

American Housing Survey

# **Weighting Strategy for 2003-2005 CINCH Analysis**

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# WEIGHTING STRATEGY FOR 2003-2005 CINCH ANALYSIS

This paper adapts the weighting strategy used by Econometrica, Inc., in its components of inventory change (CINCH) analysis of changes in the national housing stock between 2001 and 2003.<sup>1</sup> The algorithm used for the 2003-2005 analysis differs from the one used for the 2001-2003 analysis in several ways; the three most important are:

- We added a special adjustment to the manufactured home sample to account for changes that the Census Bureau made to this sample in 2005.
- We modified how we adjust the weights to estimate new construction.
- We modified the final stock adjustment so that the adjustment is made separately for mobile homes and all other units.

All the differences are explained in the section that describes the steps in the weighting algorithms.

## ***The CINCH Objective***

Figure 1 illustrates the question that CINCH analysis seeks to answer.

CINCH tries to explain how the housing stock evolves from one period to the next. Figure 1 contains four ovals and two rectangles. The Census Bureau provides estimates for both rectangles and one oval (units added through new construction between 2003 and 2005). No one estimates the other three ovals: the number of units that belong to both the 2003 and 2005 housing stock, units lost to the housing stock between 2003 and 2005, and other additions to the housing stock between 2003 and 2005.

Losses can be either permanent or temporary. Units destroyed by natural disasters or intentionally demolished are permanent losses. Temporary losses include units that are merged into other units or units that are used for non-residential purposes.<sup>2</sup> Besides new construction, additions can include units resulting from splitting up larger units, mobile home move-ins, and units that had been used formerly for non-residential purposes.

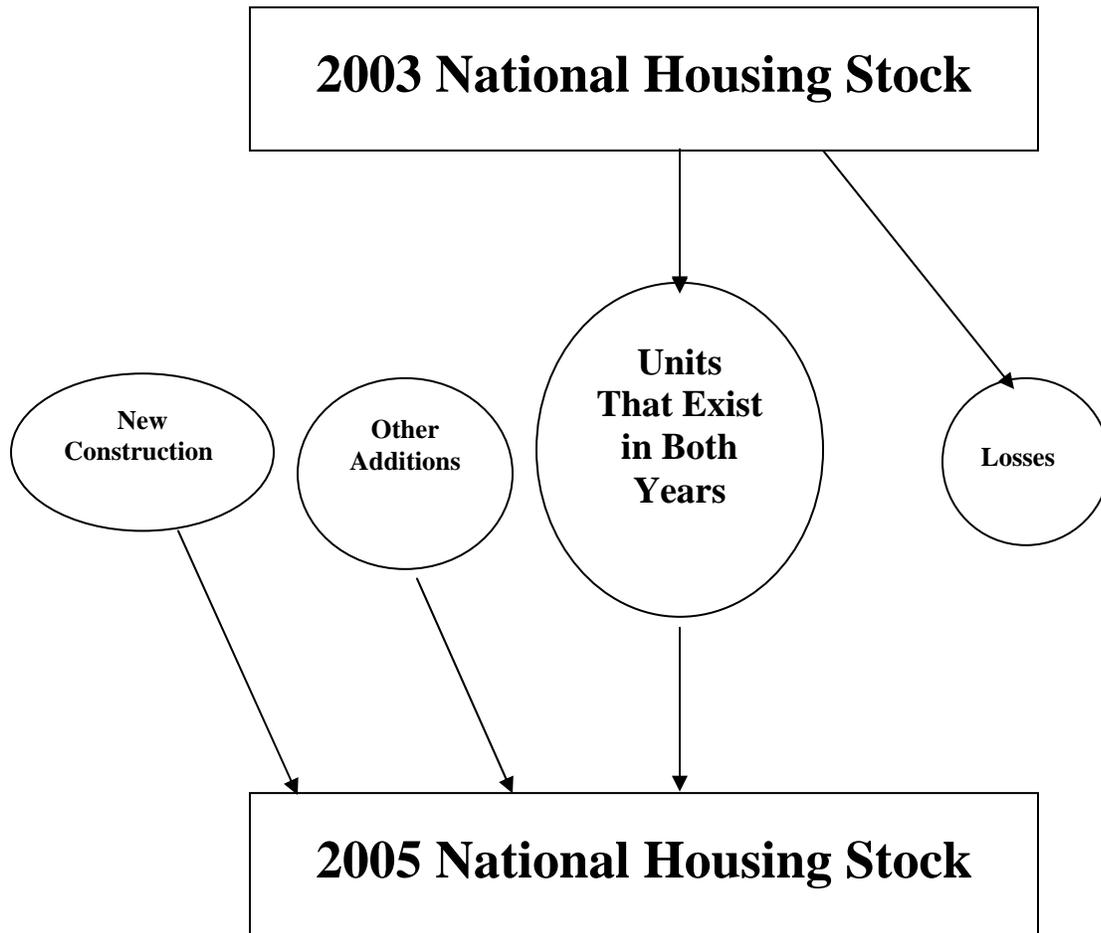
In addition to determining the size of each oval, housing analysts find information about the characteristics of the units in the different ovals useful. Interesting characteristics include: structure type, age of the unit, size of the unit, location by region, location by metropolitan status, tenure, household size and composition, resident income, and resident race and ethnicity.

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<sup>1</sup> *Weighting Strategy for 2001-2003 CINCH Analysis* at <http://www.huduser.org/datasets/cinch/cinch01-03/AHS3CINCHWeightingStrategy.pdf>.

<sup>2</sup> “Potentially reversible” might be a better term than “temporary” for these types of losses.

**Figure 1: The CINCH Objective**



CINCH analysis has three goals:

- To provide estimates for all six components of Figure 1.
- To disaggregate losses and other additions into relevant component parts.
- To characterize the units that survive from one period to the next and the units that are added or lost between periods.

The American Housing Survey (AHS) has four features that make CINCH analysis possible:

- Each unit has weights that can be used to estimate its share of the overall stock.
- The AHS tracks new construction and the various types of losses and other additions.
- The AHS has detailed information about the characteristics of each unit and its occupants.
- The AHS tracks the same unit from one period to the next so that changes in status and characteristics can be observed directly.

## **Weighting**

Ideally, analysts would like to solve two simultaneous equations using CINCH analysis:<sup>3</sup>

- (1) 2003 housing stock = units that exist in both years + losses.
- (2) New construction + other additions + units that exist in both years = 2005 housing stock.

Unfortunately, previous experience with CINCH analysis has shown it is difficult to find satisfactory simultaneous solutions to the equations. For this reason, Econometrica, Inc. chose to solve the two equations separately in previous CINCH studies.

Solving equation (1) is termed forward-looking analysis because it tracks what happens to the units in the 2003 housing stock. In terms of Figure 1, forward-looking analysis deals with the top rectangle and the two ovals on the right. Solving equation (2) is termed backward-looking analysis because it tracks where units in the 2005 housing stock came from. In terms of Figure 1, backward-looking analysis deals with the bottom rectangle and the three ovals on the left. In analytical terms, backward-looking analysis reverses the arrows at the bottom of Figure 1 by taking the 2005 housing stock as its starting point.

Separating the analysis into forward-looking and backward-looking components results in each observation having two weights: a weight for the forward-looking analysis (FLCINCHWT) and a weight for the backward-looking analysis (BLCINCHWT).

Solving the equations separately also results in two independent estimates of “units that exist in both years,” one based on each set of weights. This paper develops algorithms to carry out the forward-looking and backward-looking analyses. Table 1 shows that the separate algorithms result in estimates of “units that exist in both years” that differ by less than one-half million housing units, slightly less than one-half percent of the 2003 housing stock.

**Table 1: Comparison of Estimates of  
“Units that Exist in Both Years”**

<b>Units that Exist in Both Years</b>	
Forward-looking estimate	118,893,235
Backward-looking estimate	119,323,422
Difference	-430,187
Percent different	-0.4%

<sup>3</sup> The equations are “simultaneous” because the term “units that exist in both years” appears in each equation.

## ***Refinements to previous CINCH algorithms***

Previously we developed algorithms for CINCH analysis comparing the 2001 and 2003 AHS national surveys. The proposed analysis for the 2003 and 2005 national surveys is very similar to the 2001/2003 analysis and therefore the 2001/2003 algorithms are a useful starting point. As noted above, we made three major changes to the 2001/2003 algorithms:

- We added a special adjustment to the manufactured home sample to account for changes that the Census Bureau made to this sample in 2005.
- We modified how we adjust the weights to estimate new construction.
- We modified the final stock adjustment so that the adjustment is made separately for mobile homes and all other units.

### **Manufactured (mobile) homes**

The major concern in preparing new algorithms based on the old algorithms is the reconstitution of the manufactured (mobile) home sample in 2005. The Census Bureau added new mobile home units in 2005 and dropped some mobile home units that had been in previous AHS samples. Table 2 shows how the sample of mobile homes that were in the 2003 sample was affected.

**Table 2: Changes to the Sample of Mobile Home Units**

	<b>Number of Cases</b>	<b>Aggregate Pure Weight</b>	<b>Aggregate WGT90GEO</b>
Mobile homes in the 2003 sample	3,006	7,056,688	8,968,847
2003 mobile homes still in the 2005 sample	1,567	3,654,479	4,750,298
Mobile homes in the 2005 sample	2,959	6,768,943	8,630,461

Approximately half the mobile home sample from 2003 was dropped in the reconstitution of the mobile home sample in 2005 and replaced by different mobile homes. Because of these sample adjustments, we would substantially undercount mobile homes in both 2003 and 2005 if we were to use the 2001/2003 algorithms.<sup>4</sup>

Step 4 was added to both algorithms to correct this problem. The logic of the mobile-home adjustment is as follows. Each algorithm attempts to adjust the pure weight of each sample unit sequentially for (1) deviations between the aggregate of the pure weights and the published total stock, (2) the loss of sample due to type A non-interviews, and (3) deviations between the sum of the adjusted pure weights and key published subtotals.

<sup>4</sup> In previous work involving both the national and metropolitan surveys, our CINCH estimates exceed published AHS estimates for single-family detached units and fall short of the published AHS estimates for manufactured homes by roughly equal amounts. We have always suspected that the Census Bureau may use more than NUNIT2 to calculate these subtotals.

The Step 4 adjustment changes the pure weights of the 1,567 units so that they sum to the pure weights of all the mobile home units (except newly manufactured mobile homes). This means that the mobile home units enter stage (2) and (3) with the correct aggregate count.

At the suggestion of Dennis Schwanz of the Census Bureau, we adjusted the weights only for mobile homes built prior to 2000 because the Census Bureau did not drop any units built in 2000 or later. The Census Bureau used the address list for the 2000 census to update the mobile home sample and therefore could not replace units built in 2000 or later with other units built in 2000 or later.

Step 4 should allow us to obtain reasonable counts of mobile homes in both years. Using these 1,567 mobile homes, we will provide estimates of losses and additions to the stock by type of loss and type of addition. The estimates of losses and additions and the estimates of type of loss and type of addition depend upon the extent to which the 1,567 mobile homes are a representative sample of all mobile homes in both 2003 and 2005. We can correct for the decline in the sample but not for any biases introduced by dropping and adding mobile homes.

## **New Construction**

After adding Step 4, we ran the old algorithms and examined some key totals. In one test, we compared our backward-looking estimate for new construction with an alternative estimate: the Census Bureau's series on completions. As part of the Survey of Construction, the Census Bureau estimates the number of privately owned units completed each month. Data collection for the 2003 AHS occurred between late May and mid-September 2003, while data collection for the 2005 AHS occurred between late-April and mid-September 2005. During the 24-month period beginning October 2003 and ending with September 2005, the Census Bureau reports that 3,717,800 privately owned housing units were completed (using non-seasonally adjusted monthly data). Using the backward-looking algorithm from 2001-2003 with only the mobile home adjustment, we estimate that 2,948,624 units were completed between the two surveys. Our CINCH estimate is 20.7 percent lower than the estimate we derived from the published completions series.

In the algorithms, our definition of new construction combines units identified by the Census Bureau as new constructed since the last survey ( $IN05\_REUAD = 3$ ) and units interviewed in 2005 that were under construction in 2003 ( $10 \leq IN03\_NOINT \leq 11$ ). There were 1,500 units that meet these criteria in 2005. The sum of WGT90GEO for these units was 3,730,913. WGT90GEO is the final weight used for 1990 Census geography; it incorporates adjustments by the Census Bureau, including an adjustment to match other totals for new construction.<sup>5</sup> This sum is close to the independent estimate of newly completed units from the Survey of Construction, so the problem is not with the

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<sup>5</sup> New construction as measured by the WEIGHT weights was 3,735,553.

AHS weights but with our algorithm. Our CINCH estimate is 20.9 lower than the WGT90GEO sum.

Based on this additional information, we decided to change the algorithm so that at an intermediate stage the weights for newly constructed units would equal the WGT990GEO sum. The adjustment is made separately for newly constructed mobile homes and all other newly constructed units. The change occurs at step 10 in the backward-looking algorithm and affects the ratios developed in step 11 for adjusting the weights for SAMES and new construction, but does not affect the ratio used to adjust the weights for other additions.

### **Final adjustment to published stock totals**

Dennis Schwanz of the Census Bureau suggested an additional refinement to the 2001/2003 algorithms. In both algorithms, step 13 adjusts the weights to match published totals for owner-occupied units, renter-occupied units, vacant units, and seasonal units. Previously this adjustment was made for all units without regard to structure type; now we make the adjustment for mobile homes and all other units separately. As a result, we are matching 8 published totals instead of 4 published totals.<sup>6</sup>

### **Other relevant considerations**

In the 2001/2003 forward-looking algorithm, we obtained BASECOUNT using the final weight (IN01\_ WGT90GEO). This procedure would not be desirable for the 2003/2005 analysis because we dropped so many mobile homes with non-zero IN03\_ WGT90GEO. So in step 5 of the forward-looking algorithm we used the published total for the existing stock. Upon reflection we believe this total is a better choice independent of the mobile home sample changes and use published totals for CURRENTCOUNT in step 5 of the backward-looking algorithm as well.

In an attempt to improve coverage of the elderly, the Census Bureau selected a sample of 486 special living units from the 2000 census. We ignored these additions to the AHS sample because the added units were not part of the 2003 sample and had no counterpart in the 2003 sample. CINCH analysis is feasible only when a unit can be tracked from one period to the next. These additions are eliminated in step 2 of the backward-looking algorithm.

Finally, the 2005 AHS uses a new definition for housing unit. Appendix C provides the following explanation:

In 2005, a new definition of a “housing unit” was used. It came out of the Census 2000 Coverage Redesign. It was used to stay consistent with the Current Population Survey (CPS) and other current demographic surveys whose data are

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<sup>6</sup> We derived the “published” counts for non-mobile home units by subtracting the mobile home counts from the all units counts.

collected by the U.S. Census Bureau. The Census Bureau required in the old 1990 sample design that the occupants (1) live and eat separately from other people on the property and (2) have direct access from the outside or a common hallway. The Census Bureau has modified the first condition in the new 2000 sample design definition by dropping the words “and eat.” The occupants must merely “live separately from all other people on the property.”

This means that part of the change in the total number of housing units reported in the 2003 AHS and in the 2005 AHS results from a change in definition. We could find no published information that would allow us to adjust either 2003 or 2005 counts for this change in definition.

### ***Draft algorithms for weighting 2003 and 2005 AHS data for CINCH analysis***

The following descriptions of the new algorithms contain key numbers from our initial runs. Sometimes we list the same numbers from the 2001/2003 algorithms for comparison purposes.

### **Forward Looking: From 2003 to 2005**

The following are the steps necessary to prepare the data to analyze what happened between 2003 and 2005 to units that existed in 2003. AHS variables are given their codebook names and presented in capital letters. We refer to 2003 variables by the suffix IN03\_; 2005 variables are labeled IN05\_.

1. Merge the 2003 and 2005 files, using the flat files. ( $N = 75,807$ ) Eliminate non-matches. (20,863)
  - a. There were 4,637 units that were in the 2005 sample and not in the 2003 sample. Units are added to account for new construction and other additions to the stock of housing. These non-matches are not important for the forward-looking analysis because newly constructed units and other additions were not part of the 2003 housing stock. The Census Bureau also adds units to adjust the sample for various reasons. Sample adjustments were important in 2005 when the Census Bureau reconstituted the mobile home sample and added units to incorporate special living facilities. Many of the sample adjustment units were part of the housing stock in 2003, but we have to eliminate them because we have no information about their status in 2003 since they were not part of the 2003 sample. Step 4 is a step that was added to the algorithm used for the 2001/2003 CINCH analysis to adjust for the loss of mobile home units.
  - b. There were 16,226 units that were in the 2003 file but not in the 2005 file. These include units from the expanded samples in Los Angeles, New York,

Chicago, Philadelphia, Detroit, and Northern New Jersey in 2003. A comparison of the 2001, 2003, and 2005 files reveals that there were 6,975 cases that were in the 2003 sample only; 6,477 of these were in the 6 metropolitan areas. Step 3 adjusts for the loss of the units from the expanded sample.

- c. The remaining 9,251 cases (16,226 – 6,975), which were in 2003 but not in 2005, include two main categories. There were 1,329 mobile homes which appear to be mobile homes dropped from the sample by the Census Bureau when they reconstituted the mobile home sample. The 9,251 cases also included 7,916 cases that were not interviewed in 2003, of which 7,854 were Type-C losses or units deleted in prelisting subsampling. The file should have contained these cases with IN05\_NOINT values of 30, 31, 32, 33, 36, 37, 38, and 39. The absence of the 7,916 cases does not present a problem because these units were not part of the 2003 housing stock. The algorithm has been rewritten to adjust for this problem by moving Step 2 forward from its previous position (Step 4). The absence of the 1,329 mobile homes with no IN05\_NOINT values creates a problem. We are forced to presume that all of these units were deliberate drops. Step 4 adjusts for the mobile home units that were dropped
  - d. After deleting the non-matches, we have a sample of 54,944 units.
2. Eliminate all observations that were 2003 type B or type C losses (10 LE IN03\_NOINT LE 38) and all observations that were deleted in the 2003 prelist subsampling (IN03\_NOINT=39). These units were not part of the 2003 stock and therefore are not tracked in the forward-looking analysis. (1336)

*NOTE: In the backward-looking algorithm, we eliminate an additional 51 cases in this step that appear to have erroneous values. Arguably we should eliminate them here as well. The decision comes down to where the error is. If the error is in IN05\_REUAD, then we should keep them in the analysis. If the error is duplicate control numbers or something similar, we should drop them. We left them in because we suspect the error is in REUAD. Thirty-eight of the 51 were interviewed in 2003.*

3. For all units let  $MPWT = \max(\text{IN05\_PWT}, \text{IN03\_PWT})$ . (PWT is the pure weight.) In general, the pure weights should not differ except in the six metropolitan areas with added sample in 2003 but not 2005. If there were an unusually low IN03\_PWT for one or more observations, this step would adjust for that low value.
4. Adjust the pure weights of manufactured (mobile) homes.
  - a. From the 2003 file before merger, compute a pure weight count of mobile homes built before 2000 by summing PWT for cases where IN03\_NUNIT2

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= 4 AND IN03\_BUILT LE 1999. (N=2,830 IN03\_OLDMHPWT = 6602376.68)

- b. From merged file, compute a pure weight count of mobile homes built before 2000 that are in both years by summing MXPWT for cases where IN03\_NUNIT2 = 4 AND IN03\_BUILT LE 1999. (N=1,396 IN03\_OLDMHKEPT = 3231720.17)
  - c. Adjust the pure weights of all manufactured (mobile) homes.  
IF IN03\_NUNIT2 = 4 AND IN03\_BUILT GE 2000  
MXPWT = MXPWT  
IF IN03\_NUNIT2 = 4 AND IN03\_BUILT LE 1999  
MXPWT = MXPWT\*(IN03\_OLDMHPWT/IN03\_OLDMHKEPT)  
MXPWT = MXPWT\*(6602376.68/3231720.17) = MXPWT\*(2.042991)
5. Obtain from the published report an estimate of the 2003 stock (BASECOUNT = 120,777,000).
  6. Compute SMXPWT = sum of MXPWT after step 4; this sum is a first estimate of the size of the housing stock based on the units retained for analysis.  $N=53,608$  and  $SMXPWT = 118,896,639$
  7. Compute a FLCINCHWT = MXPWT\*(BASECOUNT/SMXPWT). This computation ratios the weights up so that they sum to the 2003 stock.  $FLCINCHWT = MXPWT*(120,777,000 / 118,896,639)$
  8. Identify *sames*, *losses*, and *interviewed losses*:
    - a. SAME = 1 if IN03\_ISTATUS = 1, 2, or 3 AND IN05\_ISTATUS = 1, 2, or 3  
 $N = 44,590$
    - b. LOSS = 1 if IN03\_ISTATUS = 1, 2, 3, or 4 AND 10 LE IN05\_NOINT LE 38  
 $N = 790$
    - c. INTLOSS = 1 if IN03\_ISTATUS = 1, 2, or 3 AND 10 LE IN05\_NOINT LE 38  
 $N = 748$
  9. Calculate:
    - a. SSAME = sum of FLCINCHWT for all SAME = 1 (100,682,474)
    - b. SLOSS = sum of FLCINCHWT for all LOSS = 1 (1,952,078)
    - c. SINTLOSS = sum of FLCINCHWT for INTLOSS = 1 (1,862,209.24)

10. Eliminate from subsequent analysis all observations that were 2003 or 2005 type A noninterviews. We cannot use the noninterviews because there is no information on the characteristics of these units. However, we retain them until this point so that we can get good estimates of the number of losses (SLOSS).

11. Calculate:

a.  $\text{Ratio1} = (\text{BASECOUNT} - \text{SLOSS})/\text{SSAME} \quad (1.1801947)$

b.  $\text{Ratio2} = \text{SLOSS}/\text{SINTLOSS} \quad (1.0482592)$

{The ratios in the 2001/2003 analysis were 1.17 and 1.13.}

12. Recalculate FLCINCHWT as follows:

a. For SAME = 1,  $\text{FLCINCHWT} = \text{Ratio1} * \text{FLCINCHWT}$

b. For INTLOSS = 1,  $\text{FLCINCHWT} = \text{Ratio2} * \text{FLCINCHWT}$

13. From published reports, obtain estimated 2003 counts for all owner-occupied units, all renter-occupied units, all vacant, and all seasonal units, distinguishing between mobile homes and all other structure types (non-mobile homes).

**Table for Forward-Looking Step 13**

	2003	Sum of FLCINCHWT	Ratio Adjustment
Housing Stock	120,777,000		
Occupied	105,842,000		
Owner-Occupied (mobile homes)	5,514,000	4,607,523	1.196738571
Owner-Occupied (other)	66,724,000	66,296,856	1.006442897
Renter (mobile homes)	1,340,000	1,250,244	1.071791164
Renter (other)	32,264,000	31,170,394	1.035084779
Vacant (mobile homes)	1,288,000	1,340,555	0.960796038
Vacant (other)	10,081,000	12,512,616	0.805666884
Seasonal (mobile homes)	829,000	821,559	1.009056663
Seasonal (other)	2,737,000	2,777,254	0.985505848

Calculate using the values in column 2 of the table:

- a. Sum FLCINCHWT in which IN03\_ISTATUS = "1" (occupied units) AND IN03\_TENURE = 1 (owner-occupied units) AND IN03\_NUNIT2 = 4 (mobile homes). Ratio adjust the FLCINCHWT for these observations so that they sum to the published total for owner-occupied mobile homes.

- b. Sum FLCINCHWT in which IN03\_ISTATUS = "1" (occupied units) AND IN03\_TENURE = 1 (owner-occupied units) AND IN03\_NUNIT2 NE 4 (non-mobile home). Ratio adjust the FLCINCHWT for these observations so that they sum to the published total for owner-occupied non-mobile homes.
- c. Sum FLCINCHWT in which IN03\_ISTATUS = "1" (occupied units) AND (2 LE IN03\_TENURE LE 3) (renter-occupied units) AND IN03\_NUNIT2 = 4 (mobile homes). Ratio adjust the FLCINCHWT for these observations so that they sum to the published total for renter-occupied mobile homes.
- d. Sum FLCINCHWT in which IN03\_ISTATUS = "1" (occupied units) AND (2 LE IN03\_TENURE LE 3) (renter-occupied units) AND IN03\_NUNIT2 NE 4 (non-mobile homes). Ratio adjust the FLCINCHWT for these observations so that they sum to the published total for renter-occupied non-mobile homes.
- e. Sum FLCINCHWT in which (IN03\_ISTATUS='2' OR IN03\_ISTATUS='3') AND NOT(8 LE IN03\_VACANCY LE 10) (URE and vacant units) AND IN03\_NUNIT2 = 4 (mobile homes). Ratio adjust the FLCINCHWT for these observations so that they sum to the published total for vacant mobile homes.
- f. Sum FLCINCHWT in which (IN03\_ISTATUS='2' OR IN03\_ISTATUS='3') AND NOT(8 LE IN03\_VACANCY LE 10) (URE and vacant units) AND IN03\_NUNIT2 NE 4 (non-mobile homes). Ratio adjust the FLCINCHWT for these observations so that they sum to the published total for vacant non-mobile homes.
- g. Sum FLCINCHWT in which (IN03\_ISTATUS='2' OR IN03\_ISTATUS='3') AND (8 LE IN03\_VACANCY LE 10) (Seasonal units) AND IN03\_NUNIT2 = 4 (mobile homes). Ratio adjust the FLCINCHWT for these observations so that they sum to the published total for seasonal mobile homes.
- h. Sum FLCINCHWT in which (IN03\_ISTATUS='2' OR IN03\_ISTATUS='3') AND (8 LE IN03\_VACANCY LE 10) (Seasonal units) AND IN03\_NUNIT2 NE 4 (non-mobile homes). Ratio adjust the FLCINCHWT for these observations so that they sum to the published total for seasonal non-mobile homes.

14. Sum of FLCINCHWT after final weighting:

**Table for Forward-Looking Step 14**

	N	Sum of FLCINCHWT
SAME	44,590	118,893,235
INTLOSS	748	1,883,765.20
Total	45,338	120,777,000

15. Check on the estimate of mobile homes:

**Table A for Forward-Looking Step 15**

	2003 Published	2003 Estimate
Single-unit, detached	74,916,000	74,831,045
Manufactured (mobile) home	8,971,000	8,971,000

Here are the same numbers from the 2001/2003 forward-looking analysis:

**Table B for Forward-Looking Step 15**

	2001 Published	2001 Estimate
Single-unit, detached	72,796,000	74,218,000
Manufactured (mobile) home	8,831,000	7,892,000

The 2002/2005 weights force the mobile home count to equal to published total; a consequence of this change in weighting procedure is to reduce the error in estimating single-unit, detached structures.

### **Backward Looking: From 2005 to 2003**

The algorithm for the 2003/2005 backward-looking analysis is based on the algorithm used for the 2001/2003 backward-looking analysis. In developing the forward-looking algorithm in the previous section, we discussed the need to alter the 2001/2003 algorithm for the reconstitution of the mobile home sample in 2005 when the Census Bureau added and dropped mobile home units from the AHS sample. At the same time, the Census Bureau added 486 units to represent “special living facilities” for the elderly. In the 2003/2005 backward-looking algorithm, step 2 is a revised version of the old step 4 with extra deletions designed to adjust for these additions to the sample. A new step 4 adjusts the weights for the dropped mobile home units.

The following are the steps necessary to prepare the data to analyze where 2005 units came from. AHS variables are given their codebook names and presented in capital letters. 2005 variables are labeled IN05\_; we refer to 2003 variables by the suffix IN03\_.

1. Merge the 2003 and 2005 files, using the flat files. ( $N= 75,807$ ) Keep units that appear in both years (54,944) and in the 2005 file only (4,367).
2. Delete cases where:
  - a.  $((IN05\_NUNIT2 = '4' \text{ OR } IN05\_ASSTSERV = '1') \text{ AND } IN05\_REUAD = 11)$ .<sup>7</sup> (1,548) These deletions eliminate the mobile homes and special living facilities added to the 2005 sample.
  - b.  $(10 \text{ LE } IN05\_NOINT \text{ LE } 38)$  (2,621) These are type B or type C losses in 2005. These units are not part of the 2005 stock and therefore we do not track them backwards.
  - c.  $(IN05\_NOINT=39)$ . (188) These are observations that were deleted in the 2005 prelist subsampling and therefore are not part of the 2005 stock.
  - d.  $(1 \text{ LE } IN03\_ISTATUS \text{ LE } 3 \text{ AND } 3 \text{ LE } IN05\_REUAD \text{ LE } 11)$  (51) These cases appear to contain erroneous information.  $IN03\_REUAD$  identifies units added to the sample in 2005, but these 51 units also had values for  $IN03\_ISTATUS$ , which indicates that they were part of the sample in 2003.
3. For all units let  $MPWT = \max (IN05\_PWT, IN03\_PWT)$ . (PWT is the pure weight.) In general, the pure weights should not differ except in the six metropolitan areas with added sample in 2003. In these six sites, the units that were not part of the added sample will have smaller pure weights in 2003 than in 2005. If there were an unusually low  $IN05\_PWT$  for one or more observations for other reasons, this step would also adjust for that low value.
4. Adjust the pure weights for manufactured (mobile) homes dropped in step 2.
  - a. From the 2005 file before merger, compute a pure weight count of mobile homes built before 2000 ( $IN05\_OLDMHPWT = 5,730,998.07$ ) by summing PWT for 2,515 cases where  $IN05\_NUNIT2 = 4 \text{ AND } IN05\_BUILT \text{ LE } 1999$ .
  - b. From merged file, compute a pure weight count of mobile homes built before 2000 that are in both years ( $IN05\_OLDMHKEPT = 3,385,380.72$ ) by summing MPWT for 1,435 cases where  $IN05\_NUNIT2 = 4 \text{ AND } IN05\_BUILT \text{ LE } 1999$ .
  - c. Adjust the pure weights of all manufactured (mobile) homes.  
 $IF IN05\_NUNIT2 = 4 \text{ AND } IN05\_BUILT \text{ GE } 2000$

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<sup>7</sup>  $NUNIT2 = 4$  identifies manufactured (mobile) homes;  $ASSTSERV = 1$  identifies units where the management provides assistance with meals, transportation, housekeeping, financial management, telephone, or shopping; and  $REUAD = 11$  identifies units added as sample adjustments.

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$$\begin{aligned} \text{MXPWT} &= \text{MXPWT} \\ \text{IF IN05\_NUNIT2} &= 4 \text{ AND IN05\_BUILT LE } 1999 \\ \text{MXPWT} &= \text{MXPWT} * (\text{IN05\_OLDMHPWT} / \text{IN05\_OLDMHKEPT}) \\ \text{MXPWT} &= \text{MXPWT} * (5,730,998.07 / 3,385,380.72) \\ &= \text{MXPWT} * (1.692866636) \end{aligned}$$

5. Obtain an estimate of the 2005 stock (CURRENTCOUNT) from the AHS publication for 2005. *CURRENTCOUNT* = 124,377,000
6. Compute SMXPWT = sum of MXPWT = 120,965,299 (N=55,173) after step 4; this sum is a first estimate of the size of the 2005 housing stock based on units retained for analysis.
7. Compute a BLCINCHWT = MXPWT\*(CURRENTCOUNT/SMXPWT). This computation ratios the weights up so that they sum to the 2005 stock.
8. Identify *sames, new construction, interviewed new construction, other adds, and interviewed other adds*.<sup>8</sup>
  - a. SAME = 1 if IN03\_ISTATUS = 1, 2, or 3 AND IN05\_ISTATUS = 1, 2, OR 3
  - b. NC = 1 if IN05\_ISTATUS=1, 2, 3, or 4 AND ((IN05\_REUAD = 3) OR (10 LE IN03\_NOINT LE 11))
  - c. INTNC = 1 IF NC=1 AND IN05\_ISTATUS=1, 2, or 3
  - d. ADD = 1 if IN05\_ISTATUS=1, 2, 3, or 4 AND ((4 LE IN05\_REUAD LE 11) OR (12 LE IN03\_NOINT LE 17))
  - e. INTADD = 1 if ADD =1 AND IN05\_ISTATUS=1, 2, OR 3
9. Calculate:
  - a. SSAME = sum of BLCINCHWT for all SAME = 1 (100,938,973 with N = 44539)
  - b. SNC = sum of WGT90GEO for NC =1 (3,707,781 with N =1,447)

SNCMH = sum of WGT90GEO for NC=1 AND IN05\_NUNIT2 = 4 (38,184.90 with N = 15)

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<sup>8</sup> Other adds are units that were type B losses in 2003 but are in the 2005 housing stock plus new housing units that are not new construction, such as the conversion to residential use of a warehouse or mobile home move-ins.

Weighting Strategy for 2003-2005 CINCH Analysis

SNCOTH = sum of WGT90GEO for NC=1 AND IN05\_NUNIT2 NE 4  
(3,669,596.12 with N=1,432)

- c. SINTNC = sum of BLCINCHWT for INTNC=1 (2,977,985.71 with N =1435)

SINTNCMH = sum of BLCINCHWT for INTNC=1 AND IN05\_NUNIT2 = 4 (N=15, SINTNCMH =36,360.82)

SINTNCOTH = sum of BLCINCHWT for INTNC=1 AND IN05\_NUNIT2 NE 4 (N=1420, SINTNCOTH =2,941,624.89)

- d. SADD = sum of BLCINCHWT for ADD =1 (1,457,211.67 with N = 648)

- e. SINTADD= sum of BLCINCHWT for INTADD = 1 (1,436,658.58 with N =637)

10. Eliminate from subsequent analysis all observations that were 2003 or 2005 type A noninterviews. We cannot use the noninterviews because there is no information on the characteristics of these units. However, we retain them until this point so that we can get good estimates of the number of recoveries (SADD) and the number of newly constructed units (SNCMH and SNCOTH).

11. Calculate:

- a. Ratio1 = (CURRENTCOUNT – (SADD + SNC))/SSAME  
(124,377.000 – (1,457,211.67+3,707,781))/100,938,973) = 1.181030516)

- b. Ratio2 = SNCMH/SINTNCMH (38184.90/36360.82 = 1.050166085)

- c. Ratio3 = SNCOTH/SINTNCOTH (3,669,596.12/2,941,624.89 = 1.247472488)

- d. Ratio4 = SADD/SINTADD (1,457,211.67/1,436,658.58 =1.014306176)

{In the 2001/2003 analysis, ratio 1 was 1.17 and ratio 4 was 1.02; ratios 2 and 3 were not calculated as defined here. }

12. Recalculate BLCINCHWT as follows:

- a. For SAME = 1, BLCINCHWT = Ratio1\*BLCINCHWT

- b. For INTNC= 1 AND IN05\_NUNIT2 = 4, BLCINCHWT = Ratio2\*BLCINCHWT

c. For  $INTNC = 1$  AND  $IN05\_NUNIT2 \neq 4$ ,  $BLCINCHWT = Ratio3 * BLCINCHWT$

d. For  $INTADD = 1$ ,  $BLCINCHWT = Ratio4 * BLCINCHWT$

13. From published reports obtain estimated 2005 counts for all owner-occupied units, all renter-occupied units, all vacant units, and all seasonal units, distinguishing between mobile homes and all other units.

**Table for Backward-Looking Step 13**

	2005	Sum of BLCINCHWT	Ratio Adjustment
Housing Stock	124,377,000	124,374,776	
Occupied	108,871,000	106,164,137.9	
Owner-Occupied (mobile homes)	5,516,000	4,459,201.15	1.236992864
Owner-Occupied (other)	69,415,000	68,751,476.88	1.009651038
Renter (mobile homes)	1,424,000	1,129,557.47	1.260670694
Renter (other)	32,516,000	31,802,675.32	1.022429707
Vacant (mobile homes)	1,047,000	1,177,081.46	0.889488141
Vacant (other)	10,613,000	13,251,196.17	0.800908828
Seasonal (mobile homes)	644,000	600,120.52	1.07311778
Seasonal (other)	3,201,000	3,203,450.73	0.999234972

The algorithm adjusts the weights to match the bottom eight rows in the above table. The sum of those rows is 124,376,000, which does not match the overall total because of rounding.

Calculate:

Sum BLCINCHWT in which  $IN05\_ISTATUS = "1"$  (occupied units) AND  $IN05\_TENURE = 1$  (owner-occupied units) AND  $IN05\_NUNIT2 = 4$  (mobile homes). Ratio adjust the BLCINCHWT for these observations so that they sum to the published total for owner-occupied mobile homes.

Sum BLCINCHWT in which  $IN05\_ISTATUS = "1"$  (occupied units) AND  $IN05\_TENURE = 1$  (owner-occupied units AND  $IN05\_NUNIT2 \neq 4$  (non-mobile home). Ratio adjust the BLCINCHWT for these observations so that they sum to the published total for owner-occupied non-mobile homes.

Sum BLCINCHWT in which  $IN05\_ISTATUS = "1"$  (occupied units) AND  $(2 \leq IN05\_TENURE \leq 3)$  (renter-occupied units) AND  $IN05\_NUNIT2 = 4$  (mobile homes). Ratio adjust the BLCINCHWT for these observations so that they sum to the published total for renter-occupied mobile homes.

Sum BLCINCHWT in which IN05\_ISTATUS = "1" (occupied units) AND (2 LE IN05\_TENURE LE 3) (renter-occupied units) AND IN05\_NUNIT2 NE 4 (non-mobile homes). Ratio adjust the BLCINCHWT for these observations so that they sum to the published total for renter-occupied non-mobile homes.

Sum BLCINCHWT in which (IN05\_ISTATUS='2' OR IN05\_ISTATUS='3') AND NOT(8 LE IN05\_VACANCY LE 10) (URE and vacant units) AND IN05\_NUNIT2 = 4 (mobile homes). Ratio adjust the BLCINCHWT for these observations so that they sum to the published total for vacant mobile homes.

Sum BLCINCHWT in which (IN05\_ISTATUS='2' OR IN05\_ISTATUS='3') AND NOT(8 LE IN05\_VACANCY LE 10) (URE and vacant units) AND IN05\_NUNIT2 NE 4 (non-mobile homes). Ratio adjust the BLCINCHWT for these observations so that they sum to the published total for vacant non-mobile homes.

Sum BLCINCHWT in which (IN05\_ISTATUS='2' OR IN05\_ISTATUS='3') AND (8 LE IN05\_VACANCY LE 10) (Seasonal units) AND IN05\_NUNIT2 = 4 (mobile homes). Ratio adjust the BLCINCHWT for these observations so that they sum to the published total for seasonal mobile homes.

Sum BLCINCHWT in which (IN05\_ISTATUS='2' OR IN05\_ISTATUS='3') AND (8 LE IN05\_VACANCY LE 10) (Seasonal units) AND IN05\_NUNIT2 NE 4 (non-mobile homes). Ratio adjust the BLCINCHWT for these observations so that they sum to the published total for seasonal non-mobile homes.

14. Sum of weights after final adjustment:

**Table for Backward-Looking Step 14**

	N	Sum of BLCINCHWT
SAME	44,539	119,323,422
INTADD	636	1,451,455
INTNC	1,435	3,601,123
Total	46,610	124,376,000

The sum matches the total of the bottom eight rows of the table in step 13, but not the overall total in row one of that table. As noted in step 13, the published subtotals do not match the published total because of rounding.

15. Check on the estimate of mobile homes:

**Table A for Backward-Looking Step 15**

	2005 Published	2005 Estimate
Single-unit, detached	77,703,000	77,602,765
Manufactured (mobile) home	8,630,000	8,631,000

The mobile total does not match the published total because of rounding; it does match the total of rows 3, 5, 7, and 9, which are the published subtotals for mobile homes.

Here are the same numbers from the 2001/2003 backward-looking analysis:

**Table B for Backward-Looking Step 15**

	<b>2003 Published</b>	<b>2003 Estimate</b>
Single-unit, detached	74,916,000	75,793,000
Manufactured (mobile) home	8,971,000	7,925,000

As in the case of the forward-looking algorithm, forcing the mobile home subtotals to equal published subtotals results in a much better estimate of the number of single-unit detached structures.

### Comparison of results from the two algorithms

The following table compares the estimates of SAMES (units that are part of the housing stock in both 2003 and 2005). The two algorithms estimate SAMES to within one-half of one percent of each other.

**Table 3: Comparison of Estimates of SAMES<sup>9</sup>**

<b>Weights</b>	<b>Estimated Count of SAMES</b>
FLCINCHWT	118,893,235
BLCINCHWT	119,323,422
Difference	-430,187
Percent difference	-0.4%

However, the difference is large compared to the flows that the CINCH analysis attempts to measure. See Table 4.

If the two measurements of SAMES had been closer, we would have considered forcing the estimates to be equal by adjusting some combination of LOSSES, NEW CONSTRUCTION, and OTHER ADDITIONS. Such an adjustment would have enabled us to solve (1) and (2) simultaneously and have a single CINCH analysis. However, this “correction” would have had a major impact on the flows that CINCH analysis is most interested in. As in previous years, concern about this impact caused us to favor the separate forward-looking and backward-looking analyses.

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<sup>9</sup> This table is the same as Table 1.

**Table 4: Relative Size of the Difference in Measuring SAMES Compared to Flows Into and Out of the Housing Stock**

	<b>Estimated Count</b>	<b>SAMES Difference as Percent of Estimated Count</b>
LOSSES	1,883,765	22.8%
NEW CONSTRUCTION	3,601,123	11.9%
OTHER ADDITIONS	1,451,455	29.6%
Net change (NC+OTHADD-LOSSES)	3,168,813	13.6%
Gross change (NC+OTHADD+LOSSES)	6,936,343	6.2%