Improving Flexibility to Increase Housing Affordability

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Improving Flexibility to Increase Housing Affordability

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This paper utilizes Census Bureau and USPS-HUD data sets to examine the relationship between address vacancy and percent of residents who are housing cost burden at the Census Tract level. This research determines there is a statistically significant positive linear relationship for four of the six New England States. Additionally, I examine spatial autocorrelation patterns among the residuals to determine if error term is clustered, dispersed, or random. Finally, I compare my results to how building codes disincentive rehabilitating buildings and incentivize greenfield development. I offer a number of policy suggestions to assist at the local, state, and Federal level in adopting rehabilitation building codes.
# Table of Contents

Executive Summary ................................................................................................................. 4
Introduction .................................................................................................................................. 4
Background ................................................................................................................................... 6
   Housing Cost Burden .................................................................................................................. 6
   Building Vacancy ....................................................................................................................... 7
   Rehabilitation Building Codes ................................................................................................... 8
Research Questions ..................................................................................................................... 12
Methodology ................................................................................................................................ 12
Analysis ........................................................................................................................................ 14
   New England Housing Market .................................................................................................. 14
State-by-state Results .................................................................................................................. 15
   Connecticut ................................................................................................................................. 15
   Maine ............................................................................................................................................. 15
   Massachusetts ............................................................................................................................. 16
   New Hampshire ........................................................................................................................... 16
   Rhode Island ............................................................................................................................... 17
   Vermont ......................................................................................................................................... 17
State Comparisons ....................................................................................................................... 18
Discussion and Future Research .................................................................................................. 19
Policy Suggestions ......................................................................................................................... 20
Conclusion ..................................................................................................................................... 21
Appendix ....................................................................................................................................... 23
   U.S. Census Bureau - American Community Survey 5-Year Estimate methodology ................. 37
   HUD Aggregated USPS Administrative Data On Address Vacancies methodology .................. 38
   Data Variables used in the analysis ............................................................................................. 39
Bibliography .................................................................................................................................... 41
Figure 1: Percent of Vacant Addresses in New England ................................................................. 23
Figure 2: Percent of Cost Burdened Housing Units in New England ............................................... 23
Figure 3: Connecticut - Scatter plot of Housing Cost Burden on Vacancy Rate .................................. 24
Figure 4: Connecticut - Map of Residuals .......................................................................................... 24
Figure 5: Connecticut - Moran's I Test of Residuals ......................................................................... 25
Figure 6: Connecticut - Moran's I Test of Residual Significance ......................................................... 26
Figure 7: Maine - Scatter plot of Housing Cost Burden on Vacancy Rate ............................................. 27
Figure 8: Maine - Map of Residuals ..................................................................................................... 28
Figure 9: Maine - Moran's I Test of Residuals .................................................................................... 28
Figure 10: Maine - Moran's I Test of Residual Significance ................................................................. 29
Figure 11: Massachusetts - Scatter plot of Housing Cost Burden on Vacancy Rate ......................... 29
Figure 12: Massachusetts - Map of Residuals ...................................................................................... 30
Figure 13: Massachusetts - Moran's I Test of Residuals ................................................................. 30
Figure 14: Massachusetts - Moran's I Test of Residual Significance ...................................................... 31
Figure 15: New Hampshire - Scatter plot of Housing Cost Burden on Vacancy Rate ...................... 31
Figure 16: New Hampshire - Map of Residuals .................................................................................. 32
Figure 17: New Hampshire - Moran's I Test of Residuals ................................................................. 32
Figure 18: New Hampshire - Moran's I Test of Residual Significance .................................................. 33
Figure 19: Rhode Island - Scatter plot of Housing Cost Burden on Vacancy Rate .............................. 33
Figure 20: Rhode Island - Map of Residuals ....................................................................................... 34
Figure 21: Rhode Island - Moran's I Test of Residuals ...................................................................... 34
Figure 22: Rhode Island - Moran's I Test of Residual Significance ..................................................... 35
Figure 23: Vermont - Scatter plot of Housing Cost Burden on Vacancy Rate .................................... 35
Figure 24: Vermont - Map of Residuals ............................................................................................ 36
Figure 25: Vermont - Moran's I Test of Residuals .......................................................................... 36
Figure 26: Vermont - Moran's I Test of Residual Significance ......................................................... 37
Executive Summary
Thirty-eight percent of New England households are housing cost burdened. Additional housing often requires significant resources while potentially abandoning existing infrastructure in our previously developed cities and towns. Building codes can have a tremendous impact on the ability and affordability for developers to utilize existing buildings to provide housing for wanting residents. However, technical requirements in building codes favor new develop over rehabilitating existing structures by providing cost incentives for developers to build new. One way to tackle this problem is drafting, adopting, and implementing rehabilitation building codes or "Smart Codes" at the state level. "Smart Codes" can help minimize costs for redevelopers who desire to utilize the existing built environment. Understanding the relationship between housing cost burden and vacancy rates is important in the process to help determine where there are potential markets for rehabilitation. This capstone utilizes a unique dataset provided by US HUD to better understand this relationship and provides suggestions at all governmental levels for advocacy, adoption, and implementation of rehabilitation building codes.

Introduction
Housing affordability for middle and lower income populations is a continual policy struggle in the United States, specifically in regions with an aging housing stock or constrained development due to geographic or regulatory features. Federal policies favoring new construction over rehabilitation and improvement of older structures via the tax code exacerbate the problem (Jackson, 1985, p. 190). This policy encourages development on "greenfields", or land currently untouched by development, and abandons our earlier developed urban areas. Many of the United States' urban core areas have structures with strong historical and cultural significance but adapting them for re-use as housing or industry for today's service-based economy is difficult without subsidies due to land-use and building code policies.

The federal government had been minimally involved in the housing market since the turn of the 20th century with the adoption of the Federal Land Bank System and the United States Housing Corporation. It was not until the Federal Housing Authority came into existence during the Great Depression to "encourage improvement in housing standards and conditions, to facilitate sound home financing on reasonable terms, and to exert a stabilizing influence on the mortgage market" that every American would feel the effect. That effect would result in the increase of suburbanization and "hollowing-out" of urban areas throughout the United States (Jackson, 1985, pp. 191-206). Many of the buildings in these urban areas would lie vacant for years, until recent migration trends indicate a return of people to inner-city areas (Jaffe, 2011). While many buildings in major metro markets have already been readapted for housing or various industrial-commercial uses, developers and property owners in mid-size and smaller markets may not believe re-adaption is profitable due to costs and risk imposed by requesting zoning changes or complying with the building codes.
Throughout the 20th century and beginning of the 21st century Federal, state, and local governments have taken various approaches in helping provide American citizens with safe and consistent housing. One regulation that helps protect health, safety, and quality of citizens’ lives are building codes. However, health, safety, and quality of housing are only one portion of the housing policy equation; affordability is an increasingly important input. Issues surrounding housing affordability have gained increasing attention as Americans find housing costs absorbing escalating amounts of their monthly wages (Center for Housing Policy, 2013). Furthermore, populations such as the elderly or minorities can be impacted by increasing housing costs disproportionately to others (Gabriel & Holak, 2014) (Dunn, 2014).

Many scholars and policymakers write on active actions community members and Federal, state, and local governments can employ to encourage rehabilitation of abandoned and vacant buildings. Such as providing incentives, grant funding, legal action, or plan implementation by community development corporations (Mallach, 2006, p. 146) (Listokin, 2006, pp. 54-61); few write on passive action states and communities can take to encourage rehabilitation and reuse of older buildings, including amending building codes to improve flexibility and adaption in a dynamic marketplace.

Significant portions of the New England population are housing cost burdened. While the 2007-2008 recession and collapse of the housing market bubble seem to have slowed the increase of housing costs, as of 2012, 38.3% of New England renters and homeowners with or without a mortgage were considered housing cost burdened (United States Census Bureau, 2012). Many demographic, economic, and social factors play into the housing market, but following a supply-and-demand model, we can assume that high housing cost burdened areas would likely experience pressure to develop or redevelop additional housing, as these are areas with demand exceeding supply leading to higher prices. However, even in the most expensive markets, buildings residential or otherwise remain vacant often due to abandonment, neglect, or regulatory barriers such as building codes and land use zoning.

Building codes serve an invaluable purpose, to protect the health and well-being of citizens in places they consider home. However, the inflexibility of these regulations can create difficulties in readapting and rehabilitating existing buildings to provide affordable housing for dynamic communities. Population shifts and migration of citizens to different areas of the country can create strong upward pressures on the housing market leading to increasing housing prices, rent values, property taxes, and potential gentrification. These problems remain even in the presence of vacant buildings (residential, commercial, or otherwise) available for conversion to housing. While occupant safety must remain the highest purpose of these regulations, enabling changes of use to move forward as easily as possible should also be a high priority to increase the re-use of vacant buildings and adapt to pressures on the housing market (Seward, 2007, p. 78). Policymakers at the state and municipal level can make decisions to reduce the delay between arrival of new residents and development of additional housing by adopting rehabilitation building codes, or "Smart Codes".
The many puzzles surrounding the availability of affordably priced housing for middle-to low-income residents cannot all be addressed in this capstone. But examining whether there is a relationship between vacancy rates and housing cost burdened residents can help the local planner and state policymaker work together to address issues of building renovation and rehabilitation. The goal of this capstone is to use quantitative data to investigate linear and spatial relationships between housing cost-burdened residents and address vacancy rates to determine whether the housing market is properly functioning, or if the lack of state specific "Smart Codes" is interfering with the rehabilitation and reuse of existing building, thus constraining the supply of housing.

**Background**

**Housing Cost Burden**

Defining housing affordability is more difficult to pin down than much of the literature and talking points would have one believe. The conventional public policy indicator of housing affordability is the percent of income spent on housing. Generally, spending more than thirty percent of one's income on housing purposes is considered "housing cost burdened". This threshold evolved from the United States National Housing Act of 1937 (Schwartz & Wilson, p. 1) and was reinforced by the maximum rent allowed in public housing, established by the 1981 Housing and Community Development Act (Mauricio, 2013, p. 7). However, the thirty percent threshold should not be considered a defined line in the sand for all homeowners or renters. For some the thirty percent ratio is not an indicator of an affordability problem, but instead a lifestyle choice (Schwartz & Wilson, p. 2). Although for low-income populations, housing costs in excess of thirty percent of their income can result in reduced spending on nutrition, healthcare, and education. In fact, the Harvard Joint Center on Housing studies reports that severely burdened families with children spend about one-fifth as much on healthcare as those that are not housing cost burdened (Harvard Joint Center for Housing Studies, 2013, p. 29). Families that stay in housing cost-burdened situations can have long-term impacts on the health, education, earning power and future success of their children.

The much-reported widening income inequality has contributed to the strain on families for affording housing, especially for already low-income households (Harvard Joint Center for Housing Studies, 2013, p. 27). National figures disguise affordability differences across states, but no single minimum-wage earner working 40 hours a week, 52 weeks a year, earns enough income to rent a modest apartment anywhere in the country (Harvard Joint Center for Housing Studies, 2013, p. 2). While the nation is mired in a debate about increasing the Federal minimum wage, state and local officials can make policy decisions

Renters, minorities, and the elderly have found themselves in greater affordability gaps than those who are white, young or middle-aged, and homeowners (Listokin, 2006, p. 19). This comes on the heels of a recent home-mortgage foreclosure crisis, a global financial meltdown,
and increasing migration of the "Millennial" generation moving into urban areas and foregoing purchases of homes. This confluence of economic and demographic trends are pushing up prices of housing rents in urban areas while Federal support for housing still devotes seventy-five percent of $207 billion per year to homeownership rather than improving rental affordability (Terwiliger, 2011, p. 2). In a period of economic distress in which many citizens of low-to-middle income would call on the Federal government to do more to assist those that are struggling, the recent Federal cutbacks known as "sequestration" hurt the neediest. In New England alone, the U.S. Department of Housing and Urban Development (U.S. HUD) estimates 8,462 subsidized housing vouchers were lost to sequestration (New England Housing Network, 2013, p. 7).

While much has been said about the Federal government's involvement (or lack thereof) in maintaining affordable housing, states and localities can do their part in assisting creation of affordable units. Wexler & Peck cite a number of analysts that assert certain zoning standards such as minimum lot sizes and dwelling area requirements do little than exclude smaller and lower priced units. Lot-size requirements that go beyond the mandated minimum for public health and safety reasons have little merit (Wexler & Peck, 1975, p. 67). Local policymakers and planners can assist in the creation of affordable housing by balancing social and fiscal needs of a community's residents and potential future residents. Additionally, states and some municipalities have jurisdiction over the building codes for structures and can make policy decisions to simplify rehabilitation.

**Building Vacancy**

Building vacancy, and potential abandonment, is a multidimensional process with functional, physical, and financial aspects (Wachsmuth, 2008, p. iii). While building vacancy cannot be equated to abandonment, signs of vacancy can often point to abandonment problems within a community and vice versa. There are many definitions of vacancy and abandonment, according to a definition by the State of New Jersey: "a property be legally unoccupied for at least six months and fulfill one other of a number of criteria, such as being in need of rehabilitation." While Hillier et al.'s paper on predicting housing abandonment in Philadelphia defines it as: "...a property be neglected functionally, financially, or physically and furthermore be deemed to be immediately dangerous..." (Wachsmuth, 2008, p. 4). Focusing on a single definition is far too difficult for the scope of this paper, however, understanding the implications of building vacancy and abandonment on communities is crucial to the scope.

Before industrialization and urbanization, property abandonment was predominately the effect of ecological factors such as soil exhaustion or weather events such as droughts or sudden freezes. However, since the urbanization of the United States, vacancy and abandonment today reflect demographic and economic changes of regions (Mallach, 2006, p. 5). Practices such as predatory lending and real estate speculation or complex tax and estate situations can exacerbate these problems for communities, especially in inner-city areas (Mallach, 2006, p. 6).
Neighborhood distress characterized by indicators such as vacant and abandoned properties can spiral into additional social and economic problems for communities (Harvard Joint Center for Housing Studies, 2013, p. 31). Mallach's book *Bringing Building Back* lists five of the most visible costs of property abandonment:

1.) Effect on neighboring property values. The presence of abandoned properties in a neighborhood significantly diminishes the value of adjacent occupied properties.
2.) Effect on public safety. Abandoned properties are frequently used as venues for criminal activity, including prostitution and drug trafficking.
3.) Effect on public health. Abandoned properties are sites of infestation by rats and other vermin and are often used as illegal dumping grounds for construction debris and garbage.
4.) Effect on fire safety. Abandoned properties increase the risk of fire that can spread to nearby occupied homes, particularly in high-density urban areas.
5.) Effect on taxpayers. Substantial costs may be imposed on local tax payers to secure, clean, or demolish abandoned properties, to take legal control of properties, and to cover the costs of the added police and fire services they demand (Mallach, 2006, pp. 8-9).

All these effects can set in motion negative and social economic patterns that affect individuals, the greater community, and put strain on public resources. State and local government have actively tackled many of these negative aspects with the use of taxpayer-supported programs such as brownfield redevelopment, direct investment in failing industries, and subsidizing further development (LaMore & LeBlac, 2013, pp. 5-6). With 188,516 New England addresses vacant for 12+ months, or a 2.4% vacancy rate, (U.S. Department of Housing and Urban Development), few policymakers are discussing how regulations can work with, rather than hinder and stall rehabilitation and redevelopment.

**Rehabilitation Building Codes**

According to the National Conference of States on Building Codes and Standards, ninety percent of the U.S. population lives in a jurisdiction that enforces some type of building code (Burby, Salvesen, Creed, & Michael, 2006, p. 183). However, Carlos Martin, Senior Research Associate in the Metropolitan Housing and Communities policy center of the Urban Institute, holds a pessimistic view of policy's role in building codes: "Economists and policymakers refrain from this because of its too 'technical' nature and the perceived diminishing returns from exhaustive work. Homebuilders and developers naturally refrain because they have spent a century perfecting a production system based on these seemingly unfair and antiquated regulations. As such, we are left with anecdotes not only about building codes, but also about the homebuilding industry in general (Seward, 2007, p. 53)." Galvan would agree with this statement declaring, "the biggest failure of traditional codes is that they do not satisfactorily address existing buildings, which far outnumber new structures" (Galvan, 2006, p. 1748). These
regulations touch our own and our community's lives every day, often-in unseen or underappreciated ways, and yet, policymakers rarely enter the debate.

Many communities' desire to preserve or retain aspects of the unique characteristics of their built environment goes against the historic nature of building codes. Originally written and implemented to encourage demolition of older, hazard-filled buildings to make room for new buildings, building codes, when enforced unscrupulously can hasten rather than prevent abandonment (Mallach, 2006, p. 40). The era of a substandard housing stock is for the most part gone and technical advances have allowed us to improve the safety of older building, yet the codes remain rooted in language that makes accommodating to older buildings difficult (Seward, 2007, p. 1). The infamous "25-50 rule" that was present in so many traditional building codes required that, if rehabilitation or renovation work met a threshold (often somewhere between 25-50%) of the building's assessed value or floor area, the entire building had to be brought up to code, thereby discouraging the renovation and rehab of older buildings (Seward, 2007, p. 4). The "25-50 Rule" was born out of building code provisions dealing with nonconforming buildings in fire districts (Listokin, 2006, p. 70) While most building codes have scrapped the fixed "25-50 rule", largely due to U.S. HUD's leadership, its legacy remains in many contemporary codes, often at lower percentages or for only certain aspects of the code.

Additional difficulties for rehabilitating older (and often abandoned) buildings include altering the use of the building, or the "change of occupancy" rule. The "change of occupancy rule" requires the entire building to be made to meet code requirements for new construction, presenting major problems for older, historic cities and towns (Seward, 2007, p. 4). If, for example, an investor wanted to turn the town's old department store or mill building into one- and two-bedroom units, the entire building would have to brought up to code, no matter whether the building is one hundred percent structurally sound. Much of the time, these changes of occupancy require insignificant code requirements resulting in significant investment and time, while adding marginally to the safety of the building such as widening doors or windows an additional few inches or mandating costly rewiring of an entire apartment building undergoing rehabilitation. All these costs drive up the price of the rehab process, increasing prices of housing, and putting them out of reach of low- to moderate-income populations (U.S. Department of Housing and Urban Development, 1991, p. 55).

The power to draft building codes often resides with the states, which occasionally they devolve to the local governments who primarily act as the enforcers (Galvan, 2006, p. 1746). The State of New Jersey is at the forefront of rehabilitation codes, with their New Jersey Rehabilitation Subcode. Developed from a partnership between the New Jersey Department of Community Affairs, the U.S. Department of Housing and Urban Development, and the Center for Urban Policy Research at Rutgers University (Seward, 2007, p. 23), the Subcode was also the basis for U.S. HUD's National Applicable Recommended Rehabilitation Provisions (NARRP). This new system based itself on three criteria: *timeliness, predictability*, and *reasonableness* (Building Technology, Inc., 2001, p. 10).
The Subcode establishes "hazard ratings", defining building uses as being more or less hazardous to persons and property, subsequently requiring stricter compliance with safety codes. Additionally, the Subcode establishes the "building as it exists" baseline as a measure of safety rather than comparing the safety to standards of new construction (Seward, 2007, p. 27). Various other states have jumped on the idea and begun developing their own rehabilitation codes or "Smart Codes" including North Carolina, Rhode Island, and briefly, Maryland. Furthermore, the Subcode allows for "work areas", areas in which rehab and renovation work will take place without affecting other areas of the building or requiring additional costly renovations (Building Technology, Inc., 2001, p. 11). Various organizations have estimated that the New Jersey Subcode reduces rehabilitation costs anywhere between ten and fifty percent (Galvan, 2006, pp. 1762-1763). While the New Jersey Rehabilitation Subcode provides a major improvement compared to the majority of other codes in the enforcement field, there is plenty of room for improvement. The complexity of six different categories of work that are sometimes unclear about which apply to an individual project (Seward, 2007, p. 100).

The majority of New England states, four of six, have adopted the International Existing Building Code (IEBC) as the "rehabilitation code" for the local code enforcement authority (see Table 1). However, the IEBC does not utilize hazard ratings to justify sprinkler requirements, one of the most costly code compliance requirements. Nor does the IEBC allow projects to be broken into work areas, applying different categories of work, to minimize triggering additional code requirements (Seward, 2007, pp. 41-42). Furthermore, New England has an abundance of older industrial buildings that have outlived their original use. These buildings could still be useful for housing or low-cost business space but code compliance causes major problems given the reuse of these buildings requires a change of occupancy (Seward, 2007, p. 94). Noting the variety of problems redevelopers and rehabilitation specialists have encountered using the IEBC, Rhode Island is the only state proactive in creating their own "Smart Code" for rehabilitation and reuse of existing structures.
<table>
<thead>
<tr>
<th>State</th>
<th>Rehabilitation/Existing Building Code</th>
<th>Adoption Process</th>
</tr>
</thead>
<tbody>
<tr>
<td>Connecticut</td>
<td>International Existing Building Code 2003</td>
<td>Statewide</td>
</tr>
<tr>
<td>Maine</td>
<td>International Existing Building Code 2009</td>
<td>Statewide, enforced only in communities greater than 2000 people</td>
</tr>
<tr>
<td>Massachusetts</td>
<td>International Existing Building Code 2009</td>
<td>Statewide</td>
</tr>
<tr>
<td>New Hampshire</td>
<td>International Existing Building Code 2009</td>
<td>Statewide</td>
</tr>
<tr>
<td>Rhode Island</td>
<td>Rhode Island State Rehabilitation Building and Fire Code for Existing Structures</td>
<td>Statewide</td>
</tr>
<tr>
<td>Vermont</td>
<td>None</td>
<td>Statewide</td>
</tr>
</tbody>
</table>

Table 1: Effective New England Rehabilitation Building Codes (International Code Council, 2014)

Some would expect the code enforcers to be partners or even in the vanguard for building code reform, however, the reality is often the opposite. Building enforcement departments are woefully underfunded, leading to some code officials to resist the drafting and implementation of additional rehabilitation codes, as it would cause additional work for themselves and their staff (Galvan, 2006, p. 1772). Galvan suggests a number of ways in which proponents of "Smart Codes" can hasten their adoptions and overcome current institutional inertia. Seeking out partners such as historical preservationists, national groups of public officials, and construction unions as rehabilitation is often more labor intensive. Additionally, statewide implementation and building on the growing public sentiment that old buildings in inner cities are valuable architectural and public treasures are important to the future of rehabilitation building codes (Galvan, 2006, p. 1773). In order to see the benefits of rehabilitation codes, it will take more than passing legislation and ordinances. Creating a facilitative enforcement philosophy, or the way in which the code is enforced, is key to fostering building rehabilitation (Burby, Salvesen, Creed, & Michael, 2006, pp. 191-192).

The field of building codes touches on both realms of planning and policy, while remaining highly technical and devoid of policy analysis. Clearly, the lack of investigation of building codes is an area ripe for policy research. It is difficult to identify areas of the country that would most benefit from rehabilitation building codes without practical knowledge and expertise of a region and specifics of the building code. Therefore, it is my goal to investigate data related to issues of vacancy rates and housing cost-burdened residents in an attempt to identify areas that can be specifically targeted for use of rehabilitation codes.
Research Questions

I aspire to answer three research questions related to address vacancy rates, housing cost burden, spatial clustering of the error term, and presence of rehabilitation building codes.

1. Is there any relationship between the vacancy rate of addresses and percentage of housing cost-burdened residents?
2. Is there spatial clustering of the regression residual, or unexplained error term?
3. Are there major differences across New England states in the relationship between vacancy rates and housing cost burden? And can differences be explained by anything about the state's building code or the way the building code authority is structured?

Through this analysis, policy analysts will be better equipped to understand the relationship between address vacancy rates and housing cost burden in New England, as well as spatial relationships between the unexplained variables of the linear relationship. Additionally, this analysis is one of the first to make use of the HUD-USPS address vacancies dataset and I hope to offer suggestions for future use based on my results.

Methodology

To answer research questions one and two, I employ a simple linear regression and spatial statistics testing for spatial autocorrelation. The scope of the analysis will be at the state level and observations will be at the geography of census tract. A simple linear regression between the dependent variable, address vacancy rates, and independent variable, percentage of housing cost-burdened residents, will be analyzed to determine whether there is a relationship between the two variables. I set my statistical significance at the 99% level.

To test for spatial autocorrelation, I employ a Local Moran's I test of the linear regression's residual to examine whether there is clustering of unexplained variables. Moran's I test is a measurement of spatial autocorrelation, evaluating whether any pattern expressed is clustered, dispersed, or random. Moran's Index values range from +1.0 indicating perfect clustering to -1.0, indicating perfect dispersion. A Moran's I Index value of 0.0 indicates perfect randomness. The Moran's I test uses a spatial lag to determine spatial autocorrelation, averaging the neighboring values of a location using spatial weights (GeoDa Center, 2014). Off-hand demographic and geographic knowledge of New England and Census Bureau statistics will assist me in trying to explain areas that present significant spatial clustering of the residual.

I consider this analysis exploratory in nature, as no known studies have utilized the USPS-HUD dataset. The analysis will combine data from the U.S. Census Bureau’s American Community Survey 5-year estimates (2008-2012) and a comprehensive address vacancy dataset collected by a partnership between the United States Postal Service and the United States Department of Housing and Urban Development at the census tract geography. I examine
whether there is any relationship between housing cost-burdened households, defined by more than thirty percent of the household’s income going to housing costs, and address vacancy rates for census tracts in all New England states. I hypothesize that there will be a negative relationship between housing cost burden and vacancy rates as regional market demand for more housing may decrease the availability of vacant addresses, no matter if they are residential or former businesses that can be renovated, rehabilitated, and repurposed. The variable housing cost burden functions as a proxy for pent up market demand for housing. It is important to remember that housing cost burden is a function of household income; areas with lower household income may naturally have higher rates of cost burden. Often lower income areas have significant poverty, which can be characterized with vacant buildings and addresses.

The American Community Survey (ACS) is an ongoing statistical survey of the American population that obtains data at various geographic levels on a one, three, or five-year rolling basis. The data used for this analysis was the five-year 2008-2012 estimates at the Census Tract level. In urban and sub-urban areas, the Census Tract can be considered the statistical version of the neighborhood (Harvard Joint Center for Housing Studies, 2013, p. 31). This five-year estimate is the summation of 60 months of collected data and comprises the largest sample size available for geographies. According to the U.S. Census Bureau, the five-year estimate is the most reliable but least current and best used when precision is more important than currency and for when one is analyzing very small populations (U.S. Census Bureau, 2013).

The HUD Aggregated USPS Administrative Data On Address Vacancies is an interesting data set policymakers and urban planners should explore further. The U.S. Postal Service provides HUD with quarterly aggregate data on addresses identified as “vacant” or “no-stat”. This data is available to researchers and practitioners to explore its utility in tracking neighborhoods. For the purpose of this study, only residential, commercial, and other addresses considered “vacant” for more than twelve months were used to calculate building vacancy rates. “No-stat” addresses were not used in the calculation as U.S. HUD provides three examples for which an address could be classified as “no-stat” 1.) Rural route addresses vacant for 90 days or longer 2.) Addresses for businesses or homes under construction and not yet occupied 3.) Addresses in urban areas identified by a carrier as not likely to be active for some time (U.S. Department of Housing and Urban Development). Additionally, HUD does not suggest using “no-stat” addresses in the calculation of a vacancy rate (U.S. Department of Housing and Urban Development).

Because the USPS-HUD data is provided quarterly, I obtained yearly estimates by averaging the four quarters. In order to control for seasonal homes I summed all types of addresses vacant for more than 12 months. To obtain an overall address vacancy rate I summed residential, business, and other buildings. The “other” category of buildings is considered “mysterious” by HUD as it is a category used by the USPS to classify buildings when the USPS is “unable or unwilling to categorize an address as either business or residential”. This may be
due to mixed-use buildings, which are not entirely residential or business, and it is unclear how
government and public buildings are classified (U.S. Department of Housing and Urban
Development). While I understand that the U.S. Census Bureau provides data on vacancy rates,
this data is confined to residential vacancy. In an effort to analyze whether building codes or
obstruct repurposing of structures I expand my analysis to ALL buildings (residential, business,
and other) included in the USPS-HUD data set.

Using the data, I will examine following relationship.

\[ Y_{VACRATEi} = \beta_0 + \beta_{PALLHCB} X_i + \epsilon_i \]

The hypothesis test is as follows.

\[ H_o: \beta_{PALLHCB} = 0 \]
\[ H_a: \beta_{PALLHCB} \neq 0 \]

The regression can be understood as: Vacancy Rate = Percentage of Housing Cost Burden residents + residual (or unexplained variable). Following a brief description of each state's simple linear regression output and Moran's I test, I will compare differences across states and theorize whether differences can be explained by the state's building code or the building code authority structure based on the available literature.

Analysis

New England Housing Market

In order to better contextualize the New England housing market the following section
includes a number of summary statistics for the region from both data sources, the Census Bureau and USPS-HUD data.

The percentage of building vacant for more than twelve months is approximately 2.4% in New England for 2012. Rhode Island had the highest percentage of building vacant for more than twelve months, 3.3%, while Vermont had the least, 1.5% (see Figure 1). The high percentage in Rhode Island may be due to the state's small size and overall less number of buildings.

Overall, New England has a high percentage of residents that are housing cost burdened. 39.8% of all occupied housing (owner occupied with or without a mortgage and renters) pay more than thirty percent of their income on housing costs. Again, Rhode Island has the highest percentage of housing cost-burdened residents, at 42.0%, potentially due to its rank as the smallest state in land area. While Maine has the lowest percentage of housing cost burdened residents, 35.1% (see Figure 2). This is an interesting observation knowing housing costs relate to developable land constraints.
State-by-state Results

Connecticut

Connecticut has at 829 observations with a mean address vacancy rate of 2.93% and a mean percent of housing cost burdened residents of 41.8%. The regression is statistically significant at the 99% level with a p-value of less than 0.01. The $\beta_{PALLHCB}$ coefficient equals 0.117; meaning for every increase in percentage of housing cost burden residents there is a 0.117 increase in address vacancy rates. Given an R-squared of 0.278, approximately 27.8 percent of the change in address vacancy rate can be explained by housing cost burden using the regression.

$$Y_{VACRATEi} = -0.0198 + 0.117*X_{i} + \epsilon_{i}$$

Connecticut has a Moran's Index value of 0.229 resulting in relatively low clustering of the residual. Observing the Moran's I Test of Residuals map (See Figure 5) we can see that most of the high-high clustering occurs around the most rural areas of Connecticut in the northwest and eastern corners as well as in the urban regions such as metro Hartford and Waterbury. The majority of low-low clustering occurs around the suburbs northwest of Bridgeport. Some urban areas such as the metro area of New Haven and the southwest tail of the state appear to have a mixture of high-low and low-low clustering.

Maine

Maine has 351 observations and the mean of the address vacancy rate is 1.98% while the mean of the percentage of housing cost-burdened residents is 34.4%. The regression is statistically significant with a p-value of less than 0.01. The $\beta_{PALLHCB}$ coefficient equals 0.111; meaning for every percentage increase of housing cost burden residents there is a 0.111 increase in address vacancy rate. With an R-squared of 0.092, approximately 9.2% of the change in address vacancy rate can be explained by housing cost burden using the regression. However, observing the scatter plot one can see that there are a large number of observations with a vacancy rate of zero. This may be due either to the Postal Service's methodology in categorizing vacant addresses in rural areas or simply due to the large number of census tracts in Maine that are rural and may have very few addresses.

$$Y_{VACRATEi} = -0.0185 + 0.111*X_{i} + \epsilon_{i}$$

Maine has a Moran's Index value of 0.242 leading me to conclude that Maine has relatively low clustering of the residual. Observing the residual map and Moran's I test of residuals map (See Figures 8 & 9), the majority of high-high clustering occurs in the urban areas of Maine including Farmington, Augusta, Portland, and Cutler. However, the Bangor region includes a group of low-low clusters. The majority of low-low clustering occurs in rural areas of the state.
Massachusetts
Massachusetts has 1,473 observations, the mean address vacancy rate is 2.31%, and the mean percentage of housing cost-burdened residents is 55.48%. The regression is statistically significant at the 99% level with a p-value of less than 0.01. The $\beta_{PALLHCB}$ coefficient equals 0.036; meaning for every percentage increase of housing cost burdened residents there is a 0.036 increase in the address vacancy rate. With an R-squared of 0.029, approximately 2.9% of the change in address vacancy rate can be explained by housing cost burden using the regression.

$$Y_{VACRATE_i} = 0.0084 + 0.036 * X_i + \epsilon_i$$

Massachusetts' Moran's Index value is 0.302, the second highest in New England, representing relatively significant clustering of census tracts. Most interesting about the Moran's I test results (See Figure 13) are the clustering of low-low residuals around the south shore of the Boston metro area and the clustering of high-high residuals in the Berkshires and the rural region between the Pioneer Valley and Worcester metro region. One explanation could be growth and demand in the south shore metro region for housing for workers commuting into Boston proper. If this is a high growth area, we could expect there to be lower vacancy rates due to increasing demand for housing.

This relationship also helps to explain the high-high clustering of residuals in the Berkshires and area between the Pioneer Valley and Worcester metro area. These areas may have less demand for housing due to recent demographic shifts to urban areas. Interestingly, the greater Gloucester region is experiencing high-high clustering, I wonder if this is a remnant of the 2007-2008 mortgage crisis as the region may have large numbers of address vacancies caused by underwater mortgages and overbuilding.

New Hampshire
New Hampshire has 295 observations, the mean address vacancy rate is 3.62%, and the mean percentage of housing cost-burdened residents is 38.64%. New Hampshire is one of two states (Vermont being the second) non-statistically significant regression results, given a p-value of 0.782. Additionally the dispersed nature of the observations results in a very low R-squared of 0.000263, approximately 0.02% of the observations can be explained by the regression. It is interesting to note the lack of statistically significance for New Hampshire given all other states' regressions have been statistically significant up to this point.

$$Y_{VACRATEi} = 0.0385 - 0.0064 * X_i + \epsilon_i$$

Given the statistical insignificance of the regression, any conclusions based on the spatial autocorrelation of the resulting residual must be observed with caution. However, it is interesting to note the southern, and most urban portion of the state around the Nashua, Concord, and Manchester have low-low autocorrelation of the residuals while the northern and most rural
portion of the state have high-high spatial autocorrelation of residuals (See Figure 17). This could be due to a variety of factors including high demand for housing leading to low vacancy rates in the southern portion of the state due to its proximity to the metro Boston market or lower household income and higher poverty rates in the northern portions of the state.

**Rhode Island**

Rhode Island has 241 observations, the mean address vacancy rate is 3.41%, and the mean percentage of housing cost-burdened residents is 42.32%. The regression is statistically significant at the 99% level with a p-value of less than 0.01. The $\beta_{\text{PALLHCB}}$ coefficient equals 0.112; meaning for every percentage increase of housing cost burdened residents there is a 0.112 increase in the address vacancy rate. Approximately 15.3% of the change in address vacancy rate can be explained given the regression, as the R-squared is 0.15332.

$$Y_{\text{VACRATEi}} = -0.0132 + 0.1116X_{\text{i}} + \epsilon_{\text{i}}$$

Rhode Island's small size and diversity of geographic regions presents an interesting case study for further analysis. The Moran's Index value is approximately 0.292, leading me to conclude that there is some spatial clustering of census tracts in Rhode Island. The urban centers of Providence and Pawtucket appear to have high-high spatial autocorrelation of the residuals (See Figure 21). While the first ring suburbs around these cities appear to have no significant autocorrelation, the second ring of suburbs and exurbs have low-low spatial autocorrelation. Potentially, this could be explained by high desirability of exurb neighborhoods that may have high housing cost burden and low vacancy rates.

**Vermont**

Vermont has 184 observations, the mean address vacancy rate is 1.20%, and the mean percentage of housing cost-burdened residents is 37.94%. Like New Hampshire, the variable percent of housing cost-burdened residents is not statistically significant at the 99% level, as the p-value is 0.115. Like Maine and New Hampshire, Vermont has many observations with zero vacancy rates. Again, this may be due to the methodology employed by the USPS in recording vacant addresses, as rural route addresses vacant for more than ninety days are considered "no stat". The lack of statistical significance of the regression is reflected in a very low R-squared, allowing us to explain only 1.35% of the change in vacancy rates due to housing cost burden. Examining the data further would be required to determine whether many of the census tract observations have large numbers of "no stat" addresses.

$$Y_{\text{VACRATEi}} = 0.00007 + 0.032X_{\text{i}} + \epsilon_{\text{i}}$$

Vermont's Moran's Index value is approximately 0.218, indicating low- to moderate-clustering. High residuals in Vermont occur in many of the urban areas of Vermont including Montpelier, Barre, Burlington, and Rutland (See Figure 24). Low-low spatial autocorrelation of the residuals cluster in the southern portion of the state and around the Burlington suburbs (See
Figure 25). Much like New Hampshire's regression, caution should be taken in considering spatial clustering of residuals for a regression that proved to be not statistically significant.

**State Comparisons**

Overall, the statistical regression between housing cost burden and vacancy rates provides very interesting results. Five out of six states did not have the hypothesized negative relationship between housing cost burden and vacancy rates, but instead a positive relationship. Only New Hampshire has a negative coefficient but the regression was not statistically significant.

Comparing across such large geographic areas using census tract level data is difficult due to the wide range of results observed in each individual state. However, a number observations can be made:

1.) Northern New England and southern New England's housing markets have different characters

   There appears to be a split between southern New England (Connecticut, Massachusetts, and Rhode Island) and northern New England (Maine, New Hampshire, and Vermont). Southern New England's regressions have a much higher goodness-of-fit (R-squared) than northern New England and spatial autocorrelation patterns between urban and rural markets appear different. Because northern New England tends to be more demographically dispersed than southern New England, it may be helpful to compare the two sections of the region separately from each other. Additionally, the rural nature of northern New England may be causing data issues as the USPS-HUD dataset classifies rural route addresses that have been vacant for more than ninety days as "no-stat", which was not included in this analysis, rather than "vacant". Finally, poverty in southern New England tends to be concentrated in urban areas while poverty in northern New England tends to be more prevalent in very rural portions of the states. This affects the housing cost burden variable because household income functions as the denominator in calculating housing cost burden.

2.) Classification of rural addresses requires further investigation

   The insignificance of the New Hampshire and Vermont housing cost burden on vacancy rates may be due to the classification system by the US Postal Service. A more investigative analysis to determine the reasons for the lack of significance could be beneficial to understand the housing market in these states.

3.) Urban cores are different

   In southern New England, urban areas appear to have spatial autocorrelation clusters of either high-high residual significance or no residual significance. This
leads me to conclude that these urban areas have higher than average vacancy
rates given the percentage of the population that is housing cost burdened. It is in
these areas that one would expect to find the most marginal gain of rehabilitation
building codes due to the dynamic nature of urban markets and the prevalence of
existing structures. This is a critical area of further research; a more in-depth
study of urban census tracts compared to rural ones could yield significant results.

4.) High-growth regions have low residuals

High-growth regions appear to have either low-low or insignificant spatial
autocorrelation of the residuals. Take for example the south shore of the metro
Boston area and the southeast corner of New Hampshire. This contrasts with low-
growth regions such as the Berkshires in Massachusetts that have high-high
spatial autocorrelation and therefore may be seeing higher than expected vacancy
rates given the housing cost burden of these census tracts. Further research may
wish to explore this area and include such variables as number of building permits
issued or population change to function as a proxy for growth.

5.) Rural and suburban census tracts in southern New England have lower residuals

In southern New England, rural and suburban areas appear to have lower residuals
and more low-low spatial autocorrelation. This may partially be due to higher
rates of rural poverty and low household income (thereby increasing housing cost
burden).

Discussion and Future Research

But how do all these observations translate in relation to the existence of a rehabi litation
building code? It is difficult to examine technical building codes without the knowledge or
consultation of an expert opinion. However, five of six New England states have codes targeted
for existing building rehabilitation. Four of these five use the International Code Council
version, the International Existing Building Code (see Table 1). Only Rhode Island has
developed its own rehabilitation building code, largely based off the New Jersey Subcode model
(Wolf, 2014). The only state without a rehabilitation building code is Vermont, unfortunately
also one of the two states in which the percentage of housing cost burdened residents variable
was not statistically significant. Thus, it is difficult to draw any definitive conclusions as to how
the presence of existing building or rehabilitation building codes influences address vacancy
rates or housing cost burden in this study. Further analysis may utilize various qualitative
aspects of the building codes such as whether they allow work areas, establish the current
building as the base safety measurement, or provide for categories of work. Ranking these
various qualitative aspects with the help of code enforcement professionals could provide
interesting categorical or binary variables that could be paired with the USPS-HUD dataset to further examine relationships between adaptive reuse and building codes.

Observing the differences in spatial autocorrelation between urban, suburban, and rural areas, the three categories of housing markets appear to be very different from each other regarding the relationship between vacancy rates and housing cost burden. Galvan's study of state rehabilitation building codes purports traditional codes hurt central cities as they offer the competitive advantage to suburban markets (Galvan, 2006, p. 1752). This could be another area ripe for additional research. The US Department of Agriculture develops *Urban Influence Codes* that utilize proximity to metropolitan areas to classify counties into twelve different categories. Applying the *Urban Influence Codes* to census tracts and examining differences in the categories could assist in understanding differences in vacancy rates and housing cost burden between urban, suburban, and rural markets.

Clearly, the realm of building codes as policy instruments for rehabilitation of housing is an area that requires further exploration. Due to the technical nature of building codes, it would be helpful to have the expertise of an enforcement officer or developer when analyzing how heavily the building code burdens redevelopers or agencies wishing to rehabilitate buildings with costly repairs that add insignificant levels to the safety of the building.

**Policy Suggestions**

As the states and local municipalities deal with ageing infrastructure and increasing demand for housing in central cities, there are many choices to be made by residents, policy makers, planners: Fix or build new? Save or destroy? In an era when culture is an increasingly important economic development tool and "branding" one's city becomes critical, state and local government should be at the forefront of saving their built environment and architectural heritage. Adoption of rehabilitation codes or "Smart Codes" by legislators and policymakers is not the panacea to the "tear down and rebuild" mentality, a variety of interlocking institutions in the private, non-profit, and public sectors must support the adoption and implementation of "Smart Codes".

Urban areas are likely to be the greatest beneficiaries from rehabilitation building codes. Assets including their older building stock and existing infrastructure combined with economic development via culture, improving the affordability of housing for residents, and younger demographics' migration into cities present an excellent policy opening for mayors, city councils, and other government officials to advocate to state legislatures for building codes friendlier to rehabilitation. My data has shown that urban housing markets are clearly different from suburban and rural markets, urban municipalities developing their own building codes would likely be controversial and could potentially hinder redevelopment in the long-run as it would create extra costs for developers working across jurisdictions (Seward, 2007, p. 66). This does not mean that urban communities cannot be on the forefront of advocacy for rehabilitation codes.
Rhode Island is one of the few New England states that have successfully implemented its own rehabilitation building code. Redevelopers in Rhode Island continually expressed frustration and discontent over the building codes, specifically in Providence and Pawtucket. Through a coalition of developers, public agencies, and policy organizations such as Grow Smart Rhode Island, as well as the leadership of the Rhode Island State Senate President, Rhode Island was able to adopt their own rehabilitation building code partially based off the New Jersey Subcode model (Wolf, 2014). The new rehabilitation code has proved critical in a number of projects including rehabilitating industrial mill that have outlived their industrial use and been vacant for years, if not longer, into affordable and market rate housing.

Building code compliance departments are woefully understaffed. The adoption of yet another code to learn, understand, and comply with will likely be met with resistance unless more funding is allocated. New Jersey State Department of Community Affairs provided training to 1,200 New Jersey code officials on the use of the Subcode (U.S. Department of Housing and Urban Development, 1999, p. 8). Other means of support could include additional funding to local code enforcement departments in the form of local aid from the state. Upfront aid could assist building code compliance departments to embrace rehabilitation codes and employ them effectively. Local aid functions as an investment of tax base growth as redevelopment can help bring additional employment and income to both localities and the state.

Finally, while the Federal government via the U.S. Department of Housing and Urban Development has established the Nationally Applicable Recommended Rehabilitation Provisions, simple suggestions and guidance documents will not overcome decades of institutional inertia. Adoption of rehabilitation building codes should be included as performance criteria when assessing applications for Community Development Block Grants or other grant based funding programs. Allowing communities to gain points for being "passively proactive" to rehabilitation of existing structures aligns with many of US HUD's goals of sustainability, affordability, and quality.

Conclusion

Policy research on building codes is an area ripe for increased analysis. Building codes remain a complicated and sometimes confusing area of technical and practical expertise. As the regulatory documents that decide what and how we structure our built environment, they imply indelible impacts on cities, towns, and rural communities. Regulations with such a large affect on our own and future generations deserve continual analyses in the same way education, trade, and environmental regulations are revisited year after year.

Roadblocks on the path to adopting rehabilitation codes may present themselves in the form of the home construction industry, fire marshals, politicians, or simply lack of public interest. Nevertheless, with strong coalitions of stakeholders and enough political willpower it is clearly possible for states to design, adopt, and enact their own rehabilitation code.
The USPS-HUD dataset presents a significant resource for planners attempting to track the health of individual neighborhoods or the policymakers concerned with the effectiveness of policies to lower vacancy rates. While the research in this capstone did not align with expected economic theory, it opens many doors to future research and presents a number of interesting findings in the relationship between address vacancy rates and housing cost burden across New England. Further research utilizing the USPS-HUD dataset and applying it to study the impacts of rehabilitation building code adoption remains promising.

As our metropolitan and urban areas regain the public spotlight, rehabilitation building codes should be at the forefront of planners, policymakers, and politicians’ mindset as ways to passively encourage redevelopment in a sustainable, historically respectful, and affordable way. Not only can we save the built environment that gives the cities and towns we call home character, we can utilize market forces to do so. All the while, increasing the housing stock supply to drive down the cost of housing, conserving our open-space resources for future generations, and encouraging adaptation of underutilized properties to ensure vacancy rates remain low and neighborhoods stay safe with eyes on the street. The many benefits of rehabilitation building codes fit perfectly with our goals for our 21st century communities.
Appendix

1.1 Maps and Figures

Figure 1: Percent of Vacant Addresses in New England

Figure 2: Percent of Cost Burdened Housing Units in New England
Figure 3: Connecticut - Scatter plot of Housing Cost Burden on Vacancy Rate

Figure 4: Connecticut - Map of Residuals
Figure 5: Connecticut - Moran's I Test of Residuals
Figure 6: Connecticut - Moran's I Test of Residual Significance
Figure 7: Maine - Scatter plot of Housing Cost Burden on Vacancy Rate
Figure 8: Maine - Map of Residuals

Figure 9: Maine - Moran's I Test of Residuals
Figure 10: Maine - Moran’s I Test of Residual Significance

Figure 11: Massachusetts - Scatter plot of Housing Cost Burden on Vacancy Rate
Figure 12: Massachusetts - Map of Residuals

Figure 13: Massachusetts - Moran's I Test of Residuals
Figure 14: Massachusetts - Moran’s I Test of Residual Significance

Figure 15: New Hampshire - Scatter plot of Housing Cost Burden on Vacancy Rate
Figure 16: New Hampshire - Map of Residuals

Figure 17: New Hampshire - Moran's I Test of Residuals
Figure 18: New Hampshire - Moran's I Test of Residual Significance

Figure 19: Rhode Island - Scatter plot of Housing Cost Burden on Vacancy Rate
Figure 20: Rhode Island - Map of Residuals

Map of Residuals: Rhode Island

Figure 21: Rhode Island - Moran's I Test of Residuals

Moran's I Test of Residuals: Rhode Island

Figure 21: Rhode Island - Moran's I Test of Residuals
Figure 22: Rhode Island - Moran's I Test of Residual Significance

Figure 23: Vermont - Scatter plot of Housing Cost Burden on Vacancy Rate
Figure 24: Vermont - Map of Residuals

Figure 25: Vermont - Moran’s I Test of Residuals
2.1 U.S. Census Bureau - American Community Survey 5-Year Estimate methodology

This multiyear ACS Accuracy of the Data document pertains to both the 2010-2012 3-year ACS data products and the 2008-2012 5-year ACS data products. Differences will be noted where applicable.

The data contained in these data products are based on the American Community Survey (ACS) sample. For the 3-year data products interviews from January 1, 2010 through December 31, 2012 were used. For the 5-year data products, interviews from January 1, 2008 through December 31, 2012 were used. Data products were produced for 1-year estimates (2008, 2009, 2010, 2011 and 2012), in addition to this set of 3-year and 5-year estimates.

In general, ACS estimates are period estimates that describe the average characteristics of population and housing over a period of data collection. The 2010-2012 3-year ACS estimates are averages over the period from January 1, 2010 to December 31, 2012, and the 2008-2012 5-year ACS estimates from January 1, 2008 through December 31, 2012, respectively. Multiyear estimates cannot be used to say what is going on in any particular year in the period, only what the average value is over the full period.

The ACS sample is selected from all counties and county-equivalents in the United States. In 2006, the ACS began collection of data from sampled persons in group quarters (GQ) – for example, military barracks, college dormitories, nursing homes, and correctional facilities.
Persons in group quarters are included with persons in housing units (HUs) in all 2010-2012 3-year and 2008-2012 5-year ACS estimates based on the total population.

The ACS, like any statistical activity, is subject to error. The purpose of this documentation is to provide data users with a basic understanding of the ACS sample design, estimation methodology, and accuracy of the 2010-2012 3-year and 2008-2012 5-year ACS estimates. The ACS is sponsored by the U.S. Census Bureau, and is part of the 2010 Decennial Census Program.

Additional information on the design and methodology of the ACS, including data collection and processing, can be found at [http://www.census.gov/acs/www/methodology/methodology_main/](http://www.census.gov/acs/www/methodology/methodology_main/)

### 2.2 HUD Aggregated USPS Administrative Data On Address Vacancies methodology

HUD receives quarterly extracts of these data at the ZIP+4 level. Under the license agreement with USPS, HUD must aggregate these data, at least to the census tract level, for public dissemination.

Each quarterly extract is geocoded by HUD’s Geocode Service Center (GSC). The ZIP+4 records that do not geocode to the census tract level (e.g., geocode only to the 5-digit ZIP Code level) are excluded from the aggregation process. On average, only about 1% of the ZIP+4 records HUD receives do not make it to the public census tract-level files. With each new quarterly extract, HUD makes an attempt to geocode the non-geocoded ZIP+4 records from the previous extract along with the new ZIP+4 records from the current extract. The GSC’s base data is updated frequently so ZIP+4 records that were not geocoded in the previous quarter may in fact geocode in the present quarter. This accounts for the variance in the number of records in the aggregate tract-level files from quarter to quarter.

Users should be aware of this when measuring change between quarters. Also note that ZIP+4 data may not necessarily align with census tract boundaries. In most cases, ZIP+4’s represent a location or set of locations on one side of a single street segment. However, ZIP+4’s can also occur across multiple segments and on both sides of a segment(s) and can possibly straddle a census tract boundary. We are currently evaluating the effect of this occurrence on the data aggregations.
### 3.1 Data Variables used in the analysis

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