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A comprehensive approach**

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Measuring Population Estimates of Housing Insecurity in the United States: A Comprehensive Approach
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Abstract

This paper develops a simple comprehensive housing security scale based on a seven dimension definition of housing security set forth by Cox et al. (2017). We compare our scale to other common measures of housing insecurity and find that failing to use a comprehensive, multidimensional measure could result in substantial bias in prevalence rates of housing insecurity. We also find that while the categories overlap, they do not do so perfectly, such that one dimension, like housing affordability, can capture, or represent, all other dimensions. Location also seems to matter in expected ways. In particular, rural, exurban, and central city locations experience the most housing concerns across domains. Moreover, we find that failure to capture housing insecurity along a multidimensional scale might undercount housing-insecure households in certain locations. Finally, using the housing insecurity scale we develop, we find that single households, poor households (i.e., income less than two times the poverty line), black households, Hispanic households, undocumented immigrants, and less educated individuals experience more severe forms of housing insecurity. In addition, we find that older adults are also more likely to experience low housing security. This provides some validation that our measure is trending with well-established poverty measures.

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I. Introduction

To better describe and understand the condition of housing for U.S. households, Cox et al. (2017) propose a new definition of housing security to unify past concepts and develop a comprehensive measure that captures the multiple dimensions of housing. The new definition for housing security is the

“Availability of and access to stable, safe, adequate, and affordable housing and neighborhoods regardless of gender, race, ethnicity, or sexual orientation” (p. 6).

Likewise, housing insecurity can be defined as

“Limited or uncertain availability of stable, safe, adequate, and affordable housing and neighborhoods; limited or uncertain access to stable, safe, adequate, and affordable housing and neighborhoods; or the inability to acquire stable, safe, adequate, and affordable housing and neighborhoods in socially acceptable ways.” (Cox et al., p. 7, 2017)

The need for a new definition has been pointed out by previous research (e.g., Curtis and Geller, 2010; Leopold et al., 2017). The development of a consistent definition and instrument to measure food security in the U.S. has improved its estimation and has furthered evidence-based policy (Coleman-Jenson, 2015; Leopold et al., 2017). For housing, the above inclusive definition improves upon prior conceptualizations by capturing multiple facets of being housed. The new definition presents housing insecurity as a continuum of housing-related issues among seven dimensions -- housing stability, housing affordability, housing quality, housing safety, neighborhood safety, neighborhood quality, and homelessness – with homelessness being the most severe form of housing insecurity.

There are conceptual and methodological problems inherent in not having a unified definition and measure of housing security. Inconsistencies in definition may cause attenuation biases, where insecurity is undercounted. Underestimates may lead to funding shortfalls in alleviating conditions or root causes of housing insecurity. Definitional issues also belie accurate comparisons: to adequately compare levels of housing insecurity across time or across various groups, a standard definition is required. In a scan of 106 papers on the topic of housing insecurity, general definitions of what constitutes housing insecurity varied widely (Cox et al., 2017). In addition to definitional alignment, consistent measurement is necessary for adequate comparison. Inconsistent measurement may also lead to attenuation bias and omitted variable bias, where certain aspects of housing insecurity might be left out or mis-measured. Using the wrong approach for measuring housing insecurity may lead to policies or programs that address the wrong issues. Cox et al.'s (2017) literature review notes vastly differing measures of insecurity as a unified concept and even more different measures of its constituent parts, whether affordability, stability, or even homelessness. The lack of consistent measurement and definition has made comparative studies across geography or dimensions of insecurity both rare and difficult to carry out.

This paper builds on the new definition of housing security and insecurity, using its expanded dimensions to measure the prevalence of housing insecurity. This paper then compares the prevalence of the newly-defined insecurity to previous measurements and demonstrates undercounts and biases in past measures. In this paper, we measure the prevalence of the seven dimensions of housing insecurity (housing stability, housing affordability, housing quality, housing safety, neighborhood safety, neighborhood quality, and homelessness) using the 2005 version of the American Housing Survey. The 2005 version enables us to measure all seven

dimensions¹ and to compare to other measures in the 2000-2010 timeframe. The overall purpose of this paper is descriptive: we demonstrate differences in prevalence attained by a more inclusive measure of housing insecurity, compared to past, less comprehensive measures. Future work will determine the exact standardized methodology for measuring housing insecurity going forward.

To guide our work in this paper, we ask the following research questions:

- 1) What is the bias, if any, in prevalence estimates of housing insecurity from the failure to use a multidimensional measure of housing insecurity?
- 2) How do the categories of housing insecurity overlap with one another?
- 3) What are the characteristics of individuals that have multiple indicators of housing insecurity versus just one or two?
- 4) Does location (e.g., urban vs. rural) change the outcomes of prevalence measures?

Based on these research questions, we find that failing to use a comprehensive, multidimensional measure could result in substantial bias in prevalence rates of housing insecurity. We also find that while the categories overlap, they do not do so perfectly, such that one dimension, like housing affordability, can capture, or represent all other dimensions. Location also seems to matter in expected ways. In particular, rural, exurban, and central city locations experience the most housing concerns across domains. Moreover, we find that failure to capture housing insecurity along a multidimensional scale might undercount housing-insecure households in certain locations. For example, compared to other metropolitan statistical areas (MSA), rural households have much lower rates of housing affordability problems, but they have much higher rates of housing quality issues; if we were to solely focus on housing affordability, we would

¹ The measures of each dimensions are defined further in the paper. We believe that the AHS 2005 is adequate for measuring housing affordability, safety and quality; and neighborhood quality and safety. AHS 2005 can reasonably measure overcrowding, but not frequent moving, so housing instability is undermeasured using this dataset. Similarly, homelessness is likely undermeasured using the AHS 2005.

undercount housing-insecure rural households. Finally, using the scale we develop, we find that single households, poor households (with income less than two times the poverty line), black households, Hispanic households, undocumented immigrants, and less educated individuals experience more severe forms of housing insecurity. In addition, we find that older adults are also more likely to experience low housing security. This provides some validation that our measure is trending with well-established poverty measures.

We believe our measure marks a contribution to the field because up to this point there has not been a housing security scale that has captured all seven dimensions included in our definition within one index. Moreover, we compare and contrast the most common measures that have been used in the literature to understand how different definitions of housing insecurity impact prevalence rates. Finally, we investigate how our measure changes with various demographic characteristics and economic indicators to verify that our measure is in alignment with what we know about these indicators. The paper begins with a brief literature review, followed by a discussion of the data, the methodology used for deriving our housing insecurity instrument, and a presentation of our results. We conclude with a discussion of our core findings.

II. Literature Review and Past Measures of Housing Insecurity

The above definition of housing insecurity includes seven dimensions: housing stability, housing affordability, housing quality, housing safety, neighborhood safety, neighborhood quality, and homelessness. This paper is concerned with 1) how these dimensions are put together into one unified measure of housing insecurity and 2) how each individual dimension is measured. Cox et al. (2017) provides a comprehensive overview of the literature. Here we briefly summarize the key points and focus our discussion on those papers that estimate national

estimates of one of the dimensions we propose of housing insecurity, or a more comprehensive measure.

Out of 106 papers related to the topic, 16 directly use the term *housing (in)security*, but often mean different things, creating a plethora of dimensional combinations used to refer to housing insecurity. Tsui et al. (2011) have the most expansive measure of insecurity, including unaffordable or unsafe housing, unsafe neighborhoods, homelessness, experiencing a foreclosure or having been in housing court. In contrast, Curtis and Geller (2010), Geller and Franklin (2014)², Goldrick-Rab et al. (2015), and Warren and Font (2015) view insecurity as a combination of housing instability, unaffordability, and homelessness. Bailey et al. (2016) see insecurity as a housing stability and affordability issue. Buffardi et al. (2008) and Diette and Ribar (2015) see it as a combination of housing instability and homelessness. Others define insecurity as a mix of homelessness and poor housing quality (Rappaport Institute, 2015) and yet others think of it as a mix of homelessness and unaffordability (Surratt et al., 2015). Campbell et al. (2014), Greder et al. (2008), Liu et al. (2014), and Stahre et al. (2016) equate housing insecurity with unaffordability only, Cutts et al. (2001) and Frank et al. (2010) equate it with only housing instability, and Thurston et al. (2013) view it solely as unsafe housing. As a result of varying definitions, comparing housing insecurity levels across these studies is difficult. Moreover, many scholars define the measurement of their version of housing insecurity to a specific sub-population of interest, making comparisons impossible.

Though a comprehensive housing insecurity measure including all seven insecurity dimensions is heretofore unavailable, some studies do document the prevalence of specific

² Geller and Franklin (2014) also mention eviction as a component of housing insecurity

dimensions at the national level for the United States. We present them here for context to provide a basis of comparison for our proposed measures.

Homelessness

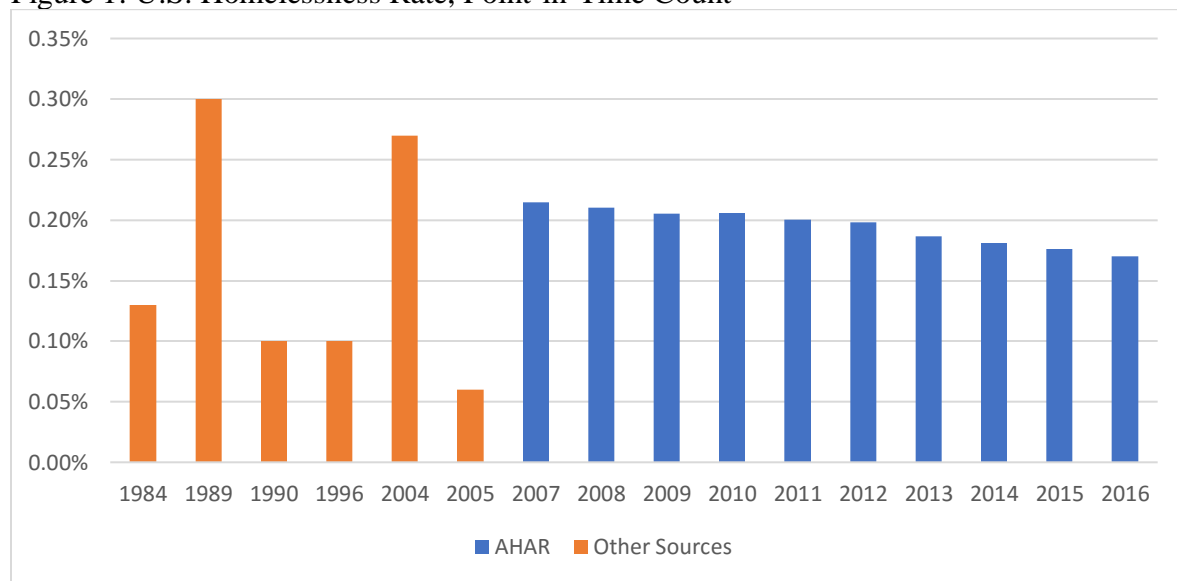
Of our seven housing insecurity dimensions, homelessness appears to have the most standardized measurement in the U.S, even though there is still disagreement on what constitutes homelessness. Homelessness is typically categorized in three ways: being homeless at the time of surveying, having been homeless at least one night throughout the survey year, and having ever been homeless. Since 2007, the U.S. Department of Housing and Urban Development (HUD) has conducted the Annual Homeless Assessment Report (AHAR) for Congress, which is an annual point-in-time (PIT) homeless count, measuring the number of literal homeless at the time of survey, throughout the country (Solari et al., 2015). The AHAR also documents homeless counts as performed by homeless services agencies, shelters, and transition centers (Solari et al., 2015). Figure 1 shows national estimates from AHAR and other sources prior to AHAR's inception in 2007.

The AHAR process standardized measurements and enabled adequate comparisons. This figure is a great illustration of how estimation of prevalence rates can improve once definitions are standardized. Prior to AHAR's introduction prevalence rates ranged from a high of roughly 0.3% to a low of about 0.06%. However, after the introduction of AHAR, prevalence rates stabilized ranging from roughly .22% to .2% from 2007 to 2012, with a continual drop in the prevalence rates from 2013 to 2016 to about .17%. Prior to AHAR, it is likely that differences in national estimates of homelessness were influenced by definitional differences versus actual differences in the prevalence of homelessness. And, while some may argue that AHAR only

captures one type of homelessness, literal homelessness, it is clear from Figure 1 that AHAR has helped to improve estimation of homelessness over time.

The prevalence of homelessness can also vary by the time-period over which it is defined and the unit of measurement (i.e., individual or household). For example, the point-in-time prevalence rate will be vastly different from prevalence rates measuring homelessness over 12 months or one’s lifetime. Specifically, prevalence estimates of individuals homeless at least once during a given year were 1.08% using the 1999 National Survey of Assistance Providers and Clients (NSHAPC) and 0.85 – 1.19% in 2004 using estimates from the Urban Institute and the Harvard Joint Center for Housing Studies (Kushel et al., 2005; NLCHP 2004). These studies occurred before AHAR’s inception and their definitions of homelessness may differ, possibly explaining the differences. Widening the measurement time period further, Link et al. (1994) estimated the U.S. ever homeless population as ~7-14% of the U.S. population. Thus, measurement time period is an important consideration in designing standardized measures.

Figure 1: U.S. Homelessness Rate, Point-in-Time Count



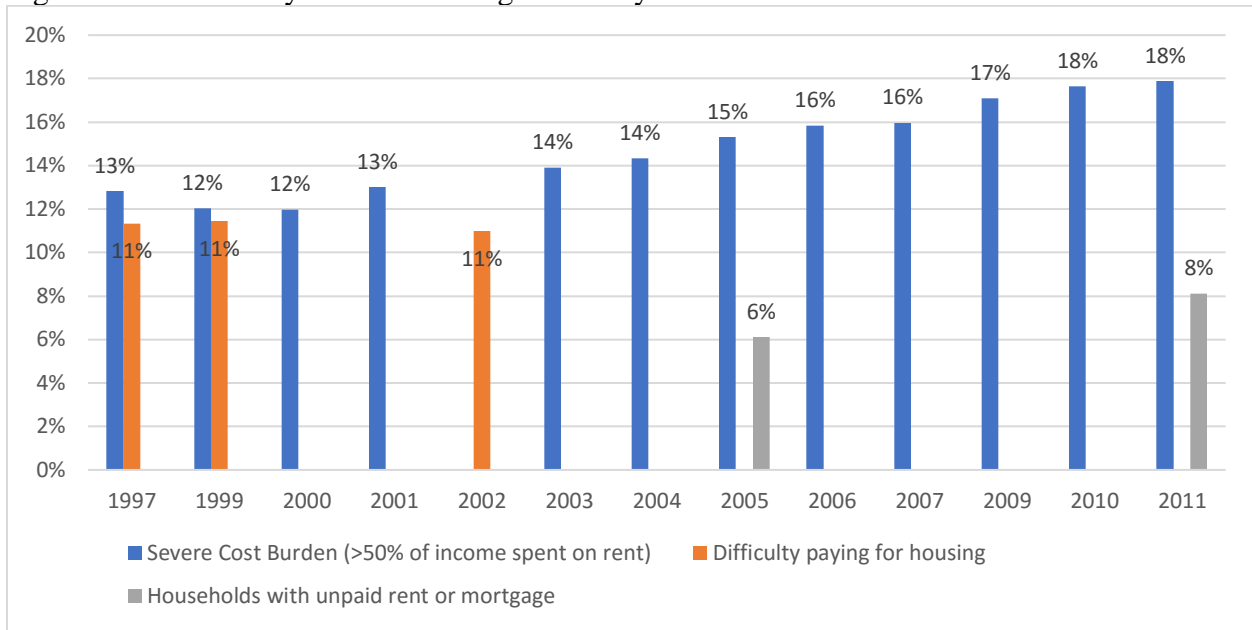
Source: U.S. HUD AHAR 2016 Report, exhibit 1.1; Honig & Filer (1993); Drake et al. (1989); Lee et al. (2010); National Law Center on Homelessness and Poverty (2004); Pearson et al. (2009)

Housing Affordability

Measures, and hence prevalence rates, vary among scholars documenting housing affordability issues. The most commonly used are whether a household demonstrates difficulty paying expenses for housing-related expenses such as rent, mortgage, or utilities, whether either rent or mortgage goes unpaid over a given time period, and whether housing cost presents a burden, defined as spending over a certain percentage (usually between 30 or 50%) of household income per month on housing. Other less common measures are whether a household has had or is having housing-finance-related legal issues, foreclosure, or whether one receives housing assistance through a government program. Figure 2 shows the national estimates for three most frequently utilized housing affordability measures over time. Depending on the statistic used, recent estimates vary from 6 to 18% of U.S. households who experience difficulties with housing affordability. Each statistic uses a different nationally representative dataset. Severe cost burden and difficulty paying for housing seem to trend closely in years where comparable data is available³. On the other hand, the statistic for unpaid rent or mortgage, measured using the U.S. Census Bureau's Survey of Income and Program Participation (SIPP), show rates twice as low as severe housing cost burden for the same years (Siebens, 2013).

³ Nationally reliable statistics on difficulty paying rent come from the National Survey of America's Families undertaken by the Urban Institute three times in 1997, 1999, 2002 and not since. We use the question "Did you have difficulty paying rent, mortgage or utilities?" asked of families and weight it to the U.S. population.

Figure 2: Affordability-related Housing Insecurity Estimates for U.S. Households 1997-2011



Sources: Joint Center for Housing Studies (2002, 2003, 2005, 2006, 2007, 2008, 2011, 2012, 2013); Urban Institute and Child Trends (NSAF) (1997, 1999, 2002); Siebens (SIPP) (2013)

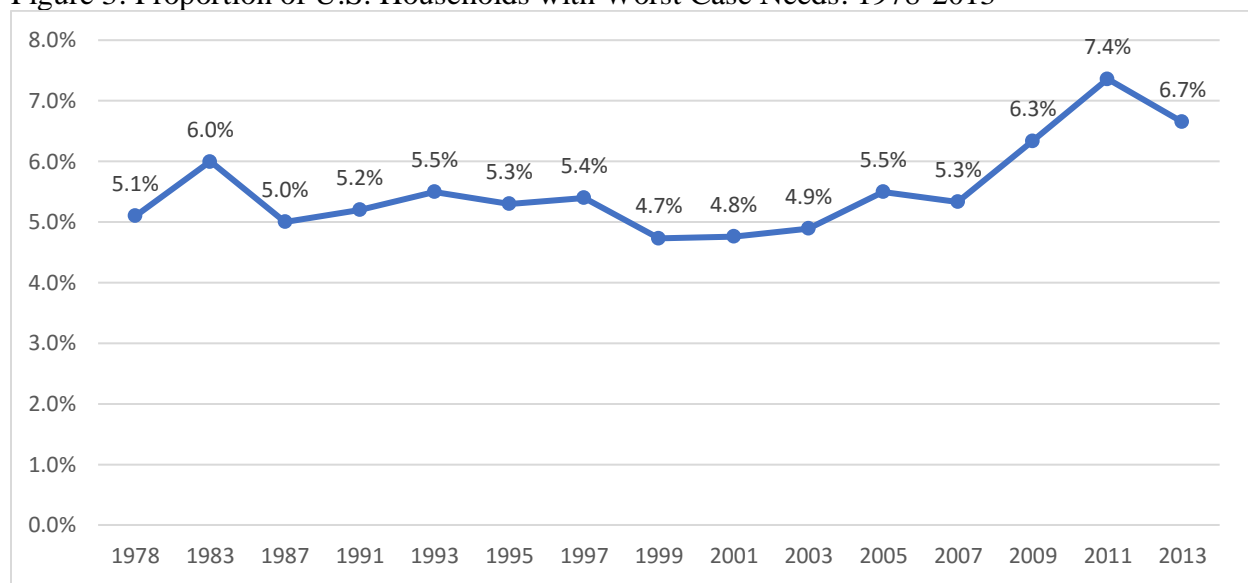
National Multidimensional Measures of Housing Insecurity

Few studies mention the dimensions of housing safety or quality and neighborhood safety or quality and national prevalence statistics for these are likewise difficult to find. Leopold et al. (2017) describe the difficulties in obtaining reliable and representative data on overcrowding, housing instability, housing quality, and neighborhood quality. They also point out the dearth of longitudinal data on these topics (Leopold et al., 2017). Prevalence of neighborhood issues is often measured for only one neighborhood, one city, or one region, and definitions and measurements vary.

One alternative for housing quality and safety is the AHS, which provides a variety of statistics, though these have not been used to publish national prevalence statistics, outside of the Worst Case Housing Needs summaries. Since 1978, HUD has released a biennial report to

Congress documenting the “Worst Case Housing Needs” based on the biennial American Housing Survey (AHS) data. Eligible U.S. households for this designation are those who are renters, have incomes below 50% of area median income, *and* do not receive housing assistance. Of these, households are counted as having Worst Case Needs if they have severe rent burdens (paying more than 50% of income toward rent) *or* severely inadequate housing quality in terms of heating, plumbing, electrical systems, or maintenance (HUD, 2015). Worst Case Housing Needs at the national level have hovered between 4.5 and 6% for most years, rising to 7.4% in 2011 in the aftermath of the Great Recession (Figure 3). The Worst Case Housing Needs reports provide a start to a national measuring of housing insecurity, including the housing affordability and quality dimensions. However, this measure does not include the remaining dimensions (neighborhood quality and safety, housing safety, instability, and homelessness) and it does not survey the whole population of households, rather focusing on the poor, renters, and those who do not receive housing subsidies.

Figure 3: Proportion of U.S. Households with Worst Case Needs: 1978-2013



Source: U.S. HUD Worst Case Needs Report 2015 Exhibit 1-4; U.S. HUD Worst Case Needs Report 2005; U.S. HUD Trends in Worst Case Needs for Housing, 1978-1999

Aside from HUD's "Worst Case Housing Needs" Reports, Siebens' (2013) U.S. Census Bureau report material well-being is the only report that takes steps toward a national snapshot of housing insecurity prevalence in 2011. The author shows that 3.4%, 2.6%, and 6.7% of U.S. households had poor housing quality, lived in unsafe housing, and lived in unsafe neighborhoods, respectively. Moreover, the author recommends summarizing a measure of hardship across nine indicators, five of which could qualify as housing-related: difficulty meeting essential expenses, not paying rent or mortgage, getting evicted, not paying utilities, having utilities cut off, having phone service cut, not seeing a doctor when needed, not seeing a dentist when needed, or not always having enough food (Siebens, 2013). According to Siebens' measure, in 2011, 78% of households faced zero hardships, 9% faced one hardship, and 3% faced three or more hardships (Siebens, 2013). This measure bears some similarity to our proposed measure of housing insecurity but focuses on overall material well-being instead of developing a comprehensive measure of housing insecurity, and while the report looks at various dimensions of housing insecurity that we have incorporated in our analysis, the focus of the report is not solely on the development of a measure of housing insecurity. Therefore, Siebens' scale captures both housing and non-housing measures of well-being of U.S. households.

A different approach which looks at the effects of housing and neighborhood quality on mental health was undertaken by Wright and Kloos (2007). This approach measured three levels of housing and environment variables among residents of supportive housing programs for the mentally ill across 34 housing sites in 10 cities in one U.S. state, for a total sample of 249 (Wright and Kloos, 2007). Self-reported data on apartment quality, neighborhood quality, and neighborhood social climate was obtained using the Housing Environment Survey. Housing data

was validated by an observer using the Housing Environment Rating Scale and neighborhood-level data was supplemented by census tract demographic and socioeconomic data from the 2000 census (Wright and Kloos, 2007). Well-being was measured using four outcome variables: psychiatric distress, orientation to recovery, residential satisfaction, and adaptive functioning. The study found that neighborhood-level variables explained more variance in well-being than either apartment or census-tract level variables. Wright and Kloos (2007) presents an important finding and buttresses the case for including neighborhood-level variables in a measure of housing security. The study, however, does not take into account considerations of housing affordability and stability, which are key components of housing insecurity present in many other studies. Additionally, it is a local sample for a sub-population, which may not readily generalize to the U.S. population as a whole.

From our review of the literature, it is evident that various approaches have been taken to define housing insecurity and to measure its prevalence in the U.S. nationally. These approaches provide a step in the right direction, but fall short of the unified definition of housing insecurity and its seven dimensions proposed in Cox et al. (2017). The remainder of this paper develops an overall measure of housing insecurity and its constituent dimensions based on our definitions, using the AHS 2005 national dataset. These measures are then contrasted with the prior estimates presented in the literature review.

III.Data

This paper uses the AHS 2005 national dataset to propose a comprehensive measure of housing insecurity and its dimensions. Since 1973, HUD has been conducting a housing survey in “two parts: a national sample of housing units from urban and rural areas to be examined every year, and metropolitan area samples from 60 selected Standard Metropolitan Statistical

Areas (SMSAs), including the largest and many of the smaller, fast growing, with one-third of them to be examined in detail every third year” (Schwartz, 2009 p.1). The surveys were annual until 1981 and biennial afterwards. The national survey sample size has remained steady, with around 60,000 housing units sampled and 52,850 interviewed in 2007 (Schwartz, 2009). Results are weighted based on the national and metropolitan level surveys, enabling a national estimate for all resulting statistics. Data is collected on a broad range of topics about the housing unit: unit quality, unit description, geography, housing cost, household composition, income, neighborhood, utilities, recent movers, commuting⁴, mobile homes, upgrading and remodeling, and income limits (Econometrica, 2015). In certain years, specialized sections of the survey are added on particular topics, such as lead-based paint, healthy homes, housing modification, public transportation, disaster planning, doubling up, and New Orleans-specific variables following Hurricane Katrina (Econometrica, 2015). We choose the 2005 version of the AHS for two reasons: it has the largest number of variables available for our seven dimensions of housing and it is readily comparable to prevalence statistics in the 2005 timeframe. The measures we design will be adaptable to other AHS years.

We use AHS 2005 data to measure the prevalence of each of the seven dimensions, using the definitions and AHS variables described in Table 1. For neighborhood and housing quality and safety, we measure a broad battery of potential housing unit or neighborhood issues. We differentiate between safety and quality in terms of severity: an issue is one of safety if it leads to imminent health threats and one of quality if it does not comply with modern definitions of what is acceptable. For housing affordability, we choose housing burden as our measure, which is available in the AHS, instead of reported difficulty in paying for housing, which is not in the AHS. We believe that housing burden is both a broader measure than difficulty in paying for

⁴ The commuting section was eliminated in 2011 and subsequent surveys.

housing (Siebens 2013) and broader measures are more in line with our definition of housing insecurity. For housing instability, we use overcrowding as a proxy for doubling up, moving in with relatives, or temporarily living with another household. Overcrowding is measured using a housing stress technique (see Table 1) (Clark and Ledwith, 2006). We do not have data to measure multiple moves, short durations, living in unstable conditions, evictions, being forced out, or other tenets of housing instability. As a result, our findings on housing instability will likely undercount actual prevalence. Similarly, we measure homelessness using the AHS definition for data consistency reasons. Since the AHS is a sampled survey and not a population count, our prevalence rates may differ from AHAR or other point-in-time counts. Nevertheless, we believe our AHS-based approach for all seven dimensions represents the broadest and fullest attempt to document housing insecurity prevalence in the U.S.

Table 1: Housing Insecurity Dimensions and Measurements

#	Dimension of Housing Insecurity	Measurement
1	Housing Instability	Percentage of households living in overcrowded conditions. Overcrowding is defined as housing stress in total rooms, bedrooms, and bathrooms, defined as the difference between actual and required rooms following the PSID (Clark and Ledwith, 2006). Two rooms (<i>rooms</i>) are allocated for each household head with or without a spouse, one room for every additional married couple or single person over 18 years old, and one room for every 2 children; similar approach for bedrooms (<i>bedrms</i>). Bathroom (<i>baths, halfb</i>) need is calculated as one per every four household members.
2	Housing Affordability⁵	Housing burden: ratio of annualized housing costs (<i>zhsmc</i>) to household income (<i>zinc2</i>).
3	Housing Safety	Households who report a housing issue that presents imminent health threats among the following: unit is cold due to inadequate heating capacity (<i>whycd2</i>) or

⁵ We use housing cost burden as our measurement of housing affordability, because other measures are not widely available and reliable in the AHS. An alternative measure could be a respondent's difficulty paying rent or mortgage. The AHS does ask a subset of renters "do you receive help with rent payments?" (variable *rcost*). However, only 13,000 of the full 69,020 sample get asked this question and only 2.2% of 13,000 responded that they receive aid with rent. We do not believe this is a complete population-level measure of difficulty paying for housing, even for renters. Hence, we choose to use housing cost burden as a more widely available and reliable AHS measure.

		<p>inadequate insulation (<i>whyd3</i>); loose, broken or missing steps in common stairs (<i>badstep</i>); holes, cracks or crumbling in the foundation (<i>ecrumb</i>); holes in roof (<i>eholer</i>); sagging or uneven roof surface (<i>esagr</i>); outside walls slope, lean, slant or buckle (<i>eslopw</i>); evidence of rodents in unit (<i>evrod</i>); unit cold for 24+ hours to the point that it was uncomfortable (<i>freeze</i>); holes in floor (<i>holes</i>); fuses blown or circuit breakers tripped (<i>ifblow</i>); exposed electrical cords (<i>nowire</i>); water leak in roof (<i>rleak</i>); water unsafe for drinking and cooking (<i>waters</i>); main heating equipment is a wood-burning stove, a cooking stove, or an unvented room heater burning gas, oil or kerosene (<i>hequip</i>)</p>
4	Housing Quality	<p>Households who report a housing issue that represents sub-standard housing by modern standards, but does not represent an imminent health threat among the following: no bathroom sink in unit (<i>bsink</i>); no working built-in cooking burners (<i>burner</i>); no working cookstove/oven (<i>cook</i>); no working elevator (<i>elev</i>); roof is missing shingles/roofing materials (<i>emissr</i>); outside walls missing siding/bricks/etc. (<i>emissw</i>); no hot and cold running water in unit (<i>hotpip</i>); main heating equipment broken down (<i>ifcold</i>); unit completely without running water (<i>ifdry</i>); sewage system broken down (<i>ifsew</i>); toilet breakdowns in the last 3 months (<i>iftlt</i>); indoor water leaks in last 12 months (<i>ileak</i>); lacking complete kitchen facilities in unit (<i>kitchen</i>); outdoor water leaks in last 12 months (<i>leak</i>); no hallway lights working (<i>ltsok</i>); main heating equipment broke down for 6+ hours 8+ times (<i>numcold</i>); water stopped for 6+ hours 8+ times (<i>numdry</i>); sewage system broken for 6+ hours 8+ times (<i>numsew</i>); toilet broken for 6+ hours 8+ times (<i>numlt</i>); some rooms lack working electrical plugs (<i>plugs</i>); plumbing facilities are incomplete or not for unit's exclusive use (<i>plumb</i>); unit unconnected to a public sewer (<i>pubsew</i>); no working refrigerator (<i>refr</i>); sewage disposal is classified as an outhouse/privy, other, or none (<i>sewdis</i>); unit lacks a flush toilet (<i>toilet</i>); unit lacks tub or shower (<i>tub</i>); commercial bottled water is the source of water for the unit (<i>water</i>) and its drinking water (<i>waterd</i>); unit is cold due to utility interruption (<i>whyd1</i>); dissatisfied with building maintenance [renters only] (<i>blmmt</i>) and grounds maintenance [renters only] (<i>grdmnt</i>); low satisfaction of unit as a place to live (2 points out of 10 or below) (<i>howh</i>); unit quality is cumulatively inadequate (<i>zadeq</i>)</p>
5	Neighborhood Safety	<p>Households who report living in a neighborhood that presents imminent health threats or safety among the following: factories or other industry is located within ½ block of unit (<i>ecom2</i>); trash or junk in streets or properties within ½ block of unit (<i>ejunk</i>); neighborhood smells are bothersome (<i>odorb</i>) or are so bad that moving is preferred (<i>odorc</i>); street noise and traffic are bothersome (<i>strnb</i>) or are so bad that moving is preferred (<i>strnc</i>);</p>

		neighborhood has crime (<i>crimea</i>); abandoned or vandalized buildings within ½ block of unit (<i>eaban</i>); windows covered with metal bars (<i>ebar</i>); buildings with bars on windows within ½ block of unit (<i>ebarcl</i>); unit is in a flood plain (<i>floodpln</i>); unsatisfactory neighborhood police protection (<i>satpol</i>)
6	Neighborhood Quality	Households who live in neighborhoods with undesirable characteristics, and low access to services and amenities nearby, but do not represent an imminent health or safety threat among the following: bothersome undesirable neighborhood/property (<i>badprp</i>); bothersome people in neighborhood (<i>badper</i>); bothersome poor city/county services (<i>badsrv</i>); unit is boarded up (<i>boardu</i>); windows boarded up (<i>eboard</i>); windows broken (<i>ebroke</i>); no businesses/institutions within ½ block (<i>ecoml</i>); no open spaces within ½ block (<i>egreen</i>); roads within ½ block need repairs (<i>eroad</i>); railroad, airport, or four-lane highway within ½ block (<i>etrans</i>); bothersome litter in neighborhood (<i>litter</i>); bothersome noise in neighborhood (<i>noise</i>); neighborhood has bad smells (<i>odora</i>); neighborhood has other bothersome problems (<i>othnhd</i>); no stores within 15 minutes (<i>shpcls</i>); heavy street noise/traffic in neighborhood (<i>strna</i>); low rating of neighborhood as a place to live (2 points out of 10 or below) (<i>hown</i>)
7	Homelessness	Percentage of households who define housing type at the time of interviews as either tent, cave, railroad car, unspecified housing unit, a boat, an RV, or an unoccupied site for a mobile home, trailer or tent. (<i>type</i>)

AHS Variables listed in *italics*. See Econometrica (2015) for additional specifics on variables.

Based on these definitions, Table 2 provides national-level prevalence rates for each housing insecurity dimension. We find a 0.3% homeless rate, 1.1 to 6.0 times greater than others’ estimates, perhaps because the AHS variable includes more uninhabitable domiciles than others. Our measure of severe housing burden (over 50% of income spent on housing) is 15.5% for all households and 13.3% for adults aged 18-64, not far from others’ estimates of 14% in 2001 and 17% in 2010. We also calculate housing burden at the more traditional 30% cutoff, which is more than double the 50% cutoff measure for adults and the total population.⁶ About 2% of all

⁶ In the remainder of this paper, we use both 50% -- severe housing burden and 30% -- housing burden statistics for housing affordability. The 30% cutoff has been used to understand whether households qualify for various housing-related programs and assistance at various levels of government (Pivo, 2013). As the proportion of those

households report overcrowding and this number is slightly higher (2.5%) for adult households. We do not have an adequate basis for comparison for overcrowding or for other measures of housing instability. We find that a large proportion of households report at least one issue related to housing and neighborhood quality and safety, well above those reported in Siebens (2013). In the next section, we will explore these dimensions in greater detail.

Table 2: Prevalence of Housing Insecurity by Dimension in the U.S.

#	Housing Security Domains	U.S. Population		Sample	
		All	Adults (ages 18-64)	All	Adult (ages 18-64)
1	Housing Stability (overcrowding)	1.9%	2.5%	1.3%	2.6%
2	Housing Affordability				
	<i>housing burden >30%</i>	33.3%	31.5%	33.5%	31.5%
	<i>housing burden >50%</i>	15.5%	13.3%	15.2%	13.3%
3	Housing Quality	48.2%	49.5%	34.8%	49.0%
4	Housing Safety	37.7%	41.9%	27.1%	41.7%
5	Neighborhood Safety	33.8%	37.1%	24.5%	37.0%
6	Neighborhood Quality	64.6%	72.6%	46.5%	72.4%
7	Homelessness	0.3%	0.3%	1.1%	0.3%

U.S. population estimates based on AHS Survey Responses and Population Weights

IV. Designing and Comparing Potential Measures of Housing Insecurity

Previously, we proposed seven domains that could form a housing insecurity index. In this section, we develop multiple indices for housing insecurity (based on our seven domains) as both a categorical scale and a continuous index. We explore the various domains of housing insecurity and how prevalence rates might change based on which domains are used to form the housing insecurity instrument, and we explore the association between the various domains.

with a 30% cutoff has grown, the 50% cutoff has been seen by some as a better reflection of severe housing affordability issues (Pivo, 2013). We utilize both cutoffs in this paper, and indicate which is used for each scale or index.

Finally, we investigate the distribution of these domains in different types of geographic locations and demographic characteristics. We begin by investigating various dichotomous definitions of housing insecurity based on the seven housing insecurity domains.

Categorical Scales of Housing Insecurity

One possible categorical housing insecurity scale would count a household as insecure if it experienced at least one of the seven domains of housing insecurity. For example, a household can be defined as insecure based on having just one of a variety of potential housing-related issues. Four possible versions of such “Categorical Measures” are shown in Table 3.

We begin by exploring the prevalence rates using a binary measure of housing insecurity that we found throughout the literature. This scale, known as Index A in Table 3, defines housing insecurity as housing affordability, stability, and homelessness and shows that 35.5% of U.S. households experience problems within at least one of these domains. This rate fits in between prior findings using the same three dimensions in population-specific samples. For example, Curtis and Geller (2010) find insecurity rates of 17-25% with homelessness accounting for 1-3% among a sample of previously incarcerated fathers, while housing insecurity rates of 18% were found among a sample of urban mothers using 20 cities in the Fragile Families and Child Well-Being Study (Geller and Franklin, 2014). Warren and Font (2015) find a higher pooled insecurity rate, 41.4%, among mothers of children ages 3 and 5, using the same Fragile Families dataset. In a sample of community college students in 7 U.S. states, housing insecurity was found to be 52-65% (Goldrick-Rab et al., 2015). While our data provide estimates for the U.S. population, our prevalence rates fall between estimates we found for specific at-risk subpopulations.

Throughout Table 3, we explore various combinations of our 7 domains to broadly define a housing insecurity index, each of which estimates a different prevalence rate for housing insecurity. It is clear that as more domains are added to the index, the prevalence rate increases to above 80% of U.S. households. Index B, which includes the five dimensions of housing stability, housing quality, housing safety, neighborhood quality, and neighborhood safety, yields an 85.2% prevalence rate. While Index C, which adds the domain of affordability, increases the rate to 88.9%, adding homelessness (Index D) does not meaningfully change the prevalence rate. This provides some evidence that, except for homelessness, the more common definition of housing insecurity (Index A) found in the literature, is underestimating the prevalence of housing problems in America by leaving out the domains of housing quality, neighborhood safety, and neighborhood quality. Narrowing the measurement to only working age adults drives Indices B, C, and D up by about three percentage points. These numbers may seem gargantuan, but they in part reflect the fact that we are using a more comprehensive definition of housing insecurity, the additive nature of these indices, and the fact that many American households struggle with at least one issue embedded in these seven dimensions of housing insecurity.

Table 3: Comparison of Various Proposed Additive Measures of Housing Insecurity Prevalence for U.S.

#	Categorical Measure	U.S. Population		Sample	
		All	Adults (ages 18-64)	All	Adult (ages 18-64)
A	Housing Affordability, Stability, and Homelessness	35.5%	34.3%	35.9%	34.3%
B	Housing Stability, Quality, Safety; Neighborhood Safety, Quality	85.2%	88.8%	62.2%	88.7%
C	Housing Affordability, Stability, Quality, Safety; Neighborhood Safety, Quality	88.9%	92.2%	64.8%	92.1%

D	Housing Affordability, Stability, Quality, Safety; Neighborhood Safety, Quality, Homelessness	88.9%	92.3%	65.4%	92.1%
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Nationally, based on AHS Survey Responses and Population Weights

Continuous Scales of Housing Insecurity

While indices A-D in Table 3 provide a categorical representation of the issue, they do not tell us the number of dimensions experienced by a household. To address this, we design a multi-dimensional continuous index of housing insecurity (Table 4), where each household is counted according to the number of housing insecurity dimensions it experiences within our scale. This measure finds that over one fifth, over one quarter, and over one fifth of U.S. households experience one, two, and three dimensions in our housing insecurity scale, respectively, accounting for about 70% of all households. In contrast, only 12.8% of households experience four issues and 4.4% experience five or more issues. Nonetheless, consistent with our findings in table 3, only 11.1% of total households are completely housing secure (i.e., 0 reported categories). In reviewing the literature, only Siebens’ (2013) study takes such a multi-dimensional approach at the national level, although her study focused on overall material well-being not housing. Using the U.S. Census Bureau’s Survey of Income and Program Participation (SIPP) that study finds that 9.4%, 5.9%, and 6.3% of households experience one, two, or three or more dimensions of material hardship, with 78.3% experiencing none (Siebens, 2013). Siebens’ broader measure and indirect focus on housing likely explains the divergent results.

Table 4: Number of Domains Reported for the Proposed Multi-Dimensional Measure of Housing Insecurity for U.S.

Number of Insecurity Domains Reported	U.S. Population		Sample	
	All	Adults (ages 18-64)	All	Adult (ages 18-64)
0	11.1%	7.7%	34.6%	7.9%
1	23.6%	20.5%	18.3%	20.6%

2	26.0%	27.0%	19.0%	27.1%
3	22.1%	24.6%	15.9%	24.4%
4	12.8%	14.7%	9.1%	14.6%
5	4.2%	5.3%	3.0%	5.2%
6	0.2%	0.2%	0.1%	0.3%
7⁷	0%	0%	0%	0%
Total	100%	100%	100%	100%

Nationally, based on AHS Survey Responses and Population Weights

A second approach to constructing a continuous index would be to capture the number of housing insecurity subcategories that households face in each of the seven housing insecurity domains. Table 5 shows the housing insecurity domains with more than one subcategory cross-tabulated by the number of constituent issues within domains for the AHS variables enumerated for each dimension in Table 2, weighted up to all U.S. households. This approach seeks to determine in which dimension do households experience most of their problems. We find that very few households are experiencing overcrowding, but a significant number are experiencing problems with neighborhood quality, housing quality, housing safety and neighborhood safety. It is important to note that these statistics do not *directly* pick up behavioral responses to housing insecurity. In all, households were more likely to report neighborhood quality issues (66%) than any other domain, followed by housing quality (52%). Very few households reported more than three subcategories in any domain and none reported meaningful prevalence of seven or more issues.

Table 5: Cross-tabulation of Number of Issues per Housing Insecurity Dimensions for All Households

Number of issues	Housing Stability (overcrowding⁸)	Housing Quality	Housing Safety	Neighborhood Safety	Neighborhood Quality
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⁷ In the AHS dataset, homeless individuals do not pay rent, by definition, due to the lack of a housing unit for which to pay rent. Therefore, the same survey respondent can not be both homelessness and facing housing unaffordability. This explains why no respondents were housing-insecure in all seven categories.

⁸ Overcrowding is defined as not having enough rooms, bedrooms, or bathrooms based on the number of reported housing unit residents. Doubling up is not measurable using our current dataset.

per category					
0	98%	52%	62%	66%	35%
1	1%	31%	25%	19%	34%
2	1%	10%	8%	8%	21%
3	0%	3%	3%	4%	7%
4	0%	2%	1%	2%	2%
5	0%	1%	1%	1%	1%
6	0%	1%	0%	0%	0%
7	0%	0%	0%	0%	0%
8	0%	0%	0%	0%	0%
9	0%	0%	0%	0%	0%
10	0%	0%	0%	0%	0%
11	0%	0%	0%	0%	0%
12	0%	0%	0%	0%	0%
13	0%	0%	0%	0%	0%
14	0%	0%	0%	0%	0%
15	0%	0%	0%	0%	0%
Total	100%	100%	100%	100%	100%

Weighted by U.S. population (AHS 2005)

Interaction between Housing Affordability and the Other Housing Insecurity Domains

Our next hypothesis states that households who are more financially burdened may also be more likely to experience other housing insecurity factors; otherwise, if issues of neighborhood quality or housing safety were so pertinent, and households had the means, why would they not move⁹? Put differently, we are interested in understanding whether our seven housing insecurity domains are simply captured by the domain of housing affordability. If so, then there would be no need to define multiple dimensions of housing insecurity if it could be captured within one domain of housing affordability. To test this hypothesis, we calculate the association of housing insecurity domains on increased housing burden, using an ordered logistic

⁹ Perhaps the decision not to move in these cases are mediated by family ties and employment, even when in the absence of financial limitations

regression¹⁰. We find that the probabilities of being insecure on 4 or 5 dimensions are the highest for households who are housing burdened, but lowest for being insecure on 2 or 3 dimensions (Table 6). This suggests, given that the plurality of households experience 2 or 3 dimensions when compared to 4 or 5, that focusing on housing affordability will cause us to undercount individuals who are experiencing housing insecurity across fewer domains.

Table 6: Predicted Probability of Housing Burden on the Number of Insecurity Domains Covered¹¹.

Housing Affordability	Number of Housing Insecurity Domains Covered ¹¹					
	0	1	2	3	4	5
Severely Housing Burdened (housing burden over 50%)	0.17	0.15	0.15	0.14	0.19	0.22
Housing Burdened (housing burden 30-50%)	0.19	0.18	0.17	0.17	0.2	0.22
Not Housing Burdened (housing burden below 30%)	0.64	0.67	0.68	0.69	0.61	0.56
All Households	1.00	1.00	1.00	1.00	1.00	1.00

Based on an ordered logistic regression using AHS 2005 household respondents who reported an income. Likelihood Ratio and Brant tests are not significant, signaling that the parallel regression assumption has not been violated and that the relationship between each pair of outcome groups is the same

We next test how specific housing insecurity domains are associated with increases in housing burden. Using an ordered logistic regression¹², we find that the remaining five¹³ housing insecurity domains generally predicts a 15-18% probability of experiencing severe housing burden (greater than 50% of income spent on housing). For those households who spend 30-50% on housing, the results are similar: 17-20% have an issue in another domain. The differences across dimensions are very small. Nonetheless, the results suggest that those who are

¹⁰ See Appendix 1: “Ordered Logistic Regression Model 1” for details

¹¹ In the AHS dataset, homeless individuals do not pay rent, by definition, due to the lack of a housing unit for which to pay rent. Therefore, the same survey respondent can not be both homeless and facing housing unaffordability. This explains the maximal number of dimensions being 5 for this analysis.

¹² See Appendix 1: “Ordered Logistic Regression Model 2” for details

¹³ As stated previously, in the AHS dataset, homeless individuals do not pay rent, by definition, due to the lack of a housing unit for which to pay rent. Therefore, the number of dimensions for this analysis is 5.

experiencing housing insecurity through the housing and neighborhood quality domains are less likely to be in the housing-burdened or severely housing-burdened category relative to the not housing burdened category. This makes sense if individuals have behavioral responses to housing insecurity such that they are willing to trade some housing and neighborhood quality for greater housing affordability.

Table 7: Predicted Probability of Housing Burden by Type of Insecurity Domains

Housing Affordability	Number of Housing Insecurity Domains Covered ¹⁴				
	Housing Stability (Overcrowding)	Housing Quality	Housing Safety	Neighborhood Safety	Neighborhood Quality
Severely Housing Burdened (housing burden over 50%)	0.18	0.15	0.16	0.18	0.15
Housing Burdened (housing burden 30-50%)	0.2	0.18	0.19	0.19	0.17
Not Housing Burdened (housing burden below 30%)	0.62	0.67	0.65	0.63	0.68
All Households	1.00	1.00	1.00	1.00	1.00

Based on an ordered logistic regression using AHS 2005 household respondents who reported an income. Likelihood Ratio and Brant tests are not significant, signaling that the parallel regression assumption has not been violated and that the relationship between each pair of outcome groups is the same

Geographic Location and Housing Insecurity Domains

Urban theory may predict that households living in older, central city neighborhoods may face more housing quality or neighborhood safety issues (e.g., Rosenthal 2008, Rosenthal 2014). Additionally, housing costs may be higher in central cities or suburbs, relative to rural or exurban areas, without proportionally higher compensation. We find that more central city and suburban households are housing burdened compared to rural, small town, and exurban area households, nationwide (see Table 8).

¹⁴ In the AHS dataset, homeless individuals do not pay rent, therefore, this category is omitted from our analysis.

Table 8: Housing Burden by Location Type for All Households

Location Type	Severely Housing Burdened (housing burden over 50%)	Housing Burdened (housing burden 30-50%)	Not Housing Burdened (Housing burden below 30%)
MSA - Central City	17%	18%	65%
MSA - Suburban	14%	17%	69%
MSA - Rural	10%	13%	77%
Non-MSA - Urban	12%	14%	74%
Non-MSA - Rural	8%	11%	81%
All Locations	13%	16%	71%

Weighted up to U.S. Population (AHS 2005)

There may be geographic differences across dimensions as well. For example, rural housing may be expected to be in worse quality and its inhabitants to have less ability to move or upgrade their housing. In contrast, suburban residents may be expected to have lower overall housing insecurity. From the AHS 2005, we find that over 40% of households in rural (non-MSA-Rural), exurban (MSA-rural), and urban (MSA- Central City) areas more frequently experience 3 or more types of housing insecurity dimensions. As a corollary, households in suburbs, central cities, and small towns have the most households with no housing insecurity issues.

Table 9: Number of Housing Insecurity Dimensions by Location Type for All Households

Number of Housing Insecurity Dimensions¹⁵	MSA - Central City	MSA - Suburban	MSA - Rural	Non-MSA - Urban	Non-MSA - Rural	All Locations
0	13%	15%	6%	12%	4%	11%
1	23%	27%	20%	26%	19%	24%
2	23%	26%	28%	27%	28%	26%
3	21%	18%	28%	20%	30%	22%
4	14%	10%	14%	12%	15%	13%
5	6%	3%	3%	4%	3%	4%
6	0%	0%	0%	0%	0%	0%
	100%	100%	100%	100%	100%	100%

Weighted up to U.S. Population (AHS 2005)

¹⁵ The AHS does not count homeless individuals as paying rent, hence no household will have all 7 dimensions of insecurity.

We next differentiate the types of housing insecurity by geographic location. Urban households are most likely to report live in overcrowded conditions, yet this only amounts to 3 percent of all urban households. Urban households are most likely to report affordability and neighborhood safety issues. In contrast, rural households in and outside of metropolitan areas report high prevalence of neighborhood quality and housing quality issues. Small town residents report neighborhood quality challenges, but fewer housing quality issues than rural households.. These findings reinforce the need for a multidimensional housing security scale, a measure that is too narrowly defined (e.g., only housing affordability) might lead to an underestimation of housing insecurity across the other domains (such as housing quality and safety).

Table 10: Housing Insecurity Dimensions by Location Type, for All Households Weighted up to U.S. Population (AHS 2005)

Housing Insecurity Dimensions	All Households	MSA - Central City	MSA - Suburban	MSA - Rural	Non-MSA - Urban	Non-MSA - Rural
Housing Stability (overcrowding)	2%	3%	2%	1%	1%	1%
Housing Affordability (Housing Cost to Income Ratio > 30%)	29%	35%	31%	23%	26%	19%
Housing Quality	48%	40%	36%	66%	38%	77%
Housing Safety	38%	40%	33%	38%	37%	43%
Neighborhood Safety	34%	47%	29%	26%	33%	28%
Neighborhood Quality	65%	56%	58%	80%	70%	78%
Homelessness	0%	0%	0%	0%	0%	0%

Categorical Definitions of Housing Insecurity Measures across Sub-Populations

Not all households face housing insecurity along the same dimensions or their constituent issues. To better compare across households and to take a first stab at the development of a nationally-representative measure, we define degrees of housing security. We propose two different categorical measures, one based on the dimensions of housing security and the other

based on a continuous variable of the number of reported housing issues. Table 10 lays out the specific definitions. The *continuous* variable amalgamates all issues across all dimensions (see Table 1) and measures overall housing concerns reported by households, regardless of whether they deal with the characteristics of the household, housing unit, or the neighborhood. This scale would have a minimum value of zero and a maximum value of 80. The *categorical* scale defines housing insecurity in two ways: 1) based on the number of domains experienced, and 2) the number of housing problems counted along the housing insecurity continuum. Specifically, a household is housing secure if they have zero reported problems along the continuum or across the seven housing domains. In contrast, households are counted as moderately housing secure if they have a cost burden below 50%, are not literally homeless, and have issues in one of the remaining domains or have less than one standard deviation of individual housing concerns (3 or fewer issues) along the continuum. Households are considered to have low housing security if they are not homeless but experience one of the following: 1) a housing cost burden of over 50%, 2) housing problems across 2-3 of the remaining domains, or 3) between 1-2 standard deviations of individual housing concerns (4-6 issues) along the continuum. Finally, households are classified as having very low housing security if they fall into one of the following categories: 1) are literally homeless, 2) have issues in 4, 5 or 6 dimensions, or 3) greater than two standard deviations of individual housing concerns (greater than 6 issues) along the continuum.

Table 11: Housing Insecurity Severity Definitions

Housing Insecurity Definition	Categorical Definition 1 Based on Number of Dimensions	Categorical Definition 2 Based on the Continuous Variable
Housing Secure	0 dimensions and cost burden below 30%	0 individual issues, not literally homeless, cost burden <50%
Moderate Housing Security	Cost burden less than 50%, not literally homeless, 1 other dimension	Number of individual issues below 1 standard deviation (1-3 issues), not literally homeless, cost burden

		<50%
Low Security	2-3 dimensions or cost burden more than 50%, but not literally homeless	Number of individual issues between 1-2 standard deviations (4 – 6 issues), or cost burden > 50% (0-6), not literally homeless
Very Low Security	4-6 dimensions, or literally homeless	Number of individual issues above 2 standard deviations (greater than 6 issues) or literally homeless

Table 12: Housing Insecurity Severity Results

Housing Insecurity Definition	Categorical Definition 1 Based on Number of Dimensions	Categorical Definition 2 Based on the Continuous Variable
Housing Secure	11%	11%
Moderate Housing Security	22%	44%
Low Security	50%	32%
Very Low Security	17%	13%

Using these definitions, we find that 11% of households are housing secure using the categorical measure 1 and 11% using categorical measure 2 across the whole AHS 2005 sample (Table 12). An additional 22% are marginally secure using the categorical measure 1 and 44% using categorical measure 2 (Table 12). This implies that households experience a higher breadth, rather than depth of housing-related issues, suggesting that if a multidimensional approach is taken, we will need to determine whether the breadth of issues should define housing security, the depth of the issues, or both. Note that these two measures use the same underlying data but one shows almost twice the proportion of secure plus marginally secure households as the other based on their definitions. These findings underscore the importance of an agreed-upon scale for a topic as important as housing security.

Next, we use the two housing insecurity categorical measures and compare them by a panel of demographic characteristics. Each of the demographic characteristics' categorical

housing insecurity measures are calculated and subtracted from the average from all households, results are displayed in Table 13 with differences larger than 1 and 2 standard deviations from the mean highlighted. We note that the demographic characteristics with significant differences between the categorical and continuous measurements move in the same direction. Moreover, we see the same pattern in the data regardless of how we define (based on domains or number of housing concerns) the categorical variables. We find that older adult households are more likely to have fewer individual housing concerns based on the continuous measure, but nevertheless are associated with having a low housing security according to the categorical scale based on the number of dimensions, or breadth. We find that households who are separated or have an absent spouse are strongly associated with lower housing security using both measures. Single and widowed households also show some association with lower housing security. As expected, households with incomes less than two times the poverty level have lower housing security and greater housing insecurity (both low and very low security). Specifically, households below the poverty line show much higher levels of low and very low housing insecurity compared to all households. Households between 1 to 2 times the poverty line also face differentially low housing security, but slightly better than those below the poverty line. Households for whom income is not listed in the AHS tend to have much fewer housing security issues. This provides some support that our indices seem to be tracking economic indicators of wellbeing. Renters tend to have lower housing security than owners. Black and Hispanic households both tend to have lower than average housing security on both measures. There are no major differences by gender. Foreign-born non-citizens have lower housing insecurity. Households headed by persons without a high-school degree or GED have higher rates of low and very low housing security.

Households headed by persons with educational attainment above a bachelor's degree are associated with higher housing security on the continuous measure.

Table 13: Housing Insecurity Continuous and Categorical Measurement for All Households weighted up to U.S. population (AHS 2005) and Differences from Mean by Demographic Category

	<u>Categorical Definition 1: Based on Housing Domains (add to 100%)</u>				<u>Categorical Definition 2: Based on Continuous Variable Measurement of Housing Insecurity (add to 100%)</u>				
	Housing Secure	Moderate Housing Security	Low Housing Security	Very Low Housing Security	Housing Secure	Moderate Housing Security	Low Housing Security	Very Low Housing Security	AHS 2005 Sample Size
All Households									
All Households	11%	22%	50%	17%	11%	44%	32%	13%	69,020
Differences from Mean by Demographic Category									
Older Adults (age>65)	-3%	-2%	7%*	-2%	-3%	0%	7%	-5%^	9,279
Adult age (18-64 years old)	-3%	-3%	3%	3%	-3%	0%	2%	2%	33,842
Married, spouse present	-3%	0%	5%	-1%	-3%	5%	0%	-2%	22,167
Widowed	-4%	-4%	8%*	1%	-4%	-4%	12%*	-3%	4,823
Divorced	-4%	-5%	3%	6%	-4%	-3%	4%	3%	6,607
Single	-3%	-5%	1%	7%*	-3%	-6%	4%	5%*	7,797
Separated or Married with absent spouse	-5%*	-7%*	2%	11%*	-5%*	-9%*	8%*	6%*	1,966
Below poverty line	-8%*	-15%**	5%	18%**	-8%*	-26%**	27%**	8%**	6,069
1x-1.25x the poverty line	-9%*	-12%**	6%*	14%**	-9%*	-16%**	19%**	5%*	2,021
1.25x - 1.5x the poverty line	-8%*	-8%*	6%*	10%*	-8%*	-7%*	11%*	4%*	1,882
1.5x - 2x the poverty line	-7%*	-8%*	7%*	8%*	-7%*	-5%	8%*	5%*	3,804
2x - 3x the poverty line	-5%	-3%	5%	2%	-5%	2%	1%	2%	7,200
>3x the poverty line	0%	3%	2%	-5%	0%	9%^	-6%	-4%	22,384
No income information reported	23%^^	18%^^	-27%^^	-14%^^	23%^^	0%	-21%^^	-2%	25,660
Owner of housing unit	-3%	-1%	5%	-1%	-3%	4%	1%	-2%	34,248
Renter of housing unit	-5%	-6%*	1%	10%*	-5%	-8%*	7%	6%*	14,507
Children present in	-4%	-4%	3%	5%	-4%	-2%	4%	3%	15,137

household									
White only	-3%	-2%	4%	1%	-3%	1%	3%	-1%	36,041
Black only	-5%	-6%*	2%	9%*	-5%	-8%*	6%	7%*	4,939
Asian only	0%	0%	2%	-2%	0%	1%	3%	-4%^	1,423
Hispanic / Latino	-4%	-6%*	-2%	12%*	-4%	-8%*	6%	6%*	4,800
Male	-2%	-1%	4%	0%	-2%	3%	1%	-1%	24,197
Female	-4%	-5%	4%	5%	-4%	-4%	6%	2%	19,163
Native, born in the US	-4%	-2%	5%	1%	-4%	1%	3%	0%	37,150
Native, born in Puerto Rico or other US territory	-3%	-2%	-2%	6%	-3%	-2%	2%	3%	897
Foreign born, naturalized citizen	-1%	-2%	2%	1%	-1%	-1%	5%	-3%	2,439
Foreign born, non-citizen	-3%	-6%*	-3%	12%**	-3%	-8%*	7%	5%*	2,635
Less than High School	-6%*	-8%*	4%	10%*	-6%*	-10%*	11%*	5%*	7,083
High School Diploma or GED	-4%	-4%	6%	2%	-4%	-1%	4%	1%	11,788
Some college, no degree	-4%	-2%	4%	2%	-4%	0%	3%	0%	7,648
Associate or vocational degree	-4%	-3%	4%	3%	-4%	0%	2%	2%	4,555
Bachelor's Degree	-1%	1%	3%	-3%	-1%	6%	-2%	-4%	7,891
Above Bachelor's Degree	0%	2%	2%	-4%	0%	7%^	-3%	-5%^	4,395

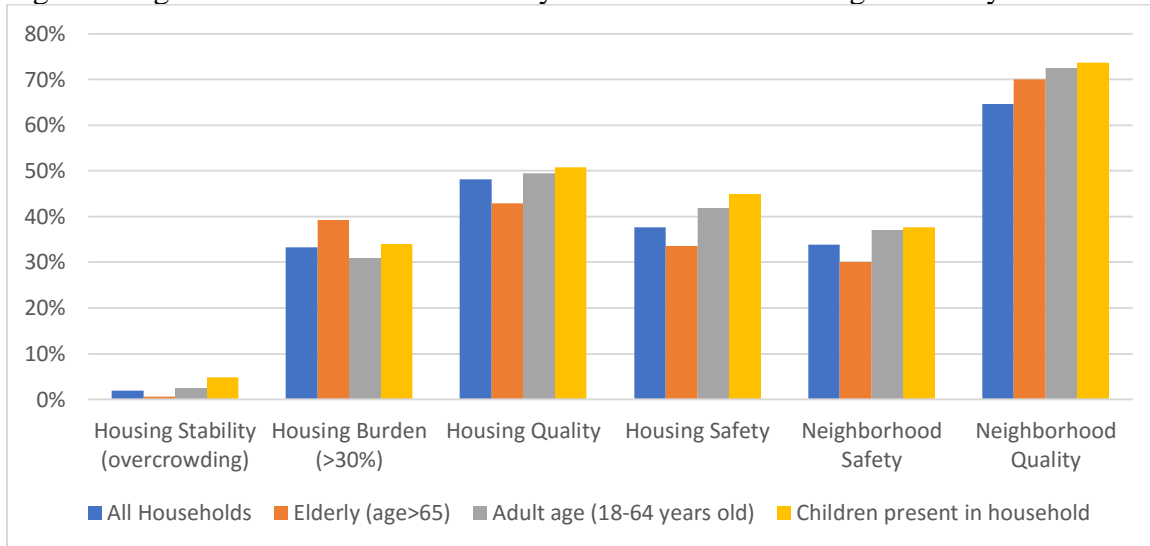
Differences of at least 2 standard deviation toward less insecurity are coded as ^, 1 standard deviation coded as ^

*Differences of at least 2 standard deviation toward more insecurity are coded as **, 1 standard deviation coded as **

Housing Insecurity Dimensions by Demographic Characteristics

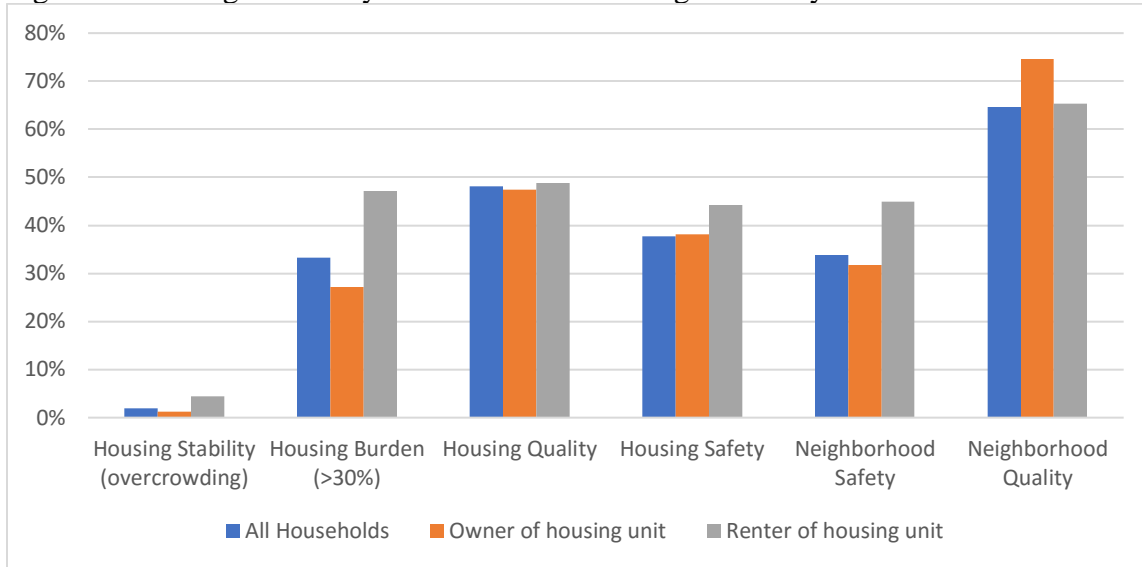
The last section presented two possible categorical scales of housing insecurity and compared their outcomes by various demographic characteristics. This section compares the distribution of housing insecurity domains by the same demographic characteristics. Figure 4 examines whether there are dimensional differences for older adult households and those with children. Older adult households have slightly lower prevalence rates on each dimension than adults aged 18-64, except for housing burden where older adults have slightly higher rates. Households with children only stand out in housing stability: their rate of overcrowding is higher than adults, older adults, and all households. Figure 5 presents the same analysis by housing tenure. Renters more frequently report issues of overcrowding, housing burden, housing safety, and neighborhood safety than homeowners. Owners, in contrast, more often report issues of neighborhood quality; housing quality rates are nearly even among owners and renters.

Figure 4: Age and Presence of Children by Dimensions of Housing Insecurity



Older Adult and Adult age households are mutually exclusive categories in Figure 4. However, Children present in household is not a mutually exclusive category, relative to older adult or adult-headed households. It should only be compared to All households.

Figure 5: Housing Tenure by Dimensions of Housing Insecurity



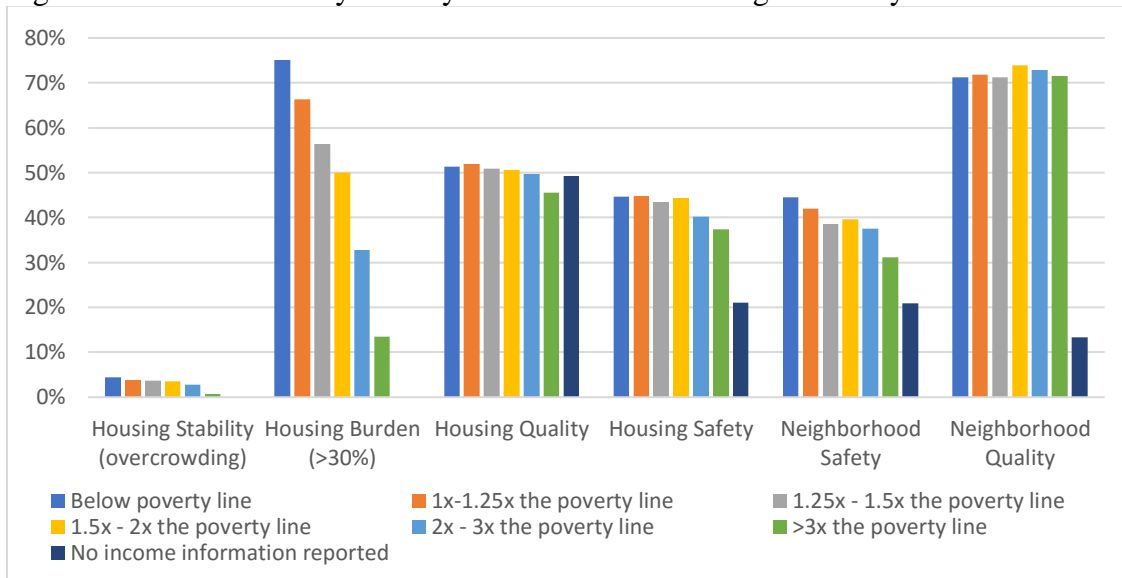
Married households tend to have lower levels of insecurity compared to all other households, except on issues of neighborhood quality, and housing quality (Figure 6). Household heads who are single, separated, or whose spouse is absent face greater levels of overcrowding, neighborhood safety, and housing safety compared to married, divorced, and widowed households.

Income and poverty rates have a direct relationship with several housing insecurity dimensions: the lower the income, the higher the reported issues (Figure 7). Specifically, over half of households below 150% of the poverty line pay over 30% of income toward housing, reflecting the high cost of housing relative to wages for low-income households. Lower-income households also have higher rates of safety issues both in their housing units and neighborhoods. In comparison, issues of housing quality and neighborhood quality do not seem to vary with income. Overcrowding is also higher for lower-income households.

Figure 6: Marital Status by Dimensions of Housing Insecurity



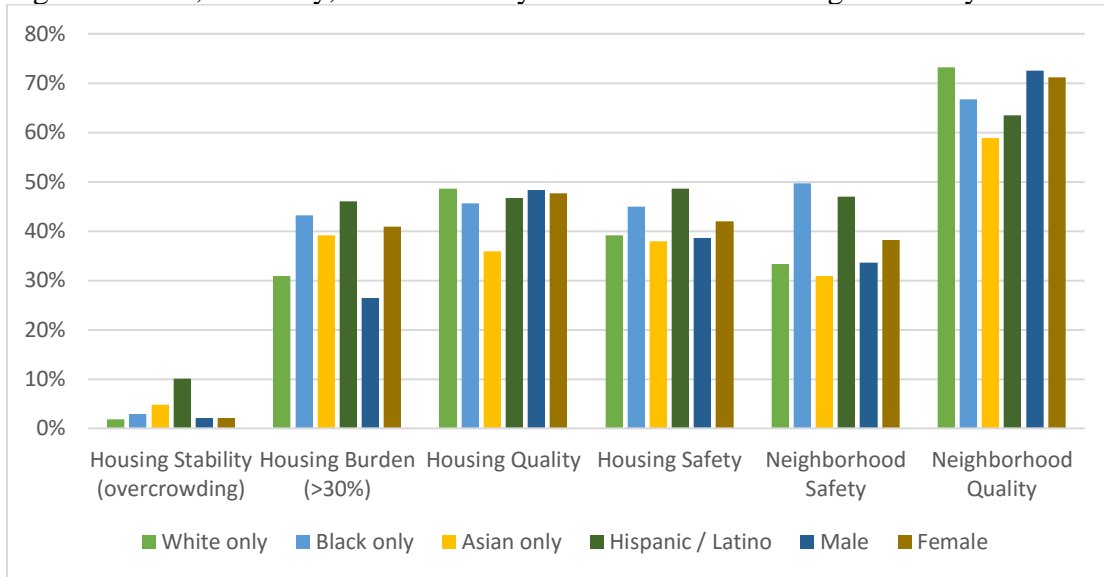
Figure 7: Income / Poverty Rate by Dimensions of Housing Insecurity



Differences in housing insecurity dimensions exist by race, ethnicity, and gender (Figure 8). Blacks face higher cost burdens, more housing safety and neighborhood safety issues compared to whites and Asians. Blacks have similar levels of housing quality issues as whites and Hispanics, and lower issues with neighborhood quality than whites. Hispanics have the highest rates of overcrowding, housing burden, and housing safety among all ethnoracial groups. Asians, in contrast, have lower rates of insecurity in all dimensions except overcrowding and

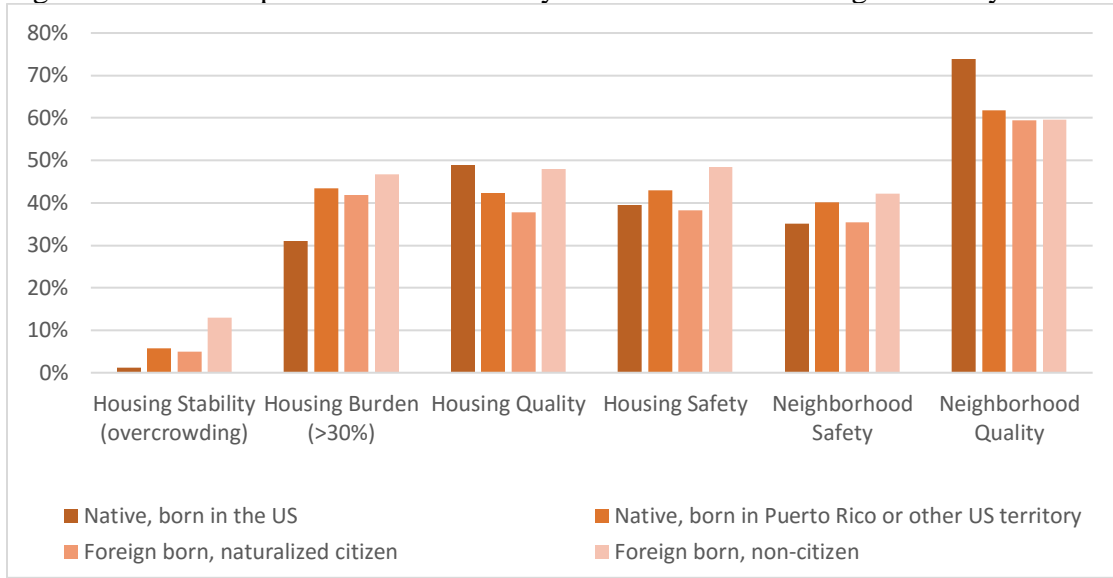
housing burden. There is parity in overcrowding, housing quality, and neighborhood quality among female- and male-headed households. However, female-headed households are much more likely to be housing burdened and slightly more likely to experience housing and neighborhood safety issues compared to male-headed households.

Figure 8: Race, Ethnicity, and Gender by Dimensions of Housing Insecurity



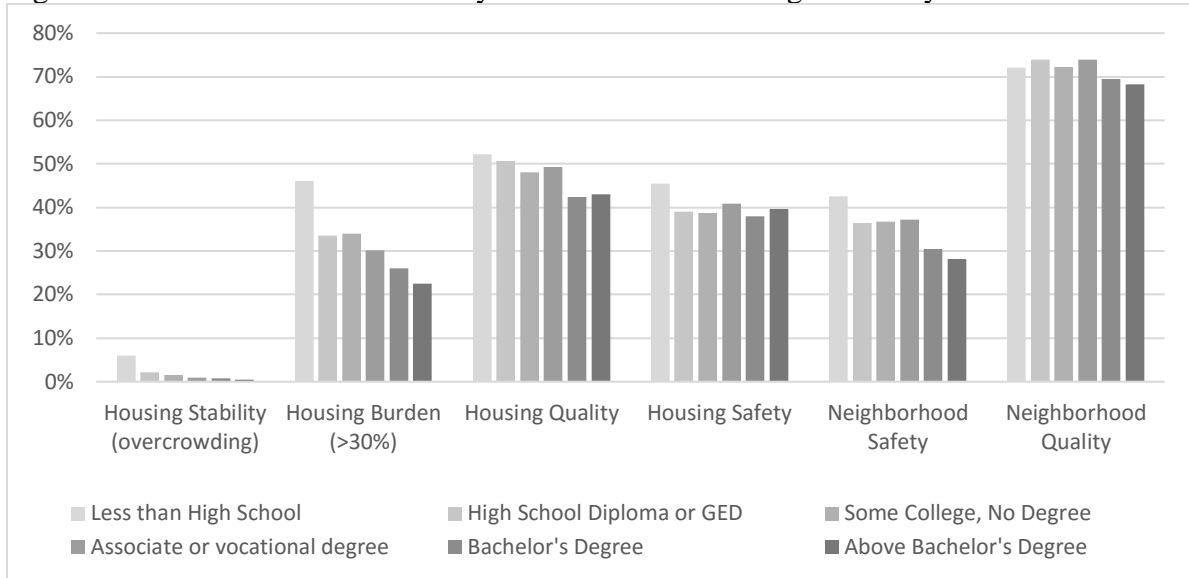
There are specific patterns of housing insecurity by citizenship status and birthplace (Figure 9). Foreign-born, naturalized citizens have the lowest prevalence on all dimensions, except for overcrowding and housing burden. In contrast, native U.S.-born households have the highest level of neighborhood quality issues and slightly higher housing quality issues than foreign-born, Puerto Ricans, or households from U.S. territories. Non-citizen, foreign-born households have the highest rate of insecurity in terms of overcrowding, housing and neighborhood safety, and housing burden.

Figure 9: Citizenship and Place of Birth by Dimensions of Housing Insecurity



There is a bifurcated pattern in the relationship between housing insecurity and educational attainment (Figure 10). Namely, households headed by persons without a high-school or equivalent degree experience higher levels of overcrowding, housing and neighborhood safety issues, and are more housing burdened. The differences between other levels of education attainment are much more muted. Nevertheless, households headed by persons with a college degree or above have lower incidence of housing burden, as well as issues with housing quality, neighborhood safety, and neighborhood quality.

Figure 10: Educational Attainment by Dimensions of Housing Insecurity



V. Discussion and Conclusion

This paper is a first attempt to develop a simple housing security scale based on the definition set forth in Cox et al. (2017). Using pre-existing items in the 2005 American Housing Survey (AHS), we develop a housing security index based on seven housing security domains: housing affordability, housing stability, housing quality, housing safety, neighborhood quality, neighborhood safety, and literal homelessness. Specifically, we develop two categorical variables based on a continuous definition of the number of household housing problems and the number of housing security dimensions experienced by households.

We begin by showing that the prevalence of housing insecurity more than doubles, once all seven domains are accounted for within one measure. When we look at the distribution of housing domains experienced by households, we find that almost 89% of households indicate a concern in at least one domain, with well over half experiencing housing problems in at least two domains. We also test whether these domains could be represented completely by housing affordability, and find that these domains do not perfectly overlap with housing affordability.

Specifically, if we develop a scale based solely on housing affordability then we will be more likely to miss those households that are experiencing housing problems across less than four domains in general, and housing and neighborhood quality in particular. Housing and neighborhood quality are both negatively associated with housing affordability suggesting that people may trade housing and neighborhood quality for more affordable housing. Our findings suggest that too much focus on the dimension of housing affordability would mean that these behavioral responses to housing insecurity would not be captured leading to biased prevalence rates. This finding is also supported by our analysis by location, which finds that although rural households experience lower rates of housing affordability, they experience the highest rate of housing quality issues compared to other areas.

We then develop two categorical scales of housing security based on the number of dimensions of housing insecurity experienced and a continuous measure we developed by summing over all positive responses to the 80 items that comprise the seven housing domains. We categorize people as housing secure, moderately housing secure, low housing security, and very low housing security using cutoffs we define in the paper. Based on these definitions, we find much higher rates of housing insecurity when we look at the breadth of the problem (i.e., the number of dimensions experienced) versus the depth of the issues (i.e., the number of housing problems experienced). Nonetheless, even among the latter, we still find 33% of households experience issues with housing insecurity.

Finally, we look at the distribution of demographic characteristics across our scale as a form of cross validation. We are particularly interested in understanding how our measure aligns with other indicators of poverty and wellbeing. In general, we find that single households, poor households (i.e., income less than two times the poverty level), less educated households, black

households, Hispanic households, and foreign born non-citizen households all experience more severe levels of housing insecurity; while older adult households experience higher rates of low housing security. Our findings suggest that our scale does a reasonable job of tracking other indicators of poverty.

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Appendix 1: Technical Supplement

Ordered Logistic Regression Model 1

We employ an ordered logistic regression model to measure the effect of cost burden on other dimensions of housing insecurity. We see cost burden categories as a natural ordering of alternatives: households are either not burdened (housing costs are below 30% of income), cost burdened (housing costs make up 30-50% of income), or severely cost burdened (over 50% of income spent on housing). We thus define a model with three alternatives ($j = 0, 1, 2$). Our latent dependent variable y_i^* which takes the value of 0 when household i is not housing burdened, 1 when it is cost burdened, and 2 when it is severely cost burdened, see Equations 1 and 2 (Cameron and Trivedi, 2005 pp.519-521). These categories are mutually exclusive. The independent variable is \mathbf{x}'_i : the number of housing insecurity dimensions encountered by household i .

$$\text{Equation 1: } y_i^* = \mathbf{x}'_i \beta + u_i$$

$$\text{Equation 2: } y_i = j \text{ if } \alpha_{j-1} < y_i^* \leq \alpha_j$$

The probability that household i is selected into alternative j is $\Pr[y_i = j] = \Pr[\alpha_{j-1} < y_i^* \leq \alpha_j] = F(\alpha_j - \mathbf{x}'_i \beta) - F(\alpha_{j-1} - \mathbf{x}'_i \beta)$. For an ordered logistic regression, the logistic cumulative distribution function is $F(z) = \frac{e^z}{1+e^z}$.

Marginal effects (predicted probabilities) are calculated as $\frac{\partial \Pr[y_i=j]}{\partial \mathbf{x}_i} = \left(F'(\alpha_{j-1} - \mathbf{x}'_i \beta) - F'(\alpha_j - \mathbf{x}'_i \beta) \right) * \beta$, where F' is the derivative of F .

Table 14 displays the results of this ordinal logit model. The ordinal logit model is valid in this case, as the likelihood-ratio test of proportionality of odds across categories is not significant, confirming that the relationship between each pair of outcome groups is the same. Moreover, a Brant test (Table 15) indicates that the parallel regression assumption, necessary for the ordinal logit model to be valid, has not been violated.

Number of Housing Insecurity Dimensions	Odds Ratio	Std. Err.	z	P>z	[95% Conf. Interval]	
1	0.8930	0.0311	-3.25	0.001	0.8341	0.9561
2	0.8646	0.0297	-4.23	0	0.8083	0.9248
3	0.8373	0.0301	-4.94	0	0.7803	0.8984
4	1.1458	0.0461	3.38	0.001	1.0588	1.2399
5	1.3942	0.1984	2.34	0.02	1.0549	1.8427
/cut1	0.5956	0.0287			0.5394	0.6518
/cut2	1.6048	0.0299			1.5463	1.6634

Table 14. Regression results for Ordinal Logit Model 1, reflected as odds ratios
Dependent variable is Housing Burden Presence.
N = 42,728. Pseudo-R²: 0.0014.

Approximate likelihood-ratio test of proportionality of odds across response categories:
 $\chi^2(1) = 1.20$, $\text{Prob} > \chi^2 = 0.2733$

Number of Housing Insecurity Dimensions	chi2	P>chi2	df
All	4.16	0.526	5
1	2.56	0.11	1
2	2.32	0.128	1
3	2.19	0.139	1
4	3.08	0.079	1
5	0.06	0.803	1

Table 15. Brant Test of Parallel Regression Assumption for Ordinal Logit Model 1
A significant test statistic provides evidence that the parallel regression assumption has been violated. None of the test statistics in this Brant analysis are statistically significant at the 95% level.

Ordered Logistic Regression Model 2

To ascertain the effect of housing burden on each of the other housing insecurity dimensions we again apply an ordered logistic regression model. Model setup, estimation, and marginal effects follow the above equations in Model 1. The dependent variable is set up in the same way. The independent variables follow Equation 1, but here $x_i'\beta$ is a set of five binary variables representing whether the household has issues in overcrowding, housing quality, housing safety, neighborhood safety, and neighborhood quality.

Table 16 displays the results of this second ordinal logit model. The ordinal logit model is valid in this case, as the likelihood-ratio test of proportionality of odds across categories is not significant, confirming that the relationship between each pair of outcome groups is the same. Moreover, a Brant test (Table 17) indicates that the parallel regression assumption, necessary for the ordinal logit model to be valid, has not been violated.

Housing Insecurity Categories	Odds Ratio	Std. Err.	z	P>z	[95% Conf. Interval]	
Overcrowding	1.2125	0.0811	2.88	0.004	1.0635	1.3823
Housing Quality	0.9516	0.0208	-2.27	0.023	0.9116	0.9933
Housing Safety	1.0988	0.0244	4.25	0	1.0521	1.1476
Neighborhood Safety	1.3071	0.0280	12.49	0	1.2533	1.3632
Neighborhood Quality	0.7510	0.0170	-12.63	0	0.7183	0.7851
/cut1	0.5981	0.0207			0.5575	0.6388
/cut2	1.6112	0.0223			1.5675	1.6550

Table 16. Regression results for Ordinal Logit Model 2, reflected as odds ratios
Dependent variable is Housing Burden Presence.
N = 42,728. Pseudo-R²: 0.0043.

Approximate likelihood-ratio test of proportionality of odds across response categories:
 $\chi^2(5) = 5.21, \text{ Prob} > \chi^2 = 0.3905$

Number of Housing Insecurity Dimensions	chi2	P>chi2	df
All	4.74	0.449	5
Overcrowding	1.13	0.288	1

Housing Quality	0.18	0.674	1
Housing Safety	2.46	0.117	1
Neighborhood Safety	0.1	0.754	1
Neighborhood Quality	1.06	0.304	1

Table 17. Brant Test of Parallel Regression Assumption for Ordinal Logit Model 2

A significant test statistic provides evidence that the parallel regression assumption has been violated. None of the test statistics in this Brant analysis are statistically significant at the 95% level.