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

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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. 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, and 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 research and development remain 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 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 talent workers from low to high innovation locations may have substantial negative consequences for global welfare. Indeed, in a series of testimonies before congress, Bill Gates has argued that U.S. limits on skilled worker inflows could ultimately 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 non-immigrant 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 U.S. 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, often around three years, work visas 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 empirical analysis of the industrial structure of international labor flows that are made possible by the L-1 and H-1B visa programs. In particular, 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

[1]Many more are given without restriction to university professors and employees of non-profits. Surely without this exception, U.S. universities would hard pressed to maintain their world-leading reputation for research!

fairly evenly distributed over high-tech industries while L-1 visas and all temporary work visas are more skewed toward the industries in which U.S. 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 non-multinational firms. This suggests that these firms are better able to overcome the frictions, both driven by U.S. policies and by the natural difficulties associated with identifying and acquiring the proper skills in distant labor markets.

We provide a simple model based on recent advances in the quantitative literature on differentiated intermediate input sourcing (i.e. Antras, Fort, and Tintelnot, 2015) to interpret these data. We argue that many features of this model are consistent with the data. This suggest that the model hints that the welfare affects 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 work force 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 U.S. workers.

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 U.S. firms to substitute lower cost workers from abroad for comparable workers in the United States. Further, assert many critics, the program allows foreign workers to be "trained" in production techniques that can then be used to move large operations offshore. The controversy is well captured by a Department of Homeland Security analysis of the governance of the L-1 program: "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 U.S. firms to remain innovative and to recruit and to retain the 'best and brightest' (DHS, p. 5, 2013)."

Within the vast academic literature on immigration, the role played by temporary work visas for skilled labor has received much less attention. To the extent that it has received attention at all, the key questions have been (1) whether the expansion of H-1B

visa programs has had the effect of increasing or decreasing demand for competing American workers, and (2) has the program had the effect of spurring additional innovation (see for instance, 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 U.S. 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 highly 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 (2015), 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.[2] Further, given the nature of the activities involved, actual worker mobility, rather than remote communication, may be critical in this context.[3]

In the context of sourcing foreign inputs, multinationals are important for two reasons. The first and most obvious 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.[4]

[2]Ideally the framework should allow for heterogeneous gains across potential tasks. The framework presented here could in princple be made to do exactly this.

[3]See Keller and Nune Hovhannisyan (2012) for the role of businessman mobility in the related context of international trade.

[4]It may be the case that workers and firms need to make relationship specific investments in order for

The remainder of the paper is organized into six sections. In the next section, we briefly describe the features of the L-1 visa program as it is relatively unfamiliar to the literature on skilled labor movements. In section two, we describe the data. In section three, 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. In section four, we provide a simple model to interpret the empirical results. Section five discusses how the full model could be estimated and used to do policy analyses were employer-employee visa data to be merged with data on the activities of U.S. multinationals. The final section concludes.

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.[5] 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 a L-1 visa a worker must have been working for a qualifying organization

the worker to be able to adequately implement an important task. In this context, L-1 intra-company transfer visas and H-1b visas may then be very different animals for different firms depending on which type of investment is most important. In this case the analysis of Antras (2003, 2005) may become relevant.

[5]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.

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 organizations 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: (i) the petitioner and each of the qualifying organizations are engaged in commercial trade or services; (ii) the petitioner has an office in the United States which has been doing business for one year or more; (iii) 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 10 L-1 approvals during the previous 12-month period; Have U.S. subsidiaries or affiliates with combined annual sales of at least $25 million; (iv) or Have a U.S. work force 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 United States Citizenship and Immigration Service.

Aside from offering access to skilled foreign workers to U.S. 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 L1 visa petitions approved or renewed in 2015 stood at 78,537 compared with 172, 748 for the H-1B program. Both program are dual intent programs that can act as a stepping stone to a green card.[6]

In other respects, the visas offered by the two programs are not perfect substitutes.

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

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 that 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.[7]

2 Data

The key data used in this study is built from a complete listing of firm name, U.S. 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.[8] While these comprehensive 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 visa 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 allow 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 20 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

[7] 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.

[8] I thank Will Kerr for providing these data to me.

for nearly 1,000 firms. We are confident that we have identified almost all the visa usage by the firms in Compustat 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 absolute sure that our coverage is entirely representative of the U.S. 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.[9]

In our analysis below, we make use of the publicly available data on the activities of U.S. multinationals abroad and in the United States. These data comes 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 U.S. 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.

3 Facts

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

3.1 Cross Industry Temporary Work Visa Usage by U.S. 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 U.S. firms by industry. We then regress these counts on the logarithm of the aggregate employment of these firms (US Employment), the logarithm of the employment of R&D

[9]Note that in principle, the raw petition data would provide data on both the country and firm of petitioner and could in principle be merged with the firm-level of the Bureau of Economic Analysis.

personnel (R&D Employment in Total Employment), the logarithm of the average wage paid to managerial and technical staff at U.S. multinationals (Managerial Wage), and the logarithm of the employment of the foreign affiliates of U.S. based multinationals (Affiliate Employment Abroad). Concording the NAICs industry classification used in Compustat to the BEA industry classification required some industrial aggregation so that we are ultimately left with 56 traded and non-traded industries. The descriptive statistics are shown in Table 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 1. We label only a handful of interesting observations in the scatter diagram to prevent the figure from becoming too busy. Table 2 shows the top ten and bottom ten industries.

The data plotted in Figure 1 shows that there is a clear tendency for the most R&D intensive industries to use the L-1 visa program most intensively. There are, however, substantial deviations from the best linear predictor. Looking at the Table 2, we see that many of the intensive users of L-1 visas are in fact in service type industries, such as computer design, publishing (which contains software development), and management consulting. Interestingly, in addition to several 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 these such industries that most represent the big deviations from the best linear predictor in Figure 1.

The results of the regression analyses are shown in Table 3. Column 1 of Table 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 industry, and column 3 shows the results when the total number of visas is the dependent variable.

Looking across the first row of Table 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. 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. Indeed, ceteris paribus an industry with a 10 percent higher managerial wage is associated with an almost 25 percent in-

crease in the expected number of visas of both types! This suggests a desire to source lower cost foreign labor might be a motivating factor for temporary work visas.

Turning to rows three and four, we see that there are significant differences in the effect of U.S. industry employment and U.S. multinational employment abroad on different visa counts. The third row suggests that the size of U.S. employment by industry does not predict the number of L-1 visas issued while H-1B visas issued by industries rise rapidly with industry employment so 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 indeed, industries that employ large numbers of people in foreign affiliates do tend to receive a greater number of 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.

3.2 The Propensity of Firms to Use Temporary Work Visas

Having documented the structure of temporary work visas by industry, we know turn our attention to the firm characteristics associated with visa usage. We consider a negative binomial regression model with conditional fixed effects by NAICs three-digit industry.

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: (i) the firm has successfully received an L-1 visa, (ii) the firm is incorporated in a country other than the United States, (iii) the firm reported foreign income, and (iv) 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. Nevertheless, 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 4.

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 non-multinationals cannot apply. The full set of firms are 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 associated with higher levels of visas of both type, 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.[10] Finally, there is some evidence that multinational firms are more likely as a whole to obtain H-1B visas than non-multinationals as shown in column two and more visas in total as shown in column three. These results suggest that larger more productive multinationals are more heavily engaged in obtaining all types of visas.

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 also change dramatically, but this appears to be because of the inclusion of the additional variables and not because of selection.[11]

In all three columns, the coefficients on advertising expenditure (row one) and R&D spending (row two) are positive and statistically significant. Moreover, the actual magnitudes are roughly similar across specifications. At the same time, the coefficients on

[10] 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.

[11] 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.

Sales (row three) and Employment (row four) all become statistically indistinquishable from zero. Looking at the coefficient on R&D in column 6, we see that economic magnitude is quite large: a ten 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 directly 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 non-multinational.

These results have important implications for 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 a skilled labor intensity rather than 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 fundamental 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 five. Finally, the fact that MNE coefficient is positive in column six, 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 non-multinationals in recruiting foreign talent by allowing these firms to at least partially *escape the H-1B visa cap*.

3.3 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.[12]

In order to make inferences about the countries that are sending the workers we turn

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

to a different dataset, maintained by the U.S. Department of State,[13] 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, which graphs the (logarithm) of the number of L-1 visas against the (logarithm) number of H-1B visas issued to workers from each country. The figure shows quite clearly that the source of workers for each skilled labor visa program is remarkably correlated across programs. 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 U.S. affiliates of the foreign country and the logarithm of the foreign affiliates employment of U.S. firms operating in that country.[14] We also include a dummy for India as it is a substantial outlier. The descriptive statistics are shown in Table 6 and the coefficient estimates are shown in Table 7.

Table 7 is organized into three columns for L-1, H-1B, and total visas. Looking across the first two rows, we see that higher GDP per capita (as we are controlling for population in row two) is associated with more temporary worker flows under these programs. 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 distance in row three, we see that distance powerfully discourages H-1B visas (a ten percent increase in distance is associated with a ten percent reduction in the expected number of visas), but it has no impact at all on L-1 visas. This is a substantial difference in the nature of worker flows induced by the two programs: L-1 visa flows are more "weightless" than H-1B flows. Looking at row six (Inward em-

[13] 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.

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

ployment), we see that the employment by foreign multinational affiliates in the United States does not predict any of the visa counts (with the exception of India, presumably). This is interesting because it suggests that after controlling for GDP and GDP per capita there is no greater propensity of firms from multinational affiliates in the U.S. to source labor from their home countries.

The picture is very different when we consider the coefficients in row seven (outward employment). Here, we see that in countries in which U.S. firms employ many workers at their affiliates there are many more L-1 visas being granted, but there is no such pattern with respect to H-1B visas. This is again (combined with the very different coefficient on distance) consistent with the interpretation that the visas themselves serve very similar roles for the applicants but the lack of a cap on L-1 visas have the implication that the visas made available will be shifted toward those countries in which U.S. firms have affiliates.

These results suggest that one of the key advantages of being a multinational is that it allows a firm to overcome distance related costs associated with recruiting talented foreign workers. This observation, combined with the earlier observation that multinationals may be less constrained by the H-1B visa cap, suggests that as multinational firms expand abroad, the flow of temporary skilled workers may increase.

4 A Formal Interpretation

In this section, we provide a sketch of a formal model to interpret the empirical results presented above. The key idea is that when considering the highly skilled labor that is necessary to provide advertising and R&D services as well as to manage complex corporations labor inputs are at least as highly differentiated as intermediate inputs. Nevertheless, labor from different countries will have some common features as workers share common experiences such as cultural backgrounds, educational systems, and industrial experiences. Multinational firms will differ from firms without global operations because they are more likely to be able to identify, train, and attract talented individuals abroad and this results in a lower cost of hiring foreign workers.

4.1 Assumptions

We consider a world in which there are a large number of countries that are endowed with skilled and unskilled labor and are indexed by i and j. We focus on a firm that has a production affiliate in country i, but which may also operate simultaneously in other countries.[15] Let the set of countries in which this firm owns an affiliate be given by J.[16]

This firm inhabits an industry in which goods are differentiated and non-tradeable, with demand given by

$$x_i = A_i p_i^{-\varepsilon}, \tag{1}$$

where p_i is the price charged in i, $\varepsilon > 1$ is the elasticity of substitution, and A_i is the level of demand that is taken as given by individual firms. The market structure in this industry is monopolistic competition. Countries are endowed with skilled and unskilled labor. Unskilled labor is internationally immobile, but skilled labor can be moved internationally at a cost to the employer. The going wage for skilled and unskilled workers in country i is w_i^s and w_i^u, respectively.

Output in country i is produced using exclusively unskilled labor according to the linear production function:

$$Y_i = \varphi_i l_i,$$

where φ_i is the productivity of the firm and l_i is the quantity of unskilled labor employed in country i. The firm's local productivity 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

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

where $r_i(t)$ 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

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

[16] 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.

share the same location. Finally, in order for the firm to obtain a productivity level of φ_i requires the firm to produce $f\varphi_i^{\phi}$ units of these bundles, where $\phi > \varepsilon - 1$.

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

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

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.

Moving workers, and their abilities, across countries is costly. This is either because the workers do not have experience with the workings of the particular firm, or because cultural differences make workers less effective abroad, or simply that 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 firm does or does not own an affiliate in the source country. If the firm owns an affiliate in country j then it faces iceberg-type costs form $\tau_{ji} \geq 1$ that varies across country pairs so that the realized cost of employing s_j skilled workers from country j for an operation in country i incurs the cost $w_j^s \tau_{ji} s_j$.[17] 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 $\delta_{ji} > 1$ so that its cost of sourcing labor is given by $\delta_{ji}\tau_{ji}$.[18]

The timing is as follows. First, the firms hire skilled workers from the countries on the planet. 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.

4.2 Implications

We solve the model backwards. 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.

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

[18] For evidence that the internal labor markets of large firms may be more efficient at matching workers and tasks see Papageorgiou (2014).

The profit associated with our representative firm located in country i that charges price p_i and productivity φ_i is

$$\Pi_i = \left(p_i - \frac{w_i^u}{\varphi_i} \right) x_i(p_i) - C_i f \varphi_i^{\phi}, \tag{2}$$

where demand $x_i(p_i)$ is given by (1) and C_i is the cost of a bundle of managerial and R&D inputs in country i. The first order condition for profit maximization with respect to the price of output has the solution

$$p_i = \frac{\varepsilon}{\varepsilon - 1} \frac{w_i^u}{\varphi_i}, \tag{3}$$

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

$$\varphi_i = \left(\frac{B_i}{C_i f} \right)^{\frac{1}{\phi - \varepsilon + 1}}, \tag{4}$$

where

$$B_i = \frac{1}{\phi} \left(\frac{\varepsilon}{\varepsilon - 1} \right)^{-\varepsilon} A_i \left(w_i^u \right)^{1-\varepsilon}$$

is the cost adjusted demand level in country i. It is immediately clear from equation (4) that a firm's choice of innovation intensity is increasing in the size of the market that it serves, is decreasing in local unskilled labor costs, and is decreasing in the cost of a bundle of management tasks. Equation (4) further implies that the total spending on skilled labor by the firm in country i (S_i) is

$$S_i = \left(C_i f \right)^{-\frac{\varepsilon - 1}{\phi - \varepsilon + 1}} \left(B_i \right)^{\frac{\phi}{\phi - \varepsilon + 1}}. \tag{5}$$

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 that are filled by the firm in location i with workers from location j is given by

$$\pi_{ji} = \begin{cases} \frac{T_j \left(w_j^s \tau_{ji} \right)^{-\theta}}{\Theta_i} & \text{if } j \in J \\ \frac{T_j \left(w_j^s (\tau_{ji} \delta_{ji}) \right)^{-\theta}}{\Theta_i} & \text{if } j \notin J \end{cases}, \tag{6}$$

where

$$\Theta_i \equiv \sum_{j \in J} T_j \left(w_j^s \tau_{ji} \right)^{-\theta} + \sum_{j \notin J} T_j \left(w_j^s \left(\tau_{ji} \delta_{ji} \right) \right)^{-\theta} \tag{7}$$

is the human resource "sourcing potential" of the firm.

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

$$C_i = \left(\gamma \Theta_i \right)^{-\frac{1}{\theta}}, \tag{8}$$

where γ is a constant. We are now in the position to derive expressions for labor flows. Combining (5)-(6). we get an expression that yields the total wage payments made to worker from country j by the firm's operations in country i is given by

$$S_{ji} = \begin{cases} \frac{T_j \left(w_j^s \tau_{ji} \right)^{-\theta}}{\Theta_i} S_i & \text{if } j \in J \\ \frac{T_j \left(w_j^s (\tau_{ji} + \delta_{ji}) \right)^{-\theta}}{\Theta_i} S_i & \text{if } j \notin J \end{cases}. \tag{9}$$

To connect our model to the empirics of the previous section, we need to make an assumption about the way that these variables appear in the data. For simplicity, it is convenient 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 as H-1B visas.[19]

We now tease out some of the qualitative implications of the model. We begin with two of the more immediate implications. First, note that by using equations (1), (3), (4), and (5) that we can solve for the share of skilled labor in total firm sales, which is given by $\frac{S_i}{R_i} = \frac{C_i f \varphi_i^{\phi}}{p_i x_i} = \frac{\varepsilon - 1}{\varepsilon \phi}$. Firms in industries in which the return to management and/or R&D will hire more skilled labor and so will also use more visas designed to allow skilled labor movement. This is a reassuring feature of the model. Second, it follows immediately from (6) and (7) that as firm becomes more multinational in the sense that

[19] 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 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. Were finer data to become available, these situations could be incorporated into the model explicitly.

it owns an affiliate in a large number of locations that it substitutes away from both domestic employment and from H-1B visa workers.

The structure of the model suggests ceteris paribus that the labor flows made possible by both the H-1B and L-1 visa programs should follow a gravity equation. The data show that a disproportionate number of both types of visas are coming from high GDP per capita countries, which is consistent with the interpretation of these countries have an absolute advantage in skilled labor (high $T_j(w_j^s)^{-\theta}$) or with relatively easier time adjusting to the transfer to the United States (low τ_{ji}). Note that the gravity implications for L-1 visa flows is likely convoluted by the investment patterns of multinational firms. For instance, if τ_{ji} is more highly correlated with the investment activities of multinational firms than it is with standard gravity variables, then the gravity relationships with respect to L-1 visas would be weaker than for H-1B visas once MNE activity by country is controlled. This is indeed what we observe in the data. The implication then is that remoteness makes it difficult for firms to match with workers perhaps because workers are to a large extent experience goods. Once a firm has in place an experienced workforce at its local affiliate, identifying workers with the right talents may become much easier. Similarly, the coefficient on language in the country regressions suggest that it is a component of τ_{ji} that foreign operation does not eliminate.[20]

By its very 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 (7) 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 (8). Hence, an increase in multinational production induces the firm to increase its innovation efforts and so expands the firm's scale of operations.[21] From (5) and (9), we see that if

$$\frac{1}{1+1/\theta} < \frac{\varepsilon - 1}{\phi}, \tag{10}$$

then firms that expand their multinational network will choose to employ more skilled

[20] The extremely large coefficient on Language in both regressions indicates that it is likely an important friction that limits skilled worker flows.

[21] 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.

workers from every location including those in which the firm did not own an affiliate and including from their home country. Note that the right-hand side of (10) 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, greater sourcing potential is likely to lead 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).

This result is consistent with observation in the data that multinational enterprises demanded more H-1B visas and all temporary work visas than did similarly sized firms without foreign operations that were operating in the same industry. 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.

5 Feasibility of Full Model Estimation

In this section, we discuss how improved access to firm-level, non-immigrant visa data could be used to extend the preliminary analyses presented in this Chapter. We will argue that 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 Bureau of Economic Analysis (BEA) would allow several key questions to be addressed. More specifically, we discuss how the model in the previous section could be expanded, estimated, and then used to conduct counterfactual exercises.

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 BEA's survey's of U.S. based multinational enterprises and foreign multinational affiliates operating in the United States as both BEA survey's 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 then be assembled that would accurately portray the degree to which a firm uses these visa programs.

The confidential BEA data from the Direct Investment Abroad surveys identifies the location, operating data, and degree of parent ownership for each of American firms' foreign affiliates. For the confidential BEA data for U.S. 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 know. For the U.S. operations of these firms, the survey provides information on the local employment of the firm (both managerial and production), the level of R&D expenditure, the industry, and the volume of exports and sales in the United States. Given this information it then becomes possible to estimate the set of key parameters (i.e. T_i, τ_{ji}, δ_{ji}, and θ) in the firm-level gravity equations given by (6). Moreover, the volume of H-1B visas obtained by U.S. multinational affiliates in countries in which they have affiliates can be contrasted directly with the H-1B visas obtained by the same firms in countries in which they do not own an affiliate. This information then sheds direct light on how improved access to foreign skilled labor markets afforded by local production induces greater worker flows and so would allow for a more nuanced specification of the options available to firms with respect to skill sourcing.

Combined with measures of firm's R&D intensities, the estimated parameters and firm-level investment patterns have several implication of immediate interest. First, they allow the quantification of how an expansion in firm's foreign production activities affect its sourcing potential and hence the cost of doing R&D and management activities. Second, the magnitude of cross country heterogeneity in work skills, θ, can be compared to R&D intensities to determine whether increased multinational activity raises or lowers demand for skilled U.S. labor.

Finally, given a set of model parameter estimates, the model can be closed in general equilibrium a la Antras, Fort, and Tintelnot (2016). By closing the model, comparative statics on the effect of the L-1 visa program on the aggregate demand for skilled and unskilled labor, American labor productivity, and the aggregate American innovation. These comparative statics would take into account the impact of the L-1 program on the activities of the non-multinationals that compete with multinationals. Finally, a fully calibrated model would allow us to assess Bill Gates' assertion that greater access to skilled labor visas would induce greater innovative activity in the United States.

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 strong 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 non-Multinationals. 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 actually increase firm level demand for domestic workers. Hence, while individual workers might find specific tasks are done by 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 petition data to BEA firm-level data on multinational activity. The advantage of this would be to have an improved link between the nature of firms' foreign operations vis-a-vis their parent operations. Combined with a structural model of the sort 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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Table 1: Industry Level Descriptive Stats

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)	0.08	0.09
Managerial Wage		
Logarithm	4.51	0.31
Level ($,000)	95.72	30.13
US Employment		
Logarithm	5.63	1.40
Level (,000)	584.18	1,056.97
Affiliate Employment Abroad		
Logarithm	4.61	1.08
Level (,000)	173.24	209.81

All data is for the year 2007. Visa counts have been aggregated to the industry level. Industry data for employment is from Compustat while R&D, Managerial Wage and Affiliate Employment are from the Bureau of Economic Analysis.

Table 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

Table 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-sq	35.5	72.1	51.1

Notes: The estimation is by Negative Binominal regression. Standard errors shown in parentheses. * indicate statistical significance at 0.1, 0.05, and 0.01 levels.

Table 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 ($mil.)	107	478
R&D		
Logarithm	2.0	2.1
Level ($mil.)	105	550
Sales		
Logarithm	5.5	2.7
Level ($mil.)	4,824	19,150
Employment		
Logarithm	0.22	2.5
Level (,000)	13	52
MNE	0.60	0.50

Table 5: Firm-Level Patterns

	(1)	(2)	(3)	(4)	(5)	(6)
	L-1 Visas	H-1b Visas	Sum	L-1 Visas	H-1b Visas	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-Sq	439	1,124	1,123	229	354	554

Notes: Estimation is by Conditional Fixed Effect (by Naics 3 digit Industry) Negative Binominal regression. The number of observations varies with the number of firms reporting the full set of covariates. L-1 visas only include multinational firms whereas H-1b and sum include all firms. * indicate statistical significance at 0.1, 0.05, and 0.01 levels.

Table 6: Descriptive Statistics, Country Level Analysis

	Mean	Standard Deviation
L-1 Visas	333	1,685
H-1 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 ($Bil.)	1,700	5,520
Population		
Logarithm	1.5	2.2
Level (million)	32.2	129.7
Distance		
Logarithm	9.1	0.49
Level (km)	9,522	3,466
Inward Employment		
Logarithm	0.78	1.6
Level (1,000)	29	116
Outward Employment		
Logarithm	1.7	1.9
Level	51	146

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

Table 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-sq	363	314	341

Notes: The estimation is by Negative Binominal regression. Standard errors shown in parentheses. * indicate statistical significance at 0.1, 0.05, and 0.01 levels.

Figure 1

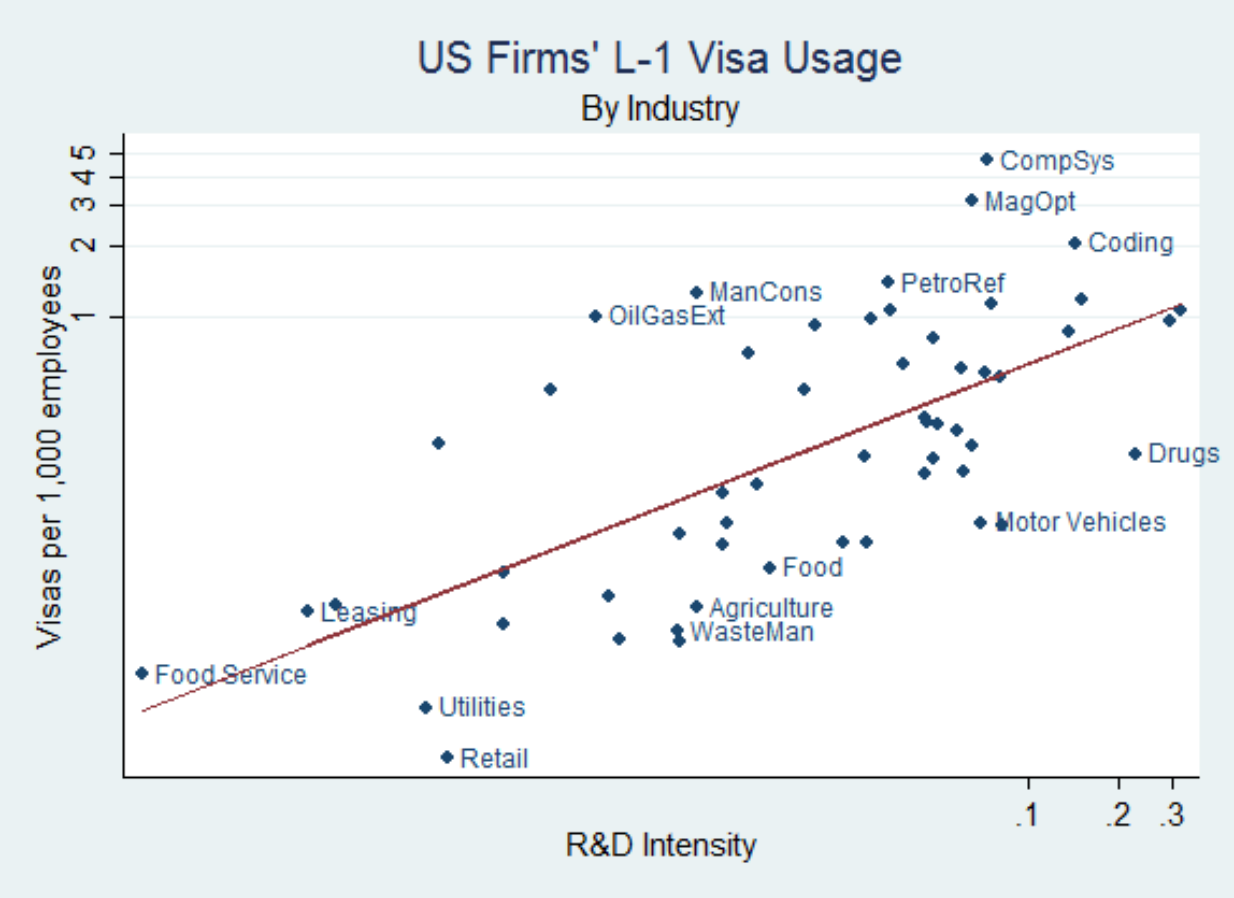
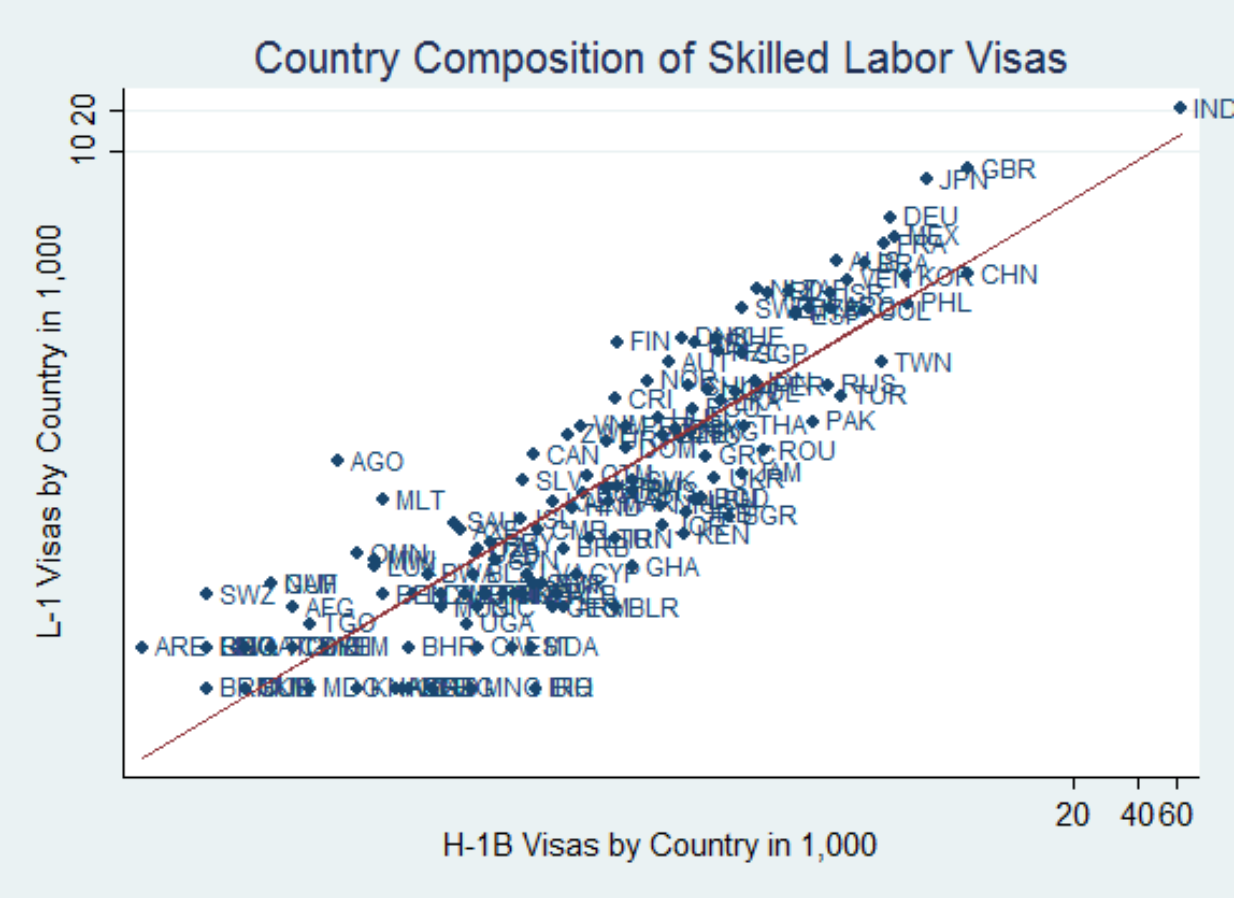

US Firms' L-1 Visa Usage
By Industry
Visas per 1,000 employees
1
2
3
4
5
R&D Intensity
.1
.2
.3
CompSys
MagOpt
Coding
ManCons
PetroRef
OilGasExt
Drugs
Motor Vehicles
Food
Leasing
Agriculture
WasteMan
Food Service
Utilities
Retail

Figure 2



Source: Department of State.