LESSONS FOR U.S. METRO AREAS:
Characteristics and Clustering of High-Tech Immigrant Entrepreneurs

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EXECUTIVE SUMMARY

Immigrant-owned enterprises are an increasingly important part of the U.S. economy. According to the 2007–2011 American Community Survey (ACS), immigrants now comprise 20 percent of the high-tech work force and 17.3 percent of high-tech entrepreneurs. This is an increase from 13.7 percent and 13.5 percent, respectively, in 2000. Between 2000 and 2011 (the ACS five-year data), the immigrant labor force in high-tech industries grew much faster than the U.S.-born labor force did—37.2 percent versus 10.7 percent. The self-employed in high-tech industries for the foreign-born grew even faster, with a rate of 64 percent, compared to 22.6 percent for the U.S.-born. For both time periods, half of the self-employed immigrants in high-tech industries are incorporated, a higher rate than for the native-born labor force.

Past empirical studies have demonstrated the importance of high-skill immigrants in high-tech sectors, entrepreneurship, and job creation (Saxenian, 1999, 2006; Wadhwa et al., 2007, 2012). However, we have little understanding about their presence outside of Silicon Valley, especially geographically and by sector. This paper further addresses geographic factors that correlate with the concentration of high-skill immigrant entrepreneurs across metropolitan areas, providing policy implications for local and state strategies to promote an immigrant-friendly environment.

> Key findings include:
> - Among the top ten countries from which immigrants in high-tech industries have arrived to the United States, there is a significant variation in rate of self-employment and its growth over time. In period 2007–2011, the national rate of self-employment in high-tech industries is 6.2 percent. The rate is around 2 percent to 3 percent for immigrants from Vietnam, Mexico, and Philippines, and 9 percent to 10 percent for immigrants from England, Iran, and Canada.
> - Since the beginning of the new century, the total number of the self-employed labor force in high-tech industries experienced significant growth in immigrants from Columbia, China, India, Korea, and Vietnam, but stagnant growth for countries like Iran, England, Mexico, Germany, and Cuba.
> - Compared to their U.S.-born counterparts, who are more evenly distributed across all the high-tech sectors, immigrant owned high-tech

businesses are more concentrated in a limited number of industries, such as semiconductor, other electronic component, magnetic, and optical media, communications, audio/video equipment, and computer science-related sectors.

- Spatially, immigrant high-tech entrepreneurs are concentrated in a smaller number of metropolitan areas, with 80 percent of them concentrated in the largest twenty-five metropolitan areas, in contrast to 57 percent of their U.S.-born counterparts.
- Across different groups, immigrant high-tech entrepreneurs demonstrate the highest concentration, surpassing all high-tech workers and all workers. At the same time, the evidence suggests that concentration fell from 2000–2011, which is consistent with growing literature that documents immigrants' dispersing settlement patterns.
- Both immigrant and U.S.-born high-tech businesses are more likely to locate within regional labor markets that have an overall higher percentage of high-tech industries and higher innovation capacity. At the same time, metropolitan areas with higher percentages of construction and social services tend to have a higher number of native-born-owned businesses in high-tech industries.
- Unlike the U.S.-born, however, higher ethnic diversity and a larger share of the foreign-born population are crucial factors in attracting or fostering immigrant high-tech entrepreneurship on the metropolitan level.

These results imply that an open and culturally diverse environment is positively associated with creative and innovative activities for both immigrants and the U.S.-born.

INTRODUCTION AND RESEARCH RATIONALE

Immigrant-owned enterprises are a vibrant component of U.S. economy (Fairlie, 2012; FPI, 2012; Saxenian, 1999; Wadhwa et al., 2007). According to the most recent data, 18 percent of small business owners in the United States are immigrants. Furthermore, immigrants are more likely to be small business owners than are U.S.-born individuals (Fairlie, 2012). These businesses employed an estimated 4.7 million people, generating an estimated total of $776 billion in receipts in 2007 (FPI, 2012). In knowledge-based industries, immigrants also are playing a vital role. Hart and Acs (2011) found that about 16 percent of their national sample of "high-impact" companies in high-tech industries has at least one immigrant entrepreneur among the funding teams. This is in accordance with the over-representation of foreign-born workers in the U.S. science and engineering fields in general (Stephan and Levin, 2001). In Silicon Valley, 24 percent of all high-technology firms in 1998 were run by Chinese or Indian immigrants (Saxenian, 1999), and that share rose to 43.9 percent between 2006 and 2012. Nationwide, 25.3 percent of the engineering and technology companies established between 1995 and 2005 had at least one immigrant key founder. In 2005, these immigrant-founded companies collectively generated roughly $52 billion in sales and employed 450,000

workers (Wadhwa et al., 2007).[2] Kerr (2008) notes the substantive increase of U.S. patents by ethnic inventors between 1975 and 2004, especially in high-tech industries like computers and pharmaceuticals.

While there are some studies in recent years on the clustering of manufacturing firms (Glaeser, Kerr, and Ponzetto, 2010) and on the intensity of agglomeration among female entrepreneurs (Rosenthal and Strange, 2012), no study has specifically examined the agglomeration patterns of immigrant entrepreneurship. Evidence suggests that immigrants have higher self-employment rates than comparable native-born populations do (e.g., Borjas, 1986; Yuengert, 1995), though variation exist across racial and ethnic groups and national origins (Fairlie and Meyer, 1996; Lofstrom and Wang, 2007). These immigrant high-tech enterprises are likely to be spatially concentrated as well, given the overall agglomeration of the high-tech industry and the fact that many entrepreneurs are spin-offs from existing firms. Saxenian's detailed descriptions of the emergence of Chinese and Indian immigrant entrepreneurs in Silicon Valley testified to the importance of spatial clustering and network effect in this industry (Saxenian, 1999). Such concentrations also are identified in other parts of the country, including Boston's Route 128 (Saxenian, 1994) and North Carolina's Research Triangle Park (Wadhwa et al., 2007). Though immigrants historically have concentrated in a few gateway coastal cities, an emerging body of research has documented their changing settlement patterns from established gateway metropolitan areas to new and emerging gateways (Singer, Hardwick, and Brettell, 2008; Lichter and Johnson, 2009; Painter and Yu, 2010). Singer (2004) classified metropolitan areas into six major types of U.S. immigrant "gateways" by their historical and current immigrant trends—former gateways, continuous gateways, post-World War II gateways, emerging gateways, re-emerging gateways and pre-emerging gateways—and found that the newly emerging gateways experienced rapid foreign-born population growth, while the more established gateways saw slower percentage growth. While many factors underlie such location choices, Baird et al.'s (2008) inter-metropolitan-level analysis demonstrates that economic and quality of life factors play a more critical role than ethnic networks factors do in immigrants' inter-metropolitan settlement patterns.

Ethnically concentrated communities provide immigrant entrepreneurs with stable consumer bases for ethnic goods, recruitment channels for ethnic suppliers and workers, easy access to credit and capital, and role models in business startup (Aldrich and Waldinger, 1990; Zhou, 2004). All these are essential for nascent entrepreneurs to mobilize resources and establish businesses. However, some caution that, rather than enhancing business opportunities, a high degree of residential segregation may create an unfavorable entrepreneurial environment due to the location of job growth in other parts of the metropolitan area (Painter, Liu, and Zhuang, 2007), especially when combined with poverty concentration (Fischer and Massey, 2000).

All this evidence suggests a high degree of clustering among immigrant entrepreneurs, especially those in high-tech industries. It is hard to predict, however, whether

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[2] More recent data show that immigrant high-tech entrepreneurship stagnated after 2005 (Wadhwa et al., 2012).

residential clustering or industrial networks would play a larger role in the generation of agglomeration economies.

This study will address the following questions:
- What are the characteristics of immigrant business owners in high-tech industries?
- How are immigrant business owners spatially distributed in the regional economy?
- What are the potential factors that shape the distribution of immigrant entrepreneurs across metropolitan areas?

DATA AND METHODOLOGY

Data

The primary data in this research are derived from the Decennial Census 2000 and American Community Survey 2007–2011 five-year sample (referred to as the 2011 sample). Drawing from these two time periods will enable the assessment of immigrant high-tech entrepreneurship growth trends over the last decade. Entrepreneurs are defined as those who are self-employed or own a business by the "class of worker" question. While it is true that not all self-employed workers are entrepreneurs, Aldrich and Waldinger (1990) argue that it is not clear how to distinguish "entrepreneurs" from "the self-employed." Even though there is debate about how well self-employment captures entrepreneurial activities, this study provides the first contribution to the literature on immigrant entrepreneurs in high-tech sectors with a nationally representative sample. We use Metropolitan Statistical Areas (MSAs) as the unit of analysis in investigating the characteristics associated with high-tech entrepreneurs' regional distribution. All the data in different years are aggregated to the MSA level based on the year 2000 boundaries.

Definition of High-Tech Industries

There exist different ways of defining high-tech immigrant entrepreneurship. It can be defined by industry (Saxenian, 1999; Cortright and Mayer, 2001; Wadhwa et al., 2007; DeVol et al., 2009), by occupation (Saxenian, 1999), and by education and skill level. In our study, we will adopt the definition developed by Milken's high-technology economy report (DeVol et al., 2009), which classifies high-tech firms by the new North American Industry Classification System (NAICS) codes instead of the old Standard Industrial Classification (SIC) codes. This characterization makes the distinction between high-tech manufacturing industries and high-tech service industries. A detailed list is provided in Appendix A.

Model Specification and Variables

In addition to descriptive statistics that show the general trends, demographic, industrial, and geographic distribution of immigrant high-tech entrepreneurship, we conduct a series of regression analyses. First, we test the association between the number of high-tech entrepreneurs in 2011 and a set of metropolitan characteristics from 2000 to

determine the correlates of metropolitan location choice. Immigrant high-tech entrepreneurs are assessed across two broad industrial groupings: (1) pharmaceutical and medicine manufacturing and services and (2) high-tech manufacturing industries in computer equipment, communication, and electronic engineering and high-tech services in telecommunication, computer system design, Internet services, and other related industries. Finally, we test the association between the growth of high-tech entrepreneurs between 2000 and 2011 and the same metropolitan area-level characteristics in 2000 to capture the change over time. The growth is measured by both the change of absolute number and of the normalized rate (per 10,000 labor force).

In this research, we are particularly interested in two sets of contextual factors measured at the metropolitan-area level: demographic composition and the high-tech industrial mix. To gauge the impacts of demographic dynamics, we use the share of the foreign-born population of the total population, as well as ethnic diversity. Due to a high correlation between the share of the foreign-born population and the total number of immigrant high-tech entrepreneurs in each MSA, we use the share of the foreign-born population in 1970 to address such contemporaneous endogeneity (e.g., Card and DiNardo, 2000; Patridge et al., 2009). There also exist different ways to measure ethnic diversity. Following earlier literature (Alesina, Spolaore, and Wacziarg, 2000; Rupasingha, Goetz, and Freshwater, 2002), we use the ethnic fractionalization index to measure ethnic diversity at the metropolitan-area level.[3] This index indicates the probability that two randomly drawn individuals from a metropolitan area belong to different ethnic groups.

To capture the regional base of high-tech industries and innovation capacity, we include the percentage of high-tech industries, producer service industries, labor force with at least a bachelor's degree, and total number of patents. Due to the high correlation among them, we conduct principal component factor analyses to create a comprehensive index.[4] Detailed listing of variables is provided in Appendix B.

RESULTS

1. Overview: National Origin and Industrial Distribution of Immigrant High-Tech Entrepreneurs

According to the 2007–2011 American Community Survey (ACS), immigrant workers constitute about 19.9 percent of the total high-tech workforce, higher than their share in the total labor force across all industries, 17.1 percent. In 2000, immigrants' share in high-tech industries was 16.7 percent, and their overall labor force share was 15.1 percent. Though sampling schemes have changed between 2000 census and subsequent ACS, results indicate a steady increase of immigrants' participation in high-tech industries commensurate with their increasing share in the U.S. population. Among

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[3] The calculation is given by Index=1-∑(Race$_i$)^2 where Race$_i$ denotes the share of population as of race i ∈ I={non-Hispanic white, black, Asian, and Hispanics}. A higher value of the index is associated with higher diversity of the ethnic composition of the population.
[4] Factor analysis statistics are available upon request.

the immigrant labor force in the high-tech industries, about 6.2 percent are self-employed in years 2007–2011 and 5.5 percent for year 2000.

Table 1 presents the total number of immigrants in the labor force, the number in self-employed labor force in high-tech industries for all the foreign-born, U.S.-born, and top-ten countries of origin in high-tech industries, from 2000 to 2011 (five-year average). The size of the immigrant labor force in high-tech industries grew much faster than the U.S.-born labor force did—37.2 percent versus 10.7 percent. The self-employed in high-tech industries for the foreign-born grew even faster, with a rate of 64 percent, compared to 22.6 percent for the U.S.-born. For both time periods, half of the self-employed immigrants in high-tech industries are incorporated, a higher rate than the native-born labor force.

Compared to their U.S.-born counterparts, who are more evenly distributed across all the high-tech sectors, immigrant-owned high-tech businesses are more concentrated in a limited number of industries. We use the Location Quotient (LQ) to calculate the relative concentration of immigrant versus U.S.-born across the detailed high-tech industrial sectors. If LQ >1, it suggests the group of interest is more concentrated in sector i when compared to the share of this sector nationally. The overall foreign-born labor force in high-tech industries is more concentrated in sectors such as semiconductor, other electronic component, magnetic, and optical media (LQ=1.6), communications, audio/video equipment (LQ=1.4), and computer science-related sectors (LQ=1.3).

Table 1. Industrial Distribution (Location Quotient) of High-Tech Workforce and Entrepreneurs, 2011

Industry	All Workers		Entrepreneurs	
	U.S.-born	Foreign-born	U.S.-born	Foreign-born
Pharmaceutical and medicine	1.0	1.2	0.9	1.4
Commercial and service industry machinery	1.0	0.9	1.0	1.2
Computer and peripheral equipment	0.9	1.3	0.9	1.4
Communications, audio and video equipment	0.9	1.4	1.0	1.1
Semiconductor, other electronic component, magnetic, and optical media	0.9	1.6	0.9	1.4
Navigational/measuring/medical/control instruments	1.0	0.9	1.0	0.9
Aerospace products and parts	1.1	0.8	1.0	1.1
Medical equipment and supplies	1.0	1.2	0.9	1.5
Software publishers	0.9	1.2	1.0	1.2
Motion pictures and video	1.1	0.6	1.0	0.8
Telecommunications	1.1	0.7	0.0	0.0
Internet service providers, web search portals, and data processing services	1.1	0.7	1.1	0.6
Other information services	1.0	0.8	0.9	1.3
Architectural, engineering, and related	1.1	0.7	1.0	0.8
Computer systems design and related	0.9	1.3	1.0	1.1

Scientific R&D	1.0	1.1	1.0	0.9
Medical and diagnostic laboratories	1.0	0.8	0.9	1.3

Source: Authors' calculation of Census 2000 and ACS 2007–11 combined
PUMS samples.

2. Spatial Distribution of Immigrant High-Tech Entrepreneurship

Immigrant-owned high-tech businesses are not evenly distributed across the metropolitan labor markets. We use two metrics to summarize their relative spatial concentration as compared to the U.S.-born population at the MSA level. We first use the Herfindahl-Hirschman Index. The second metric is the share in the top twenty-five MSAs (during the 2007–2011 period) of all metro workers/entrepreneurs.

Table 2. Concentration Measures across MSAs, 2011

	Herfindahl-Hirschman index (HHI)			Share of Top Twenty-five MSAs		
	Immigrant	U.S.-born	All	Immigrant	U.S.-Born	All
			All workers			
2000	0.057	0.014	0.018	73.2%	45.2%	49.7%
2011	0.046	0.014	0.018	70.5%	45.1%	50.2%
			All High-Tech Workers			
2000	0.054	0.020	0.024	57.1%	79.9%	61.3%
2011	0.046	0.018	0.022	77.7%	54.5%	59.6%
			All High-Tech Entrepreneurs			
2000	0.070	0.024	0.029	80.2%	57.8%	61.2%
2011	0.058	0.023	0.028	78.3%	57.5%	61.4%

Source: Authors' calculation of Census 2000 and ACS 2007–11 combined PUMS samples.

Based on HHI indices, immigrants have a greater spatial concentration in all time-group combinations than their U.S.-born counterparts do. Across different groups, immigrant high-tech entrepreneurs demonstrate the highest concentration, surpassing all high-tech workers and all workers. Interestingly, all indices are lower in 2011 than in 2000, suggesting a deconcentrating trend among the immigrant population, which is consistent with a growing literature that documents immigrants' dispersing settlement patterns. As for the share measures, the top twenty-five MSAs host up to 80 percent of all immigrant high-tech entrepreneurs as compared to about 58 percent of U.S.-born high-tech entrepreneurs in both 2000 and 2011. These results all point to the overall greater agglomeration among immigrant high-tech entrepreneurs across metropolitan areas.

Table 3 lists the top twenty-five MSAs by their share of all metro high-tech entrepreneurs in 2011 and displays their total and normalized number and change over the last decade. As is evidenced in Table 3, the three metros of New York, Los Angeles, and San Francisco alone account for about a third of all immigrant high-tech entrepreneurs in the country in 2011. This may not be surprising, given their historical ties as the largest immigrant gateway metros. Worthy of note is the fact that several other metros, including Atlanta; Chicago; Fort Lauderdale, Fla.; Houston, Texas; Miami;

Riverside, Calif.; and Washington, D.C., registered substantial growth over the last decade. Interestingly, the Silicon Valley metros—San Francisco and San Jose—did not experience substantial growth. We also map out these patterns for the top fifty MSAs.

Table 3. High-Tech Entrepreneurs for Top Twenty-five MSAs

| | 2011 | | | | | | 2000–2011 Change | | | |
| | Immigrants | | | U.S.-born | | | Immigrants | | U.S.-born | |
MSA name	Number	Share	Per 10,000	Number	Share	Per 10,000	Number	Per 10,000	Number	Per 10,000
Atlanta, GA	2502	2.4%	9.6	10631	2.4%	40.9	1543	5.1	2301	2.0
Austin, TX	859	0.8%	9.8	5667	1.3%	64.6	546	5.0	2301	12.7
Baltimore, MD	1128	1.1%	7.9	5162	1.2%	36.0	688	4.5	1221	5.5
Boston, MA-NH	2184	2.1%	9.6	10911	2.4%	48.2	432	1.3	988	0.9
Chicago, IL	4162	4.0%	8.7	15268	3.4%	31.7	1643	2.9	2482	2.7
Dallas-Fort Worth, TX	2191	2.1%	6.8	12235	2.7%	37.8	932	2.0	2221	-0.3
Denver-Boulder, CO	988	0.9%	7.0	8772	2.0%	62.0	469	2.7	1538	2.5
Detroit, MI	1001	1.0%	4.7	5405	1.2%	25.3	574	2.7	389	2.2
Fort Lauderdale, FL	2450	2.3%	25.8	3167	0.7%	33.4	1298	11.5	760	3.5
Houston-Brazoria, TX	2687	2.6%	9.6	8142	1.8%	29.0	1331	3.2	1164	-3.7
Los Angeles-Long Beach, CA	15903	15.2%	24.2	37966	8.5%	57.8	4967	5.1	6355	2.6
Miami-Hialeah, FL	4630	4.4%	37.4	2923	0.7%	23.6	1900	10.0	1028	4.6
Minneapolis-St. Paul, MN	739	0.7%	4.1	7198	1.6%	40.3	157	0.5	104	-3.6
New York, NY	14487	13.9%	15.8	34207	7.7%	37.3	4538	3.7	5786	2.8
Orlando, FL	1093	1.0%	9.7	4910	1.1%	43.7	639	4.3	2026	9.3
Philadelphia, PA	1581	1.5%	5.7	9602	2.2%	34.7	579	1.7	647	-0.9
Phoenix, AZ	1392	1.3%	7.3	7191	1.6%	37.9	742	3.0	610	-5.7
Portland, OR	764	0.7%	6.9	6184	1.4%	55.7	41	-0.6	1419	6.2
Riverside, CA	1853	1.8%	9.5	4888	1.1%	25.1	1221	4.9	2086	4.9
San Diego, CA	2492	2.4%	15.6	8486	1.9%	53.1	912	4.4	2121	8.0
San Francisco, CA	5627	5.4%	21.5	16005	3.6%	61.3	862	1.8	2243	4.3
San Jose, CA	3133	3.0%	33.7	4714	1.1%	50.7	615	5.1	325	0.9
Seattle-Everett, WA	1796	1.7%	12.2	9100	2.0%	61.8	632	3.2	2803	13.1
Tampa-St. Petersburg, FL	1197	1.1%	8.6	5671	1.3%	40.9	637	3.7	1341	2.8
Washington, DC	4943	4.7%	15.8	11915	2.7%	38.0	2597	6.8	1814	-0.6

Source: Authors' calculation of Census 2000 and ACS 2007–11 combined PUMS samples.

Figure 1 maps out the distribution of all immigrant high-tech entrepreneurs among the top fifty MSAs in 2011, and Figure 2 demonstrates their change between 2000 and 2011.

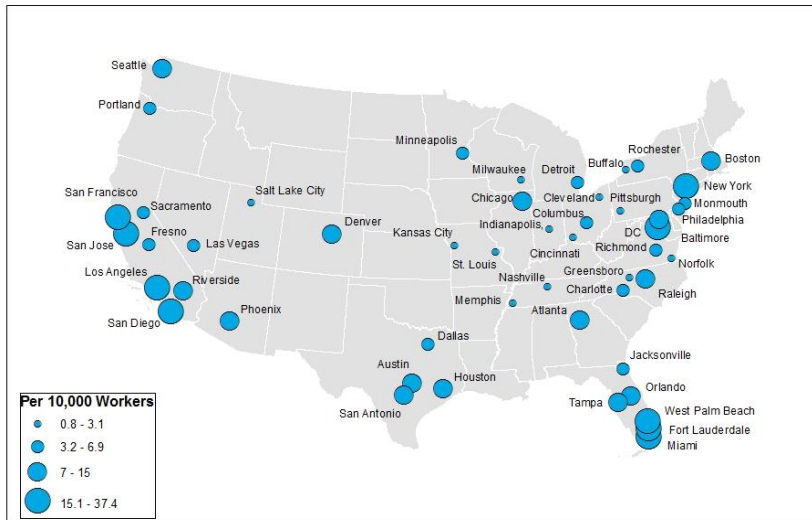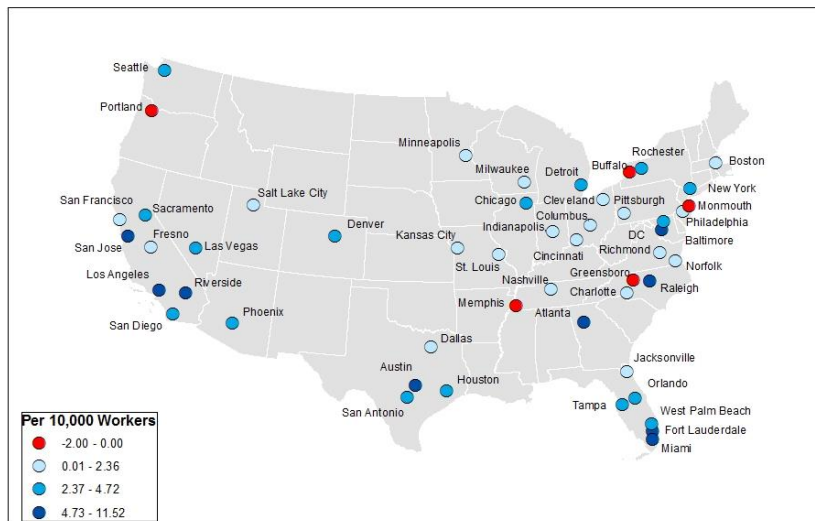Figure 1. Immigrant High-Tech Entrepreneurs by MSA, 2011

Figure 2. Immigrant High-Tech Entrepreneur Growth by MSA, 2000–2011

3. Regression Results

Table 4 presents the model results that display the impact of MSA-level characteristics associated with the number of high-tech entrepreneurs per 10,000 labor force. The first two columns show the comparison between the immigrant and U.S.-born high-tech entrepreneurs. Results suggest that a metropolitan area with a historically high foreign-born population, a higher ethnic diversity, a stronger base of high-tech industries, and higher innovation capacity is more likely to have a higher level of immigrant high-tech entrepreneurship. Specifically, holding all other conditions constant, a 10 percent increase in percentage of the foreign-born in a metropolitan area in 1970 implies an increase of 5.58 self-employed immigrants in high-tech industries per 10,000 labor force in 2007–2011. This suggests that the context for immigration matters. Similarly, percentage of high-tech industries, producer services, and college graduates and the total number of patents in 2000 are all significant positive predictors of immigrants in high-tech businesses.

Similar to immigrants, the total number of high-tech businesses for U.S.-born entrepreneurs is higher in metropolitan areas with a stronger base of high-tech industries and higher innovation capacity. However, a historical immigrant presence and ethnic diversity of the regional labor market are not significant for U.S.-born entrepreneurs. Metropolitan areas with higher percentages of construction and social services tend to have a higher number of native-born-owned businesses in high-tech industries.

Table 4. Regression Results on MSA-Level High-Tech Entrepreneurs in 2011 (Per 10,000 labor force)

Variable	Immigrant	U.S.-Born	Immigrant	
			Medical	Computer
Foreign-born Share	0.558***	-0.057	0.066**	0.347***
Ethnic Diversity	6.912***	3.002	1.313**	6.013***
Unemployment Rate	-0.218	0.643	-0.026	-0.276*
Incorporation Rate	-0.041	-0.391**	-0.016	-0.014
Manufacturing Share	-0.033	-0.06	0.018	0.022
Construction Share	0.283*	3.546***	0.095*	-0.079
Trade Share	0.134	-0.056	0.017	0.153
Social Services Share	-0.045	0.314*	0.035	0.0479
High-Tech Index	1.005**	11.562***	0.312***	1.264***
Intercept	-1.381	2.114	-1.835	-2.965
R^2	0.4972	0.5388	0.1786	0.5125
N	283	283	283	283

* $p<0.05$; ** $p<0.01$; *** $p<0.001$

Notes: Foreign-born share is from year 1970; all other variables from year 2000.
High-Tech Index is a composite variable of four factors: percent high-tech, percent producer service, percent bachelor's degree, and (ln)number of patents in 2000.

Medical is medical and pharmaceutical industry, including manufacturing, services, and R&D.

Computer is computer sciences, electronic engineering industries in manufacturing, services, and R&D.

The next two columns show immigrant entrepreneurs results for two industrial groups: medical and computer/IT. Similar to the overall model for the entire immigrant group, a historical immigrant concentration in the metropolitan area and a strong base for high-tech industries are significant predictors for both of these models. In addition, a metropolitan area with a higher unemployment rate is less likely to have a large immigrant high-tech presence in computer and IT-related industries.

These patterns suggest that the number of immigrant owned high-tech businesses are highly contingent on both the regional industrial structure and immigrant/minority population. A high presence of similar industries or agglomeration of high-tech industries at the regional level signals a favorable environment critical to creative activities. By locating in these regional labor markets, immigrant high-tech businesses could have better access to markets, financial resources, critical capabilities and skills, and institutional support that constitute an "entrepreneurship environment" (Malecki, 1997, p. 164). "Embeddedness" in a regional milieu that is conducive to innovation is important for both immigrant- and U.S.-born owned high-tech businesses.

At the same time, immigrant high-tech businesses are more likely to be located in metropolitan areas that have higher historical share of the foreign-born population and higher ethnic/racial diversity. The positive association among these variables could be derived from several sources. First, a large immigrant population directly increases the base of both potential immigrant business owners and co-ethnic labor demanded by immigrant businesses. Previous studies have found that immigrant entrepreneurs begin by working for co-ethnic firms and then move to self-employment in an ethnic enclave before they expand to wider non-ethnic markets (Iyer and Shapiro, 1999). Destinations with a historically high level of immigration also may be more accepting of immigrant-owned businesses. In addition, a regional labor maker with higher ethnic diversity and a larger foreign-born population is more likely to be open, tolerant, and creative in producing high levels of entrepreneurship. This finding is consistent with previous studies on immigrant-owned businesses or ethnic self-employment in general (Hart et al., 2011; Wang, 2010, 2012). The overall pattern suggests that immigrant entrepreneurs in high-tech industries strategically take advantage of both classic resources favorable to high-tech industries in general and ethnic- or immigrant-bounded resources provided by large immigrant populations.

CONCLUSION AND DISCUSSION

While previous studies on immigrant entrepreneurship and have focused largely on small businesses in low-skilled industries, this study examines the characteristics spatial patterns of immigrant entrepreneurship in high-tech industries in the United States on the metropolitan level. Commensurate with their increasing share in the U.S. population, immigrants' participation in high-tech industries as both workers and business owners has increased steadily since 2000, at a faster rate than for their U.S.-born counterparts. Also different from the U.S.-born, who are more evenly distributed across all the high-tech sectors, immigrant owned high-tech businesses are more concentrated in a limited

number of industries, such as computer sciences and medical and pharmaceutical-related fields.

Immigrant-owned high-tech businesses have different spatial concentration patterns across metropolitan areas than the U.S.-born do. In particular, immigrant high-tech entrepreneurs are more likely to be concentrated in select metropolitan areas, although there has been slight deconcentration across the first decade of this century. While the largest immigrant gateways account for a dominant share of all immigrant high-tech entrepreneurs in the country in 2011, new immigrant destinations in the South and West have seen significant increase of immigrants in high-tech industries.

In understanding the spatial patterns across metropolitan labor markets, this study finds that, for both immigrants and the U.S.-born, a higher number of high-tech businesses is positively associated with regional labor markets that have an overall higher percentage of high-tech industries. At the same time, higher ethnic diversity and a larger share of the foreign-born population are crucial factors in attracting or fostering immigrant high-tech entrepreneurship on the metropolitan level. Findings from this study suggest that a historic base of high-tech industries and innovation capacity in terms of college graduates and patents is conducive to innovation and high-tech entrepreneurship.

It is worth noting that residential location choice on any geographic level is an endogenous process that is contingent on area characteristics, but also helps shape area characteristics. Though we try to control such simultaneity through lagged models to account for the time any effect will take place, we cannot make a strong claim that these are causal relationships. Another limitation of this study is that we have to approximate high-tech entrepreneurship with self-employment due to lack of public data at the firm level with owners' information and their geographic identification. Future research also will investigate the benefits of agglomeration for both residential clustering and firm location. Urban economic theory is not definitive as to the location of knowledge spillovers. Most models assume firm location and residential location are the same. However, it might be the case that knowledge spillovers could happen near one's residence rather than one's firm location.

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APPENDIX

Appendix A. List of NAICS codes for High-Tech Industries

	High-tech manufacturing industries
3254	Pharmaceutical and medicine manufacturing
3333	Commercial and service industry machinery manufacturing
3341	Computer and peripheral equipment manufacturing
3342	Communications equipment manufacturing
3343	Audio and video equipment manufacturing
3344	Semiconductor and other electronic component manufacturing
3345	Navigational/measuring/medical/control instruments manufacturing
3346	Manufacturing and reproducing magnetic and optical media
3364	Aerospace products and parts manufacturing
3391	Medical equipment and supplies manufacturing
	High-tech services industries
5112	Software publishers
5121	Motion picture and video industries
517	Telecommunications
518	Internet service providers, web search portals, and data processing services
5191	Other information services
5413	Architectural, engineering, and related services
5415	Computer systems design and related services
5417	Scientific R&D services
6215	Medical and diagnostic laboratories

Appendix B. Independent Variables and Definitions

Name of Variable	Coding Strategy
Immigrant Share	Share of the immigrant population in 1970
Ethnic Diversity	ethnic diversity = $1-\mathrm{sum}(Race_i)2$
Unemployment Rate	unemployment rate
Incorporation Rate	rate of incorporation among all the self-employed labor force
Manufacturing Share	percentage of labor force in manufacturing
Construction Share	percentage of labor force in construction
Trade Share	percentage of labor force in wholesale and retail trade
Social Service Share	percentage of labor force in education, social service, art and recreation, personal service
High-Tech Index	composite index composed of four variables: high-tech industry share, producer service share, share college degree or higher in the labor force and number of patents