

American Housing Survey

Weighting Strategy for 2007-2009 CINCH Analysis

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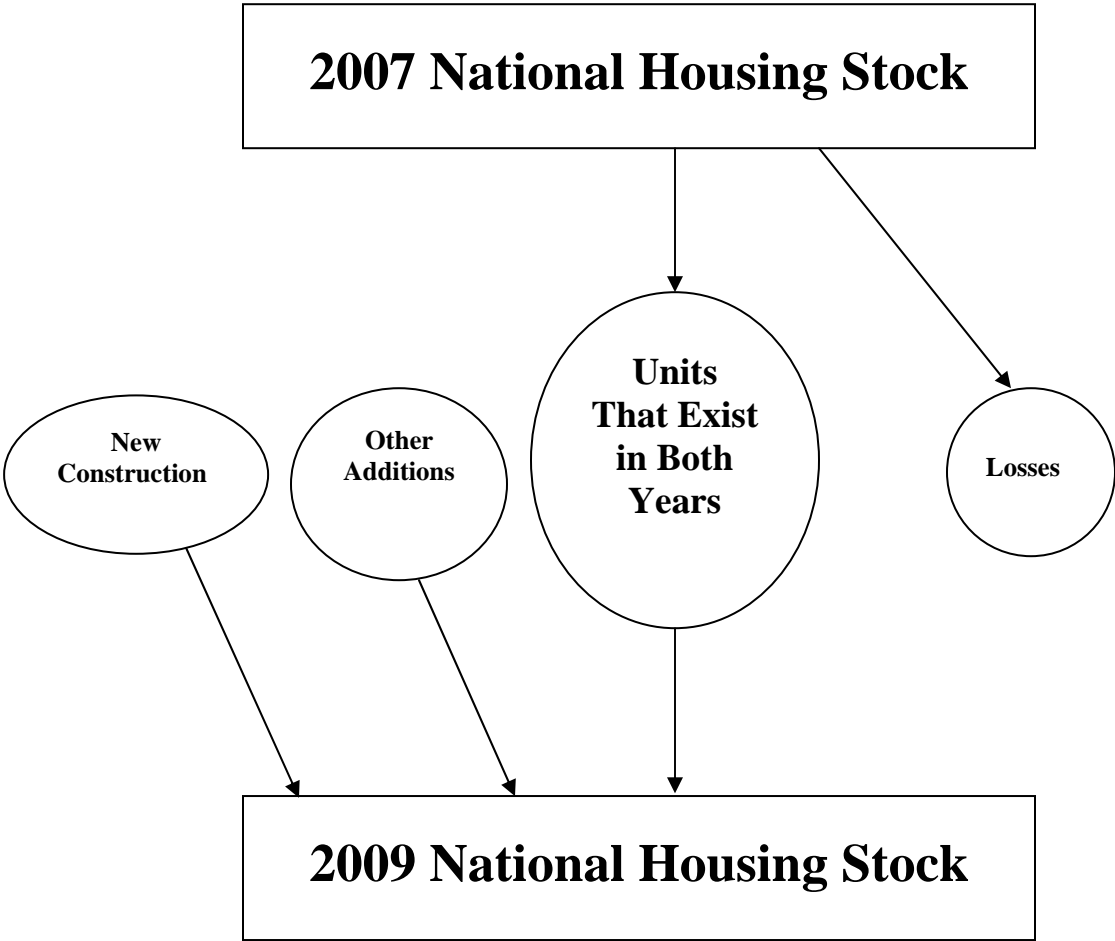
WEIGHTING STRATEGY FOR 2007-2009 CINCH ANALYSIS

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 2005 and 2007.¹

The CINCH Objective

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

Figure 1: The CINCH Objective



¹ Weighting Strategy for 2005-2007 CINCH Analysis at: <http://www.huduser.org/datasets/cinch/cinch05/CINCHWeightingStrategy2009.pdf>.

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 2007 and 2009). No one estimates the other three ovals: the number of units that belong to both the 2007 and 2009 housing stock, units lost to the housing stock between 2007 and 2009, and other additions to the housing stock between 2007 and 2009.

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 nonresidential purposes.² 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 nonresidential 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.

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 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:³

- (1) 2007 housing stock = units that exist in both years + losses.
- (2) New construction + other additions + units that exist in both years = 2009 housing stock.

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

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

Unfortunately, previous experience with CINCH analysis has shown it is difficult to find satisfactory simultaneous solutions to the equations. For this reason, Econometrica 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 2007 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 2009 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 2009 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 198,511 housing units, 0.2 percent of the 2007 estimate.

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

Units that Exist in Both Years	
Forward-looking estimate	126,118,583
Backward-looking estimate	126,317,094
Difference	198,511
Percent different	0.2%

Creation of SAMEDU2

In developing the new weighting algorithms for the national 2007 PUF, we changed the algorithm to make better use of the information in SAMEDU. The changes related to SAMEDU are implemented prior to the forward-looking and backward-looking algorithms.

SAMEDU (same dwelling unit) is a categorical (yes/no) variable that takes a value of “1” if the same unit is interviewed in successive AHS surveys. Unfortunately, there are five reasons why SAMEDU might take a value of “2.” The following is the explanation for SAMEDU from the AHS Frequently Asked Questions (FAQ):

Q. What, exactly, does a “no” answer for SAMEDU mean?

If you get a 'no' in the question for SAMEDU, it could mean that:

- the unit is the result of a conversion or merger since the previous survey
- the interviewer went to the wrong place last survey
- the current unit is a replacement mobile home (or, much less frequently, a replacement structure)
- the unit is a vacant mobile home site that was occupied in the previous survey
- the address identifies a location that is now a type C noninterview {2/29/2008}

Here is our approach to using SAMEDU: We presume that IN09_SAMEDU = 2 is correct; that is, the 2009 unit is *not* the same as the 2007 unit with same control number for one of the five reasons listed in AHS_FAQ. Then we try to distinguish among the five reasons using other variables. If the number of rooms is greater in 2009, we presume that this is *not* the result of alterations to the unit—otherwise SAMEDU would equal 1. Then we have to figure out whether the greater number of rooms results from a merger or because the Census Bureau went to the wrong unit. We need information from the 2005 PUF to make this distinction. If the number of rooms in 2005 and 2007 are equal, then we presume there was a merger. If the number of rooms in 2005 and 2009 are equal but different from the number in 2007, we presume that the Census Bureau went to the wrong unit in 2007. If the number of rooms differs across all 3 years, we cannot determine what happened.

Here are steps used to create a new variable, IN09_SAMEDU2:

1. Merge the 2005, 2007, and 2009 PUFs, keeping 2007-2009 matches and 2009-only cases.

MATCH_07_09	Frequency	Percent	Cumulative Frequency	Cumulative Percent
IN 07 AND IN 09	65,419	89.34	65,419	89.34
IN 09 ONLY	7,803	10.66	73,222	100

2. Create a new variable, SAMEDU2, defined as follows:

IN09_SAMEDU2 = B

IF IN09_SAMEDU = 2, IN09_SAMEDU2 = 1

IF (IN09_SAMEDU = 2 AND (((IN05_NUNIT2 = IN09_NUNIT2) AND (IN07_NUNIT2 NE IN09_NUNIT2)) OR ((IN05_ROOMS = IN09_ROOMS) AND (IN07_ROOMS NE IN09_ROOMS)))) THEN IN09_SAMEDU2 = 2

IF (IN09_SAMEDU = 2 AND ((IN07_NOINT = "B" OR IN07_NOINT LT 30) AND IN09_NOINT GE 30)) THEN IN09_SAMEDU2 = 3

IF (IN09_SAMEDU =2 AND (IN07_NUNIT2 = 4 AND IN09_NOINT = 13)) THEN IN09_SAMEDU2 = 4

IF (IN09_SAMEDU =2 AND IN09_SAMEDU2 NE 2 AND (IN09_NUNIT2 = 4 AND (IN07_NUNIT2 = B OR (IN07_NUNIT2 = 4 AND (IN07_BUILT NE IN09_BUILT)) OR IN07_NUNIT2 LT 4))) THEN IN09_SAMEDU = 5

IF (IN09_SAMEDU = 2 AND IN09_NUNIT2 NE 4 AND (IN09_BUILT LT 2007 AND ((IN05_ROOMS = IN07_ROOMS) AND (IN07_ROOMS LT IN09_ROOMS))) AND IN09_NOINT = B) THEN IN09_SAMEDU2 = 6

IF (IN09_SAMEDU = 2 AND IN09_NUNIT2 NE 4 AND (IN09_BUILT LT 2007 AND ((IN05_ROOMS = IN07_ROOMS) AND (IN07_ROOMS GT IN09_ROOMS))) AND IN09_NOINT = B) THEN IN09_SAMEDU2 = 7

IF (IN09_SAMEDU = 2 AND IN09_NUNIT2 NE 4 AND (IN09_BUILT LT 2007 AND ((IN05_ROOMS = IN07_ROOMS) AND (IN07_ROOMS NE IN09_ROOMS))) AND 1 LE IN09_NOINT LE 12) THEN IN09_SAMEDU2 = 8

Interpret SAMEDU2 as follows:

IN09_SAMEDU2 = B Not applicable

IN09_SAMEDU2 = 1 Not clear why SAMEDU = 2

IN09_SAMEDU2 = 2 Possibly the wrong unit was interviewed in 2007

IN09_SAMEDU2 = 3 A new type-C non-interview

IN09_SAMEDU2 = 4 Vacant mobile home lot that was occupied in 2007

IN09_SAMEDU2 = 5 Mobile home move in (to a vacant lot, replacing an old mobile home, or replacing a non-mobile home structure) – note that, if IN07_NOINT NE B, this implies either a mobile home move out or a demolition of another structure type

IN09_SAMEDU2 = 6 Possible merger

IN09_SAMEDU2 = 7 Possible split

IN09_SAMEDU2 = 8 Possible merger or split – we cannot tell because the work has not been completed or the unit was not interviewed

This table was computed after step 1b in the forward-looking algorithm.

IN09_SAMEDU2_GROUP	Frequency	Cumulative Frequency
1_Not clear why SAMEDU = 2	209	209
2_Possibly the wrong unit was interviewed in 2007	63	272
3_A new type-C non-interview	202	474
4_Vacant mobile home lot that was occupied in 2007	38	512
5_Mobile home move in	41	553
6_Possible merger	15	568
7_Possible split	10	578
8_Possible merger or split	3	581
B_Not applicable	62,369	62,950

Forward-Looking Weighting Algorithm: From 2007 to 2009

The following are the steps necessary to prepare the data to analyze what happened between 2007 and 2009 to units that existed in 2007. AHS variables are given their codebook names and presented in capital letters. We refer to 2007 variables by the prefix IN07_; 2009 variables are labeled IN09_.

1. Merge the 2007 and 2009 files, using the flat files.

MATCH 07 09	Frequency	Percent	Cumulative Frequency	Cumulative Percent
IN 07 AND IN 09	65,419	89.34	65,419	89.34
IN 09 ONLY	7,803	10.66	73,222	100

- a. Eliminate non-matches. (7,803 non-match cases) ($N = 65,419$)
 - b. Eliminate cases where IN09_NOINT GE 38. (2,469 cases) This eliminates losses from sample changes. CINCH should ignore these losses because they are not physical losses and because we cannot say anything useful about what happens to them. ($N = 62,950$)
 - c. Eliminate cases where 1 LE IN09_SAMEDU2 LE 2. (272 cases) This eliminates cases where it is possible that the Census Bureau went to the wrong unit in 2007. $N = 62,678$
2. Eliminate all observations that were 2007 type B or type C losses (10 LE IN07_NOINT LT 38). These units were not part of the 2007 stock and, therefore, are not tracked in the forward-looking analysis. This step eliminates 9,829 cases, leaving a file with $N = 52,849$ cases.
 3. For all units, let $MPWT = \max(\text{IN09_PWT}, \text{IN07_PWT})$. (PWT is the pure weight.)
 4. Obtain from the published report an estimate of the 2007 stock ($\text{BASECOUNT} = 128,203,000$).

Compute $\text{SMXPWT} = \text{sum of MPWT after step 3}$; this sum is a first estimate of the size of the housing stock based on the units retained for analysis. $N = 52,849$ and $\text{SMXPWT} = 124,483,713$

5. Compute a $\text{FLCINCHWT} = \text{MPWT} * (\text{BASECOUNT} / \text{SMXPWT})$. This computation ratios the weights up so that they sum to the 2007 stock.
 $\text{BASECOUNT} / \text{SMXPWT} = 1.0298777$

6. Identify *sames*, *losses*, and *interviewed losses*:
 - a. SAME = 1 if IN07_ISTATUS = 1, 2, or 3 AND IN09_ISTATUS = 1, 2, or 3 AND NOT(IN09_SAMEDU2 GE 4) $N = 42,736$
 - b. LOSS = 1 if IN07_ISTATUS = 1, 2, 3, or 4 AND (10 LE IN09_NOINT LT 38 OR IN09_SAMEDU2 GE 4) IN09_SAMEDU2 GE 4 means that the Census Bureau considers this a different unit than the unit in the 2007 sample and, therefore, we will treat the 2007 unit as a loss. $N= 864$
 INTLOSS = 1 if IN07_ISTATUS = 1, 2, or 3 AND LOSS = 1 $N = 804$

7. Calculate:
 - a. SSAME = sum of FLCINCHWT for all SAME = 1 ($N = 42,736$, $SSAME = 103,456,211$)
 - b. SLOSS = sum of FLCINCHWT for all LOSS = 1 ($N = 864$, $SLOSS = 2,187,780$)
 - c. SINTLOSS = sum of FLCINCHWT for INTLOSS = 1 ($N = 804$, $SINTLOSS = 2,045,696$)

8. For CINCH analysis, we need information on the characteristics of units and their occupants in both 2007 and 2009 for all units that were part of the stock in both 2007 and 2009. For units that are part of the stock in only 2007, we need information on the characteristics of the units and their occupants in 2007 but only in 2007. Up to this point, we retained units that failed to meet these conditions so that we can get good estimates of the number of losses (SLOSS).
 Keep for future analysis only those units where SAME =1 OR INTLOSS = 1.
 (9,309 cases deleted) $N=43,540$.
 Note that this formulation keeps a few 2009 Type A non-interviews if the unit is interviewed in 2007 and is also an eligible SAMEDU = 2 case. Since we treat the 2009 version of the unit as a different unit, we do not need to know the characteristics of the unit or its occupants in 2009 for the forward-looking analysis.

9. Calculate:
 - a. Ratio1 = (BASECOUNT – SLOSS)/SSAME (1.2180537)
 - b. Ratio2 = SLOSS/SINTLOSS (1.0694553)

10. Recalculate FLCINCHWT as follows:
 - a. For SAME = 1, FLCINCHWT = Ratio1*FLCINCHWT
 - b. For INTLOSS = 1, FLCINCHWT = Ratio2*FLCINCHWT

11. From published reports, obtain estimated 2007 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). Calculate new adjustment ratios using the formulas in columns C & D of the table:

Table for Forward-Looking Step 11

	A	B	C	D
		2007	Sum of FLCINCHWT	Ratio Adjustment
1	Housing Stock	128,203,000		
2	Occupied	110,692,000		
3	Owner-Occupied (mobile homes)	5,419,000	IN07_ISTATUS = "1" AND IN07_TENURE = 1 AND IN07_NUNIT2 = 4 $\Sigma = 4,820,798$	D3 = B3/C3 = 1.12409
4	Owner-Occupied (other)	70,228,000	IN07_ISTATUS = "1" AND IN07_TENURE = 1 AND IN07_NUNIT2 NE 4 $\Sigma = 68,773,843$	D4 = B4/C4 = 1.02114
5	Renter (mobile homes)	1,500,000	IN07_ISTATUS = "1" AND (2 LE IN07_TENURE LE 3) AND IN07_NUNIT2 = 4 $\Sigma = 1,258,852$	D5 = B5/C5 = 1.19156
6	Renter (other)	33,545,000	IN07_ISTATUS = "1" AND (2 LE IN07_TENURE LE 3) AND IN07_NUNIT2 NE 4 $\Sigma = 32,502,819$	D6 = B6/C6 = 1.03206
7	Vacant (mobile homes)	1,053,000	(IN07_ISTATUS="2" OR IN07_ISTATUS="3") AND NOT(8 LE IN07_VACANCY LE 11) AND IN07_NUNIT2 = 4 $\Sigma = 1,147,863$	D7 = B7/C7 = 0.91736
8	Vacant (other)	12,056,000	(IN07_ISTATUS="2" OR IN07_ISTATUS="3") AND NOT(8 LE IN07_VACANCY LE 11) AND IN07_NUNIT2 NE 4 $\Sigma = 15,552,355$	D8 = B8/C8 = 0.77519
9	Seasonal (mobile homes)	733,000	(IN07_ISTATUS="2" OR IN07_ISTATUS="3") AND (8 LE IN07_VACANCY LE 11) AND IN07_NUNIT2 = 4 $\Sigma = 579,253$	D9 = B9/C9 = 1.26542
10	Seasonal (other)	3,669,000	(IN07_ISTATUS="2" OR IN07_ISTATUS="3") AND (8 LE IN07_VACANCY LE 11) AND IN07_NUNIT2 NE 4 $\Sigma = 3,567,216$	D10 = B10/C10 = 1.02853

12. Use the new adjustment ratios to make final adjustment in the FLCINCHWT.

- a. If $IN07_ISTATUS = "1"$ (occupied units) AND $IN07_TENURE = 1$ (owner-occupied units) AND $IN07_NUNIT2 = 4$ (mobile homes), $FLCINCHWT = D3*FLCINCHWT$.

This step ratio adjusts the FLCINCHWT for these observations so that they sum to the published total for owner-occupied mobile homes.

- b. If $IN07_ISTATUS = "1"$ (occupied units) AND $IN07_TENURE = 1$ (owner-occupied units) AND $IN07_NUNIT2 \neq 4$ (non-mobile home), $FLCINCHWT = D4*FLCINCHWT$.

This step ratio adjusts the FLCINCHWT for these observations so that they sum to the published total for owner-occupied non-mobile homes.

- c. If $IN07_ISTATUS = "1"$ (occupied units) AND (2 LE $IN07_TENURE$ LE 3) (renter-occupied units) AND $IN07_NUNIT2 = 4$ (mobile homes), $FLCINCHWT = D5*FLCINCHWT$.

This step ratio adjusts the FLCINCHWT for these observations so that they sum to the published total for renter-occupied mobile homes.

- d. If FLCINCHWT in which $IN07_ISTATUS = "1"$ (occupied units) AND (2 LE $IN07_TENURE$ LE 3) (renter-occupied units) AND $IN07_NUNIT2 \neq 4$ (non-mobile homes), $FLCINCHWT = D6*FLCINCHWT$.

This step ratio adjusts the FLCINCHWT for these observations so that they sum to the published total for renter-occupied non-mobile homes.

- e. If FLCINCHWT in which ($IN07_ISTATUS="2"$ OR $IN07_ISTATUS="3"$) AND NOT(8 LE $IN07_VACANCY$ LE 11) (URE and vacant units) AND $IN07_NUNIT2 = 4$ (mobile homes), $FLCINCHWT = D7*FLCINCHWT$.

This step ratio adjusts the FLCINCHWT for these observations so that they sum to the published total for vacant mobile homes.

- f. If FLCINCHWT in which ($IN07_ISTATUS="2"$ OR $IN07_ISTATUS="3"$) AND NOT(8 LE $IN07_VACANCY$ LE 11) (URE and vacant units) AND $IN07_NUNIT2 \neq 4$ (non-mobile homes), $FLCINCHWT = D8*FLCINCHWT$.

This step ratio adjusts the FLCINCHWT for these observations so that they sum to the published total for vacant non-mobile homes.

- g. If FLCINCHWT in which ($IN07_ISTATUS="2"$ OR $IN07_ISTATUS="3"$) AND (8 LE $IN07_VACANCY$ LE 11) (Seasonal units) AND $IN07_NUNIT2 = 4$ (mobile homes), $FLCINCHWT = D9*FLCINCHWT$.

This step ratio adjusts the FLCINCHWT for these observations so that they sum to the published total for seasonal mobile homes.

- h. If FLCINCHWT in which ($IN07_ISTATUS="2"$ OR $IN07_ISTATUS="3"$) AND (8 LE $IN07_VACANCY$ LE 11) (Seasonal units) AND $IN07_NUNIT2 \neq 4$ (non-mobile homes), $FLCINCHWT = D10*FLCINCHWT$.

This step ratio adjusts the FLCINCHWT for these observations so that they sum to the published total for seasonal non-mobile homes.

13. Calculate the sum of FLCINCHWT after final weighting for cases with SAME=1, cases with LOSS=1, cases with INTLOSS =1, and for all cases:

Table for Forward-Looking Step 13

	N	Sum of FLCINCHWT
SAME=1	42,736	126,118,583
INTLOSS=1	804	2,084,417
Total	43,540	128,203,000

14. Check on the estimate of mobile homes (IN07_NUNIT2 = 4) and single-unit, detached (IN07_NUNIT2 = 1):

Table for Forward-Looking Step 14

	2007 Published	2007 Estimate
Single-unit, detached	80,406,000	80,038,089
Manufactured (mobile) home	8,705,000	8,705,000

Except for rounding, the results in the Table for Step 13 total to the published count for the housing stock in 2007 and the results in the Table for Step 14 match the published count for mobile homes. The weights were designed to produce these exact matches. The estimate for units in single-unit, detached structures in the Table for Step 14 is within 0.5 percent of the published estimates. In CINCH studies before the 2005/2007 study, the adjustments in steps 11 and 12 were not included in the weighting algorithm. In those studies, the estimates of units in single-unit, detached structures had substantially higher error rates.

Backward-Looking Weighting Algorithm: From 2009 to 2007

The following are the steps necessary to prepare the data to analyze where 2009 units came from. AHS variables are given their codebook names and presented in capital letters. 2009 variables are labeled IN09_; we refer to 2007 variables by the prefix IN07_.

1. Merge the 2007 and 2009 files, using the flat files. Keep units that appear in both years and in the 2009 file only ($N = 73,222$).

MATCH 07 09	Frequency	Percent	Cumulative Frequency	Cumulative Percent
IN 07 AND IN 09	65,419	89.34	65,419	89.34
IN 09 ONLY	7,803	10.66	73,222	100

2. Delete cases where:
 - a. (IN09_NOINT GE 38). (2,469 cases) $N=70,753$ These are observations that were deleted in prelist subsampling or were inappropriate for the sample. The units may still be part of the housing stock, but the AHS provides no information on them in 2009. They are not part of the sample that is traced backwards.
 - b. (10 LE IN09_NOINT LT 38). (10,838 cases) $N= 59,915$ These are type B or type C losses in 2009. These units are not part of the 2009 stock, and therefore we do not track them backwards.
 - c. (1 LE IN09_SAMEDU2 LE 2). (220 cases) $N=59,695$ These are cases where it is possible that the Census Bureau interviewed the wrong unit in 2007.
 - d. IN09_REUAD = 11. (3,448 cases) $N=56,247$ These are cases added as sample adjustments. They are part of the 2009 housing stock, but we cannot tell whether they were in the 2007 stock or added by new construction or other means between 2007 and 2009. This eliminated 3,339 cases from the metropolitan areas for which supplemental sample cases were drawn for the first time in 2009.
 - e. IN09_REUAD = 10. (1,192 cases) $N=55,055$. This will eliminate an additional 1,166 cases from the metropolitan areas for which supplemental sample cases were drawn for the first time in 2009 and an additional 26 that were coverage improvements. Only 2 cases were legitimate “others.”⁴
3. For all units let $MXPWT = \max (IN09_PWT, IN07_PWT)$. (PWT is the pure weight.)

⁴ In the initial CINCH run, we eliminated only 1,164 cases from the metro supplement but further communication from the Census Bureau indicated that it was better to eliminate all the cases. 3-7-11 email from Mousumi Sarkar: *We ran some crosses with some other sample identifier variables and our conclusion is that almost all those cases should be coded as 11. Of the 1,192 cases that are REUAD=10, 1,166 were added as supplemental sample for the Big 5 and hence can be coded as 11, and another 26 were added for coverage improvement and hence can also be coded as 11. Only 2 (1 each) were adds and extras. I hope that helps and let me know if you have other questions or need anything else.*

4. Obtain an estimate of the 2009 stock (CURRENTCOUNT) from the AHS publication for 2009. $CURRENTCOUNT = 130,112,000$
5. Compute $SMXPWT = \text{sum of } MXPWT (N=555,055, \Sigma = 127,382,954)$ after step 4; this sum is a first estimate of the size of the 2009 housing stock based on units retained for analysis.
6. Compute a $BLCINCHWT = MXPWT * (CURRENTCOUNT / SMXPWT)$. This computation ratios the weights up so that they sum to the 2009 stock. ($CURRENTCOUNT / SMXPWT = 1.0214239$)
7. Identify *sames*, *new construction*, *interviewed new construction*, *other adds*, and *interviewed other adds*.⁵ This is the fourth place where the backward-looking algorithm differs from past procedures.
 - a. $SAME = 1$ if $IN07_ISTATUS = 1, 2, \text{ or } 3$ AND $IN09_ISTATUS = 1, 2, \text{ OR } 3$ AND NOT($IN09_SAMEDU2 \geq 4$)
 - b. $NC = 1$ if $IN09_ISTATUS = 1, 2, 3, \text{ or } 4$ AND (($IN09_REUAD = 3$) OR ($10 \leq IN07_NOINT \leq 11$)) AND NOT($IN09_SAMEDU2 \geq 4$)
 - c. $INTNC = 1$ IF $NC = 1$ AND $IN09_ISTATUS = 1, 2, \text{ or } 3$
 - d. $ADD = 1$ if $IN09_ISTATUS = 1, 2, 3, \text{ or } 4$ AND (($4 \leq IN09_REUAD \leq 11$) OR ($12 \leq IN07_NOINT \leq 17$) OR ($IN09_SAMEDU2 \geq 4$))
 - e. $INTADD = 1$ if $ADD = 1$ AND $IN09_ISTATUS = 1, 2, \text{ OR } 3$
8. Calculate:
 - a. $SSAME = \text{sum of } BLCINCHWT \text{ for all } SAME = 1 (N=42,736 \Sigma=102,606,991)$
 - b. $SNC = \text{sum of } BLCINCHWT \text{ for } NC = 1 (N=1,448 \Sigma=2,631,889)$
 $SNCMH = \text{sum of } BLCINCHWT \text{ for } NC=1 \text{ AND } IN09_NUNIT2 = 4 (N= 12 \Sigma=20,263)$
 $SNCOTH = \text{sum of } BLCINCHWT \text{ for } NC=1 \text{ AND } IN09_NUNIT2 \neq 4 (N=1,436 \Sigma=2,611,626)$
 $TNC = \text{sum of } BLCINCHWT \text{ for } INTNC=1 (N=1,430 \Sigma=2,593,146)$
 $SINTNCMH = \text{sum of } BLCINCHWT \text{ for } INTNC=1 \text{ AND } IN09_NUNIT2 = 4 (N=12 \Sigma=20,263)$
 $SINTNCOTH = \text{sum of } BLCINCHWT \text{ for } INTNC=1 \text{ AND } IN09_NUNIT2 \neq 4 (N=1,418 \Sigma=2,572,883)$
 - d. $SADD = \text{sum of } BLCINCHWT \text{ for } ADD = 1 (N=564 \Sigma=1,251,070)$
 - e. $SINTADD = \text{sum of } BLCINCHWT \text{ for } INTADD = 1 (N=553 \Sigma=1,224,572)$

⁵ *Other adds* are units that were type B losses in 2007 but are in the 2009 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.

9. For CINCH analysis, we need information on the characteristics of units and their occupants in both 2007 and 2009 for all units that were part of the stock in both 2007 and 2009. For units that are part of the stock in only 2009, we need information on the characteristics of the units and their occupants in 2009 but only in 2009. Up to this point, we retained units that failed to meet these conditions so that we can get good estimates of the number of newly constructed units (SNC) and other additions (SADD).

Keep for future analysis only those units where: SAME = 1 OR INTNC = 1 OR INTADD = 1 (10,336 cases deleted) N=44,719.

10. Calculate:

- a. $\text{Ratio1} = (\text{CURRENTCOUNT} - (\text{SADD} + \text{SNC})) / \text{SSAME}$
 $(130,112,000 - (1,251,070 + 2,631,889)) / 102,606,991 = 1.2302187$
- b. $\text{Ratio2} = \text{SNCMH} / \text{SINTNCMH}$ (20,263 / 20,263)
- c. $\text{Ratio3} = \text{SNCOTH} / \text{SINTNCOTH}$ (2,611,626 / 2,572,883 = 1.0150581)
- d. $\text{Ratio4} = \text{SADD} / \text{SINTADD}$ (1,251,070 / 1,224,572 = 1,0216384)

11. Recalculate BLCINCHWT as follows:

- a. For SAME = 1, BLCINCHWT = Ratio1*BLCINCHWT
- b. For INTNC= 1 AND IN09_NUNIT2 = 4, BLCINCHWT = Ratio2*BLCINCHWT
- c. For INTNC= 1 AND IN09_NUNIT2 NE 4, BLCINCHWT = Ratio3*BLCINCHWT
- d. For INTADD = 1, BLCINCHWT = Ratio4*BLCINCHWT

12. From published reports obtain estimated 2009 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 12

	A	B	C	D
		2009	Sum of BLCINCHWT	Ratio Adjustment
1	Housing Stock	130,112,000		
2	Occupied	111,806,000		
3	Owner-Occupied (mobile homes)	5,418,000	IN09_ISTATUS = "1" AND IN09_TENURE = 1 AND IN09_NUNIT2 = 4 $\Sigma = 4,665,743$	D3 = B3/C3 = 1.16123
4	Owner-Occupied (other)	71,010,000	IN09_ISTATUS = "1" AND IN09_TENURE = 1 AND IN09_NUNIT2 NE 4 $\Sigma = 69,131,1000$	D4 = B4/C4 = 1.02718
5	Renter (mobile homes)	1,421,000	IN09_ISTATUS = "1" AND (2 LE IN09_TENURE LE 3) AND IN09_NUNIT2 = 4 $\Sigma = 1,234,982$	D5 = B5/C5 = 1.15062
6	Renter (other)	33,957,000	IN09_ISTATUS = "1" AND (2 LE IN09_TENURE LE 3) AND IN09_NUNIT2 NE4 $\Sigma = 34,074,765$	D6 = B6/C6 = 0.99654
7	Vacant (mobile homes)	1,201,000	(IN09_ISTATUS='2' OR IN09_ISTATUS='3') AND NOT(8 LE IN09_VACANCY LE 11) AND IN09_NUNIT2 = 4 $\Sigma = 1,315,493$	D7 = B7/C7 = 0.91297
8	Vacant (other)	12,487,000	(IN09_ISTATUS='2' OR IN09_ISTATUS='3') AND NOT(8 LE IN09_VACANCY LE 11) AND IN09_NUNIT2 NE 4 $\Sigma = 15,552,595$	D8 = B8/C8 = 0.80289
9	Seasonal (mobile homes)	730,000	(IN09_ISTATUS='2' OR IN09_ISTATUS='3') AND (8 LE IN09_VACANCY LE 11) AND IN09_NUNIT2 = 4 $\Sigma = 580,467$	D9 = B9/C9 = 1.25761
10	Seasonal (other)	3,888,000	(IN09_ISTATUS='2' OR IN09_ISTATUS='3') AND (8 LE IN09_VACANCY LE 11) AND IN09_NUNIT2 NE 4 $\Sigma = 3,556,854$	D10 = B10/C10 = 1.09310

The algorithm adjusts the weights to match the bottom eight rows in the above table.

13. Use the new adjustment ratios to make final adjustment in the BLCINCHWT.

- a. If $IN09_ISTATUS = "1"$ (occupied units) AND $IN09_TENURE = 1$ (owner-occupied units) AND $IN09_NUNIT2 = 4$ (mobile homes), $BLCINCHWT = D3*BLCINCHWT$.

This step ratio adjusts the BLCINCHWT for these observations so that they sum to the published total for owner-occupied mobile homes.

- b. If $IN09_ISTATUS = "1"$ (occupied units) AND $IN09_TENURE = 1$ (owner-occupied units) AND $IN09_NUNIT2 \neq 4$ (non-mobile home), $BLCINCHWT = D4*BLCINCHWT$.

This step ratio adjusts the BLCINCHWT for these observations so that they sum to the published total for owner-occupied non-mobile homes.

- c. If $IN09_ISTATUS = "1"$ (occupied units) AND $(2 \leq IN09_TENURE \leq 3)$ (renter-occupied units) AND $IN09_NUNIT2 = 4$ (mobile homes), $BLCINCHWT = D5*BLCINCHWT$.

This step ratio adjusts the BLCINCHWT for these observations so that they sum to the published total for renter-occupied mobile homes.

- d. If BLCINCHWT in which $IN09_ISTATUS = "1"$ (occupied units) AND $(2 \leq IN09_TENURE \leq 3)$ (renter-occupied units) AND $IN09_NUNIT2 \neq 4$ (non-mobile homes), $BLCINCHWT = D6*BLCINCHWT$.

This step ratio adjusts the BLCINCHWT for these observations so that they sum to the published total for renter-occupied non-mobile homes.

- e. If BLCINCHWT in which $(IN09_ISTATUS='2' \text{ OR } IN09_ISTATUS='3')$ AND $NOT(8 \leq IN09_VACANCY \leq 11)$ (URE and vacant units) AND $IN09_NUNIT2 = 4$ (mobile homes), $BLCINCHWT = D7*BLCINCHWT$.

This step ratio adjusts the BLCINCHWT for these observations so that they sum to the published total for vacant mobile homes.

- f. If BLCINCHWT in which $(IN09_ISTATUS='2' \text{ OR } IN09_ISTATUS='3')$ AND $NOT(8 \leq IN09_VACANCY \leq 11)$ (URE and vacant units) AND $IN09_NUNIT2 \neq 4$ (non-mobile homes), $BLCINCHWT = D8*BLCINCHWT$.

This step ratio adjusts the BLCINCHWT for these observations so that they sum to the published total for vacant non-mobile homes.

- g. If BLCINCHWT in which $(IN09_ISTATUS='2' \text{ OR } IN09_ISTATUS='3')$ AND $(8 \leq IN09_VACANCY \leq 11)$ (Seasonal units) AND $IN09_NUNIT2 = 4$ (mobile homes), $BLCINCHWT = D9*BLCINCHWT$.

This step ratio adjusts the BLCINCHWT for these observations so that they sum to the published total for seasonal mobile homes.

- h. If BLCINCHWT in which $(IN09_ISTATUS='2' \text{ OR } IN09_ISTATUS='3')$ AND $(8 \leq IN09_VACANCY \leq 11)$ (Seasonal units) AND $IN09_NUNIT2 \neq 4$ (non-mobile homes), $BLCINCHWT = D10*BLCINCHWT$.

This step ratio adjusts 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	42,736	126,317,094
INTADD	553	1,247,614
INTNC	1,430	2,547,292
Total	44,719	130,112,000

15. Check on the estimate of mobile homes:

Table for Backward-Looking Step 15

	2009 Published	2009 Estimate
Single-unit, detached	82,472,000	81,718,324
Manufactured (mobile) home	8,769,000	8,770,000

The estimates of units that remained in the stock (SAME) and additions to the stock (INTADD and INTNC) equal the published count for the 2009 housing stock. Except for the rounding error, the estimate of mobile homes is equal to the published count of mobile homes. The weights were created to produce these exact matches. The estimate of units in single-unit, detached structures is within 1.0 percent of the published count. In CINCH studies before the 2005/2007 study, the adjustments in steps 12 and 13 were not included in the weighting algorithm. In those studies, the estimates of units in single-unit, detached structures had substantially higher error rates.