Measuring the Number of Unauthorized Immigrants in the United States: A Review of the Residual Estimation Method

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This first of three related articles on the U.S. unauthorized immigrant population discusses the predominant method of measuring that population: the residual estimation method, so named because an estimated population of authorized immigrants is subtracted from an estimated population of all foreign-born U.S. residents, with the residual result presumed to constitute the unauthorized immigrant population. We describe the method step by step and trace historical trends in the estimates it produces. We then differentiate between unauthorized immigrants who arrived via entry without inspection and those who overstayed a visa, noting that the shares who overstayed a visa have risen in recent years. We then discuss several recent studies: one that used a different methodology to estimate the unauthorized immigrant population, and others that proposed adjustments to the residual method.

Introduction

Hinting at the challenges of measuring their numbers, unauthorized immigrants are known by multiple labels—such as illegal immigrants, undocumented immigrants, extralegal immigrants, and unlawful permanent residents. Their elusive status makes estimating their current and historical numbers challenging. This article uses the terms "unauthorized immigration" and "unauthorized immigrants," which we define as foreign-born individuals who reside in the United States without a valid temporary visa, a permanent resident visa ("green card"), or U.S. citizenship. The importance of accurately measuring this population goes beyond issues directly affected by unauthorized immigration. For example, discussions about appropriate levels of legal immigration hinge on the assumed levels and trends in the unauthorized immigrant population.

This article attempts to summarize the complicated literature on measuring the U.S. unauthorized immigrant population. Following this introduction, it begins with a section that describes the residual estimation method—commonly known as simply the residual method—to date, the most widely used approach to estimating the U.S. unauthorized immigrant population. The second section presents estimates of the unauthorized immigrant population in the United States from various studies using the residual method. The third section highlights the increasing incidence of visa overstays among unauthorized

Selected Abbreviations

ACS	American Community Survey
CMS	Center for Migration Studies of New York
CPS	Current Population Survey
DHS	Department of Homeland Security
EWI	entry without inspection
MPI	Migration Policy Institute

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immigrants and the significance of that trend for measuring the unauthorized immigrant population. The fourth section describes a widely critiqued study that estimated about twice the number of unauthorized immigrants as the residual-method studies. The fifth section reviews a revision to the residual method used in post-2010 research from the Center for Migration Studies of New York (CMS), a public policy educational institute. The article then closes with a concluding summary.

The Residual Method of Estimating the Unauthorized Immigrant Population

The residual method is used in computing various benchmark estimates, including those of the Department of Homeland Security (DHS) and independent think tanks such as the Pew Research Center (Pew), the Migration Policy Institute (MPI), and CMS.[1] Residual-method estimates also underlie Social Security's actuarial forecasts and demographic assumptions.

As described in Warren and Passel (1987), the residual-method process begins with the use of national survey data, such as Census Bureau's annual American Community Survey (ACS) or the Annual Social and Economic Supplement to its Current Population Survey (CPS),[2] to estimate the total foreign-born population.[3] The next step is to identify the foreign-born individuals who reside in the United States legally, using one or more of various possible data sources. For example, DHS uses its administrative records to identify all who are citizens or have legal permanent resident status. Administrative data from the Department of Health and Human Services' Office of Refugee Resettlement provide counts of refugees and asylees, which are added to the count of legal permanent residents. Researchers then adjust the sum of authorized immigrants by applying demographic statistical techniques to account for deaths, emigration, and new arrivals in the year. Alternatively, Pew, MPI, and CMS impute the likely authorized-resident population based on certain characteristics of foreign-born individuals available in the survey data. The Congressional Budget Office uses a similar imputation methodology to identify the legal status of foreign-born residents (Heinzel, Heller, and Tawil 2021). After subtracting the estimated total number of legal residents from the total foreign-born population, the residual population is identified as likely to be composed of unauthorized immigrants.

The results are adjusted by additional corrections that account for the likely undercount of the unauthorized immigrant population in the ACS and CPS data. Additional survey data provide indications of whether immigrant groups participated in the decennial census or a prior national survey, and how participation rates vary depending on selected respondent characteristics. Researchers may also consult survey and census results in Mexico, which provide additional information on how many Mexican immigrants might be missed in U.S. data sources. Such adjustments can affect the estimates by as little as 5 percent or as much as 15 percent and may vary by age, sex, years since arrival, and other factors.

The tabulation below shows three relatively recent estimates of the unauthorized immigrant population. Their similarity is not surprising: The DHS analysis of the unauthorized immigrant population in January 2018 describes the minor differences between its methodology and those used by Pew, MPI, and CMS, and acknowledges the similarity of the resulting estimates (Baker 2021).

Source	Year	Unauthorized immigrant population estimate (millions)
Pew	2017	10.5
CMS	2018	10.7
DHS	2018	11.4

SOURCES: Passel (2019); Warren (2019b); and Baker (2021).

Pew and CMS use federal surveys and the residual method to generate two major series of recurring estimates of the unauthorized immigrant population (Passel 2005, 2019; and Warren 1997, 2003, 2018a, 2018b, 2019a, 2019b). The CPS Annual Social and Economic Supplement and the ACS are the surveys most often used with the residual method for this purpose. Both surveys ask respondents where they were born and whether they are U.S. citizens. An advantage of using the ACS and the CPS over panel studies such as the Survey of Income and Program Participation (SIPP) is that their much larger sample sizes ostensibly provide more accurate data on immigrant populations, particularly at the state and local levels.[4] Providing more recent measurements of the unauthorized immigrant population in the United States, DHS estimates 10.99 million as of January 2022 (Baker and Warren 2024), Pew estimates 11.0 million for 2022 (Passel and Krogstad 2024), and CMS estimates 10.94 million for 2022 (Warren 2024).

Historical Residual-Method Estimates

Pew estimates that the number of unauthorized immigrants rose from about 3.5 million in 1990 to about 8.6 million in 2000 (Krogstad, Passel, and Cohn 2019). Average net growth in the unauthorized immigrant population was about 10 percent each year during that period. In the 2000s, the average net increase was steady at about 4 percent per year. The total unauthorized immigrant population peaked at about 12 million in 2007 then decreased to about 11 million in 2009. Since 2009, the number of unauthorized immigrants has stayed relatively flat at about 11 million (Warren 2018b).[5] Different studies cover different time periods, but the trends they report follow a similar pattern.

Pew and CMS analyses show substantial declines in unauthorized immigration from Mexico, Eastern Europe, and South America since 2007. About 4.9 million Mexican unauthorized immigrants lived in the United States in 2017, compared with 6.9 million in 2007. Non-Mexican unauthorized immigration—mainly from Asia, Central America, and Africa—rose from about 5.3 million in 2007 to 5.5 million in 2017. Reflecting acute political and economic challenges, three "Northern Triangle" countries in Central America—Guatemala, Honduras, and El Salvador—have since 2015 been the origins of increasing unauthorized immigration (Krogstad, Passel, and Cohn 2019).

As net unauthorized immigration declined or slowed in recent years, the total estimated populations of unauthorized immigrants declined substantially in many states. From 2010 through 2017, their numbers dropped by about 500,000 in California, about 150,000 in New York, and about 75,000 in Illinois and Florida (Pew Research Center 2019). Consequently, the recent-arrival share of the unauthorized immigrant population has declined: The fraction who have been in the United States for 10 or more years rose from about two in five persons in 2007 to about two in three in 2017 (Krogstad, Passel, and Cohn 2019).

Visa Overstays

Many persons enter the U.S. legally as tourists, students, temporary workers, or members of other permitted categories, but overstay the period designated in their visas. From 2009 to 2019, "the primary mode of entry for the unauthorized population [was] to overstay temporary visas" (Warren 2019b).

Despite their growing share of the unauthorized immigrant population, accurate estimates of their numbers are elusive largely because there is no direct information on visa overstays. Warren and Warren (2013a, 2013b) and Warren (2019a, 2019b) propose an estimation method that uses indirect data sources. A key component of that method is to differentiate unauthorized immigrants who arrive via entry without inspection (EWI) from those who overstay their visas. This involves identifying the country of origin of immigrants estimated to be unauthorized under the residual method. Unauthorized immigrants from four countries—Mexico, Honduras, Guatemala, and El Salvador—are considered to be more likely to have entered without inspection, while those from other countries are considered more likely to have overstayed a visa.

Specifically, Warren and Warren (2013a) use data from the ACS on the resident population whose country of origin is Mexico, Honduras, Guatemala, or El Salvador, then subtract from that count the estimated number of legal residents (based on DHS data and demographic imputations). To account for slight variations in these assumptions, Warren and Warren multiply the residual estimate of the combined unauthorized immigrant population from Mexico, Honduras, Guatemala, and El Salvador by 90 percent; the result is the estimated EWI population. The rest of the estimated unauthorized immigrant population is assumed to be composed of visa overstays.

From 2000 to 2010, both the new EWI and the new visa overstay populations declined substantially (Warren and Warren 2013a, 2013b). By the 2010s, visa overstays constituted an expanding proportion of new unauthorized immigrants because the number of EWI arrivals was declining more rapidly than that of overstays. Nevertheless, among the total unauthorized population residing in the United States as of 2017, an estimated 4.9 million, or 46 percent, had overstayed a visa, and the other 54 percent had originally arrived via EWI (Warren 2019a).

Annual compilations of DHS data on lawful immigrant entries and deportations (DHS 2018) and on visa overstays (DHS 2020) help to inform estimates of the yearly arrivals of unauthorized immigrants. Yet converting these annual flow estimates into estimates of the total U.S. unauthorized immigrant population is hampered by the difficulty of estimating the numbers of unauthorized immigrants who emigrate, die, or attain legal residency.

DHS publishes annual visa-holder *Entry/Exit Overstay Reports,* of which the fiscal year 2019 edition

(DHS 2020) covers the most recent prepandemic year and thus reflects the overstay flow of a typical year. It reports 574,740 suspected visa overstays in that year. Most of these individuals (92 percent) overstayed visas permitting temporary visits for business (B1) or tourism (B2), or came from countries that participate in the DHS Visa Waiver Program (VWP), which allows business or tourism visits of up to 90 days without a visa.[6]

The other 8 percent, or about 45,000 individuals, overstayed other types of visas in fiscal year 2019. Some of them likely held an Employee Authorization Document that allowed an extended period of employment and in some cases may have entitled them to obtain a Social Security number, unlike those who overstayed B1/B2 visas or visits from VWP participant countries.

An Alternative Methodology: Analyzing Border Crossings and Emigration

Because the unauthorized population is difficult to identify and measure, alternatives to the residual method should be encouraged, studied, and evaluated. Offering one such alternative, Fazel-Zarandi, Feinstein, and Kaplan (2018) estimate the size of the unauthorized immigrant population by analyzing cumulative inflows (EWI and visa overstays) and outflows (deportations, voluntary emigration, mortality, and legal status change). From statistics on border apprehensions and visa overstays, one can theoretically deduce the number of new unauthorized immigrant arrivals by imagining the flow in reverse: How many new arrivals are needed to offset the observed number of apprehensions and visa overstays? For outflows, the authors use data from DHS, the Centers for Disease Control and Prevention, Warren and Warren (2013b), and other sources.[7] With this methodology, they estimate an unauthorized immigrant population of over 22 million, about twice the estimated counts based on the residual method.

The approach has been criticized by the Center for Immigration Studies (Camarota 2018), an independent research organization that advocates reduced immigration, and the CMS, which advocates increased immigration. Both groups take issue with using data on the apprehension of border crossers to measure inflows because the count of apprehension incidents exceeds the number of individuals apprehended.[8] As such, they exaggerate the inflow of unauthorized immigrants from Mexico.

Fazel-Zarandi, Feinstein, and Kaplan's model estimates that the U.S. unauthorized immigrant population from Mexico increased by 17.5 million in the 1990s. Warren (2018a) tests this estimate using Mexican census data[9] for the period from 1990 to 2000. The population of Mexico was 86.1 million in 1990. From 1990 to 1999, 27.6 million births and 4.3 million deaths occurred there. Assuming zero net international migration during the decade, the population in 2000 would have been 109.4 million. The population in 2000 was 103.9 million, indicating a net migration of 5.5 million people from Mexico during the 1990s.

The 2000 U.S. census supports the 5.5 million emigrant statistic from Mexico in the 1990s: It counted 4.5 million immigrants from Mexico who entered from 1990 through 1999. Thus, official Mexican and U.S. statistics suggest that emigration from Mexico to the United States ranged from 4.5 million to 5.5 million people in the 1990s. This result implies that the estimate of 17.5 million in the Fazel-Zarandi, Feinstein, and Kaplan study overestimates the unauthorized population from Mexico by about 12 million.

That study may also overestimate the count of unauthorized immigrants in the United States by underestimating the extent to which these individuals subsequently emigrate. These discrepancies may help explain the disconnect between the unauthorized immigrant populations estimated by Fazel-Zarandi, Feinstein, and Kaplan and those derived from government statistics on births and the school-aged child population, which align more closely with the estimates produced by the residual method (Camarota 2018).

The CMS Methodology for Post-2010 Estimates

CMS used its own version of residual techniques to produce annual estimates of the unauthorized immigrant population from 2010 to 2019. The CMS estimates are based on ACS data for immigrants who arrived after 1981. CMS estimated that the total unauthorized immigrant population for 2010 was 11,725,000 (Warren and Warren 2013b), slightly more than the DHS estimate of 11.6 million (Baker 2021). However, for subsequent years, CMS altered its methodology for estimating components of immigrant population change (Warren 2021). Below, we summarize Warren's revised CMS methodology.

In the first step, CMS used 2010 ACS data on the foreign-born population from each of 145 countries

or areas of origin and used the conventional residual method to estimate the unauthorized immigrant population from each of those places of origin. In the second step, CMS applied "logical edits" to identify post-1981 immigrant arrivals from each place of origin who had likely attained legal status based on certain characteristics. For example, CMS considered individuals who worked in occupations that generally require legal status, had legal temporary migrant status, were immediate relatives of U.S. citizens, received public benefits that are restricted to legal residents, were aged 60 or older at entry, or were from countries from which most U.S. arrivals would be refugees to be legal residents. CMS then subtracted the numbers of these presumed legal residents from the conventional estimates of unauthorized immigrants to calculate an "edited population" of unauthorized immigrants from each country or area of origin. In the third step, CMS consulted independent databases to refine its figures, which resulted in estimates for 145 countries or areas of origin that were deemed plausible for each area and summed to 10,850,000.[10]

Next, a set of ratios was computed by dividing the residual-method estimate of the unauthorized immigrant population for 2010 by the edited population for each of the 145 countries or areas. These individual country ratios form the basis of the detailed CMS estimates for each year after 2010.

To illustrate the methodology step by step, Warren (2021) uses Mexico as the country-of-origin example. Using the residual method, CMS estimated that 6.138 million unauthorized residents were among the noncitizens from Mexico counted in the 2010 ACS. CMS found that, in all, the 2010 ACS counted 8.062 million noncitizen residents who arrived from Mexico after 1981. Of those, 1.645 million were determined to be likely legal residents, producing an edited population of 6.417 million. Dividing the number of unauthorized residents in 2010 estimated with the residual method (6.138 million) by the edited population (6.417 million) yields 0.956.[11] CMS then multiplied the ratio 0.956 by the edited population calculations for each year 2011–2016 to estimate the unauthorized immigrant population from Mexico. This procedure was repeated for each country or area of origin.

CMS used the same country-specific ratios to estimate the unauthorized immigrant population each year from 2011 through 2016 because the 2010 population numbers and ratios were "the cumulative result of legal and undocumented entries throughout the entire 28-year period from 1982 to 2010. If the proportion of unauthorized to legal entries in 2011 deviated from that long-term trend, the effect on the ratio, and thus the estimate [for 2011], would likely be small. Examination of the annual ACS data for noncitizens, and of annual DHS data for legal permanent residents… admitted, shows that arrivals and population trends for nearly all countries [of origin] tend to be fairly stable over time" (Warren 2021). In any event, annual variations in the ratios for each of the 145 countries or areas would likely tend to offset each other over time, such that the total unauthorized immigrant population estimates would be stable in the period 2011–2016. However, for its annual estimates for 2017–2019, CMS devised a set of procedures to revise the ratios as needed. CMS based those revisions on administrative data and estimates of noncitizen deaths and emigration from DHS (Warren 2021).

Regardless of the rigor and sophistication of the methodologies they use, how do we know whether the estimates from CMS—and other organizations—accurately reflect the size of the unauthorized immigrant population? The validity of residual-method estimates of the unauthorized immigrant population rests in part on the adequacy of the adjustments for undercount in the ACS. CMS evaluated the accuracy of those adjustments in part by comparing its unauthorized immigrant population estimates with those of reliable administrative sources such as DHS' data sets on Deferred Action for Childhood Arrivals (DACA) applicants and Temporary Protected Status (TPS) beneficiaries, the latter group being principally from El Salvador, Honduras, and Haiti.

If the CMS estimates of the total unauthorized immigrant population are too low, then the number of DACA applicants reported by DHS would be much higher than the CMS projections. In fact, DHS reported about 800,000 DACA applicants for 2010, considerably *lower* than the approximately 1.2 million applicants projected by CMS and other organizations. The number of DACA applicants likely was lower than the actual population of individuals eligible to apply for DACA because, as in other legalization programs, some who are eligible do not apply, for various reasons (Warren 2021).

It is difficult to estimate the number of TPS beneficiaries from specific countries such as El Salvador, Honduras, and Haiti and for specific periods of entry. The DHS data, based on administrative records, provide an approximate number that should have been counted in the ACS. Warren (2021) observes that "for each country, the CMS estimates are higher than the

DHS data. The CMS and DHS numbers differ because of sampling variability in the ACS, [the] timing of the estimates (2015 vs. 2017), and other differences in the underlying data. The similarity of these figures, however, provides additional strong support for the overall [unauthorized immigrant] population size and the adequacy of [each organization's] adjustments for undercount in the ACS."

Conclusion

This first of three articles on unauthorized immigration focuses on the predominant method of measuring the unauthorized immigrant population in the United States: the residual estimation method. It also highlights the ever-changing nature of unauthorized immigration: Past trends do not always predict future patterns. For instance, Warren (2024) finds that after a decade of decline, the U.S. unauthorized immigrant population increased by 650,000 in 2022.

Refining the residual method and developing potential new methods—and analyzing their strengths and weaknesses—illuminates the various complexities of measuring unauthorized immigration. For instance, Fazel-Zarandi, Feinstein, and Kaplan (2018), and its critique (Warren 2018a), highlight that different immigrant groups have different patterns of subsequent emigration from the United States. Accounting for such differences is important in measuring their populations, earnings, family structures, and other characteristics, as our second article (Tamborini and others 2025) shows.

This article also describes a methodological extension of the residual method used in estimating post-2010 unauthorized immigrant populations. The methodology has evolved to account for immigrants' countries of origin and mode of arrival (EWI or visa overstay). Our second article also explores additional statistical techniques that may be better able to identify unauthorized immigrant populations and provide a deeper understanding of their characteristics. Our third and concluding article (Gesumaria and others 2025) introduces a new method of estimating the unauthorized immigrant population.

Notes

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[1] The benchmark estimates from DHS and these independent think tanks in turn provide the basis for Census Bureau and Congressional Budget Office estimates. The Congressional Research Service and the University of Pennsylvania's U.S. budget model also rely on estimates generated by this method. Note that CMS used the residual method as part of its estimation procedure for 2010 but has revised it for its post-2010 estimates, as we will describe.

[2] The Census Bureau conducts the CPS for the Bureau of Labor Statistics.

[3] Pew, MPI, and CMS have all used CPS data. However, their more recent estimates (from 2005 forward) have been based on the ACS.

[4] The ACS, CPS, and SIPP are nationally representative household surveys administered by the Census Bureau. For more information on ACS, see https://www.census.gov/programs-surveys/acs. For more information on the CPS, see https://www.census.gov/programs-surveys/cps/technical-documentation.html. For detailed descriptions of the SIPP data, see https://www.census.gov/programs-surveys/sipp.html.

[5] There is little evidence, if any, that the recession stopped the upward trend in unauthorized immigrant population after 2008. More likely, a long-term increase in departures coincided with declining arrivals, mostly from Mexico. If the recession had been the cause of a decrease after 2008, the unauthorized immigrant population would have increased thereafter, but it did not.

[6] Because DHS cannot acquire complete departure records for many VWP participants, it likely overestimates the number of overstays for visitors from those countries.

[7] The authors note that "voluntary emigration rates are the largest source of outflow and the most uncertain based on limited data availability."

[8] Some individuals are apprehended multiple times, on repeated instances of returning to a U.S. residence from visits to Mexico.

[9] Specifically, statistics from the National Institute of Statistics and Geography of Mexico.

[10] The 10,850,000 figure reflects the estimated undocumented immigrant population based on ACS data prior to adjusting for undercount. That adjustment produces the 11,725,000 population estimate (Warren 2014).

[11] The ratio for Mexico is the highest for any country. Most countries of origin with relatively large unauthorized immigrant populations have ratios in the range of about 0.80 to 0.92.

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