WEIGHTING FOR CINCH AND RENTAL DYNAMICS

FULL DRAFT

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Introduction

This report documents the weighting used in Components of Inventory Change (CINCH) and rental dynamics studies based on the American Housing Surveys (AHS) for 2015 and 2017. The same weighting strategy is likely to be used for similar studies based on the 2019 AHS.

The report consists of three sections:

- A discussion, using a FAQ-like Q&A format, of the research goals and the methodology issues.

- A step-by-step description of the techniques used to create the weights.

- An appendix containing key output from the various steps in creating the weights used in the national-level CINCH and rental dynamics studies for 2015 and 2017.

Additional appendixes will be added for other CINCH and Rental dynamics studies, such as those for Houston and Detroit.

Research Goals and Methodological Issues

What are CINCH and rental dynamics studies?

A CINCH study tracks the evolution of the housing stock between AHS surveys. In simple terms:

$$\text{Base-year housing stock} - \text{Losses} + \text{Additions} = \text{Final-year housing stock}$$

The stocks in the 2 years can be thought of as satisfying two equations, where "Units in both years" consist of the same units in both years:

$$\text{Units in both years} = \text{Base-year housing stock} - \text{Losses}$$

$$\text{Units in both years} = \text{Final-year housing stock} - \text{Additions}$$

The goals of CINCH analysis are:

1. Estimate the size of the two key flows, Losses and Addition, and of the "units in both years."

2. Explain and measure the causes of Losses and the sources of Additions.

3. Examine the characteristics (that is, owned vs. rental, single-family vs. multifamily) of Losses and Additions.

4. Determine the extent to which "Units in both years" change characteristics between the base year and final year.

A rental dynamics study tracks the evolution of the rental stock between two AHS surveys. In simple terms:

Base-year rental stock – Changes to non-rental use – Rental losses from the stock + Changes from non-rental use + Rental additions to the stock = Final-year rental stock

In similar fashion, this can be broken down as follows:

Units rental in both years = Base-year rental stock – Changes to non-rental use – Rental losses to the stock

Units rental in both years = Final-year rental stock – Changes from non-rental use – Rental additions to the stock

The goals of rental dynamics analysis are similar to those of CINCH analysis, except that the main characteristic of interest is the affordability of the rental unit:

1. Estimate the size of the four key flows, rental losses, rental additions, changes to non-rental use, and changes from non-rental use and of the "units rental in both years."

2. Explain and measure the nature of two types of losses (changes to non-rental use and rental losses to the stock) and the two sources of additions (changes from non-rental use and rental additions to the stock).

3. Examine the affordability and other characteristics (that is, single-family vs. multifamily, number of bedrooms) of losses and additions.

4. Determine the extent to which "units rental in both years" changes affordability between the base year and final year.

CINCH and rental dynamics are defined in terms of the AHS because the AHS is the only data source that can satisfy the goals of these studies; therefore, these analyses are limited to the times and places for which AHS data are available. Because CINCH and rental dynamics analyses are so similar in structure and goals, the same weights are used for both.

What is the role of weighting in CINCH and rental dynamics analysis?

The simple characterization of CINCH is:

Base-year housing stock – Losses + Additions = Final-year housing stock

This characterization would work perfectly if one could count all four elements but, unfortunately, each element has to be estimated from samples using weights.

What weights are available in the AHS for possible use in CINCH and rental dynamics analysis? What are their limitations?

* **PWTXX:** The U.S. Census Bureau makes available for public use a file called "Sample Case History File: 2015 and beyond," better known among AHS users as the "Where

Did They Go" (WDTG) file.[1] This file contains a "base weight" which is the weight a unit should receive on the basis of how the unit was sampled.[2] The XX indicates the survey year for which the value of the pure weight applies (for example, PWT15 is the pure weight in the 2015 AHS). Normally the pure weight does not vary between surveys. Among all units that had pure weights in both the 2015 and 2017 AHS surveys, PWT15 = PWT17.

- **WEIGHT:** Every case on an AHS public use file (PUF) has a variable WEIGHT, called "final weight." The U.S. Census Bureau derives WEIGHT from PWTXX by refining it. The refinements fall into two types: (1) an adjustment to account for units that are not interviewed and (2) a series of adjustments to ensure the data in a particular AHS survey provide the most accurate possible representation of the American housing stock in that survey year. Since these refinements are made on a survey-by-survey basis, the value of WEIGHT for a particular unit can change between surveys.[3]

For CINCH and rental dynamics purposes, the greatest limitation of WEIGHT is that WEIGHT = 0 for units that are not interviewed. The first goal for CINCH is to count losses and additions. Often units lost between the base year and final year are not interviewed in the base year, and the non-interview adjustment incorporated in WEIGHT for other units was not specifically designed to reflect non-interviews among lost units. Similarly, often units added between the base year and final year are not interviewed in the final year, and the non-interview adjustment incorporated in WEIGHT for other units was not specifically designed to reflect non-interviews among added units.

This report uses PWTXX to create special weights for CINCH and rental analysis but makes refinements to PWTXX similar to those made by the U.S. Census Bureau in creating WEIGHT.

Why does CINCH and rental dynamics analysis require separate weights for forward-looking and backward-looking analysis?

Tracking the base-year housing stock to the final year is called forward-looking analysis; explaining how the final-year housing stock evolved from the base year is called backward-looking analysis.

The main reason for using separate weights is that, traditionally, forward-looking CINCH analysis starts from the official AHS count of the base-year housing stock and backward-looking CINCH analysis starts from the official AHS count of the final year.

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[1]See *Sample Case History: 2015 and Beyond*, retrieved from https://www.census.gov/programs-surveys/ahs/tech-documentation/help-guides/national-sample-case-history_2015.html.
[2]Technically, the base weight for each unit is the inverse of the probability of that unit being selected into the sample. Before the 2015 AHS, the base weight was called the "pure weight," hence the name PWTXX.
[3]"2015 AHS Integrated National Sample: Sample Design, Weighting, and Error Estimation" explains these refinements in detail. See https://www.census.gov/programs-surveys/ahs/tech-documentation/def-errors-changes.2015.html.

Conceptually, a single set of weights could be used for CINCH analysis but, in practice, it is not feasible. To see this, consider the fundamental CINCH equations:

AHS control total for the base-year housing stock = Weighted sum of units in both years + Weighted sum of units lost from the base-year stock

AHS control total for the final-year housing stock = Weighted sum of units in both years + Weighted sum of units added to the final-year stock

In CINCH analysis, these two equations work because we use different weights in each equation, permitting the "weighted sum of units in both years" to be different in each equation.

Now assume that the same set of weights is used in both equations and subtract the top equation from the bottom equation. Because the "weighted sum of units in both years" is the same in both equations, the resulting equation is the following:

Change in the control totals between base year and final year = Weighted sum of units added to the final-year stock – Weighted sum of units loss from the base-year stock

This equation is true ONLY IF the analysis has correctly counted additions and losses. In practice, the weighted counts of additions and losses are only approximate. Therefore, the analysis cannot use a single set of weights and match the controls totals in **both** the base year and the final year.

Steps in Creating CINCH Weights[4]

The steps used to create forward-looking weights are conceptually the same as the steps used to create backward-looking weights; however, the details differ. This section explains, in order, each step conceptually and then, within the discussion, presents the details for forward-looking and backward-looking analysis application for that step.

Notation and Other Issues

Variable names are written in capital letters; for example, BLD (structure type).[5] The variables come from two sources: (1) the AHS PUFs and (2) the WDTG file. In the conceptual discussion, this document uses the formal name (Sample Case History file) but, in the applications, it uses the simpler and more familiar WDTG. Some WDTG variables take different values in different surveys; these variables names end in XX, where the XX suffix stands for the survey year (for

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[4]This section treats all AHS variables as being numeric. Readers should be aware that some AHS variables are character in format. For example, NOINTXX is a character variable. Therefore, the statement $1 \leq NOINTXX \leq 6$ makes no sense in code unless NOINTXX is first converted into a numeric variable.

[5]The AHS website contains a codebook for the PUFs that defines the variables, explains their coding, and contains other useful information on the variables. See https://www.census.gov/data-tools/demo/codebook/ahs/ahsdict.html.

example, NOINT17 (reason not interviewed in 2017)).[6] When we merge two PUFs, we add the prefix INXX_ to identify the survey year (for example, IN15_BLD (structure type in 2015)). Because there are only two PUFs available at this time, the applications will be given in terms of the 2015 and 2017 PUFs.

In reading the following discussion, it is important to distinguish among three groups:

1. Cases in the AHS sample.
2. Units in the housing stock.
3. Cases not in the housing stock.

The AHS sample consists of all cases drawn in 2015 or added in subsequent survey years. The housing stock consists of those cases in the AHS sample that either were interviewed in a particular survey year or were considered available for occupancy but failed to be interviewed because of refusals, language difficulties, or similar reasons (NOINTXX ≤ 6). Cases not in the housing stock consisted of sampled units that were not interviewed because they not available for occupancy (6 < NOINTXX). Only interviewed units are on the PUF. All sampled cases are on the WDTG File.

Steps for Analysis

Step 1. Preparing the Files

CINCH and rental dynamics analysis involve following AHS units between survey years so two PUFs will be involved. The WDTG file contains four variables that are essential for these analyses: NOINTXX, PWTXX, INTSTATUSXX, and YRINTRO. All four files need to be merged. The weighting process begins with the full 2015 PUF, the full 2017 PUF, and full WDTG file and proceeds to develop a working file that contains only those cases being tracked. For forward-looking analysis, only those cases that are in the base-year housing stock are retained; for backward-looking analysis, only those cases that are in the final-year housing stock are retained. Using CINCH 2015–2017 as an example, the following two paragraphs explain how the working files are constructed.

For forward-looking analysis, merge the 2015 and 2017 PUFs, keeping only those cases that are in the 2015 PUF. Merge that file with the WDTG file, keeping only those cases in the 2015–2017 merge where INTSTATUS15 (whether interviewed and type of interview) is not equal to N (value missing because case is not in the sample in 2015). The 2015 PUF contains all cases that were both in the 2015 AHS sample and were interviewed in 2015. These units are perforce part of the 2015 housing stock. The merge with the WDTG sample where YRINTRO = 2015 added units that were potentially habitable but not interviewed in 2015 for reasons such as "no one home," "refusal," or "language problems." These units may be part of the 2015 housing stock. The WDTG merge also added units that were not inhabitable in 2015 and therefore not part of

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the 2015 housing stock. Eliminating units where NOINT15 $\geq$ 10 removes these uninhabitable units. The final result is a working file with all the sample units that were part of the 2015 housing stock.

For backward-looking analysis, merge the 2015 and 2017 PUFs, keeping only those cases that are in the 2017 PUF. Merge that file with WDTG file, keeping only those cases in the 2015–2017 merge where INTSTATUS17 is not equal to N.[7] If a unit was in the 2017 PUF, it was interviewed in 2017 and perforce part of the 2017 housing stock. Units from WDTG not in the 2017 PUF fall into two groups: habitable but not interviewed in 2017 and uninhabitable in 2017. The first group is part of the 2017 housing stock; the second is not in that stock. Eliminate cases if NOINT17 $\geq$ 10; these are units in the 2017 sample that are not in the 2017 housing stock. The final result is a working file with all the sample units that were part of the 2017 housing stock.

Step 2. Identifying the Housing Stock, Losses, and Additions

The housing stock in any survey consists of those AHS units that were interviewed (INTSTATUSXX (interview status) $\leq$ 3) and those units that existed and were inhabitable but could not be interviewed (INTSTATUSXX = 4 AND $1 \leq$ NOINTXX $\leq$ 6).

Units that are in the housing stock in both the base year and final years are called sames. X is a SAME IF (INTSTATUS15 $\leq$ 3 OR $1 \leq$ NOINT15 $\leq$ 6) AND (INTSTATUS17 $\leq$ 3 OR $1 \leq$ NOINT17 $\leq$ 6). The first parenthetical phase identifies units in the 2015 housing stock; the second parenthetical phrase identifies units in the 2017 housing stock.

To identify units that have left the housing stock (a loss) after a given year, one has to look at NOINTXX for the next survey year. For example, losses from the 2015 housing stock are units that were in the housing stock by the above definition in 2015 but have NOINT17 values of 10 or higher. Typically, losses are classified as temporary ($10 \leq$ NOINTXX $\leq$ 19); that is, it is possible for such a unit to return to the housing stock in subsequent surveys,[8] or permanent remain out of the housing stock ($30 \leq$ NOINTXX). If a case is in the 2015 housing stock, that case is a loss (LOSS = 1) if NOINT17 $\geq$ 10.

Units can be added to the housing stock in two ways. First, before each survey, the U.S. Census Bureau can add new sample units drawn from new addresses in the master address file (MAF). Because these units are drawn from new addresses, they represent units that were not in the housing stock in the previous survey.[9] We identify newly sampled units by when they enter the sample; for the 2015–2017 CINCH, YRINTRO = 2017 for the newly sampled units. Second, units that were temporary losses in the previous survey can return to the housing stock. For the 2015–2017 CINCH, these recovered units will have $10 \leq$ NOINT15 $\leq$ 19. A unit is an addition

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[7] This condition is relevant only if there were AHS surveys after the final year of the CINCH analysis.
[8] Perhaps "potentially recoverable" might be better terminology than "temporary loss."
[9] Of course, things are not this simple. There are a variety of ways in which a unit already in the MAF might have a "new" address in the next version of the MAF. Although this is not exactly accurate, one might think of the set of new residential units as a subset of the set of new addresses. Currently the authors presume the set of "new addresses that are not new residential units" is a small subset of "new addresses."

(ADD = 1) if it satisfies two conditions: (1) It is part of the 2017 stock (INTSTATUS17 IN {'1', '2', '3'} OR NOINT17 < 6) but (2) new to the 2017 stock (YRINTRO = 2017 OR 10 ≤ NOINT15 ≤ 19).

Note that a unit does not have to be interviewed to be considered a loss from or an add to the housing stock. INTSTATUSXX can equal "4" (not interviewed) if NOINTXX ≤ 6 and, under these circumstances, the unit is still considered part of the stock.

CINCH breaks additions into three classes:

- **New construction (NC =1):** NC occurs in two ways: (1) additions to the 2017 sample that are newly constructed units and (2) units that were part of the 2015 sample but were not in the 2015 stock because construction had not been completed. The only way to classify newly sampled units (YRINTRO = 2017) as NC is to determine when they were built. In the PUF files, the YRBUILT variable reports year built in multiyear categories. For IN17_YRBUILT, the most recent category is YRBUILT = 2010 (built in 2010 or later). Thus, for the 2015–2017 CINCH, newly sampled units built in 2010 or later are considered NC. The second NC group consists of units in the 2017 stock, where NOINT15 = 10 (a unit for which a permit was granted and the unit was added to the sample in 2015 but construction was not started in 2015) or NOINT 15 = 11 (a unit in the 2015 sample that was still under construction in 2015).

- **Other additions to the sample (OTHNEW = 1):** These are units newly added to the sample (YRINTRO = 2017) but are not by NC (IN17_YRBUILT < 2010).

- **Other units that were temporarily losses in 2015 (OTHB = 1):** These units have 12 ≤ NOINT15 ≤ 19.

Step 3. Measuring the Housing Stock, Losses, and Additions

Table Creator provides the official estimate of the housing stock but does not estimate either losses or additions. To estimate losses and additions, CINCH creates new weights using the base weight PWTXX, found in the WDTG file.

The first step in this process is to adjust the base weight to accurately measure the housing stock. This is done by (1) summing PWTXX over all sample units considered to be in the housing stock (INTSTATUS15 ≤ 3 OR 1 ≤ NOINT15 ≤ 6) and (2) ratioing PWTXX up or down so the sum equals the official AHS housing count found in Table Creator. Call this new weight PWTXXS1.

Note PWTXXS1 from forward-looking analysis will be different than PWTXXS1 from backward-looking analysis; that is, PWT15S1 will not equal PWT17S1 even though PWT15 will almost always equal PWT17.

Then, in forward-looking analysis, sum PWTXXS1 over the identified loss sample cases (LOSS = 1) to produce the CINCH estimate of losses. For the 2015–2017 CINCH, loss cases are those units in the 2015 housing stock where 10 ≤ NOINT17.

In backward-looking analysis, sum PWTXXS1 over all additions (ADD =1) to produce the CINCH estimate of additions. For the 2015–2017 CINCH, additions are those units in the 2017 stock where YRINTRO = 2017 OR $10 \leq$ NOINT15 ≤ 19.

Step 4. Adjusting the Weights for Non-Interviews

Both CINCH and rental dynamics analyses aim to describe the characteristics of losses, additions, and units that are in both surveys. The characteristics are available only for interviewed units (INTSTATUS ≤ 3). The next step is to separate each of these groups into interviewed and not interviewed and ratio up the weights for interviewed units so they sum to the count for each group. We call this new weight PWTXXS2.

For forward-looking analysis:

If X is a unit that was both interviewed and lost:

PWTXXS2 for X = PWTXXS1 * (Sum of PWTXXS1 over all units that were lost, both interviewed and not interviewed / Sum of PWTXXS1 over all units that were lost but still interviewed in the base year)

In the code, LOSS = 1 if a unit was lost, regardless of whether it was interviewed; INTLOSS =1 if the unit was lost but interviewed in the base year. So this becomes:

$$\text{PWTXXS2} = \text{PWTXXS1} * \sum(\text{LOSS*PWT15S1}) / \sum(\text{INTLOSS * PWT15S1})$$
(where * denotes multiplication)

If X is a unit in the housing stock in and interviewed in both years:

PWTXXS2 for X = PWTXXS1 * (Sum of PWTXXS1 over all units that were in both years whether they were interviewed or not) / (Sum of PWTXXS1 over all units that were in the housing stock and interviewed in both years)

In the code, SAME = 1 if a unit was in both the base-year and final-year housing stocks regardless of whether it was interviewed; INTSAME = 1 if a unit was in both the base year and final year and was interviewed in both years (INTSAME = 1 if INTSTATUS15 ≤ 3 AND INTSTATUS17 ≤ 3).

So this becomes:

$$\text{PWTXXS2} = \text{PWTXXS1} * \sum(\text{SAME*PWT15S1}) / \sum(\text{INTSAME*PWT15S1})$$

For backward-looking analysis:

This is two-stage process for backward-looking analysis because NC depends on YRBUILT, which is only available for interviewed units.

The first stage identifies all added units, regardless of type. If X was a unit that was both added and interviewed:

PWTXXS2 for X = PWTXXS1 * (Sum of PWTXXS1 over all units that were added, both interviewed and not interviewed / Sum of PWTXXS1 over all units that were added but interviewed in the final year)

In the code, using the 2015–2017 CINCH as an example, ADD = 1 if YRINTRO = 2017 OR 10 $\leq$ NOINT15 $\leq$ 19; INTADD = 1 if a unit was added and interviewed in the final year. This becomes:

$$PWTXXS2 = PWTXXS1 * \sum ADD * PWTXXS1 / \sum INTADD*PWTAAS1$$

And, using the same logic as in the forward-looking analysis:

$$PWTXXS2 = PWTXXS1 * \sum SAME*PWTXXS1 / \sum INTSAME*PWTS1$$

At this point, CINCH and rental dynamics analyses discard all units in both years that were not interviewed in both years, all losses that were not interviewed in the base year, and all additions that were not interviewed the final year.

For forward-looking analysis, keep only base year INTSAMES = 1 OR INTLOSS = 1. For backward-looking analysis, keep only final year INTSAMES = 1 OR INTADD = 1.

Using the 2015–2017 CINCH as an example:

To obtain estimates of NC: sum PWT17S2 over all units where YRINTRO = 2017 AND IN17_YRBUILT = 2010, OR 10 $\leq$ NOINT15 $\leq$ 11}.

To obtain estimates of other additions from new sampled cases: sum PWT17S2 over all units where YRINTRO = 2017 AND IN17_YRBUILT < 2010.

To obtain estimates of additions from recovered temporary losses: sum PWT17S2 over all units where 12 $\leq$ NOINT15 $\leq$ 19.

PWT15S2 for the forward-looking analysis will not be the same as PWT17S2 for the backward-looking analysis even though PWT15 is almost always the same PWT17.

The adjustments to PWTXXS1 that produced PWTXXS2 are similar in concept to the first refinements to PWTXX that the U.S. Census Bureau makes to produce WEIGHT. The only difference is that these refinements were made in a way that preserves the count of losses and the count of additions.

Step 5. Further Refinements in the Weights

While PWTXXS2 weights will produce accurate estimates of the base-year housing stock and losses in forward-looking CINCH analysis and accurate estimates of the final-year housing stock and additions in backward-looking CINCH analysis, they sometimes fail to produce satisfactory estimates of subsets of the population; that is, estimates close to those provided by Table Creator.[10] In previous studies, notable discrepancies were found in the regional distribution of the housing stock, the metropolitan/nonmetropolitan distribution, the distribution of the housing stock by structure type, and the distribution of occupied units by the race and ethnicity of the householder. In general, these discrepancies were confined to one category of a distribution. For example, typically the count of housing units in the Northeast region was off by more than 5 percent but the counts for other regions were off by less than 3 percent. Similarly, only the count of units with Black householders were off by more than 5 percent.

These discrepancies are not surprising because the U.S. Census Bureau, in creating WEIGHT, adjusts PWTXX to match what are considered reliable counts of most of the characteristics listed in the preceding paragraph. These adjustments become incorporated into the estimates reported by Table Creator.[11]

The approach adopted in this CINCH analysis was twofold:

1. To decide what counts the weights had to produce exactly for forward-looking and backward-looking CINCH and rental dynamics analysis.

2. To decide what counts were sufficiently off target to be concerned about but did not have to be matched precisely.

For the second group, simple rakings were performed seriatim to smooth over discrepancies. Iterative raking then was performed to ensure the final weights produced the exact counts needed for CINCH and rental dynamics. This process is analogous to the refinements that the U.S. Census Bureau applies to PWTXX to derive WEIGHT.

The U.S. Census Bureau produced short papers to explain sampling and weighting for both the 2015 AHS and the 2017 AHS. Appendix C in each of these documents explain the raking process. Essentially, simple raking takes a set of weights and, using ratio adjustments, changes the weights so they produce a perfect fit to a predetermined distribution. For example, Table Creator can be used to get what the U.S. Census Bureau thinks is the most accurate distribution of the housing stock by Census Division. The existing weights then are ratioed up or down by the following formula:

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[10]Table Creator is a tool provided by the U.S. Census Bureau that allows analysts to produce many useful estimates from the AHS without having to use PUFs. An additional advantage of Table Creator is that it uses data not available in the PUFs.

[11]The authors matched their estimates to those produced by Table Creator rather than seeking out the controls used by the U.S. Census Bureau.

PWTXXS3 = PWTXXS2 * (Table Creator estimate for Division X / Sum of PWTXXS2 over all unit in Division X)

Example C1 in Appendix C describes simple raking.

The problem with applying simple raking seriatim is that a perfect fit is achieved only for the most recent rake. For example, if simple raking is used to improve the fit for Census Division and then another simple raking is applied to improve the fit for structure type, the fit for structure type will be perfect but the fit for Census Division will no longer be perfect. However, the new fit for Census Division will, in general, be much better than the original fit.

Appendix C also explains a form of raking that can be applied two different distributions simultaneously. Example C2 in Appendix C describes this more complicated raking. It is an iterative process that eventually converges.

In developing the final CINCH weights, it was decided that the final weights should satisfy these conditions:

- For forward-looking looking CINCH analysis, the base-year counts of SAME and LOSS should equal the counts produced in Step 3 and the counts of occupied units, vacant units, and seasonal units should equal those from Table Creator. Note that if the count of SAME and LOSS equal their Step 3 counts, then the count of the base-year housing stock should equal the Table Creator count except for rounding. If the count of occupied units, vacant units ($1 \leq$ VACANCY ≤ 7), and seasonal units ($8 \leq$ VACANCY) equal their Table Creator counts, then the count of the base-year housing stock should equal the Table Creator count except for rounding.

- For forward-looking rental dynamics analysis, the base-year counts of owner-occupied units (TENURE = 1), unassisted rental units (HUDSUB = 3), voucher units (HUDSUB = 2), and public housing or privately owned multifamily units (HUDSUB = 1) should equal their Table Creator values. Note that if these conditions are met, the final-year count of occupied units should match the Table Creator value except for rounding.

- For backward-looking analysis CINCH analysis, the final-year counts of SAME, NC, OTHNEW, and OTHB should equal the counts produced in Step 3 and the counts of occupied units, vacant units, and seasonal units should equal those from Table Creator. If the count of SAME, NC, OTHNEW, and OTHB equal their Step 3 counts, then the count of the final-year housing stock should equal the Table Creator count except for rounding. Note that if the count of occupied units, vacant units ($1 \leq$ VACANCY ≤ 7), and seasonal units ($8 \leq$ VACANCY) equal their Table Creator counts, then the count of the final-year housing stock should equal the Table Creator count except for rounding.

- For backward-looking rental dynamics analysis, the final-year counts of owner-occupied units (TENURE = 1), unassisted rental units (HUDSUB = 3), voucher units (HUDSUB = 2), and public housing or privately owned multifamily units (HUDSUB = 1) should equal their Table Creator values. Note that if these conditions are met, the final-year count of occupied units should match the Table Creator value except for rounding.

Adjustments should be made during the weighting process to improve the fit of the distributions of these variables to their Table Creator distributions:

- Census Division (DIVISION).
- Occupancy status (TENURE, VACANCY).
- Structure type and number of units (BLD).[12]
- Race of householder (HHRACE).[13]
- Ethnicity of householder (HHSPAN).
- Year structure built (YRBUILT).
- Age of householder (HHAGE).

In producing the CINCH weights, simple raking was performed for these seven characteristics listed in the order in which they are listed.

Previous CINCH studies found that the initial weights undercounted housing units in suburban areas. The current PUFs do not contain variables that allow users to determine the metropolitan vs. nonmetropolitan location of units. It was therefore not possible to check on location discrepancies or to correct for them. Iterative raking then was applied to achieve conditions that the final weights should satisfy.

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[12]Occupancy status and structure type were matched simultaneously, and occupancy status was limited to occupied, vacant, and seasonal.
[13]The race categories were collapsed.

Appendix A: Documentation for 2015–2017 National CINCH

Forward-Looking Weighting

Step 1. Preparing the File

The 2015 public use file (PUF) contained 69,493 cases.

The merged 2015 PUF and 2017 PUF contained 69,493 cases because only cases in the 2015 PUF were kept.

The merger with the Sample Case History File, better known as the "Where Did They Go" (WDTG) file, added only those cases where SAMPLETYPE = 1 (national sample) and INTSTATUS15 NE N. After the merger with WDTG, the file contained 85,287.

After elimination of cases not in the 2015 housing stock (NOINT15 ≥ 10), there were 81,985 cases in the working file called FLCINCH1517. Of these, there were 12,492 Type A non-interviews (NOINT15 ≤ 6).

Step 2. Identifying the Housing Stock, Losses, and Additions

There were 80,843 cases that were in both the 2015 and 2017 housing stock, called sames (SAME = 1). Of these, 58,475 were interviewed in both 2015 and 2017 (INTSAME = 1).

There were 1,142 cases that were in the 2015 housing stock that were not in the 2017 housing stock (LOSS = 1). Of these, 991 were interviewed in 2015 (INTLOSS = 1).

SAME, INTSAME, LOSS, and INTLOSS were dichotomous variable created to classify the cases in FLCINCH1517.

Step 3. Measuring the Housing Stock, Losses, and Additions

The Table Creator estimate of the 2015 housing stock is 134,790,000.

The sum of PWT15 over all 81,985 cases in FLCINCH1517 was 130,896,390.

PWT15S1 = PWT15*(134,790,00/130,896,390) ~ 1.0297457*PWT15

The sum of PWT15S1 over sames (all cases where SAME = 1) was 132,696,256.

The sum of PWT15S1 over losses (all cases where LOSS = 1) was 2,093,742. THIS IS THE CINCH ESTIMATES OF UNITS LOST FROM THE 2015 HOUSING STOCK BY 2017.

This was the code used to calculate a new weight that, when applied to the interviewed sames, would produce the count of all sames (132,696,256).

IF INTSAME =1 THEN PWT15S2 = PWT15S1 *
∑(SAME*PWT15S1)/∑(INTSAME*PWT15S1)

IF INTSAME =1 THEN PWT15S2 = PWT15S1 * 132,696,256/ 95,974,560
~ 1.3826191* PWT15S1

This was the code used to calculate a new weight that, when applied to the interviewed losses, would produce the count of all losses (2,093,742).

IF INTLOSS = 1 THEN PWT15S2 = PWT15S1 *
∑(LOSS*PWT15S1)/∑(INTLOSS*PWT15S1)

IF INTLOSS = 1 THEN PWT15S2 = PWT15S1 * 2,093,742/ 1,828,210
~ 1.1452415*PWT15S1

At this point, non-interviews were dropped from the analysis, leaving a file of 59,466.

Step 5. Further Refinements in the Weights

Simple Rakings

PWT15S2 was used to produce weighted frequency distribution of eight key characteristics, which were compared with counts from Table Creator. The most notable discrepancies are reported below.

- **Census Division (DIVISION):** The count of housing units was 12.6 percent low for the New England Division and 7.6 percent low for Middle Atlantic Division.

- **Occupancy status (TENURE, VACANCY):** The count of all renters was 5.4 percent low, the count of vacant units was 18.2 percent high, and the count of seasonal units was 24.1 percent high.

- **Structure type and number of units (BLD):** The count of mobile homes was 9.6 percent high.

- **Race of householder (HHRACE):** The count of Black alone householders was 13.3 percent low.

- **Ethnicity of householder (HHSPAN):** The count of Hispanic householders was 6.5 percent low.

- **Year structure built (YRBUILT):** The count of units built in 2010 or later was 13.2 percent low.

- **Age of householder (HHAGE):** Discrepancies ranged from 8.9 percent low for householders ages 25 to 29 to 8.3 percent high for householders 75 or older; the only discrepancy less than 5 percent in absolute value was for householders ages 5 to 64.

Simple raking was applied seriatim to each variable in the order in which they are listed. Each raking resulted in the refined weight producing an exact match to the Table Creator distribution for that variable. As the Weighting Strategy Paper explained, each new rake produced small changes in the previous distributions that negated the exact matches achieved in those rakings.

The raking for occupancy status and structure type was done for the crosstab of those variables. Here is the crosstab from Table Creator. TENURE was used to identify occupied units and was not broken down by owner-occupied and renter-occupied. For BLD, the mobile home (BLD = 1) and other—Boats, RV, vans, etc.—BLD =10 categories were combined.

Exhibit 1.Weighted Cases by Structure Type and Occupancy Status

	Occupied	Seasonal	Vacant
1, detached	74,623	1,685	6,841
1, attached	8,650	212	978
2 to 4	8,849	110	1,403
5 to 9	5,234	67	774
10 to 19	4,754	45	756
20 to 49	3,941	83	704
50 or more	5,269	158	899
Manufactured/mobile home or trailer & other	6,971	562	1,223

Final Iterative Rakings

After these simple rakings were performed, an iterative raking was performed with the aim of matching the row and column totals in the matrix on the following page.[14]

Each iteration has two parts. In the first part, the weights are adjusted to match the row totals; in the second part, the weights are adjusted to match the column totals. The process then is repeated using the same row and column totals converge to the control totals.

After eight iterations, the ratio of the weighted counts to the row and column totals were all 1.000000. The iterations were stopped at this point.

The final weight was called FLCINCHWT.

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[14]Rounding errors caused the sum of the row totals not to equal the sum of the column totals. Small adjustments were made in some row and column totals so the sum of the row totals and the sum of the column total equal 134,790,000.

Exhibit 2. Control Totals for Final Adjustments

	A	B	C	D	E
			INTSAME = 1	INTLOSS =1	
1	CODE				
2		CATEGORIES	SAMES	LOSSES	Row Controls
3	TENURE = '1'	Owners	NA	NA	**74,299,000**
4	HUDSUB = '3'	Unassisted renters	NA	NA	**39,517,000**
5	HUDSUB = '1'	Public housing or Privately owned multifamily	NA	NA	**2,355,000**
6	HUDSUB = '2'	Vouchers	NA	NA	**2,120,000**
7	VANCANCY IN {'01','02'.'03','04','05','06','07'}	Vacant	NA	NA	**13,579,000**
8	VANCANCY IN {'08','09','10','11'}	Seasonal	NA	NA	**2,922,000**
9		Column controls	**132,696,000**	**2,094,000**	

Step 6. Checking the Results

The iterative raking forced the result that the FLCINCHWT produced the desired key totals:

> For forward-looking looking CINCH analysis, the base-year counts of SAME and LOSS should equal the counts produced in Step 3 and the counts of occupied units, vacant units, and seasonal units should equal those from Table Creator. Note that if the count of SAME and LOSS equal their Step 3 counts, then the count of the base-year housing stock should equal the Table Creator count except for rounding. If the count of occupied units, vacant units ($1 \leq$ VACANCY ≤ 7), and seasonal units ($8 \leq$ VACANCY) equal their Table Creator counts, then the count of the base-year housing stock should equal the Table Creator count except for rounding.

> For forward-looking rental dynamics analysis, the base-year counts of owner-occupied units (TENURE = 1), unassisted rental units (HUDSUB = 3), voucher units (HUDSUB = 2), and public housing or privately owned multifamily units (HUDSUB = 1) should equal their Table Creator values. Note that if these conditions are met, the final-year count of occupied units should match the Table Creator value except for rounding.

FLCINCHWT was used to produce weighted frequency distribution of eight key characteristics, which were compared with counts from Table Creator. The most notable discrepancies are reported below.

- **Census Division (DIVISION):** None larger in absolute value than 1.7 percent.
- **Occupancy status (TENURE, VACANCY):** The iterative raking caused owner-occupied, renter-occupied, vacant, and seasonal counts to all equal their controls.
- **Structure type and number of units (BLD):** None larger in absolute value than 2.1 percent.
- **Race of householder (HHRACE):** None larger in absolute value than 1.3 percent.[15]
- **Ethnicity of householder (HHSPAN):** The count of Hispanic householders was 1.1 percent high.
- **Year structure built (YRBUILT):** None larger in absolute value than 0.8 percent.
- **Age of householder (HHAGE):** None larger in absolute value than 1.9 percent.

While the weighting procedure did not involve raking to the Table Creator value for households with a member with disabilities, that discrepancy was 2.8 percent.

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[15]The racial categories were collapsed to White alone, Black alone, American Indian alone, Asian alone, Hawaiian and Pacific Islander alone, and two or more races.

Backward-Looking Weighting

Step 1. Preparing the File

The 2017 PUF contained 66,752 cases.

The merged 2015 PUF and 2017 PUF contained 66,752 cases because only cases in the 2017 PUF were kept.

The merger with WDTG added only those cases where SAMPLETYPE = 1 (national sample). After merger with WDTG, the file contained 87,035.

After elimination of cases not in the 2017 housing stock (NOINT17 ≥ 10) and INSTATUS17 = N, there were 82,907 cases in the working file called BLCINCH1517. Of these, there were 16,155 Type A non-interviews.

Step 2. Identifying the Housing Stock, Losses, and Additions

There were 80,843 cases that were in both the 2015 and 2017 housing stock, called sames (SAME = 1). Of these, 58,475 were interviewed in both 2015 and 2017 (INTSAME = 1).

There were 2,064 cases that were in the 2017 housing stock that were not in the 2015 housing stock (ADD = 1). Of these, 1,684 were interviewed in 2015 (INTADD = 1).

SAME, INTSAME, ADD, and INTADD were dichotomous variable created to classify the cases in BLCINCH1715.

Step 3. Measuring the Housing Stock, Losses, and Additions

The Table Creator estimate of the 2015 housing stock is 137,403,000.

The sum of PWT15 over all 82,907 cases in BLCINCH1715 was 132,385,412.

PWT17S1 = PWT17*(137,403,000/132,385,412) ~ 1.03790137*PWT17

The sum of PWT17S1 over sames (all cases where SAME = 1) was 133,747,221.

The sum of PWT17S1 over additions (all cases where ADD = 1) was 3,655,779. THIS IS THE CINCH ESTIMATES OF UNITS ADDED TO THE 2015 HOUSING STOCK BY 2017.

Step 4. Adjusting the Weights for Non-Interviews

This was the code used to calculate a new weight that, when applied to the interviewed sames, would produce the count of all sames (133,747,221).

IF INTSAME =1 THEN PWT17S2 = PWT17S1 *
∑(SAME*PWT17S1)/∑(INTSAME*PWT17S1)

IF INTSAME =1 THEN PWT17S2 = PWT17S1 * 133,747,221/96,734,6685
~ 1.3826191* PWT17S1

This was the code used to calculate a new weight that, when applied to the interviewed additions, would produce the count of all additions (3,655,779).

IF INTADD = 1 THEN PWT17S2 = PWT17S1 *
∑(ADD*PWT17S1)/∑(INTADD*PWT17S1)

IF INTADD = 1 THEN PWT17S2 = PWT17S1 * 3,655,779/3,011,698
~ 1.21386* PWT17S1

At this point, all non-interviews were dropped from the file, leaving 60,159 cases.

There are three types of additions: new construction (NC) from both newly sampled cases and units whose construction was initiated in 2015 (NC =1); other additions from newly sampled cases (OTHNEW = 1); and additions from units temporarily out of the stock in 2015 (OTHB = 1).

To measure NC, we need YRBUILT, which is only available from interviewed units. PWT17S2 was used to estimate these three types of additions:

∑(NC*PWT15S2) = 2,102,671

∑(OTHNEW*PWT15S2) = 502,793

∑(OTHB*PWT15S2) = 1,050,315

Step 5. Further Refinements in the Weights

Simple Rakings

PWT17S2 was used to produce weighted frequency distribution of eight key characteristics, which were compared with counts from Table Creator. The most notable discrepancies are reported below.

- **Census Division (DIVISION)**: The count of housing units was 8.6 percent low for the New England Division and 12.7 percent low for Middle Atlantic Division.

- **Occupancy status (TENURE, VACANCY):** The count of all renters was 5.7 percent low, the count of vacant units was 24.3 percent high, and the count of seasonal units was 28.0 percent high.

- **Structure type and number of units (BLD):** The count of mobile homes was 11.0 percent high.

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- **Race of householder (HHRACE):** The count of Black alone householders was 14.8 percent low.

- **Ethnicity of householder (HHSPAN)**: The count of Hispanic householders was 5.4 percent low.

- **Year structure built (YRBUILT):** The count of units built in 2010 or later was 7.9 percent low.

- **Age of householder (HHAGE):** Discrepancies ranged from 6.1 percent low for householders 75 and older to 7.6 percent high for householders ages 30 to 34; no discrepancy was less than 5 percent in absolute value.

Simple raking was applied seriatim to each variable in the order in which they are listed. Each raking resulted in the refined weights producing an exact match to the Table Creator distribution for that variable. As the Weighting Strategy Paper explained, each new raking produced small changes in the previous distributions that negated the exact matches achieved in those rakings.

The raking for occupancy status and structure type was done for the crosstab of those variables. Here is the crosstab from Table Creator. TENURE was used to identify occupied units and was not broken down by owner-occupied and renter-occupied. For BLD, the mobile home (BLD = 1) and other—Boats, RV, vans, etc.—BLD =10 categories were combined.

Exhibit 3. Weighted Cases by Structure Type and Occupancy Status

	Occupied	Seasonal	Vacant
1, detached	76,833	1,685	6,310
1, attached	8,958	154	928
2 to 4	8,363	133	1,248
5 to 9	5,780	59	805
10 to 19	5,282	73	826
20 to 49	4,116	68	719
50 or more	5,427	145	1,021
Manufactured/mobile home or trailer & other	6,802	477	1,192

Final Iterative Rakings

After these simple rakings were performed, an iterative raking was performed with the aim of matching the row and column totals in the matrix on the following page.[16]

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[16]Rounding errors caused the sum of the row totals not to equal the sum of the column totals. Small adjustments were made in some row and column totals so the sum of the row totals and the sum of the column total equal 137,403,000.

Exhibit 4. Control Totals for Final Adjustments

	A	B	C	D	E	F	G
1	CODE		INTSAME = 1	NC =1	OTHNEW =1	OTHEB =1	
2		CATEGORIES	SAMES	NC	OTHNEW	OTHB	Row Controls
3	TENURE = '1'	Owners	NA	NA	NA	NA	77,567,000
4	HUDSUB = '3'	Unassisted renters	NA	NA	NA	NA	39,453,000
5	HUDSUB = '1'	Public housing or Privately owned multifamily	NA	NA	NA	NA	2,371,000
6	HUDSUB = '2'	Vouchers	NA	NA	NA	NA	2,169,000
7	VANCANCY IN {'01','02'.'03','04','05','06','07'}	Vacant	NA	NA	NA	NA	13,050,000
8	VANCANCY IN'08','09','10','11'}	Seasonal					2,793,000
9		Column controls	133,747,000	2,103,000	503,000	1,050,000	137,403,000

Each iteration had two parts. In the first part, the weights are adjusted to match the row totals; in the second part, the weights are adjusted to match the column totals. The process then is repeated using the same row and column totals to converge to the control totals.

After eight iterations, the ratio of the weighted counts to the row and column totals were all 1.000000. The iterations were stopped at this point.

The final weight was called BLCINCHWT.

Step 6. Checking the Results

The iterative raking forced the result that the BLCINCHWT produced the desired key totals:

> For backward-looking analysis CINCH analysis, the final-year counts of SAME, NC, OTHNEW, and OTHB should equal the counts produced in Step 3 and the counts of occupied units, vacant units, and seasonal units should equal those from Table Creator. Note that if the count of SAME, NC, OTHNEW, and OTHB equal their Step 3 counts, then the count of the final-year housing stock should equal the Table Creator count except for rounding. If the count of occupied units, vacant units ($1 \leq$ VACANCY ≤ 7), and seasonal units ($8 \leq$ VACANCY) equal their Table Creator counts, then the count of the final-year housing stock should equal the Table Creator count except for rounding.

> For backward-looking rental dynamics analysis, the final-year counts of owner-occupied units (TENURE = 1), unassisted rental units (HUDSUB = 3), voucher units (HUDSUB = 2), and public housing or privately owned multifamily units (HUDSUB = 1) should equal their Table Creator values. Note that if these conditions are met, the final-year count of occupied units should match the Table Creator value except for rounding.

BLCINCHWT was used to produce weighted frequency distribution of eight key characteristics, which were compared with counts from Table Creator. The most notable discrepancies are reported below.

- **Census Division (DIVISION):** None larger in absolute value than 2.1 percent.
- **Occupancy status (TENURE, VACANCY):** The iterative raking caused owner-occupied, renter-occupied, vacant, and seasonal counts to all equal their controls.
- **Structure type and number of units (BLD):** None larger in absolute value than 2.5 percent.
- **Race of householder (HHRACE):** None larger in absolute value than 2.0 percent.[17]
- **Ethnicity of householder (HHSPAN):** The count of Hispanic householders was 0.8 percent high.

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[17]The racial categories were collapsed to White alone, Black alone, American Indian alone, Asian alone, Hawaiian and Pacific Islander only, and two or more races.

- **Year structure built (YRBUILT):** None larger in absolute value than 1.8 percent.

- **Age of householder (HHAGE):** None larger in absolute value than 1.9 percent.

Although the weighting procedure did not involve raking to the Table Creator value for households with a member with disabilities, that discrepancy was 2.8 percent.

Appendix B: Documentation for 2015–2017 Houston CINCH

Forward-Looking Weighting

Step 1. Preparing the File

The 2015 public use file (PUF) contained 69,493 cases.

The merged 2015 PUF and 2017 PUF contained 69,493 cases because only cases in the 2015 PUF were kept.

The merger with the Sample Case History File, better known as the "Where Did They Go" (WDTG) file, added only those cases where SAMPLETYPE = 1 (national sample) and INTSTATUS15 NE N (not included in the 2015 sample). After the merger with WDTG, the file contained 87,085 cases.

After the elimination of cases not in the 2015 housing stock (NOINT15 $\geq$ 10) and not in Houston (OMB13CBSA NE 26420), there were 2,995 cases in the working file called FLHOUSTON1517. Of these, there were 350 Type A non-interviews (NOINT15 $\leq$ 6).

Step 2. Identifying the Housing Stock, Losses, and Additions

There were 2,899 cases that were in both the 2015 and 2017 housing stock, called sames (SAME = 1). Of these, 2,259 were interviewed in both 2015 and 2017 (INTSAME = 1).

There were 96 cases that were in the 2015 housing stock, but were not in the 2017 housing stock (LOSS = 1). Of these, 60 were interviewed in 2015 (INTLOSS = 1).

SAME, INTSAME, LOSS, and INTLOSS were dichotomous variables created to classify the cases in FLHOUSTON1517.

Step 3. Measuring the Housing Stock, Losses, and Additions

The Table Creator estimate of the 2015 housing stock is 2,501,900.

The sum of PWT15 over all 2,995 cases in FLHOUSTON1517 was 2,394,781.

> PWT15S1 = PWT15*(2,501,900 / 2,394,781), or PWT15*1.04473

The sum of PWT15S1 over sames (all cases where SAME = 1) was 2,421,074.

The sum of PWT15S1 over losses (all cases where LOSS = 1) was 80,806. **This is the CINCH estimate of units lost from the 2015 housing stock by 2017.**

This was the code used to calculate a new weight that, when applied to the interviewed sames, would produce the count of all sames (132,696,256):

IF INTSAME = 1 THEN PWT15S2 = PWT15S1 * $\sum$ (SAME*PWT15S1) / $\sum$(INTSAME*PWT15S1)

IF INTSAME = 1 THEN PWT15S2 = PWT15S1 * 2,421,074 / 1,887,299
~ 1.2828* PWT15S1

This was the code used to calculate a new weight that, when applied to the interviewed losses, would produce the count of all losses (2,093,742):

IF INTLOSS = 1 THEN PWT15S2 = PWT15S1 * $\sum$(LOSS*PWT15S1) / $\sum$(INTLOSS*PWT15S1)

IF INTLOSS = 1 THEN PWT15S2 = PWT15S1 * 80,806 / 50,647
~ 1.5959*PWT15S1

At this point, non-interviews were dropped from the analysis, leaving a file of 2,319.

Step 5. Further Refinements in the Weights

Simple Rakings

PWT15S2 was used to produce weighted frequency distribution of eight key characteristics, which were compared with counts from Table Creator. The most notable discrepancies are reported below.

- **Occupancy Status (TENURE, VACANCY):** The count of vacant units was 3.9 percent low and the count of seasonal units was 10.5 percent high because the count of occupied units was 5.3 percent high.

- **Structure Type and Number of Units (BLD):** The count of 2–4-unit buildings was 6.7 percent low.

- **Race of Householder (HHRACE):** The count of Black alone householders was 10.4 percent low.

- **Ethnicity of Householder (HHSPAN):** The count of Hispanic householders was 8.5 percent low.

- **Year Structure Built (YRBUILT):** The count of units built in 2010 or later was 17.9 percent low and the percentage built before 1920 was approximately 14 percent low.

- **Age of Householder (HHAGE):** The count of householders 65 years old or older were approximately 7 percent high.

Simple raking was applied seriatim to most of these variables in the following order: HHAGE, HHRACE, HHSPAN, YRBUILT, and BLD. Each raking resulted in the refined weight, producing an exact match to the Table Creator distribution for that variable. As the Weighting Strategy Paper explained, each new rake produced small changes in the previous distributions that negated the exact matches achieved in those rakings.

The raking for occupancy status and tenure was done as part of the final raking.

Final Iterative Rakings

After these simple rakings were performed, an iterative raking was performed with the aim of matching the row and column totals in the matrix on the following page.[18]

Each iteration has two parts. In the first part, the weights are adjusted to match the row totals; in the second part, the weights are adjusted to match the column totals. The process is then repeated, using the same row and column control totals until the estimated converge to the control totals.

After eight iterations, the ratio of the weighted counts to the row and column totals were all 1.000000. The iterations were stopped at this point.

The final weight was called FLCINCHWT.

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[18]Rounding errors cause the sum of the row totals and the sum of the column totals to not be equal. Small adjustments were made in some row and column totals so the sum of the row totals and the sum of the column total equal 134,790,000.

Exhibit 5. Control Totals for Final Adjustments

	A	B	C	D	E
1	CODE		INTSAME = 1	INTLOSS =1	
2		CATEGORIES	SAMES	LOSSES	Row Controls
3	TENURE = '1'	Owners	N/A	N/A	**1,354,500**
4	HUDSUB = '3'	Unassisted renters	N/A	N/A	**846,400**
5	HUDSUB = '1'	Public housing or Privately owned multifamily	N/A	N/A	**17,000**
6	HUDSUB = '2'	Vouchers	N/A	N/A	**25,800**
7	VANCANCY IN {'01','02'.'03','04','05','06','07'}	Vacant	N/A	N/A	**229,800**
8	VANCANCY IN {'08','09','10','11'}	Seasonal	N/A	N/A	**28,400**
9		Column controls	**2,421,074**	**80,826**	**2,501,900**

Step 6. Checking the Results

The iterative raking forced the result that the FLCINCHWT produced the desired key totals:

> For forward-looking looking CINCH analysis, the base year counts of SAME and LOSS should equal the counts produced in Step 3 and the counts of occupied units, vacant units, and seasonal units should equal those from Table Creator. Note that if the count of SAME and LOSS equal their Step 3 counts, then the count of the base year housing stock should equal the Table Creator count (except for rounding). If the count of occupied units, vacant units ($1 \leq$ VACANCY ≤ 7), and seasonal units ($8 \leq$ VACANCY) equal their Table Creator counts, then the count of the base year housing stock should equal the Table Creator count (except for rounding).

> For forward-looking rental dynamics analysis, the base year counts of owner-occupied units (TENURE = 1), unassisted rental units (HUDSUB = 3), voucher units (HUDSUB = 2), and public housing or privately owned multifamily units (HUDSUB = 1) should equal their Table Creator values. Note that if these conditions are met, the final year count of occupied units should match the Table Creator value (except for rounding).

FLCINCHWT was used to produce weighted frequency distribution of eight key characteristics, which were compared with counts from Table Creator. The most notable discrepancies are reported below.

- **Occupancy Status (TENURE, VACANCY):** The iterative raking caused owner-occupied, renter-occupied, vacant, and seasonal counts to all equal their controls.

- **Structure Type and Number of Units (BLD):** None larger in absolute value than 1.0 percent.

- **Race of Householder (HHRACE):** None larger in absolute value than 1.4 percent (Asian alone).[19]

- **Ethnicity of Householder (HHSPAN):** The count of Hispanic householders was 1.3 percent low.

- **Year Structure Built (YRBUILT):** None larger in absolute value than 1.1 percent.

- **Age of Householder (HHAGE):** None larger in absolute value than 5.1 percent. An overestimate of those 55–64 offset underestimates of the 65–74 and over 75 age groups.

While the weighting procedure did not involve raking to the Table Creator value for households with a member with disabilities, that discrepancy was 6.4 percent high.

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[19]The racial categories were collapsed to White alone, Black alone, American Indian alone, Asian alone, and all other.

Backward-Looking Weighting

Step 1. Preparing the File

The 2017 PUF contained 66,752 cases.

The merged 2015 PUF and 2017 PUF contained 66,752 cases because only cases in the 2017 PUF were kept.

The merger with the WDTG file added only those cases where SAMPLETYPE = 1 (national sample). After merger with WDTG, the file contained 87,035 cases.

After the elimination of cases not in the 2017 housing stock (NOINT17 $\geq$ 10), not in the 2017 AHS sample (INSTATUS17 = N), and not in Houston (IN17_OMB13CBSA NE 26420), there were 3,036 cases in the working file called BLHOUSTON1517. Of these, there were 462 Type A non-interviews.

Step 2. Identifying the Housing Stock, Losses, and Additions

There were 2,899 cases that were in both the 2015 and 2017 housing stock, called sames (SAME = 1). Of these, 2,259 were interviewed in both 2015 and 2017 (INTSAME = 1).

There were 137 cases that were in the 2017 housing stock, but were not in the 2015 housing stock (ADD = 1). Of these, 118 were interviewed in 2017 (INTADD = 1).

SAME, INTSAME, ADD, and INTADD were dichotomous variable created to classify the cases in BLHOUSTON1715.

Step 3. Measuring the Housing Stock, Losses, and Additions

The Table Creator estimate of the 2017 Houston housing stock is 2,598,600.

The sum of PWT15 over all 3,036 cases in BLHOUSTON1715 was 2,428,752.

$$PWT17S1 = PWT17*(2,598,600 / 2,428,752), \text{ or } PWT17*1.06993$$

The sum of PWT17S1 over sames (all cases where SAME = 1) was 2,479,476.

The sum of PWT17S1 over additions (all cases where ADD = 1) was 119,124. **This is the CINCH estimates of units added to the 2015 Houston housing stock by 2017.**

Step 4. Adjusting the Weights for Non-Interviews

This was the code used to calculate a new weight that, when applied to the interviewed sames, would produce the count of all sames (2,479,124).

IF INTSAME = 1 THEN PWT17S2 = PWT17S1 * $\sum$(SAME*PWT17S1) / $\sum$(INTSAME*PWT17S1)

IF INTSAME =1 THEN PWT17S2 = PWT17S1 * 2,479,124 / 1,932,826
~ 1.2829* PWT17S1

This was the code used to calculate a new weight that, when applied to the interviewed additions, would produce the count of all additions (3,655,779).

IF INTADD = 1 THEN PWT17S2 = PWT17S1 * $\sum$(ADD*PWT17S1) / $\sum$(INTADD*PWT17S1)

IF INTADD = 1 THEN PWT17S2 = PWT17S1 * 119,476 / 102,528
~ 1.1619* PWT17S1

At this point, all non-interviews were dropped from the file, leaving 2,377 cases.

There are three types of additions: new construction (NC) from both newly sampled cases and units with construction initiated in 2015 (NC =1); other additions from newly sampled cases (OTHNEW = 1); and additions from units temporarily out of the stock in 2015 (OTHB = 1).

To measure NC, we need YRBUILT, which is only available from interviewed units. PWT17S2 was used to estimate these three types of additions:

$\sum$ (NC × PWT15S2) = 101,481

$\sum$ (OTHNEW × PWT15S2) = 7,104

$\sum$ (OTHB × PWT15S2) = 10,539

Step 5. Further Refinements in the Weights

Simple Rakings

PWT17S2 was used to produce weighted frequency distribution of eight key characteristics, which were compared with counts from Table Creator. The most notable discrepancies are reported below.

- **Occupancy Status (TENURE, VACANCY):** The count of vacant units was 24.8 percent high and the count of seasonal units was 18.0 percent high because the count of occupied units was 2.2 percent low.

- **Structure Type and Number of Units (BLD):** The count of mobile homes was 11.7 percent high.

- **Year Built (YRBUILT):** The percentage of units built in 2010 or later was 11.9 percent low.

- **Race of Householder (HHRACE):** The count of Black alone householders was 13.1 percent low; the count of American Indian, Alaskan Native alone householders was 14.4 percent low.

- **Ethnicity of Householder (HHSPAN):** The count of Hispanic householders was 5.4 percent low.

- **Year Structure Built (YRBUILT):** The count of units built in 2010 or later was 1.4 percent low.

- **Age of Householder (HHAGE):** The percentage of householders 65 or older was 7.1 percent high; the percentage of households younger than 35 was 5.6 percent low.

Simple raking was applied seriatim to each variable in the following order: HHAGE, HHRACE, HHSPAN, YRBUILT, and BLD. Each raking resulted in the refined weights producing an exact match to the Table Creator distribution for that variable. As the Weighting Strategy Paper explained, each new raking produced small changes in the previous distributions that negated the exact matches achieved in those rakings.

The raking for occupancy status and tenure was done as part of the final raking.

Final Iterative Rakings

After these simple rakings were performed, an iterative raking was performed with the aim of matching the row and column totals in the matrix on the following page.[20]

Each iteration had two parts. In the first part, the weights are adjusted to match the row totals; in the second part, the weights are adjusted to match the column totals. The process is then repeated, using the same row and column totals to converge to the control totals.

After eight iterations, the ratio of the weighted counts to the row and column totals were all 1.000000. The iterations were stopped at this point.

The final weight was called BLCINCHWT.

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[20]Rounding errors caused the sum of the row totals not to equal the sum of the column totals. Small adjustments were made in some row and column totals so the sum of the row totals and the sum of the column total equal 137,403,000.

Exhibit 6. Control Totals for Final Adjustments

	A	B	C	D	E	F	G
1	CODE		INTSAME = 1	NC =1	OTHNEW =1	OTHEB =1	
2		CATEGORIES	SAMES	NC	OTHNEW	OTHB	Row Controls
3	TENURE = '1'	Owners	N/A	N/A	N/A	N/A	1,432,100
4	HUDSUB = '3'	Unassisted renters	N/A	N/A	N/A	N/A	851,000
5	HUDSUB = '1'	Public housing or Privately owned multifamily	N/A	N/A	N/A	N/A	17,900
6	HUDSUB = '2'	Vouchers	N/A	N/A	N/A	N/A	27,900
7	VANCANCY IN {'01','02'.'03','04','05','06','07'}	Vacant	N/A	N/A	N/A	N/A	243,100
8	VANCANCY IN'08','09','10','11'}	Seasonal					26,600
9		Column controls	2,479,500	101,500	7,100	10,500	2,598,600

The iterative raking forced the result that the BLCINCHWT produced the desired key totals:

> For backward-looking analysis CINCH analysis, the final year counts of SAME, NC, OTHNEW, and OTHB should equal the counts produced in Step 3 and the counts of occupied units, vacant units, and seasonal units should equal those from Table Creator. Note that if the count of SAME, NC, OTHNEW, and OTHB equal their Step 3 counts, then the count of the final year housing stock should equal the Table Creator count (except for rounding). If the count of occupied units, vacant units ($1 \leq$ VACANCY ≤ 7), and seasonal units ($8 \leq$ VACANCY) equal their Table Creator counts, then the count of the final year housing stock should equal the Table Creator count (except for rounding).

> For backward-looking rental dynamics analysis, the final year counts of owner-occupied units (TENURE = 1), unassisted rental units (HUDSUB = 3), voucher units (HUDSUB = 2), and public housing or privately owned multifamily units (HUDSUB = 1) should equal their Table Creator values. Note that if these conditions are met, the final year count of occupied units should match the Table Creator value (except for rounding).

BLCINCHWT was used to produce weighted frequency distribution of eight key characteristics, which were compared with counts from Table Creator. The most notable discrepancies are reported below.

- **Occupancy Status (TENURE, VACANCY):** The iterative raking caused owner-occupied, renter-occupied, vacant, and seasonal counts to all equal their controls.

- **Structure Type and Number of Units (BLD):** None larger in absolute value than 1.6 percent.

- **Race of Householder (HHRACE):** None larger in absolute value than 3.0 percent (American Indian alone).[21]

- **Ethnicity of Householder (HHSPAN):** The count of Hispanic householders was 0.6 percent low.

- **Year Structure Built (YRBUILT):** The largest deviation was for built in 2010 or later at 3.9 percent low.

- **Age of Householder (HHAGE):** None larger in absolute value than 1.0 percent.

Although the weighting procedure did not involve raking to the Table Creator value for households with a member with disabilities, that discrepancy was 3.4 percent high.

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[21]The racial categories were collapsed to White alone, Black alone, American Indian alone, Asian alone, Hawaiian and Pacific Islander only, and two or more races.

Appendix C: Documentation for 2015–2017 Detroit CINCH

Forward-Looking Weighting

Step 1. Preparing the File

The 2015 public use file (PUF) contained 69,493 cases.

The merged 2015 PUF and 2017 PUF contained 69,493 cases because only cases in the 2015 PUF were kept.

The merger with the Sample Case History File, better known as the "Where Did They Go" (WDTG) file, added only those cases where SAMPLETYPE = 1 (national sample) and INTSTATUS15 NE N (not included in the 2015 sample). After the merger with WDTG, the file contained 87,035 cases.

After the elimination of cases not in the 2015 housing stock (NOINT15 $\geq$ 10) and not in Detroit (OMB13CBSA NE 19820), there were 2,951 cases in the working file called FLDETROIT1517. Of these, there were 415 Type A non-interviews (NOINT15 $\leq$ 6).

Step 2. Identifying the Housing Stock, Losses, and Additions

There were 2,915 cases that were in both the 2015 and 2017 housing stock, called sames (SAME = 1). Of these, 2,126 were interviewed in both 2015 and 2017 (INTSAME = 1).

There were 35 cases that were in the 2015 housing stock, but were not in the 2017 housing stock (LOSS = 1). Of these, 15 were interviewed in 2015 (INTLOSS = 1).

SAME, INTSAME, LOSS, and INTLOSS were dichotomous variable created to classify the cases in FLDETROIT1517.

Step 3. Measuring the Housing Stock, Losses, and Additions

The Table Creator estimate of the 2015 housing stock is 1,895,700.

The sum of PWT15 over all 2,951 cases in FLDETROIT1517 was 1,840,113.

   PWT15S1 = PWT15*(1,895,700 / 1,840,113), or PWT15*1.0302

The sum of PWT15S1 over sames (all cases where SAME = 1) was 1,872,910.

The sum of PWT15S1 over losses (all cases where LOSS = 1) was 22,790. **This is the CINCH estimate of units lost from the 2015 Detroit housing stock by 2017.**

Step 4. Adjusting the Weights for Non-Interviews

This was the code used to calculate a new weight that, when applied to the interviewed sames, would produce the count of all sames (1,872,910):

IF INTSAME =1 THEN PWT15S2 = PWT15S1 * ∑(SAME*PWT15S1) / ∑(INTSAME*PWT15S1)

IF INTSAME =1 THEN PWT15S2 = PWT15S1 * 1,872,910 / 1,365,395
~ 1.3718* PWT15S1

This was the code used to calculate a new weight that, when applied to the interviewed losses, would produce the count of all losses (22,790):

IF INTLOSS = 1 THEN PWT15S2 = PWT15S1 * ∑(LOSS*PWT15S1) / ∑(INTLOSS*PWT15S1)

IF INTLOSS = 1 THEN PWT15S2 = PWT15S1 * 22,790 / 9915
~ 2.2986*PWT15S1

At this point, non-interviews were dropped from the analysis, leaving a file of 2,319.

Step 5. Further Refinements in the Weights

Simple Rakings

PWT15S2 was used to produce weighted frequency distribution of eight key characteristics, which were compared with counts from Table Creator. The most notable discrepancies are reported below.

- **Occupancy status (TENURE, VACANCY):** The count of vacant units was 18.2 percent high and the count of seasonal units was 45.0 percent low because the count of occupied units was 1.6 percent low.

- **Structure type and number of units (BLD):** The count of mobile homes was 22.8 percent high; the count of 2–4-unit buildings was 8.2 percent low.

- **Race of householder (HHRACE):** The count of Black alone householders was 15.8 percent low.

- **Ethnicity of householder (HHSPAN):** The count of Hispanic householders was 4.0 percent low.

- **Year structure built (YRBUILT):** The count of units built in 2010 or later was 12.5 percent low and the percent built 1980–1989 was 10.9 percent high.

- **Age of householder (HHAGE):** The count of householders 65 years old or older were approximately 7 percent high; the count of householders under 30 was 11.2 percent low.

Simple raking was applied seriatim to most of these variables in the following order: HHAGE, HHRACE, HHSPAN, YRBUILT, and BLD. Each raking resulted in the refined weight, producing an exact match to the Table Creator distribution for that variable. As the Weighting Strategy Paper explained, each new rake produced small changes in the previous distributions that negated the exact matches achieved in those rakings.

The raking for occupancy status and tenure was done as part of the final raking.

Final Iterative Rakings

After these simple rakings were performed, an iterative raking was performed with the aim of matching the row and column totals in the matrix on the following page.[22]

Each iteration has two parts. In the first part, the weights are adjusted to match the row totals; in the second part, the weights are adjusted to match the column totals. The process is then repeated, using the same row and column control totals until the estimated converge to the control totals.

After eight iterations, the ratio of the weighted counts to the row and column totals were all 1.000000. The iterations were stopped at this point.

The final weight was called FLCINCHWT.

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[22]Rounding errors cause the sum of the row totals and the sum of the column totals to not be equal. Small adjustments were made in some row and column totals so the sum of the row totals and the sum of the column total equal 134,790,000.

Exhibit 7. Control Totals for Final Adjustments

	A	B	C	D	E
1	CODE		INTSAME = 1	INTLOSS =1	
2		CATEGORIES	SAMES	LOSSES	Row Controls
3	TENURE = '1'	Owners	NA	NA	**1,189,000**
4	HUDSUB = '3'	Unassisted renters	NA	NA	**457,300**
5	HUDSUB = '1'	Public housing or Privately owned multifamily	NA	NA	**37,300**
6	HUDSUB = '2'	Vouchers	NA	NA	**25,400**
7	VANCANCY IN {'01','02'.'03','04','05','06','07'}	Vacant	NA	NA	**176,800**
8	VANCANCY IN {'08','09','10','11'}	Seasonal	NA	NA	**9,900**
9			**1,872,910**	**22,790**	**1,895,700**

Step 6. Checking the Results

The iterative raking forced the result that the FLCINCHWT produced the desired key totals:

> For forward-looking looking CINCH analysis, the base year counts of SAME and LOSS should equal the counts produced in Step 3 and the counts of occupied units, vacant units, and seasonal units should equal those from Table Creator. Note that if the count of SAME and LOSS equal their Step 3 counts, then the count of the base year housing stock should equal the Table Creator count (except for rounding). If the count of occupied units, vacant units ($1 \leq \text{VACANCY} \leq 7$), and seasonal units ($8 \leq \text{VACANCY}$) equal their Table Creator counts, then the count of the base year housing stock should equal the Table Creator count (except for rounding).

> For forward-looking rental dynamics analysis, the base year counts of owner-occupied units (TENURE = 1), unassisted rental units (HUDSUB = 3), voucher units (HUDSUB = 2), and public housing or privately owned multifamily units (HUDSUB = 1) should equal their Table Creator values. Note that if these conditions are met, the final year count of occupied units should match the Table Creator value (except for rounding).

FLCINCHWT was used to produce weighted frequency distribution of eight key characteristics, which were compared with counts from Table Creator. The most notable discrepancies are reported below.

- **Occupancy status (TENURE, VACANCY):** The iterative raking caused owner-occupied, renter-occupied, vacant, and seasonal counts to all equal their controls.

- **Structure type and number of units (BLD):** Mobile homes, single family detached, and single family attached were under 1.2 percent in absolute value. Multiunit structures were under 5.0 percent in absolute value except for buildings with 50 or more units, which were 7.1 percent higher.

- **Race of householder (HHRACE):** None reported larger in absolute value than 2 percent.[23]

- **Ethnicity of householder (HHSPAN):** The count of Hispanic householders was 1.1 percent low.

- **Year structure built (YRBUILT):** None higher than 1.6 percent in absolute value.

- **Age of householder (HHAGE):** None larger in absolute value than 1.6 percent.

Although the weighting procedure did not involve raking to the Table Creator value for households with a member with disabilities, that discrepancy was 2.0 percent high.

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[23]Only White alone, Black alone, and Asian alone were reported.

Backward-Looking Weighting

Step 1. Preparing the File

The 2017 PUF contained 66,752 cases.

The merged 2015 PUF and 2017 PUF contained 66,752 cases because only cases in the 2017 PUF were kept.

The merger with the WDTG file added only those cases where SAMPLETYPE = 1 (national sample). After merger with WDTG, the file contained 87,035 cases.

After the elimination of cases not in the 2017 housing stock (NOINT17 ≥ 10), not in the 2017 AHS sample (INSTATUS17 = N), and not in Detroit (IN17_OMB13CBSA NE 19820), there were 2,961 cases in the working file called BLDETROIT1715. Of these, there were 585 Type A non-interviews.

Step 2. Identifying the Housing Stock, Losses, and Additions

There were 2,916 cases that were in both the 2015 and 2017 housing stock, called sames (SAME = 1). Of these, 2,126 were interviewed in both 2015 and 2017 (INTSAME = 1).

There were 45 cases that were in the 2017 housing stock, but were not in the 2015 housing stock (ADD = 1). Of these, 38 were interviewed in 2017 (INTADD = 1).

SAME, INTSAME, ADD, and INTADD were dichotomous variables created to classify the cases in BLDETROIT1715.

Step 3. Measuring the Housing Stock, Losses, and Additions

The Table Creator estimate of the 2017 Detroit housing stock is 1,905,900.

The sum of PWT15 over all 2,961 cases in BLDETROIT1715 was 1,846,880.

$$PWT17S1 = PWT17*(1,905,900 / 1,846,880), \text{ or } PWT17*1.0320$$

The sum of PWT17S1 over sames (all cases where SAME = 1) was 1,876,088.

The sum of PWT17S1 over additions (all cases where ADD = 1) was 29,812. **This is the CINCH estimate of units added to the 2015 Detroit housing stock by 2017.**

Step 4. Adjusting the Weights for Non-Interviews

This was the code used to calculate a new weight that, when applied to the interviewed sames, would produce the count of all sames (2,479,124).

IF INTSAME =1 THEN PWT17S2 = PWT17S1 * $\sum$(SAME*PWT17S1) / $\sum$(INTSAME*PWT17S1)

IF INTSAME =1 THEN PWT17S2 = PWT17S1 * 1,876,088 / 1,367,611
~ 1.3718*PWT17S1

This was the code used to calculate a new weight that, when applied to the interviewed additions, would produce the count of all additions (3,655,779).

IF INTADD = 1 THEN PWT17S2 = PWT17S1 * $\sum$(ADD*PWT17S1) / $\sum$(INTADD*PWT17S1)

IF INTADD = 1 THEN PWT17S2 = PWT17S1 * 29,812/25,200
~ 1.1830*PWT17S1

At this point, all non-interviews were dropped from the file, leaving 2,164 cases.

There are three types of additions: new construction (NC) from both newly sampled cases and units with construction initiated in 2015 (NC =1); other additions from newly sampled cases (OTHNEW = 1); and additions from units temporarily out of the stock in 2015 (OTHB = 1).

To measure NC, we need YRBUILT, which is only available from interviewed units. PWT17S2 was used to estimate these three types of additions:

$\sum$(NC*PWT15S2) = 9,365

$\sum$(OTHNEW*PWT15S2) = 778

$\sum$(OTHB*PWT15S2) = 19,669

Step 5. Further Refinements in the Weights

Simple Rakings

PWT17S2 was used to produce weighted frequency distribution of eight key characteristics, which were compared with counts from Table Creator. The most notable discrepancies are reported below.

- **Occupancy status (TENURE, VACANCY):** The count of vacant units was 25.5 percent high and the count of seasonal units was 22.0 percent high because the count of occupied units was 2.7 percent low.

- **Structure type and number of units (BLD):** The count of mobile homes was 17.1 percent high.

- **Year built (YRBUILT):** The percentage of units built in 2010 or later was 11.9 percent low.

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- **Race of householder (HHRACE):** The count of Black alone householders was 16.5 percent low.

- **Ethnicity of householder (HHSPAN)**: The count of Hispanic householders was 17.9 percent low.

- **Age of householder (HHAGE):** The percentage of householders 75 or older was 9.6 percent high; the percentage of households between 25 and 29 was 13.6 percent low.

Simple raking was applied seriatim to each variable in the following order: HHAGE, HHRACE, HHSPAN, YRBUILT, and BLD. Each raking resulted in the refined weights, producing an exact match to the Table Creator distribution for that variable. As the Weighting Strategy Paper explained, each new raking produced small changes in the previous distributions that negated the exact matches achieved in those rakings.

The raking for occupancy status and tenure was done as part of the final raking.

Final Iterative Rakings

After these simple rakings were performed, an iterative raking was performed with the aim of matching the row and column totals in the matrix on the following page.[24]

Each iteration had two parts. In the first part, the weights are adjusted to match the row totals; in the second part, the weights are adjusted to match the column totals. The process then is repeated using the same row and column control totals until the estimated converge to the control totals.

After eight iterations, the ratio of the weighted counts to the row and column totals were all 1.000000. The iterations were stopped at this point.

The final weight was called BLCINCHWT.

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[24]Rounding errors caused the sum of the row totals not to equal the sum of the column totals. Small adjustments were made in some row and column totals so the sum of the row totals and the sum of the column total equal 137,403,000.

Exhibit 8. Control Totals for Final Adjustments

	A	B	C	D	E	F	G
1	CODE		INTSAME = 1	NC =1	OTHNEW =1	OTHEB =1	
2		CATEGORIES	SAMES	NC	OTHNEW	OTHB	Row Controls
3	TENURE = '1'	Owners	NA	NA	NA	NA	**1,195,900**
4	HUDSUB = '3'	Unassisted renters	NA	NA	NA	NA	**464,000**
5	HUDSUB = '1'	Public housing or Privately owned multifamily	NA	NA	NA	NA	**37,400**
6	HUDSUB = '2'	Vouchers	NA	NA	NA	NA	**26,000**
7	VANCANCY IN {'01','02'.'03','04','05','06','07'}	Vacant	NA	NA	NA	NA	**176,000**
8	VANCANCY IN'08','09','10','11'}	Seasonal					**6,600**
9		Column controls	**1,876,088**	**9,365**	**778**	**19,669**	**1,905,900**

Step 6. Checking the Results

The iterative raking forced the result that the BLCINCHWT produced the desired key totals:

> For backward-looking analysis CINCH analysis, the final year counts of SAME, NC, OTHNEW, and OTHB should equal the counts produced in Step 3 and the counts of occupied units, vacant units, and seasonal units should equal those from Table Creator. Note that if the count of SAME, NC, OTHNEW, and OTHB equal their Step 3 counts, then the count of the final year housing stock should equal the Table Creator count (except for rounding). If the count of occupied units, vacant units ($1 \leq VACANCY \leq 7$), and seasonal units ($8 \leq VACANCY$) equal their Table Creator counts, then the count of the final year housing stock should equal the Table Creator count (except for rounding).

> For backward-looking rental dynamics analysis, the final year counts of owner-occupied units (TENURE = 1), unassisted rental units (HUDSUB = 3), voucher units (HUDSUB = 2), and public housing or privately owned multifamily units (HUDSUB = 1) should equal their Table Creator values. Note that if these conditions are met, the final year count of occupied units should match the Table Creator value (except for rounding).

BLCINCHWT was used to produce weighted frequency distribution of eight key characteristics, which were compared with counts from Table Creator. The most notable discrepancies are reported below.

- **Occupancy status (TENURE, VACANCY):** The iterative raking caused owner-occupied, renter-occupied, vacant, and seasonal counts to all equal their controls.

- **Structure type and number of units (BLD):** All counts were within 2 percent of the Table Creator values, except for units in buildings with 50 or more units, which was 4.0 percent low.

- **Race of householder (HHRACE):** None reported larger in absolute value than 1.5 percent.[25]

- **Ethnicity of householder (HHSPAN):** The count of Hispanic householders was 0.6 percent low.

- **Year structure built (YRBUILT):** None higher than 3 percent in absolute value; the count of units built in 2011 or later was 2.1 percent low.

- **Age of householder (HHAGE):** None larger in absolute value than 2 percent except the count of householders less than 25 which was 3.7 percent high.

Although the weighting procedure did not involve raking to the Table Creator value for households with a member with disabilities, that discrepancy was 2.4 percent high.

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[25]Only White alone, Black alone, and Asian alone were reported.

August 2020