skilled labor from country j if

$$\frac{w_j^s}{z_j} d_{ji} \leq \frac{w_k^s}{z_k} d_{ki} \text{ for all } k,$$

where $d_{ji} = \tau_{ji}$ if $j \in J$ and $d_{ji} = \tau_{ji}\delta_{ji}$ otherwise. Following the calculations made in Eaton and Kortum (2002), it follows that the share of tasks performed for firm from country i with affiliate network J that are filled with skilled workers from country j is

$$\pi_{ji}(J) = \begin{cases} \dfrac{T_j \left(w_j^s \tau_{ji} \right)^{-\theta}}{\Theta_i(J)} & \text{if } j \in J \\ \dfrac{T_j \left(w_j^s \left(\tau_{ji} \delta_{ji} \right) \right)^{-\theta}}{\Theta_i(J)} & \text{if } j \notin J \end{cases}, \tag{10}$$

where

$$\Theta_i(J) \equiv \sum_{j \in J} T_j \left(w_j^s \tau_{ji} \right)^{-\theta} + \sum_{j \notin J} T_j \left(w_j^s \left(\tau_{ji} \delta_{ji} \right) \right)^{-\theta} \tag{11}$$

is the human resource "sourcing potential" of the firm with affiliate network J.

Following the algebra presented in Eaton and Kortum (2002), the cost of bundle of managerial inputs for a firm with affiliates in the set J of countries can be shown to be

$$C_i(J) = \left(\gamma \Theta_i(J)\right)^{-1/\theta}, \tag{12}$$

where γ is a constant.

We now tease out some of the qualitative implications of the model, beginning with two of the most immediate. First, note that by using equations (3), (6), (7), and (9) that we can solve for the share of skilled labor in total firm revenues (R), which is given by $(S_i/R_i) = (C_i f \varphi_i^{\phi}) / (p_i x_i) = (\varepsilon - 1)/\varepsilon\phi$. The first proposition follows from this observation.

Proposition 1. *Absolute demand for temporary skilled-worker visas is higher in R&D-intensive industries (i.e., those with high* $(\varepsilon - 1)/\varepsilon\phi$*).*

Firms in industries in which the return to management and/or R&D will hire more skilled labor and so will also use more skilled-labor visas.

Turning to the next firm-level implication, it follows immediately from equations (10) and (11) that as a firm becomes more multinational in the sense that it owns an affiliate in a larger number of locations that it substitutes away from both domestic employment and from H-1B visa workers. By construction the model implies that at *the level of the task*, L-1 visa holders displace domestic workers. This does NOT mean, however, that as a group the employment of domestic, or H-1B visa holders, becomes less commonplace as the firm opens more foreign affiliates. To see this, consider an increase in the number of countries in which a firm invests. From equation (11), adding a country to the set J of countries with an affiliate increases the firm's sourcing potential, which in turn reduces its cost of innovation through equation (12). Hence, an increase in multinational production induces the firm to increase its innovation efforts and so expands the firm's scale of operations.[11] The following proposition follows from equations (9) and (14):

Proposition 2. *A firm that opens an additional foreign affiliate reduces the share of domestic workers employed in innovation activities, but expands the absolute employment of skilled workers from all existing locations if*

$$\frac{1}{1+1/\theta} < \frac{\varepsilon - 1}{\phi}. \tag{13}$$

When demand for final varieties is elastic relative to the elasticity of innovation costs, a reduction in the costs of innovation labor leads to a large

11. This expansion may come at the expense of other firms in the industry or firms in other industries. The aggregate impact on demand for domestic skill depends on the details of the full general equilibrium that we do not address here.

increase in a firm's market share. If, in addition, workers across countries are not very substitutable (low θ), then skilled workers are net complements at the level of the firm. Note that the right-hand side of equation (13) is monotonic in the R&D/managerial intensity of a firm so that, everything else equal, more R&D-intensive firms are more likely to expand their total employment of all types of skilled labor when increasing their sorting potential. Another implication is that holding fixed the elasticity of innovation costs with respect to productivity, φ, greater sourcing potential leads to an increase in the absolute number of all worker types if the extent of heterogeneity of worker types across countries is high (so that θ is low) relative to the extent of heterogeneity across consumption goods (captured by ε).

Note also that this implication of the model is consistent with the findings of Kerr, Kerr, and Lincoln (2015), who find that increased H-1B usage made possible by increases in the visa cap had the effect of increasing net employment of skilled workers at those firms.

2.2.3 Parameter Estimation

In this subsection, we sketch how the model parameters could be estimated were we in possession of firm-level data that included the payments to L-1 and H-1B visa holders by the country of origin of the employee, the size of domestic employment by firm, and the location of production by country. This data would allow the estimation of a gravity equation that identifies many of the model's key parameters.

Equations (9)–(10) can be manipulated to obtain an expression for the total wage payments made by headquarters in country i to workers from country j for a firm of type (φ,J):

$$S_{ji}(\varphi,J)=\begin{cases}\dfrac{T_j\left(w_j^s\tau_{ji}\right)^{-\theta}}{\Theta(J)}S_i(\varphi_i,J) & \text{if } j\in J\\ \dfrac{T_j\left(w_j^s\left(\tau_{ji}\delta_{ji}\right)\right)^{-\theta}}{\Theta(J)}S_i(\varphi_i,J) & \text{if } j\notin J\end{cases}. \tag{14}$$

Expression (14) illustrates how the employee-sourcing part of the model can be estimated as a gravity equation using data on firm-level payments to temporary visa holders.[12] As in Antras, Fort, and Tintelnot (2017), the model implies the equation

12. To connect our model to data we need to assume that the worker inflows associated with countries in which a firm owns an affiliate occur using L-1 visas issued for the purpose of intercompany transfers, while the worker inflows associated with countries in which a firm does not own an affiliate occur as H-1B visas. Of course, a firm with an affiliate in a given country might identify a worker who is not currently an employee in that country and so use the H-1B program, such a situation might be an intermediate case in which δ_{ji} is lower for firms with a

$$\log \frac{S_{ji}(\varphi, J)}{S_{ii}(\varphi, J)} = \xi_{ji} + \xi_{ji}^{wa} + e_{ij},$$

where the country sourcing potential dummies $\xi_{ji} = \log[T_j(\tau_{ji})^{\theta} / T_i(w_i^s)^{-\theta}]$ for firms with a local affiliate in country j and $\xi_{ji}^{wa} = \log[T_j(w_j^s \tau_{ji} \delta_{ji})^{-\theta} / T_i(w_i^w)^{-\theta}]$ for firms without an affiliate. Regressing the sum of these country-level dummy coefficients on country controls for distance and efficiency would then allow instrumented skilled wage data to reveal θ.

From the coefficient estimates of θ, and estimates of T_j backed out from the data using equation (14), the cost reduction enjoyed by individual firms made possible by their multinational network and to the visa program can be calculated. To infer whether these firms are induced to hire more American workers in the model, we can compare the estimate of θ to the R&D intensity of American firms, which is $(\varepsilon - 1)/\phi$ in the model. In the most-R&D-intensive industries we would expect multinational firms to be most aggressive in hiring skilled labor from all countries.

2.2.4 Temporary Work Visas and Domestic Skilled-Worker Wages

Proposition 2 suggests that at the level of the individual firm foreign skilled workers and domestic skilled workers can be net complements. This outcome is consistent with some of the existing evidence. In this section, we show that this complementarity could be so strong that in the aggregate restrictions on skilled-worker visas could lower the welfare of a country's skilled workforce. The mechanism through which this would work in our model lines up well with the concerns of skilled-worker employers in the United States. If costs of innovation become very high because of restrictions on skilled foreign workers then the entire industry could shrink, leaving domestic skilled workers worse off.

In our special case we consider a world with two countries, now called H and F. In this world, both countries share the same number of workers and skilled workers have the same average productivity, determined by common T. Countries differ in that H has more demand for skilled labor, that is, $N_H > N_F = 0$. We assume that in a regime in which international sourcing of labor is allowed that it occurs frictionlessly (i.e., $\tau_{FH} = \delta_{FH} = 1$). Finally, all firms are identical in their productivity ($\varphi = 1$ for all firms) and no firm owns a foreign affiliate ($J = 0$).

In this setting, skilled workers from H are as vulnerable as possible to competition from immigrants from F and, as such, are most likely to be harmed by skilled-worker inflows.

We first characterize the equilibrium in which labor flows are unimpeded.

local affiliate but greater than one given the lack of experience with that worker. Further, it is also possible that a firm might choose to use the H-1B program for an employee were H-1B visas available.

Associating the worker-mobility equilibrium variables with a subscript m, the representative firm in H pays $C_m f r_m^{\phi}$ units of the numeraire to skilled workers to fund its R&D efforts. Of this spending, fraction $(w_H^s)^{-\theta}/[(w_H^s)^{-\theta}+(w_F^s)^{-\theta}]$ is paid to domestic skilled workers while the rest is paid to foreign skilled workers. It is easily confirmed that the free flow of skilled labor in this setting, in which countries that are identical except for the presence of local differentiated goods producers, implies factor price equalization.[13]

Given factor price equalization, the shares of domestic and foreign workers equally split domestic employment and the wage is determined by the single skilled-labor market-clearing condition:

$$w_m^s 2L^s = N_H C_m f r_m^{\phi}, \tag{15}$$

This expression shows that the cost of innovation activities of the N_H firms in H given the endogenous choice of productivity r_m is paid out to the skilled workers from both countries.

Using factor price equalization and equations (12) and (11), it is straightforward to show that the cost of a bundle of innovation inputs is linear in the wage paid for a unit of skilled labor:

$$C_m = (2\gamma T)^{-1/\theta} w_m^s. \tag{16}$$

Finally, homogeneity among firms implies that the price index in H[14] is always given by

$$P = \frac{\varepsilon}{\varepsilon - 1}(N_H)^{1/(1-\varepsilon)}\frac{1}{r}. \tag{17}$$

These three expressions combined with equations (7) and (8) completely characterize the worker-mobility equilibrium.

Now consider the equilibrium that obtains when workers are not able to move. We denote this "autarky" equilibrium with subscript α on the endogenous variables. Now the skilled-labor market-clearing condition becomes

$$w_a^s L^s = N_H C_a f r_a^{\phi}, \tag{18}$$

and the cost of a bundle of innovation inputs becomes

$$C_a = (\gamma T)^{-1/\theta} w_a^s. \tag{19}$$

The key difference in expressions (18) and (19) from (15) and (16) is the factor by which L^s and T are multiplied. This reflects the fact that there is only half

13. Although skilled workers are differentiated by their source, they have identical average productivities and they are in equal supplies given the symmetry assumption. Therefore, factor prices must equalize.

14. Because $M_F = 0$ and because there is no trade in final goods and no local foreign affiliates, the differentiated good is not available in F.

the skilled-labor supply in this equilibrium, and there is a lack of intellectual diversity as only one country's labor type is available.

These expressions, when combined with (7) and (8), imply the following price differences between the two equilibria:

$$\frac{P_m}{P_a} = 2^{-(1+\theta)/\theta\phi},$$

$$\frac{w_m^s}{w_a^s} = 2^{(1/\theta)-[(1+\theta)/\theta][1-(\sigma-1)/\phi]}.$$

These expressions imply the following proposition:

Proposition 3. *Home's skilled workers have higher income under perfect skilled-labor mobility than with no skilled-labor mobility if*

$$\frac{1}{1+1/\theta} < \frac{\sigma-1}{\phi}. \tag{20}$$

The proposition establishes a sufficient condition for skilled workers in the "protected" country to lose from that protection. Intuitively, if workers internationally are poor substitutes for one another (θ low), then international labor mobility will substantially lower the cost of innovation. If, in addition, lower innovation costs induce a substantial increase in demand for differentiated goods (high σ), then allowing skilled-labor migration from a country with excess supply of skilled labor may increase aggregate demand for skilled labor by so much that the real income of domestic skilled workers increases relative to the price of homogeneous goods. Moreover, more innovation lowers the marginal cost of production and so lowers the relative price of differentiated goods. Were the condition in the proposition not to hold, skilled workers might yet gain because skilled immigration lowers the price of differentiated goods through increased innovation. In this sense, condition (20) is sufficient but is not necessary.

That the conditions (13) and (20) are so similar is not surprising. At the firm level, opening an affiliate yields better access to foreign workers and so allows the firm to benefit from the increased diversity and the productivity gain associated with that cost reduction depends on the elasticity of innovation costs with respect to productivity. At the firm level, the key issue is how this cost reduction shifts market share away from competitors, whereas at the industry level this is about how lower marginal costs induced by productivity gains induces a shift in consumption toward the innovative industry.

This model presented in this section has interesting implications regarding how skilled-labor welfare is affected by the existence of a skilled-labor temporary visa program. The discussion in the previous subsection showed how with the right data set the relevant elasticities and international mobility frictions could be estimated in a manner similar to that of Antras, Fort, and Tintelnot (2017).

2.2.5 Summary of Model Implications

We have discussed how existing, but hard to access, data could be used to estimate the model. The data to which we do have access includes components of the ideal data set but lacks the detail necessary for estimation. Hence, we instead explore in our data whether the model is consistent with the key assumptions and implications of our model.

The model is built upon several premises. Among these is the premise that L-1 and H-1B visas are substitutes at the level of the task, the premise that sourcing frictions induce a gravity structure to worker flows, and that multinational firms can source L-1 employees more freely than they can source H-1B visa holders. Implications of the model are that in the aggregate that multinationals will not only hire more L-1 visa employees but also more H-1B employees and domestic workers because skilled workers from different backgrounds can be complements in aggregate employment. This is especially true in R&D-intensive sectors. The remainder of this chapter will explore variation in the publicly available data.

2.3 Data

The key data used in this study is built from a listing of firm name, US state of location, and the number of L-1 and H-1B visa petitions approved by the United States Citizenship and Immigration Service (USCIS) in the year 2007.[15] While these data are only flows for a single year, the largest users of this program reliably petition a similar number each year and so it is likely to be reasonably representative of the stock. These petitions reflect a subset of the actual petitions as the USCIS has substantial leeway in its approval of these visas and a visa can be rejected because a worker does not fit the description of a long-term employee of the foreign operations of the firm operating in the United States. As a result, up to a quarter of petitions each year are rejected.

We matched the USCIS data to the Compustat database using the name-matching algorithm written by Wasi and Flaaen (2014). This allowed us to associate the operating characteristics of the petitioner provided by the Compustat database. As many of the heaviest users of the L-1 visa program are not publicly listed companies, and so do not appear in the Compustat database, we conducted Internet searches for all petitioners who had more than twenty petitions and recorded country of incorporation, main line of business, and global employment in the year closest to 2007. The final match rate accounted for slightly more than 51 percent of petitions approved or nearly 26,000 petitions approved for nearly 1,000 firms. We are confident that we have identified almost all the visa usage by the firms in Compustat

15. I thank Will Kerr for providing these data to me.

and have a reasonably representative picture of the cross-industry aggregate usages of these visas as well. Nevertheless, with respect to our firm-level data, the fact that so many firms are not public means that we cannot be absolutely sure that our coverage is entirely representative of the US population of firms.

As these data do not reveal the country source of the workers entering the United States, we also used the aggregate statistics provided by the USCIS, which breaks out the number of petitions filed by country for each year.

In our analysis below, we make use of the publicly available data on the activities of US multinationals abroad and in the United States. These data come from the 2007 Benchmark Survey of the affiliates of foreign firms operating in the United States and the 2007 annual survey of the domestic and foreign operation of US-based multinationals. We use these data to measure the cross-industry and cross-country structure of employment by parents and affiliates and the cross-industry R&D and management intensity of parent-firm operations.

2.4 Facts

This section has three parts. In the first, we aggregate the matched data to the level of the industry to investigate the cross-industry characteristics associated with temporary skilled-worker visas. In the second, we consider purely within-industry, cross-firm variation. We find that R&D-intensive, multinational firms in R&D-intensive sectors dominated by multinational firms are the heaviest users of the visa programs.

In the third subsection, we consider a different dimension of the data: the cross-country variation in the two programs. We find that visa usage follows a "gravity" equation: bilateral visa flows are proportional to the size of the economy and decay with physical and cultural differences between countries. However, this relation is weaker for the L-1 program where visa flows are instead skewed toward those countries that are favored locations for US firms' foreign affiliates. As a whole, the aggregate data suggests that the model presented in the chapter is worthy of serious estimation.

As our data is in the form of counts that display evidence of overdispersion, we use negative binomial regression analysis. The results are qualitatively similar when Poisson regression is used and so we report only the negative binomial regression results below.

2.4.1 Cross-Industry Temporary Work Visa Usage by US-Based Firms

In this section, we aggregate our approved visa petition data across all firms that are incorporated in the United States according to their main line of business. This gives us a snapshot of the cross-industry structure of temporary skilled-worker visas by US firms by industry. We then regress these counts on the logarithm of the aggregate employment of these firms

Table 2.1 Industry-level descriptive statistics

$N = 56$	Mean	Standard deviation
L-1 visas	202	458
H-1B visas	225	378
Total visas	427	782
R&D Intensity		
Logarithm	−3.27	1.65
Level (share of sales)	0.08	0.09
Managerial wage		
Logarithm	4.51	0.31
Level ($ thousands)	95.72	30.13
US employment		
Logarithm	5.63	1.40
Level (thousands)	584.2	1,057
Affiliate employment abroad		
Logarithm	4.61	1.08
Level (thousands)	173.24	209.8

Notes: All data is for the year 2007. Visa counts have been aggregated to the industry level on the basis of the main line of business of the firm. Industry data for employment is from Compustat while R&D, managerial wage, and affiliate employment are from the Bureau of Economic Analysis.

(US employment), the logarithm of the employment of R&D personnel (R&D employment in total employment), the logarithm of the average wage paid to managerial and technical staff at US multinationals (managerial wage), and the logarithm of the employment of the foreign affiliates of US-based multinationals (affiliate employment abroad). Bringing the North American Industry Classification System (NAICS) industry classification used in Compustat into concordance with the Bureau of Economic Analysis (BEA) industry classification required some industrial aggregation, and so we are left with fifty-six traded and nontraded industries. The descriptive statistics are shown in table 2.1. Note that variables that enter the regression in logarithms have their descriptive statistics shown in both logarithms and levels.

As a first pass, we plot the logarithm of the number of new L-1 visas per 1,000 employees by industry against the logarithm of R&D intensity (R&D employment by total employment) by industry in figure 2.1. We label only a handful of interesting observations in the scatter diagram to prevent the figure from becoming too busy. Table 2.2 shows the top ten and bottom ten industries.

The data plotted in figure 2.1 shows that the most R&D-intensive industries use the L-1 visa program most thoroughly. There are, however, substantial deviations from the best linear predictor. Looking at table 2.2, we see that many of the intensive users of L-1 visas are in service industries such as computer design, publishing (which contains software develop-

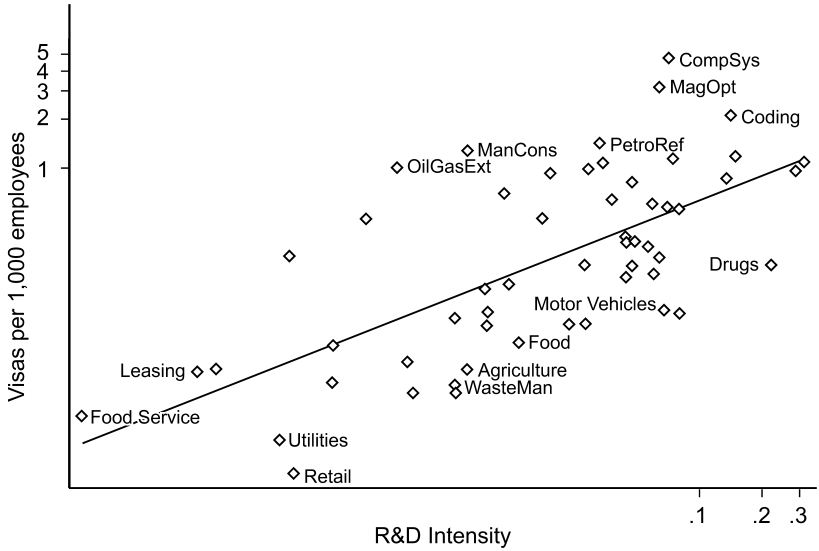

Fig. 2.1 US firms' L-1 visa usage by industry

Table 2.2 Top and bottom L-1 intensities

Rank	Name	Rank	Name
1	Computer systems design	47	Retail trade
2	Wholesale, petroleum	48	Beverages & tobacco
3	Publishing	49	Telecommunications
4	Computers & peripheral	50	Printing
5	Management consulting	51	Misc. services
6	Industrial machinery	52	Furniture
7	Petroleum refining	53	Real estate
8	Communication equipment	54	Rental & leasing
9	Fabricated metal products	55	Utilities
10	Mining, other	56	Agriculture, forestry, fishing

ment), and management consulting. Interestingly, in addition to high-tech manufacturing industries such as semiconductors, computer equipment, and industrial machinery, a number of extraction industries appear as well. These include mining, petroleum refining, and petroleum wholesaling. It is industries such as these that most represent the big deviations from the best linear predictor in figure 2.1.

The results of the regression analyses are shown in table 2.3. Column (1) of table 2.3 reports the coefficient estimates when the dependent variable is the number of L-1 visas by industry, column (2) reports the coefficient estimates when the dependent variable is the number of H-1B visas by indus-

Table 2.3 Cross-industry patterns

	L-1 visas	H-1B visas	Sum of visas
R&D employment	0.167*	0.270***	0.171**
	(0.091)	(0.074)	(0.080)
Managerial wage	2.402***	2.226***	2.520***
	(0.572)	(0.413)	(0.482)
US employment	0.208*	1.225***	0.371***
	(0.115)	(0.183)	(0.107)
Affiliate employment abroad	0.455***	0.252	0.467**
	(0.158)	(0.196)	(0.159)
Constant	−8.641***	−14.5***	−9.498***
	(2.933)	(2.26)	(2.524)
Alpha	0.906***	0.854***	0.838***
	(0.155)	(0.152)	(0.144)
N	56	56	56
Chi-squared	35.5	72.1	51.1

Notes: The estimation is by negative binomial regression. Standard errors are shown in parentheses. All independent variables enter the specifications in logarithms.

***Significant at the 1 percent level.

**Significant at the 5 percent level.

*Significant at the 10 percent level.

try, and column (3) shows the results when the total number of visas is the dependent variable.

Looking across the first row of table 2.3, we see that controlling for industry employment, higher R&D employment is associated with higher expected number of visas of both types. The effect is particularly strong for H-1B visas. This supports the premise of our model that temporary skilled-worker visas are an important feature of supporting innovation. Turning to the second row, we see that a high average wage paid to managerial and technical workers is also associated with greater visa usage for both types of visas. Ceteris paribus, an industry with a 10 percent higher managerial wage is associated with an almost 25 percent increase in the expected number of visas of both types.

The coefficient estimates in rows three and four provide evidence that there are differences in the effect of US industry employment and US multinational employment abroad on different visa counts. The third row suggests that the size of US employment by industry does not predict the number of L-1 visas issued, while H-1B visas issued by industries rise so quickly with industry employment that the total number of visas issued rise moderately with industry size. The fourth row suggests that it is the size of an industry's foreign employment that predicts the expected number of L-1 visa issued, but this measure of industry size has no predictive power whatsoever with regard to H-1B visas issued. When the total count (the sum of H-1B and

L-1 visas) is considered as the dependent variable in the third column, we see that industries that employ large numbers of people in foreign affiliates receive more visas.

These results suggest that the motives for applying for both L-1 and H-1B visas are indeed to hire specialized personnel but that the fact that there is no cap on the number of L-1 visas has the impact of skewing the total number of visas issued toward industries with a significant multinational presence abroad.

2.4.2 The Propensity of Firms to Use Temporary Work Visas

Having documented the structure of temporary work visas by industry, we now focus on the firm-level characteristics associated with visa usage. We consider a negative binomial regression model with conditional fixed effects by the NAICS three-digit industry code.

As we will be interested in the differences in the behavior of multinational firms relative to those that are not, we define an indicator variable (MNE) that takes the value of one if at least one of four conditions are satisfied: (a) the firm has successfully received an L-1 visa, (b) the firm is incorporated in a country other than the United States, (c) the firm reported foreign income, and (d) the firm reported paying foreign income taxes. Of the 4,227 firms for which we have data, just shy of half met the criteria of being a multinational enterprise. Among the publicly listed firms that are in the Compustat database, multinationals account for over 90 percent of visa petition approvals. Of these, half of multinationals' visa approvals are H-1B.

To measure a firm's size and its (rough) productivity, we measured a firm's employment (employment) and its sales (sales). These data were available for most firms in the Compustat database. We also measured the extent to which specialized employees are needed using the advertising expenditures (advert) and R&D expenditures (R&D) reported by the firm. All of these continuous variables are in logarithms, and to construct advert and R&D we first add one to the raw data to keep the zero observations. When data is missing we simply drop the observation. Finally, as it is widely believed that Indian-based firms tend to be much more aggressive in applying for H-1B visas for potentially strategic reasons, we include a dummy variable (INDIA), which takes the value of one if the firm is incorporated in India. The descriptive statistics are to be found in table 2.4 and the firm-level patterns in table 2.5.

In columns (1)–(3) we first consider a more limited set of independent variables in order to not lose observations. In column (1) where the dependent variable is the count of L-1 visas by firm, we restrict the sample to only multinational firms as nonmultinationals cannot apply. The full set of firms is present when the dependent variable is H-1B visa (column [2]) or the total number of visa approvals (column [3]).

Looking across row three, we see that an increase in sales per worker is

Table 2.4 **Descriptive statistics, firm-level patterns**

	Mean	Standard deviation
L-1 visas	4.6	32.3
H-1B visas	7.4	62.9
Total visas	12	85
Advert		
Logarithm	2.0	4
Level ($ millions)	107	478
R&D		
Logarithm	2.0	2.1
Level ($ millions)	105	550
Sales		
Logarithm	5.5	2.7
Level ($ millions)	4,824	19,150
Employment		
Logarithm	0.22	2.5
Level (thousands)	13	52
MNE	0.60	0.50

Note: Visa counts are for only those visas that were matched to Compustat data and so are not in the same proportion to visa totals for 2007.

Table 2.5 **Firm-level patterns**

	(1) L-1 visas	(2) H-1B visas	(3) Sum	(4) L-1 visas	(5) H-1B visas	(6) Sum
Advert				0.095*	0.140***	0.153***
				(0.054)	(0.051)	(0.042)
R&D				0.183***	0.305***	0.284***
				(0.049)	(0.044)	(0.037)
Sales	0.282***	0.215***	0.215***	0.119	−0.068	0.003
	(0.037)	(0.030)	(0.030)	(0.140)	(0.099)	(0.091)
Employment	0.071*	0.089**	0.089**	0.136	0.145	0.110
	(0.039)	(0.031)	(0.031)	(0.631)	(0.096)	(0.084)
India	0.777*	1.090***	1.093***	3.03***	5.10***	4.57***
	(0.411)	(0.35)	(0.35)	(0.63)	(0.542)	(0.442)
MNE		1.170***	1.170***		0.039	0.600***
		(0.078)	(0.078)		(0.196)	(0.175)
N	2,059	4,210	4,227	480	771	792
Chi-square	439	1,124	1,123	229	354	554

Notes: Estimation is by conditional fixed effect (by NAICS's three-digit industry codes) negative binomial regression. All independent variables are from Compustat and are in logarithms. The number of observations varies with the number of firms reporting the full set of covariates. L-1 visas only included only multinational firms, whereas H-1B and sum include all firms. Standard errors are shown in parentheses.

***Significant at the 1 percent level.

**Significant at the 5 percent level.

*Significant at the 10 percent level.

associated with higher levels of visas of both types, while rows three and four indicate that larger firms also receive a larger number of visas. Indian firms are indeed much more likely to receive visas, including L-1 type, than non-Indian firms.[16] Finally, there is some evidence that multinational firms are more likely as a whole to obtain H-1B visas than nonmultinationals as shown in column (2) and more visas in total as shown in column (3). These results suggest that larger, more productive multinationals are more heavily engaged in obtaining all types of visas. This result is consistent with workers from all locations being complements.

We now expand our variable set to include direct measures of the importance of skilled workers to firms in columns (4)–(6). Doing so reduces the sample substantially. The coefficients on the common variables are very different across data sets, but this appears to be because of the inclusion of the additional variables and not because of selection.[17]

In all three columns, the coefficients on advertising expenditure (row 1) and R&D spending (row 2) are positive and statistically significant. Hence, even within industry, it is the most R&D-intensive firms that are engaged in hiring temporary skilled workers from abroad. Moreover, the actual magnitudes are roughly similar across specifications. At the same time, the coefficients on sales (row 3) and employment (row 4) all become statistically indistinguishable from zero. Looking at the coefficient on R&D in column (6), we see that economic magnitude is quite large: a 10 percent increase in a firm's R&D spending relative to its industry peers is associated with an almost 3 percent increase in the expected number of visas.

Even after controlling for firm characteristics associated with demand for skilled labor (i.e., R&D and advertising), the coefficient on MNE in column (6) is large and statistically significant. Everything else equal, a multinational will expect to get 60 percent more visas per year than a nonmultinational. This is consistent with the foundations on which the model is built: ceteris paribus, multinationality confers a talent-sourcing advantage.

These results shape our view of who demands and who has access to skilled foreign workers. First, the fact that R&D and advertising expenditures predict visa counts, while firm productivity or size does not, suggests that it is skilled-labor intensity rather than inherent productivity per se that influences firms' petitioning behavior. Second, the similarity in the coefficients on firm characteristics (excluding multinationality) across columns suggests that the firms that demand skilled workers do not perceive funda-

16. We have experimented with adding dummies for other countries and have found that this proclivity to obtain visas is not universally prevalent across foreign firms operating in the United States.

17. When the smaller coefficient set model is run on a sample restricted to only those observations with both advertising and R&D data, the coefficients are roughly unchanged with the exception of the coefficient on MNE when the dependent variable is H-1B counts. In that case, it is considerably smaller.

mental differences in the type of visa program used. Third, within multinationals there is no tendency to favor one type of visa program over another as is suggested by the zero coefficient on MNE in column (5). Finally, the fact that MNE coefficient is positive in column (6), where the dependent variable is the sum of the two counts tells us that multinational firms do have an inherent advantage obtaining access to talented foreign labor. These stark results are consistent with a simple explanation: the L-1 visa program gives multinational firms an advantage over nonmultinationals in recruiting foreign talent by allowing these firms to at least partially *escape the H-1B visa cap*.

2.4.3 Cross-Country Pattern of Visa Issuance

Our data affords substantial information about the nature of the firms that are making use of the temporary work program but are less informative about the nature of the workers. For instance, the country of origin of the workers is not available at the firm level in our L-1 visa data.[18]

In order to make inferences about the types of countries that are sending the workers, we turn to a different data set from the US Department of State,[19] that compiles the total numbers of new and renewed L-1 and H-1B visas by country of origin. Unfortunately, the data does not break out whether these visas are issued to US or foreign firms operating in the United States. In addition, the data does not allow us to distinguish between multinational enterprises and purely domestic firms.

The breakdown by country is shown in figure 2.2, which graphs the (logarithm of the) number of L-1 visas against the (logarithm of the) number of H-1B visas issued to workers from each country. The figure shows a high correlation between the sources of workers for each skilled-labor visa program. As is well known, India is an enormous outlier in both programs. The other important sources of workers are an interesting mixture of developed countries (e.g., Japan, Great Britain, and Germany), and developing countries (e.g., Mexico, the Philippines, Korea, and China).

In our analysis we estimate a negative binomial regression with a gravity structure that has been augmented to include the logarithms of the employment of the US affiliates of the foreign country and the logarithm of the foreign affiliates employment of US firms operating in that country.[20] We include a dummy for India as it is a substantial outlier. The descriptive statistics are shown in table 2.6 and the coefficient estimates are shown in table 2.7.

18. Unlike the H-1B program, the L-1 program does not require a petitioner to submit a local labor conditions form and so this source of information is lacking.

19. The data can be found at https://travel.state.gov/content/visas/en/law-and-policy/statistics/non-immigrant-visas.html. Note that we use data for 2004 in order to expand the number of countries for which publically available multinational affiliate is available.

20. We first add one to the levels of employment to avoid dropping observations for which there are no employees.

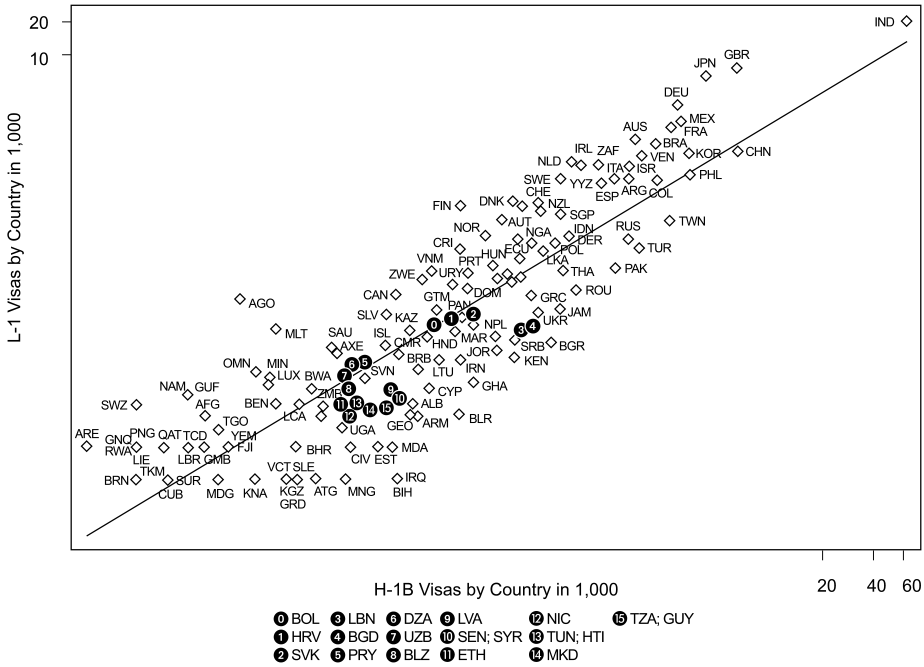

Fig. 2.2 Country composition of skilled-labor visas
Source: US Department of State.

Table 2.7 is organized into three columns for L-1, H-1B, and total visas. Looking across the first two rows, we see that higher log gross domestic product (GDP) is associated with more temporary worker flows under these programs. As this result obtains controlling for log employment, this can be interpreted as temporary worker visas coming primarily from more developed countries. This is consistent with these countries being abundant in the skilled labor for which the program is intended. The positive and statistically significant coefficients on GDP and population tell us that larger countries send more workers.

Looking at the effect of log distance in row 3, we see that distance powerfully discourages H-1B visas (a 10 percent increase in distance is associated with a 10 percent reduction in the expected number of visas), but it has no impact on L-1 visas: L-1 visa flows are more "weightless" than H-1B flows. This is evidence that experience with foreign labor markets confers an advantage on multinational firms in sourcing global talent. This advantage does not extend to language barriers, however, as the coefficients on the dummy variable for shared language for the two visa counts of similar size.

Looking at row 6 (inward employment), we see that the employment by

Table 2.6 Descriptive statistics, country-level analyses

	Mean	Standard deviation
L-1 visas	333	1,684
H-1B visas	738	4,715
Total visas	1,072	6,327
Language	0.430	0.500
Contig.	0.006	0.075
GDP		
Logarithm	23	2.4
Level ($ billions)	1,700	5,520
Population		
Logarithm	1.5	2.2
Level (millions)	32.2	129.7
Distance		
Logarithm	9.1	0.49
Level (km)	9,522	3,466
Inward employment		
Logarithm	0.078	1.6
Level (thousands)	29	116
Outward employment		
Logarithm	1.7	1.9
Level (thousands)	51	146

Notes: Affiliate employment data are from BEA surveys, gravity variables are from the CEPII data set, and visa data are from the US Department of State.

foreign multinational affiliates in the United States does not predict any of the visa counts (with the exception of India). This is interesting because it suggests that after controlling for log GDP and log population there is no greater propensity of firms from multinational affiliates in the United States to source labor from their home countries.

When we consider the coefficients in row 7 (outward employment), we see that more L-1 visas are granted to workers from countries in which US affiliates employ many workers, but there is no such pattern with respect to H-1B visas. As in the case of the very different coefficients on distance, this result is consistent with similar roles for the visas themselves in practice, but the lack of a cap on L-1 visas shifts the total number of visa awards toward those countries in which US firms have affiliates.

Overall, these results suggest that multinationals are better able to overcome distance-related costs associated with recruiting talented foreign workers.

2.5 Feasibility of Full Model Estimation

In this section, we discuss how improved access to firm-level, nonimmigrant visa data could be used to extend the preliminary analyses presented

Table 2.7 Cross-country patterns

	L-1 visas	H-1B visas	Sum
GDP	0.776***	0.796***	0.803***
	(0.098)	(0.104)	(0.098)
Population	0.132*	0.276**	0.260***
	(0.073)	(0.078)	(0.075)
Distance	−0.187	−1.041***	−0.951***
	(0.204)	(0.233)	(0.220)
Language	1.052***	0.880***	0.894***
	(0.188)	(0.195)	(0.186)
Contig.	−4.982***	−5.219***	−5.287***
	(1.007)	(1.113)	(1.077)
Inward employment	0.072	−0.118	−0.048
	(0.256)	(0.087)	(0.088)
Outward employment	0.256***	−0.052	−0.012
	(0.088)	(0.105)	(0.104)
INDIA	1.845*	2.377*	2.201***
	(0.965)	(1.075)	(1.025)
Alpha	0.859	1.071	0.972***
	(0.106)	(0.113)	(0.103)
N	172	172	172
Chi-squared	363	314	341

Notes: The estimation is by negative binomial regression. Standard errors are shown in parentheses. All independent variables enter the specifications in logarithms.

***Significant at the 1 percent level.

**Significant at the 5 percent level.

*Significant at the 10 percent level.

in this chapter to the full model estimation strategy sketched in section 2.2.3. A data-sharing agreement between government agencies that would allow the matching of H-1B and L-1 visa firm-level data to the multinational enterprise data collected by the BEA would allow several questions to be addressed.

All approved petitions of H-1B and L-1 visas provide information on the employer identification number, name, and geographic location of the petitioner as well as the country from which the approved employee resides. This visa data could then be matched with the BEA's surveys of US-based multinational enterprises and foreign multinational affiliates operating in the United States, as both BEA surveys collect this information to identify firms. Given many years of visa approval data, a stock of current L-1 and H-1B visa holders by firm and country of origin could be assembled.

The confidential BEA data from the Direct Investment Abroad surveys identifies the location, operating data, and degree of parent ownership for each of the American firms' foreign affiliates. For the confidential BEA data for US affiliates of foreign multinationals, collected by the Foreign Direct

Investment in the United States surveys, less data is collected about their parents' foreign operations, but the country of the ultimate beneficial owner of each firm is known. For the US operations of these firms, the survey provides information on the local employment of the firm (both managerial and production workers), the level of R&D expenditure, the industry, and the volume of exports and sales in the United States.

Given this information, the key parameters (i.e., T_i, τ_{ji}, δ_{ji}, and θ) can be estimated via the firm-level gravity equations (14). Moreover, the volume of H-1B visas obtained by US multinational affiliates in countries in which they have affiliates can be contrasted with the H-1B visas obtained by the same firms in countries in which they do not own an affiliate. This information would shed light on how improved access to foreign skilled-labor markets afforded by local production induces greater worker flows. Combined with measures of firm's R&D intensities, the estimated parameters and firm-level investment patterns have two implications. First, they would reveal how an expansion in a firm's foreign production activities affect its sourcing potential and hence the cost of doing R&D and management activities. Second, they could be compared to R&D intensities to determine whether increased multinational activity raises or lowers demand for skilled US labor, and whether, as Bill Gates has asserted, tighter restrictions on temporary worker visas would lower American innovation and ultimately hurt skilled Americans.

2.6 Conclusion

This chapter has provided a first look at the structure of temporary worker flows at the firm, industry, and country level. It has documented a tendency for these flows to be concentrated in high-tech and high-wage industries and within industries in high-tech, multinational corporations. Controlling for their size and technical intensity, multinational firms use foreign workers more intensively than do nonmultinationals. At the firm level, there is no evidence that on net L-1 visas are a substitute for H-1B visas, because multinational status does not reduce the absolute level of H-1B visas but rather expands the total number of visas.

These facts are consistent with a framework built on firm sourcing of differentiated intermediate inputs. A key feature of this sort of model is that it can reconcile diverse sourcing behavior of firms. In industries with highly differentiated inputs and high R&D intensities, greater access to foreign workers can increase firm-level and country-level demand for domestic workers. Hence, while individual workers might find specific tasks are reallocated to foreigners, the total employment of firms accessing foreign workers may actually increase.

The chapter concluded with a blueprint for the future work that would be made possible were it possible to match administrative L-1 individual peti-

tion data to BEA firm-level data on multinational activity. Combined with the structural model sketched in this chapter, matched petition firm data of this sort would allow the size of migration frictions to be estimated and the welfare implications backed out from the model. Creating such a matching is technically feasible, but challenging, given that the government agencies that collect the data are part of very different bureaucracies.

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