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High-Tech Immigrant Entrepreneurship in the United States

David M. Hart[1] and Zoltan J. Acs[1]

Abstract

This article reports the results of a national survey that estimates the rate of immigrant entrepreneurship in a representative sample of high-impact firms in high-technology industries in the United States. The authors report key descriptive statistics about the companies and their founders. About 16% of the companies in the sample, for instance, number at least one immigrant entrepreneur among their founding teams, while about 77% of the immigrant entrepreneurs are U.S. citizens. Three multivariate analyses are carried out that compare high-impact, high-tech firms that count at least one immigrant in their founding teams with those that were founded by native-born entrepreneurs. It is found that the two groups of firms are similar with respect to economic and technological performance. Immigrant-founded firms are more likely to report that they have a strategic relationship with a foreign firm. The authors conclude by briefly considering the potential implications of our findings for immigration and economic development policy.

Keywords

entrepreneurship, high technology, immigration, United States, public policy

Introduction

A vigorous high-technology sector is vital to sustain U.S. prosperity in the 21st century. The new products, services, and business models that the high-tech sector generates differentiate this nation's output from that of the rest of the world and enable capital accumulation, wage gains, and productivity growth (Jorgenson, Ho, & Stiroh, 2005). A high level of entrepreneurship, by which we mean the founding of new businesses, makes the high-tech sector vigorous. High-tech entrepreneurs take risks that existing high-tech businesses are afraid to take and recognize opportunities that they fail to spot (Acs, Audretsch, Braunerhjelm, & Carlsson, 2009).

The perception that immigrant[1] entrepreneurs play a disproportionately important role in the U.S. high-tech sector is widely held. Silicon Valley superstars, such as Google founder Sergey Brin, former Intel chief executive officer (CEO) Andrew Grove, and venture capitalist Vinod Khosla, figure prominently in accounts of the high-tech economy (Herman & Smith, 2009). Advocates of a more open immigration policy for foreign students and highly skilled workers, such as Microsoft founder Bill Gates (2008), frequently reference the contributions of immigrant high-tech entrepreneurs.

Social scientific research has lagged behind the policy dialogue on this subject. Empirical studies of immigrant high-tech entrepreneurship (described in detail below) have generally been restricted to particular regions and sectors that may not be representative of the United States as a whole. Moreover, there are theoretical reasons to hypothesize that the foreign born might be underrepresented relative to the native born in high-tech entrepreneurship as well as reasons to expect that they might be overrepresented.

In this study, we quantify the role of immigrants in high-tech entrepreneurship in a nationally representative sample of rapidly growing companies. We find that, although most previous studies have overstated the role of immigrants in high-tech entrepreneurship, it is nonetheless very important. For instance, about 16% of the companies in our sample number at least one immigrant entrepreneur among their founding teams. The survey also allows us to provide a profile of immigrants who have founded the sample companies. The vast majority of these entrepreneurs are strongly rooted in the United States. About 77% of the immigrant founders of the sample firms, for instance, are U.S. citizens.

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In addition to reporting key descriptive statistics about the firms and their founders, we carry out three multivariate analyses that compare firms that count at least one immigrant in their founding teams with those that were founded by native-born entrepreneurs. We find that the two groups of firms are not significantly different with respect to economic and technological performance. Immigrant-founded firms are significantly more likely to report that they have a strategic relationship with a foreign firm. We conclude by briefly considering the implications of our findings for public policy, highlighting the need to build a more coherent pathway to permanent status for highly educated, highly skilled immigrants who might become high-tech entrepreneurs.

Why Rapidly Growing High-Tech Firms Are Important

Highly skilled individuals, whether native born or foreign born, feed into a U.S. national economy that is increasingly reliant on creating new technologies and putting them to innovative uses. The capacity to innovate allows the United States to stay one step ahead of rigorous global competition in economic sectors where production processes have been routinized. The "recipe" (Feldman & Martin, 2005) for success in this context is undoubtedly complex, involving effective legal, financial, and educational institutions (Nelson, 1993); sophisticated demand (Porter, 1990); and manifold linkages to the global economy (Mowery & Nelson, 1999). No matter what the "recipe," though, one essential "ingredient" is a steady supply of rapidly growing firms, which in turn requires entrepreneurs to found and run them.

Entrepreneurship is linked theoretically to positive economic outcomes through the concepts of opportunity (Shane & Venkataraman, 2000), innovation (Schumpeter, 1942), risk (Rosenberg, 1994), and standard operating procedures (March & Simon, 1958). At any moment in time, some opportunities exist to perform an economic activity more efficiently than existing businesses (process innovation) or to offer a new good or service (product innovation). Pursuing these opportunities is riskier than investing in existing activities. The standard operating procedures of existing businesses cause them to fail to recognize some opportunities and to limit the risks that they take. Successful entrepreneurs realize opportunities for innovation that would not have been realized in their absence. Society benefits from productivity growth in the case of process innovation and from greater variety and choice in the case of product innovation.

These theoretical premises now find wide acceptance within the economic development research community, but there has been an extended debate over how to identify growth-enhancing entrepreneurial firms empirically. Birch (1981) kicked off this debate with his work on small business. A later stream of work (e.g., Acs & Armington, 2006; Haltiwanger, 2009) showed that firm age is more important than firm size as a determinant of employment growth. An emerging body of evidence (summarized by Autio, 2005) suggests that a small fraction of young businesses have a disproportionate impact from the growth perspective; 1% to 10% of new firms, in these studies, generate 40% to 75% of new jobs.

The most recent and somewhat surprising twist in this literature (Acs, Parsons, & Tracy, 2008; Henrekson & Johansson, 2008) is the finding that although many of the small fraction of firms that are generating most of the jobs are young, their age distribution is wider than is commonly believed, including older firms that take off on a new trajectory. This finding does not mean that older firms' founders are of little interest to scholars. In many cases, we believe (and we find support for this belief in our data[2]) that these ventures are still led by their founders. The slower pace of growth in their early years may reflect the founders' managerial learning curve or that the firm needed more than a few years to develop its market, product, or business model.

Although rapidly growing firms are present in a wide variety of industries, the dynamics of those in high-technology sectors are especially important for scholars and policy makers to understand. These firms are more likely than others to be pursuing opportunities associated with radical innovations that produce positive knowledge externalities and that may have transformative consequences for society. Because such opportunities are so challenging and so risky, existing businesses are particularly unlikely to find out about them or to pursue them (Christensen & Rosenbloom, 1995; Utterback, 1994). High-technology start-ups are the main organizational vehicles by which new knowledge is converted into economic benefits (Acs, Audretsch, Braunerhjelm, et al., 2009; Acs, Audretsch, & Strom, 2009).

Immigrant High-Tech Entrepreneurs: Mixed Theoretical Expectations

High-tech start-ups are founded by people who are able to recognize and exploit entrepreneurial opportunities (Hart, in press; Shane & Venkataraman, 2000). Our understanding of the processes of opportunity recognition and exploitation is incomplete. Indeed, these processes may never be entirely comprehensible from the outside, depending on an ineffable "flash of creative genius," as Justice William O. Douglas famously described the process of invention (*Cuno Engineering Corp. v. Automatic Devices Corp.*, 1941). But we know enough to suggest that the foreign born have both advantages and disadvantages with respect to the native born in high-tech entrepreneurship. This mixed expectation provides a strong motivation for empirical research.

Kirzner (1973) argues that entrepreneurs are more "alert" to opportunities than others. This attribute may be passed down through families; the children of entrepreneurs are

more likely than others to become entrepreneurs themselves (Reynolds & Curtin, 2008). Immigrants may be more "alert" in the Kirznerian sense than native born. Those who come to the United States for education or employment, for instance, have, at a minimum, recognized opportunities for personal achievement outside the borders of their native land.

"Alertness" is difficult to measure. Formal knowledge reaped from education and skills gained from work experience are also typical prerequisites for recognizing high-tech business opportunities (Bullvaag, Allen, Bygrave, & Spinelli, 2006), and these attributes are easier to measure. The foreign born are disproportionately represented in science and engineering (S&E) disciplines in U.S. higher education and in S&E occupations in the U.S. workforce. Foreign students constituted 25% of all S&E graduate students in 2005, with the highest concentrations in engineering (45%) and computer sciences (43%). Twenty-six percent of college-educated workers in S&E occupations were foreign born, compared with their 12% share of the overall population (National Science Board, 2008).

Some theorists, such as Florida (2002), suggest that immigrant high-tech entrepreneurs recognize different opportunities than their native-born counterparts. As Carlsson and Jacobson (1997) put it (in a different context), the blending of cultures experienced by immigrants may enlarge the "search space" in which opportunities are sought. Immigrants may see, for instance, potential markets or supply chain relationships in their native lands that are not visible to those who lack such a background.

Even if they are more alert, more knowledgeable, and more creative in the ways suggested above, immigrant entrepreneurs face obstacles in recognizing high-tech opportunities that do not challenge most natives. Language barriers, for instance, may impede opportunity recognition. Language proficiency in general is the most important determinant of immigrant success in the labor market (Borjas, 1999). Foreign-born experts may also be more likely to pursue (or to be shunted onto) technical career ladders and thus leave the management track within existing businesses (Saxenian, 2002). This career path leads to less exposure to market trends and customer feedback that may give rise to the "flash of creative genius" that sparks an entrepreneurial venture.

When we turn from opportunity recognition to opportunity exploitation, immigrants also hold some advantages. For example, immigrant entrepreneurs may have less to lose from taking the entrepreneurial "plunge" than the native born, particularly if discrimination blocks their promotion within existing businesses. The opportunity cost of entrepreneurship is lower in such a circumstance. On the other hand, potential immigrant entrepreneurs may also perceive greater difficulties in getting back on their old career track in the case of failure, which is frequent in entrepreneurial ventures, and so be reluctant to take the "plunge."

On the whole, in fact, we believe that the barriers facing immigrant high-tech entrepreneurs with regard to opportunity exploitation are more pronounced than with regard to opportunity recognition. The exploitation of high-tech opportunities requires that entrepreneurs draw not only on their own resources to build their businesses but also on those of colleagues and of society more broadly. These resources include money, talent, contacts, and knowledge. Access to these resources quickly, and at a reasonable cost, depends on the entrepreneurs' social capital—that is, the networks in which they are embedded and the levels of trust that exist in these networks—and the social institutions that surround the high-tech start-up process. Some key networks in the U.S. high-tech sector, most notably those that provide access to venture capital, seem to be composed of "bonding" social capital, epitomized by "old-boys clubs." Brush (2003), for example, shows that female entrepreneurs tend to be excluded from these networks. Immigrants may suffer from a similar process of discrimination in seeking financial support.

The dominance of old-boys clubs ought to reduce the probability that immigrant entrepreneurs can effectively exploit the opportunities that they perceive. Saxenian (2006), though, has shown that, at least in some cases, immigrant high-tech entrepreneurs take effective advantage of their own bonding social capital in the form of networks of co-ethnics and linkages to their countries of origin. Ethnic professional associations and alumni clubs, for instance, provide access to potential new hires and funders. The Indus Entrepreneurs, an organization of U.S. residents from South Asia, for example, aims to enhance the social capital of its membership. Some foreign governments have also enacted "diaspora policies" that support these kinds of networks and even provide venture capital to high-tech entrepreneurs abroad. Scotland, Chile, South Africa, and Armenia are among the countries that have undertaken such policies, demonstrating the breadth of the appeal of this idea (Ionescu, 2006; Kuznetsov & Sabel, 2006).

We conclude that theory does not provide certain guidance about the relative representation of immigrants and natives in the population of high-tech entrepreneurs. Although like most others in this field, we would expect the factors that predict overrepresentation to dominate those that predict underrepresentation, the issue can only be resolved through empirical observation of the sort that we have undertaken and report here.

Prior Empirical Research on Immigrant Entrepreneurship

Empirical research on immigrant entrepreneurship is dominated by the study of self-employment, ethnic enclaves, and, most recently, transnationalism. This literature finds that the foreign born are more likely to start companies than the native born (Fairlie, 2008; Light & Rosenstein, 1995). Immigrant-founded companies (IFCs) play key roles in creating and

sustaining ethnic communities in major U.S. cities such as Los Angeles and Miami (Light & Gold, 2000). Business networks, populated by highly educated elites who have deep roots in the United States, link these communities to their countries of origin (Portes, Guarnizo, & Haller, 2002). Immigrant entrepreneurs from particular ethnic groups tend to concentrate in specific niches, including low-skill as well as high-skill sectors (Fairlie, 2008; Federman, Harrington, & Krynski, 2006).

Saxenian (2002) pioneered research focused specifically on high-tech immigrant entrepreneurship. She observed that Indians and Chinese were an increasingly visible presence within Silicon Valley and that many had founded start-ups there, in part because of the "glass ceiling" that blocked their promotion within existing high-tech companies. She discovered that 24% of Silicon Valley start-ups between 1980 and 1998 had CEOs with Chinese or Indian surnames, although she was unable to distinguish their location of birth. Qualitative research revealed that the Indian and Chinese high-tech communities, like ethnic enclaves in the rest of the economy, were sustained by a rich network of associations and often maintained strong linkages to their countries of origin.

Saxenian's work demonstrates that high-tech immigrant entrepreneurship is very important for Silicon Valley, but because it concentrates on the region of the United States in which high-tech immigrant entrepreneurs seem most likely to be found, one cannot necessarily generalize from it. Anderson and Platzer (2006), who studied independent, publicly traded, venture-backed companies, and Monti, Smith-Doerr, and MacQuaid (2007), who surveyed the membership of the Massachusetts Biotechnology Association, also found that about 25% of the firms in their samples were founded by at least one immigrant entrepreneur. These populations, like Silicon Valley's, like Saxenian's, may not be representative of high-tech entrepreneurship nationally. Wadhwa, Saxenian, Rissing, and Gereffi (2007) explicitly seek to generalize Saxenian's study to the national level and to update it with more recent data. In their population, high-tech companies founded between 1995 and 2005 that had achieved more than $1 million in sales or employed more than 20 people, 25% were reported to have CEOs or chief technical officers (CTOs) who were born abroad.

Two large national surveys that draw on broader populations of high-tech firms report results that are substantially lower, around 15%. One is the Kauffman Firm Survey (Ballou et al., 2007), which sampled high-tech companies founded in 2004. Many of these firms had zero or one employee, so they may not be contributing very much to economic growth. The other is the Panel Study of Entrepreneurial Dynamics (Reynolds & Curtin, 2008), a representative national sample of individuals involved in business founding.[3] Many of these individuals do not ultimately form viable businesses, despite their stated intentions, again raising a concern as to whether this population is central to economic growth in the way conjectured above. Table 1 summarizes the population, data source, and definition of immigrant-founded firm used by each of these studies. The lack of consensus among them is an important motivation for our study.

Survey Method

The population for our survey sample includes all "high-impact" companies (HICs) in high-tech industries in the United States for the period 2002-2006. An HIC is an enterprise, the sales of which have at least doubled over the relevant 4-year period and which has an employment growth quantifier of two or greater over the same period.[4] Acs et al. (2008) show that HICs account for the bulk of job creation and economic growth in the United States. They identified 376,605 HICs (approximately 2.2% of all companies) in the United States in 2002-2006, which is the most recent period in their study, using data drawn from the Corporate Research Board's American Corporate Statistical Library (ACSL).[5]

High-tech companies are disproportionately important among HICs because of the positive externalities that they generate for companies in the rest of the economy. Our definition of "high-tech" draws heavily on the work of the Bureau of Labor Statistics (Hadlock, Hecker, & Gannon, 1991), which uses research and development (R&D) employment as a share of total employment as the key criterion. We also include several other industries that have a high ratio of R&D spending to total revenues, which are identified in Varga (1998). The 49 industries at the three-digit standard industrial classification (SIC) level that meet our definition are listed in the appendix.[6] The resulting list is very similar to that used by the Kauffman Firm Survey. The total population of high-tech, high-impact companies from which we draw our sample numbered about 24,000. About 70% of these companies were in five service sector SICs, whereas the remaining 30% were manufacturing firms. Computer and data processing services (SIC 737) and engineering and architectural services (SIC 871) were the two largest industries in the population, together accounting for about half of the total.

Our strategy for the design of the survey questionnaire was to keep it short and focused, targeting completion within 5 to 10 minutes. This approach boosted the response rate and minimized respondent error, although, of course, it limited the amount of data collected. The survey asked about the respondent company's technological and business activities in general terms, such as whether it has an R&D laboratory and holds patents or has made a patent application. It then concentrated on the company's founders, gathering information for each founder about his or her home country, citizenship, length of residence in the United States, educational background, gender, race, and relationship with other members of the founding team.

Table 1. Immigrant Share of High-Tech Entrepreneurship in the United States: Comparison of Studies

Authors	Year Released	Population/Source	Estimated Immigrant Share (%)	Definition
Hart and Acs (this study)	2010	*Population:* High-impact companies in select SICs as identified in Acs, Parsons and Tracy (2008) *Source:* CRB American Corporate Statistical Library	16	Companies with at least one foreign-born founder (self-defined) as stated by survey respondent.
DesRoches et al. **[AQ: 1]**	2007	*Population:* Firms in select SICs founded in 2004 *Source:* Kauffman Firm Survey	16	Companies with at least one foreign-born founder (self-defined) as stated by survey respondent.
Reynolds and Curtin	2007	*Population:* U.S. adults *Source:* Panel Study of Entrepreneurial Dynamics I and II	15	Nascent entrepreneurs who expect to have substantial impact (50+ jobs) and who reported being foreign born.
Wadhwa et al.	2007	*Population:* Firms in select SICs with $1 million+ sales, 20+ employees, 1995-2005 *Source:* D&B Million Dollar Database	25%	Companies with foreign-born CEO or CTO, as stated by respondent.
Monti, Smith-Doerr, and MacQuaid	2007	*Population:* Biotech firms founded in New England *Source:* Massachusetts Biotechnology Council members list	26	Companies with at least one foreign-born founder (self-defined) as stated by respondent or listed on company website.
Anderson and Platzer	2006	*Population:* Publicly traded, venture-backed companies that are still independent, 1990-2005 *Source:* Thomson Financial	25	Companies with at least one foreign-born founder (self-defined), as stated by respondent or listed in public or Internet documents.
Saxenian	2002	*Population:* High-tech firms in select SICs founded in Silicon Valley, 1980-1998 *Source:* D&B custom database	24	Companies that have CEOs with Chinese or Indian surnames.

NOTE: SIC = standard industrial classification; CEO = chief executive officer; CTO = chief technical officer; D&B = Dun & Bradstreet; CRB = Corporate Research Board.

The survey was administered by the George Mason University Center for Social Science Research in late 2008. To help maximize response rates, the center's computer-assisted telephone interviewing system was programmed to make callbacks until a final disposition was reached. The survey yielded a national random sample of high-tech, high-impact companies. The response rate for the survey was higher than we initially expected. The cooperation rate (as defined by the American Association for Public Opinion Research, Definitions 1-4) for eligible respondents who were actually reached was 53%. The overall response rate, which includes busy signals, fax machines, and the like (American Association for Public Opinion Research, Definitions 1-2), was 29%.

The survey data were used to create two databases, one in which the unit of observation is the company and another in which the unit of observation is the founder. (Many companies have more than one founder, as described in more detail below.) There are approximately 1,300 companies in the first database and 2,000 founders in the second one. The survey data were combined with ACSL data on key characteristics, such as firm size, for the analyses reported below.

Descriptive Statistics

Building on the theoretical and empirical literature described in prior sections, our first group of research questions is descriptive. We wanted to know how many of the firms in our sample were founded by immigrant entrepreneurs and whether the populations of immigrant- and native-founded firms are similar. We also wanted to understand the backgrounds of the immigrant founders to inform immigration policy.

Our survey finds that about 16% of high-impact, high-tech companies were founded by teams that included at least one immigrant entrepreneur. Our results join those of the Kauffman Firm Survey and the Panel Survey on Entrepreneurial Dynamics at the low end of the range of published studies reported in Table 1. Nonetheless, we regard 16% to be a substantial fraction of the survey population.

We surmise that the differences between our findings and those at the higher end of the range of Table 1 are accounted for in large part by differences in the populations surveyed and how founder has been defined. Saxenian (2002) and Monti et al. (2007), for instance, survey populations that are likely to have a positive selection bias for immigrant entrepreneurs because they are geographically restricted.[7] The firm size threshold ($1 million in sales or 20 employees) used by Wadhwa et al. (2007) is likely to exclude many small high-tech companies that are growing rapidly and making important economic contributions. Defining "founder" as CEO or CTO, as Saxenian (2002) and Wadhwa et al. (2007) do, probably excludes up to half of all founders (Burton, 1995; Hannan, Burton, & Baron, 1996), while including managers hired after the firm's direction has been set. It is also possible that differences in survey technique help account for differences in the results. We believe that our definitions capture well the concepts identified by theory, as discussed above, and that they have been implemented in accordance with high standards of professional practice.

The demographics of IFCs in the sample are very similar to those of native-founded companies (NFCs), with the exception of their location. The distributions of the two groups of companies between manufacturing and services and across age categories were not significantly different in a chi-square test. The distributions across three-digit SICs showed some statistically significant differences (e.g., IFCs are overrepresented in business services and electronics), but the overall pattern is very similar to that of the NFCs. An overwhelming fraction of both groups of firms (about 90%) are still owned by their founders. With respect to location, IFCs tend to be disproportionately located in states with large foreign-born populations in general, such as California and Texas.

Of the 205 IFCs in the sample, more than half were founded only by immigrant entrepreneurs—85 by a single individual, 30 by a team of two, and 5 by teams of three or more. About 55% of all companies in the sample were founded by a single individual. We asked the companies with multiple founders how the founders came together to create the company. Founding teams of companies with at least one foreign-born founder were slightly more likely to have gotten together through previous school or work relationships and slightly less likely to have done so through family relationships than founding teams made up only of U.S.-born founders.

Turning from the company database to the founder database, we find that about 12.8% of the founders were foreign born. The vast majority of these founders were reported to have lived in the United States for more than a decade. The average duration was more than a quarter century, 25.9 years. Only about 25% were reported to have been in the United States for less than 15 years. About 77% of the immigrant high-tech entrepreneurs in our sample are U.S. citizens.

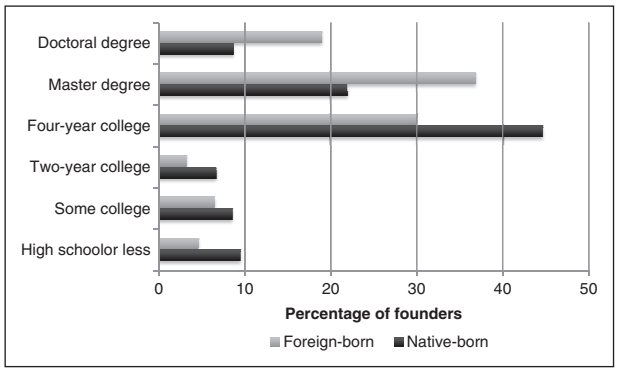

Figure 1. Founders of high-impact, high-tech companies by nativity and level of education

As Figure 1 shows, the immigrant founders are a highly educated group. Roughly 55% of them hold a master's degree or doctorate. Foreign-born founders are more than twice as likely as native-born founders to hold a doctorate and substantially more likely to hold a master's degree as well. On the other end of the spectrum, about twice as many of the U.S.-born founders (9.5%) held a high school degree or less. Exactly two thirds of the immigrant founders about whom we have information received their highest level of education in the United States.

The countries of origin of the immigrant founders (see Table 2) are diverse. Fifty-four countries are represented in our founder database—about 28% of the United Nations' membership. India is the largest source country, accounting for about 16% of this group. The United Kingdom provided 10%, followed by Canada and Japan, each of which comprised 6%, and Germany, which accounted for 5%. China and Cuba were the home countries of about 3%. To China's total, one might add Hong Kong and Taiwan, which would bring it up to a third-place tie with Canada and Japan.

Multivariate Analysis

In this section, we report three multivariate analyses that use the survey and ACSL data to compare IFCs and NFCs. Our research questions focus on whether, holding other key variables constant, the IFCs perform better or worse, in economic and technological terms, than the NFCs. We also ask begin to explore whether IFCs might pursue different strategies than their native-founded counterparts by comparing their responses to a survey question about their relationships with partners located abroad. The reader should bear in mind that all the firms in the sample are high impact and high tech according to the definitions provided above. Thus, when we analyze the differences between the two groups of firms, we are asking whether one group or another has more superstars, so to speak, among its population of stars. We are not studying the relative

Table 2. Immigrant Founders of High-Impact, High-Tech Companies by Country of Origin

Country	Number	Percentage	Country	Number	Percentage
India	40	15.9	Greece	2	0.8
United Kingdom	25	10.0	Haiti	2	0.8
Canada	15	6.0	Iraq	2	0.8
Japan	15	6.0	Philippines	2	0.8
Germany	13	5.2	Serbia	2	0.8
China	8	6.0	Sweden	2	0.8
Cuba	8	3.2	Hong Kong	2	0.8
Iran	7	2.8	West Indies	2	0.8
Russia	7	2.8	Argentina	1	0.4
France	6	2.4	Burma	1	0.4
Mexico	5	2.0	Chile	1	0.4
Netherlands	5	2.0	Colombia	1	0.4
Taiwan	5	2.0	Croatia	1	0.4
Vietnam	5	2.0	Denmark	1	0.4
Australia	4	1.6	El Salvador	1	0.4
Belgium	4	1.6	Ghana	1	0.4
Ireland	4	1.6	Guyana	1	0.4
Korea	4	1.6	Israel	1	0.4
Pakistan	4	1.6	Nicaragua	1	0.4
Ukraine	4	1.6	Nigeria	1	0.4
Austria	3	1.2	Panama	1	0.4
Brazil	3	1.2	Peru	1	0.4
Italy	3	1.2	Poland	1	0.4
Lebanon	3	1.2	Spain	1	0.4
Romania	3	1.2	Tanzania	1	0.4
South Africa	3	1.2	Turkey	1	0.4
Switzerland	3	1.2	Uruguay	1	0.4

performance of average native- and immigrant-founded firms in the U.S. economy.

The first analysis takes employment to be the dependent variable and asks whether IFCs tend to be larger, other things being equal. We find that they are not. The second analysis takes high technological performance (defined as conducting or funding R&D, holding patents, or making patent applications) as the dependent variable and asks whether IFCs tend to have higher technological performance, other things being equal. We find that they do not. The third analysis assesses whether IFCs are more likely to maintain a strategic relationship with a foreign firm than NFCs, other things being equal. We find that they do.

Employment is the best proxy that we have in our data set for the economic performance of the sample firms.[8] The ACSL derives these data from Dun & Bradstreet (D&B). We also have D&B's revenue estimates for the sample firms, but because most of the sample firms are privately held, we believe that the employment data are more reliable. (Employment and revenue are highly correlated in any case.) A simple bivariate analysis suggests that IFCs are more likely to be found in the high employment group (21 or more employees) to a statistically significant degree; 33% of the IFCs are in this group, compared with about 24% of the NFCs.

However, when we weight the sample, add controls, and run a multivariate linear regression with employment (logged) as the dependent variable, this result is washed out. The purpose of weighting is to make the analysis reflect the population's characteristics more accurately and reduce the impact of bias due to random variation and nonresponse in the survey sample. We have full data for the entire population from D&B for several variables that may be analytically important, including firm age, industrial sector, employment, and location. We created weights in several steps (Lee & Forthofer, 2006). We first split the sample and the population into categories (such as low, medium, or high) according to the values of each of these four variables. We then cross-tabulated the four variables and divided the proportion of the population in each cell by the proportion of the sample. There are 36 cells in all in our weighting matrix. These weights were then entered into STATA, associated with the appropriate observations, and used by STATA's weighted regression commands.

This regression employs three control variables. We control for company age (logged), because we expect older firms to employ more people. We know that average firm size differs by industry, so we employ a dummy variable for each two-digit SIC code in the sample. We also control for the education level of the most educated founder of each firm, because we

Table 3. Economic Performance of Immigrant- and Native-Founded Companies

Variable	Coefficient	Standard Error	*t* Statistic	*p* Value
Constant	1.61	0.187	8.61	<.001**
Nativity of firm	0.11	0.10	1.04	.3
Age of the firm (logged)	0.31	0.070	4.45	<.001**
Founder education				
High school or less	−0.29	0.14	−2.09	.037**
Some college	−0.11	0.12	−0.85	.40
Two year/tech	−0.49	0.13	−3.86	<.001**
Master's degree	0.15	0.092	1.68	.093*
Doctoral/professional	0.27	0.12	2.21	.027**
Mining (two-digit SIC)	0.17	0.34	0.48	.63
Textile (two-digit SIC)	−0.96	0.27	−3.61	<.001**
Paper (two-digit SIC)	0.27	0.74	0.37	.71
Chemicals (two-digit SIC)	0.40	0.16	2.54	.011**
Petroleum (two-digit SIC)	−0.86	0.078	−11.01	<.001**
Prm. metal (two-digit SIC)	−0.14	0.076	−1.87	.061*
Machinery (two-digit SIC)	0.30	0.12	2.37	.018**
Electr. (two-digit SIC)	0.78	0.21	3.74	<.001**
Transport. (two-digit SIC)	0.38	0.23	1.65	.099*
Ind. Instr. (two-digit SIC)	0.49	0.18	2.73	.006**
Comm. (two-digit SIC)	−0.042	0.31	−0.13	.89
Bus. Svc. (two-digit SIC)	0.11	0.090	1.19	.24
Other Svc. (two-digit SIC)	−0.68	0.13	−5.14	<.001**
Linear regression, weighted by age, sector, employment, and location				
Dependent variable: Firm employment (logged)				
Observations = 1,046				
R^2 = .10				

*$p < .10$. **$p < .05$.

believe that a high level of education, especially graduate training, may convey an advantage in high-tech entrepreneurship (Van de Ven, Hudson, & Schroeder, 1984). This control is made up of five dummy variables, ranging from high school or less to graduate degree, with bachelor's degree serving as the omitted reference category.

The results of the regression are found in Table 3. Nativity of the firm's founders is not significantly related to firm employment in our sample. The firm age variable is highly significant, as we expected. Some industries, too, contain firms that are significantly larger than our reference category, which is engineering services. We also find that founder educational attainment of less than a 4-year college degree is significantly correlated with lower levels of employment, whereas founders who hold master's or doctoral degrees run significantly larger firms on average.

Our interpretation of the educational variable is worth a bit of further consideration. Figure 1 shows that immigrant founders are more highly educated than their native-born counterparts. Our interpretation is that this correlation is not causal and that, therefore, it is appropriate to think of educational attainment as a control variable. However, if one believes that founders who came to the United States for higher education (as most in our sample did) are more gifted academically than native-born founders, because they are drawn from a much larger population, then one might view education as an intermediating variable rather than a control variable. When we remove education from the regression (results not shown), nativity does become significant at the 5% level.

We measured technological performance in our survey by asking whether companies conducted R&D in their own labs, contracted out R&D, held a patent, or made a patent application. Positive responses to these questions overall ranged from 17% for contract R&D to 28% for in-house R&D, with patent holding lying in between at about 22%. In bivariate tests, IFCs outperformed NFCs to a statistically significant degree with respect to in-house R&D and patent holding. For instance, 36% of the IFCs housed an R&D unit, compared with 25% of NFCs.

This bivariate result does not withstand controls in multivariate tests. We constructed a dummy dependent variable that is positive if the sample firm answered affirmatively to one or more of the three questions about technological performance (in-house R&D, contract R&D, or patent holding). We use a logit specification. We use the same weighting approach as in the previous regression. We add firm size (employment) to the set of control variables because we expect

Table 4. Technological Performance of Immigrant- and Native-Founded Companies

Variable	Odds Ratio	Standard Error	*t* Statistic	*p* Value
Nativity of Firm	1.06	0.20	0.33	.74
Age of the firm (logged)	0.76	0.098	−2.13	.033**
Employment (logged)	1.29	0.090	3.72	<.001**
Founder education				
High school or less	0.46	0.16	−2.2	.028**
Some college	1.43	0.38	1.33	.18
Two year/tech	0.90	0.30	−0.32	.75
Master's degree	1.58	0.28	2.61	.009**
Doctoral/professional	4.59	1.10	6.33	<.001**
Mining (two-digit SIC)	0.32	0.28	−1.3	.19
Paper (two-digit SIC)	4.43	6.33	1.04	.30
Chemicals (two-digit SIC)	7.61	3.07	5.03	<.001**
Machinery (two-digit SIC)	1.76	0.44	2.24	.025**
Electr. (two-digit SIC)	3.05	1.06	3.22	.001**
Transport. (two-digit SIC)	1.83	0.79	1.39	.16
Ind. Inst. (two-digit SIC)	2.84	1.05	2.84	.005**
Comm. (two-digit SIC)	0.91	0.65	−0.14	.89
Bus. Svc. (two-digit SIC)	1.26	0.22	1.3	.19
Other Svc. (two-digit SIC)	0.60	0.28	−1.09	.27
Logistic regression, weighted by age, sector, employment, and location.				
Dependent variable: Technological performance (positive response to any survey question on patenting, contract R&D, or in-house R&D)				
Observations = 1,041				
Pseudo R^2 = .11				
Log pseudo-likelihood = 628.72				

*$p < .10$. **$p < .05$.

that larger firms are more likely to do R&D, fund R&D, or own or apply for patents than smaller firms.

The results of this regression are found in Table 4. Firm age and firm size are both significantly related to a high level of technological performance; younger and bigger firms tend to support R&D or hold patents. Some industries, such as chemicals and electronics, are significantly more active technologically than our reference group, engineering services. The most striking findings have to do with founder educational attainment. Firms with founders that hold master's degrees are 50% more likely to be active technologically than the reference group, which is firms with founders who hold bachelor's degrees, and firms with founders who hold doctoral degrees are 350% more likely. (When education is removed from this regression [results not shown], nativity is not statistically significant, but it comes close; the *p* value drops to .12.)

We asked our survey respondents whether their firms have a strategic relationship with a firm outside of the United States, such as a major supplier, key partner, or major customer. Our interest in asking the question was to begin to explore whether the cross-border social networks of the immigrant founders are leveraged to build their firms. Relationships with suppliers, partners, or customers in the founder's country of origin (or elsewhere) may provide an advantage to his or her firm. For instance, the IFC in such a case may be better able to use an internationally distributed business model than an NFC.

Bivariate tests show a strong relationship. About 42% of IFCs reported that they had a strategic relationship with a firm outside of the United States, compared with only about 23% of the NFCs. Table 5 shows that this relationship holds up in a multivariate specification as well. Our approach is similar to that used for technological performance. The control variable for firm size remains significant in this regression, as do the dummy variables for certain industry groups and for founder educational attainment. Even with these controls in place, having an immigrant founder nearly doubles the likelihood of a firm reporting a strategic relationship with a foreign firm. This result is significant at the 1% level.

Public Policy Implications

Our study is descriptive, not prescriptive. Additional assumptions and assertions are required to reach policy conclusions, and reasonable people may differ as to what these ought to be. In this section, we briefly lay out our views on some of the key immigration and economic development policy issues that our study informs.

Table 5. Strategic Foreign Relationships of Immigrant- and Native-Founded Companies

Variable	Odds Ratio	Standard Error	*t* Statistic	*p* Value
Nativity of Firm	1.88	0.38	3.07	.002**
Age of the firm (logged)	0.95	0.14	−0.34	.73
Employment (logged)	1.29	0.096	3.45	.001**
Founder education				
High school or less	0.34	0.14	−2.69	.007**
Some college	0.43	0.14	−2.52	.012**
Two year/tech	0.18	0.087	−3.52	<.001**
Master's degree	0.76	0.15	−1.41	.16
Doctoral/professional	1.86	0.46	2.5	.012**
Paper (two-digit SIC)	10.9	9.67	2.71	.007**
Chemicals (two-digit SIC)	3.67	1.25	3.81	<.001**
Machinery (two-digit SIC)	2.69	0.78	3.38	.001**
Electr. (two-digit SIC)	8.02	2.92	5.72	<.001**
Transport. (two-digit SIC)	4.78	2.08	3.58	<.001**
Ind. Instr. (two-digit SIC)	3.98	1.67	3.3	.001**
Comm. (two-digit SIC)	1.28	1.04	0.3	.77
Bus. Svc. (two-digit SIC)	1.35	0.28	1.47	.14
Other Svc. (two-digit SIC)	0.46	0.33	−1.07	.29
Logistic regression, weighted by age, sector, employment, and location				
Dependent variable: Strategic relationship with a foreign firm (positive response to survey question)				
Observations = 1,009				
Pseudo R^2 = .13				
Log pseudo-likelihood = −516.16				

*$p < .10$. **$p < .05$.

The broadest questions in immigration policy are how many people the United States ought to admit, for what length of stay, and what criteria it ought to use to admit them. Our findings to date provide at least two interpretations with respect to the issue of "how many" that are in tension with one another. If one believes that immigrant entrepreneurs recognize and exploit the same opportunities that American society would generate even in the absence of immigration, and that native-born entrepreneurs would recognize and exploit these opportunities in the absence of immigrants, the case for quantitative expansion is hard to make. Our analysis might support that conclusion, since NFCs and IFCs cannot be distinguished with respect to sector, economic performance, or technological activity. One might then argue that public policy should work to substitute native- for foreign-born graduate students in key technical fields so that natives are better prepared for high-tech entrepreneurship. An alternative interpretation might focus on the finding that IFCs are more likely to have strategic relationships with foreign firms. This finding implies that IFCs follow qualitatively different strategies than NFCs and are complementary to them. To this point, one might add the argument that U.S. graduate education provides a filter for selecting talented entrepreneurs from the enormous global population and that we are mistaken to control for education. Further research will be required to distinguish between these positions.

We have more to say about the length of stay and criteria for admission. The extensive work experience and strong educational backgrounds of the immigrant founders in our sample provide support for maintaining and possibly strengthening the long-term educational and employment-based immigrant and nonimmigrant visa categories. People who come to the United States seeking opportunities to learn at the university and graduate school levels and to work in high-skill positions for extended periods of time add significantly to the pool of residents who have a reasonable chance of creating high-impact, high-tech companies. Yet the U.S. immigration system does not generally favor such people, relying heavily on family relationships to determine who is admitted (Martin, 2004).

The linkages among nonimmigrant visa categories and between nonimmigrant status and legal permanent residence are also important policy issues illuminated by this study. These linkages ought to create clear pathways to permanent residence or, alternatively, to return to the home country, but they do not do so now. They send mixed signals and leave many people uncertain about their long-term status. Despite these flaws in U.S. immigration policy, a large proportion of the immigrant founders in our sample somehow found their way from higher education to professional work to the green card and, ultimately, citizenship. They gained sufficient certainty about their immigration status during this journey that they were willing to make the investment of a lifetime by starting their own businesses. We worry, though, that some potential high-tech entrepreneurs who are admitted in a nonimmigrant status will lack the certainty that they will be here long enough able to reap the benefits of taking the entrepreneurial "plunge."

Passage from one status to another has gotten harder in some respects in recent years. Admission to the United States as a student is generally not too difficult, as long as the applicant has an offer of a place from a credible school and the means to pay. However, the adjustment from student status to nonimmigrant work status is strewn with obstacles. In many cases, recent graduates can stay for an additional year after graduation without changing status if they are employed in "optional practical training" (OPT) directly related to their field of study. OPT was recently extended to 29 months for graduates in science, technology, engineering, and mathematics (STEM) fields (U.S. Immigration and Customs Enforcement, 2009). However, if the student visa holder is without a firm job offer from a sponsor who holds a nonimmigrant visa slot when the OPT period expires, the former student must leave the country immediately (as he or she must on graduation, as well if not eligible for OPT).

The availability of nonimmigrant visa slots to graduating students and employers who desire them is spotty at best. The H-1B category, which is the largest one for long-term nonimmigrant workers, has faced a glut of applicants for a limited number of visas in recent years. These visas are distributed primarily through a lottery, and no priorities are set with respect to the types of qualifications that the country might value beyond the general language of the law. Applicants are left in the dark for many months and sometimes years as to whether they will be admitted (Lowell, 2001). Indeed, it was this uncertainty, the so-called H-1B "cap gap," that seems to have stimulated the extension of OPT described above. Yet the extension of OPT simply expands the pool of H-1B applicants who are in limbo. The second largest long-term nonimmigrant work visa category, the L-1 for intracompany transferees, is increasingly subject to similar uncertainty, as companies have apparently begun to use it to try to work around the constraints of the H-1B process (Hira, 2007).

The third step along this pathway, from temporary work status to the green card, is perhaps the most difficult of all. Unless the aspiring immigrant marries an American citizen and thus becomes eligible for legal permanent residence as a member of a citizen's family, the wait can be quite long and burdened with onerous conditions and uncertainty. The conditions include remaining with the sponsoring employer until the green card is in the final stages of approval. The wait for an employment-based green card usually lasts several years, but it can be much longer. Because green cards are subject to annual per-country limits, applicants from India, China, Mexico, and the Philippines, which are among the largest source countries, must usually wait longer than applicants from other countries.

There are no easy fixes to the substantial problems that vex the U.S. immigration system. Our study suggests several options for consideration that might allow the country to better use high-tech-oriented entrepreneurial talent from outside its borders. One option is to set priorities within temporary employment visa programs, such as the H-1B, that favor the most qualified applicants.[9] A second is to restructure or abolish the numerical per-country limits on green cards that operate without regard for the size of the home country population. A third option is to loosen the linkages between employment and immigration to facilitate high-tech immigrant entrepreneurship, for instance, through the introduction of a point system that rewards individual attributes associated with entrepreneurial potential.

Although immigration policy is a domain of exclusive federal competence in the United States, policy makers at lower jurisdictional levels nevertheless exercise some influence over it. State and local economic development strategies that focus on attracting entrepreneurial talent (Florida, 2002, 2005; Hart, 2006) naturally extend to foreign-born talent and provide an incentive to get involved in immigration policy. The Greater Cleveland Partnership, for instance, has recently called on the federal government to establish high-skill immigration zones in distressed metropolitan areas (Greater Cleveland Partnership, 2009). Our finding that immigrant high-tech entrepreneurs tend to locate their businesses in places that have larger immigrant populations in general suggests that such an approach may not be very fruitful. Such concentrations in gateway locations are a common feature of immigrant populations historically in the United States and cross-nationally as well. Immigration policies targeted to particular regions outside established gateways have not produced good results in trials in Australia (Papademetriou, Somerville, & Tanaka, 2009), and ensuring that immigrants admitted under such policies remain in the designated regions would be even more difficult to enforce in the more open U.S. system.

Conclusion

Immigrants play an important role in founding some of the nation's most important businesses. About 16% of the companies in our nationally representative sample of high-impact, high-tech companies count at least one immigrant among their founders. These immigrant high-tech entrepreneurs are deeply rooted in the United States. A large proportion of them have been in this country for two decades or more, are citizens, and received graduate degrees here. They hail from a diverse array of countries.

High-impact, high-tech companies founded by immigrant entrepreneurs tend to be located in states that have large immigrant populations. They operate in the same industries as their native-founded counterparts, are about the same size, and have about the same level of technological performance (as measured by patenting and R&D activity). They are more likely to have strategic relationships with foreign firms.

The significance of these companies to the U.S. economy stems from their disproportionate role in economic growth. Policy makers are rightly concerned that government sustains a healthy climate for starting and running HICs like those in our sample. Immigration policy, as it affects highly educated and highly experienced foreign-born individuals who might

be drawn into high-tech entrepreneurship, is an important element of that climate that deserves more attention and more creative thinking than it has received in the past.

Appendix

High-Technology SICs (Three-Digit)

Manufacturing	
Crude petroleum and natural gas	131
Cigarettes	211
Miscellaneous textile goods	229
Pulp mills	261
Miscellaneous converted paper products	267
Industrial inorganic chemicals	281
Plastic materials and synthetics	282
Medicinals and botanicals	283
Soap	284
Paints	285
Industrial organic chemicals	286
Agricultural chemicals	287
Miscellaneous chemical products	289
Petroleum refining	291
Miscellaneous petroleum and coal products	299
Reclaimed rubber	303
Nonferrous rolling and drawing	335
Ordnance and accessories n.e.c.	348
Engines and turbines	351
Construction and related machinery	353
Metal working machinery	354
Special industry machinery	355
General industrial machinery	356
Computer and office equipment	357
Industrial machines, n.e.c.	359
Electronic distribution equipment	361
Electrical industrial apparatus	362
Household appliances	363
Electric lighting and wiring	364
Audio and video equipment	365
Communications equipment	366
Electronic components and accessories	367
Miscellaneous electrical equipment and supplies	369
Motor vehicles and equipment	371
Aircraft and parts	372
Railroads	374
Guided missiles and space	376
Miscellaneous transportation equipment	379
Search and navigation equipment	381
Measuring and controlling devices	382
Optical instruments and lenses	383
Medical instruments and supplies	384
Ophthalmic goods	385
Photographic equipment and supplies	386
Services	
Communication services not elsewhere classified	489
Computer and data processing services	737
Engineering and architectural services	871
Research and development and testing services	873
Services, n.e.c.	899

Note. SIC = standard industrial classification; n.e.c. = not elsewhere classified.

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Notes

1. We use the term *immigrants* when referring to foreign-born entrepreneurs because the vast majority of the founders in our sample have been in the United States for decades and have become citizens.
2. A total of 90.5% of all firms in our sample for which we have data reported that at least one founder is a current owner of the firm.
3. A recent study by Hunt (2009) finds that among college graduates, immigrants are more likely than natives to have founded companies employing more than 10 people between 1998 and 2003, once level and field of education are controlled for.
4. The employment growth quantifier is the product of the absolute and percent change in employment over a 4-year period of time, expressed as a decimal. Employment growth quantifier is used to mitigate the unfavorable impact of measuring employment change solely in either percent or absolute terms, since the former favors small companies and the latter large businesses.
5. The Corporate Research Board's American Corporate Statistical Library (ACSL) contains more than 140 variables on all business establishments in the country. The ACSL links each establishment over time from its birth through any physical moves it makes, capturing changes in ownership along the way, and recording the establishment's death if it occurs. The result is a unique longitudinal business file that allows for micro- and macroeconomic analysis of the U.S. economy. Corporate Research Board updates the ACSL every 6 months, drawing on hundreds of public and private sector data sources.
6. To maintain historical continuity, our database uses SIC codes rather than North American Industry Classification System (NAICS) codes. We dropped SIC 874, management and public

relations, which met the Bureau of Labor Statistics definition, but was so large that it would have dominated our results.

7. Hsu, Roberts, and Eesley (2007) and Bhide (2008) also have a positive selection bias relative to the national population of firms.
8. When we control for firm age, as described in the next paragraph, using employment as the dependent variable gives us a proxy for employment growth over the lifetime of the firm.
9. The H-1B program does set aside an additional 20,000 visas for recent graduates who hold master's or doctoral degrees.

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