

Intellectual Property, the Immigration Backlog, and a Reverse Brain-Drain

America's New Immigrant Entrepreneurs, Part III



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Table of Contents

Introduction	2
Summary	3
Foreign-National Contributions to U.S. International Patent Applications	3
Indian and Chinese Inventors	4
The Growing Immigration Backlog	4
A Reverse Brain-Drain?	5
International Patents	6
Foreign-National Contributions to U.S. International Patent Applications	6
Figure 1: Foreign-National Contribution to U.S. PCT Applications from 1998-2006	7
Figure 2: U.S. International Patent Applications by State in 2006	7
Figure 3: U.S. International Patent Applications by Corporations	8
Figure 4: Foreign-National and Foreign-Resident Inventor Contributions to PCT Applications Filed in the U.S. by Corporations	9
Indian- and Chinese-Immigrant Contributions to U.S. International Patent Applications	10
Table 1: Indian and Chinese Contributors to U.S. International Patent Applications Filed in 1998 and 2006	10
Table 2: Indian- and Chinese-Inventor PCT Applications by State	11
Areas of Intellectual Property Contribution by Immigrant	12
Table 3: Indian and Chinese Patent Applications by IPC in 2006	12
Table 4: U.S.-Citizen vs. Foreign-National Filings by IPC	13
The Growing Immigration Backlog	14
The Basics	14
Background and Objectives	15
Preliminaries	17
Estimation Strategies	19
Table 5: Six Subsets of the Pre-LPR Population, Four Information Sources, and Three Estimation Strategies	20
Numerical Approximations	21
Figure 5: I-140 Petitions Pending Adjudication at End of Fiscal Year	22
Figure 6: Employment-Based Principals with Approved I-140 and Unfiled/Pending I-485 Adjusted for Initial Queue in 1992	24
Numerical Approximation of the Employment-Based Pre-LPR Population	25
Figure 7: Employment-Based Principals with Approved I-140 and Unfiled/Pending I-485 Adjusted for Initial Queue in 1992 and Departures from the Queue in 1994, 1995, and 1996	25
Figure 8: Employment-Based Principals with Pending or Approved I-140. (Approved I-140 Series Adjusted as in Figure 7)	25
Table 6: Estimated Employment-Based Pre-LPR Population at the End of Fiscal Year 2006	26
Discussion	26
Table 7: Immigrant Visa Categories of Former F1 Students and H-1B Temporary Workers: Immigrant Cohort of 2003	28
Table 8: Immediately Previous Nonimmigrant Visas of Immigrants Adjusting as Employment Principals or Spouses of U.S. Citizens: Immigrant Cohort of 2003	29
Final Remarks on Immigration Backlog	30
Conclusion	31
Author Biographies	32
Appendices	35
Appendix A: Methodology	36
Data Acquisition and Analysis	36
Appendix B: PCT Application Data	38
References	40

Introduction

The founders of the United States considered intellectual property worthy of a special place in the Constitution—*“To promote the Progress of Science and useful Arts, by securing for limited Times to Authors and Inventors the exclusive Right to their respective Writings and Discoveries.”*¹

In today’s knowledge-based economy, capturing value from intellectual capital and knowledge-based assets has gained even more importance. Global competition is no longer for the control of raw materials, but for this productive knowledge.

This paper is the third in a series of studies focusing on immigrants’ contributions to the competitiveness of the U.S. economy. Earlier research revealed a dramatic increase in the contributions of foreign nationals to U.S. intellectual property over an eight-year period. In this paper, we offer a more refined measure of this change and seek to explain this increase with an analysis of the immigrant-visa backlog for skilled workers. The key finding from this research is that the number of skilled workers waiting for visas is significantly larger than the number that can be admitted to the United States. This imbalance creates the potential for a sizeable reverse brain-drain from the United States to the skilled workers’ home countries.

¹ “The Constitution of the United States,” Article 1, Section 8.

Summary

Our earlier papers, “America’s New Immigrant Entrepreneurs” and “Entrepreneurship, Education, and Immigration: America’s New Immigrant Entrepreneurs, Part II,” documented that one in four engineering and technology companies founded between 1995 and 2005 had an immigrant founder. We found that these companies employed 450,000 workers and generated \$52 billion in revenue in 2006. Indian immigrants founded more companies than the next four groups (from the United Kingdom, China, Taiwan, and Japan) combined. Furthermore, these companies’ founders were very highly educated in science, technology, math, and engineering-related disciplines, with 96 percent holding bachelor’s degrees and 75 percent holding master’s or PhD degrees.²

The analysis of the World Intellectual Property Organization (WIPO) database in this earlier work revealed that the percentage of foreign nationals contributing to U.S. international patent applications increased from an estimated 7.3 percent in 1998 to 24.2 percent in 2006. The largest foreign-born group was from China (mainland and Taiwan). Indian nationals were second, followed by Canadians and the British. As the WIPO database records inventor nationality at the time of filing, these numbers do not include the contributions of immigrants who became U.S. citizens before filing patent applications.³

In this paper, we expand on this earlier research to gain a more robust understanding of the impact of foreign-born citizens to U.S. intellectual property and to explain the increasing numbers of

foreign nationals contributing to U.S. international patent applications. First, our research team downloaded several years of additional data from the WIPO database to refine our previous estimates and obtain demographic information. We inspected each record to identify inventors with Indian- and Chinese-heritage names to identify and include foreign-born citizens. In an effort to explain the increase in the contributions of foreign nationals, we examined extensive information published by the U.S. Departments of Homeland Security, Labor, and State. We used this information to create detailed estimates of the numbers of foreign nationals residing in the United States who are waiting for legal permanent resident status. We also reviewed the “New Immigrant Survey” to gain insight into the process of becoming a legal permanent resident and the potential that, even after becoming legal permanent residents, they might return home.

Our key findings include:

Foreign-National Contributions to U.S. International Patent Applications

- Foreign nationals residing in the United States were named as inventors or co-inventors in 25.6 percent of international patent applications filed from the United States in 2006. This represents an increase from 7.6 percent in 1998.

² Wadhwa, V., G. Gereffi, B. Rissing, A. Saxenian, June 11, 2007. Education, Entrepreneurship, and Immigration: America’s New Immigrant Entrepreneurs, Part II. Kauffman Foundation.

³ Wadhwa, V., G. Gereffi, B. Rissing, A. Saxenian, January 2007. America’s New Immigrant Entrepreneurs. Duke University.

- Foreign-national contributions to international patent applications were highest in California, Massachusetts, and New Jersey.
- Foreign nationals and foreign residents contributed to more than half of the international patents filed by a number of large, multi-national companies, including Qualcomm (72 percent), Merck & Co. (65 percent), General Electric (64 percent), Siemens (63 percent), and Cisco (60 percent). Foreign nationals contributed to relatively smaller numbers of international patent applications at other firms, such as Microsoft (3 percent) and General Motors (6 percent). Forty-one percent of the patents filed by the U.S. government had foreign nationals or foreign residents as inventors or co-inventors. (Foreign-national inventors are individuals with foreign citizenship working in the United States. Foreign resident inventors have foreign citizenship and are not based in the United States.)

Indian and Chinese Inventors

- In 2006, 16.8 percent of international patent applications from the United States had an inventor or co-inventor with a Chinese-heritage name, representing an increase from 11.2 percent in 1998. The contribution of inventors with Indian-heritage names increased to 13.7 percent from 9.5 percent in the same period.
- Chinese inventors tended to reside in California, New Jersey, and New York. Indian inventors chose California, New Jersey, and Texas.
- Both Indian and Chinese inventors tended to file most patents in the fields of sanitation/medical preparations, pharmaceuticals, semiconductors, and electronics.

The Growing Immigration Backlog

We estimate that as of September 30, 2006 there were 500,040 principals in the main employment-based categories and an additional 555,044 family members awaiting legal permanent resident status in the United States.

- The number of employment-based principals waiting for labor certification—the first step in the U.S. immigration process—was estimated at 200,000 in 2006.
- The number of pending I-140 applications—the second step of the immigration process—stood at 50,132 in 2006. This was more than seven times the total in 1996 (6,743).
- The number of employment-based principals with approved I-140 applications and unfiled or pending I-485s—the last step in the immigration process—was estimated at 309,823 in 2006, representing almost a three-fold increase from the previous decade.
- Overall, we estimate that the number of employment-based principals (in the three main employment visa categories—EB-1, EB-2, and EB-3) waiting for legal permanent residence in the United States in 2006 was 500,040.
- The total number of employment-based principals in the focal employment categories and their family members waiting for legal permanent residence in the United States in 2006 was estimated at 1,055,084. We further estimate that 126,421 residents abroad were also waiting for U.S. legal permanent residence, giving a worldwide total of 1,181,505.

We also gathered estimates of the numbers of students and skilled temporary workers. There is some overlap between this group and the estimates above; the two totals, therefore, cannot be added together.

- In the 2005-2006 academic year, 259,717 international graduate students were studying in the United States. In addition, 38,096 were

in practical training, and at least some of these individuals were likely to be postdoctoral scholars.

- A previous study estimated the 2004 population of all H and L workers (all Hs except H4 spouses, plus L1) at 704,000.

A Reverse Brain-Drain?

Approximately 120,120 permanent resident visas are available annually for employment-based principals and their family members in the three main employment visa categories (EB-1, EB-2, and EB-3). Additionally, the number of visas that can be issued to immigrants from any one of the major sending countries—China, India, Mexico, and Philippines—is less than 10,000 per year (7 percent of the total pool of 120,120 available visas per country). Our estimates indicate that there are more than 1 million individuals waiting in line for legal permanent resident status. The wait time for visas for countries with the largest populations, like India and China, ranged to four years in June 2007—not counting visa processing time—and may be even higher when visas are again available in October 2007. This backlog is likely to increase substantially, given the limited number of visas available.

Evidence from the “New Immigrant Survey” indicates that approximately one in five new legal immigrants and about one in three employment principals either plan to leave the United States or are uncertain about remaining. Moreover, media reports suggest that increasing numbers of skilled workers have begun to return home to countries like India and China where the economies are booming.

Given the substantial role of foreign-born residents in the United States in international patent creation, and the huge backlog in granting visas to employment-based principals, the potential exists for a reverse brain-drain of skilled workers who contribute to U.S. global competitiveness.

International Patents

Before the era of globalization, patents filed with the U.S. Patent and Trademark Office (USPTO) were of principal importance to many corporations. Today, however, international patents are becoming increasingly important.

The World Intellectual Property Organization (WIPO) is an international group that regulates and governs global intellectual property. One of the United Nations' 16 special agencies, it has close to 200 member states. The first step toward obtaining intellectual property protection through WIPO is to file a Patent Cooperation Treaty (PCT) application. This treaty, an international agreement recognized by more than 125 countries, allows an individual or corporation to file a single application to seek simultaneous protection for an invention in a multitude of countries worldwide. This system allows inventors to bypass the time-consuming process of applying for separate national or regional patent protection.⁴

In this paper, we focus on PCT applications filed through WIPO's U.S. receiving office. These generally are a subset of patent applications filed with the USPTO. The PCT applications, however, arguably represent some of the most sophisticated inventions originating in this country. Not only does the perceived need for international intellectual property protection indicate that the inventions are characterized by a higher level of sophistication than those only submitted to the USPTO, but also the costly and time-intensive application process for PCT patents suggests that inventions described in PCT applications largely have market potential in multiple countries, global visibility, and diverse applications.

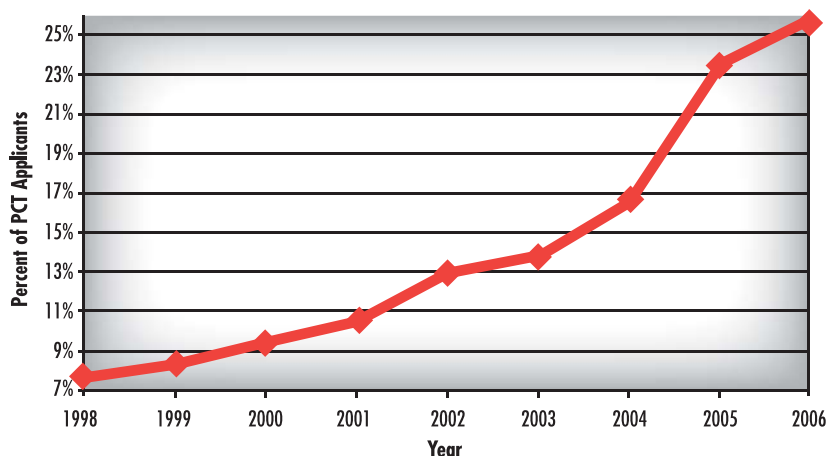
Our original study, "America's New Immigrant Entrepreneurs," presented several estimates of foreign-national inventor contributions to U.S. international patent applications. For this paper, we downloaded several years of complete WIPO data in order to refine these estimates and present concrete numbers. Appendix A details the methodology utilized in this analysis. Appendix B presents more detailed data concerning foreign nationals' contributions to U.S. intellectual property by state. And Appendix C, available as a separate document, offers a complete list of international patent classification (IPC) codes and the total applications in each of these technical areas. In our previous work, we used the terms "immigrant citizens" and "immigrant non-citizens" to differentiate between foreign nationals who had become citizens before filing PCT applications and those who had not. In this paper, we instead refer to these groups as "foreign-born citizens" and "foreign nationals."

Foreign-National Contributions to U.S. International Patent Applications

In our January 2007 paper, "America's New Immigrant Entrepreneurs," we estimated foreign-national contributions to PCT applications filed through the U.S. receiving office. These estimates were calculated by indexing inventor records from all countries that filed PCT applications in the United States. We then added each country's PCT filing activity and applied a discount factor to

⁴ World Intellectual Property Organization, April 2006. PCT: Protecting Your Inventions Abroad: Frequently Asked Questions About the Patent Cooperation Treaty (PCT). WIPO Publication no. 433(E).

Figure 1
Foreign-National Contribution to U.S. PCT Applications
from 1998-2006*



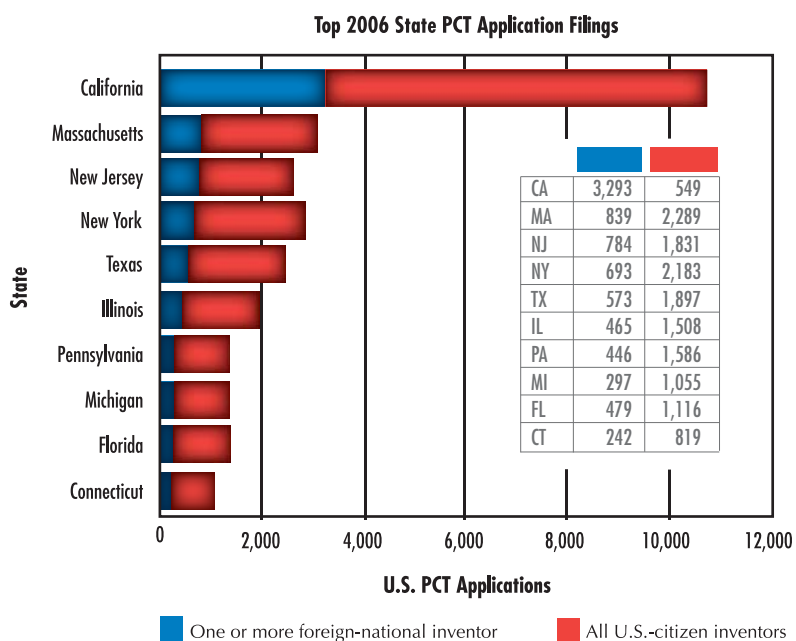
*1998 and 2006 statistics were gathered through measured data. 1999-2005 are estimates.

compensate for PCT applications with inventors from multiple countries.

For this paper, we reanalyze the full 1998 and 2006 WIPO records to produce an exact count of foreign-national activities in these years. Foreign nationals residing in the United States were named as inventors or co-inventors in 25.6 percent of international patent applications filed from the United States in 2006. This represented an increase from 7.6 percent in 1998. Figure 1 presents this change over time.

The vast majority of international patent applications with foreign-national inventors (or co-inventors) originated from California, followed by Massachusetts, New Jersey, and New York (see Figure 2).

Figure 2
U.S. International Patent Applications by State in 2006



Appendix B presents more detailed data concerning foreign nationals' contributions to U.S. intellectual property by state.

Figure 3
U.S. International Patent Applications by Corporations

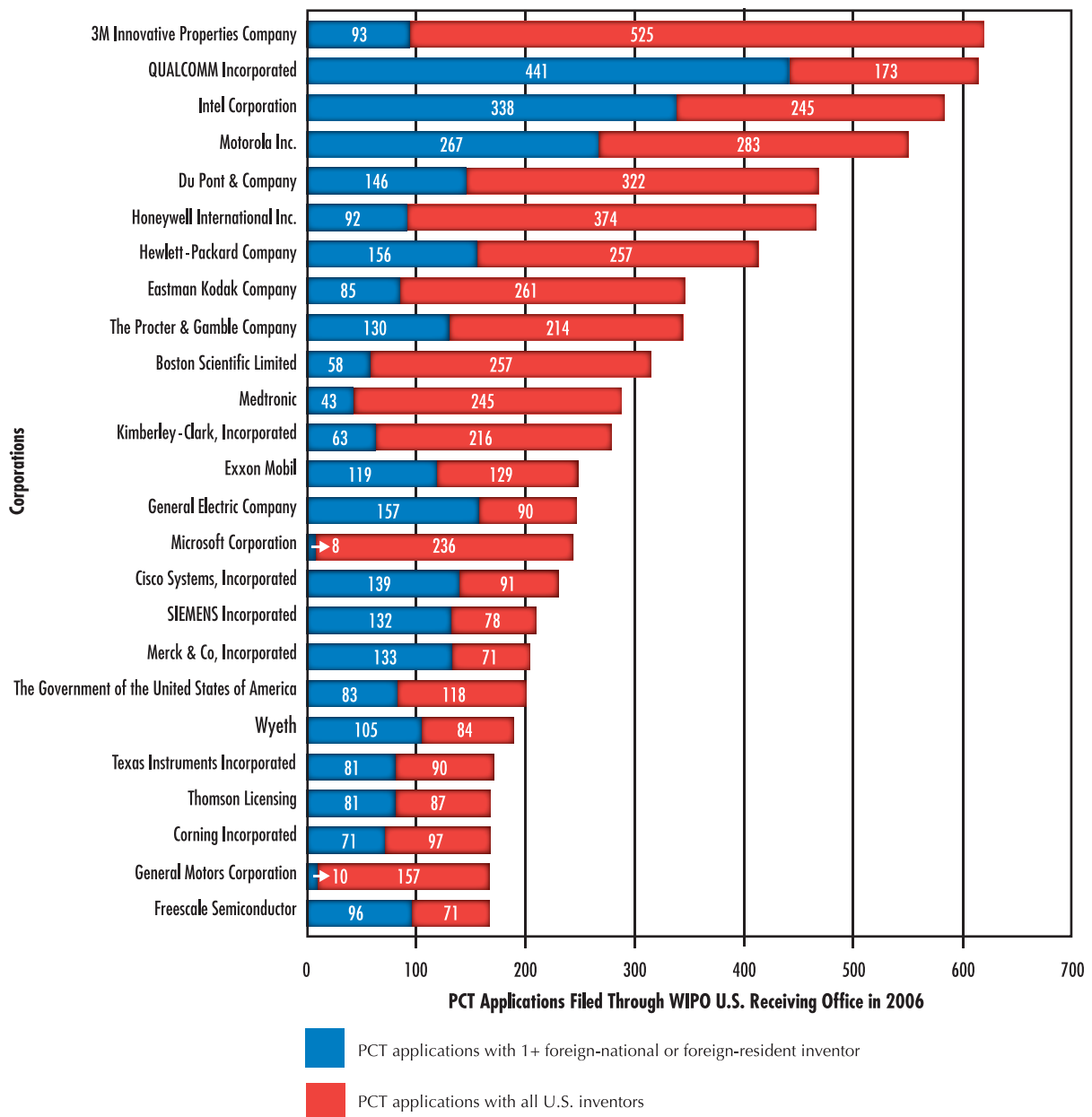
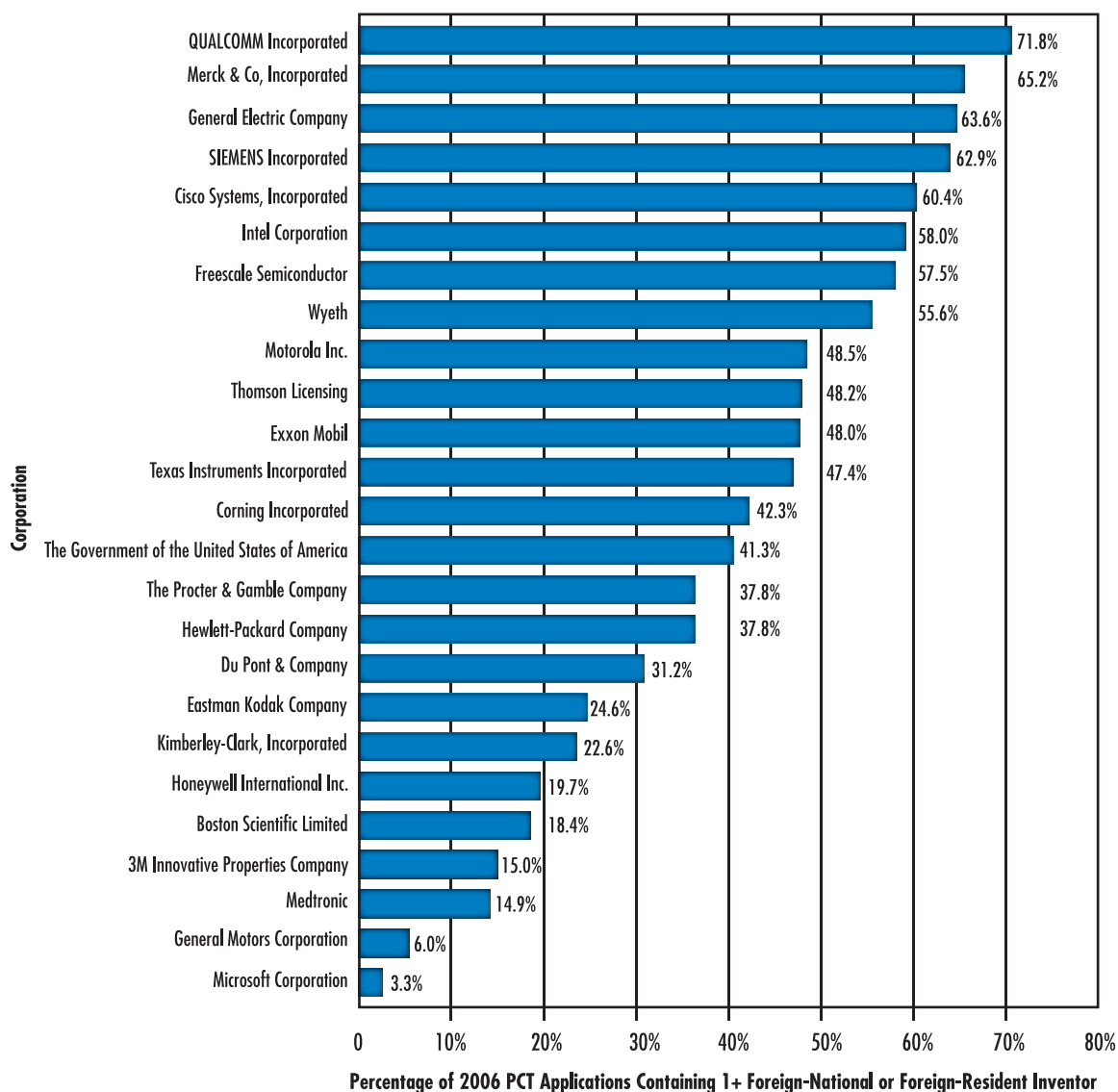


Figure 3 displays the top 25 corporations that filed PCT applications from the United States in 2006. The blue bar represents the number of PCT applications with one or more foreign-national or foreign-resident inventor. Red bars represent those with only U.S.-citizen inventors.

While each of these 25 corporations are actively involved in securing intellectual property protection, the breakdown of inventor nationality at these firms differs significantly.

Figure 4 displays the percentage of all PCT applications filed by these corporations that contained one or more foreign-national inventor.

Figure 4
Foreign-National and Foreign-Resident Inventor Contributions to PCT Applications
Filed in the U.S. by Corporations



Indian- and Chinese-Immigrant Contributions to U.S. International Patent Applications

In our January 2007 study, “America’s New Immigrant Entrepreneurs,” we found that Chinese (mainland and Taiwan-born) and Indian immigrants were the largest groups of foreign-national inventors. We were able to distinguish these two groups because PCT records include information on inventor nationality at the time of filing. Unfortunately, however, it is not possible to identify the contributions of immigrants who became U.S. citizens (foreign-born citizens) before filing a PCT application.

To estimate the contributions of these two groups, we performed a manual name analysis of all 1998 and 2006 PCT applications. Two teams of native Indian and Chinese graduate students inspected these records to identify Indian and Chinese names. We adopted a conservative strategy—names that could not be definitively linked to China or India were not flagged. This analysis allowed us to quantify the intellectual property contributions of Indian and Chinese immigrants living in the United States regardless of citizenship.

Of the approximately 130,000 inventors listed on U.S. PCT applications in 2006, 16.8 percent had Chinese-heritage names (mainland and Taiwan) and 13.7 percent had names with Indian origins. By subtracting the number of inventors who were Indian and Chinese citizens, we can create an estimate of foreign-born citizen inventors.

According to the last census, 75.4 percent of U.S. residents of Asian-Indian descent, and 70.8 percent of Chinese descent, were foreign-born.⁵

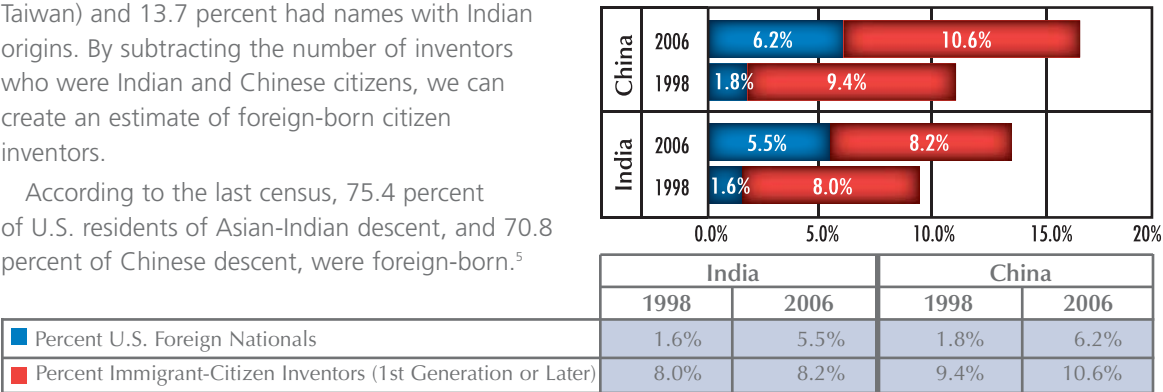
Additionally, 81 percent of foreign-born Indian immigrants and 75 percent of foreign-born Chinese immigrants entered the United States after 1980.^{6,7} These statistics suggest that the vast majority of those with Indian- and Chinese-heritage names are likely to be first-generation immigrants who arrived after 1980.

Table 1 below presents our estimate of the contributions of Indian and Chinese citizens and foreign nationals to U.S. international intellectual property.

The contribution of inventors with Indian- and Chinese-heritage names increased significantly from 1998 to 2006. In 1998, 11.2 percent of PCT applications had one or more inventor with a Chinese-heritage name; by 2006 this had increased to 16.8 percent. The Indian contribution increased from 9.6 percent to 13.7 percent in the same time period.

PCT applications with Indian and Chinese inventors tend to originate from certain states, indicating the presence of regional communities of skilled workers. The top U.S. states filing PCT applications with Chinese inventors include California, New Jersey, and New York. The equivalent states for Indian inventors are California, New Jersey, and Texas. A listing by state can be found in Table 2.

Table 1
Indian and Chinese Contributors to U.S. International Patent Applications Filed in 1998 and 2006



⁵ Reeves, T., C. Bennet, December 2004. We the People: Asians in the United States. *Census 2000 Special Report*. P. 9.
⁶ U.S. Census Bureau, 2000. Table FBP-1. Profile of Selected Demographic and Social Characteristics: 2000, Population Universe: People Born in India. <http://www.census.gov/population/cen2000/stp-159/STP-159-india.xls>.
⁷ U.S. Census Bureau, 2000. Table FBP-1. Profile of Selected Demographic and Social Characteristics: 2000, Population Universe: People Born in China. <http://www.census.gov/population/cen2000/stp-159/STP-159-china.xls>.

Table 2
Indian- and Chinese-Inventor PCT Applications by State

State	State Name	TOTAL		INDIAN		CHINESE	
		1998	2006	1998	2006	1998	2006
CA	California	4,716	9,196	592	1,625	673	2,183
MA	Massachusetts	1,643	2,603	144	363	219	429
NY	New York	1,067	2,551	96	358	137	501
TX	Texas	1,454	2,329	137	381	167	358
NJ	New Jersey	1,246	2,116	205	448	214	634
PA	Pennsylvania	1,130	1,915	87	218	103	297
MN	Minnesota	1,003	1,877	73	194	86	194
IL	Illinois	914	1,735	106	267	121	280
OH	Ohio	1,112	1,436	107	138	68	167
FL	Florida	639	1,338	32	126	56	149
MI	Michigan	821	1,337	74	189	53	201
WA	Washington	484	1,088	43	138	48	150
NC	North Carolina	566	1,047	62	142	48	107
CT	Connecticut	482	976	27	103	56	191
GA	Georgia	519	805	49	73	52	108
MD	Maryland	552	795	53	102	115	145
OR	Oregon	213	770	25	145	10	114
CO	Colorado	510	747	30	55	25	43
WI	Wisconsin	434	742	23	73	36	61
AZ	Arizona	357	675	25	71	24	72
VA	Virginia	318	655	28	76	29	65
IN	Indiana	461	643	32	74	48	84
TN	Tennessee	276	526	16	24	16	32
UT	Utah	207	404	11	26	12	28
MO	Missouri	287	400	23	54	26	47
NH	New Hampshire	209	354	10	31	12	39
DE	Delaware	218	349	32	59	39	102
SC	South Carolina	137	260	10	19	7	34
NV	Nevada	70	221	0	7	8	7
IA	Iowa	120	201	10	12	12	39
LA	Louisiana	174	168	11	16	27	11
KS	Kansas	104	163	4	17	10	20
KY	Kentucky	80	162	6	9	2	15
AL	Alabama	98	159	5	17	8	22
ID	Idaho	108	153	3	18	3	18
OK	Oklahoma	100	152	2	19	15	26
NM	New Mexico	111	152	6	9	6	11
RI	Rhode Island	73	124	9	4	4	17
NE	Nebraska	51	110	1	10	4	12
VT	Vermont	36	97	2	10	2	8
WV	West Virginia	42	87	5	10	2	8
ME	Maine	39	82	1	1	4	4
MS	Mississippi	24	70	2	7	1	5
AR	Arkansas	30	49	1	7	1	4
DC	District of Columbia	19	45	2	3	2	5
MT	Montana	30	45	0	0	2	2
ND	North Dakota	4	35	0	7	0	2
HI	Hawaii	18	34	3	5	0	1
WY	Wyoming	15	22	0	1	0	1
AK	Alaska	5	8	0	0	0	0
SD	South Dakota	11	5	0	0	0	0
VI	Virgin Islands	1	4	0	0	0	0
PR	Puerto Rico	5	2	0	0	0	0
Total–United States		23,343	42,019	2,225	5,761	2,613	7,053
Percent of Total				9.53%	13.71%	11.19%	16.79%

Areas of Intellectual Property Contribution by Immigrants

International Patent Classification Codes

When a PCT application is filed, the patent must be classified under one or more international patent classification (IPC) codes. Most PCT applications include only one or two IPC codes. Complicated inventions, however, may include more than thirty.

We cross-referenced all 1998 and 2006 PCT applications' IPC codes against PCT applications with foreign-national inventors and inventors with Indian- and Chinese-heritage names. This analysis

allowed us to determine the technical areas in which these groups are contributing.

Indian and Chinese Inventors

Both Indian and Chinese inventors tend to file the most patents in sanitation/medical preparations, medicine, pharmaceuticals, semiconductors, and electronics. The top ten IPC fields for each of these groups are presented in Table 3. Like entries have been similarly highlighted for ease of comparison.

Table 3
Indian and Chinese Patent Applications by IPC in 2006

Indian		Chinese	
Description	PCT Apps	Description	PCT Apps
1 Preparations for Medical, Dental, or Toilet Purposes	922	1 Preparations for Medical, Dental, or Toilet Purposes	1,495
2 Electric Digital Data Processing	638	2 Heterocyclic Compounds	737
3 Transmission of Digital Information	534	3 Therapeutic Activity of Chemical Compounds or Medicinal Preparations	539
4 Semiconductor Devices; Electric Solid State Devices not Otherwise Provided for	381	4 Semiconductor Devices; Electric Solid State Devices not Otherwise Provided for	455
5 Heterocyclic Compounds	376	5 Electric Digital Data Processing	439
6 Therapeutic Activity of Chemical Compounds or Medicinal Preparations	314	6 Investigating or Analyzing Materials by Determining Their Chemical or Physical Properties	376
7 Selecting (Switches, Relays)	248	7 Micro-Organisms or Enzymes	320
8 Investigating or Analyzing Materials by Determining Their Chemical or Physical Properties	189	8 Peptides	304
9 Diagnosis, Surgery, Identification	160	9 Transmission of Digital Information	291
10 Transmission Systems	159	10 Measuring or Testing Processes Involving Enzymes or Micro-Organisms	261

U.S.-Citizen vs. Foreign-National Filings

We also compared the IPC filings of U.S.-citizen inventors and foreign-national inventors from the United States. We did not observe a significant difference between these groups; they share eight of their top ten IPC categories. A full breakdown can be found in Table 4.

Table 4
U.S.-Citizen vs. Foreign-National Filings by IPC

U.S.-Citizen Inventors 2006		1+ Foreign-National Inventor 2006	
Description	PCT Apps	Description	PCT Apps
1 Preparations for Medical, Dental, or Toilet Purposes	4,359	1 Preparations for Medical, Dental, or Toilet Purposes	1,907
2 Electric Digital Data Processing	2,653	2 Electric Digital Data Processing	885
3 Diagnosis, Surgery, Identification	1,630	3 Heterocyclic Compounds	802
4 Investigating or Analyzing Materials by Determining Their Chemical or Physical Properties	1,382	4 Transmission of Digital Information	703
5 Semiconductor Devices; Electric Solid State Devices not Otherwise Provided for	1,285	5 Semiconductor Devices; Electric Solid State Devices not Otherwise Provided for	656
6 Heterocyclic Compounds	1,260	6 Therapeutic Activity of Chemical Compounds or Medicinal Preparations	638
7 Therapeutic Activity of Chemical Compounds or Medicinal Preparations	1,232	7 Investigating or Analyzing Materials by Determining Their Chemical or Physical Properties	549
8 Contraceptive Devices, Bandages, Dressings	1,161	8 Micro-Organisms or Enzymes	443
9 Transmission of Digital Information	1,132	9 Measuring or Testing Processes Involving Enzymes or Micro-Organisms	398
10 Micro-Organisms or Enzymes	892	10 Peptides	398

The Growing Immigration Backlog

As detailed earlier, the percentages of U.S. international patent applications with contributions from foreign nationals increased from 7.6 percent in 1998 to 25.6 percent in 2006. To explain this increase and understand the correlation with immigration trends, we developed a methodology to estimate the population of skilled immigrants from which such inventors may originate. No such data are available from the U.S. State Department or the Citizenship and Immigration Services (USCIS).

The Basics

Process

A skilled worker who wants to become a legal permanent resident (LPR) of the United States based on employment must, in most cases, have a permanent employment offer from a U.S.-based firm. There are several steps in the immigration process:

1. The employer must, in most cases, file a labor certification request with the Department of Labor's Employment and Training Administration.
2. Once the labor certification is approved (if needed), the employer must file a Petition for Alien Worker (Form I-140) with the USCIS for the worker. The employer needs to demonstrate that the company is in a good financial position and capable of paying the salary advertised for the job. In some cases, the worker can self-petition.
3. Once the I-140 is approved, the employee must wait for the State Department to provide a visa number, which indicates that an immigrant visa is available for the applicant.

4. If already in the United States, the employee now must file for adjustment of status (I-485) for himself/herself and family members.

Eligibility

There are five categories for granting permanent residence to foreign nationals based on employment. We focus on the first three:

EB-1 priority workers

- Foreign nationals of extraordinary ability in the sciences, arts, education, business, or athletics
- Foreign nationals who are outstanding professors or researchers
- Foreign nationals who are managers and executives subject to international transfer to the United States

EB-2 professionals with advanced degrees or persons with exceptional ability

- Foreign nationals of exceptional ability in the sciences, arts, or business
- Foreign nationals who are advanced-degree professionals
- Qualified alien physicians who will practice medicine in an underserved area of the United States

EB-3 skilled or professional workers

- Foreign-national professionals with bachelor's degrees (not qualifying for a higher-preference category)
- Foreign-national skilled workers (minimum two years training and experience)
- Foreign-national unskilled workers

Other Visas

Foreign nationals who file U.S. international patents also include persons who acquire LPR on

family or diversity visas, as well as persons with temporary visas such as:

1. H-1B temporary work visa for specialty occupations, which requires theoretical and practical application of a body of specialized knowledge along with at least a bachelor's degree or its equivalent
2. L-1 visas for intra-company transferees (foreign nationals employed by a company that has offices both in the United States and abroad)
3. F-1 visas to study or conduct research at an accredited U.S. college or university

Background and Objectives

Every year, approximately one million persons are admitted to LPR in the United States. More than half of them are already residing in the United States and adjust their status from a legal temporary visa or from undocumented status. Henceforth in this paper, these individuals will be referred to as "adjustees."

For example, during the ten-year period from 1996 to 2005, the number of adjustees exceeded that of new arrivals in every year except three (1998, 1999, and 2003—years in which administrative and staffing conditions produced large backlogs in immigrant visa processing in offices of the INS and its successor agency, CIS), and for the entire period, the proportion adjustee was 55.8 percent.

Until recently, little was known about the adjustee subset of new LPRs, and even less after 2002. Traditionally, the INS and, subsequently, USCIS published tabulations in the *Statistical Yearbook*, which provided the immediately preceding nonimmigrant category of new adjustee LPRs and the year of admission to that nonimmigrant category (e.g., Tables 10 and 11 in the *Statistical Yearbook* of 2000). Fiscal Year 2002 was the last year for which the *Yearbooks* provided this information. Since then, the

Yearbook has included only the breakdown of adjustees and new arrivals for every immigrant visa category.

Fortuitously, the "New Immigrant Survey," the first nationally representative longitudinal study of new legal immigrants⁸, has collected extensive data on the immigrant cohort of 2003. More than 8,500 main sampled adult immigrants were interviewed at, on average, four-and-a-half months after admission to LPR, and the second round of interviews began in June 2007. From these data we learn the following, for example:

1. For the 2003 cohort, the average time to LPR since filing of the first application that started the visa process was 4.4 years (4.2 for adjustees and also for adjustee employment principals).
2. The process of applying for an LPR visa is sufficiently arduous that approximately 17.4 percent of new legal immigrants became depressed as a result of the visa process (18.7 percent of adjustees and 21.9 percent of adjustee employment principals).
3. 21.7 percent of new legal immigrants either plan to leave the United States or are uncertain about remaining (34.5 percent of both employment principals and adjustee employment principals).

Visa processing times have been increasing due, it is thought, to twin causes: the increase in applications and the post-9/11 increase in background checks of applicants. These increases in visa processing times are distinct from the waiting times for numerically restricted visas, as will be discussed below. Concomitantly, the agencies involved have established aggressive plans to eliminate the ensuing backlogs. For example, the Department of Labor's Employment and Training Administration, which adjudicates labor certification petitions, is scheduled to completely eliminate its backlog by the end of Fiscal Year 2007 (September 30, 2007); the INS/CIS had special funds to reduce backlogs

⁸For description of the "New Immigrant Survey" project, see Jasso, Massey, Rosenzweig, and Smith (in press), available online at <http://nis.princeton.edu>.

during the five-year period Fiscal Years 2002-2006, and in June 2007 adjudicated so many immigration applications that all employment-based visas for Fiscal Year 2007 were used (Department of State 2007b).

Waiting for visa processing makes a stressful time even more stressful, notwithstanding the relief available to some of those waiting for their visas in the United States while in a nonimmigrant status, notably in the form of employment authorization and travel permission for both principals and accompanying spouses and children.

The question thus arises: How many persons are waiting to adjust to LPR in the United States? One important subset of what we may call the pre-LPR population involves immigrants in line for employment-based visas. Accordingly, the question addressed in this section is: How many employment principals are waiting to adjust to LPR in the United States? It is a pressing question and one for which there is no official answer, due, apparently, to technical constraints of the USCIS case processing system. As the CIS Ombudsman observed in the annual report to Congress, submitted in June (2007, p. 13):

Failing to correct the system annually results in hundreds, if not thousands, of wasted hours by all levels of USCIS leadership in trying to account for an often-asked question by Congress, the Ombudsman, stakeholders, and others: "Exactly how many employment-based green card applications does the agency have pending?" USCIS still cannot answer that question today with certainty.

To correctly pose the question, and thus to make progress in answering it, it is important to distinguish between two elements in the wait for adjustment to LPR. The first involves availability of numerically limited visas. The total number of visas available annually to principals and family members in EB-1, EB-2, and EB-3 is approximately

120,120. The second element involves processing delays at each step of the visa process—in processing the labor certification application (ETA 9089), the employer's (or, in some cases, self-) petition for an alien worker (I-140), and the prospective immigrant's application to adjust status (I-485).

The two are interrelated. As the State Department has been noting in its monthly *Visa Bulletins* since June 2004 (but see especially the issue for January 2005) and as the *CIS Ombudsman* has been discussing, clearing I-485 backlogs means that numerical caps are reached and employment visas are no longer available. Thus, prospective immigrants are stranded at the first or second step, unable to submit the I-485.

The impact of this intertwining of numerical limitations and visa processing is periodically felt, for example, in January 2005, when application cutoff dates of January 2002 were placed on the employment third preference category for nationals of China, India, and the Philippines, and most recently on July 2, 2007, when the State Department updated its previous *Visa Bulletin* for July and announced that all employment categories had become unavailable for the rest of the fiscal year (an announcement subsequently rescinded on July 17, when the State Department and USCIS reinstated the original *Visa Bulletin* for July, in which all employment-based categories except the subcategory of the third preference for "other workers" are current, and extended the filing period until August 17).⁹

Notwithstanding their interrelatedness, it is of the utmost importance to distinguish between these two distinct elements of the wait for adjustment to LPR. Among other things, relief for the two is of very different kinds, as the numerical caps are governed by statute, while application processing is governed by agency management practices.

At the outset, it also is useful to note that the current immigration debate has popularized a

⁹ Of course, the impact of the numerical caps has long been felt in the family preference categories, where all categories have substantial backlogs and the extreme case is that of the 22-year wait for nationals of the Philippines in the category for siblings of U.S. citizens.

false dichotomy between skilled immigrants and family immigrants. In practice, many skilled immigrants acquire LPR as family immigrants, especially as spouses of U.S. citizens, as will be discussed below. It is not unusual for a prospective employer, upon learning of the principal's marriage to a U.S. citizen, to suggest that he or she get the visa as a spouse rather than as an employee, for "the process is easier that way." Moreover, even skilled immigrants who immigrate as workers have spouses and children, not all of whom work. Further, note that U.S. citizens may be superior to employers in screening future citizens, as they are thinking of the long term rather than the short term (Jasso and Rosenzweig 1995).

In the following sections, we address the question of the size of the pre-LPR population, refine it, note special subgroups of interest, consider estimation strategies, and provide a numerical estimate.

Preliminaries

We focus on employment principals who are going through the visa process in the United States; specifically, on principals in the first, second, and third employment-based immigrant visa categories EB-1, EB-2, and EB-3. In the rest of this paper, we refer to this set as "employment principals." For some purposes, the focus is on highly skilled employment-based immigrants, and this set consists of the employment principals, as just defined, minus the small subcategory of EB-3 reserved for "other workers." However, much of the available information that will be used for estimating the pre-LPR population pertains to the employment categories together and does not permit removing the "other workers." Thus, we focus on the first, second, and third employment-based visa categories.¹⁰

The visa process lasts from the filing of the first application to the date of admission to LPR. In general, the priority date for the case is assigned based on the first application filing. For EB-2 and EB-3 cases, the first application is the Application for Permanent

Employment Certification (ETA Form 9089, formerly Form 750), and for EB-1 cases, the first application is the Petition for Alien Worker (I-140). EB-2 and EB-3 cases file the I-140 after labor certification is obtained. Note that self-petition on the I-140 is permitted for one subcategory of EB-1 cases (the first of three subcategories, viz., those with "extraordinary ability in the sciences, arts, education, business, or athletics, which has been demonstrated by sustained national or international acclaim and whose achievements have been recognized in the field through extensive documentation") and one subset of EB-2 cases (those who obtain a national interest waiver).

Persons with temporary U.S. visas can file for adjustment of status if the visa for which they qualify is immediately available. In the employment sphere, this means that the visa category must be "current," in State Department parlance. In this case, prospective immigrants submit the Application to Register Permanent Residence or Adjust Status (I-485).

The classical sequence of steps in the visa process for a prospective employment-based immigrant already in the United States was, first, to file for labor certification (if needed); second, upon granting of labor certification, to file the I-140; and third, upon approval of the I-140, to file the I-485 for adjustment of status if a visa number is available (or as soon as it becomes available). However, for the past five years (since July 31, 2002) immigrants have been permitted to file both the I-140 and the I-485 at the same time—a process known as concurrent filing—provided, of course, that a visa number is available.

It is illuminating to track the availability of employment-based visas. For example, in January 2007, EB-1 visas were current, EB-2 visas were current for everyone except nationals of China and India (whose cutoff dates were, respectively, April 22, 2005 and January 8, 2003), and EB-3 had cutoff dates in place worldwide. In July, EB-2 and EB-3 (excepting the "other workers" subcategory, which was unavailable) were made current worldwide. As explained by the State

¹⁰ The fourth and fifth employment categories are not of interest here; the fourth is largely for ministers and other religious workers, and the fifth for investors. Moreover, note that these categories are quite small. For example, in Fiscal Year 2006, of the 159,081 immigrants admitted with employment visas, only 10,288 visas, or 6.5 percent, went to these categories.

Department (2007a) in its *Visa Bulletin* for July, posted on June 12:

This has been done in an effort to generate increased demand by Citizenship and Immigration Services (CIS) for adjustment of status cases, and to maximize number use under the annual numerical limit. However, all readers should be alert to the possibility that not all Employment preferences will remain Current for the remainder of the fiscal year. Should the rate of demand for numbers be very heavy in the coming months, it could become necessary to retrogress some cut-off dates for September, most likely for China-mainland born and India, but also possibly for Mexico and Philippines. Severe cut-off date retrogressions are likely to occur early in FY [Fiscal Year] 2008.

But the “current” designation was short-lived. The State Department (2007b) issued an Update to the *Visa Bulletin* on July 2 stating that “sudden backlog reduction efforts by Citizenship and Immigration Services Offices during the past month have resulted in the use of almost 60,000 Employment numbers.” Thus, it was announced, all employment numbers had been used, the employment categories were no longer “current,” and prospective immigrants could not submit the I-485 until October 1, 2007, the start of the next fiscal year. However, the State Department (2007c) and USCIS announced on July 17, that the rules in the original *Visa Bulletin* for July were being re-instated and extended the filing period until August 17. The August *Visa Bulletin* also said that, after August 17, all employment-based categories would be unavailable until the start of the new fiscal year.

The population of interest thus consists of persons in the United States for whom the labor certification or I-140 is filed, even if the visa is not

currently available, plus persons filing to adjust their status. As mentioned above, the wait for the immigrant visa consists of two kinds of waiting times, the first pertaining to the wait for a numerically limited visa (i.e., a “visa number”) and the second pertaining to visa processing, which is associated with all three applications. It may happen that visa processing for the labor certification and the I-140 are completed before the visa number becomes available. For such cases, all the experience of visa processing delay pertains to the I-485. Alternatively, it may happen that a visa number is available, but that there is a delay for processing the labor certification and a subsequent delay in processing the I-140, which, in this case, can be filed concurrently with the I-485. We may call the first kind of waiting time the visa number time and the second kind the visa processing time.

Our objective, then, is to estimate the size of the population who (1) have a priority date, (2) are in line for a principal visa in EB-1, EB-2, or EB-3, and (3) are in the United States. In principle, it would appear easy to construct an electronic database with a record for each such person in the visa process, and to store all relevant information such as origin country, immigrant visa category, and priority date, as has been proposed by the *CIS Ombudsman* (2007, p. 35). Indeed, any number of IT firms involved in the petitioning for workers could do it. But in practice, there appear to be many obstacles. For example, in the ideal database, the units would be *persons*—prospective immigrants—but part of the immigrant visa system is based on *applications*, not on persons.¹¹

Additionally, while the labor certification and I-140 applications cover only principals, the I-485 covers both principals and family members. Further, the labor certification and I-140 cover applicants worldwide, while the I-485 covers only adjustment of status in the United States.

¹¹ For example, sometimes more than one application can be filed for the same person. In the labor certification process, although an employer can no longer file more than one application for the same beneficiary, it is still possible for two employers to file for the same beneficiary. It also is the case that more than one I-140 can be filed for the same beneficiary. And, finally, the same prospective immigrant may file more than one I-485. The most common case of multiple I-485s involves married couples in which each spouse is the principal on a separate application.

Notwithstanding these challenges, it is earnestly hoped that (1) the data systems improve so that the number of pending applications can be generated at the end of each fiscal year (if not the end of each quarter), separately by visa category, and separately for principals and family members, and (2) the agencies publish the numbers pending. It would then become possible to compare the true numbers with the estimates we present below.

Estimation Strategies

The basic premise for our estimation approach is a simple description of the population of interest, as follows: The population of employment principals who have a priority date and are waiting for LPR in the United States at any given time consists of six subsets:

1. Those with pending labor certifications.
2. Those whose labor certification has been approved but whose I-140 is not yet filed.
3. Those with a pending I-140 who have not filed the I-485 (in most cases, because a visa number is not available).
4. Those with a pending I-140 and a pending I-485.
5. Those with an approved I-140 who have not filed the I-485 (again, in most cases, because a visa number is not available).
6. Those with an approved I-140 and a pending I-485.

Obtaining direct figures for each subset is, in our view, an appropriate goal for the data systems architects in the Departments of Labor, State, and Homeland Security. For example, the State Department for many years provided counts of approved eligible prospective immigrants waiting for numerically limited visas. Such counts could be used to approximate the fifth subset. Unfortunately, however, the State Department discontinued publication of these figures after

1997 (it is not known whether the data continue to be compiled annually).

Note that, at each of the three steps (labor certification, I-140, I-485), some applications are denied. Thus, a fraction of the first subset disappears, as does a fraction of the third and fourth subsets. Similarly, not all of the sixth subset will proceed to LPR, as some will have their I-485 applications denied. Moreover, a prospective immigrant also may leave the employment-based pre-LPR queue if, for example, marriage to a U.S. citizen provides a faster route to LPR.

To develop an estimation strategy, we list in Table 5 the six subsets and examine four potential sources of information. The first piece of information is the number of pending labor certifications. Obviously, this exactly corresponds to the first subset, as indicated by the checkmark. The second indicates the number of pending I-140 applications. This corresponds to the combined third and fourth subsets of the population. The third, the number of pending I-485 applications, corresponds to the combined fourth and sixth subsets. Finally, the number of approved I-140s corresponds to the combined fifth and sixth subsets.¹²

The three rightmost columns of Table 5 present alternative estimation strategies. We make the simplifying assumption that there are no multiple filings and, therefore, an individual can be found in only one of the six subsets. In the table, one checkmark denotes that the subset is represented, and two checkmarks indicate double-counting of the subset.

We now examine three possible estimation strategies. First, however, we note that there does not seem to be any information on the second subset—those whose labor certification has been approved but whose I-140 is not yet filed. This subset is likely to be small, as most visa applicants (or their petitioners) are thought to file the I-140 as soon as the labor certification is obtained.

¹² Note that the labor certification application and the I-140 pertain to principals, while the I-485 pertains to all prospective immigrants, including the spouses and children of the principals. Thus, figures on I-485 applications must be deflated before use in estimating the population of pre-LPR principals.

Table 5
Six Subsets of the Pre-LPR Population, Four Information Sources,
and Three Estimation Strategies

Subsets of Pre-LPR Population	Sources of Information				Estimation Strategies		
	(1) Labor Cert Pending	(2) I-140 Pending	(3) I-485 Pending	(4) I-140 Approved	(1) + (3)	(1) + (2) + (3)	(1) + (2) + (4)
1. Labor certification pending	✓				✓	✓	✓
2. Labor certification approved; I-140 not yet filed							
3. I-140 pending; I-485 not yet filed		✓				✓	✓
4. I-140 pending; I-485 pending		✓	✓		✓	✓ ✓	✓
5. I-140 approved; I-485 not yet filed				✓			✓
6. I-140 approved; I-485 pending			✓	✓	✓	✓	✓

Notes: The second, third, and fourth sources of information each capture two subsets of the pre-LPR population but cannot distinguish between them. Information on pending labor certifications pertains to employment principals in EB-2 and EB-3. Information on pending and approved I-140s pertains to employment principals in EB-1, EB-2, and EB-3. Information on pending I-485s pertains to all prospective immigrants (both principals and family members) in both employment- and family-based visa categories. The I-140 and I-485 information is available for each year since 1992 from the USCIS Performance Analysis System (*Ombudsman* 2007:113-114). Information on the I-140 and I-485 pending applications is as of the end of the fiscal year; information on I-140 approvals pertains to approvals during the fiscal year. Thus, the fifth and sixth subsets cannot be approximated solely from the I-140 approval information but require building up the stock of persons with approved I-140s who either have not filed the I-485 or whose I-485 is pending.

Of course, the sources of information have to be adjusted appropriately so that they pertain to our population of interest. Specifically, the labor certification and I-140 figures have to be deflated for non-U.S.-resident applicants, and the I-485 figures have to be deflated for non-principals.

Estimation using the pending labor certifications and pending I-485s. Suppose we sum, on the same day, the pending labor certification applications and the pending I-485 applications, appropriately deflated for non-U.S.-residents and non-principals, respectively. This procedure misses the third and fifth subsets: non-concurrent filers, whose I-140 may be pending or approved, and who have not yet submitted the I-485. Thus, this procedure produces an underestimate of principals waiting for

adjudication of their employment-based visa applications.

Estimation using the pending labor certifications, pending I-140s, and pending I-485s. Suppose we sum, again on the same day, the pending labor certification applications, the pending I-140 applications, and the pending I-485 applications, all appropriately deflated, the first two for non-U.S. residents and the last for non-principals. As shown in Table 5, this procedure double-counts the fourth subset (concurrent filers whose I-140 and I-485 are both pending) and misses the fifth subset (those whose I-140 is approved but who have not filed the I-485).

Estimation using the pending labor certifications, pending I-140s, and approved I-140s. Here we sum, again on the same day and

appropriately deflated, the pending labor certification applications, the pending I-140 applications, and the number of persons with approved I-140s who have not yet filed I-485s or whose I-485s are pending. This procedure, as shown in Table 5, captures five of the six subsets and does not double-count any subset. It thus appears to be the procedure of choice.

All three estimates represent the set waiting for adjudication of their petitions and applications. Of course, as noted above, not all petitions or applications are approved. Denial rates vary across petition/application type and over time. For labor certification applications in the new, automated case-processing system (PERM), the denial rate in the period from March 28, 2005 to June 1, 2007 was 20 percent; during Fiscal Year 2006, the denial rate was 21.5 percent. For the I-140, the denial rate was 7 percent in Fiscal Year 1992, subsequently increased to 17 percent in Fiscal Year 1998 and to 28 percent in Fiscal Year 2002, and has declined since then, to 21 percent in Fiscal Year 2004 and Fiscal Year 2005, and to 16 percent in Fiscal Year 2006. Denial rates for the I-485 pertain to all adjustees, so that denial rates for employment-based applicants are not known. For the entire set of I-485s, the denial rate of 4 percent in Fiscal Year 1992 subsequently increased to 20 percent in Fiscal Year 2003, and has declined since then, to 16 percent in Fiscal Year 2005 and to 17 percent in Fiscal Year 2006. Thus, the number of employment principal LPR applicants in the United States who will, in fact, be admitted to LPR is smaller than the number awaiting adjudication. Put differently, the number of future LPRs is smaller than the number in the pre-LPR queue.¹³

Finally, note that other estimation strategies are possible. For example, if the State Department reinstated the annual count of approved applicants waiting for numerically limited visas and

if USCIS generated the pending totals for the I-485 separately by visa category, these two sets of figures could be used to estimate the fifth and sixth subsets (see Table 5). These estimates then could be compared with those obtained below.

Numerical Approximations

The preferred strategy for estimating the number of employment-based principals who have a priority date and are in the United States waiting for LPR (rightmost column of Table 5) has three components: (1) the number of pending labor certification applications; (2) the number of pending I-140 applications; and (3) the number of persons with approved I-140 applications whose I-485 is unfilled or pending. To implement this estimation strategy, we estimate the three components for the same time period and, because the three components pertain to both adjustees and new arrivals, we then remove the new arrivals.¹⁴ Finally, we also estimate the total number in the employment-based pre-LPR population, including family members.

As will be seen below, estimation of the number of persons with approved I-140 applications who are in the population requires information on the number who actually are admitted to LPR each year. This information is published annually by the INS/CIS. Information on both pending and approved I-140s is available from the USCIS Performance Analysis System (PAS) and published in the *CIS Ombudsman's* (2007, pp.113-114) report. As of this writing, the PAS data and the LPR data are available through Fiscal Year 2006.

Accordingly, we estimate the employment-based pre-LPR population as of the end of Fiscal Year 2006. We had hoped to locate a parallel time series for the pending labor certifications, but, as will be seen, even estimating the number as of the end of Fiscal Year 2006 is a challenge.

¹³ Denial rates for the I-140 and the I-485 are from the CIS PAS system, as reported in *CIS Ombudsman* (2007:113-114). Denial rates for the labor certification are drawn from DOL (2007) and calculated from the data set of completed PERM applications for Fiscal Year 2006 (microdata available for download on the Web).

¹⁴ Note, however, that some new arrivals are persons who are living in the United States and choose consular processing over CIS processing (a choice made on the I-140 form but not a permanently binding choice).

Components of the Estimates

Labor certification pending applications. The number of pending labor certification applications has two components: The first pertains to pending applications in the pre-automated backlog and the second pertains to pending applications in the automated PERM system.

To estimate the first component, we use two pieces of information. First, the Department of Labor's PART assessments, which accompanied the Fiscal Year 2006 budget published in February 2005, mention a backlog of 315,000 cases and the goal to eliminate the backlog in two years, or by the end of Fiscal Year 2007. Second, DOL's annual report for Fiscal Year 2006 states in the "Performance and Accountability Report" that "Backlog Elimination Centers eliminated over 50 percent of the permanent program backlog three weeks ahead of the September 30, 2006, goal."

Accordingly, we estimate the number pending in the pre-PERM backlog at the end of Fiscal Year 2006 at half of 315,000, or 157,500.

To estimate the second component, we examine DOL production statistics. The automated PERM system started on March 28, 2005. We use two pieces of information. First, the total number of applications filed at three points in time were: 80,272 as of March 17, 2006; 182,411 as of March 2, 2007; and 204,280 as of June 1, 2007. Second, the number pending was 10,561 on March 2, 2007 and 16,799 on June 1, 2007.

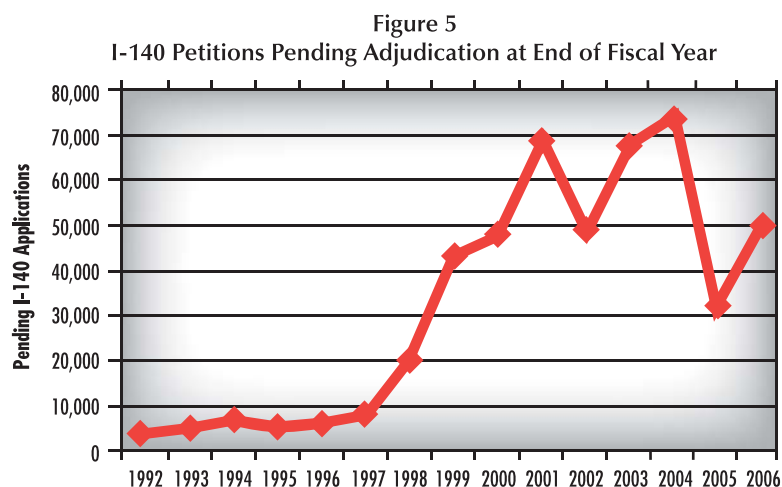
If the number pending at the end of Fiscal Year 2006 resembles the number pending five to eight months later, it would be in the 10,000-17,000 range. On the other hand, if the number pending at the end of Fiscal Year 2006 met but did not exceed the target of a six-month processing cycle for 90 percent of receipts, then it would be in the 45,000-52,000 range.

Given the uncertainty and the recurring idea that the number of pending cases is decreasing, we fix the number pending at the end of Fiscal Year 2006 at 42,500.

Accordingly, we put the number of labor certification applications pending at the end of Fiscal Year 2006 at around 200,000.

I-140 pending applications. USCIS's PAS provides a time series of the number of pending I-140 applications at the end of each fiscal year since 1992 (when the provisions of the Immigration Act of 1990 took effect). This time series, along with other PAS figures, is published in *CIS Ombudsman* (2007, pp. 113-114). Figure 5 depicts the pending I-140 applications for the years 1992 to 2006. As shown, the number pending at the end of the fiscal year began its steep climb after 1997 and, since 2002, reflects the two countervailing forces of aggressive backlog reduction and increased demand.

The number of pending I-140 applications at the end of Fiscal Year 2006, as shown in Figure 5, is 50,132. This number represents the



combined third and fourth subsets of the pre-LPR population, as shown in Table 5.

At the end of a fiscal year, the number of persons with approved I-140 applications who either have not yet filed the I-485 (presumably because a visa number is not available) or whose I-485 is pending is equal to the number at the start of the year plus the number of new I-140 approvals during the year, minus the number who became LPR or left the LPR queue (because they died, became discouraged by the wait, or achieved LPR by another route).

As noted above, new I-140 approvals are reported by the PAS system, and new LPRs are reported annually by CIS. The PAS figures cover all I-140s, and thus to match exactly to the LPR figures, we include in the LPR figures all visa categories that require an I-140. The number of deaths is likely to be small, as this is a healthy, prime-age population. There is no information on the number who get discouraged waiting for a visa number and leave the queue—though there is plenty of anecdotal information to that effect—nor is there information on the number who switch pathways to LPR—though again the anecdotal evidence is that courtship and marriage sometimes outpace visa number availability.

Additionally, the number of principals with approved I-140 applications at the start of the first year—1992—has to be estimated.

Accordingly, our procedure for estimating the number of principals with approved I-140 applications, and either unfilled or pending I-485s, has three steps. First, we calculate for each year in the period 1992-2006 the number of new approved I-140 petitions minus the number of new LPR principals in EB-1, EB-2, and EB-3 for whom the I-140 is required. Second, we estimate the number at the start of the period. Third, we generate a running sum of the number of new approved I-140s minus new LPRs, taking into

account the estimate for the start of the period. Fourth, we examine the time series with an eye to adjusting it for the unmeasured departures from the LPR queue.

To implement the second step, we rely on the annual visa waiting lists published by the State Department until 1997. In the context of employment-based visas, the waiting lists cover all principals worldwide with approved I-140 petitions who have not filed the I-485 because a visa number is not available, plus their spouses and children, as of the first of each calendar year (i.e., the fifth subset in Table 5). Accordingly, we use the visa waiting list figures for January 1992—three months after the start of Fiscal Year 1992. The visa queues were: EB-1, 535; EB-2, 32,452; EB-3 skilled, 50,003; and EB-3, “other workers,” 87,806. To deflate these figures for non-principals, we calculate for each category/subcategory the ratio of family members to principals among new LPRs in Fiscal Year 1992: EB-1, 1.69; EB-2, 1.12; EB-3 skilled, 1.35; and EB-3 “other workers,” 1.40. This procedure yields an estimate of 73,394 principals with approved I-140s who had not filed for the I-485 in January 1992. The number of principals with approved I-140s and pending I-485s at the start of Fiscal Year 1992 is left unmeasured; it is likely to have been small, as immigration and consular officers expanded their efforts to clear applications under the pre-1992 immigration law (U.S. Department of State, 1992).

At the third step, we calculate the running sum of approved I-140s minus LPRs plus the initial number at the start of the period (73,394). Figure 6 depicts the time series of the number of persons with approved I-140 applications who have not filed the I-485 or whose I-485 is pending. As shown, except for a dip in 2005, the number has increased steadily since 1992. At the end of Fiscal Year 2006, the number of employment principals with approved I-140 applications and unfilled or pending I-485s is estimated at 327,556.¹⁵

¹⁵ If we omit the number at the start of the period, the running sum at the end of Fiscal Year 2006 is equal to the sum of all approved I-140s over the fifteen-year period, minus the sum of all the employment principal LPRs during the period (254,162). Of course, this number plus 73,394 equals the adjusted estimate of 327,556.

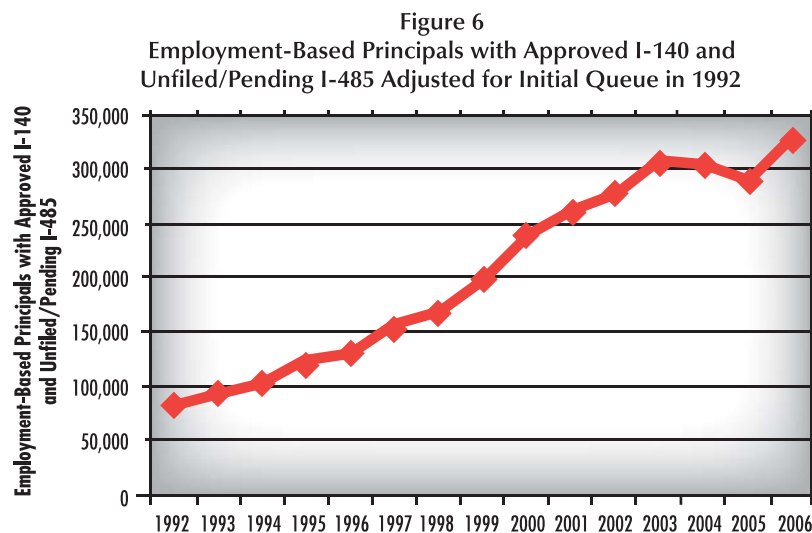
At the fourth step, we examine the time series depicted in Figure 6 and consider whether it should be adjusted downward to reflect the unmeasured departures from the LPR queue. As discussed above, departures would be in the form of deaths (likely to be negligible), persons discouraged by the long wait, and immigrants switching visa category. The visa waiting lists compiled annually by the State Department in the period 1992-1997 (none was compiled for 1996) indicate that the number of “other workers” and their families with approved I-140s and waiting for numerically limited visas was 87,806 in 1992, climbed to 95,362 in 1993, and subsequently decreased steeply, to 78,946 in 1995, and to 21,834 in 1997. These were years when the ceiling for this category was 10,000 and the average number of LPRs was 9,454. As noted in the visa waiting list (State Department 1997), “The Other Worker applicant total has dropped considerably over the past year, perhaps because the long (currently about seven-year) wait for a visa has helped to discourage new cases and has given persons previously registered time to reconsider their employment and immigration plans.” Moreover, the number of LPRs in the “other workers” subcategory of EB-3 declined further after 1997, reaching 5,001 in 1999 and never again going above 5,000—due to the new

provision of immigration law by which a portion of legalizations under the Nicaraguan Adjustment and Central American Relief Act of 1997 (NACARA) would be offset by taking numbers from this subcategory.

Thus, a nontrivial number of prospective immigrants in the EB-3 “other workers” subcategory disappeared from the employment-based LPR queue. Where did they go? Jasso, Rosenzweig, and Smith (2000) show how immigrants switch categories when it proves advantageous. In this case, some applicants may have immigrated via NACARA or by marrying a United States citizen.

Hence, our estimate of the employment pre-LPR queue needs to be adjusted downward. If the ceiling of 10,000 was reached each year, the unexplained decrease between 1994 and 1997 was 42,514, reflecting approximately 17,733 principals. Accordingly, we adjust our initial estimate of 327,556 downward to 309,823.

Our estimate is that there were 309,823 employment principals with approved I-140 applications and unfiled or pending I-485s at the end of Fiscal Year 2006. This number represents the combined fifth and sixth subsets of the pre-LPR population, as shown in Table 5.¹⁶ Figure 7 shows the adjusted time series.



¹⁶ If the unexplained decrease is based on actual LPRs rather than the ceiling of 10,000, the unexplained decrease totals 18,098 principals, which differs only trivially from the 17,733 calculated above.

Numerical Approximation of the Employment-Based Pre-LPR Population

In the preceding section, we presented estimates of each of three components used in the preferred estimation strategy described earlier (shown in the rightmost column of Table 5). We now sum the three components to obtain the worldwide estimate for the end of Fiscal Year 2006: 200,000 with pending labor certifications (the first subset) plus 50,132 with pending I-140 applications (the third and fourth subsets), plus 309,823 with approved I-140 applications and unfiled or pending I-485 applications (the fifth and sixth subsets) equals 559,955. Next we deflate this figure for new arrivals. In 2005, the proportion adjustee was approximately 89.3. **Applying this figure, we obtain an estimate of the number of employment-based principals waiting for LPR in the United States of approximately 500,040.**

As discussed above, we do not have a time series of pending labor certifications. Accordingly, we show in Figure 8 the combined pending and approved I-140 subsets of the pre-LPR population.

To estimate the total number of employment-based prospective immigrants waiting for LPR in the United States, we inflate for family members. In Fiscal Year 2005 the ratio of non-principals to principals among employment-based adjustees was 1.11. **Using this ratio, we obtain an estimate of the entire employment-based LPR queue in the United States of 1,055,084.**

The corresponding estimate for the worldwide total is 1,181,505.

Figure 7
Employment-Based Principals with Approved I-140 and Unfiled/Pending I-485 Adjusted for Initial Queue in 1992 and Departures from the Queue in 1994, 1995, and 1996

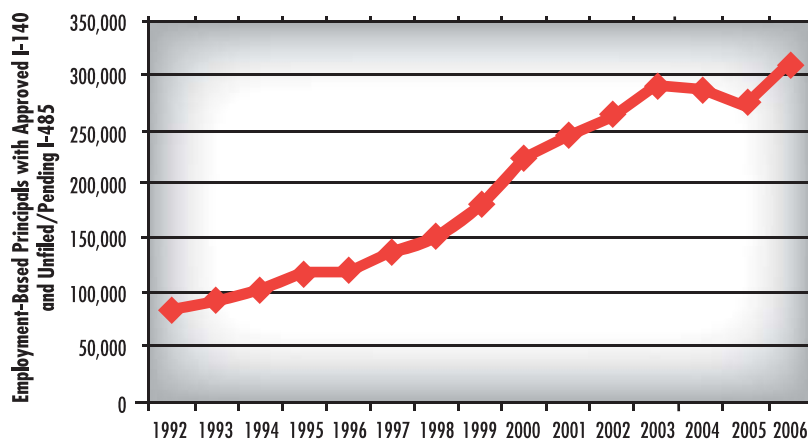


Figure 8
Employment-Based Principals with Pending or Approved I-140. (Approved I-140 Series Adjusted as in Figure 7)

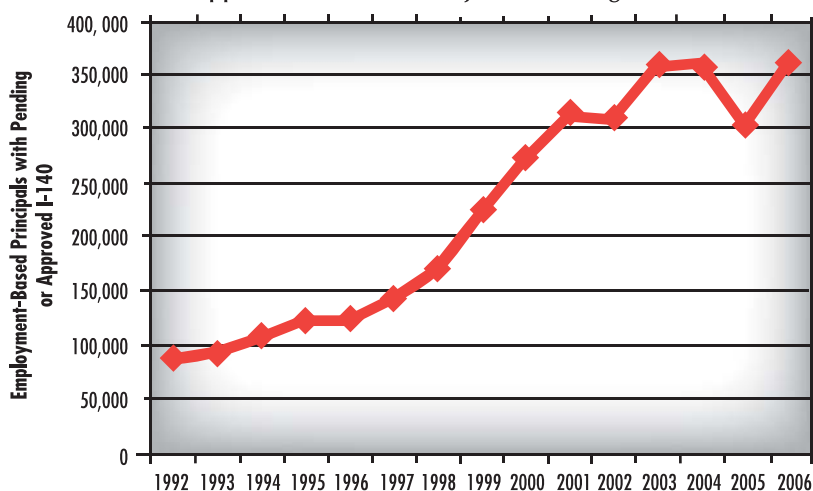


Table 6 summarizes our estimates for the employment-based pre-LPR population, as of the end of Fiscal Year 2006. The table provides a handy way to see at a glance the number of employment-based persons in the pre-LPR queue, with or without family members and whether living in the United States or abroad.

Reviewing the principal features of these estimates, there are several things to note. First, the estimates assume that there is no double filing of applications. Second, they leave unmeasured the subset with an approved labor certification application who have not yet filed the I-140 and the number who die while in the queue, which may offset each other. Third, the estimates also leave unmeasured the fraction who may have left the queue after 1997, either because they were discouraged or because they switched pathways to LPR. Fourth, the estimates of the U.S.-resident pre-LPR queue are based on adjustees, but in fact some new arrivals actually are living in the United States and choose consular processing for their immigration case. Fifth, at each of the three steps in the employment-based LPR process, there are denials, so that the number of future LPRs is less than the number in the pre-LPR queue.

Finally, we note that these estimates can be updated as soon as information becomes available for Fiscal Year 2007. And we note again that

alternative procedures for estimating one or more of the subsets of the pre-LPR population may become available.

Discussion

Visa Number Wait and Visa Processing Wait

Our estimates indicate that it is a safe bet that on October 1, 2006 there were about half a million prospective immigrants in the United States waiting to adjust to LPR as employment-based principals and that the total including family members was more than a million. Even if these estimates turn out to overstate the employment-based pre-LPR population in the United States, they probably do not overstate the employment-based pre-LPR population worldwide. Thus, there were more than a million persons in line for approximately 120,120 visas a year—implying that we already had mortgaged almost nine years' worth of employment visas. If all visa processing backlogs were eliminated, approximately 120,120 persons would receive EB-1, EB-2, and EB-3 visas within a year. The others would experience visa number wait. Those who had filed the I-485 before the processing backlogs were eliminated would be in a kind of semi-halcyon time. They would now have a long wait to LPR, but they would retain their employment authorization and travel benefits, based on pending adjustment of status. Those who had not filed the I-485 would have to continue to rely on a succession of temporary work visas.

At this very moment, we are seeing this situation develop. As of August 17, 2007, all available employment visas for Fiscal Year 2007 have been given out. No one may file a new I-485. Thus, there are prospective immigrants waiting for adjudication of I-485s as well as prospective immigrants with priority dates who are stranded at the I-140 stage because not enough employment-based visas are available. And none of these can make the transition to LPR, no matter how efficient the Department of Labor and USCIS were to become at visa processing. Put differently, relief would come, not from more

Table 6
Estimated Employment-Based Pre-LPR Population
at the End of Fiscal Year 2006

	Resident In the U.S.	Resident Abroad	Worldwide
Principals	500,040	59,915	559,955
Family Members	555,044	66,506	621,550
Total	1,055,084	126,421	1,181,505

Notes: As described in the text, summing the estimates of the pending labor certifications, the pending I-140 applications, and the approved I-140 applications with unfilled or pending I-485s yields the worldwide estimate of principals: 559,955. Using the Fiscal Year 2005 proportion adjustee (89.3 percent) yields the estimates of principals resident in the United States and resident abroad. Using the Fiscal Year 2005 ratio of non-principals to principals among employment-based adjustees (1.11) yields the estimates of family members and, hence, the total estimates.

backlog elimination and timely processing at DOL and USCIS, but rather from larger allotments of employment visas—something only Congress can provide.

Relevant Population for Patent Activity

For patent activity, the relevant population is larger than the United States population of adjustee principals in the LPR queue. The relevant population would include graduate students and temporary workers, especially H-1B workers. In this section we approximate the size of this population. Note that some fraction of this population is in the LPR queue (i.e., already have priority dates and are included in the estimates above). Therefore, the total here cannot be added to the totals above.

Graduate students and postdoctoral scholars. Here we focus on three fields—science, engineering, and health—and on students and postdoctoral scholars with temporary visas. Estimates from the fall 2005 NSF-NIH “Survey of Graduate Students and Postdoctorates in Science and Engineering” (NSF 2007) indicate that, as of fall 2005, the numbers of graduate students with temporary visas were 85,397 in science fields, 53,835 in engineering fields, and 7,464 in health fields, for a total of 139,232 in science and engineering, and a grand total, including health fields, of 146,696 (NSF 2007, Table 5). Postdoctoral appointees with temporary visas in fall 2005 included 17,641 in science, 2,742 in engineering, and 6,566 in health, for a total of 20,383 in science and engineering, and a grand total, including health fields, of 26,949 (NSF 2007, Table 50).

Of course, total graduate enrollment of international students in all fields is substantially higher. Estimates from the International Institute of Education (IIE 2006) indicate that, in the 2005-2006 academic year, there were 259,717 international graduate students. In addition, there were 38,096 in practical training, at least some of whom are likely to be postdoctoral scholars.

Temporary workers. The population of foreign-born temporary workers includes two main types of persons: (1) those holding explicit temporary work visas (such as one of the H or L principal visas); and (2) those with other types of temporary visas who are permitted to work if they apply for an Employment Authorization Document (EAD) and are approved (the form is I-765). This second set includes parolees and family members of various temporary visitors, such as treaty traders, J exchange visitors, and L intra-company transferees. Nonimmigrants who are not permitted to work (i.e., cannot file an I-765) include spouses of H workers and of F students.

Estimates of both subsets of temporary workers are difficult to obtain. Again, it appears that the requisite data systems are not in place at USCIS. Accordingly, we report the best available estimates.¹⁷ ***Passel, Van Hook, and Bean (2004) and Lowell (2000) estimated the H-1B population in 2000 at 122,000 and 425,000, respectively. Passel, Van Hook, and Bean (2004) estimated the number of L workers in 2000 at 164,300. Grieco (2006) estimated that on a typical day in 2004 the population of H and L workers (all Hs except H4 spouses, plus L1) stood at 704,000.***

To estimate the second subset above, we turn to EAD issuances. The number of EADs issued for the year ending in May 2003 was 1.723 million; the overwhelming majority were approvals for one year, so that the number issued may be a plausible gauge of the number of persons who have temporary visas that are not explicitly for work (or, in some cases, do not have temporary visas at all, but “entered without inspection”) and who are in the labor force. Of this number, 617,863 (or about 36 percent) went to persons with pending applications for adjustment of status, and a small additional number went to persons with other pending applications that would lead to LPR (e.g., pending LIFE legalization application, 25,102, and pending legalization application, 4,651).

¹⁷ Of course, there may be a non-trivial number of former H-1B workers in the United States—some of them in the pre-LPR queue—so that the number of H-1Bs may appear to be higher than the number of current H-1Bs.

Table 7
Immigrant Visa Categories of Former F1 Students and H-1B Temporary Workers:
Immigrant Cohort of 2003

Immigrant Visa Category	Adjusting from H-1B	Adjusting from F1	Ever F1
EB-1 principal	4.62	.17	1.92
EB-2 principal	28.00	.32	7.46
EB-3 principal	36.80	2.74	8.17
Spouse of U.S. citizen	19.20	78.90	59.10
Other	11.40	17.80	23.30
Percent of Cohort	2.77	1.63	5.58

Notes: Columns sum to 100 percent. The “Ever F1” column includes both adjustees and new arrivals, and thus includes those shown in the “Adjusting from F1” column. The “Ever F1” set also includes respondents who provided only a generic response, such as “international student,” which could not be disaggregated into academic and vocational students.

Finally, we caution again that the estimates in this section cannot be added to the estimates of the LPR queue, as they do not pertain to the same time period, and even if they did, there might be substantial overlap (including, for example, persons in the LPR queue who have EADs).

Becoming a Legal Permanent Resident

An important feature of immigration to the United States is that many skilled immigrants acquire legal permanent residence with visas other than employment visas. Table 7 reports the major immigrant visa categories for three subsets of the adult immigrants in the “New Immigrant Survey”: those adjusting from an H-1B visa, those adjusting from an F1 visa, and those who report ever having an F1 or student visa.¹⁸

As shown, the employment visa categories are the dominant pathway to LPR for the subset adjusting from H-1B visas, a total of more than 69 percent. However, the dominant pathway to LPR for those adjusting from F1 or who were ever F1 is the spouse-of-U.S.-citizen visa, with 79 percent of the F1 adjustees and 59 percent of those who were ever F1s using this visa. These figures suggest that international students are attractive marriage prospects and thus have other avenues,

besides employment visas, for remaining in the United States.¹⁹

It also is interesting to examine the nonimmigrant origins of the employment principals, approximately 70 percent of whom are adjustees. Table 8 reports the major nonimmigrant visa categories for the adjustee employment principals (excluding the “other worker” subcategory) and, for contrast, the adjustee spouses of U.S. citizens (who are 76 percent of all spouses of U.S. citizens). It is no surprise that the largest nonimmigrant category for EB-1 consists of L1 intra-company transferees (49 percent), followed by H-1B (28 percent) or that the largest nonimmigrant visa category for EB-2 and EB-3 is H-1B (89 percent and 50 percent, respectively). What is, however, of some interest is the other nonimmigrant origins of the EB-3 set. Almost 6 percent of this group entered without inspection—that is, they had no visas and crossed the border between ports of entry—not too dissimilar from the 7.4 percent among spouses of U.S. citizens. Moreover, the EB-3 subset includes almost 11 percent adjusting from a tourist visa, which raises the question whether they had overstayed that visa or worked without

¹⁸ The “New Immigrant Survey” oversampled employment-based principals and undersampled spouses of U.S. citizens. Thus, the figures in Tables 7 and 8 are based on a larger number of cases than would appear based on the proportions in the cohort.

¹⁹ All the EB-3 principals in Table 7 are in the skilled subcategory. That is, among the new immigrants adjusting from F1 or H-1B or who were ever international students, none are admitted to LPR with an EB-3 “other workers” visa.

authorization (among spouses of U.S. citizens the comparable figure is 25 percent). Finally, there are the proportions in the two questionable nonimmigrant visa categories, “visa unknown” and “visa missing”; though the requisite research has not been carried out, it sometimes is thought that the “visa unknown” code is a euphemism for a nonexistent visa, that is, for EWI; and “visa missing” may point in the same direction. Note, for example, that the EB-1 and EB-2 immigrants, who have negligible EWI backgrounds (zero in the case of EB-1), have small “visa missing” contingents, both hovering about 5 percent. In contrast, the EB-3 immigrants, who have a nontrivial EWI contingent, also have almost 17 percent in the “visa missing” category, not too far behind spouses of U.S. citizens, 24 percent of whom are in the “visa missing” category.

Some commentators suggest that the immigration system is so arduous and uncertain, even for skilled immigrants, that they run the risk of lapsing into illegality. These data hint at that possibility. And the information on having become depressed because of the visa process is not inconsistent with that supposition: The

proportions of adjustee principals who became depressed line up with the employment-based categories—17.3 percent in EB-1, 21.7 percent in EB-2, and 24.4 percent in EB-3.

Finally, some commentators suggest that a portion of the demand for employment-based visas is generated by the ban on employment for spouses of H temporary workers. That is, employment-based principals adjusting from H worker visas may not intend to live permanently in the United States, but instead may desire to obtain work authorization for their spouses. If that is the case, then the three employment categories, which differ greatly in the proportions adjusting from H-1B (Table 8), also should differ in the intention to stay in the United States. Indeed, EB-2, which has the highest proportion adjusting from H-1B (89 percent), has the lowest proportion who intend to stay in the United States—48.8 percent. In EB-1 and EB-2, the proportions intending to stay are 60 percent and 73 percent, respectively. These figures contrast with 76 percent among adjustee spouses of U.S. citizens and 86 percent among all other adult adjustee immigrants.

Table 8
Immediately Previous Nonimmigrant Visas of Immigrants Adjusting as Employment
Principals or Spouses of U.S. Citizens: Immigrant Cohort of 2003

Nonimmigrant Visa	EB-1	EB-2	EB-3	All Emp Principals	Spouses of U.S. Citizens
B2 visitor	1.71	0.00	10.70	6.63	25.00
F1 student	0.53	0.53	2.00	1.41	4.98
H-1B worker	27.80	89.00	49.50	56.80	2.06
L1 transferee	48.90	0.29	0.59	7.30	0.48
O1 worker	6.99	0.00	0.31	1.17	0.09
EWI	0.00	0.42	5.91	3.64	7.41
Visa unknown	1.53	3.00	4.75	3.84	20.40
Visa missing	5.55	4.47	16.80	12.00	23.70
Other	6.99	2.29	9.44	7.21	15.90
Percent of Cohort	0.53	0.99	2.24	3.76	25.90

Notes: Columns sum to 100 percent. The EB-3 category excludes “other workers.” The “All Employment Principals” column includes only EB-1, EB-2, and EB-3 (less the “other workers”). The major nonimmigrant visa category represented in the “Other” set for spouses of U.S. citizens is the fiancée K visa. Percent in cohort is defined as the number of adjustee principals in the given visa category divided by the total number of respondents in the cohort (8,573).

Final Remarks on Immigration Backlog

Our main purpose has been to estimate the size of the U.S.-resident employment-based pre-LPR population. To that end, we developed a procedure based on estimation of six subsets of the population and approximated five of the six subsets. Our estimates are both a starting and an ending point. They are a starting point because new estimates can be obtained whenever new data become available—for example, at the end of Fiscal Year 2007—and because novel ways of estimating the subsets may emerge. They are an ending point because advances in the data systems of the Departments of Labor, State, and Homeland Security, together with transparent publication of statistics, may render estimation exercises unnecessary.

Our estimates indicate that, as of the end of Fiscal Year 2006, there were about half a million employment-based principals awaiting LPR in the United States, and more than half a million family members. These numbers suggest that what has been viewed as a visa processing problem is actually—and formidably—a visa number problem. The approximately 120,120 visas available annually are no match for a million persons in line.

Meanwhile, all who work to advance scientific understanding of migration and enlightened policymaking may want to collect items large and small for public discussion. For example, there is no substitute for good data systems that provide “we the people” with the information necessary to make intelligent decisions. It is a mystery why, in the recent immigration discussion, minds seemed to be formed without knowledge of even the number of persons with different types of applications pending. Similarly, it might be useful to consider letting some of the time spent waiting for a visa number or for visa processing count toward naturalization—such a precedent exists in refugee procedures, and it could be a way of saying to visa applicants that the long wait has

not been in vain. With respect to assessing the contributions of foreign-born immigrants, it might be useful for the great science and humanities foundations, as well as the Patent Office, to consider collecting data on nativity. Otherwise the contributions of naturalized immigrants cannot be ascertained.

Conclusion

In the global economy, America's greatest advantage is its ability to push the frontier of knowledge and its application. In contrast to current debates about trade, international capital flows, and illegal immigration, we have analyzed the role that highly educated immigrants to the United States have in creating knowledge and innovation. By combining evidence from several data sets, we illuminate this contribution, and then highlight the problems these immigrants face in attaining permanent status and the country's risk in losing some of them.

Specifically,

1. Using data from WIPO, we find that in 2006, foreign nationals residing in the United States were inventors or co-inventors of one in four U.S. PCT applications—a more than three-fold increase over their proportion in 1998.
2. Using data from U.S. immigration statistics, we estimate that more than half a million skilled immigrants are awaiting legal permanent employment status, and more than a million principals, including family members, are in this situation. The immigration backlog is not simply a visa processing problem—which government agencies are working to reduce—but a visa shortage problem: Only 120,000 or so visas are available annually for the million or so applicants.
3. Using data from the “New Immigrant Survey,” we estimate that, in 2003, approximately one in five new legal immigrants in the United States, and about one in three employment principals, either planned to leave the United States or were uncertain about remaining.

We would expect that at least some of those who considered leaving have actually returned to their homelands. Though we don't know how many of those who have contributed to patents are discouraged by the visa process, we see no reason to expect them to be markedly different than other foreign residents working in the United States. Some are undoubtedly discouraged by the visa backlog and are considering leaving the United States. They constitute the possible “reverse brain-drain” of our title.

The United States benefits from having foreign-born innovators create their ideas in the country. Their departures would, thus, be detrimental to U.S. economic well-being. And, when foreigners come to the United States, collaborate with Americans in developing and patenting new ideas, and employ those ideas in business in ways they could not readily do in their home countries, the world benefits. Therefore, foreign national departures from the United States also reduce global well-being.

Given that the U.S. comparative advantage in the global economy is in creating knowledge and applying it to business, it behooves the country to consider how we might adjust policies to reduce the immigration backlog, encourage innovative foreign minds to remain in the country, and entice new innovators to come.

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Vivek Wadhwa is a Wertheim fellow with the Labor and Worklife Program at Harvard Law School and executive-in-residence/adjunct professor for the Pratt School of Engineering at Duke University. He is also an entrepreneur who has founded two successful technology companies, an active mentor and advisor to various startups, and a columnist for *BusinessWeek.com*. Wadhwa was named a "Leader of Tomorrow" by *Forbes.com*, and his company, Relativity Technologies, was named as one of the 25 "coolest" companies in the world by *Fortune* magazine. Mr. Wadhwa holds a bachelor's in computing studies from Canberra University in Australia and a master's from New York University.

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Ben Rissing is a Wertheim fellow with the Labor and Worklife Program at the Harvard Law School. He was previously a research scholar at the Pratt School of Engineering at Duke University. He has a bachelor's in mechanical engineering from the University of Virginia and a master's in engineering management from Duke. He has been involved in initiatives ranging from engineering design/technology commercialization to cardiovascular laboratory research and public-policy development in Washington, D.C. Rissing has traveled extensively, enjoys multiculturalism, and is a nationally ranked competitive fencer.

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Richard Freeman holds the Herbert Ascherman Chair in Economics at Harvard University, and serves as faculty director of the Labor and Worklife Program at the Harvard Law School. He also is director of the labor studies program at the National Bureau of Economic Research, senior research fellow in Labour Markets at the London School of Economics' Centre for Economic Performance, and visiting professor at the London School of Economics. Professor Freeman has published more than 300 articles dealing with a wide range of research interests, and has written or edited more than 35 books, including: *America Works: The Exceptional Labor Market* (2007), *What Workers Want?* (2006, 1999), *Seeking a Premiere League Economy* (2004), and *Emerging Labor Market Institutions for the 21st Century* (2004).

Appendices

Methodology

U.S. WIPO Patent Filings

Every year in the United States, tens of thousands of patent applications are filed. In this study, we focus on Patent Cooperation Treaty (PCT) applications submitted to the World Intellectual Property Organization's (WIPO) U.S. receiving office. PCT applications are unique for several reasons. These applications represent the first step toward securing international protection for intellectual property, a time-intensive and costly process. As such, the invention described in a PCT application generally has market potential in multiple countries, global visibility, and/or diverse applications.

PCT applications record a great deal of information on inventors and their inventions. Our analysis utilizes the following information disclosed at the time of filing:

- Inventor name
- Inventor nationality
- Inventor residency
- Inventor address
- Owner name
- Owner address
- International Patent Classification (IPC) Code

This information has enabled our team to conduct a nuanced analysis on the roles of U.S. citizens and foreign nationals who generate intellectual property in the United States.

Data Acquisition and Analysis

With the assistance of Neopatents, a Raleigh, North Carolina-based patent research and analytics firm, we obtained full records of all 1998 and 2006 PCT applications published by WIPO's U.S. receiving office. We chose to limit our analysis to 1998 and 2006. WIPO records in

electronic form are available from 1998 onward; at the time of this paper's publication, 2006 was the most recent full year of data.

Our search of the PCT application database was conducted using Neopatents Spore® Search software. The specific search strings our team employed to collect this data can be found in Appendix C, available as a separate document.

After downloading full PCT records for 1998 and 2006, our team conducted a manual name-heritage analysis of all WIPO patent applications for these years. During research for our January 2007 paper, "America's New Immigrant Entrepreneurs," we observed that foreign nationals from China and India filed more PCT applications in the United States than any other foreign-national group. That analysis did not, however, identify the IP contributions of Indian and Chinese immigrants who had immigrated to the United States and obtained U.S. citizenship. To identify this information, two small teams of native Indian and Chinese graduate students were assembled to scan inventor name fields and flag names with Indian and Chinese ancestry.

After collecting raw PCT data from NeoPatents and flagging inventors with Indian- and Chinese-heritage names, we delivered this data to Chmura Economics and Analytics, an economic research and quantitative solutions firm. Chmura produced cross-references between patents' state of ownership, inventor citizenship, inventor nationality, and IPC code.

During this analysis, only patent records with owners in the United States were counted. This resulted in the omission of 1,094 PCT applications filed through the U.S. receiving office in 1998 and 2,583 applications filed in 2006. These omissions constituted ~5 percent of the total filings in each year. We determined if a patent owner was based

in the United States based on the owner address field. If no owner address was present, the first-inventor address was employed instead. The zip code listed in the address field was used to map a patent record to a county and state. We used the two-letter state abbreviation from the address line in some instances where the zip code was missing.

We linked patents to the broader field of technology and inventions based upon IPC codes. It is important to note that each patent record can list multiple IPC codes. As a result, our patent IPC code analysis is non-cumulative and instead tracks patent classification activity across the range of IPC filings.

WIPO requires inventors to record nationality and residency information at the time of filing a PCT application. However, a portion of PCT application records are missing this inventor information. In the 1998 dataset, 41,722 out of the 60,997 inventor records (68.4 percent) do not have nationality or residency information. In the 2006 dataset, 16,132 of the 129,655 inventor records (12.4 percent) do not include this data. These records were omitted from our foreign national/U.S. citizen queries. The large portion of 1998 PCT records missing nationality information in the WIPO database are likely due to an old legal practice in which U.S.-based patent applicants did not designate the United States in applications because of a lack of perceived need (a separate USPTO application would be filed concurrently).

State Breakdown of PCT Applications with U.S.-Citizen and Foreign-National Inventors

State	State Name	Total 1998	Total 2006	Foreign- National Inventor 1998	US Citizen Inventor 1998	Foreign- National Inventor 2006	U.S. Citizen Inventor 2006
CA	California	4,716	9,196	473	1,627	3,293	7,540
MA	Massachusetts	1,643	2,603	139	459	839	2,289
NJ	New Jersey	1,246	2,116	139	371	784	1,831
NY	New York	1,067	2,551	88	412	693	2,183
TX	Texas	1,454	2,329	114	415	573	1,897
IL	Illinois	914	1,735	62	222	465	1,508
PA	Pennsylvania	1,130	1,915	104	366	446	1,586
MI	Michigan	821	1,337	52	269	297	1,055
FL	Florida	639	1,338	38	212	279	1,116
CT	Connecticut	482	976	33	150	242	819
MN	Minnesota	1,003	1,877	35	152	242	1,264
NC	North Carolina	566	1,047	38	171	235	954
OH	Ohio	1,112	1,436	51	335	234	1,251
MD	Maryland	552	795	108	280	212	686
OR	Oregon	213	770	7	65	211	672
WA	Washington	484	1,088	21	153	162	749
GA	Georgia	519	805	18	146	149	656
AZ	Arizona	357	675	10	80	147	582
IN	Indiana	461	643	48	278	139	566
VA	Virginia	318	655	20	108	115	568
WI	Wisconsin	434	742	12	63	109	690
CO	Colorado	510	747	24	165	102	619
DE	Delaware	218	349	18	65	93	305
MO	Missouri	287	400	21	115	72	360
NH	New Hampshire	209	354	12	57	72	295
IA	Iowa	120	201	9	42	53	179
SC	South Carolina	137	260	2	52	44	234
UT	Utah	207	404	8	55	42	367
TN	Tennessee	276	526	15	72	40	385
ID	Idaho	108	153	2	30	37	95
OK	Oklahoma	100	152	6	37	37	127
KS	Kansas	104	163	2	24	33	142
NM	New Mexico	111	152	5	42	32	116
AL	Alabama	98	159	6	36	30	142
KY	Kentucky	80	162	4	32	24	103
NE	Nebraska	51	110	8	19	24	97
LA	Louisiana	174	168	4	78	20	154
RI	Rhode Island	73	124	5	12	18	108
VT	Vermont	36	97	3	15	17	92
ME	Maine	39	82	1	13	16	70
NV	Nevada	70	221	11	35	15	188
ND	North Dakota	4	35	0	0	11	34
WV	West Virginia	42	87	1	9	11	81
DC	District of Columbia	19	45	2	10	10	42
MS	Mississippi	24	70	3	13	10	48
AR	Arkansas	30	49	1	12	9	37
HI	Hawaii	18	34	2	11	8	30
MT	Montana	30	45	1	12	5	40
WY	Wyoming	15	22	0	9	5	20
PR	Puerto Rico	5	2	0	4	1	2
AK	Alaska	5	8	0	4	0	6
SD	South Dakota	11	5	0	5	0	5
VI	Virgin Islands	1	4	0	1	0	3
Total-U.S.		23,343	42,019	1,786	7,420	10,757	34,988
Percentage of Total				7.65%	31.79%	25.60%	83.27%

State Breakdown of PCT Applications with Inventors of Indian- and Chinese-Name Heritage

State	State Name	Total 1998	Total 2006	Chinese 1998	Chinese 1998	Indian 2006	Indian 2006
CA	California	4,716	9,196	673	2,183	592	1,625
NJ	New Jersey	1,246	2,116	214	634	205	448
NY	New York	1,067	2,551	137	501	96	358
MA	Massachusetts	1,643	2,603	219	429	144	363
TX	Texas	1,454	2,329	167	358	137	381
PA	Pennsylvania	1,130	1,915	103	297	87	218
IL	Illinois	914	1,735	121	280	106	267
MI	Michigan	821	1,337	53	201	74	189
MN	Minnesota	1,003	1,877	86	194	73	194
CT	Connecticut	482	976	56	191	27	103
OH	Ohio	1,112	1,436	68	167	107	138
WA	Washington	484	1,088	48	150	43	138
FL	Florida	639	1,338	56	149	32	126
MD	Maryland	552	795	115	145	53	102
OR	Oregon	213	770	10	114	25	145
GA	Georgia	519	805	52	108	49	73
NC	North Carolina	566	1,047	48	107	62	142
DE	Delaware	218	349	39	102	32	59
IN	Indiana	461	643	48	84	32	74
AZ	Arizona	357	675	24	72	25	71
VA	Virginia	318	655	29	65	28	76
WI	Wisconsin	434	742	36	61	23	73
MO	Missouri	287	400	26	47	23	54
CO	Colorado	510	747	25	43	30	55
IA	Iowa	120	201	12	39	10	12
NH	New Hampshire	209	354	12	39	10	31
SC	South Carolina	137	260	7	34	10	19
TN	Tennessee	276	526	16	32	16	24
UT	Utah	207	404	12	28	11	26
OK	Oklahoma	100	152	15	26	2	19
AL	Alabama	98	159	8	22	5	17
KS	Kansas	104	163	10	20	4	17
ID	Idaho	108	153	3	18	3	18
RI	Rhode Island	73	124	4	17	9	4
KY	Kentucky	80	162	2	15	6	9
NE	Nebraska	51	110	4	12	1	10
LA	Louisiana	174	168	27	11	11	16
NM	New Mexico	111	152	6	11	6	9
VT	Vermont	36	97	2	8	2	10
WV	West Virginia	42	87	2	8	5	10
NV	Nevada	70	221	8	7	0	7
DC	District of Columbia	19	45	2	5	2	3
MS	Mississippi	24	70	1	5	2	7
AR	Arkansas	30	49	1	4	1	7
ME	Maine	39	82	4	4	1	1
MT	Montana	30	45	2	2	0	0
ND	North Dakota	4	35	0	2	0	7
HI	Hawaii	18	34	0	1	3	5
WY	Wyoming	15	22	0	1	0	1
AK	Alaska	5	8	0	0	0	0
PR	Puerto Rico	5	2	0	0	0	0
SD	South Dakota	11	5	0	0	0	0
VI	Virgin Islands	1	4	0	0	0	0
Total-U.S.		23,343	42,019	2,613	7,053	2,225	5,761
Percentage of Total				11.19%	16.79%	9.53%	13.71%

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