American Housing Survey

Components of Inventory Change & Rental Dynamics: Houston 2015–2017

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Foreword

The U.S. Department of Housing and Urban Development is pleased to release this report on changes in the housing stock of the Houston-The Woodlands-Sugar Land metropolitan area between 2015 and 2017. The report leverages the special features of the American Housing Survey (AHS) to examine the underlying changes in the housing available to Houston residents, with a special emphasis on changes in the affordability of the rental housing stock.

The AHS is a biennial survey of the national housing stock administered by HUD and implemented by the U.S. Census Bureau. Although a national survey, its core sample includes oversamples of 15 metropolitan areas, including Houston. This report is based on the Houston oversample, which includes more than 2,000 cases. The analysis in this report is possible because the AHS uses a longitudinal sample design: the same housing units stay in the AHS sample and are surveyed every 2 years. Thus, it is possible to track which units leave the housing stock, how existing units change, and (through additions to the sample) which units are added. AHS is uniquely able to track housing unit losses and changes in characteristics.

One part of this report, called Components of Inventory Change (CINCH), deals with the entire housing stock. It uses a bidirectional approach, using separate tables to examine what happened to housing that existed in 2015 ("forward-looking") and the sources of housing that existed in 2017 ("backward-looking"). This analysis reveals that the net increase of 168,000 housing units (6 percent) was the result of gross flows of about the same magnitude into and out of the stock, for various reasons. In addition, many units change their characteristics during the period. The CINCH tables of this report track 96 overlapping categories.

The Rental Dynamics part of this report concentrates on the rental housing stock, with a special emphasis on affordability. It identifies three categories of affordability: affordable, moderate, and high rent. Using the longitudinal features of the AHS, the movements of housing units in these categories can be tracked. Thus, we can see which units became more affordable (called "filtered" in this report) or less affordable (called "gentrified"). We can also see what units left the rental stock through physical loss or conversion to owner-occupied and which were added through new construction or conversion from owner-occupied. The Houston metropolitan area experienced a net gain of 10,000 rental units, the result of gross flows of over 200,000 units in one direction or the other. The affordable rental category (units suitable for households earning 50 percent of the area median income) declined by 42,000 units, mostly due to net gentrification.

This report illustrates the power of the AHS to reach into metropolitan-level data. It provides a specific look at one of the Nation's most dynamic housing markets and underlines the continuing challenge of providing affordable housing.

Seth D. Appleton
Assistant Secretary for Policy Development and Research
U.S. Department of Housing and Urban Development

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Executive Summary

The Houston-The Woodlands-Sugar Land metropolitan statistical area is the 5th largest in the country, containing 2,425,500 households and 2,801,400 housing units in 2017. Its population grew from 4.7 million in 2000 to 5.9 million in 2010 and 7.0 million in 2017. The city of Houston is known as the energy capital of the world. The metropolitan area has four major ports; the Port of Houston processes the most foreign tonnage in the United States. Houston is also home to several important medical centers such as the Texas Medical Center, which is the largest in the world. Hurricane Harvey hit Houston late in the normal data collection period for the 2017 American Housing Survey (AHS), and so its effects are only minimally picked up in the data used in the report.

The Houston housing stock grew from 2,633,200 in 2015 to 2,801,400 in 2017. This report ascribes the 168,000 increase to three factors: the identified loss of 80,200 units from the housing stock, the identified addition of 118,800 units, and an unexplained increase of 129,700 that was achieved by adjusting the weights. This last factor is an unavoidable feature of Components of Inventory Change (CINCH) analysis. It means, in this case, that the AHS does not have sufficient information to measure all additions.

The AHS breaks the losses into two groups: 63,900 temporary losses (units that might return to the housing stock after 2017) and 16,900 permanent losses (units that cannot return to the stock with the same characteristics). An example of a temporary loss is a residential unit being used as a group home. The large majority (54,400) of reported temporary losses fall into the "not classified above" categories. The permanent losses include 5,300 units that were demolished or destroyed due to fire or natural disaster.

New construction accounted for 101,500 of all additions, but the national CINCH study found that CINCH overestimates new construction. Another 10,500 new units came from the recovery of units that were temporary losses in 2015. The remaining additions are classified as "other."

The overall loss rate for Houston was 3.0 percent, and the overall rate of additions was 4.4 percent. This report divided the Houston housing market into 96 overlapping segments to determine the extent to which losses and additions vary across the segments. The most notable findings were the following:

- Vacant units and seasonal units have substantially higher loss rates and higher addition rates as well. For example, the loss rate for vacant units was 8.2 percent, and the addition rate for seasonal units and second homes was 12.5 percent.

- The report uses two measures of unit quality: the long-standing AHS adequacy measure and a simple count of how many problems out of a possible 20 a unit may have. For both measures, the loss rate rose as unit quality dropped, but only one of six results was even marginally significant.

- Change rates are interesting with respect to the quality measures (change rates are the percent of a market segment in a given survey year that is in a different segment but still in the stock in the other survey year). At the good end of both measures, the change rates are approximately 5 percent, meaning that good units tend to stay good. At the bad end of

both measures, the change rates are high, suggesting that if bad units remain in the stock, they move to a less bad category in the next survey.

- For both renters and owners, the addition rate for low- and moderate-cost units are significantly lower than the addition rates for all renters and all owners, while the addition rates for high-cost units are significant and substantially higher.

Counting vacant units for rent, the Houston rental stock grew from 1,015,000 units in 2015 to 1,044,000 in 2017. This report applies rental dynamics techniques to describe how the rental housing in Houston changed from 2015 to 2017, with particular attention to the availability of affordable rental housing.

There were large flows between the rental stock and the owner and seasonal stocks (209,000 in absolute value), but the net outflow from the rental stock was only 7,000. Additions numbered 42,000 units whereas losses were 32,000, for a net gain of 10,000. Despite these large flows, the biggest contributor to the growth of the rental stock was a weight adjustment of 24,000.

Using a dataset created by the U.S. Department of Housing and Urban Development (HUD), the report divides the rental stock into three affordability categories: affordable rent, moderate rent, and high rent. Affordability is a simple concept; it is the relationship between the gross rent (rent plus utilities and other related costs) and household income. If a unit's gross rent is less than 30 percent of income for a particular household, then the unit is said to be affordable for that household. In 2015, the median family income in Houston was $69,300; a family earning 50 percent of median family income would be able to afford a unit renting for approximately $870 (($69,300/12)*0.5*0.3) and a family earning 80 percent of median family income would be able to afford a unit renting for approximately $1,390 (($69,300/12)*0.8*0.3). The actual classification in the HUD data of units by affordability is complicated because it simultaneously takes household size into account when considering income and number of bedrooms when considering gross rent.

Flow among the affordability categories was large and was also a contributor to the decline in affordable rentals. Here are the experiences of each of the three affordability categories:

- **Affordable Rent:** This group includes HUD-assisted and no-cash rent units and all units with gross rents at or below the highest rent that a household earning 50 percent of the local family median income could afford. This category declined from 294,000 to 254,000. Gentrification was the primary reason the "affordable rent" category declined, accounting for 34,000 of the 42,000 decrease. The category also lost 6,000 units to the owner and seasonal sectors, and physical losses exceeded additions by 10,000.

- **Moderate Rent:** This group includes all units with gross rents higher than the affordable rent cap, but at or below the highest rent that a household earning 80 percent of the local family median income could afford. The "moderate rent" category gained 39,000 units. Although 3,000 more units filtered out of this category than filtered into it, it gained 46,000 units from net gentrification. This net inflow offset a 5,000-unit loss to the owner or seasonal sectors and a 7,000 net loss when physical losses exceeded additions.

- **High Rent:** This group includes all units with gross rents higher than the moderate rent cap. The "high rent" category gained 32,000 units. The flows within the rental stock were mostly balanced for this category, with a net outflow of 3,000. The "high rent" category

grew mostly because of a 28,000 excess of additions over physical losses. Net flows into and out of the owner and seasonal sectors was another 4,000-unit gain.

Although the Houston rental stock grew by 29,000, the "affordable rent" category declined by 42,000 units from 2015 to 2017.

Components of Inventory Change & Rental Dynamics: Houston 2015–2017

Section 1: Introduction

The U.S. Department of Housing and Urban Development (HUD) and the U.S. Census Bureau conduct the American Housing Survey (AHS), a large-scale survey of the housing stock that occurs in 2-year cycles. In addition to the approximate 50,000 units in the national-level survey, the AHS oversamples units in the 15 largest metropolitan areas. A separate metropolitan AHS draws samples in 20 of the 16th through 50th largest metropolitan areas. The samples from the 15 largest are collected every 2 years, while samples from the 20 areas are collected every 4 years (10 in one survey cycle and 10 in the next survey cycle). As a result, HUD and the U.S. Census Bureau are able to produce detailed portraits of the housing units and the households who inhabit them for 25 metropolitan areas every 2 years.

The AHS survey is longitudinal, which means that the same housing units are interviewed in each 2-year cycle. This special feature allows researchers to observe changes at the unit level. HUD has exploited this feature in a series of studies called Components of Inventory Change (CINCH), which explore how the national housing stock evolves between surveys, and a related series of studies called Rental Dynamics Analyses, which focus on the evolution of the rental stock (particularly affordable rental stock).

HUD is seeking to use longitudinality to examine how the housing stock evolves at the metropolitan level. This report, sponsored by HUD, uses CINCH and rental dynamics techniques to describe change in the Houston housing market between 2015 and 2017. The AHS samples from Houston are large enough to furnish reliable information on housing conditions in Houston. The 2015 sample contained 2,342 interviewed cases, and the 2017 sample contained 2,377 interviewed cases. Flows into and out of the Houston housing market, however, are small; losses to the 2015 housing market are represented by only 83 interviewed cases, and additions to the Houston housing market between 2015 and 2017 are represented by only 118 interviewed cases. Therefore, the level of detail and its precision are necessarily less than that found in the corresponding studies at the national level.

Section 1.1: Related Studies

Three related studies demonstrate the power of CINCH and rental dynamics analysis at the national level. Of particular importance, they contain relevant methodological background for this study of Houston.

- *Components of Inventory Change: 2015–2017* assesses changes in the U. S. housing market. Section 2.3: Units in Both Housing Stocks explains how CINCH is composed of two separate analyses: one that looks forward from 2015 to 2017 and one that looks back from 2017 to 2015. Appendix A explains how to read the classic forward-looking and backward-looking CINCH tables.

- *Rental Market Dynamics: 2015–2017* tracks changes in the U.S. rental market. Section 3: The Fundamental Structure of Rental Dynamics Analysis explains how the basic rental dynamics tables are constructed.

- *Weighting for CINCH and ental Dynamics* explains how the weights used in CINCH and rental dynamics analysis are constructed. The Research Goals and Methodological Issues section explains the methodology involved in CINCH analysis. Appendix B documents the weights used in this study.

All three reports are available online.[1]

Section 1.2: Organization

This report is organized as follows:

- Section 2 explains how the Houston housing stock grew from 2015 to 2017.

- Section 3 examines segments of the Houston housing market that underwent noteworthy changes.

- Section 4 shows how the Houston rental market changed.

There are three appendices:

- Appendix A contains the classic forward-looking and backward-looking CINCH tables for Houston.

- Appendix B contains loss rate, addition rates, t-statistics, and change rates for 96 overlapping segments of the Houston housing market.

- Appendix C presents the fundamental forward-looking and backward-looking rental dynamics tables for Houston.

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[1]HUD. *Components of Inventory Change (CINCH) Reports.* Retrieved from https://www.huduser.gov/portal/datasets/cinch.html.

Section 2: Houston Housing Stock: 2015–2017

Section 2.1: Background[2]

The Houston-The Woodlands-Sugar Land metropolitan statistical area is the fifth largest in the country, containing 2,425,500 households and 2,801,400 housing units in 2017. Its population grew from 4.7 million in 2000 to 5.9 million in 2010 and 7.0 million in 2017. The city of Houston is known as the energy capital of the world. The metropolitan area has four major ports; the Port of Houston processes the most foreign tonnage in the United States. Houston is also home to several important medical centers such as the Texas Medical Center, which is the largest in the world.

Houston experienced strong job growth in the early and mid-2000s but, along with the rest of the country, suffered through the recession of 2009–2010. Employment growth picked up in 2011 and ran through 2015. There was a small decline in employment in 2016 due to a fall in crude oil prices, but job growth picked up again in 2017.

Two hurricanes have had a huge effect on Houston. The aftermath of Hurricane Katrina in 2005 brought a large influx of people from New Orleans. Before 2005, net in-migration averaged 46,200 annually; in 2005, it increased to 128,200. Hurricane Harvey dumped 50 inches of rain on Houston in August 2017; however, it hit Houston late in the normal AHS data collection period, and its effects are only minimally picked up in the data used in the report.

Section 2.2: Growth in the Housing Stock, 2015–2017

Exhibit 2-1 identifies the basic mechanisms in Houston's housing stock growth. One contribution of CINCH analysis is to measure losses from the stock and additions to the stock. There is no other published information on losses, and the information on additions involve only new construction, not all additions.

Exhibit 2-1. Basic Mechanism in Houston's Housing Stock Growth

Source	Number
2015 Housing Stock	2,633,200
Losses From the Stock	80,200
2015 Units to 2017	2,552,900
Weight Adjustment	129,700
2017 Units From 2015	2,682,600
Additions to the Stock	118,800
2017 Housing Stock	2,801,400

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[2]This Background draws heavily from *Comprehensive Housing Market Analysis Houston, Texas*, found at https://www.huduser.gov/portal/publications/pdf/HoustonTX-comp-17.pdf.

CINCH uses different weights for forward-looking and backward-looking analyses; the fourth row in exhibit 2-1 is an adjustment based on the switch in CINCH weights.[3] This adjustment is interpreted as the "error" in CINCH's attempt to track the evolution of the stock from 2015 to 2017.[4] It means, in this case, that the AHS does not have sufficient information to identify and measure all additions.

Another contribution of CINCH is to identify and measure the different ways in which a unit can leave the stock. The AHS classifies losses as either temporary (the lost unit can return to the stock) or permanent (the lost unit cannot return to the stock with the same characteristics).[5] Exhibit 2-2 lists nine types of temporary losses and seven types of permanent losses and provides estimates for each. An estimate of "0" does not mean that Houston experienced no losses of that type; it means most likely that the sample (83 cases) was too small or that the followup to "not classified above" was incomplete.

Of the losses, 80 percent were temporary and only 20 percent considered permanent. The temporary designation does not mean that the unit will return to the stock; it only means that it potentially could return. Many temporary losses eventually become permanent. It is disappointing that a large majority of temporary losses (54,400 of 63,900) are listed as "not classified." When a unit is not occupied, it is difficult for U.S. Census Bureau field staff to learn why.

A third of the permanent losses (5,300 out of 16,900) involve the physical destruction of the unit. The movement of a mobile home is considered a loss because it involves the separation of the capital and the land that composed the original unit. Large numbers of permanent losses (3,800 and 2,700) are in the two "other" categories.

CINCH also identifies the various ways that units can enter the housing stock, but measurement is not precise even with larger samples. CINCH separates units that enter the stock into three groups. First, it counts units that were considered residential when sampled but were found in the 2015 survey to be out of the stock temporarily for one of the reasons listed in the top panel of exhibit 2-2. If these units are in the 2017 housing stock, they are considered additions. If a unit had not started construction or construction was not completed in 2015, CINCH labels them as "new construction" in 2017. Second, every year the U.S. Census Bureau adds to the AHS sample units from new entries in its Master Address File. All of these new addresses are considered new additions. If a newly sampled unit was built in 2010 or later, CINCH lists them as "new construction."[6] Third, if a newly sampled unit was built before 2010, CINCH lists them as "other additions" without clarifying how they were added. There are many possibilities; for example, an

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[3]CINCH weights have to measure losses accurately and sum to the 2015 stock and also measure additions accurately and sum to the 2017 stock; one set of weights cannot do both. The AHS also uses different weights to portray the 2015 and 2017 housing stock. If this analysis had used the AHS weights, the difference between 2015 and 2017 for these same 2,259 cases would have been 124,800.

[4]"Error" is appropriate in the sense that the needed adjustment would be close to zero if the original sample selection and weighting had been perfect and non-response introduced no biases, and if the sample added in 2017 accurately reflected all additions to the stock and was appropriated weighted.

[5]For example, when a unit is split in two, there are now two units in the stock but neither is the same as the original unit. The U.S. Census Bureau considers this case to be the loss of a unit and the addition of two units.

[6]The AHS does not have a variable that identifies new construction, and CINCH has to use "year built" to identify them. Unfortunately, concerns about protecting confidentiality caused the U.S. Census Bureau to group "year built" into categories, the most recent being "2010 and later."

older mobile home could have been moved to a new location, a new unit could have been created by splitting an older unit or by merging two older units, or a warehouse could have been converted into residential units.

Exhibit 2-2. Losses From the Houston Housing Stock, 2015–2017

Temporary Losses	Number
Permit granted, construction not started	0
Under construction, not ready	1,300
Permanent or temporary business or commercial storage	1,400
Unoccupied site for mobile home or tent	0
Other unit including non-staff, or converted to institutional unit	3,300
Occupancy prohibited	0
Interior exposed to the elements	1,300
Not classified above, structure type is not boat, RV, tent, cave, or railroad car	54,400
Not classified above, structure type is boat, RV, tent, cave, or railroad car	2,200
Subtotal	63,900
Permanent Losses	
Demolished or disaster loss	5,300
House or mobile home moved	2,700
Unit eliminated in structural conversion	0
Merged, not in current sample	2,400
Permit abandoned	0
Not classified above	3,800
Unit does not exist or unit is out of scope	2,700
Subtotal	16,900
Total Losses	80,800

Exhibit 2-3 contains all three groups and, where possible, breaks the group down into components. As in exhibit 2-2, a "0" means that the sample was probably too small to include examples of this type of addition or follow-up was not complete enough to move a case out of the "not classified above" groups.

Exhibit 2-3 shows a total of 119,100 additions—slightly higher, because of rounding, than the most reliable CINCH estimate of 118,800 in exhibit 2-1. New construction accounted for 101,500 additions. All of the new construction came from newly sampled cases; none were units unfinished in 2015. The CINCH report covering the entire nation found that the CINCH estimate of new construction probably overestimated new construction by roughly 25 percent at the expense of "other additions." There were 10,500 recovered units that had been temporary losses in 2015. Finally, there were 7,100 other additions—that is, newly sampled units built prior to 2017.

Exhibit 2-3. Additions to the Houston Housing Stock, 2015-2017

Additions by Source	Number
New Construction	**101,500**
Newly sampled units built 2010 or later	101,500
Uncompleted units in 2015	0
Recovered Units Temporarily Lost in 2015	**10,500**
Permanent or temporary business or commercial storage	0
Unoccupied site for mobile home or tent	800
Other unit including non-staff, or converted to institutional unit	400
Occupancy prohibited	0
Interior exposed to the elements	800
Not classified above, structure type is not boat, RV, tent, cave, or railroad car	5,600
Not classified above, structure type is boat, RV, tent, cave, or railroad car	2,900
Other Additions	**7,100**
Newly sampled units built before 2010	7,100
Total Additions	**119,100**

Section 3: Houston Housing Market Segments with Noteworthy Loss or Addition Rates or Changes in Characteristics

CINCH analysis typically looks at changes not only in the overall housing stock but also in interesting subsets of the housing market. Appendix A contains four forward-looking tables and four backward-looking tables that decompose the housing market in 96 overlapping segments. These segments are defined by unit characteristics such as structure type and size; by unit quality; by householder and household characteristics such as age, race, and household composition; and by tenure, housing costs, and household income.

This section looks across all 96 segments to see if any differed in noteworthy ways from the general housing stock in terms of rate of loss, rate of new additions, or the extent to which members of the segment adhered (between the 2015 and 2017 surveys) to the characteristics that define the segment. Appendix B contains loss rates, addition rates, and change rates for all the segments.

To avoid calling attention to numbers based on small sample sizes, the analysis uses a statistical test to compare the loss and addition rates of each segment to an overall rate, such as the loss rate for all units.[7] Exhibit 3-1 gives the loss rate and addition rates of the comparison groups.

Exhibit 3-1. Loss and Addition Rates of Comparison Segments

Segment	Loss Rate (%)	Addition Rate (%)
All housing units	3.0	4.4
All occupied units	2.4	4.0
All renter-occupied units	2.6	3.6
All owner-occupied units	2.2	4.3

Three percent of the 2015 Houston stock was lost by 2017—2.4 percent of occupied units, 2.6 percent of renter-occupied units, and 2.2 percent of owner-occupied units. None of these rates differed significantly from one another. With respect to additions, 4.4 percent of the 2017 housing stock were additions—4.0 percent of the 2017 occupied stock, 3.6 percent of the 2017 renter-occupied stock, and 4.3 percent of the 2017 owner-occupied stock. Again, none of these rates differed significantly from one another.

Change rates are the percent of a market segment in a given survey year that is in a different segment but still in the stock in the other survey year. Change rates can reveal insights into how the housing market operates, but one must interpret them cautiously. Not having the same characteristic may mean many things. For example, not being renter-occupied can mean being owner-occupied, vacant, or seasonal. The information on characteristics comes from interviews, and respondents can make mistakes.

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[7]The test used is a comparison of percentages. For various reasons, this is not the preferred test, but it is convenient and serves the purpose of differentiating among segments.

Section 3.1: Housing Characteristics

Vacant units and seasonal units have substantially higher loss rates and higher addition rates as well (see exhibit 3-2). The seasonal sector includes second homes—UREs (usual residence elsewhere) in AHS terminology. Three of these rates, all except the addition rate for seasonal units, would be considered significantly different than the rates for the entire housing stock. Both sectors have high change rates (between 60 and 80 percent), suggesting that vacant units move quickly out of the vacant status and that there is a great deal of movement between the seasonal sector and the other two sectors.

Exhibit 3-2. Loss and Addition Rates for Vacant and Seasonal Units

Segment	Loss Rate (%)	Addition Rate (%)
Vacant	8.2	7.9
Seasonal	17.7	12.5

While loss and addition rates vary with type of structure and building size, the sample sizes are too small to draw conclusions—the one exception being an exceptionally low addition rate (0.4 percent) among units in buildings containing two to nine units.

Section 3.2: Unit Quality

Small sample sizes are a particular problem with respect to unit quality. The report uses two measures of unit quality: the long-standing AHS adequacy measure and a simple count of how many problems out of a possible 20 a unit may have. In general, unit quality is so high in Houston that only 51 sample cases had the worst AHS adequacy score and only 7 of them became losses. Similarly, only 87 sample cases had 4 or more of the 20 problems and only 6 of them left the stock. For both measures, the loss rate rose as unit quality dropped, but only one of six results would be considered significant at the 0.10 level.

Change rates are interesting with respect to the quality measures. At the good end of both measures, the change rates are approximately 5 percent, meaning that good units tend to stay good. At the bad end of both measures, the change rates are 72 percent for the count measure and 91 percent for the AHS measure. This indicates that if bad units remain in the stock, they move to a less bad category in the next survey.

Section 3.3: Householder and Household Characteristics

In CINCH analysis of the national stock, the report concluded that there was no evidence that losses occur at higher rates among any groups defined by policy-sensitive characteristics such as age, race, ethnicity, or the presence or absence of children. This encouraging finding holds for Houston, but the observation of no evidence is helped by low sample sizes.

One statistically sound finding is that only 0.7 percent of the 2017 stock inhabited by households with householders 75 years old or older are new additions. This percentage compares to 4.0 percent for all occupied units. This result would appear to be due to the lower move rates among this cohort.

Section 3.4: Tenure, Housing Costs, and Household Income

The only notable finding in this category is the strong relationship between housing costs and addition rates for both owners and renters. For both renters and owners, the addition rate for low- and moderate-cost units are significantly lower than the addition rates for all renters and all owners, while the addition rates for high-cost units are significant and substantially higher.

Exhibit 3-3. Addition Rates and Housing Costs

Housing Costs	Addition Rates (%)	
	Renters	**Owners**
No-cash rent or HUD assisted	3.5	NA
Less than $800	0.9**	2.2*
$800–$1,249	1.0**	2.0*
$1,250 or more	10.2**	6.5*
All	3.6	4.3

*Significant at 0.05.
**Significant at 0.01.

Section 4: Houston Rental Housing: 2015–2017

The U.S. Census Bureau's Table Creator tool indicates that renter-occupied housing units in Houston grew from 889,200 in 2015 to 896,800 in 2017, an increase of only 7,600. At the same time, the median cash rent increased by 8.0 percent from $918 to $991. This section applies rental dynamics techniques to explain how rental housing in Houston changed from 2015 to 2017, with particular attention to the availability of affordable rental housing.

For this purpose, this report makes use of the Housing Affordability Data System (HADS), a component of the redesigned AHS created by HUD using AHS data. HADS has two advantages. First, it includes vacant for-rent units in the rental stock and imputes a total housing cost estimate to these vacant units. Total housing cost equals the sum of rent, utilities, and related costs, which is sometimes called gross rent. Second, it classifies all rental units into one of eight affordability categories. Because of the limited sample size, the report compresses the eight categories into three. Counting vacant units for rent, the Houston housing stock grew from 1,015,000 units in 2015 to 1,044,000 in 2017.

Section 4.1: Flows at the Rental Stock Level

Exhibit 4.1 tracks the flow of units out of and into the rental stock. While the net flows were small, the gross flows were large relative to the 29,000 increase in the housing stock. More than 100,000 units left the 2015 rental stock to become owner or seasonal stock, whereas more than 100,000 units from the 2015 owner and seasonal stocks became rental in 2017. The net inflow of rental units was -7,000. Forty-two thousand new rental units were added to the 2017 stock, whereas 32,000 rental units from the 2015 stock became temporary or permanent losses.

Exhibit 4-1. Flows into and Out of the Houston Rental Stock, 2015–2017

Rental units in 2015	1,015,000
2015 rental units to owner or seasonal stock in 2017	108,000
2015 rental units lost to the stock by 2017	32,000
2015 rentals to 2017 rentals	875,000
Forward-looking weights above	
Weight adjustment	24,000
Backward-looking weights below	
2017 rentals from 2015	900,000
2015 owner or seasonal stock to rental in 2017	101,000
Rental units added by 2017	42,000
Rental units in 2017	1,044,000
Gross flow into and out of rental stock (excludes weight adjustment)	283,000
Net inflow from owner or seasonal stock	-7,000
Net addition over losses	10,000

Note: Totals do not equal the sum of components due to rounding.

As explained earlier, different weights are used in the forward-looking and backward-looking analyses. A large percentage of the 2015 rental stock remained rental in 2017. The forward-looking

weights estimate these units at 875,000 in 2015. The backward-looking weights estimate these same units as 900,000 in 2017, a difference of 24,000 (rounded).

Section 4.2: Flows Within the Rental Stock

Using HADS, the report divides the rental stock into three affordability categories: affordable rent, moderate rent, and high rent. Affordability is a simple concept; it is the relationship between the gross rent (rent plus utilities and other related costs) and household income. If a unit's gross rent is less than 30 percent of income for a particular household, then the unit is said to be affordable for that household. In 2015, the median family income in Houston was $69,300; a family earning 50 percent of median family income would be able to afford a unit renting for approximately $870 (($69,300/12)*0.5*0.3) and a family earning 80 percent of median family income would be able to afford a unit renting for approximately $1,390 (($69,300/12)*0.8*0.3). The actual classification in the HUD data of units by affordability is complicated because it simultaneously takes household size into account when considering income and number of bedrooms when considering gross rent.

- **Affordable Rent:** This group includes HUD-assisted and no-cash rent units and all units with gross rents at or below the highest rent that a household earning 50 percent of the local family median income could afford.

- **Moderate Rent:** This group includes all units with gross rents higher than the affordable rent cap, but at or below the highest rent that a household earning 80 percent of the local family median income could afford.

- **High Rent:** This group includes all units with gross rents higher than the moderate rent

There were large flows among these three categories between 2015 and 2017. Exhibit 4-2 measures the gross flows.

Exhibit 4-2. Flows Among Affordable Categories[8]

Forward-looking analysis—2015 to 2017	Number
Flows to more affordable categories	101,000
Same category in 2017	844,000
Flows to less affordable categories	134,000
Net flows to more affordable categories	-33,000
Backward-looking analysis—2017 from 2015	
Flows from less affordable categories	104,000
Same category in 2015	658,000
Flows from more affordable categories	137,000
Net flows from less affordable categories	-33,000
Forward-looking gross flows	235,000
Weight adjustment	6,000
Backward-looking gross flows	241,000

[8] The weight adjustment is smaller in Exhibit 4-2 than in Exhibit 4-1 because it applies only to the units that remained in the same categories.

Whether measured using forward-looking or backward-looking weights, internal flows resulted in 33,000 rental units being in less affordable categories in 2017 than in 2015.

Section 4.3: Changes in Rental Stock at the Affordable Category Level

Exhibit 4-3 combines data on internal and external flows to explain the growth or decline of each affordability category and by summation, the entire Houston rental stock. Collapsing to three categories makes it easier to understand what is going on with respect to filtration (flows down to a less affordable category) and gentrification (flows up to a less affordable category). Only the "moderate rent" category can experience filtration and gentrification in two directions; that is, moderate-rent units can filter down to the "affordable rent" category, whereas high-rent units can filter down to the "moderate rent" category. For this category, net filtration can be either positive or negative. Filtration can be only positive for the "affordable rent" category and can be only negative for the "high rent" category.

The bottom two rows of exhibit 4-3 draw attention to how much activity took place within the rental stock despite the marginal overall growth in rental housing.

Exhibit 4-3. Changes From 2015 to 2017, by Affordability Category

	Affordable Rent	Moderate Rent	High Rent	Rental Stock
Rental units in 2015	294,000	482,000	239,000	1,015,000
Flows among affordable categories	-34,000	43,000	-3,000	6,000*
From less to more (filtration)	62,000	-3,000	-56,000	3,000
From more to less (gentrification)	-96,000	46,000	53,000	3,000
Net owner or seasonal to rental	-6,000	-5,000	4,000	-7,000
Net additions minus losses	-10,000	-7,000	28,000	11,000
Change in weight	8,000	8,000	2,000	18,000*
Rental units in 2017	252,000	521,000	271,000	1,044,000
2015–2017 change	-42,000	39,000	32,000	29,000
Absolute value of inflows and outflows (excludes weight changes)	248,000	297,000	215,000	760,000
Flows as percent of 2017 units	98.4%	57.0%	79.3%	72.8%

*The flows within the categories should cancel out to zero. The 6,000 is the weight adjustment from exhibit 4-2. The 24,000-unit weight adjustment from exhibit 4-1 is split in exhibit 4-3 into a 6,000 and 18,000 adjustment.

Here are the experiences of each of the three affordability categories:

- **Affordable Rent:** This category declined from 294,000 to 254,000. Gentrification was the primary reason the "affordable rent" category declined, accounting for 34,000 of the 42,000 decrease. The category also lost 6,000 units to the owner and seasonal sectors, and physical losses exceeded additions by 10,000.

- **Moderate Rent:** The "moderate rent" category gained 39,000 units. Although 3,000 more units filtered out of this category than filtered into it, it gained 46,000 units from net gentrification. This net inflow offset a 5,000-unit loss to the owner or seasonal sectors and a 7,000-unit net loss when physical losses exceeded additions.

- **High Rent:** The "high rent" category gained 32,000 units. The flows within the rental stock were mostly balanced for this category, with a net outflow of 3,000. This category grew

mostly because of a 28,000 excess of additions over physical losses. Net flows into and out of the owner and seasonal sectors was another 4,000-unit gain.

Although the overall rental stock grew by 29,000, the "affordable rent" category declined by 42,000 units. The Houston rental stock was less affordable in 2017. HUD's report to Congress on worst case housing needs provides a good discussion of how reduced affordability affects lower-income households.[9]

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[9]See the *Worst Case Housing Needs: 2019 Report To Congress* at https://www.huduser.gov/portal/publications/worst-case-housing-needs-2020.html.

Appendix A: CINCH Tables

Since 2000, CINCH studies have produced eight tables: four forward-looking tables and four backward-looking tables. Each set of four tables cover (A) housing characteristics, (B) housing quality, (C) householder and householder characteristics, and (D) tenure, housing costs, and household income.

When CINCH analysis is applied at the metropolitan level, the smaller sample sizes necessitate reducing the number of columns that explain where units go or where they come from and collapsing the categories (rows) that describe various unit and household characteristics.

CINCH does not allow some characteristics, such as structure type, year built, or stories, to change between survey years.

Appendix A in *CINCH: 2015–2017* explains how these tables are constructed and how to read them.

Forward-Looking Table A—Housing Characteristics (Rounded to Hundreds of Housing Units)

Row	Characteristics	Present in 2015	Present in 2017 With Same Characteristics	Present in 2017 With Different Characteristics	Temporary or Permanent Loss in 2017
1	Housing Stock	2,633,200	2,552,900	0	80,200
	Occupancy Status				
2	Occupied	2,373,200	2,121,200	195,600	56,400
3	Vacant	232,600	65,300	148,300	19,000
4	Seasonal	27,300	4,400	18,100	4,800
	Structure Type				
5	Single-family, detached	1,643,800	1,592,300	NA	51,500
6	Single-family, attached	183,500	179,200	NA	4,300
7	2- to 9-unit building	199,200	192,300	NA	6,900
8	10- to 19-unit building	182,100	178,200	NA	3,900
9	20-or-more-unit building	311,300	304,000	NA	7,300
10	Mobile home/manufactured/other	113,300	106,900	NA	6,400
	Year Built				
11	2010 or later	186,500	182,100	NA	4,400
12	2000–2009	610,800	596,800	NA	14,000
13	1990–1999	317,700	309,500	NA	8,200
14	1980–1989	410,800	400,000	NA	10,800
15	1970–1979	474,900	458,000	NA	17,000
16	1950–1969	467,400	448,900	NA	18,500
17	1949 or earlier	165,000	157,500	NA	7,400
	Number of Rooms				
18	3 or fewer rooms	280,600	7,900	266,100	6,600
19	4 rooms	432,000	217,900	200,200	13,900
20	5 rooms	501,900	222,300	262,000	17,700
21	6 rooms	560,300	256,800	279,800	23,700
22	7 rooms	364,400	159,000	195,700	9,800
23	8 or more rooms	494,000	164,100	321,300	8,600
	Number of Bedrooms				
24	None or 1 bedroom	402,700	3,400	389,300	10,100
25	2 bedrooms	588,700	474,300	92,700	21,700
26	3 bedrooms	939,100	777,500	125,900	35,600
27	4 or more bedrooms	702,700	612,700	77,200	12,800
28	**Multiunit structures**	692,600	674,500	NA	18,100
29	Stories: 1 or 2	455,700	444,400	NA	11,300
30	Stories: 3 or more	236,900	230,100	NA	6,800

Forward-Looking Table B—Housing Condition (Rounded to Hundreds of Housing Units)

Row	Characteristics	Present in 2015	Present in 2017 With Same Characteristics	Present in 2017 With Different Characteristics	Temporary or Permanent Loss by 2015
		A	B	C	D	E
1	Housing Stock	2,633,200	2,552,900	0	80,200
	AHS Adequacy Measure				
2	Adequate	2,433,700	2,250,800	117,200	65,600
3	Moderately inadequate	144,800	30,800	105,400	8,700
4	Severely inadequate	54,600	2,500	46,100	5,900
	Possible Unit Problems				
5	Unit cold for 24 hours at least once last winter	147,100	9,800	133,300	4,000
6	No working toilet at least once in last 3 months	67,600	3,800	58,300	5,500
7	Unit without running water at least once in last 3 months	105,900	13,600	91,300	1,000
8	Unit has no hot and cold running water	25,300	2,500	18,700	4,100
9	Unit had sewer breakdown at least once in last 3 months	61,500	5,300	54,100	2,100
10	Signs of rodents in last 12 months	202,200	62,000	135,200	4,900
11	Foundation has cracks or is crumbling	182,000	25,900	148,500	7,700
12	Holes in roof	50,100	13,900	33,600	2,600
13	Roof sags or is uneven	56,000	7,400	45,000	3,600
14	Outside walls missing siding or bricks	84,500	13,500	65,400	5,600
15	Outside wall leans, slopes, or buckles	43,900	6,900	32,300	4,800
16	Window(s) boarded up	59,300	10,400	44,000	4,900
17	Holes in floors	50,600	3,300	42,100	5,200
18	Water leak from outside in last 12 months	212,100	50,600	155,500	6,000
19	Water leak from inside in last 12 months	193,400	21,400	170,700	1,400
20	Mold present in last 12 months	105,900	13,700	90,700	1,400
21	Unit has no stove or range with oven	45,300	9,800	28,800	6,600
22	Unit has no working refrigerator	64,900	8,400	45,900	10,700
23	Unit has no kitchen sink	26,200	6,400	15,700	4,200
24	Unit does not have exclusive use of kitchen	14,900	2,600	11,500	800
	Count of Problems				
25	Two or fewer problems	2,423,200	2,236,800	117,800	68,600
26	Three problems	116,900	7,600	103,000	6,300
27	Four or more problems	93,000	21,000	66,800	5,300
	Water Source				
28	Public/private water	2,504,700	2,419,300	14,100	71,300
29	Well	125,300	108,800	8,400	8,100
30	Other water source	3,200	0	2,300	800

Row	A Characteristics	B Present in 2015	C Present in 2017 With Same Characteristics	D Present in 2017 With Different Characteristics	E Temporary or Permanent Loss by 2015
	Sewerage Treatment				
31	Public sewer	2,418,600	2,349,800	0	68,800
32	Septic tank/cesspool	187,400	133,200	45,100	9,000
33	Other, none, or no response	27,200	2,000	22,800	2,500

Forward-Looking Table C—Householder and Household Characteristics (Rounded to Hundreds of Housing Units)

Row	Characteristics	A	B Present in 2015	C Present in 2017 With Same Characteristics	D Present in 2017 With Different Characteristics	E Temporary or Permanent Loss by 2015
1	Occupied Units		2,373,200	2,121,200	195,600	56,400
	Age of Householder					
2	Under 65		1,984,300	1,830,500	102,700	51,100
3	65–74		224,500	148,300	72,700	3,500
4	75 or older		164,400	120,100	42,500	1,800
	Children in Household					
5	Children: Some		864,300	625,200	222,900	16,200
6	Children: None		1,509,000	1,299,300	169,400	40,300
	Race of Householder					
7	White alone		1,690,200	1,375,100	272,100	43,000
8	Black alone		485,800	337,400	137,000	11,300
9	Two or more races		197,200	154,900	40,200	2,100
	Ethnicity of Householder					
10	Hispanics		704,000	571,900	116,700	15,400
	Household Composition					
11	Married couple		1,235,700	965,600	250,000	20,100
12	Other family: Male householder, no wife		118,800	52,700	65,100	1,000
13	Other family: Female householder, no husband		289,900	156,200	121,600	12,100
14	Nonfamily: Male householder, living alone		295,600	140,300	141,100	14,200
15	Nonfamily: Male householder, not living alone		78,200	15,500	61,600	1,000
16	Nonfamily: Female householder, living alone		305,700	166,900	131,700	7,100
17	Nonfamily: Female householder, not living alone		49,300	15,100	33,200	1,000

Forward-Looking Table D—Tenure, Housing Cost, and Household Income (Rounded to Hundreds of Housing Units)

Row	A Characteristics	B Present in 2015	C Present in 2017 With Same Characteristics	D Present in 2017 With Different Characteristics	E Temporary or Permanent Loss by 2015
1	Occupied Units	2,373,200	2,121,200	195,600	56,400
	Tenure of Unit				
2	Owner occupied	1,417,100	1,278,000	107,800	31,300
3	Renter occupied	956,200	720,400	210,600	25,100
	Renter Monthly Housing Costs				
4	No-cash rent or HUD-assisted	67,700	37,800	27,500	2,500
5	Less than $800	292,500	129,800	155,400	7,200
6	$800–$1,249	380,000	223,100	148,400	8,400
7	$1,250 or more	216,000	113,000	96,000	7,000
	Renter Household Income				
8	Less than $30,000	390,800	182,500	198,000	10,300
9	$50,000 or more	220,600	46,700	170,000	3,900
10	$80,000 or more	344,800	123,000	210,900	10,900
	Owner Housing Costs				
11	Less than $800	468,800	251,200	203,000	14,600
12	$800–$1,249	282,800	104,300	172,000	6,500
13	$1,250 or more	665,500	455,900	199,400	10,200
	Owner Household Income				
14	Less than $59,999	551,600	301,900	234,000	15,700
15	$60,000–$99,999	329,500	117,600	206,500	5,400
16	$100,000 or more	535,900	324,900	200,800	10,300

Backward-Looking Table A—Housing Characteristics (Rounded to Hundreds of Housing Units)

Row	Characteristics	Present in 2017	Present in 2015 With Same Characteristics	Present in 2015 With Different Characteristics	Added by 2017
		B	**C**	**D**	**E**
1	Housing Stock	2,682,600	2,563,800	0	118,800
	Occupancy Status				
2	Occupied	2,425,500	2,143,100	185,000	97,400
3	Vacant	232,000	62,300	151,500	18,200
4	Seasonal	25,100	4,100	17,800	3,100
	Structure Type				
5	Single-family, detached	1,666,800	1,597,400	NA	69,400
6	Single-family, attached	111,300	103,600	NA	7,800
7	2- to 9-unit building	217,700	216,800	NA	1,000
8	10- to 19-unit building	196,300	189,900	NA	6,400
9	20-or-more-unit building	365,500	338,800	NA	26,700
10	Mobile home/ manufactured/other	124,900	117,400	NA	7,500
	Year Built				
11	2010 or later	309,800	204,700	NA	105,100
12	2000–2009	606,600	600,200	NA	6,400
13	1990–1999	320,300	318,600	NA	1,700
14	1980–1989	428,400	424,800	NA	3,600
15	1970–1979	469,300	469,300	NA	0
16	1950–1969	424,700	423,400	NA	1,300
17	1949 or earlier	123,600	122,800	NA	800
	Number of Rooms				
18	3 or fewer rooms	290,200	5,800	266,500	17,900
19	4 rooms	440,300	216,200	207,000	17,200
20	5 rooms	542,800	220,200	307,400	15,200
21	6 rooms	528,800	260,500	254,300	14,000
22	7 rooms	385,200	158,600	205,400	21,200
23	8 or more rooms	495,400	146,700	315,200	33,400
	Number of Bedrooms				
24	None or 1 bedroom	423,100	5,800	393,600	23,600
25	2 bedrooms	581,100	475,000	90,300	15,900
26	3 bedrooms	931,600	783,300	116,200	32,000
27	4 or more bedrooms	746,800	615,500	84,000	47,300
28	**Multiunit structures**	779,600	745,500	NA	34,100
29	Stories: 1 or 2	496,200	490,100	NA	6,100
30	Stories: 3 or more	283,400	255,300	NA	28,000

Backward-Looking Table B—Housing Conditions (Rounded to Hundreds of Housing Units)

Row	Characteristics	Present in 2015	Present in 2015 With Same Characteristics	Present in 2015 With Different Characteristics	Added by 2017
		A	B	C	D	E
1	Housing Stock	2,633,200	2,552,900	0	80,200
	AHS Adequacy Measure				
2	Adequate	2,433,700	2,250,800	117,200	65,600
3	Moderately inadequate	144,800	30,800	105,400	8,700
4	Severely inadequate	54,600	2,500	46,100	5,900
	Possible Unit Problems				
5	Unit cold for 24 hours at least once last winter	147,100	9,800	133,300	4,000
6	No working toilet at least once in last 3 months	67,600	3,800	58,300	5,500
7	Unit without running water at least once in last 3 months	105,900	13,600	91,300	1,000
8	Unit has no hot and cold running water	25,300	2,500	18,700	4,100
9	Unit had sewer breakdown at least once in last 3 months	61,500	5,300	54,100	2,100
10	Signs of rodents in last 12 months	202,200	62,000	135,200	4,900
11	Foundation has cracks or is crumbling	182,000	25,900	148,500	7,700
12	Holes in roof	50,100	13,900	33,600	2,600
13	Roof sags or is uneven	56,000	7,400	45,000	3,600
14	Outside walls missing siding or bricks	84,500	13,500	65,400	5,600
15	Outside wall leans, slopes, or buckles	43,900	6,900	32,300	4,800
16	Window(s) boarded up	59,300	10,400	44,000	4,900
17	Holes in floors	50,600	3,300	42,100	5,200
18	Water leak from outside in last 12 months	212,100	50,600	155,500	6,000
19	Water leak from inside in last 12 months	193,400	21,400	170,700	1,400
20	Mold present in last 12 months	105,900	13,700	90,700	1,400
21	Unit has no stove or range with oven	45,300	9,800	28,800	6,600
22	Unit has no working refrigerator	64,900	8,400	45,900	10,700
23	Unit has no kitchen sink	26,200	6,400	15,700	4,200
24	Unit does not have exclusive use of kitchen	14,900	2,600	11,500	800
	Count of Problems				
25	Two or fewer problems	2,423,200	2,236,800	117,800	68,600
26	Three problems	116,900	7,600	103,000	6,300
27	Four or more problems	93,000	21,000	66,800	5,300
	Water Source				
28	Public/private water	2,504,700	2,419,300	14,100	71,300
29	Well	125,300	108,800	8,400	8,100
30	Other water source	3,200	0	2,300	800

Row	A Characteristics	B Present in 2015	C Present in 2015 With Same Characteristics	D Present in 2015 With Different Characteristics	E Added by 2017
	Sewerage Treatment				
31	Public sewer	2,418,600	2,349,800	0	68,800
32	Septic tank/cesspool	187,400	133,200	45,100	9,000
33	Other, none, or no response	27,200	2,000	22,800	2,500

Backward-Looking Table C—Householder and Household Characteristics (Rounded to Hundreds of Housing Units)

Row	Characteristics (A)	Present in 2015 (B)	Present in 2015 With Same Characteristics (C)	Present in 2015 With Different Characteristics (D)	Added by 2017 (E)
1	Occupied Units	2,425,500	2,143,100	185,000	97,400
	Age of Householder				
2	Under 65	2,006,800	1,854,800	62,500	89,500
3	65–74	248,200	151,800	89,700	6,700
4	75 or older	170,500	123,200	46,000	1,300
	Children in Household				
5	Children: Some	904,600	630,600	237,700	36,300
6	Children: None	1,520,900	1,292,200	167,600	61,100
	Race of Householder				
7	White alone	1,651,300	1,382,400	216,300	52,500
8	Black alone	499,400	345,700	126,700	27,000
9	Two or more races	274,800	160,600	96,200	18,000
	Ethnicity of Householder				
10	Hispanics	749,700	571,400	155,200	23,100
	Household composition'				
11	Married couple	1,277,300	973,800	250,300	53,200
12	Other family: Male householder, no wife	144,900	53,600	87,300	4,000
13	Other family: Female householder, no husband	323,700	157,400	153,500	12,700
14	Nonfamily: Male householder, living alone	278,900	143,200	122,600	13,100
15	Nonfamily: Male householder, not living alone	69,900	15,200	50,300	4,400
16	Nonfamily: Female householder, living alone	276,600	168,000	99,800	8,800
17	Nonfamily: Female householder, not living alone	54,000	15,500	37,300	1,100

Backward-Looking Table D—Tenure, Housing Costs, and Household Income—Continued (Rounded to Hundreds of Housing Units)

	A	B	C	D	E
Row	Characteristics	Present in 2015	Present in 2017 With Same Characteristics	Present in 2017 With Different Characteristics	Added in 2017
1	Occupied Units	2,425,500	2,143,100	185,000	97,400
	Tenure of Unit				
2	Owner occupied	1,480,300	1,287,000	130,000	63,400
3	Renter occupied	945,100	731,700	179,400	34,100
	Renter Monthly Housing Costs				
4	No-cash rent or HUD assisted	69,600	37,800	29,400	2,400
5	Less than $800	214,000	130,700	81,400	1,900
6	$800–$1,249	411,600	226,800	180,500	4,300
7	$1,250 or more	249,900	115,500	108,900	25,500
	Renter Household Income				
8	Less than $30,000	386,500	183,500	194,600	8,500
9	$50,000 or more	219,300	46,800	169,200	3,200
10	$80,000 or more	339,300	126,700	190,300	22,300
	Owner Housing Costs				
11	Less than $800	426,900	255,200	162,500	9,200
12	$800–$1,249	324,100	105,400	212,300	6,400
13	$1,250 or more	729,300	456,700	224,900	47,700
	Owner Household Income				
14	Less than $59,999	527,700	305,500	211,600	10,600
15	$60,000–$99,999	356,900	118,200	222,500	16,100
16	$100,000 or more	595,800	328,200	230,900	36,600

Appendix B: Loss Rates, Addition Rates, t-Statistics, and Change in Characteristics Rate

The loss rates reported here were computed from the forward-looking tables in Appendix A, the additional rates were computed from the backward-looking tables in Appendix A, and the change rates were computed from all the tables in Appendix A.

The t-statistics were computed using the data from unweighted and weighted versions of the tables in Appendix A. The t-statistics are computed from a test of the difference of two percentages. The comparison percentages were for unit characteristics and unit quality, the percentages for all housing; for household and householder characteristics and for tenure, the percentages for all occupied units; and for housing costs and household income, the percentages for all renter-occupied units and for all owner-occupied units. The test of differences is not the preferred test because of the interrelationship because segments and for other reasons. However, this test does help sort through the data for the more meaningful findings.

CINCH does not allow some characteristics, such as structure type or year built, to change between AHS surveys.

Exhibit B-1. Loss Rates, Addition Rates, t-Statistics, and Rates of Change in Characteristics

Row	Market Segment	Forward-Looking			Backward-Looking		
		Loss Rate (%)	t-statistic	2015 Unit, Different in 2017 (%)	Addition Rate (%)	t-statistic	2017 Unit, Different in 2015 (%)
	Housing Characteristics						
1	Housing Stock	3.0	0.000	0.0	4.4	0.000	0.0
	Occupancy Status						
2	Occupied	2.4	-1.369	8.4	4.0	-0.684	7.9
3	Vacant	8.2	2.896	69.4	7.9	1.994	70.8
4	Seasonal	17.7	2.131	80.6	12.5	1.331	81.2
	Structure Type						
5	Single-family, detached	3.1	0.149	NA	4.2	-0.392	NA
6	Single-family, attached	2.3	-0.586	NA	7.0	0.993	NA
7	2- to 9-unit building	3.5	0.296	NA	0.4	-6.274	NA
8	10- to 19-unit building	2.1	-0.788	NA	3.3	-0.839	NA
9	20-or-more-unit building	2.3	-0.721	NA	7.3	1.928	NA
10	Mobile home/manufactured/other	5.6	1.153	NA	6.0	0.719	NA
	Year Built						
11	2010 or later	2.3	-0.537	NA	33.9	10.090	NA
12	2000–2009	2.3	-1.017	NA	1.1	-5.501	NA
13	1990–1999	2.6	-0.477	NA	0.5	-6.451	NA
14	1980–1989	2.6	-0.469	NA	0.8	-5.695	NA

Row	Market Segment	Forward-Looking			Backward-Looking		
		Loss Rate (%)	t-statistic	2015 Unit, Different in 2017 (%)	Addition Rate (%)	t-statistic	2017 Unit, Different in 2015 (%)
15	1970–1979	3.6	0.557	NA	0.0	-10.496	NA
16	1950–1969	4.0	0.900	NA	0.3	-8.165	NA
17	1949 or earlier	4.5	0.842	NA	0.6	-4.385	NA
	Number of Rooms						
18	3 or fewer rooms	2.4	-0.683	97.1	6.2	1.121	97.9
19	4 rooms	3.2	0.173	47.9	3.9	-0.499	48.9
20	5 rooms	3.5	0.505	54.1	2.8	-1.906	58.3
21	6 rooms	4.2	1.226	52.1	2.6	-2.092	49.4
22	7 rooms	2.7	-0.375	55.2	5.5	0.814	56.4
23	8 or more rooms	1.7	-1.800	66.2	6.7	1.802	68.2
	Number of Bedrooms						
24	None or 1 bedroom	2.5	-0.603	99.1	5.6	0.929	98.5
25	2 bedrooms	3.7	0.716	16.3	2.7	-2.045	16.0
26	3 bedrooms	3.8	0.994	13.9	3.4	-1.303	12.9
27	4 or more bedrooms	1.8	-1.880	11.2	6.3	1.815	12.0
28	**Multiunit structures**	2.6	-0.600	NA	4.4	-0.062	NA
29	Stories: 1 or 2	2.5	-0.672	NA	1.2	-4.795	NA
30	Stories: 3 or more	2.9	-0.160	NA	9.9	2.838	NA
	Housing Conditions						
	AHS Adequacy Measure						
2	Adequate	2.7	-0.702	5.0	4.4	-0.006	5.9
3	Moderately inadequate	6.0	1.432	77.4	3.4	-0.636	76.6
4	Severely inadequate	10.9	1.786	94.8	9.6	0.945	90.6
	Possible Unit Problems						
5	Unit cold for 24 hours at least once last winter	2.7	-0.225	93.1	3.2	-0.567	85.8
6	No working toilet at least once in last 3 months	8.1	1.444	93.8	1.8	-1.492	93.8
7	Unit without running water at least once in last 3 months	1.0	-1.927	87.1	1.0	-3.065	86.1
8	Unit has no hot and cold running water	16.2	1.818	88.1	9.0	0.674	84.6
9	Unit had sewer breakdown at least once in last 3 months	3.5	0.170	91.1	0.0	-10.496	84.2
10	Signs of rodents in last 12 months	2.4	-0.497	68.5	1.1	-3.841	70.8
11	Foundation has cracks or is crumbling	4.2	0.728	85.2	3.6	-0.470	81.0
12	Holes in roof	5.2	0.646	70.8	3.9	-0.208	72.5
13	Roof sags or is uneven	6.4	0.986	85.8	4.1	-0.093	81.1

Row	Market Segment	Forward-Looking			Backward-Looking		
		Loss Rate (%)	t-statistic	2015 Unit, Different in 2017 (%)	Addition Rate (%)	t-statistic	2017 Unit, Different in 2015 (%)
14	Outside walls missing siding or bricks	6.6	1.242	82.9	4.9	0.161	75.8
15	Outside wall leans, slopes, or buckles	10.8	1.581	82.4	5.3	0.224	81.7
16	Window(s) boarded up	8.2	1.382	80.9	7.9	0.848	77.9
17	Holes in floors	10.2	1.602	92.7	4.0	-0.144	90.9
18	Water leak from outside in last 12 months	2.9	-0.154	75.5	4.1	-0.196	77.2
19	Water leak from inside in last 12 months	0.7	-3.165	88.9	2.3	-1.681	87.9
20	Mold present in last 12 months	1.3	-1.417	86.8	2.9	-0.710	81.0
21	Unit has no stove or range with oven	14.6	2.266	74.6	8.0	0.747	65.2
22	Unit has no working refrigerator	16.5	2.996	84.6	12.7	1.664	77.4
23	Unit has no kitchen sink	15.8	1.819	71.1	8.7	0.671	63.0
24	Unit does not have exclusive use of kitchen	5.2	0.359	81.3	0.0	-10.496	80.8
	Count of Problems						
25	Two or fewer problems	2.8	-0.426	5.0	4.5	0.110	6.4
26	Three problems	5.4	1.064	93.1	3.2	-0.637	91.3
27	Four or more problems	5.7	1.041	76.1	3.7	-0.302	71.6
	Water Source						
28	Public/private water	2.8	-0.399	0.6	4.4	-0.114	0.5
29	Well	6.5	1.464	7.2	5.3	0.422	8.0
30	Other water source	26.3	0.914	100.0	16.9	0.744	100.0
	Sewerage Treatment						
31	Public sewer	2.8	-0.400	0.0	4.2	-0.356	2.3
32	Septic tank/cesspool	4.8	1.041	25.3	6.6	0.989	4.5
33	Other, none, or no response	9.1	1.066	92.1	27.1	1.613	71.7
	Household Characteristics						
	Age of Householder						
2	Under 65	2.6	0.384	5.3	4.5	0.667	3.3
3	65–74	1.6	-0.907	32.9	2.7	-1.172	37.2
4	75 or older	1.1	-1.426	26.1	0.7	-4.145	27.2
	Children in Household						
5	Children: Some	1.9	-0.845	26.3	4.0	0.000	27.4
6	Children: None	2.7	0.521	11.5	4.0	0.000	11.5
	Race of Householder						
7	White alone	2.5	0.311	16.5	3.2	-1.326	13.5
8	Black alone	2.3	-0.052	28.9	5.4	1.148	26.8
9	Other & two or more races	1.1	-1.509	20.6	6.5	1.510	37.5

Row	Market Segment	Forward-Looking			Backward-Looking		
		Loss Rate (%)	t-statistic	2015 Unit, Different in 2017 (%)	Addition Rate (%)	t-statistic	2017 Unit, Different in 2015 (%)
	Ethnicity of Householder						
10	Hispanics	2.2	-0.282	16.9	3.1	-1.146	21.4
	Household composition'						
11	Married couple	1.6	-1.463	20.6	4.2	0.198	20.4
12	Other family: Male householder, no wife	0.8	-1.595	55.3	2.8	-0.788	62.0
13	Other family: Female householder, no husband	4.2	1.397	43.8	3.9	-0.071	49.4
14	Nonfamily: Male householder, living alone	4.8	1.746	50.2	4.7	0.477	46.1
15	Nonfamily: Male householder, not living alone	1.3	-0.751	79.9	6.2	0.699	76.8
16	Nonfamily: Female householder, living alone	2.3	-0.046	44.1	3.2	-0.681	37.3
17	Nonfamily: Female householder, not living alone	2.0	-0.190	68.7	2.1	-0.867	70.6
	Tenure, Costs & Income						
	Tenure of Unit						
2	Owner occupied	2.2	-0.311	7.8	4.3	0.369	9.2
3	Renter occupied	2.6	0.383	22.6	3.6	-0.527	19.7
	Renter Monthly Housing Costs						
4	No-cash rent or HUD assisted	3.6	0.647	42.1	3.5	-0.265	43.8
5	Less than $800	2.5	0.088	54.5	0.9	-3.829	38.4
6	$800–$1,249	2.2	-0.180	40.0	1.0	-4.271	44.3
7	$1,250 or more	3.2	0.633	45.9	10.2	2.895	48.5
	Renter Household Income						
8	Less than $30,000	2.6	0.295	52.0	2.2	-2.039	51.5
9	$50,000 or more	1.7	-0.616	78.5	1.5	-2.576	78.3
10	$80,000 or more	3.2	0.724	63.2	6.6	1.665	60.0
	Owner Housing Costs						
11	Less than $800	3.1	0.810	44.7	2.2	-2.155	38.9
12	$800–$1,249	2.3	-0.086	62.2	2.0	-2.163	66.8
13	$1,250 or more	1.5	-1.362	30.4	6.5	2.325	33.0
	Owner Household Income						
14	Less than $59,999	2.8	0.564	43.7	2.0	-2.571	40.9
15	$60,000–$99,999	1.6	-0.897	63.7	4.5	0.399	65.3
16	$100,000 or more	1.9	-0.640	38.2	6.1	1.847	41.3

Appendix C: Rental Dynamics Tables

Exhibit C-1. Forward-Looking Rental Dynamics Analysis, Counts: 2015–2017

2015 Rental Stock	2015 Total	Non-Market, Extremely Low Rent, Very Low Rent in 2017	Low Rent, Moderate Rent in 2017	High Rent, Very High Rent, Extremely High Rent in 2017	Owner or Seasonal Stock in 2017	Lost to Stock by 2017
Non-Market, Extremely Low Rent, Very Low Rent	294,000	145,000	82,000	14,000	39,000	14,000
Low Rent, Moderate Rent	482,000	45,000	349,000	38,000	38,000	12,000
High Rent, Very High Rent, Extremely High Rent	239,000	15,000	41,000	146,000	31,000	6,000
Total	1,015,000	205,000	472,000	198,000	108,000	32,000

Exhibit C-2. Forward-Looking Rental Dynamics Analysis, Row Percentages: 2015–2017

2015 Rental Stock	2015 Total	Non-Market, Extremely Low Rent, Very Low Rent in 2017	Low Rent, Moderate Rent in 2017	High Rent, Very High Rent, Extremely High Rent in 2017	Owner or Seasonal Stock in 2017	Lost to Stock by 2017
Non-Market, Extremely Low Rent, Very Low Rent	294,000	49.3	27.9	4.8	13.3	4.8
Low Rent, Moderate Rent	482,000	9.3	72.4	7.9	7.9	2.5
High Rent, Very High Rent, Extremely High Rent	239,000	6.3	17.2	61.1	13.0	2.5
Total	1,015,000	20.2	46.5	19.5	10.6	3.2

Exhibit C-3. Backward-Looking Rental Dynamics Analysis, Counts: 2015–2017

2017 Rental Stock	2017 Total	Non-Market, Extremely Low Rent, Very Low Rent in 2015	Low Rent, Moderate Rent in 2015	High Rent, Very High Rent, Extremely High Rent in 2015	Owner or Seasonal Stock in 2015	Added by 2017
Non-Market, Extremely Low Rent, Very Low Rent	252,000	153,000	46,000	16,000	33,000	4,000
Low Rent, Moderate Rent	521,000	84,000	357,000	42,000	33,000	5,000
High Rent, Very High Rent, Extremely High Rent	271,000	13,000	40,000	148,000	35,000	34,000
Total	1,044,000	251,000	443,000	206,000	101,000	42,000

Exhibit C-4. Backward-Looking Rental Dynamics Analysis, Row Percentages: 2015–2017

2017 Rental Stock	2017 Total	Non-Market, Extremely Low Rent, Very Low Rent in 2015	Low Rent, Moderate Rent in 2015	High Rent, Very High Rent, Extremely High Rent in 2015	Owner or Seasonal Stock in 2015	Added by 2017
Non-Market, Extremely Low Rent, Very Low Rent	294,000	60.7	18.3	6.3	13.1	1.6
Low Rent, Moderate Rent	482,000	16.1	68.5	8.1	6.3	1.0
High Rent, Very High Rent, Extremely High Rent	239,000	4.8	14.8	54.6	12.9	12.5
Total	1,015,000	24.0	42.4	19.7	9.7	4.0

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