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Mexico–US Migration: Views from Both Sides of the Border

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THE PROPORTION FOREIGN-BORN of the total population of the United States recorded by decennial censuses declined steadily from 14.7 percent in 1910 to 4.7 percent in 1970 but has climbed sharply since then to 10.4 percent in 2000 as immigration increased (US Census Bureau 2003). By fiscal year 2000, the annual number of permanent immigrants admitted had climbed to nearly 850,000 (US Immigration and Naturalization Service 2002). According to the US Census estimates, the foreign-born population increased by more than 50 percent in the period 1990–2000, compared to an increase of 9.3 percent for the native-born and 13 percent for the overall population of the United States (US Census Bureau 2003).

This rise in immigration has been accompanied by increasingly vociferous calls to implement new entry restrictions. Although the volume of overall inflow is sometimes an issue, unauthorized immigration is often the dominant concern. Perceived increases in flows of unauthorized migrants have resulted in enhanced border enforcement and several legislative initiatives such as the 1986 Immigration Reform and Control Act (Massey et al. 2002). The majority of unauthorized immigrants are believed to originate in Mexico, where the phenomenon is also regarded with concern (Canales 2002), partly because it is a source of friction with the United States and partly because the remittances from Mexicans working in the United States are an important contribution to Mexico's economy (the second largest source of foreign exchange after oil). In such a charged political atmosphere, good data would greatly assist the formation of sound policy, but the data are far from good. Almost by definition, unauthorized immigrants are not documented, so direct records of their numbers do not exist. The initially estimated substantial excess of the enumerated population of the United States in the 2000 census over the Census Bureau's projected figure, as well

as the subsequent upward revisions (US Census Bureau 2001; Robinson et al. 2002) to the estimated number of residual foreign-born population (largely comprised of unauthorized immigrants), has added impetus to the study of immigration and of unauthorized immigration. The combination of a politically charged issue and poor data provides fertile soil for inflammatory and poorly supported claims.

Estimates of unauthorized migration made with US data have generally been based on the difference between an observed population of migrants (for example in the decennial census or other surveys) and an estimate of the size of the authorized migrant population (Bean 1998; Warren and Passel 1987). A problem with this approach is that the unauthorized population may be seriously undercounted in censuses and surveys, thus producing an erroneous count of total migrants. Another approach to estimate unauthorized migration has used US data on apprehensions of Mexicans trying to enter the United States without legal documents (Massey and Singer 1995; Espenshade 1995). Bean and his coauthors (1998) have documented a wide variety of approaches to assessing the magnitude of this problem, but all rely on heroic assumptions or observations from potentially unrepresentative surveys.

Mexico has taken steps over the last decade to assess the magnitude of the migratory flow to the United States and, most importantly, to measure the characteristics of the population involved in international movements. A number of household surveys since 1992 have included questions concerning household members who had lived outside Mexico within the previous five years. Data collected in Mexico have a clear advantage over those collected in the United States because there is no incentive to avoid reporting on unauthorized persons living in the United States. Various researchers have used data from Mexico to estimate the magnitude of net emigration to the United States (Corona 1997; CONAPO 1995).

Despite the political interest in the topic, there has been little attempt to analyze the US and Mexico data jointly as a way to surmount possible data errors. A notable exception among recent work is the Mexico–United States Binational Study of Migration during the 1990s (Bean et al. 1998). Most efforts to assess the volume of migration have sought to estimate the unauthorized migrant population from Mexico, although deriving it as the difference between total migrants and authorized migrants. In this article, we focus on overall migration, rather than unauthorized migration, and obtain estimates of net migration from Mexico using data from the 1990 and 2000 population censuses of both Mexico and the United States. We also examine data from the household surveys conducted in Mexico concerning household members who live or have lived abroad.

After reviewing the residual methods, we apply these methods to the Mexico data from the censuses and vital registration to estimate net out-

flow to the United States, followed by the equivalent exercise using US data from the 1990 and 2000 censuses on the Mexico-born population. We end with a discussion of the results and future directions for improving estimates of international migration with a binational methodological perspective.

Residual methods

Lacking the equivalent of vital statistics, net migration is often estimated through the use of residual methods, whereby contributions of known components of population change (births and deaths) are subtracted from actual population change over a time period. The Demographic Balancing Equation (DBE) provides a simple residual method for estimating net migration by age (Hill 1987). The advantages of this residual approach over the more common intercensal cohort survival approach are that it provides estimates for specific age groups instead of for specific birth cohorts and that there is no equivalent of the forward or backward projection choice that affects cohort survival analysis. The DBE states that the change in population between two time points is equal to the net balance between entries and exits. This tautology applies not only to entire populations but also to any population subgroup, such as an age group. Thus

$${}_5N2_x = {}_5N1_x + B_x - B_{x+5} - {}_5D_x + {}_5NM_x, \quad (1)$$

where ${}_5N1_x$ and ${}_5N2_x$ are the initial and final populations aged $(x, x+5)$, and, for the intervening period,

B_x and B_{x+5} are the entries into and exits from the age group $(x, x+5)$ as a result of birthdays at age x and $x+5$ respectively,

${}_5D_x$ is the number of deaths of residents aged $(x, x+5)$, and

${}_5NM_x$ is the number of net migrants aged $(x, x+5)$.

Rearranging,

$${}_5NM_x = {}_5N2_x - {}_5N1_x - B_x + B_{x+5} + {}_5D_x. \quad (2)$$

The number of birthdays, B_x , can be estimated from two age distributions from censuses separated by between five and ten years as follows:

$$B_x = (t/5)({}_5N1_{x-5} * {}_5N2_x)^{1/2}, \quad (3)$$

where t is the intercensal interval in years.

The idea behind this approximation is that those persons aged $(x-5, x)$ at the first census will (if they survive) have an x^{th} birthday during the intercensal interval, whereas those persons aged $(x, x+5)$ at the second census are the survivors of those who have had an x^{th} birthday during the

intercensal period. This approximation cannot be applied at age 0, but registered births can be used for Mexico, and births into the US population born in Mexico are by definition zero. Nor does the approximation work for the open-ended age group: one age group has to be sacrificed.

Numbers of deaths can be obtained for Mexico from vital records or for the United States by applying age-specific mortality rates from a US life table to estimated person-years lived by each age group:

$${}_5D_x = t \cdot {}_5M_x \cdot ({}_5N1_x \cdot {}_5N2_x)^{1/2}, \quad (4)$$

where ${}_5M_x$ is the appropriate age-specific mortality rate for the age group. This methodology is applied to intercensal population change for the population of Mexico and the Mexico-born population of the United States. We also apply it to information from the 2000 US census, using data on the reported residence five years before the census of persons born in Mexico. This population can be reverse-projected to estimate the 1995 population born in Mexico resident in Mexico in 1995 but resident in the United States in 2000.

The view from Mexico

Residual estimates from the 1990 and 2000 censuses and vital registration data

Table 1 shows the application of equation (1) to data from the 1990 and 2000 censuses of Mexico for males and females separately. Both births and deaths are the numbers recorded by the Mexico vital registration system, with no adjustment. The population counts applied are for the overall population; we would have preferred to use the Mexico-born population, but the required numbers were not available to us. We do, however, know that the foreign-born population is small, about 0.5 percent in the Mexican 2000 census for both males and females. Figure 1 summarizes the estimated annual net emigration (a negative sign in Table 1 implies net emigration).

Our analysis indicates average annual net emigration from Mexico between the 1990 and 2000 censuses of 404,000 males and 308,000 females, for a net total of 712,000. However, inspection of Table 1 or Figure 1 reveals that, for both males and females, over half the total is made up of emigrants aged 0 to 4 years, a highly implausible result. There is then apparently substantial net immigration between ages 5 and 9 years. We later discuss possible reasons for these results, but for now we focus on the estimate of net emigration between ages 10 and 80 years, amounting to 197,000 males and 129,000 females. Figure 1 suggests a plausible distribution of this emigration by age: a sharp peak in the 20s, somewhat earlier for males than females, and little net migration after age 30. Indeed, there is some indication of return migration for males in their 30s.

TABLE 1 Residual estimates of net emigration from Mexico using census data from Mexico

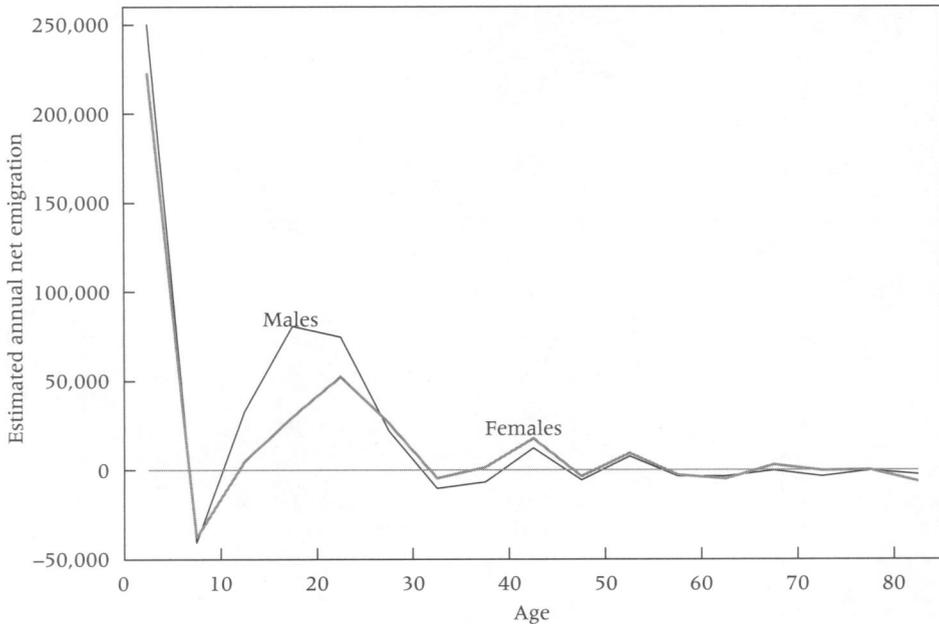
Age group	Females										Annual net migration, both sexes
	Males					Females					
	Population of Mexico		Deaths 1990-2000	Estimated birthdays	Annual net migration	Population of Mexico		Deaths 1990-2000	Estimated birthdays	Annual net migration	
	1990	2000			1990	2000					
0-4	5,191,052	5,521,224	340,361	14,150,586	-250,232	5,065,883	5,343,102	266,507	13,476,749	-223,004	-473,236
5-9	5,370,408	5,803,765	25,507	10,977,731	40,638	5,255,807	5,653,203	18,609	10,702,984	37,910	78,548
10-14	5,262,133	5,556,419	26,277	10,925,243	-32,678	5,189,893	5,411,403	16,489	10,666,075	-4,961	-37,639
15-19	4,788,534	5,018,650	62,087	10,277,899	-80,627	4,934,421	5,188,578	25,730	10,378,471	-29,734	-110,361
20-24	3,760,622	4,399,147	88,568	9,179,426	-74,676	4,115,984	4,867,051	29,339	9,801,240	-52,320	-126,996
25-29	3,068,952	3,947,213	90,954	7,705,576	-22,057	3,374,371	4,385,940	29,990	8,497,638	-26,471	-48,528
30-34	2,594,253	3,458,472	92,564	6,515,791	10,400	2,826,013	3,831,510	33,894	7,191,366	4,634	15,034
35-39	2,223,867	3,090,451	99,288	5,663,007	6,573	2,382,996	3,398,703	41,756	6,198,316	-1,502	5,071
40-44	1,715,273	2,550,159	98,643	4,762,862	-12,440	1,803,690	2,756,423	48,614	5,125,834	-17,770	-30,210
45-49	1,461,314	2,000,629	107,996	3,704,929	5,745	1,528,552	2,159,060	60,471	3,946,784	3,400	9,145
50-54	1,168,866	1,660,089	118,541	3,115,067	-7,673	1,239,429	1,770,114	75,982	3,289,809	-9,337	-17,010
55-59	924,393	1,261,470	136,413	2,428,572	3,270	981,570	1,352,820	96,841	2,589,768	2,785	6,055
60-64	774,550	1,068,614	157,926	1,987,782	3,557	846,531	1,176,804	123,714	2,149,526	4,970	8,527
65-69	571,057	796,976	174,035	1,571,366	142	619,767	899,511	145,069	1,745,239	-3,137	-2,995
70-74	396,402	602,185	185,932	1,172,829	3,526	435,637	670,273	157,922	1,289,051	226	3,752
75-79	279,507	420,326	178,649	816,378	146	314,910	463,551	164,062	898,754	-59	87
80-84	180,902	222,155	167,592	498,373	2,501	223,366	272,110	176,099	585,457	6,335	8,836
85+	160,440	214,309	260,669			215,319	291,002	348,283			
Total 10-80	NA	NA	NA	NA	-196,792	NA	NA	NA	NA	NA	-326,068
Total	39,892,523	47,592,253	2,412,001		-403,885	41,354,138	49,891,159	1,859,371		-308,035	-711,920

NA = not applicable.

NOTE: Annual net migration is calculated as 1/10th of decadal migration calculated from equation (2). Estimated birthdays are calculated from equation (3) except for age 0, for which registered births in Mexico 1990-2000 are used.

SOURCE: Data from the 1990 and 2000 censuses of Mexico and registered births and deaths.

FIGURE 1 Residual estimates of annual net emigration by age from Mexico 1990–2000, using data from the Mexican 1990 and 2000 censuses



SOURCE: Estimates in Table 1.

Estimates from surveys in Mexico

During the last decade, Mexico's National Statistics Office (Instituto Nacional de Estadística, Geografía e Informática, INEGI) has included questions in four household surveys on household members living outside the country: two National Surveys of Population Dynamics—ENADID—(1992 and 1997), the Inter-Censal Population and Housing Survey—CONTEO—(1995), and as a sample topic in the 12th Population and Housing Census (2000). The objective of including suitable questions in these surveys was to estimate the approximate magnitude of emigration and to collect socioeconomic information about the emigrants. Each household was asked whether any members of the household had left to live abroad within the five years prior to the survey. If the answer was yes, the sex, age at departure, month and year of departure, country of destination, country of present residence, and month and year of return of each such member were recorded.

For each of these surveys, it is therefore possible to estimate, for households that still exist at the time of the survey, the total number of members who left to live in the United States during the time periods 1987–92, 1990–95, 1992–97, and 1995–2000, and the number who had returned by the date of the survey. The survey estimates of gross outflow to the United States

are remarkably consistent, ranging from an annual figure of 311,000 per year for the period 1995 to 2000 from the 2000 census, to 364,000 per year for the period 1992 to 1997 from the 1997 survey. The estimates of net outflow (subtracting those reported to have returned) are less consistent, reflecting different apparent rates of return. They range from an outflow of 183,000 for the period 1987 to 1992 to 273,000 for the period 1990 to 1995. Proportions reported as having returned range from 47 percent for those reported to have left between 1987 and 1992 to 23 percent for those reported to have left from 1990 to 1995 and 1995 to 2000.¹

It is not possible to compare these numbers directly with the residual estimates from the 1990 and 2000 censuses of Mexico. First, the household survey estimates exclude any component of emigration that consists of entire households, because no household member remains behind to report the move. Second, the net outflow is not defined in the same way as the residual estimate: the survey net estimates count departures less returns of those same departees, whereas the residual estimates count departures less returns regardless of time of departure. Detail from the survey data, reporting year of departure by year of return, suggests (regardless of cohort) that between 60 and 75 percent of those departing who stay away for a year or more do not return. (The 1992 ENADID reports higher rates of return.) A detailed inspection of the data on year of return by year of departure also reveals patterns that are unlikely to be correct: for each survey, the number of persons reported as leaving in the year before the survey is double the number reported as leaving in earlier years.

Caveats aside, the household survey data indicate lower net emigration than do the total residual estimates. Taking only the figures for the year immediately preceding the survey, gross outflow is close to 650,000, of whom at least 25 percent return, indicating a maximum net outflow per year of about 490,000 (males and females combined). The residual estimate in Table 1 suggests an average net outflow of 712,000 per year, though the figure for ages between 10 and 80 years is 326,000.

The survey data provide useful indicators of the migration. The vast majority of Mexico's emigrants are reported to go to the United States to live: 97 percent of males and 93 percent of females, according to the 2000 census data. The surveys show a very young distribution by age at migration that becomes gradually younger over the 1990s. For both males and females, the modal age at departure is around 18 or 19 years. The sex ratio of departures varies by source, ranging from about 250 males per 100 females from the 1992 ENADID to 313 males per 100 females from the 1997 ENADID. The residual estimate, by contrast, is only about 130 males per 100 females. This huge discrepancy may be related to the use of households as the source of data: it may be that when females leave, the whole household is likely to depart, leaving no one behind to report the migration to

the United States. Cerrutti and Massey (2001) report that the migration of Mexican women and men follows quite different patterns. Women tend to follow other family members (a spouse or a parent), whereas men are more likely to leave Mexico without a wife or parent.²

The view from the United States

Residual estimates from the 1990 and 2000 censuses and vital registration data

Table 2 shows the application of equation (1) to the data on the Mexico-born population of the United States from the 1990 and 2000 censuses of the United States for males and females separately. This population has by definition zero births. Deaths have been estimated as follows. First, age-sex-specific mortality rates were calculated for both 1990 and 2000 by dividing US registered deaths of persons born in Mexico by the US census population of persons born in Mexico. The 1990 and 2000 mortality rates were averaged to approximate intercensal mortality risks. These rates were then applied to the estimated person-years lived³ from 1990 to 2000 by the Mexico-born population of the United States, with no adjustment. These rates may not be error free: both the census counts and the deaths (Patel et al. 2004) may be under-recorded, but net bias may be small. Residual migration estimates are not sensitive to mortality assumptions since the age range of peak net migration is one of low mortality in any mortality regime. Figure 2 summarizes the estimated annual net immigration by age group.

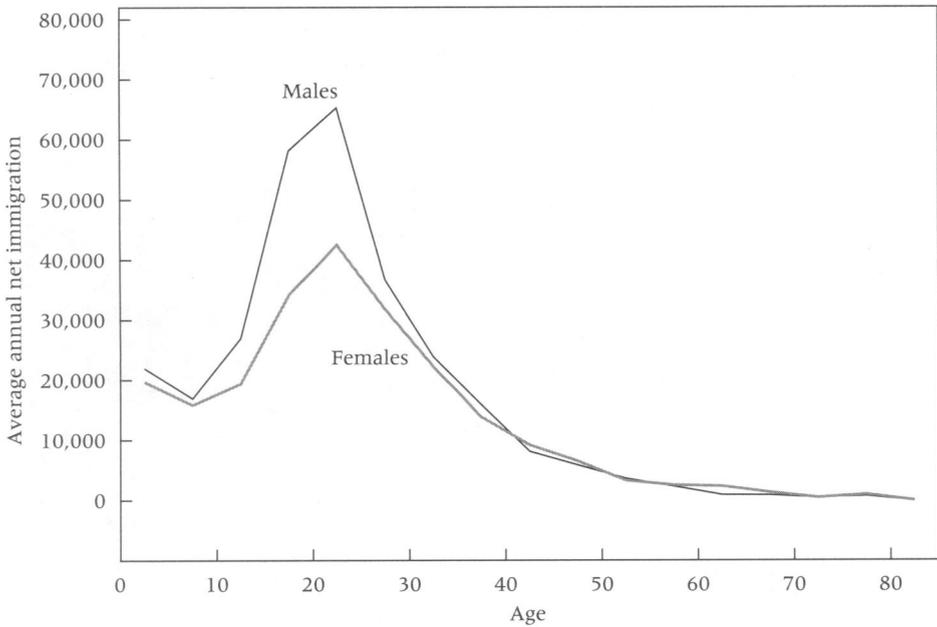
This analysis indicates average annual net immigration from Mexico between the 1990 and 2000 censuses of 288,000 males and 226,000 females, for a net total of 514,000. Inspection of Table 2 or Figure 2 reveals a plausible age distribution: peak immigration in the age groups 15–19 and 20–24 years, with over half (for males) and almost half (for females) of all net migration concentrated in the age range 15–29 years. These estimates of average annual total net movement from Mexico are substantially lower than those obtained from the Mexico analysis: 404,000 males and 308,000 females. However, if we focus on the estimates of net movement between ages 10 and 80 years, the totals are higher: 250,000 compared to 197,000 for males and 190,000 compared to 129,000 for females. Another noteworthy feature in Table 2 is that, for both males and females, net migration above age 60 is close to, though generally slightly greater than, zero. There is no feature of the estimation that guarantees such an outcome; even moderate changes in enumeration completeness of the Mexico-born population between the two censuses would generate a substantial positive or negative balance. The fact that the results are so close to zero suggests that the coverage of the two censuses was very similar, though this does not imply anything about the absolute level of coverage.

TABLE 2 Residual estimates of net immigration from Mexico: Mexico-born population of the United States, 1990 and 2000

Age group	Males										Females									
	ASMR 1990-2000 (Mexico-born pop.)					ASMR 1990-2000 (Mexico-born pop.)					ASMR 1990-2000 (Mexico-born pop.)					ASMR 1990-2000 (Mexico-born pop.)				
	Mexico-born population in US		Deaths 1990-2000		Annual net migration	Mexico-born population in US		Deaths 1990-2000		Annual net migration	Mexico-born population in US		Deaths 1990-2000		Annual net migration	Mexico-born population in US		Deaths 1990-2000		Annual net migration
1990	2000	1990	2000	Estimated birthdays	1990	2000	1990	2000	Estimated birthdays	1990	2000	1990	2000	Estimated birthdays	1990	2000	1990	2000	Estimated birthdays	
0-4	52,120	89,095	0.00068	0.00068	0	21,942	460	460	0	48,339	76,395	0.00056	0.00056	0	19,693	41,635				
5-9	80,009	158,860	0.00026	0.00026	181,987	16,915	293	293	181,987	78,102	146,905	0.00017	0.00017	177	168,538	32,744				
10-14	101,984	231,155	0.00034	0.00034	271,989	26,957	514	514	271,989	100,243	212,820	0.00021	0.00021	299	257,850	46,347				
15-19	218,882	415,855	0.00148	0.00148	411,876	58,166	4,450	4,450	411,876	168,291	286,395	0.00037	0.00037	801	338,875	34,164				
20-24	388,973	716,640	0.00195	0.00195	792,110	65,306	10,295	10,295	792,110	257,035	468,550	0.00040	0.00040	1,371	561,615	42,482				
25-29	379,572	787,910	0.00168	0.00168	1,107,205	36,697	9,160	9,160	1,107,205	268,873	582,000	0.00035	0.00035	1,385	773,549	31,809				
30-34	311,506	735,410	0.00165	0.00165	1,056,676	23,856	7,873	7,873	1,056,676	242,746	561,530	0.00046	0.00046	1,698	777,124	22,232				
35-39	242,184	598,350	0.00185	0.00185	863,457	15,871	7,023	7,023	863,457	188,635	474,765	0.00059	0.00059	1,751	678,962	13,834				
40-44	163,300	448,260	0.00211	0.00211	658,973	8,120	5,709	5,709	658,973	140,575	371,465	0.00099	0.00099	2,251	529,420	9,186				
45-49	110,588	309,325	0.00299	0.00299	449,501	5,848	5,330	5,330	449,501	111,866	267,915	0.00155	0.00155	2,675	388,135	6,506				
50-54	77,440	208,530	0.00442	0.00442	303,716	3,614	5,617	5,617	303,716	82,139	193,785	0.00266	0.00266	3,356	294,469	3,274				
55-59	61,242	133,230	0.00667	0.00667	203,149	2,279	6,025	6,025	203,149	60,616	137,060	0.00455	0.00455	4,143	212,207	2,494				
60-64	42,798	89,320	0.01044	0.01044	147,921	877	6,452	6,452	147,921	49,795	101,095	0.00714	0.00714	5,062	156,563	2,324				
65-69	33,948	62,840	0.01846	0.01846	103,719	829	8,524	8,524	103,719	39,430	76,500	0.01309	0.01309	7,189	123,439	1,290				
70-74	20,270	40,975	0.02737	0.02737	74,593	430	7,888	7,888	74,593	23,985	53,755	0.01956	0.01956	7,022	92,077	429				
75-79	19,340	31,210	0.04712	0.04712	50,304	680	11,577	11,577	50,304	26,338	37,000	0.03259	0.03259	10,174	59,580	924				
80-84	13,796	14,645	0.07580	0.07580	33,659	-102	10,774	10,774	33,659	16,912	21,855	0.05595	0.05595	10,757	47,984	-39				
85-89	8,883	8,005	0.11564	0.11564	21,018	-168	9,751	9,751	21,018	9,542	15,035	0.10088	0.10088	12,082	31,892	331				
90+	3,677	4,860	0.21968	0.21968	9,286		9,286	9,286	9,286	5,572	8,195	0.22201	0.22201	15,002						
Total 10-80	NA	NA	NA	NA	NA	249,530	NA	NA	NA	NA	NA	NA	NA	NA	190,338	439,868				
Total	2,330,512	5,084,475	0.00370	0.00370	127,202	288,116	1,919,034	4,093,020	0.00312	87,534	226,152	514,268								

ASMR = Age-specific mortality rates. NA = not applicable.
 NOTE: Annual net migration is calculated as 1/10th of decadal migration calculated from equation (2). Estimated birthdays are calculated from equation (3).
 SOURCE: Data from the 1990 and 2000 US censuses and NCHS data.

FIGURE 2 Residual estimates of annual net immigration by age to the United States from Mexico, using data from the US 1990 and 2000 censuses



SOURCE: Estimates in Table 2.

Residual estimates from the 2000 census and vital registration data

The 2000 US census included a question on place of residence five years before the enumeration (as did the 1990 census). It is thus possible to quantify by age and sex the Mexico-born population reported as resident in the United States five years earlier. This population can be reverse-projected (using life table survivorship ratios) to estimate the Mexico-born population resident in the United States in 1995. The residual method of equation (1) can then be applied to the estimated Mexico-born population in 1995 and the enumerated Mexico-born population in 2000. Life table survivorship ratios have been calculated from a life table based on the age-specific mortality rates for 2000 described in the previous section. Results of the residual method are shown in Table 3.

The age pattern shown in Figure 3 is strikingly similar to that in Figure 2, with the exception of greater net inflow in the age group 0–4. This analysis indicates average annual net immigration from Mexico over the five years before the 2000 censuses of 234,000 males and 158,000 females, for a net total of 391,000. Although these estimates of average annual total net movement from Mexico are substantially lower than those obtained from either the Mexico analysis or the 1990–2000 US census analysis, the

TABLE 3 Residual estimates of average annual net immigration to the United States, 1995 to 2000, based on 2000 US census data on place of residence five years earlier

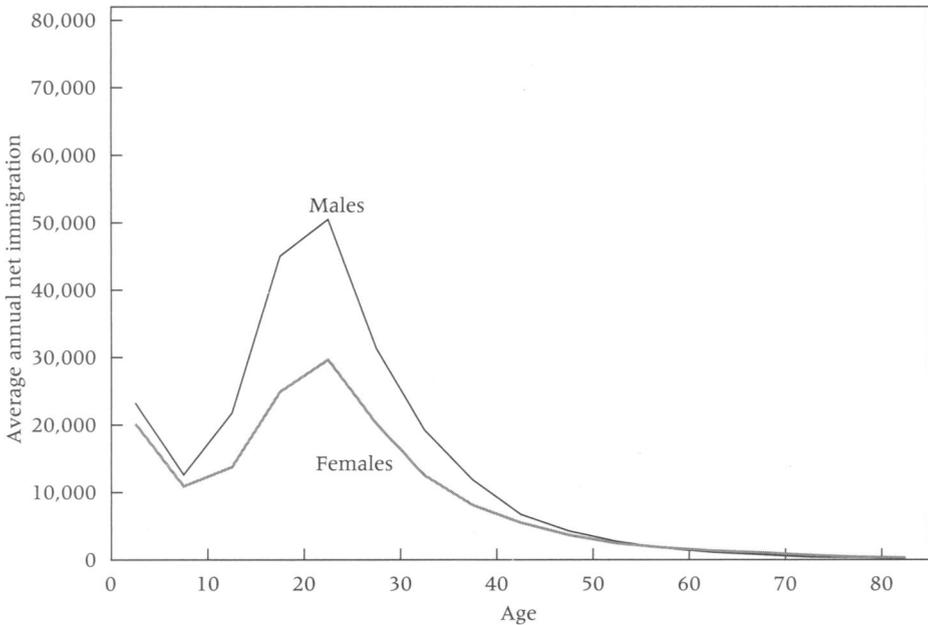
Age group	Males											Females														
	Population born in Mexico					Deaths 1995-2000			Average annual net migration			Population born in Mexico					Deaths 1995-2000			Average annual net migration						
	Estimated 1995	Enumerated 2000	1998 US ASMR	Estimated birthdays	Average annual net migration	1995	2000	ASMR	Estimated birthdays	Average annual net migration	Estimated 1995	Enumerated 2000	1998 US ASMR	Estimated birthdays	Average annual net migration	Estimated 1995	Enumerated 2000	1998 US ASMR	Estimated birthdays	Average annual net migration	Estimated 1995	Enumerated 2000	1998 US ASMR	Estimated birthdays	Average annual net migration	
0-4	97,542	89,095	0.00030	140	23,235	0	0.00026	0	20,205	91,280	76,395	0.00026	109	20,205	43,440											
5-9	169,106	158,860	0.00014	115	12,620	124,481	0.00011	85	10,903	162,825	146,905	0.00011	85	10,903	23,523											
10-14	242,393	231,155	0.00028	331	21,775	197,711	0.00021	213	13,765	193,410	212,820	0.00021	213	13,765	35,540											
15-19	430,745	415,855	0.00096	2,032	45,050	317,491	0.00030	443	24,905	304,980	286,395	0.00030	443	24,905	69,955											
20-24	601,177	716,640	0.00134	4,398	50,500	555,598	0.00034	790	29,669	460,897	468,550	0.00034	790	29,669	80,169											
25-29	624,758	787,910	0.00112	3,929	31,334	688,239	0.00029	772	20,185	486,711	582,000	0.00029	772	20,185	51,519											
30-34	525,941	735,410	0.00112	3,483	19,220	677,830	0.00038	931	12,520	427,692	561,530	0.00038	931	12,520	31,740											
35-39	410,451	598,350	0.00136	3,370	11,846	560,978	0.00048	964	8,109	339,905	474,765	0.00048	964	8,109	19,955											
40-44	286,255	448,260	0.00171	3,063	6,739	428,939	0.00082	1,242	5,525	246,981	371,465	0.00082	1,242	5,525	12,264											
45-49	195,243	309,325	0.00251	3,084	4,275	297,567	0.00132	1,453	3,684	180,995	267,915	0.00132	1,453	3,684	7,959											
50-54	125,316	208,530	0.00362	2,926	2,715	201,777	0.00236	1,868	2,432	129,369	193,785	0.00236	1,868	2,432	5,147											
55-59	86,031	133,230	0.00549	2,939	1,717	129,213	0.00413	2,364	1,792	95,633	137,060	0.00413	2,364	1,792	3,509											
60-64	62,434	89,320	0.00967	3,611	1,095	87,660	0.00626	2,708	1,340	74,029	101,095	0.00626	2,708	1,340	3,509											
65-69	41,997	62,840	0.01592	4,089	756	62,637	0.01132	3,599	1,058	52,860	76,500	0.01132	3,599	1,058	2,435											
70-74	35,241	40,975	0.02413	4,585	400	41,483	0.01686	3,849	679	38,791	53,755	0.01686	3,849	679	1,079											
75-79	17,398	31,210	0.04307	5,018	326	33,164	0.02688	3,999	411	23,925	37,000	0.02688	3,999	411	737											
80-84	11,871	14,645	0.06239	4,113	135	15,962	0.04820	4,995	304	19,658	21,855	0.04820	4,995	304	439											
85-89	10,228	8,005	0.14412	6,520	-118	9,748	0.09090	6,029	73	11,704	15,035	0.09090	6,029	73	-45											
90+		4,860					0.22507			8,195																
Total 10-80	NA	NA	NA	NA	197,748	NA	NA	NA	126,074	NA	NA	NA	NA	NA	323,822											
Total	3,974,130	5,084,475	0.00257	57,745	233,618	3,341,646	0.00197	36,414	157,558	3,341,646	4,093,020	0.00197	36,414	157,558	391,176											

ASMR = age-specific mortality rates. NA = not applicable.

NOTE: Annual net migration is calculated as 1/10th of decadal migration calculated from equation (2). Estimated birthdays are calculated from equation (3)

SOURCE: Data from the 2000 US census and NCHS. 1995 population estimated by reverse-projecting the 2000 Mexico-born population resident in the US in 1995.

FIGURE 3 Residual estimates of average annual net immigration by age from Mexico 1995–2000, using US census data on residence five years earlier



SOURCE: Estimates in Table 3.

estimates of net movement between the ages of 10 and 80 years are remarkably similar to the residual analysis of the Mexico censuses: 198,000 compared to 197,000 for males and 126,000 compared to 129,000 for females. Net migration above age 70 is close to zero, and is negative for males above age 85. Because this analysis is based entirely on 2000 US census data (on birthplace and residence five years earlier) plus a minor component from registration of deaths in the United States of persons born in Mexico, the estimates will be unaffected by changes in enumeration completeness between 1990 and 2000, though their absolute magnitude will be affected by coverage of the 2000 census.

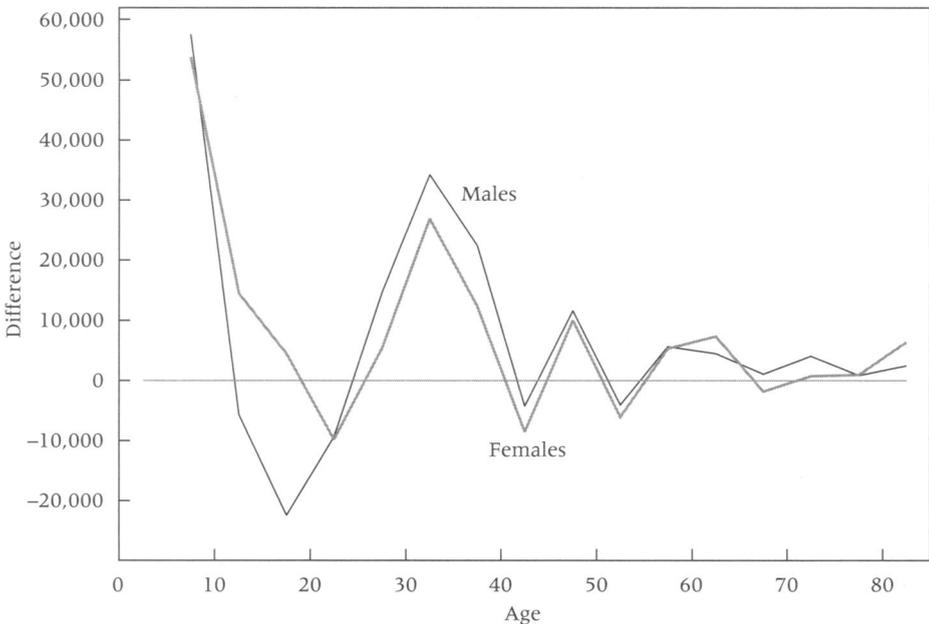
A binational perspective

Data on the population of Mexico and the Mexico-born population of the United States can be usefully combined to give a binational perspective. Data from the Mexican household surveys (ENADID, CONTEO, and the 2000 census) report that over 95 percent of Mexican emigrants go to the United States; Mexican censuses, in turn, suggest that the foreign-born population of Mexico is very small—about 0.5 percent—and that 60 percent of the foreign-born are US-born children of Mexican families (Bean et al. 1998). It is therefore in

essence correct to view the combination of the population of Mexico and the Mexico-born population of the United States as a closed system. Residual estimates of net migration for the closed system (combining the US and Mexico data) should be more revealing of data errors than of any true process of migration since the net migration to the system should be very small. The residual estimate for the closed system is simply the difference between the Mexico-based estimate of emigration in Table 1 and the US-based estimate of immigration in Table 2. This net result is shown by age and sex in Figure 4; the large and negative estimate for the 0–4 age group has been omitted to permit differences at other age groups to be visible.

The age pattern of these residuals is strikingly similar by sex, except for the age group 15–19 years (large and negative for males, slightly positive for females). Values are positive for the age group 5–9, turn negative (especially for males) between ages 15 and 24, and then turn positive between 25 and 40. Overall, the residuals are positive, indicating that US estimates of net immigration are higher than the corresponding Mexico estimates of net emigration—although, at ages where we expect little net migration (that is, over age 50), the residuals are quite small. This pattern disagrees with the view that a high proportion of unauthorized Mexican residents in the United States are omitted by the US censuses: if a high proportion were excluded from the

FIGURE 4 Difference between average annual estimate of immigration into the United States and emigration from Mexico 1990–2000, ages 5 to 85



SOURCE: Tables 1 and 2.

TABLE 4 Residual estimates of average annual net migration from Mexico to the United States of persons aged 10 to 80 years between 1990 and 2000

Source of estimate	Males	Females	Total
US 1990 and 2000 censuses	250,000	190,000	440,000
Mexico 1990 and 2000 censuses	197,000	129,000	326,000
US 2000 census	198,000	126,000	324,000

NOTE: Rounded to nearest 1,000.

SOURCE: Tables 1 through 3

census, the residuals would be negative. The age pattern of the residuals, however, does suggest some omission, especially of males, in the age range 15–24, where the balance is negative; the positive balance at ages 25–39 also supports this interpretation, since it could be explained by the unrecorded youths resident in the United States in 1990 reappearing (as net “immigrants” to the system) in the 2000 Mexico census.

Summary of residual estimates

Table 4 summarizes the residual estimates of average annual net migration from Mexico to the United States for persons between ages 10 and 80 years. The estimates range from about 200,000 to 250,000 for males and from about 130,000 to 190,000 for females. The residual estimates from the 1990 and 2000 Mexico censuses are remarkably consistent with the quasi-residual estimates from the 2000 US census using information both on country of birth and on residence five years before the census. It is not easy to find other estimates for comparison, since most research has focused on stocks of unauthorized migrants. However, Bean et al. (2001) arrive at “median” estimates for 1996 of authorized and unauthorized Mexican migrants of 4.50 and 2.54 million respectively, and extrapolate these forward to rough estimates of 5.05 and 3.90 million respectively for 2000, for an average annual increase of close to half a million (both sexes combined).

Data errors and sensitivity analysis

Residual estimates are notoriously sensitive to error. Even small measurement errors in the component parts can add up in the residual to a large proportionate error. Certain errors in the data are evident. Most glaring is the huge estimate of net emigration of Mexicans aged 0–4 years using Mexican census and vital registration data. This error probably consists of several components. First, the population 0–4 is probably undercounted relative to the rest of the population; such an error is very common in developing-country censuses. Second, it is possible that the number of deaths

under age 5 years is undercounted in the vital statistics. Third, it seems likely that the number of births is overcounted, at least relative to census coverage; one possible explanation for such overcounting is that births that actually occurred in the United States (and were registered there) were subsequently also registered in Mexico. It is also possible that births get registered more than once in Mexico, for example in the case of a lost birth certificate that is needed to register a child for school. A second error is evident from Figure 4: a net deficit of persons aged 15–24 years from the Mexico–United States system is followed by a net surplus aged 25–39. This pattern, as suggested above, is probably the result of undercoverage in the US censuses of unauthorized Mexicans, who subsequently reappear as residents in the Mexico censuses. A third likely error probably accounts for the high apparent immigration of children under age 10 based on the analysis of the 2000 US census; the error may be the result of inappropriate imputation of missing birthplace or residence information for young children.

Typical errors likely to have a major impact on residual estimates of net migration are those associated with census coverage (and particularly change in census coverage), age misreporting (in Mexico, probably associated with the saw-tooth patterns in Figures 1 and 4), and errors in measuring mortality. To test the possible magnitude of these errors, we have adjusted the basic data as if they suffered from specific problems. The errors we tested for data from both Mexico and the United States were: a 3 percent undercount in 1990 relative to 2000, a 3 percent undercount in 2000 relative to 1990, and a 10 percent underestimation of deaths; for the United States, but not for Mexico (because we regard it as very unlikely that deaths are over-recorded in Mexico) we also tested a 10 percent overestimation of deaths. We have not explicitly tested the effects of a level of undercoverage that does not change from one census to the next because the effect of such an error on the estimates will be exactly equal to the level of undercoverage. If, for example, both the 1990 and 2000 censuses of Mexico were undercounts by 5 percent, the effect would be to underestimate the net emigration by 5 percent; if the Mexico-born population of the United States were undercounted in 1990 and 2000 by 10 percent, the estimates of net immigration would be 10 percent too low. Results for males are shown in Table 5 in terms of net migration between ages 10 and 80 years.

It is clear from Table 5 that a moderate change in census coverage (of 3 percent) makes a very large difference (roughly plus or minus 50 percent) to the residual estimate of emigration from Mexico, but makes a much smaller difference to the residual estimate of Mexican immigration into the United States (little more than plus or minus 5 percent). As noted above, a constant level of undercoverage of 3 percent would affect both estimates by 3 percent. The reason that the Mexico residual is much more affected than the US residual is that the former residual is a much smaller proportion of the total

TABLE 5 Sensitivity to simulated errors of residual estimates of average annual net emigration (Mexico) or immigration (United States) of males aged 10 to 80 years between 1990 and 2000

Method	Simulated error	Mexico data	US data
Intercensal change	No error	197	250
	3% undercount in 1990 relative to 2000	303	243
	3% undercount in 2000 relative to 1990	102	264
	10% underestimation of deaths/mortality rates	179	251
	10% overestimation of deaths/mortality rates	NA	248
Reverse projection of 2000 US population	No error	NA	198
	3% undercount in 2000 US census	NA	204
	10% underestimation of deaths/mortality rates	NA	198
	10% overestimation of deaths/mortality rates	NA	198

NA = not applicable.

SOURCE: Additional calculations based on Tables 1 through 3.

population being analyzed than is the latter. Errors in mortality, by contrast, make much less difference: even a 10 percent under-recording of deaths in Mexico would affect the estimate of emigration by only 10 percent or so. An error of 10 percent in the death rates for the United States has only a minuscule effect on the residual estimate, less than 0.5 percent, primarily because most of the Mexico-born population of the United States is in low-mortality age groups. The residual estimates based on reverse projection of the 2000 US population born in Mexico and resident in the United States five years before the census are virtually unaffected by the type of data errors that we explored: a 3 percent US undercount in 2000 affects the estimate by 3 percent, and errors of 10 percent in the death rates have trivial effects.

Conclusions

Our analysis of 1990 and 2000 census data from Mexico and the United States suggests an annual level of net emigration from Mexico during the decade of persons aged 10 to 80 years of somewhere between 324,000 and 440,000. Internal patterns by age and sex appear plausible, except for errors under age 10 years. Although residual estimates of emigration from Mexico are quite sensitive to possible changes in enumeration completeness of the Mexican censuses, the residual estimates of immigration into the United States are much less sensitive. In particular, the estimates de-

rived from reverse-projecting the Mexico-born population of the US in 2000 resident in the United States five years before the census to 1995 are remarkably robust to likely errors of census undercount or mortality estimates. Even if the Mexico-born population had been underenumerated in 2000 by as much as 50 percent, the true net inflow would not have exceeded 600,000 annually. Although we do not directly address the size of the unauthorized US population of Mexican origin, our estimates are inconsistent with the often-cited high estimates and appear to be somewhat lower than the more conservative estimates of Bean et al. (2001), though our estimates refer only to the age range 10 to 80.

Our binational approach has highlighted the advantages of comparing data on international migration from the perspective of the sending and the receiving countries. Specifically, the Mexico–United States experience offers at least two important lessons. First, the international migration data gathered from any one country may be too sensitive to errors to be used in isolation. By having the other-country source of data as a supplement, the quality of the data in both countries can be “checked.” Second, collecting information at both the sending and the receiving end of a migration stream provides a much better basis for understanding the processes involved. Survey data in the origin and destination countries do not have to be gathered solely for the purposes of measuring international migration; many countries conduct general demographic or health surveys or censuses within which questions about migration or country of birth/residence could be included. It will often be advantageous to open the channels of collaboration to include supplementary survey questions in the origin and destination countries involved. Detailed surveys conducted in migrant-sending and migrant-receiving communities, in particular studies with longitudinal design, also can be used to supplement national-level data, thereby suggesting explanations of inconsistencies in the estimates derived from national-level data.

Notes

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1 Durand et al. (2001) use data from the ENADID 1992 survey in Mexico to construct cohorts of migrants from 1970 to 1992, and

report a rise in the rate of return migration to Mexico from the United States during the early 1990s. The authors interpret this as a reflection of the legalization efforts of the late 1980s.

2 Using data from Cerrutti and Massey (2004) from the Mexican Migration Project on 81 communities with high out-migration, we estimate sex ratios for 1990–95 among migrants aged 15 and older: 2.7 males per female overall, 2.1 for authorized, and 3.6 for unauthorized persons. While these are not national estimates, they provide a rough idea of the sex composition of migrants to the United States in the first part of the 1990s.

3 Person-years lived in a given 5-year age group ($x, x+5$) were estimated as the geometric mean of the initial and final population of the age group multiplied by the duration of the intercensal interval in years; see equation (4).

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