

**POPULATION DIVISION**

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**Evaluating Components of International Migration:  
Estimates of the Foreign-Born Population by Migrant  
Status in 2000**

Kevin E. Deardorff

Lisa M. Blumberman

## Synopsis

On March 1, 2001, the U.S. Census Bureau issued the recommendation of the Executive Steering Committee for A.C.E. Policy (ESCAP) that the Census 2000 Redistricting Data not be adjusted based on the Accuracy and Coverage Evaluation (A.C.E.). By mid-October 2001, the Census Bureau had to recommend whether Census 2000 data should be adjusted for future uses, such as the census long form data products, post-censal population estimates, and demographic survey controls. In order to inform that decision, the ESCAP requested that further research be conducted.

Between March and September 2001, the Demographic Analysis-Population Estimates (DAPE) research project addressed the discrepancy between the demographic analysis data and the A.C.E. adjusted estimates of the population. Specifically, the research examined the historical levels of the components of population change to address the possibility that the 1990 Demographic Analysis understated the national population and assessed whether demographic analysis had not captured the full population growth between 1990 and 2000. Assumptions regarding the components of international migration (specifically, emigration, temporary migration, legal migration, and unauthorized migration) contain the largest uncertainty in the demographic analysis estimates. Therefore, evaluating the components of international migration was a critical activity in the DAPE project.

This report focuses on the evaluation of the U.S. Census Bureau's estimates of the foreign-born population by migrant status in 2000. In particular, we assess the assumptions used to estimate the various types of international migrants (legal immigrants, temporary migrants, unauthorized migrants, and emigrants) and the effect of alternative assumptions in estimating the size of the foreign-born population. By reviewing alternative assumptions about the types of international migrants, we assess the completeness of coverage of the foreign-born population in Census 2000, and the reasonableness of the resulting Demographic Analysis (DA) estimates.

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## INTRODUCTION

This report presents a discussion of the components of the foreign-born population and focuses on the findings from the Demographic Analysis-Population Estimates (DAPE) research project. In particular, we assess the assumptions used to estimate the various types of international migrants (legal immigrants, temporary migrants, unauthorized migrants, and emigrants) and the effect of alternative assumptions in estimating the size of the foreign-born population. By reviewing alternative assumptions about the types of international migrants, we assess the completeness of coverage of the foreign-born population in Census 2000, and the reasonableness of the resulting Demographic Analysis (DA) estimates.

## BACKGROUND

The foreign-born population is defined by the U.S. Census Bureau as people who are not U.S. citizens at birth.

### Defining the Components of the Foreign-Born Population (FB)

The foreign born consist of legal immigrants, temporary migrants, and unauthorized migrants (Deardorff, 2001b). Stated as an equation, the foreign-born population is defined as:

$$FB = [L - (M + E)] + T + R$$

where

- FB = Foreign-born population
- L = Legal immigrants
- M = Mortality to legal immigrants
- E = Emigration of legal immigrants
- T = Temporary (legal) migrants
- R = Residual foreign born (unauthorized and quasi-legal migrants)

For the foreign-born population, we estimated demographic characteristics (age, sex, race, and Hispanic origin) for implied legal status (legal immigrants, temporary migrants, and residual foreign born) by place of birth, defined for DAPE as 40 unique groupings of countries (see Mulder et al., 2001).

### *Legal Immigrants (L)*

The Immigration and Nationality Act defines legal immigration as the process by which a non-citizen of the United States is granted legal permanent residence. A non-citizen with legal permanent residence status may remain in the country, be employed, travel freely, and seek naturalization to become a U.S.

citizen. Legal immigrants, as categorized by the Census Bureau, include new arrivals to the United States, people adjusting their migrant status to legal permanent resident (including Special Agricultural Workers (SAWs) and pre-1982 entrants (LAWs)), asylees, and refugees (Perry et al., 2001).

We estimated the number of legal immigrants using Immigration and Naturalization Service (INS) data. In 2000, the estimate of survived legal immigrants ( $[L - (M + E)]$ ) was 21,612,023.

#### *Foreign-Born Emigrants (E)*

Foreign-born legal emigrants were residents of the United States who departed from the United States to reside abroad. Unauthorized migrants, migrants from Puerto Rico, temporary migrants, and natives (U.S. citizens at birth) are excluded from this population universe. For purposes of the DAPE project, we estimated the number of emigrants from a residual methodology using data on the foreign-born population by period of entry from two consecutive censuses (Mulder et al., 2001). We used the resulting number of emigrants to calculate rates of emigration. Although these emigration rates reflect the behavior of the entire foreign-born population, they were used as a reasonable proxy for the legal immigrant population. By applying these emigration rates to the legal immigrant population annually from 1990 to 2000, we estimated the number of emigrants from the legal population between 1990 and 2000.

#### *Mortality (M)*

Survival rates for the legal immigrant population were calculated from life tables of the total population by sex and single year of age (Mulder et al., 2001). Although these survival rates were calculated for the total population, they were used as a reasonable proxy for the legal immigrant population. By applying these survival rates to the legal immigrant population, we estimated the number of deaths that occurred to this population between 1990 and 2000.

#### *Temporary Migrants (T)*

The Immigration and Nationality Act defines temporary migrants (also referred to as nonimmigrants) as aliens admitted to the United States for a specified purpose and temporary period, but not for permanent residence. Temporary migrants, as categorized by the Census Bureau and defined for the remainder of this paper, include those who would be considered residents of the United States for purposes of the decennial census, including foreign students and temporary workers, but excluding tourists and business workers (see Cassidy and Pearson, 2001).

We estimated temporary migrants using INS data. In 2000, the estimate of temporary migrants was 1,200,000.

### *Residual Foreign Born (R)*

The residual foreign born, as categorized by the Census Bureau, include the foreign born who were not otherwise accounted for in a legal migration component, whether or not they were counted in the census (Costanzo et al., 2001). Although the residual foreign born include mostly unauthorized migrants, it also includes some categories of legal (or “quasi-legal”) migrants for whom data were not available. Later in our evaluation section, we have attempted to account for this shortcoming by separating the residual foreign born into known components of the foreign born (e.g., immigrants such as asylee applicants who were in a processing backlog at the INS, most of whom will become legal permanent residents) and the implied unauthorized population (Costanzo et al., 2001; Deardorff, 2001a; Deardorff, 2001b). Therefore, the residual foreign born is actually:

$$R = R_1 + R_2$$

where

$R_1$  = Known components of the residual foreign born (mostly quasi-legal migrants)

$R_2$  = Implied unauthorized migrants

We estimate known components of the residual foreign born ( $R_1$ ) using INS data. In 2000, the estimate of this group was 1,700,000. We estimate unauthorized migrants ( $R_2$ ) by applying undercount rate assumptions to the part of this population counted in the census.

Researchers have not agreed on how many unauthorized migrants were missed in the census. However, after reviewing research conducted by independent migration experts, and after reviewing the results for hard-to-count populations from the Accuracy and Coverage Evaluation (A.C.E.), we assumed a 15-percent average undercount for the foreign born enumerated in the census *and* categorized as residual foreign born (see Table 1). Applying this average 15-percent undercount to the residual foreign born counted in the census, we estimated the following “true” level of foreign born by migrant status in 2000 (see Table 2).

Table 1: Census Level Estimates of the Foreign-Born Population by Migrant Status in 2000: Baseline

Migrant Status	Number
Foreign Born Population	<b>31,098,945</b>
Survived Legal Immigrants (implied)	<b>21,612,023</b>
Temporary Migrants <sup>1</sup>	<b>781,507</b>
Residual Foreign Born	<b>8,705,419</b>

<sup>1</sup> Estimates of temporary migrants were calculated from the census using previous census methodology. Components of the foreign born do not add to the total foreign born due to rounding in underlying calculations.

Table 2: “True” Level Estimates of the Foreign-Born Population by Migrant Status in 2000: Baseline

Migrant Status	Number
Foreign Born	<b>32,635,199</b>
Survived Legal Immigrants (implied)	<b>21,612,023</b>
Temporary Migrants <sup>1</sup>	<b>781,507</b>
Residual Foreign Born	<b>10,241,669</b>

<sup>1</sup> For the Baseline estimates, we assumed complete census coverage for temporary migrants. For subsequent scenarios, we assumed a “true” level estimate of temporary migrants of 1,200,000.

The demographic analysis estimates presented in detail in the main section of this report used the levels of temporary migrants and unauthorized migrants (counted within the residual foreign born) shown above. These levels represent the results of detailed analysis and the application of detailed age, sex, race, and Hispanic origin distributions.

## **DETAILED METHODOLOGY**

Previous estimates of the foreign-born population by migrant status used a variety of often unrelated data sets. Using different data sets to estimate types of international migrants is problematic given the residual methodology used previously and in this analysis. To minimize inconsistencies, we used an integrated approach to calculate the migrant status of the foreign born. Additionally, we generated standardized files for the 1990 Census and Census 2000 data which were used for the calculations of the number of each type of international migrant. We also used a standard method to impute values for missing variables and characteristics in these files.

### Data Sets Used for Calculations

For temporary migrants, data from the Census 2000 Supplementary Survey were used as a proxy for Census 2000 data that were not yet available. A review and evaluation of these data suggest they are a reasonable approximation for yet unavailable detailed Census 2000 sample data (Malone, 2001; Deardorff and Malone, 2001).

For 1990, we used the census sample edited detail file modified to remove the category of “some other race.” Missing data for country of birth were imputed using responses to the country of birth question, independently for each state. For 2000, we used preliminary census sample data, based on intermediate weighting schemes and editing procedures, and modified to match the 1990 racial categories (Malone, 2001). The preliminary Census 2000 sample data were available only for certain variables, including age, sex, race, Hispanic origin, country of birth, citizenship, and year of entry into the United States.



Using these data sets, we estimated the foreign born in 2000 by migrant status (legal immigrants, temporary migrants, and a residual component consisting of quasi-legal and unauthorized migrants) by DA race (Black, NonBlack), sex, and A.C.E. age groups (ages 0-17, 18-29, 30-49, and 50 and older). In addition, we estimated the number of foreign born by migrant status, sex, A.C.E. age groups, and mutually exclusive race/ethnic categories (non-Hispanic White, non-Hispanic Black, non-Hispanic Asian and Pacific Islander, non-Hispanic American Indian and Alaska Native, and Hispanic).

#### Review of Previous Methodology Used to Calculate the Foreign-Born Population by Migrant Status

Historically, the Census Bureau employed demographic analysis to evaluate the accuracy of census results. In the course of these evaluations, the Census Bureau made assumptions regarding the level of legal migrants and the residual foreign born. Based on previous research about census coverage of these populations, the Census Bureau traditionally assumed a higher coverage rate for legal immigrants than for the residual foreign born (Costanzo et al., 2001). After the 1990 Census, the Census Bureau expanded estimates of international migrants to include temporary migrants to the United States, as previous estimates of temporary migrants were limited to the number of foreign students in the country. A primary reason for estimating temporary migrants was to account for this group independently of the unauthorized population in the decennial census. Other reasons were to develop better demographic characteristics of the foreign-born population (specifically, temporary migrants do not age during the decade because of legal requirements restricting length of stay in the United States), and to evaluate the upcoming results of Census 2000.

A major component of the DAPE project was to validate estimates of the number of international migrants (legal immigrants, temporary migrants, and unauthorized migrants) in 1990. After our validation work, we used the same methodologies to develop estimates of the number of international migrants for 2000 using available data. Independent teams were formed to evaluate work on each of these components of international migration. For detailed descriptions of how the teams revised and improved previous estimates, see Costanzo et al., 2001; Mulder et al., 2001; Cassidy and Pearson, 2001; and Perry et al., 2001.

#### Evaluation of the Methodology Used to Calculate the Foreign-Born Population by Migrant Status

Although researchers have routinely adjusted census level estimates of unauthorized migrants to account for those missed in the census, they usually do not adjust explicitly for similar undercounts to the legal immigrant and temporary migrant populations (Passel, 2001; Bean et al., 2001).

To assess the robustness of these levels to varying assumptions about the undercount of legal immigrants and temporary migrants, we developed several scenarios. As discussed later, the application of alternative assumptions results in different implied total foreign-born populations by migrant status. Nevertheless, the totals are not different enough to greatly affect the total DA estimates. Thus, while the results based on the 15-percent assumptions discussed above could vary, the variations would not be substantively different.

This evaluation of the methodology used to calculate the components of international migration addressed several questions:

- 1) Was the assumption of complete coverage of legal immigrants and temporary migrants in the census reasonable?
- 2) Was the assumption of 15-percent undercount for all residual foreign born reasonable?
- 3) Was the resulting estimate of the residual foreign born a reasonable approximation of unauthorized migrants?

### *Evaluation Question 1*

When assigning the foreign born counted in the census to migration statuses, previous researchers at the Census Bureau assumed complete (100 percent) coverage of legal immigrants and temporary migrants in the decennial census. Because the residual foreign born were calculated in the residual category (foreign-born population minus the sum of legal immigrants and temporary migrants), the number of foreign born counted in the census who were categorized as the residual foreign born would be even higher if the assumption of complete coverage of legal immigrants and temporary migrants was dropped.

Researchers studying the foreign born, both inside and outside the Census Bureau, agreed that an assumption of complete coverage for legal immigrants and temporary migrants was unreasonable (Deardorff and Cresce, 2001). A change to this assumption of full coverage in the census would mean fewer foreign born being categorized as legal immigrants and temporary migrants, and more foreign born being categorized as residual foreign born during census level calculations.

### *Evaluation Question 2*

Due to time constraints of the DAPE project, we assumed an average 15-percent undercount rate for the residual foreign born, before meeting with external experts on international migration, even though we expected rates to differ for all groups (legal immigrants and temporary migrants, as well as the residual foreign born) and to vary by demographic characteristics (age, sex, race, and Hispanic origin) and country of birth. Although no consensus emerged on the appropriate levels of undercount to

assume, experts we consulted agreed that the previously assumed average undercount of 15 percent was probably too high, especially given the undercount rates of other hard-to-count groups from Census 2000 (e.g., the undercount rate for Hispanic renters was less than 5 percent), (see Hogan and Whitford, 2001). Additionally, a 15-percent undercount represented the midpoint of previously used rates, but evaluation results suggest census coverage improved from the 1990 Census to Census 2000.

### *Evaluation Question 3*

Most importantly, researchers were concerned about the possible implications of not correcting the assumptions discussed above. Although an explanation that some legal immigrants and temporary migrants were categorized as residual foreign born was helpful, the media and policy makers could mistakenly interpret our results for the residual foreign born as a “best” guess of the size of the unauthorized migrant population. Furthermore, because we had not included “quasi-legal” immigrants (e.g., refugees who had not adjusted to legal permanent resident status because of processing backlogs at INS) in the legal immigrant category, additional foreign born were included in this residual category. For a more detailed discussion of these populations, see Costanzo et al., 2001.

Based on these discussions, we decided to produce alternative undercount assumptions for the foreign-born population and to evaluate the initial, detailed set of estimates against the alternatives. In addition, we are emphasizing that the residual group (as identified by our initial equation) is not an accurate portrayal of the unauthorized foreign born. Finally, we identified additional information about the foreign-born population to separate the residual foreign born category into two components: known components of the foreign born (or those identified as quasi-legal) and the implied unauthorized population (Costanzo et al., 2001; Deardorff and Cresce, 2001).

## **RESULTS OF ALTERNATIVE ASSUMPTIONS**

Table 1 and Table 2 show estimates of the foreign-born population by migrant status using our baseline estimates that assume a 15-percent undercount of the residual foreign born. For the remainder of this report, we calculated the foreign-born population by migrant status using alternative assumptions about census level coverage of these populations. In addition to using different coverage assumptions, we attempt also to separate the residual foreign born into two components: known components (mostly quasi-legal migrants) and the implied unauthorized migrant population.

To address our initial assumption about complete (100 percent) coverage of legal immigrants and temporary migrants in the census, we estimated undercount rates for both groups, then applied those undercount rates to the census level calculations. Although an endless number of possibilities existed for alternative undercount scenarios, we attempted to create a lower and upper bound around our most reasonable assumptions, which will be referred to as the “DAPE Estimate” in this report (Deardorff, 2001a).

### Assumptions for the DAPE Estimate of the Foreign-Born Population

Beginning with a preliminary census level foreign-born population of 31,098,945, we assumed a 2-percent undercount rate for legal immigrants, a 35-percent undercount rate for temporary migrants, a 5-percent undercount rate for known components of the residual foreign born, and a 12.5-percent undercount rate for implied unauthorized migrants (see Table 6 and Equation A). [Table 3 through Table 5 show data with the underlying estimates of the foreign-born population by migrant status consistent with the undercount rate assumptions shown in Table 6.]

For this scenario, the undercount rate of legal immigrants was assumed to be about twice as high as for the total household population; the undercount rate of temporary migrants was calculated based on the difference between the number we identified from our estimate (Cassidy and Pearson, 2001) and the number of temporary migrants identified by INS, or 35 percent; the undercount rate of known components of the residual foreign born was assumed to be about 4 times as high as for the total household population (or slightly higher than the rate for Hispanic renters); and the undercount rate of unauthorized migrants was assumed to be approximately 10 times the rate for the total household population, or approximately 3 times the undercount rate for Hispanic renters (see Hogan and Whitford, 2001).

Table 3 shows the resulting foreign-born population by migrant status.

Table 3: “True” Level Estimates of the Foreign-Born Population by Migrant Status in 2000: DAPE Estimate

Migrant Status	Number
Foreign Born	<b>33,091,988</b>
Survived Legal Immigrants	<b>21,612,023</b>
Temporary Migrants	<b>1,200,000</b>
Residual Foreign Born	<b>10,279,965</b>
Known Components	<b>1,789,474</b>
Unauthorized (Implied)	<b>8,490,491</b>

### Assumptions for the DAPE Lower-Bound Estimate of the Foreign-Born Population

Beginning with a census level foreign-born population of 31,098,945, for the lower-bound estimate, we assumed a 1-percent undercount rate for legal immigrants, a 7-percent undercount rate for temporary migrants, a 1-percent undercount rate for known components of the residual foreign born, and a 10-percent undercount rate for implied unauthorized migrants, as shown in Table 6 and Equation B.

For this scenario, the undercount rate of legal immigrants was assumed to be about the same as for the total household population; the undercount rate of temporary migrants was assumed to be almost twice

as high as for Hispanic renters; the undercount rate of known components of the residual foreign born was assumed to be about the same as for the total household population; and the undercount rate of unauthorized migrants was assumed to be approximately 8 times the rate for the total household population, or a little more than twice the undercount rate for Hispanic renters (see Hogan and Whitford, 2001).

Table 4 shows the resulting foreign-born population by migrant status.

Table 4: “True” Level Estimates of the Foreign-Born Population by Migrant Status in 2000: Lower-Bound DAPE Estimate

Migrant Status	Number
Foreign Born	<b>32,174,511</b>
Survived Legal Immigrants	<b>21,612,023</b>
Temporary Migrants	<b>1,200,000</b>
Residual Foreign Born	<b>9,362,488</b>
Known Components	<b>1,700,000</b>
Unauthorized (Implied)	<b>7,662,488</b>

Assumptions for the DAPE Upper-Bound Estimate of the Foreign-Born Population

Beginning with a census level foreign-born population of 31,098,945, for the upper-bound estimate, we assumed a 2-percent undercount rate for legal immigrants, a 35-percent undercount rate for temporary migrants, a 5-percent undercount rate for known components of the residual foreign born, and a 15-percent undercount rate for implied unauthorized migrants (see Table 6 and Equation C).

For this scenario, the undercount rate of legal immigrants was assumed to be about twice as high as for the total household population; the undercount rate of temporary migrants was calculated based on the difference between the number we identified from our estimate (Cassidy and Pearson, 2001) and the number of temporary migrants identified by INS; the undercount rate of known components of the residual foreign born was assumed to be about 4 times as high as for the total household population (or slightly higher than the rate for Hispanic renters); and the undercount rate of unauthorized migrants was assumed to be approximately 12 times the rate for the total household population, or nearly 4 times the undercount rate for Hispanic renters (see Hogan and Whitford, 2001).

Table 5 shows the resulting foreign-born population by migrant status.

Table 5: “True” Level Estimates of the Foreign-Born Population by Migrant Status in 2000: Upper-Bound DAPE Estimate

Migrant Status	Number
Foreign Born	<b>33,347,473</b>
Survived Legal Immigrants	<b>21,612,023</b>
Temporary Migrants	<b>1,200,000</b>
Residual Foreign Born	<b>10,535,450</b>
Known Components	<b>1,700,000</b>
Unauthorized (Implied)	<b>8,835,450</b>

Implications and Reasonableness

The estimates of the foreign-born population differ because of alternative assumptions about coverage rates by migrant status. The implied total undercount for the foreign-born population ranges from 3.3 percent using the assumptions for the lower bound to 6.7 percent using the assumptions for the upper bound (see Table 6). These ranges are similar to the undercount rates (as measured by the A.C.E.) of approximately 3 percent for Hispanics and approximately 4 percent for Hispanic renters.

Table 6: Census Level Undercoverage Rate Assumptions for the Foreign-Born Population by Migrant Status: 2000

Migrant Status	DAPE Estimate		
	Lower Bound	"DAPE"	Upper Bound
Foreign Born	32,174,511	33,091,988	33,347,473
Survived Legal	1%	2%	2%
Temporary <sup>1</sup>	7%	35%	35%
Residual Foreign Born			
Known Components	1%	5%	5%
Unauthorized (Implied) <sup>2</sup>	10%	12.5%	15%
Average Undercount Rate <sup>3</sup>	3.3%	6.0%	6.7%

<sup>1</sup> The 35-percent undercount assumption for temporary migrants is consistent with the Census Bureau’s estimate using 1990 methodology. This methodology does not identify temporary migrants in certain visa categories that did not exist until after 1990.

<sup>2</sup> The undercount assumptions for unauthorized migrants are for “true” level, not census level.

<sup>3</sup> Average undercount rate = (estimated foreign born - Census foreign born) / estimated foreign born x 100. The Census foreign-born population was 31,098,945.

The “true” level for the foreign born would be 3.3 percent higher than census level using the assumptions for the Lower-Bound DAPE Estimate; 6.0 percent higher using assumptions for the DAPE Estimate; and 6.7 percent higher using assumptions for the Upper-Bound DAPE Estimate.

Using these new results for the total foreign-born population to calculate DA estimates results in figures lower than the A.C.E. total population of 284,683,782 (see Table 7). Including the Lower-Bound DAPE Estimate of the foreign born in the calculation of the DA population would result in an estimate of 281,299,186, or more than 3 million people lower than the A.C.E. total population. The DA population would be 282,216,664 using the DAPE Estimate for the foreign born, or more than 2 million people lower than the A.C.E. total population. Similarly, the DA population would be 282,472,149 using the Upper-Bound DAPE Estimate for the foreign born, also more than 2 million lower than the corresponding A.C.E. total population. In summary, despite the use of alternative assumptions in these scenarios, resulting estimates of the foreign-born population do not explain the different total populations calculated by DA and the A.C.E.

Table 7: Effect of Alternative Assumptions for the Foreign-Born Population on Demographic Analysis Estimates

Component	“DAPE” Estimate		
	Lower Bound	“DAPE”	Upper Bound
DA Total Population	281,299,186	282,216,664	282,472,149
Foreign Born			
Number	32,174,511	33,091,988	33,347,473
Percent	11.44	11.73	11.81
Implied Net Undercount of DA Total Population Relative to Census 2000			
Number	-122,720	<b>794,758</b>	1,050,243
Percent of DA Total	-0.04	<b>0.28</b>	0.37

Notes: The Census 2000 Population is 281,421,906. A minus sign denotes a net overcount.

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## APPENDIX 1: EQUATIONS FOR DAPE

### Equations for Estimating the Foreign-Born Population by Migrant Status

*Equation A: DAPE Estimate of the Foreign-Born Population by Migrant Status<sup>1</sup>*

$$\text{Census Level Foreign Born} = [L - (M + E)] + T + R_1 + R_2$$

$$\text{“True” Level Foreign Born} = AR_L + AR_T + AR_{R1} + \text{Implied Unauthorized}$$

$$\text{Counted L} = 0.98 AR_L$$

$$\text{Counted T} = 0.65 AR_T$$

$$\text{Counted } R_1 = 0.95 AR_{R1}$$

$$\begin{aligned} \text{Census Level Foreign Born} - (0.98 AR_L) - (0.65 AR_T) - (0.95 AR_{R1}) = \\ \text{Counted Unauthorized} = R_2 \end{aligned}$$

To get implied unauthorized:

$$\text{Apply Undercount to Counted Unauthorized } (R_2) = 1/.875 R_2$$

where:

$[L - (M + E)]$  = Survived legal immigrants (counted)

T = Temporary migrants (counted)

$R_1$  = Residual foreign born–known components (counted)

$R_2$  = Residual foreign born–implied unauthorized (counted)

$AR_L$  = Administrative record estimate of implied survived legal immigrants  
(INS data)

$AR_T$  = Administrative record estimate of temporary migrants (INS data)

$AR_R$  = Administrative record estimate of residual foreign born known  
components (INS data)

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<sup>1</sup>The census level estimates used to produce results in Table 3 assumed a survived legal immigrant population of 21,188,258 rather than 21,179,783. The “true” level estimates in Table 3 assumed known components of the residual foreign born were 1,789,474 rather than 1,700,000.

*Equation B: DAPE Lower-Bound Estimate of the Foreign-Born Population by Migrant Status<sup>2</sup>*

$$\text{Census Level Foreign Born} = [L - (M + E)] + T + R_1 + R_2$$

$$\text{“True” Level Foreign Born} = AR_L + AR_T + AR_{R1} + \text{Implied Unauthorized}$$

$$\text{Counted L} = 0.99 AR_L$$

$$\text{Counted T} = 0.93 AR_T$$

$$\text{Counted } R_1 = 0.99 AR_{R1}$$

$$\begin{aligned} \text{Census Level Foreign Born} - (0.99 AR_L) - (0.93 AR_T) - (0.99 AR_{R1}) = \\ \text{Counted Unauthorized} = R_2 \end{aligned}$$

To get implied unauthorized:

$$\text{Apply Undercount to Counted Unauthorized } (R_2) = 1/.90 R_2$$

where the notation is as defined above.

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<sup>2</sup>The census level estimates used to produce results in Table 4 assumed a survived legal immigrant population of 21,398,043 rather than 21,395,903; a temporary migrant population of 1,121,495 rather than 1,116,000; and known components of the residual foreign born of 1,683,168 rather than 1,683,000.

*Equation C: DAPE Upper-Bound Estimate of the Foreign-Born Population by Migrant Status<sup>3</sup>*

$$\text{Census Level Foreign Born} = [L - (M + E)] + T + R_1 + R_2$$

$$\text{“True” Level Foreign Born} = AR_L + AR_T + AR_{R_1} + \text{Implied Unauthorized}$$

$$\text{Counted L} = 0.98 AR_L$$

$$\text{Counted T} = 0.65 AR_T$$

$$\text{Counted } R_1 = 0.95 AR_{R_1}$$

$$\begin{aligned} \text{Census Level Foreign Born} - (0.98 AR_L) - (0.65 AR_T) - (0.95 AR_{R_1}) = \\ \text{Counted Unauthorized} = R_2 \end{aligned}$$

To get implied unauthorized:

$$\text{Apply Undercount to Counted Unauthorized } (R_2) = 1/.85 R_2$$

where the notation is as defined above.

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<sup>3</sup>The census level estimates used to produce results in Table 5 assumed a survived legal immigrant population of 21,188,258 rather than 21,179,783 and known components of the residual foreign born of 1,619,048 rather than 1,615,000.

## **APPENDIX 2: DAPE WORKING PAPER SERIES BIBLIOGRAPHY**

**(in order of Working Paper Series Number)**

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