Highly Qualified Mexican Migration: 1990-2013

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Abstract:
The phenomenon of highly qualified Mexican migration has received little attention, and even less has been given to migrants with post-graduate studies. This is principally due to the scarcity of information sources to directly examine the number of qualified migrants worldwide and their characteristics. This paper offers an indirect estimate of the number of qualified Mexicans residing abroad, a figure estimated at 2.22 million in 2013. Drawing on data from the U.S. Census Bureau, this research analyzes the trends of highly qualified Mexican immigrants in the United States in 1990-2013. It also presents a descriptive analysis with ACS 2011-2013 data for migrants with post-graduate studies in the fields of Science, Technology, Engineering, and Mathematics (STEM).
Key Words: Qualified migration, qualified immigrants, post-graduate studies, education level, human capital.

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Introduction

Highly qualified migration has undeniably become increasingly relevant in the modern age, not only in terms of the greater selectivity of migration flows, but also in terms of what this trend means for the development prospects of both origin and destination countries. Some of the concepts that researchers have used to analyze these migration flows include the "brain drain," describing the loss of a population that could be harnessed to promote economic development in the country of origin; "brain waste or abuse," referring to the high number of migrants whose capacities are undervalued when they perform activities that do not match their qualifications or run up against barriers to validate their credentials (Bauder, 2003); "brain gain," meaning that there are incentives for potential migrants to accumulate more human capital, and not all of them end up emigrating (Böhme and Glaser, 2014); "brain circulation" or "brain exchange," and the diaspora, which emphasizes potential benefits for boosting development in origin countries (Docquier and Rapoport, 2011). No single approach is exclusive. Insofar as migrants are considered inputs and outputs, it is certainly possible for the brain drain for some to coexist with a brain gain for others, especially with new forms of mobility (Pellegrino and Martínez, 2001; Martínez, 2005).

The case of Mexico, however, as will be demonstrated below, is not one of the win-win circulation of talent. Tuirán and Ávila (2013) underscored the importance of qualified

migration as a dynamic and complex phenomenon with real and potential benefits, not only in the immediate present, but also in the medium and long term. Their study has become vital to the design of public policies and strategies to better take advantage of this potential to develop innovation systems that contribute to the strengthening and development of sending countries by way of efficient linkages and/or temporary or permanent return strategies. Qualified and highly qualified migration, particularly in Science, Technology, Engineering, and Mathematics (STEM) fields, is becoming a matter of strategic importance for countries of origin.

The United States is the top destination country for migration worldwide, and for qualified migration, in particular. In 2013, the country was home to 45.8 million international immigrants (UN, 2013), of whom 19.6 million held at least one higher education degree. Of the last group, "more than two million were born in Mexico" (ACS, 2013). Similarly, Mexico is now ranked sixth worldwide on the list of countries that export professionals in all areas of knowledge, according to data from the Organization for Economic Cooperation and Development (OCDE, 2013).

Given the dimensions and ranking of Mexico's position in the global context as an exporter of professionals, the objective of this research is to quantify the volume of qualified and highly qualified Mexicans living abroad, and, in particular, examine the number of Mexican immigrants with graduate-level studies in order to elucidate their demographic and labor-related characteristics, as well as areas of specialization and employment. The qualified and highly qualified population is defined based on level of education. As such, the term highly qualified[1] (QA) refers to those individuals with undergraduate studies, while the term highly qualified (HQA) refers to people with graduate school studies.[2]

This paper is organized into two sections. The first provides an overview of available sources of information dating back to the 1990s to study qualified migration from Mexico, evaluating their strengths and weaknesses. Based on this overview, we offer an estimate of the number of QA and HQA Mexican emigrants living abroad in 2000, 2010, and 2013. The second section focuses on Mexican QA emigrants residing in the United States, with a special emphasis on those who have completed graduate-level studies.

Estimating the number of qualified and highly qualified mexican migrants

The study of QA and HQA migration tends to be limited by virtue of the lack of information available and comparable over space and time, which entails a methodological challenge to learning about the volume of this migration and profiling it. To this difficulty are added the diverse criteria used to define QA migrants, which vary by age, level of education or

[1] The abbreviation QA refers to the group of qualified people and includes the following levels of education: any bachelor's degree or related; the abbreviation HQA refers to the highly qualified population, or people who have earned a master's degree, professional degree, or PhD.

[2] Throughout this document, we refer to highly qualified migration to include people with graduate studies and vice versa.

employment, or a combination of both (Pellegrino and Martínez, 2001). Despite the fact that population censuses are the most suitable source of information for population studies, they also exhibit three challenges: *1*) timeframe, because not all countries conduct census surveys with the same frequency and some do not do a census at all; *2*) comparability, because they do not necessarily include information about education level and type of employment in the same way, which certainly has an impact on defining qualified migration; and *3*) sample size, that is, when there is information available about migrants from certain countries or groups of countries represented in the country on the available census and at certain ages.

In order to understand the magnitude and nature of international QA and HQA migration, we drew on information sources generated by the recipient countries, including censuses and/or household surveys. On occasion, in order to learn more about the volume of migration, we used statistical techniques or models to compensate for data gaps. Despite the use of sophisticated statistics techniques, QA migration continues to be one of the most difficult phenomena to measure. As proof of this, we need only mention that at the moment, there are currently four major projects aiming to study this topic, but only one has been updated to the 2010s.

The first project is handled by the OECD. This project gathers information about immigrants in member countries (DIOC)[3] and non-member countries (DIOC-E). The information in the DIOC has been compiled by the OECD with the support of the statistics offices in each country; however, when this is not possible, it resorts to information available on IPUMS-International, led by the Minnesota Population Center, Eurostat, and data available at IMILA-CELADE. The 2000 version includes information for 28 member countries, while the 2010 version includes 34 OECD countries with people aged 15 years and older, education level, gender, occupation, duration of stay, and other socioeconomic variables depending on the country of birth. For more details about the methodology and definition of variables, refer to the OECD (2008) and Artuc *et al.* (2015).

The OECD database on immigrants in member and non-member countries, DIOC-E (version 3.0), was created using census data from the year 2000. It includes information from 100 countries and 32 OECD member countries. For the population of 15 years and older, it provides information about socio-demographic data, duration of stay, labor characteristics, such as the condition of activity, occupation, and economic sectors, knowledge field, education level, and birth country.

Information in the DIOC-E was taken from population censuses for 89 countries, four national records systems, and four job surveys, as well as household surveys and public access sources (IPUMS-International, IMILA-CELADE through REDATAM and online searches). This means that in some cases, the information cannot be disaggregated beyond the regional or even continental level.

The second project is International Migration in Latin America (IMILA), led by the Population Division of the Latin American and Caribbean Center for Demographics of the Economic Commission for Latin America and the Caribbean (ECLAC). It contains information from national population and housing censuses conducted in 1990 and 2000. The website allows users to search 12 tabs of information online by country of birth. There is also a way to search by country of residence in the five years prior to the information survey.

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[3] Available through the OECD DIOC website with reference years 2000/1, 2005/6, and 2010/11. The DIOC-E database is only available for reference years 2000/1, but 2010/11 is currently under construction together with the World Bank and Oxford University.

This database provides information on the population 10 years of age and older by degrees earned by age and gender. The information is organized by country of origin or birth and country of destination or residence, and the information archives are available for a minimum number of 500 records; otherwise the information is aggregated at the regional or continental level.

The third database project aims to gain an understanding of the size of the HQA migrant population worldwide, and was created by Artuc *et al.* (2015) and Docquier *et al.* (2011). It is an extension and improvement upon the World Bank database containing information about the migrant population in the world, *Global Bilateral Migration*, which does not include information about education level. It contains bilateral matrices with information for 190 countries, counting the migrant population aged 25 years and older in censuses conducted in 1990 and 2000, sorted by country of origin and destination, gender, education level, and age at which the person moved to the destination country. They use pseudo-gravity regression models to calculate unavailable values.

A fourth project, which is the most important to the study of Mexican QA and HQA migration, is led by the U.S. Census Bureau and the Bureau of Labor Statistics (BLA), considering that Mexico is the Latin American country that has sent the highest number of QA and HQA migrants to the United States (UN, 2013).

Methodological and theoretical-conceptual limitations

The three sources in Table 1 define a qualified migrant as "someone who lives in a country other than that in which he or she was born, with a certain level of education." The OECD defines this group as people with tertiary studies, the IMILA as people with 10 years of schooling or more, and Artuc *et al.* (2015) as people with university studies or more. The operational challenge in this definition resides in the different ways in which countries gather information. For example, some countries do not ask a question about country of birth, but do include country of nationality or citizenship, which is different from country of birth (see Table 1).

The data used vary by the source from which they were gathered. The majority draw on population censuses, while others add in information from household surveys and national records. Four of the most significant limitations are as follows: *a*) periodicity of the data in terms of dates on which surveys are conducted and continuity; *b*) the sample size when the data come from parallel surveys conducted alongside the census; *c*) the lack of data for some countries and years; and *d*) statistical representativeness of the target population group.

The aforementioned limitations obey the various methodologies applied for missing data, including extrapolation techniques, aggregation of data at the regional level, and even missing figures. Despite the limitations of the information, a few major trends observed in these information sources for the period 1990-2000 emerge, in the case of Mexico:

1) Significant growth in the amount of qualified Mexican migration. Data from Artuc *et al.* (2015) show that the population aged 25 years or older with university studies tripled from 370,000 to 961,000.

2) There is a "volume effect" observed in the DIOC-E-2000/1 data. The United States is the destination with the highest number of Mexicans aged 25 years or older with

tertiary education. In 2010, of the 846,000 Mexicans with tertiary education abroad, only 74,000 were living in a country other than the United States.

3) However, there is also a "selectivity effect," given that the percentage of Mexicans with tertiary schooling as compared to the total population of Mexicans in the United States is 4.9%, while for the rest of destinations, the percentages were closer to between 10% and 50%.

Table 1. Methodological Limitations of the Sources Available About Qualified Migration

Definitions	*DIOC and DIOC-E from OECD*	*IMILA-CELADE*	*Artuc et al. (2013)*
Volume of qualified Mexicans			
1990 censuses		7 502	370 004
Population censuses and/or household surveys 2000 and 2001; 2005 and 2006; 2010 and 2011	DIOC-2000/01: 473,923 DIOC-E 2000/01: 484,327	12 312	961 241
Total destinations identified	DIOC 2000/01: 232 countries DIOC-E 2000/01: 232 countries DIOC 2005/06: 225 countries DICO 2010/11: 230 countries	1990: 15 countries 2000: 13 countries	208 countries
Mexico with respect to other country totals	DIOC 2000/01: 6th of 232 countries DIOC-E 2000/01: 11th of 232 countries DIOC 2005/06: 5th of 225 countries DICO 2010/11: 6th of 230 countries		8th of 190 countries
Definition of qualified migrant			
1. Country of birth	A migrant is someone living in a country other than where he or she was born		
2. Schooling	Qualified according to your level of education		
Definition of information sources			
1. Population and housing censuses	x	x	x
2. National records	x		x
3. Occupational and job surveys	x		x

4. Other household surveys	x		x
Information from other countries			
	DIOC 2000/01: 232 countries DIOC-E 2000/01: 100 countries DIOC 2005/06: 27 countries DICO 2010/11: 33 countries	80	190
Definition of key variables			
1. Education level	Tertiary education	10y of schooling	University+
2. Age	15y+	10y+	25y+
3. Gender	x	x	x
4. Condition of activity	x	x	
5. Field of study	x	x	
6. Occupations	x		
7. Country of birth	x	x	x
Definition of treatment of missing data			
1. Extrapolation through estimated percentages	x		
2. Extrapolation using regression models			x
3. Aggregation at the regional or continental level	x	x	

Source: SIMDE-UAZ. Created by the authors based on Arslan, C. *et al.* (2014); Artuc *et al.* (2013); OCDE (2008 and n.d.a,b,c); CELADE (n.d.).

Estimating the population of highly qualified Mexicans living abroad, 2000, 2010, and 2013

As part of the methodological strategy, we reviewed microdata for the population censuses from 39 countries. The information from the Minnesota Population Center was used as a

suitable source.[4] Finally, we took into account census rounds available for 1990, 2000, and 2010, for countries with information on QA and HQA Mexican immigrants. Using this census information, and an indirect procedure, we constructed complete data series for the Mexican QA and HQA population, to then estimate the figures for the years 2000, 2010, and 2013.

The methodology used for QA and HQA Mexican migrants living in a country other than the United States was as follows: we considered the Mexican-born population aged 20 years or over at three levels of schooling: *1*) higher education studies, but no degree; *2*) bachelor's degree; and *3*) graduate degree. In total, we obtained data for 26 countries, including the United States.

It should be noted that the data for all years considered was incomplete and, as such, we resorted to an indirect technique to complete the series for the years 2000 and 2010. The data obtained for the years 1990, 2000, and 2010 were grouped into three regions: North America (excluding the United States), South American and Central American countries, and countries from another continent. For the specific case of QA Mexicans living in the United States, we had data for all three levels of schooling and the years considered in the estimate, and as such, no additional treatment was necessary.

For the years 2000 and 2010, the populations were constructed with incomplete data by applying the growth rates for 1990-2000 and 2000-2010 for each regional group. Once the complete series was obtained for 2010, growth rates for 2000-2010 were calculated in order to estimate figures for the 2013 population. This procedure was applied separately at all three levels of schooling considered. The total sum of the procedure applied to each population subgroup produced the total number of QA and HQA Mexicans living abroad in 2013.

Table 2 presents the final results of the estimate. Needless to say, despite having been estimated with census sources, we must consider these data to be an underestimate, because information was lacking for some countries that are certainly home to QA and HQA Mexico migrants. The population estimate of qualified Mexicans abroad amounted to 2,217,150 in 2013, of whom 53.5% had completed some higher education without a degree, 37.7% held bachelor's degrees, and 8.8% graduate degrees.

The distribution by destination country indicates that 97% of Mexicans abroad with some higher education but no degree, 87.8% of Mexicans abroad with a bachelor's degree, and 81.7% of Mexicans abroad with a graduate degree live in the United States. The data also reveal less diverse destinations for QA Mexican migrants than for HQA Mexican migrants. It could be asserted that at greater selectivity, the more diverse the geographic spread of the Mexican diaspora, considering that 12.2% of Mexicans abroad with a bachelor's degree, versus 18.3% of Mexicans abroad with graduate studies, have chosen as their destination country a nation other than the United States.

The following are the top destinations for Mexicans with graduate studies: United States, Spain, Switzerland, Canada, and Colombia, the first four of which have a very high level of human development, and three of which are among the five top-rated countries in human

[4] IPUMS-International: the world's largest archive of publicly available census samples, which is available for free at the level of microdata. The information dates back to 1960 and is harmonized across countries and years, which permits comparability and consistency between years and countries. At the moment, it contains microdata for 73 countries, including Mexico and the United States.

development.[5] Mexicans who hold bachelor's degrees display greater diversification in their destinations. Similar to Mexicans with graduate degrees, a higher proportion of bachelor's degree-holders select developed countries as their destinations (see Map 1).

Trends and characteristics 1990-2013

Statistics on international migration in the United States are kept by the Census Office and the Bureau of Labor Statistics (BLS). The American Community Survey (ACS) is a household survey *that turns out to be the best option for studying QA and HQA migration*, given its design and large sample size.

Table 2. Estimation of the Number of QA and HQA Mexicans Living Abroad 2000, 2010, and 2013

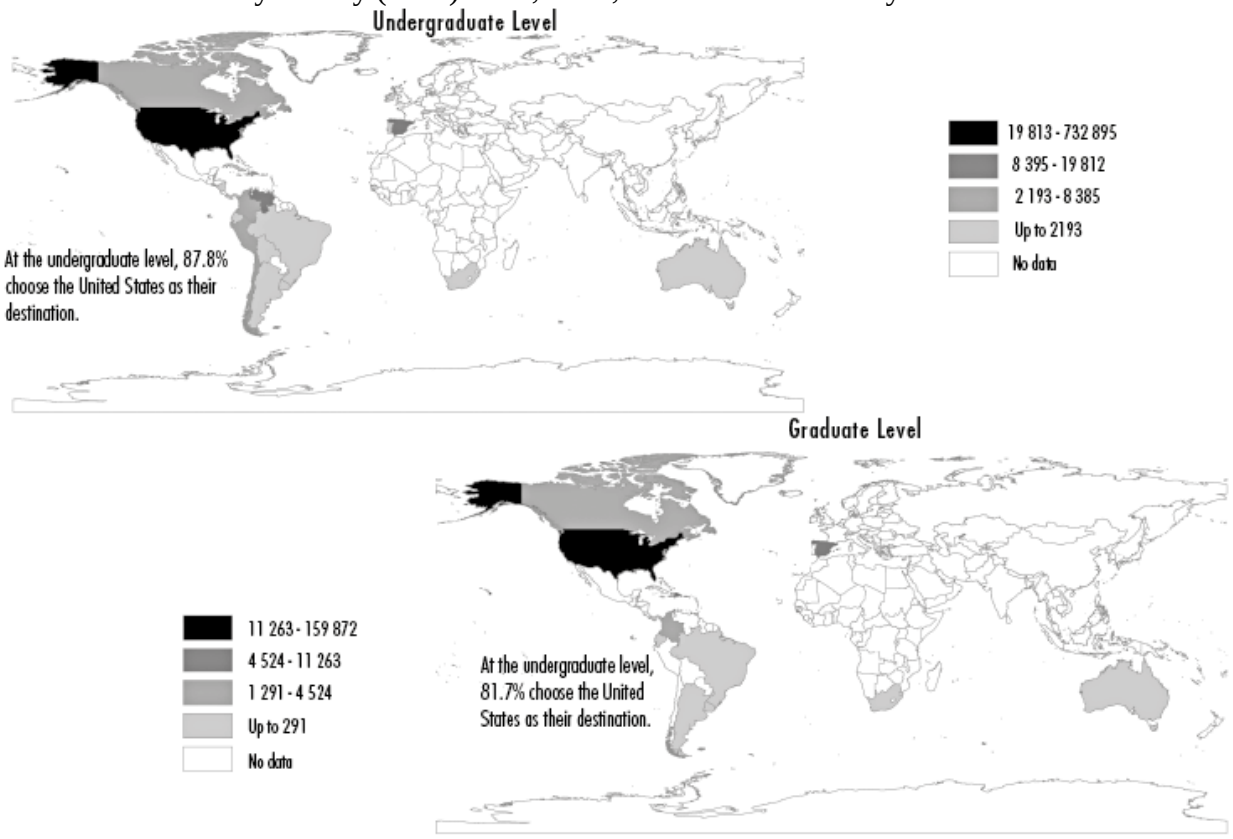
Level of higher education	*2000*		*2010*		*2013*		*Percentage Increase*		*Annual Growth Rate*	
	Stock	*%*	*Stock*	*%*	*Stock*	*%*	*2000 - 2013*	*2010 - 2013*	*2000 - 2013*	*2010 - 2013*
At least one or more higher education degrees	1 136 157	100.0	2 004 348	100.0	2 217 150	100.0	95.1	10.6	5.3	3.4
At least one higher education degree	689 305	60.7	1 108 346	55.3	1 185 804	53.5	72.0	7.0	4.3	2.3
Bachelor's Degree	392 824	34.6	731 637	36.5	835 570	37.7	112.7	14.2	6.0	4.5
Graduate Degree	54 028	4.8	164 364	8.2	195 776	8.8	262.4	19.1	10.4	6.0

Source: SIMDE-UAZ. Estimates made by the authors based on censuses from countries available at IPUMS International from the Minnesota Population Center, 2014 and UN-DESA, 2013; and U.S. Census Bureau, Percent Samples 1990, American Community Survey (ACS) 2000, 2010, and 2013. For further details or questions about the estimates, write to: selene_gaspar@yahoo.com.mx and monick.elorza@gmail.com.

Source: SIMDE-UAZ. Estimates made by the authors based on the country censuses available at IPUMS International from the Minnesota Population Center, 2014 and UN-

[5] UNDP, Human Development Report, available at: http://www.undp.org/content/dam/venezuela/docs/undp_ve_IDH_2013.pdf

DESA, 2013; and U.S. Census Bureau, Percent Samples 1990 and 2000, American Community Survey (ACS) 2000, 2010, and 2013. Created by the authors.



Map 1. QA and HQA Mexican Immigrants Abroad, 2013

Trends in Mexican Migration by Level of Schooling 1990-2013

This portion of the paper introduces how the number of Mexicans with higher education studies has evolved, with special mind paid to those who hold graduate degrees and live in the country's neighbor to the north, from the 1990s up until 2013. The flow of Mexicans that has traditionally characterized Mexican migration (working age and low-skilled) has slowed down, while, on the contrary, the number of Mexicans with higher education has grown, and has shown more momentum. This points to a rise in selectivity and the transfer of the QA and HQA labor force, which has consolidated over the years, because there are increasingly more forms of institutional and political support for their professional performance (Delgado, 2014a).

It is estimated that by 2013, the number of Mexican-born people living in the United States who hold at *least one higher education degree or more* was a little over two million; in 1990, this figure was 455,000 and in 2000, 1.1 million, meaning that the population would have more than quadrupled between 1990 and 2013.

In light of the significant volume of Mexicans living in the United States, it can be inferred that, by level of schooling, there are four main migration flows that have shaped Mexican emigration: *1*) low qualification, which has so characterized Mexican migration; *2*) medium

qualification, consisting of those who hold at least one higher education degree; *3*) the professionals; and *4*) those who have completed graduate studies. The first flow and the latter three comprise, to a certain extent, the two main groups identified by Bermúdez Rico (2010: 138), who wrote that these flows can be seen as two sides of the migration coin. For Mexico, it means reduced accumulation capacity and, as a result, a surplus of workers with no other choice but to migrate (Delgado, Márquez, and Gaspar, 2015: 116).

QA and HQA Mexican migration was more dynamic in the period of analysis than its peers from other parts of the world. Mexican immigrants with upper secondary education levels or less grew between 2000 and 2013 at an annual rate of 2.6%, which is lower than the rate found for those with at least one higher education degree or more (4.6% annually). Over the past 13 years, the number of Mexicans with at least one higher education degree or more grew at a rate above both the natives (2.2% annually) and the rest of immigrants (3.5% annually).

The population with a higher education degree, either undergraduate or graduate, amounted to 13.6 million in 2013, representing 16.2% of the total population with that level of education; Mexican migrants account for 6.5%, which in absolute terms, is equivalent to 893,000, a figure that was as low as 156,000 in 1990. Since then, this population has grown constantly. In fact, between 1990 and 2000, it more than tripled, and between 2000 and 2013, it nearly doubled, going from 464,000 in 2000 to 893,000 in 2013 (see Table 3).

In particular, the population of Mexican immigrants with a *bachelor's degree* during the observation period rose constantly and sharply. In percentage terms, the number increased by 550% between 1990 and 2013. For Mexico, this population represents 7.0% of the little more than 10 million undergraduate degree holders born in the country. Strikingly, women saw higher growth throughout the observation period, displaying a higher share than their male peers since 2005 (see Figure 1). The trend observed points to both the educational attainment of women, as well as the fact that migration is an equally viable and appealing option as it is for men (Tuirán and Ávila, 2013). The information shown confirms the growing selectivity of migration, in terms of education and gender. More professionals with higher degrees of schooling are emigrating (Márquez and Delgado, 2012: 104).

The data in this section exhibit a *selective trend* for Mexican migration, by virtue of the fact that in proportion to the total group of Mexicans abroad, there are increasingly more compatriots with higher education leaving the country, a trend that goes against what characterized Mexican migration in the past and has been accented against the backdrop of an overall slowdown in total migration in light of the crisis, especially if we also take into account QA and HQA migrants living outside of the United States.

This significant growth in QA and HQA Mexican migration[6] confirms the Clemens (2013: 1) study about the possibility that Mexican migration in the years to come will shift towards more QA migration. This argument is reinforced by other researchers who have looked at the demographic changes happening in both Mexico and the United States, and the fact that immigration policy in the latter country tends to display a greater affinity for QA migration.

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[6] At the graduate level in general, there are few trained human resources in Mexico (INEGI). In 2013, the National Autonomous University of Mexico administered 3,858 degree exams, 19.2% of which were doctoral exams (742) and 80.8% of which were master's degree exams (Source: DGAE, UNAM. Cut-off date: 31-XII-2014. Last date updated: 12-V-2014).

International networks of QA Mexicans constitute another factor that tends to promote and facilitate QA emigration out of Mexico.[7] Yet another aspect is related to the bilateral agreements that induce Mexican professionals to leave their home country as a result of the few opportunities available to them in the domestic labor market, in the current context of the *maquiladora* Mexican economy and asymmetrical integration with the United States economy. This is a trend that entails the "devaluation" of professional work, particularly in STEM fields in Mexico and, on the contrary, the promotion and encouragement of these same fields, made to look attractive, in the United States. Emigration forecasts may serve as a motivation to acquire more human capital, or graduate degree holders might look to the foreign market as an option rather than the national market (Gaspar, 2015). It has been documented that people who have completed studies abroad are potential candidates to join the QA migration wave (Martínez, 2011).

Table 3. Mexican-Born Population Living in the United States and Aged 20 Years or Over by Level of Schooling 1990-2013. Stock, Annual Growth Rate (per Hundred) and Percentage Increase

Level of Schooling	1990	1995	2000	2005	2010	2013	% Increase 1990-2013
Total	3 498 217	5 766 357	7 435 786	9 590 675	10 695 110	10 811 110	209.0
Upper secondary school studies or less	3 027 867	4 994 366	6 300 254	8 116 632	8 804 448	8 768 575	189.6
At least one higher education degree or more	**470 350**	**771 991**	**1 135 532**	**1 474 043**	**1 890 662**	**2 042 535**	**334.3**
At least one higher education degree	314 498	521 253	671 146	796 004	1 079 452	1 149 768	265.6
bachelor's degree	112 735	200 968	378 872	549 078	666 494	732 895	550.1
Graduate degree	43 117	49 770	85 514	128 961	144 716	159 872	270.8
Total	100.0	100.0	100.0	100.0	100.0	100.0	5.0
Upper secondary	86.6	86.6	84.7	84.6	82.3	81.1	4.7

[7] The author cites Zúñiga and Molina (2008); Borjas and Friedberg (2009); Chiquiar and Salcedo (2013); and McKenzie and Rapoport (2010).

school studies or less							
At least one higher education degree or more	**13.4**	**13.4**	**15.3**	**15.4**	**17.7**	**18.9**	**6.6**
At least one higher education degree	9.0	9.0	9.0	8.3	10.1	10.6	5.8
bachelor's degree	3.2	3.5	5.1	5.7	6.2	6.8	8.5
Graduate degree	1.2	0.9	1.2	1.3	1.4	1.5	5.9

Source: SIMDE-UAZ. Estimates made by the authors based on the U.S. Census Bureau, Percent Samples, 1990, CPS, 1995, American Community Survey (ACS), various years.

Highly qualified Mexican migrants (graduate level)

The academic and political debate about qualified migration has slowly moved away from the concept of the "brain drain," supplanting it with "brain or talent circulation" (Meyer, 2011, cited in Delgado, 2014b: 655). With this pivot, the pessimism and concern tied to South-North QA emigration has been transformed into optimism, replacing the notion of loss with that of gain (Delgado, 2014b: 655-656), where presumably, both nations win. However, asymmetrical integration means new forms of unequal exchange and the cheapening of labor (Delgado, Márquez, and Rodríguez, 2009: 50), which makes the gains derived from the exportation of the labor force significantly higher for Mexico's northern neighbor, in a situation in which Mexican migrants are on the short end of the deal.

Highly educated and specialized migrants with experience and accumulated knowledge constitute the fundamental critical mass needed to generate innovation, raise productivity, and boost economic growth and, therefore, to promote national development. The Mexican-born population with graduate studies living in the United States has grown in percentage terms between 1990 and 2013 by 271%, practically tripling in this time period. This subgroup, just like that of the professionals, was the most dynamic during the period of observation. It grew at an annual average rate of 7.1% between 1990 and 2000 and at 4.9% annually between 2000 and 2013, going from 43,000 to 86,000 in the first period and then reaching 160,000 people 13 years later (see Table 3 and Figure 1).

Source: SIMDE-UAZ. Estimates made by the authors based on the U.S. Census Bureau. Dataferret. Percent Samples 1990 and 2000 and American Community Survey (ACS), 2000-2012; Current Population Survey Match Supplementary (CPS) 1994-1998 and 2013-2014.

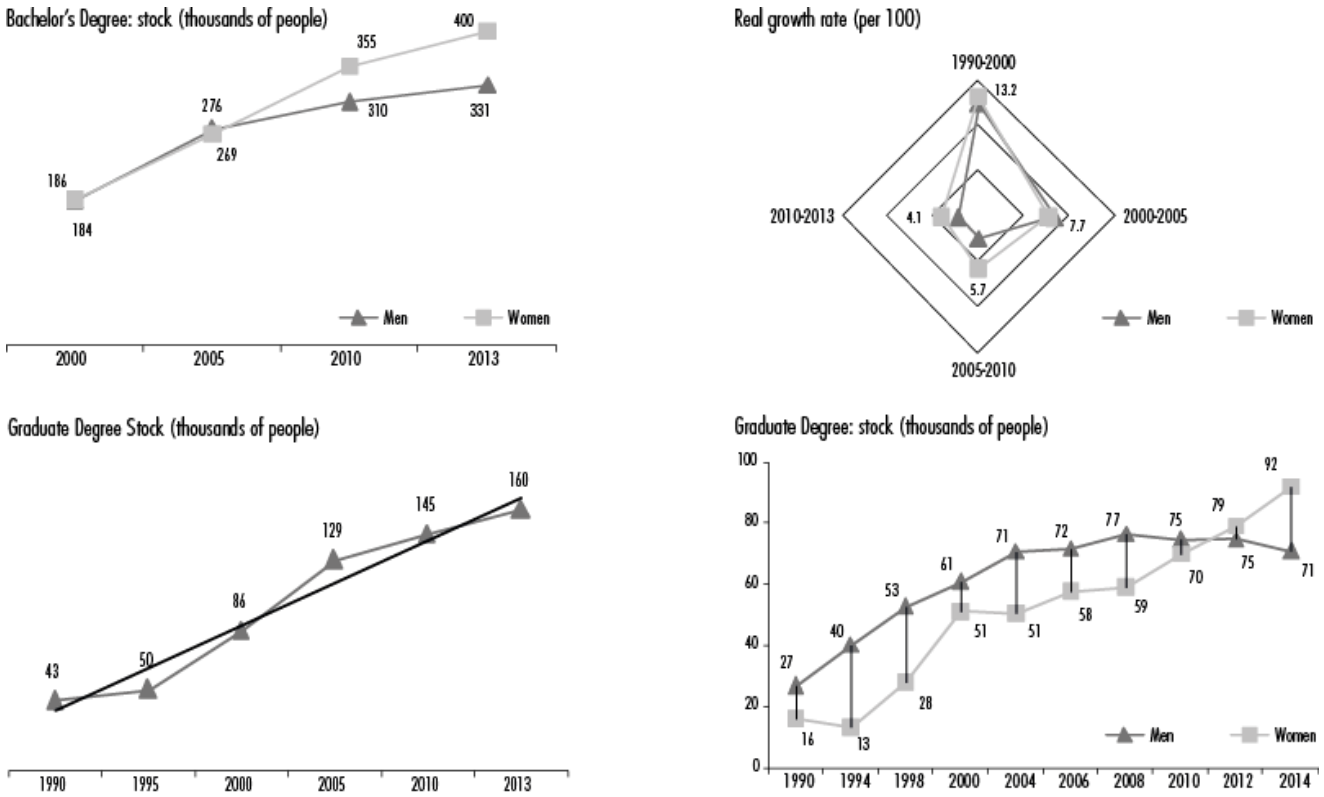


Figure 1. Mexican-Born Population Living in the United States with Undergraduate and Graduate Education 1990-2013. Total and by Gender.

Of the 160,000 Mexicans with graduate studies in the United States in 2013, 66.7% had master's degree studies, 24.3% professional degrees, and 9% doctorates. This ratio in 1990 was 43.2% master's, 46.9% professional, and 9.9% doctorate. The highest intensity of growth during the observation period was seen in the group of Mexican immigrants with doctoral studies.

In light of this scenario, as Delgado Wise wrote: "[…] the big challenge looming for Mexico consists of counteracting the dynamics brought on by highly qualified migration and detaching it from development processes in the country, to build an institutional framework that makes it possible to grow and harness the highly qualified Mexican population to support a large-scale, avant-garde, and sustainable national development project" (2014a: 8).

The importance of the share of women in the qualified migrant population is another of the peculiarities observed since the 1990s (Docquier *et al.,* 2009). As is true for those with a bachelor's degree, there are more women than men with graduate degrees, and women saw the greatest growth in this area over the past decade and the beginning of the current decade, both at the undergraduate and graduate level. The number of Mexican female graduate degree holders grew at an annual rate of 10.4% between 2000 and 2005, while for men, it grew at 4.1% annually. The higher growth intensity observed in the Mexican-born population with graduate degrees of both genders was seen in the 1990s and up until at least 2008, precisely when the economic crisis at the end of 2007 made itself felt (see Figure 1). These parameters confirm that women are more likely to take part in the QA and HQA migration flows that the United States receives.

In 2013, female Mexican migrants with master's or doctoral degrees represented 51.0% and 53.7%, respectively. At the professional level, the share of Mexican male immigrants is higher, as six out of ten have attained this level of schooling, while at the doctoral level, 46.3% are male and 53.7% are female.

Principal sending countries and the geographic distribution of graduate degree holders

Mexican immigrants holding graduate degrees play a key role in the economic dynamics of the United States. Based on the 1990 census and the 2013 ACS population survey in the United States, Mexicans are highly ranked as compared to other groups of HQA immigrants. In 1990, Mexican immigrants with graduate degrees were ranked ninth on the overall list with 43,000 people, with India and China as the top two countries with the greatest number of graduate degree holders in the United States. From 2000 to 2013, Mexico was ranked fifth, behind India, China, South Korea, and Canada (see Figure 2). The duality of the Mexican migration dynamics observed (unskilled and highly qualified) confirms the linkages and importance of Mexican migration for the United States.

The top countries sending people to the United States with a master's degree are India, China, South Korea, and Mexico. Among those holding professional degrees, India, Philippines, Canada, and Mexico stand out in the top four spots (see Figure 2). Looking at doctoral degree holders, the top three positions go to China, India, and South Korea; Mexico is ranked twelfth.

The heterogeneity of the destinations and places where QA Mexican migrants settle is one of the aspects that characterizes the current patterns of this migration in the United States (Gaspar, 2015). Map 2 displays that Mexicans with graduate degrees are located practically throughout the entire North American territory, and the importance of this migration in each state. Using data from the ACS, it was verified that in 14 states, Mexican migrants are ranked in the top five terms of number of HQA immigrants. These include California, Texas, Arizona, and Illinois, states where there is not only a high presence of Mexicans with graduate degrees, but also where the highest growth between 2000 and 2010-2012 was observed.

A significant portion of these immigrants did their studies in Mexico, but others completed their education in the United States (Tuirán and Ávila, 2013: 49). Approximately, "it is estimated that 22.7% did their entire education in the United States, 25.8% have mixed studies, beginning in Mexico and finishing in the United States, and 51.5% completed all of their academic training in Mexico" (Gaspar, 2015: 81).

An analysis of the profile of Mexicans holding graduate degrees indicates that 51.2% are male and the remaining 48.8% are female, with an average age of 46 years old, 68.9% married or in a free union, 55.3% have obtained citizenship, eight of every ten speak English well or very well, only 8% are poor, and the population is predominantly there for work.

Source: SIMDE-UAZ. Estimates by the authors based on the U.S. Census Bureau. Dataferret. Percent Samples 1990 and American Community Survey (ACS), 2000 and 2013.

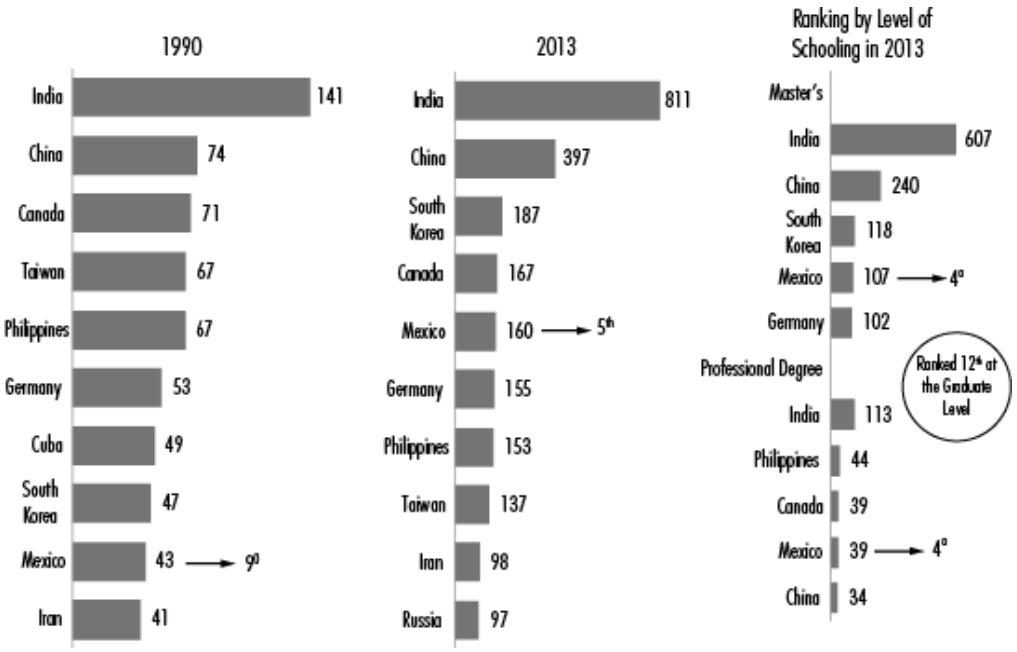


Figure 2. Top Sending Countries of People with Graduate Degrees Living in the United States 1990 and 2013 (thousands of people)

Knowledge areas of Mexican graduate degree holders: Mexico vs. The United States

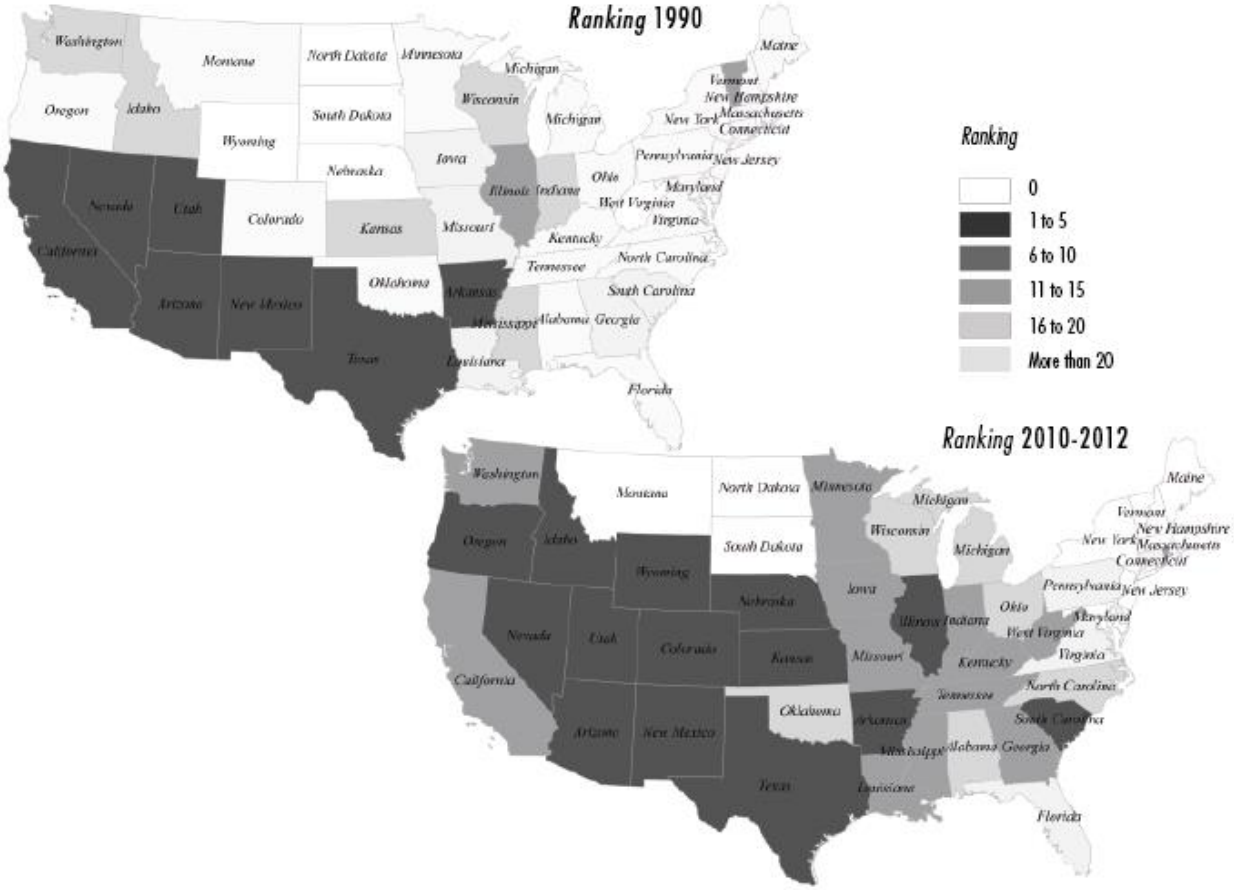
Table 4 presents information about the Mexican-born population with graduate studies as collected by the 2010 Population and Housing Census (CPV, 2010) for people living in Mexico, and the records kept by the ACS 2010 for residents of the United States by knowledge area. In 2010, 898,000 Mexicans held a graduate degree in Mexico and 145,000 living in the United States; altogether, the population adds up to a little over one million and represented 86.1% of the total number of Mexican-born graduate degree holders in the country. The relative weight of Mexican graduate degree holders in the United States with respect to those living in Mexico is 16%.

Graduates from professional careers and graduate degree programs constitute the principal members of the QA and HQA workforce joining the labor market every year. Table 5 lists the knowledge areas in which the Mexican population holding graduate degrees majored for their undergraduate degrees. The classification is organized into 12 categories, based on the classification categories used by the National Science and Technology Council (Conacyt).[8]

[8] The categories of majors were standardized using information from CPV 2010 and ACS 2009-2011. For this construction, we resorted to the following methodological documents: *Clasificación de las áreas de conocimiento (Classification of Knowledge Areas)*, by Conacyt; *Clasificación mexicana de programas de estudio por campos de formación académica* 2011(INEGI) (*Mexican Classification of Coursework by Academic Training Fields*); the CPV 2010 Catalogue of Classifications; and the ACS Catalogue. The proposal was reviewed and approved by the working group coordinated by Raúl Delgado Wise and Héctor

The majority of graduate degree holders in the country (72.2%) majored in the following four areas for their undergraduate studies: *1*) Administration, Business, and Finance (24.7%); *2*) Education (18.0%); *3*) Social and Economic Sciences (15.1%); and *4*) Engineering (13.7%).

Source: SIMDE-UAZ. Estimates made by the authors based on the U.S. Census Bureau. Percent Samples 1990 and the American Community Survey (ACS), 2010-2012.
Map made by Alfonso Velázquez Solorzano.



Map 2. Ranking by State of the Mexican-Born Population with Graduate Studies Living in the United States 1990 and 2010-2012

Table 4. Mexicans Living Abroad and in Mexico by Level of Schooling 2010. Bachelor's and Graduate Degrees.

Level of Higher Education	*Country of Residence*	*Relative weight of U.S.*	**Relative weight of*	*Ratio of U.S. residents to*	**Ratio of residents in*

Rodríguez Ramirez, focused on qualified migration. For more details and questions about the classification, write to: selen_gaspar@yahoo.com.mx.

	In the United States	%	Another Country	%	In Mexico	%	*residents (per 100)*	*residents abroad (per 100)*	*residents in Mexico (per 100)*	*another country (per 100)*
Bachelor's Degree or More	811 210	100.0	84 791	100.0	10 970 791	100.0	6.9	7.6	7.4	8.2
Bachelor's Degree	666 494	82.2	65 143	76.8	10 073 204	91.8	6.2	6.8	6.6	7.3
Graduate Degree	**144 716**	**17.8**	**19 648**	**23.2**	**897 587**	**8.2**	**13.9**	**15.5**	**16.1**	**18.3**

*Includes the United States.

Source: SIMDE-UAZ. Estimates made by the authors based on INEGI, the 2010 Population and Housing Census, and the American Community Survey (ACS) 2010, as well as own estimates of qualified migration abroad in 2010 based on country censuses in the database kept by IPUMS-International from the Minnesota Population Center, 2014 and UN-DESA, 2013; and the U.S. Census Bureau, Percent Samples 1990, American Community Survey (ACS), 2000, 2010.

In addition, 70% of Mexican immigrants with graduate studies had specialized in the following five fields: *1*) 18.3% in Administration, Business, and Finance; *2*) 16.0% in Engineering; *3*) 13.7% in Education; *4*) 10.9% in the Humanities and Arts; and *5*) 10.8% in the Social and Economic Sciences, in that order of importance. The data point to a major difference in the profile of Mexican graduate degree holders by country of residence, which becomes relevant if we consider that knowledge areas are closely tied to the innovation system (see Table 5).

For the subject areas of Engineering (13.7%), Physics-Mathematics and Earth Sciences (5.5%), Biology and Chemistry (3.2%), and Biotechnology and Agriculture and Livestock Sciences (2.2%), it turns out that one of every four Mexicans living in Mexico is specialized in these areas.[9] However, three of every ten Mexican immigrants in the United States holding a graduate degree are specialized in these same areas (30.9%): 16.0% in Engineering, 5.8% in Physics-Mathematics and Earth Sciences; 7.6% in Biology and Chemistry; and 1.4% in Biotechnology and Agriculture and Livestock Sciences. This indicates that Mexican holders of graduate degrees find more job opportunities in the United States, and is also indirect evidence for the fact that the innovation system there offers better linkages between industry, jobs, and innovation processes.

Striking is the fact that the share of people who studied Engineering living in the United States was 16% as compared to 13.7% for those living in Mexico; in basic sciences, the

[9] Unlike the data for the United States, these data reflect the area of specialization for the educational level mentioned, and not for the bachelor's degree.

situation was the same; looking at Physics-Mathematics, Earth Sciences, Biology, and Chemistry, the percentages were 13.4% against 6.7%, respectively (see Table 5). In 2012, the United States graduated 15 engineers from advanced research programs for every 1 who graduated in Mexico (OECD, 2012). This statistic reveals how important graduate students in engineering are for Mexico, especially in light of the fact that 15.9% of them reside in the United States. We must keep in mind that, pursuant to job forecasts for the United States, the number of positions that will require human resources with graduate degrees will grow 16.9% between 2012 and 2022 (BLS, 2013). This means that the migration of Mexican graduate degree holders will continue to rise until at least the beginning of the next decade, if the current trend persists.

Table 5. Mexican Immigrants with Graduate School Studies by Knowledge Area and Place of Residence, 2010. Mexico vs. United States.

Knowledge Area	*Born in Mexico*				*Graduate Degree Holders in the U.S. with respect to total in both countries B/(A+B)*100*	*Graduate Degree Holders in the U.S. with respect to Graduate Degree Holders in Mexico B/A*100*
	Living in:					
	Mexico/1 (A)		*United States (B)*			
Total Graduate Degree Holders	897 587	100.0	144 716	100.0	13.9	16.1
I Physical-Mathematics and Earth Sciences	49 367	5.5	8 445	5.8	14.6	17.1
II Biology and Chemistry	28 780	3.2	10 954	7.6	27.6	38.1
III Medicine and Health Sciences	60 689	6.8	7 840	5.4	11.4	12.9
IV Biotechnology and Agricultural Sciences	19 701	2.2	2 067	1.4	9.5	10.5
V Engineering	123 122	13.7	23 194	16.0	15.9	18.8
VI Arts	13 075	1.5	4 467	3.1	25.5	34.2
VII Humanities	25 384	2.8	15 820	10.9	38.4	62.3
VIII Behavioral Sciences	49 449	5.5	9 298	6.4	15.8	18.8
IX Social and Economic Sciences	135 238	15.1	15 658	10.8	10.4	11.6

X Education	167 717	18.7	19 823	13.7	10.6	11.8
XI Administration, Business, and Finance	221 889	24.7	26 465	18.3	10.7	11.9
XII Services	3 175	0.4	687	0.5	17.8	21.6
Areas related to Science, Mathematics and Engineering	220 970	24.6	44 660	30.9	16.8	20.2

Marked in gray: indicates less than 20 sample cases. Not included in the analysis due to lack of sample size. Data adjusted to absolutes from 2010 for U.S. residents and CPV 2010 for Mexican residents.

Source: SIMDE-UAZ. Estimated by the authors based on INEGI, sample from the Population and Housing Census 2010 and the U.S. Census Bureau, American Community Survey (ACS), 2010 and 2009-2011.

Occupation and the growth of professional employment in the United States

One of the most important features of Mexican migrants holding graduate degrees is their professional profile: 78.5% are economically active, the same of which is true for their peers from other countries (78.6%) and natives (75.2%). Moreover, 96.8% of Mexican graduate degree holders manage to find a job; this figure for the rest of immigrants is 96.1% and 97.0% for natives. The statistics point to a predominantly work-oriented and low unemployment profile among Mexican graduate degree holders.

The informational nature of knowledge societies, according to Castells (1998) is expressed in the decline of industrial activities, which implies the rise of jobs oriented towards information processing and innovation. This phenomenon is the result of economic globalization derived from advances in technology and communications. The number of jobs in professional and related occupations occupations will rise 14% between 2012 and 2022 (BLS, 2013). Occupations where growth will be the highest include Healthcare and Technical Assistance (28.1%), Healthcare Professionals and Technical Assistance (21.5%), Computation and Mathematics (18.0%), and Community and Social Services (17.2%).

In 2013 (ACS, 2011-2013), the highest percentage of Mexicans holding graduate degrees in the United States were employed in occupations related to Education, Training, and Library Sciences (25.2%), followed by Management (24.7%) and Healthcare Professionals and Technical Occupations (14.4%). According to job forecasts for 2022, these occupations will see an 11.1%, 7.2%, and 21.5% rise each, respectively. Of the Mexicans holding graduate degrees who remain in the sciences and engineering (49,000), 19.8% manage to find a job in the STEM field, while the other 80.2% are employed in some other type of professional activity (see Table 6).

Table 6. Growth of Professional Employment in the United States by Type of Occupation 2012-2022 and Mexican-Born Population Living in the United States with Graduate Degrees by Type of Occupation

Occupation Type	Employment		Change 2012-2011		Average Annual Income (dollars) 2012	Mexican-born and employed (thousands) ACS (2011-2013)	% Born in Mexico
	2012	2022	Number	Percentage			
Total	51 036	58 188	7 153	14.0	34 750	85.11	100.0
Management jobs	8 862	9 498	637	7.2	93 910	21.06	24.7
Business and financial operations	7 168	8 066	898	12.5	62 500	7.77	9.1
Computation and mathematics	3 815	4 501	686	18.0	76 270	3.68	4.3
Architecture and engineering	2 475	2 654	180	7.3	73 540	3.61	4.2
Health, physics, and social sciences	1 249	1 375	126	10.1	60 100	2.97	3.5
Social services	2 375	2 783	409	17.2	40 400	6.70	7.9
Legal	1 247	1 380	133	10.7	75 270	2.75	3.2
Education, training, and library sciences	9 116	10 132	1 016	11.1	46 020	21.49	25.2
Art, design, entertainment, sports, communication media	2 571	2 752	181	7.0	43 930	1.99	2.3
Healthcare professionals and technical occupations	8 050	9 783	1 733	21.5	60 200	12.29	14.4
Healthcare and technical assistance	4 110	5 266	1 156	28.1	25 550	0.80	0.9

* /25% of Mexicans holding graduate degrees have non-professional jobs; ** Includes professional and technical occupations in computer sciences, math, and engineering, as well as health and physical sciences. Also includes three management occupations with clear ties to STEM.

Source: SIMDE-UAZ. Created by the authors based on job forecasts from the U.S. Department of Labor (BIS). Office of Labor Statistics. Estimates made by the authors based on the American Community Survey (ACS) 2011-2013.

Conclusions

In the case of Mexico, the projects analyzed here point to three trends: *1*) a significant increase in qualified Mexican migration throughout the world; *2*) a "volume effect," observed in the higher number of qualified Mexicans living in the United States; and *3*) a "selectivity effect," in light of the fact that the percentage of Mexicans with tertiary level studies as compared to the entire population in the case of the United States is 4.9%, while for the rest of the destinations, the percentages are closer to 10% to 50%. *The estimated number of qualified Mexicans abroad in 2013 was 2,217,150, of whom 1,031,346 have undergraduate and graduate studies, the latter with a share of 195,776 people.* This estimate is a sign of the diversity of destinations for Mexican graduate degree holders. Although the United States is home to 81.7% of Mexican graduate degree holders abroad, the remaining 18.3% live elsewhere.

The number of Mexican graduate degree holders living in the United States is equivalent to 16% of all graduate degree holders living in Mexico and to 19%, if taking into account Mexicans with graduate degrees living abroad, in 2010.

Mexico has repositioned itself as one of the top senders of QA and HQA migrants to the United States. The relative weight of Mexicans living in the United States as compared to those living in Mexico in the Science and Technology knowledge areas is particularly important for innovation. There is a concentration of Mexican migrants in STEM knowledge areas living in the United States and their participation in Engineering, at 16% with respect to 13.7% among those living in Mexico, is striking. The gap is even more pronounced for the basic sciences: 13.4% as compared to 6.7%.

The backdrop to all of this is that these characteristics, which translated into rising emigration of HQA Mexican human capital and a sort of loss of their potential for development in the country, underlie the structural causes associated with the prevailing development model in Mexico and the asymmetric integration observed with the United States. This is expressed particularly clearly in the features and dynamics that distinguish the labor markets in the two countries. This situation is also applicable to Mexican compatriots that emigrate to other destinations.

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