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THE ENVIRONMENTAL COST OF EASY CREDIT:  
THE HOUSING CHANNEL

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**ABSTRACT**

Heating, cooling, and powering the residential housing stock accounts for about one-fifth of total annual greenhouse gas emissions in the US. Home size is a key determinant of energy intensity. The average newly built single-family home is 50% larger than in the 1950s. Using distinct identification strategies spanning the last four decades of banking history, we show that more abundant credit increases average new home size. It also facilitates more construction but does not produce offsetting increases in home quality or durability. These results highlight potential environmental costs associated with monetary policies that expand access to credit.

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The growing urgency of climate change and the need to take collective action to curb global greenhouse gas (GHG) emissions has placed concerns about energy and the environment at the forefront of public debate throughout the world. The residential housing stock is a large contributor to GHG emissions, especially in the developed world. In the United States, which is second only to China in the global league tables of CO<sub>2</sub>-emitting countries, as much as 20% of all carbon emissions stem from heating, cooling, and powering residential households (US Energy Information Administration, 2019). Because the US is both a populous and a wealthy country, the aggregate carbon emissions of the US housing stock are greater than the overall carbon emissions of all but a handful of countries—Japan, Russia, India, China, and the rest of the US.

In this paper, we consider how the supply of credit affects the carbon intensity of the residential housing stock. There is a burgeoning literature on environmental, social and governance (ESG) considerations in financial markets.<sup>1</sup> The question in this paper considers the environmental consequences of credit conditions in capital markets, even when no explicit ESG investor preferences are driving capital allocation decisions.

Credit availability affects carbon intensity through a variety of distinct channels: new home size, new home quality and durability, and the quality and durability of existing structures that have undergone renovation. All else equal, larger homes unambiguously increase the carbon footprint of the housing stock. Not only do bigger houses require more material to build, they require more energy to operate on a day-to-day basis, as can be seen in Figure 1 (and is studied in detail in Wilson and Boehland, 2005; Larson, Liu, Yezer, 2012; Goldstein, Gounaridis, and Newell, 2020).<sup>2</sup>

### **Insert Figure 1 About Here**

Figure 1 plots coefficients from a regression of household energy costs on household square footage using data from the American Housing Survey.<sup>3</sup> The figure shows a distinct

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<sup>1</sup> This literature is too large to survey here; however, a number of recent papers explicitly connect ESG preferences to capital flows and the cost of capital. Recent work includes Hartzmark and Sussman, 2019, Oehmke and Opp, 2020, Bolton and Kacperczyk, 2021, Pastor, Stambaugh and Taylor, 2021, among others.

<sup>2</sup> Evidence outside the US shows the same basic relation between size and energy use. Yohanis et al (2008) find similar patterns in Northern Ireland, Paulsen and Sposto (2013) find similar patterns in Brazil, while Santin et al (2009) report evidence from the Netherlands and Clune et al (2012) find similar evidence in Australia.

<sup>3</sup> The regressions include controls for the natural logarithm of household income (HINCP), CBSA fixed effects and fixed effects for the decade in which the house was built (precise years are omitted for the sample of households

increase in total monthly energy cost for bigger homes relative to smaller homes. In terms of magnitudes, the point estimates indicate that houses over 3000 square feet in area spend almost \$100 more in energy (in 2019 dollars) than those that are around 1000 square feet after accounting for the effects of income, geography, and other observables.

While the relation between individual home size and energy use is clear, the direction of the environmental impact of mortgage credit on the average size and total number of new homes (i.e., the *quantity* of residential structures) depends on how additional credit affects the composition of buyers of new homes. By shifting the distribution of borrowers across new and existing structures (and the rent vs own decision), easier credit could either lead to higher or lower carbon intensity of new housing construction. For example, easier credit could enable lower-income borrowers to become first-time new home buyers, increasing the supply of smaller, new homes—an effect that could potentially lighten the carbon footprint of the housing stock. Or it could allow middle-income borrowers to afford larger new homes with greater amenities, potentially increasing the carbon footprint of the housing stock.

Changes in the supply of credit can also affect the *quality* of the housing stock through its effects on new homes and on the propensity to renovate the existing housing stock. More credit can ease the adoption of energy-saving home improvements for new or existing structures and simultaneously encourage renovations that expand energy needs. The durability channel is equally ambiguous. Building costs represent between 26 and 50% of the total energy use over the life of a home (Stephan, Crawford, and Myttenaere, 2012; Stephan and Crawford, 2016), so any energy-saving improvements in new building technologies must be weighed against these initial costs and the corresponding amortization period. Ultimately the aggregate net effect of these forces, and hence the overall impact of easier credit on the environmental cost of housing, is an empirical question.

Over the long term, the number, size, and quality of new homes are likely to reflect low-frequency effects like changes in fertility, migration, household formation rates, and household preferences. The question we ask in this paper is whether, at the margin and holding these effects constant, higher frequency shifts in the availability of credit affect the carbon footprint of new

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with CBSA information to preserve anonymity). Energy costs are expressed in constant 2019 dollars, and include ELECMT (monthly electricity costs), GASMT (monthly gas costs), OILMT (monthly oil costs). We also control for the year the house was built (YRBUILT).

residential housing stock. Ultimately, the marginal home buyer at any given point is not necessarily the buyer of the marginal home built. Given the longevity of residential structures, these high-frequency shocks have the potential to affect the energy consumption of homes over many decades.

To connect changing new home construction to credit conditions, we focus on three natural experiments covering four decades between the 1970s and the 2000s that have been shown to affect the local supply of credit. Our central result is that easier mortgage credit makes for larger homes, but it generally does not create better or more durable homes. In addition, some episodes of credit expansion lead to more construction. Across a range of historical episodes, the elasticity of home size with respect to the quantity of credit supplied is about 0.2. This magnitude is significantly higher in areas with low housing supply elasticity (Saiz, 2010), with higher construction costs, and where outside temperatures require cooling and heating houses for more days of the year on average. There is generally a sizable acceleration of construction of new homes when credit is easier, but no noticeable changes in average new home quality or current condition.

The first empirical setting we consider is the wave of banking deregulation that occurred beginning in the 1970s through the mid-1990s, culminating in the Riegle-Neal Interstate Banking and Branching Efficiency Act (IBBEA) of 1994. Banking deregulation brought about profound changes in the scope and operation of banks, with sharp increases in bank acquisitions (Jayaratne and Strahan, 1998; Berger, Kashyap, Scalise, Gertler, and Friedman, 1995; Strahan, 2002; Stiroh and Strahan, 2003, provide an overview of the changes to the banking industry structure and Kroszner and Strahan, 2014, survey the literature) and evidence of economic growth (Jayaratne and Strahan, 1996; Mian, Sufi and Verner, 2020, show that higher growth is followed by more severe recessions), firm entry and exit (Black and Strahan, 2002; Kerr and Nanda, 2009) and innovation (Chava, Oettl, Subramanian and Subramanian, 2013, and Amore, Schneider and Zaldokas, 2013). We exploit the staggered introduction of banking deregulations that allowed banks to expand within states (intrastate deregulation), resulting in a significant reduction in the importance of small banks, and across states (interstate deregulation) that allowed acquisitions by out-of-state banks. We use the dates identified in the literature (see, e.g., Kroszner and Strahan, 1999) to compare housing composition in treated and non-treated states around the time of deregulation.

As a second test, we draw on recent work by Mian and Sufi (2022), who show that regions with higher fractions of mortgage originators that relied primarily on non-core deposit financing

(or non-core liabilities, NCL) experienced looser mortgage credit conditions in the 2001-2006 housing boom. Motivated by this observation, we consider variation in the cross-section of non-core liabilities at the Zip code level as a source of credit supply variation and examine how the flow of new homes in Zip codes exposed to higher NCL ratios differs from new construction in Zip codes with lower exposure.

Finally, to fill the gap between the two periods we use the introduction of state-level restrictions to interstate banking that arose following the Riegle-Neal IBBEA Act of 1994. We follow Rice and Strahan's (2010) classification of each state's restrictions to both *de novo* branches by out-of-state banks, and restrictions to acquisitions of in-state institutions by out-of-state banks, including minimum age of the target institutions, whether banks allow partial acquisitions, and size caps of acquisitions. These restrictions have been associated with the cost of financing for small firms (Rice and Strahan, 2010), increased housing credit supply (Favara and Imbs, 2015), and increases in innovation by private firms (Cornaggia, Mao, Tian, and Wolfe, 2015).

The magnitudes of the effects we measure are economically and environmentally important. For example, depending on the specification, we find that interstate banking deregulation pre-1994 causes a permanent increase in average new house size of between 1 and 2%, and up to five percentage points in areas with below-median housing supply elasticity.<sup>4</sup> To put this in perspective, consider long-run changes in average home size. A new home built in 1965 averaged around 1600 square feet; new homes average around 2,400 square feet today. This amounts to a 7-10% per decade increase from the 1960s to the decade ending with the Global Financial Crisis, which implies that our (cross-sectional) coefficients are about one-third of the magnitude of the average house size increase per decade over the last few decades. We find coefficients of a very similar magnitude when we consider the effect on new home size of exposure to originators that relied on non-core liabilities for funding.

The total environmental implications of credit supply are driven by the total square footage of the overall housing stock and its condition, and thus the number of houses is also important. Pre-1994 interstate banking deregulation created bigger homes on average, and it also increased the number of new homes. The flow of newly built single-family houses built per year is 15-20% larger in Zip codes located in states treated by interstate banking deregulation than in non-treated

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<sup>4</sup> These results control for large remodeling, renovation or new construction on the same land parcel, as well as for changes in state-level income and population.

states, with an economically smaller effect in areas where it is harder to build (although the difference is not statistically significant). The quantity of new construction also increases for the NCL identification strategy in the early 2000s and is clustered in a few states with higher NCL concentration.

The effects we identify are important not only because they are large in magnitude, but because they are long-lasting. Houses in the US have an average lifespan of 40 years (Goldstein, Gounaridis, and Newell, 2020). This means the extra square footage built today will most likely be heated and cooled well into the second half of this century, with potentially large consequences for carbon emissions. Replacing these structures with more environmentally efficient ones introduces a heavy toll in terms of the upfront environmental cost of teardown and new construction.

The availability of mortgage credit also operates through changes in the quality of new and existing residential structures. Home renovation, especially advances in the energy efficiency of heating and cooling, are potentially important channels for mediating some of the effects we identify, at least in principle. Our data includes the current quality and condition ratings assigned by counties to the existing structures, so we can ask whether homes built following credit supply shocks differ on these dimensions. In general, and across all three empirical settings, the answer is that they do not. This suggests that expansions in credit supply did not affect average new home quality very significantly. In addition, we can measure whether a home was torn down or underwent renovations that require a permit. We do not find that the likelihood that a house will undergo this type of major renovation changes significantly with variation in the supply of credit.

Despite the tests described above, the measures of quality in our setting are imperfect. We are also unable to observe many potential renovations to existing structures that do not require permits (or are measured with error in the data). We can, however, assess the likely impact of the “quality” channel on overall energy use by turning to an alternative data source, the American Housing Survey. To be clear, in this subset of tests we are not asking how credit affects quality but, rather, how changes in home quality affect energy use. But this allows us to put bounds around potentially unobserved effects on home quality due to changes in the supply of credit that might mitigate or exacerbate the effects on home size we estimate.

Using the American Housing Survey we can measure how average home quality is correlated with monthly energy costs (and, with some reasonable assumptions, monthly energy

use), as well as how home improvements affect energy costs, irrespective of what gave rise to the renovations in the first place. We obtain three main results from this analysis. First, “better” homes consume more energy, not less, once we have accounted for all available observables in the data (including controlling flexibly for home size and household income). This implies that, to the extent that more credit might lead to higher quality homes, this would increase its overall effect on carbon output. Second, the marginal energy operating costs of an additional square foot of a home built up to the 2010s are similar to those of a home built in the 1960s. Thus, more recently constructed homes are not generally cheaper to heat and cool on a per-square-foot basis. Third, and finally, we show that home improvements do not, on average, reduce the energy usage of homes. Even energy-saving home improvements, which in principle lower monthly utility costs, do not lower the utility costs of homes in which they are adopted because they coincide with other home improvements that have offsetting effects. These results suggest that it is unlikely that renovations meaningfully attenuate the overall trends associated with increasing home size.

This paper connects distinct literatures in banking, climate finance, and the effects of credit supply on real outcomes. Our empirical setting builds on important work in banking deregulation, including Jayaratne and Strahan (1996, 1998), Rice and Strahan (2010), Favara and Imbs (2015), Brook, Hendershott, and Lee, (1998); Kerr and Nanda (2009) consider firm entry and exit, and Chava, Oettl, Subramanian, and Subramanian (2013), and Amore, Schneider, Žaldokas (2013) study deregulation and firm innovation. Recent work by Mian and Sufi (2022) and Griffin, Kruger, and Maturana (2021) motivate the increase of non-core liabilities as a shock to mortgage credit in the 2000s.

Our work is part of growing interest in the effects of climate change risk on different dimensions of housing finance. Flood risk has received particular attention given the predicted increase in this type of risk for coastal regions in the US over the coming decades. The effect of flood risk on house prices is explored in Murfin and Spiegel (2020), Baldauf, Garlappi, and Yannelis (2020), Bernstein, Gustafson and Lewis (2021), and Giglio, Maggiori, Rao, Stroebel, and Weber (2021). Keys and Mulder (2020) explore the relation between flood risk and transaction volume. Flood risk affects the sorting of homeowners (Bakkensen and Barrage, 2021; Billings, Bernstein, Gustafson, and Lewis, 2022) as well as insurance uptake (Wagner, 2019). Recent work by Sastry (2021) explores how the banking sector attenuates the moral hazard associated with

subsidized insurance through changes in equilibrium loan-to-value ratios.<sup>5</sup> Bolton and Kacperczyk (2020) and Giglio, Kelly, and Stroebel (2021) provide excellent recent surveys of climate finance. In related work connecting credit and investment, Kacperczyk and Peydro (2021) show that bank-level commitments to carbon neutrality affect loan supply to green relative to brown firms and, consequently, these firms' investment activity. Finally, the paper is related to Shapiro (2021) who uncovers an environmental bias in trade policy, whereas we consider indirect consequences of changes in credit supply.

The remainder of the paper is organized as follows. In Section 1, we describe the Zillow Transaction and Assessment Dataset (ZTRAX) housing data that allow us to measure the key properties of the housing stock over time and relate it to other key variables in our analysis. Sections 2-4 relate credit shocks to changes in the composition of the housing stock using each of the empirical specifications discussed above. Section 5 explores the potential for renovations of existing structures to attenuate the main results we document. Section 6 concludes with a discussion of policy implications.

## **1. Housing Data**

Our primary source of data for analyzing housing characteristics is the ZTRAX Assessor files pulled in Oct-2021. The Assessor files contain information on a variety of house characteristics, including the year a house was built (or, more precisely, the year the first housing structure on a given plot was finished and included in the local county assessor files), as well as the living area and two other variables of interest for our analysis, an index for the quality of the structure and

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<sup>5</sup> Additional work includes that examining flood damage and securitization (Ouazad and Kahn, 2021), origination behavior (Cortés and Strahan, 2017), household finance and delinquencies (Gallagher and Hartley, 2017; Kousky, Palim, and Pan, 2020; Issler, Stanton, Vergara-Alert and Wallace, 2021). For work on climate change, the price of risk and hedging see Arrow (1995), Bansal, Kiku and Ochoa (2016), Barnett, Brock and Hansen, (2020), Krueger, Sautner, and Starks (2020), and Engle, Giglio, Kelly, Lee, and Stroebel (2020).

another index for the current condition of the house (as of October of 2021). For all of our analysis, we aggregate the house-level data down to the (Zip code)-by-(year built)-by-(house type) level.

We start with approximately 1.5 million observations pertaining to single-family homes. Multi-family structures such as duplexes, condominiums, and townhouses are excluded.<sup>6</sup> For the square footage analysis, we drop 382,831 observations in which the average living area in new homes in the Zip code is missing, less than 100 square feet, or above 10,000 square feet. The result is an unbalanced panel of 1.12 million (Zip code)-by-(year built) observations. To simplify the graphs and tables, we code homes built before 1930 as “1930”, those between 1931 and 1940 are coded as “1940”, and similarly homes built between 1941 and 1950 are coded as “1950”. All years 1951 and later are left unchanged.

Next, we connect the housing data to each of the three identification strategies. For banking deregulation, we use intra- and interstate banking deregulation dates that pre-date the Riegel-Neal Interstate Banking and Branching Efficiency Act (IBBEA) of 1994 from the literature (see, for example, Kroszner and Strahan, 1999, or Kerr and Nanda, 2009). We code twelve states that had deregulated intrastate banking pre-1965 as “1965” so that they appear as always treated in the regressions.

For the second set of tests, we use the Zip code-level non-core deposit liability ratio in 2002 made available by Griffin, Kruger, and Maturana (2021).<sup>7</sup> The NCL ratio is calculated as one minus the share of core deposits as a fraction of total liabilities for banks and thrifts using call report data and following Mian and Sufi (2022). Our third experiment uses the restrictiveness index developed by Rice and Strahan (2010), which measures the extent to which states restricted the ability of out-of-state banks and bank holding companies to expand across state lines following the IBBEA. Kroszner and Strahan (2014) provide a detailed overview of the changes in the banking industry that run through both sets of experiments used in this paper.

We explore the heterogeneity of our effects across a few dimensions: First, we split the effects at the median of the county-level housing supply elasticity measure from Saiz (2010). We also split by city-level building cost indices at the 3-digit Zip code level from the 2003 RSMean Residential Cost Report. The Report provides a comparison of the cost of materials and labor for

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<sup>6</sup> Robustness checks indicate that this is not central to our findings.

<sup>7</sup> Non-core deposit liabilities data available for Griffin, Kruger and Maturana (2021) from <https://www.jfinec.com/data-and-code>.

a standard structure across locations in the US (the RSMMeans data covers virtually the whole US as of 2003). We further evaluate the impact of credit in locations with above-median and below-median heating and cooling needs, as expressed through “degree days.” Degree days are computed by aggregating at the yearly level the daily deviation of the average temperature from 65° Fahrenheit. For this calculation, we rely on the state-level averages spanning the period from 1950 to 2021. Finally, we partition the results based on the percentage of the population commuting by car weighted by their commute duration, as this is strongly associated with the carbon cost of new housing (Glaeser and Kahn, 2010). The required data is sourced from the American Community Survey (ACS), specifically from the variables *JWTR* and *JWMNP*. We use ACS data for 1990 and aggregate at the county level (in unreported results, we confirm that the 1990 measures are strongly correlated with data from 2010 to 2014). In many of our empirical specifications, we weigh the regressions using Zip code-level population data obtained from the Internal Revenue Service (IRS).

In a subset of empirical tests described in Section 5, we use data from the American Housing Survey (AHS). The survey is sponsored by the Department of Housing and Urban Development (HUD), and it is the U.S.'s most comprehensive housing survey. Houses are included in the survey over several years and are surveyed biennially in odd-numbered years, with the housing samples updated in 1985 and 2015. The AHS offers insights into the nation’s housing size, composition, and quality, tracking changes over time. It includes coarse information (that changes over time) on the metropolitan areas that a home is located in, and it includes detailed information on the physical state of homes, financing, energy and maintenance costs, and profiles of residents.

### **Insert Table 1 About Here**

Summary statistics for the main variables are reported in Table 1. Panel A shows that the (population-weighted) average living area for the zip codes in our sample is approximately 1,950 square feet, and the standard deviation is approximately 800 square feet. Zip code weights are the 1998 Zip code population estimates from IRS data and we use these weights throughout the empirical analysis. Panel B of the same table shows the increase in living area over the last few

decades. The average living area for new homes in our data was under 1,500 square feet before 1960 and rises to approximately 2,400 square feet by the last decade.

Figure 2 plots coefficients from a regression of average house living area for new homes built in a Zip code by year. The “*Year built*” variable corresponds to the first year a residential structure appears in the assessor records. Houses built before 1930 are about 100 square feet larger than those built in the 1940s and 1950s, up to about 1957. Then we see the start of a relatively rapid increase in home sizes up to 1970. By then, new single-family homes were larger on average than they were before 1930. The late 1980s and then the 2000s are periods of rapid increase in new home size that stabilizes by the peak of the housing boom and shows a slight decrease over the last decade.

Panel A of Table 1 shows that there are approximately 91 new single-family homes built in a Zip code each year, ranging from a minimum of 1 new house to a maximum of over 13 thousand. We do not include Zip code-year observations without new single-family homes built in the regressions except when we consider the quantity of new construction. The regressions on the number of new houses are not, however, qualitatively affected by the exclusion of those observations.

Panels A and B of Table 1 also show the summary building quality and current building condition measures from the assessor files. We replace county-assigned building quality ratings with a numeric scale. Ratings range from a minimum of “D-” (replaced by a value of “1”) to a maximum of “A+” (coded as “12”). Average quality in our data is 5.8, the equivalent of a “C+” rating. Figure A1 in the Online Appendix provides two examples from Durham County, NC of a high- and a medium-grade single-family house, as well as the criteria used by the county to assign this grade. Panel B shows that average building quality has been steadily increasing throughout our sample period. Similarly, building condition is coded in the assessor files from a minimum of “Poor”, which we replace with a numeric value of “1”, to a maximum of “Excellent”, replaced with a value of “5”. The average building condition in our data receives a score of 4.1, the equivalent of an “Average” code in the assessor files.

Even though all our regressions are based on the year in which a residential structure first appears in the assessor records, we also have information on whether homes undergo new construction, significant renovations, or remodeling. This information is captured in the “*Effective year built*” and “*Year remodeled*” variables in ZTRAX. Panel A of the summary statistics shows

that 12% of houses in the sample appear with a new effective year built in the data, and Panel B shows that this percentage is increasing every decade, as we would expect, from 20% of homes for the oldest homes in the sample to 4% for the most recent decade. There are fewer homes appearing as remodeled, probably because these capture smaller renovations that are less likely to require a permit. We see 4% of all records experiencing a remodeling, again with an increase over the decades (Panel B).

Summary statistics for the 2005-2019 sample we use from the American Housing Survey are in Appendix Table A6. Households spend, on average, 189 dollars on energy (in 2020 constant dollars), 134 of which are on electricity and 48 on gas. About 8% of households indicate making home improvements to make the home more energy efficient (*HMRENEFF* post 2013, *ENEFIC* in 2011 and 2013; the variable was not available in previous surveys). 40% of households report some cost of repairs or alterations to the unit in the previous two years. These costs are spread over several categories (*RADI-RADn*, where *n* is the maximum number of replacements/additions reported in that survey for 2005-2013, *JOBCOST* for the years post-2013). We flag the household as having made some improvement and summarize this information in the “Improvement Flag” shown on the table.

## 2. Banking deregulation and housing characteristics

The empirical methodology for our first natural experiment uses the staggered introduction of both intrastate and interstate deregulation pre-1994 at the state level to implement a differences-in-differences regression beginning in 1965.<sup>8</sup> Specifically, we run regressions that mirror those in Chava, Oettl, Subramanian and Subramanian (2013) of the form:

$$\text{Characteristic}_{\text{Zip},t} = \beta_1 \text{Deregulated}_{d,s,t} + X_{\text{Zip},t} + \eta_{\text{Zip}} + \eta_t + \varepsilon_{\text{Zip},t} \quad (1)$$

The characteristics of interest are the logarithm of the average living area square footage in the Zip code for new homes each year, the logarithm of (one plus) the count of new homes built in a Zip

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<sup>8</sup> Regulations started being relaxed in the 1970s. See Jayaratne and Strahan (1998) Table 1 for exact dates.

code, the average quality of new homes (as included in the assessor deeds), converted into a rating scale (as described in the previous section) and the current condition of homes built in that year (as included in the assessor deeds and likewise converted to a rating scale).

$Deregulated_{d,s,t}$  are indicator variables for whether each type of deregulation  $d$  (intra- and interstate deregulation) has already taken place in state  $s$  in year  $t$  as defined in Jayaratne and Strahan (1996, 1998). As we discuss in Section 2.2 below, our main focus is on interstate deregulation as the better setting for investigating the role of expanded credit at the state level. The controls  $X_{Zip,t}$  include state-level income and population and, importantly, the share of homes built in a given year that are remodeled or undergo new construction or substantial renovation after the initial “*Year built*”. Even though we consider house quality and house condition separately, there might still be a concern that homes built during periods of looser credit might have later been more likely to undergo renovations and, consequently, changes in living area and quality that would be unobserved in the main regressions. By controlling directly for the share of homes that are renovated and considering how the main coefficients of interest change, we can assess whether this is likely to have a significant effect in our estimation. All regressions include Zip code ( $\eta_{Zip}$ ) and year of construction fixed effects ( $\eta_t$ ). We cluster standard errors at the county code and year level, and weight regressions by the Zip code population as of 1998.

We now turn to the results when we estimate equation (1) in our data between 1965 and 1995. This period spans the whole experience of intrastate and interstate deregulation before the Riegle-Neal Act of 1994. Table 2 shows the results. Below we also consider several subperiods of this separately. We use 4 outcome variables in turn: the logarithm of the average Zip code-level new single-family house size, the (log) count of Zip code level new houses, a house quality index and a house condition index (both as raw indices, not in logs).

### **Insert Table 2 About Here**

Panel A shows that interstate deregulation, i.e., the ability of banks to purchase branches out of their state and our preferred shock to access to credit at the state level, is associated with homes that are 1 to 2% larger, depending on whether we consider weighted or unweighted regressions. Column 3 shows that these effects are not sensitive to the inclusion of controls for state-level income and population, and for the share of homes that are renovated or remodeled.

Column 4 shows the effect of interstate deregulation without including the intrastate indicator. The coefficient does not change significantly relative to the previous specifications.

Figure 3 shows that the effect of interstate deregulation on new home size becomes positive and significant in the year after deregulation and that it is associated with a permanent increase in house size that does not revert back even several years after the deregulation event.

### **Insert Figure 3 About Here**

We obtain different results when we consider intrastate banking deregulation. For this type of deregulation we see a negative change in living area, particularly when we add all of the controls to the regressions and when we consider it in isolation, i.e., without the interstate indicator (column 5). This reversal is consistent with contrasting results in the broader literature for the two types of deregulation. For example, Kerr and Nanda (2009) and Chava, Oettl, Subramanian and Subramanian (2013) show sharply contrasting results for the two types of deregulation. Jayaratne and Strahan (1996) show no increase in the volume of bank lending following intrastate deregulation despite faster growth, and Jayaratne and Strahan (1998) show decreases in nonperforming loans only for intrastate banking, suggesting reductions in risk-taking and so possibly tighter, not looser credit conditions. Each is consistent with the direction of the coefficient in our tests. As we discuss in the next subsection, the results on intrastate deregulation (unlike those on interstate shocks) are also highly sensitive to the sample period, suggesting these effects may not reflect true causal treatment effects of deregulation and, instead, may be affected by treatment heterogeneity concerns relating to staggered difference-in-differences estimation.

Deregulation is also associated with more construction. We find that interstate deregulation leads to 12 to 14% higher number of new houses, while intrastate deregulation shows no impact on the number of new homes. This result is consistent with the finding in Favara and Imbs (2015), who find that increased credit supply due to inter-state restrictions implemented after 1995 is associated with more construction. We include all observations in these regressions, including Zip code-year combinations with no construction. The results are similar (though 2-3 percentage points larger in magnitude) when we exclude Zip code-year combinations with no new construction.

When we turn to measures of building quality and building condition, deregulation seems to have an economically muted effect. Building quality is related positively to both types of

deregulation after we include controls, but the effect of 0.05 points for interstate deregulation is small relative to the standard deviation of 1.8 points in the data. Similarly, we find a 0.02 point increase in the building condition index after interstate deregulation (i.e., 1/50 of the distance between a rating of “Average” and a rating of “Good”).<sup>9</sup> To put this number in perspective, the standard deviation of this measure in our data is 0.6 points on this scale.

## 2.1 Heterogeneous Effects

We next consider how the effect of deregulation changes across areas that we would expect ex-ante to react differently to changes in the supply of mortgage credit, or where changes in home size or the number of new homes are likely to have a larger environmental footprint (because of heating and cooling needs or because of car travel, Glaeser and Kahn, 2010). We first rely on the housing supply elasticity measure of Saiz (2010) to look at how house characteristics change in high and low house price areas. Then, we turn to a dataset created by RSMMeans and maintained over the last several decades that measures differences in the cost of labor and materials for building a standard residential structure in several cities across the United States (we focus on the costs for 2003 to split 3-digit Zip codes at the median cost). We next consider the state-level cross section of heating and cooling days (“Degree days”) from the EPA. Finally, we split the results based on the share of the population commuting by car multiplied by the duration of the commute (which we call “Car Travel Intensity”). Table 3 includes the results on the interaction of the interstate deregulation measure with indicators for whether a Zip code is above or below the median of each of these variables.

### Insert Table 3 About Here

Panel A shows significant differences across areas when we split the data along these dimensions. Interstate deregulation affects house size much more in high-price and in high-construction cost areas. In fact, for areas below the median on either dimension we do not find any effect of deregulation on average square footage of single-family homes. In contrast, interstate

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<sup>9</sup> Note that these regressions are run on the raw index values, not in logs, so the coefficients do not represent percent increases.

deregulation increases the number of new homes more in high elasticity areas (although we cannot distinguish the effects statistically in column 5), and we do not observe differences across high- and low-construction cost areas for the number of new homes.

We also uncover meaningful differences when we split the data based on degree days and on the intensity of car travel of the average household. The effects of credit are larger in magnitude for observations that are above the median on both measures. This suggests that credit facilitated the increase in house size and, to some extent, the quantity of housing in places where the carbon footprint of the extra square footage and new homes is likely to be larger.

Table A2 in the Online Appendix shows the results based on intrastate deregulation. Mirroring the results in Panel A, we find differences in the same direction as we did for interstate deregulation for low elasticity, high building costs, high degree days, and high car travel areas.

## **2.2 Robustness Considerations**

Recent work by Baker, Larcker and Wang (2022) highlights important methodological concerns with staggered difference-in-differences (DiD) estimators in financial economics research. One of the key issues is that in a setting where treatment effects vary (“dynamic treatment effects” in the language of Baker et al, 2022), the fact that some units appear as both treatment and control observations introduces bias into the estimates that arises from treatment heterogeneity across units and over time.

To address this concern in our measurement of the effect of banking deregulation on new home construction, we begin by visually inspecting the timing of inter- and intrastate banking deregulation for each state. This is presented in Figure 4 and mirrors the visual presentation in Baker et al (2022) also of intrastate deregulation.

Insert Figure 4 about here

The blue-shaded areas are pre-deregulation years for each state, whereas the red-shaded areas indicate years after the deregulation, including the year of deregulation itself. For example, Panel A illustrates that Maine is an early state to deregulate, while South Dakota and the District of Columbia are states that never experience deregulation.

In this context, the natural concern is that the treatment effect on early-deregulating states is different from that of late-deregulating states, and that it may change over time, such that our results connecting deregulation to home size are confounded. To guard against this, we break the data into sub-periods, and repeat our main estimation sub-period by sub-period. This is presented in Table 4.

Insert Table 4 about here

Our regressions in Tables 2 and 3 include the period 1965-1995 to account for all states undergoing intra- and interstate deregulation. Guided by Figure 4, we re-estimate the key equations from Table 2 for both types of deregulation separately (columns 4 and 5 for each outcome variable) on four sub-periods: 1977-1995, 1980-1993, 1977-1986, and 1987-1995. The first period, 1977-1995, spans all interstate deregulation events, but starts after some of the earliest states implemented intrastate deregulation. The 1980-1993 window removes any effect associated with the earliest and latest deregulating states. The 1977-1986 window is the first half of the interstate deregulation window, while the 1987-1995 window is the second half and, by this point, many states had already experienced deregulation. To the extent that heterogeneous treatment effects over time (and across states) may introduce bias into our estimates, eliminating early and late periods from the regressions should reveal different point estimates for the main effects.

Comparing across subsample periods, we see only modest differences in the point estimates on interstate deregulation on home size, the key variable of interest. The point estimate for the broadest sample period is 0.016, while within sub-periods the point estimate ranges from 0.015 to 0.019. The effect of interstate deregulation on the number of new homes and on building quality differs from the other subperiods in the early part of the sample (1977-1986 subperiod), but this table suggests that our results connecting interstate deregulation to the characteristics and number of newly built homes is generally robust to concerns associated with staggered difference-in-difference estimates.

Panel B shows that the effects of intrastate deregulation become weaker or disappear altogether in different subperiods, suggesting that concerns about treatment heterogeneity over time or across units may be responsible for the findings in Table 2. This is true for all outcome

variables, consistent with the findings in Baker et al (2022) on intrastate deregulation and inequality. This further supports our emphasis on interstate deregulation as the more appropriate laboratory for studying our question.

### 3. Non-core liabilities and house characteristics in the 2000s boom

In our second set of tests, we exploit the non-core liability (NCL) measure introduced by Mian and Sufi (2022). Unlike deregulation, it is harder to define a precise timing where we expect the Zip code-level cross-section of non-core liability share to be associated with expanded credit and, consequently, changes in house characteristics. However, given the dynamics of the housing boom and the changes in private label securitization volume, as well as the timing of the changes in mortgage rate spreads (Justiniano, Primiceri and Tambalotti, 2022), we would expect this measure to matter primarily after 2001 and even more so after 2003. To capture this timing, we run cross-sectional regressions using long differences in the dependent variables. For this analysis we run regressions of the form:

$$\Delta_{2001-2006} \text{Log(Square feet)}_{\text{zip}} = \beta_1 \text{Non-core Liabilities}_{\text{zip}} + \eta_{\text{State}} + \varepsilon_{\text{Zip}} \quad (2)$$

Instead of outcomes in one specific year, the main outcome of interest for these regressions is the 5-year change in the logarithm of the average square footage in the Zip code for new homes between 2001 and 2006. As for the first empirical strategy, other outcomes include the 5-year change in the logarithm of the count of new homes, as well as 5-year changes in the quality index of new homes and the condition index of homes.

The variable *Non-core Liabilities* is the non-core liability measure as of 2002 calculated at the Zip code level and described in more detail in Section 1.1. The variables  $\eta_{\text{State}}$  are state fixed effects. Standard errors are clustered at the county level, and regressions are weighted by Zip code population in line with the results in Table 2 and 3.

**Insert Table 5 About Here**

Table 5, Panel A shows that the non-core liability measure at the ZIP Code level is strongly associated with increases in average house size. This effect holds across a range of specifications. The estimate implies that a one standard deviation increase in the NCL measure is associated with 2% larger homes.

The number of new homes also changes, but this effect is sensitive to specification choice. In regressions without state fixed effects, we find a highly statistically significant effect of 0.33 on the log of new homes. The effect is imprecisely estimated, but similar in magnitude, when we include state fixed effects. This is consistent with the fact that the housing boom in the early 2000s was especially strong in a cluster of states in the Sunbelt region, which would lead to stronger identification across rather than within states; however, introducing controls for the fraction of houses in a zip code that were remodeled, the sign flips and the effect becomes negative but imprecisely estimated. This suggests that high NCL areas undergo increases in the overall housing stock but homes built in these areas are more likely to have undergone major renovations after this period, consistent with the lower quality we also measure.

### **Insert Figure 5 About Here**

Figure 5 shows coefficients from a dynamic version of equation (2), where we consider multiple five-year periods starting with the period of 1986 through 1991 as the baseline and ending in 2011. The figure shows that the NCL variable does not affect house size during the 1990s and that this effect only appears for the 2001 through 2006 period. The effect again becomes null during the crisis period of 2006 through 2011.

Panel B shows that house quality is somewhat reduced by easier access to credit, with a magnitude that is larger than the effect in Table 3 regarding house condition grades. A one standard deviation change in the NCL variable is associated with a 0.06 point reduction in quality, which is meaningful when we consider that homes increased in quality, on average, by 0.3 points in the index between the 1990s and the 2000s. We do not find any effect on the condition of new homes today as a function of NCL. Table A3 of the Online Appendix shows that the effects on house size and house quality are close to monotonic in the NCL variable.

Table A4 of the Online Appendix shows that the effects of easier credit translate more into larger homes in high-priced and in high-building cost areas, mirroring the results in Table 4. We

do not find significant differences across different areas in the drop in house quality we find in Table 5, although we see that high NCL exposure is associated with worse building condition in high building cost areas.

Overall, there is no evidence that changes in quality (that could potentially be correlated with investments in energy conservation innovations) or increased durability that might have offset the energy use implications of the increase in house size we observe in high NCL areas.

#### 4. Post-1994 interstate banking restrictions

Our final empirical strategy uses the state restrictiveness index post-IBBEA implemented by each state in a staggered fashion (following Rice and Strahan, 2010, and Favara and Imbs, 2015). We implement differences-in-differences regressions with the same outcomes as in equation (1) and our first empirical strategy. Outcomes are all in logs and the time-period for these regressions spans 1994 (the year the IBBEA was implemented and the last year for our regressions using intrastate and interstate deregulation before this Act) to 2001 (the first year we use for the NCL regressions). Regressions are of the form:

$$\text{Log(Square feet)}_{\text{Zip},t} = \beta_1 \text{Restrict Index}_s \times \text{Post}_t + \eta_{\text{Zip}} + \eta_t + \varepsilon_{\text{Zip},t} \quad (3)$$

The main variable of interest is the interaction “*Restriction Index<sub>s</sub> x Post<sub>t</sub>*”, where *Restriction Index* enters the equation linearly and can have a maximum value of 4 and subtracts one for each of four possible restrictions put in place by the states. Those restrictions are listed in detail in Table I of Rice and Strahan (2010) and include both restrictions on *de novo* interstate branching and three possible restrictions on interstate bank acquisitions (minimum age of a target, the possibility of acquiring parts of another institution, and a cap on concentration of deposits in a single institution after a merger). All regressions include Zip code ( $\eta_{\text{Zip}}$ ) and year of construction fixed effects ( $\eta_t$ ), as well as controls for state-level income, population, and the Zip code share of remodeled and renovated homes (“*Effective year built*” and “*Remodeled*”). We cluster standard errors at the county code and year level, and weight regressions by the Zip code population as of 1998.

**Insert Table 6 About Here**

The results from this estimation are reported in Table 6. We find that lower restrictions following the passage of the IBBEA are only weakly related with changes in average home size. The effects are considerably stronger in regions characterized by low housing supply elasticity areas or high building costs. Here, we find that homes are larger by about one percentage point for every one-point increase in the index, which is equivalent to one fewer restriction to interstate banking expansion. We find no evidence that interstate post-1994 banking restrictions affect the supply or quality of homes.

## **5. Home Quality and Energy Use**

The analysis thus far has focused on the effect of mortgage credit on the environmental footprint of newly built homes, including the effect on current measured quality and condition ratings assigned by counties to homes built in the past. These are, however, imperfect measures of current home quality, and it is possible that some of the effects described in the previous sections might be attenuated if the supply of credit also improves (unobserved) home quality and higher quality, in turn, reduces the carbon footprint of residential structures. In this section we take tackle this issue not by analyzing the link between credit and quality but, instead, by considering how home quality affects monthly energy costs. This allows us to assess to what extent and in which direction effects operating through unobserved quality might change the overall carbon impact of changes in the supply of credit.

We analyze the link between home quality and energy use in three steps and using data from the American Housing Survey. First, we show how monthly energy costs vary with perceived home quality, where home quality is measured by the rating of the “unit as a place to live” assigned by the respondents to the survey (*RATINGHS* for pre-2013 survey years, and *HOWH* post-2013). Second, we explore the relationship between energy use and home size for homes originally constructed in different time-periods. Finally, we compare energy costs for the same residential structure before and after renovations have occurred to measure the average effect of renovations.

The effects of renovations on energy use directly speak to how home quality translates into energy use, assuming renovations are usually done to improve the quality of a home.

### **5.1 Home Ratings and Energy Costs**

Figure 6 shows the coefficients of a regression of monthly energy costs on the respondent's assessment of the quality of their unit "as a place to live". The figure shows that, relative to the highest rated units, and after controlling carefully for income and home size both in logarithms and using fixed effects for income and size deciles, energy costs are monotonically increasing in quality or, equivalently, monotonically decreasing in ratings (since a higher rating is a lower quality home in this data).

#### **Insert Figure 6 About Here**

This suggests that higher quality homes are associated with higher energy use. We find similar results in Section 5.3 below. This means that, to the extent that easier access to credit increases average unobserved quality, this would lead to a larger effect of credit on overall carbon intensity of the housing stock.

### **5.2 Elasticity of Energy Use to Home Size Over Age Cohorts**

Mortgage credit also affects a homeowner's ability to renovate an existing structure, as well as (potentially) the quality of the new home. Although the regressions in sections 2-4 capture the effect on measured quality of newly built structures, the possibility remains that mortgage credit creates attenuating effects through affecting the carbon footprint of existing structures through renovations and home improvements, or by affecting unobserved quality of new homes.

The second step in our analysis is to examine the relationship between home size and energy use for homes built in different time periods. These results are reported in Table 7.

#### **Insert Table 7 About Here**

To interpret the coefficients in Table 7, assume that the energy cost of a home can be described as

$$Total\ Cost_{ijt} = Unit\ Energy\ Cost_{it} * Total\ Energy\ Usage_{jt},$$

for house  $j$  in region  $i$  at time  $t$ . The region subscript on unit energy costs captures the fact that energy is more expensive in some parts of the country than in others, while the time subscript reflects rate resets that periodically occur. If we assume that *Total Energy Usage* is a Cobb-Douglas function of home size and income ( $Size^\alpha * Income^\beta$ ), then in logs we have

$$\log Total\ Cost_{ijt} = \log Unit\ Cost_{it} + \alpha \log Size_j + \beta \log Income_{jt}.$$

This is the equation estimated in Table 7. The location fixed effects absorb the location-specific variation in average unit cost, leaving the  $\alpha$  and  $\beta$  parameters to capture the effect of additional size and household income (which proxies for amenities) in the home. Comparing point estimates across columns allows us to assess the aggregate impact of renovations, because newer constructions will naturally be better insulated and have more efficient heating and cooling than what was present originally in older construction, but older construction will be more likely to have been renovated.

The point estimates are largely stable over the different decades of original home construction. The final column reports point estimates for the full sample. The fact that extra square footage for older homes has a smaller impact on energy costs than the overall average is suggestive evidence that older homes have been refitted with newer heating and cooling systems. But these differences are small. The point estimates indicate that a ten percent increase in home size, holding constant income and hence the average level of amenities, raises energy costs by three to four percent. These effects are robust across time, and generally are higher for more recently built homes than older homes.

### **5.3 The Link Between Renovations and Energy Usage**

The previous section only points to a modest average, aggregate effect of renovation on overall heating and cooling costs based on the age of a structure in question. In this section, we examine

the link between renovations and energy usage more directly with evidence from the AHS linking home improvement to changes in monthly energy costs within a given structure over time.

Specifically, the AHS includes flags for whether a structure has undergone a home improvement, as well as whether the home improvement was an energy-saving improvement. We examine the relationship between energy use and renovations in Table 8.

### **Insert Table 8 About Here**

The dependent variable in Table 8 is the change in the natural logarithm of total monthly energy costs in a particular structure between two surveys. Column (1) shows that renovations, on average, are associated with a 2% increase in monthly energy costs. This specification includes Year fixed effects. In Column (2), we include city-by-year fixed effects so that the point estimate is being identified by the comparison between renovated and unrenovated homes in the same city in the same survey year. In Column (3) we include the change in household income between the surveys, which captures not only within family changes of income but also the possibility that a dwelling is now occupied by a different homeowner than was the case in the previous survey period. (Home sales to wealthier buyers are a natural source of home renovation, as the new buyer replaces old appliances and fixtures and possibly adds to the overall square footage of the home.) These columns indicate that, on average, improving the quality of a home increases its energy consumption.

To push further, in columns (4) and (5) we replace the home renovation flag with a flag that captures whether the home underwent any energy-saving home renovations between the surveys. There is no effect of energy-saving home improvements on energy costs, even controlling for changes in income. Green home improvements apparently do not make homes greener.

Why not? Columns (6)-(8) show that a major reason is that the green home renovations occur at the same time as other quality-improving renovations that have offsetting effects on energy consumption. In Column (6), when we introduce both flags side by side, we see that there is a strong energy-saving effect associated with energy-saving home renovation once we control for the co-occurrence of other home renovations. This continues to hold in Column (7) when we control for the change in income, although the energy savings associated with green renovation is approximately cut in half. Column (8) controls for the change in square footage of the dwelling.

First, note that this cuts the size of the home improvement flag by around 50%. Thus, much of the overall increase in energy costs associated with home improvements occurs by making homes bigger. But at the same time, the home improvement flag continues to be marginally significant, suggesting that the incremental changes to appliances, HVAC systems, etc., all contribute to the energy usage in the home, irrespective of the change in home size. Note too that the loading on change in income drops significantly, which indicates that a common pattern in the data is for wealthier families to purchase existing structures and undertake add-on renovations that increase square footage as well as improve overall amenities. Finally, note that in Column (8) the loading on the energy-saving renovation flag is approximately three times larger than that reported in Column (7). This speaks to the degree of crowding out that occurs when otherwise energy-saving features are incorporated into a more all-encompassing renovation.

Thus, taken together, the evidence from the American Housing Survey does not support the idea that modernizing homes makes homes greener (or that higher quality homes, on average, consume less energy). The issue is not whether more energy-efficient windows, for example, save energy. They do. The issue is that these hypothetical energy-efficient windows are installed as part of a broader renovation that incorporates many features and amenities that increase energy usage. The energy-efficient windows are installed alongside hot tubs, better appliances, and newly added wings to the house, and the net effect is that home renovations make homes browner, not greener.

## **6. Conclusion**

There is significant academic and policy interest in understanding how environmental, social and governance (ESG) concerns affect the allocation of capital in financial markets, including how capital flows across ESG and non-ESG funds, companies and projects. However, even absent explicit ESG considerations, the expansion or contraction of availability of capital may have large carbon consequences that are rarely measured in the literature. This paper explores the consequences of a particularly salient channel, which is how variation in credit across regions affects the energy intensity of the residential housing stock.

We show that relaxing the supply of mortgage credit amplified the carbon footprint of the US residential housing stock by making homes larger, but not higher in quality or more durable.

This shows that financial market conditions affect environmental outcomes not just through the pricing and sharing of environmental risk, but by literally shaping the carbon footprint of an important component of the real sector of the economy.

The fact that the energy impact of easier credit is so directly tied to home size suggests fruitful avenues for policy makers who wish to consider policy interventions. Ultimately, the issue is how to tie the ongoing energy costs associated with new construction to decisions made at the time homes are built and sold. On the supply-side, size-based carbon taxes on new construction coupled with offsets associated with adopting energy-saving amenities could achieve these goals. On the demand side, tying closing costs or mortgage points to the energy efficiency of a structure could encourage internalization of ongoing energy costs more fully into the home purchase decision. As energy grids become more efficient and operating costs drop, the salience of this concern grows, because more of the overall environmental weight of residential housing takes place during construction, which also scales with house size.

Our findings help to clarify the role of different policy tools on mitigating climate change. While policy makers across the globe scramble to find solutions to climate change, Hansen (2021) writes that “effective climate policy levers are in the fiscal but not in the monetary toolkit.” Lagarde (2021) also acknowledges that “[it] is governments, not central banks, who are primarily responsible for facilitating an orderly transition” but also argues that central banks can “further incorporate climate considerations without prejudice to [their] primary mandate.” Our results suggest there is a role of central bankers in this context. Given that easier monetary policy lowers interest rates, and that recent non-conventional monetary policy has explicitly targeted the home mortgage sector, we show that monetary policy has unintended environmental consequences through the house size channel. This does not mean that monetary policy is necessarily the appropriate tool to mitigate these effects, simply that we can use the framework in this paper to measure the impact of monetary policy and macro-prudential policies on the carbon footprint of the housing sector.

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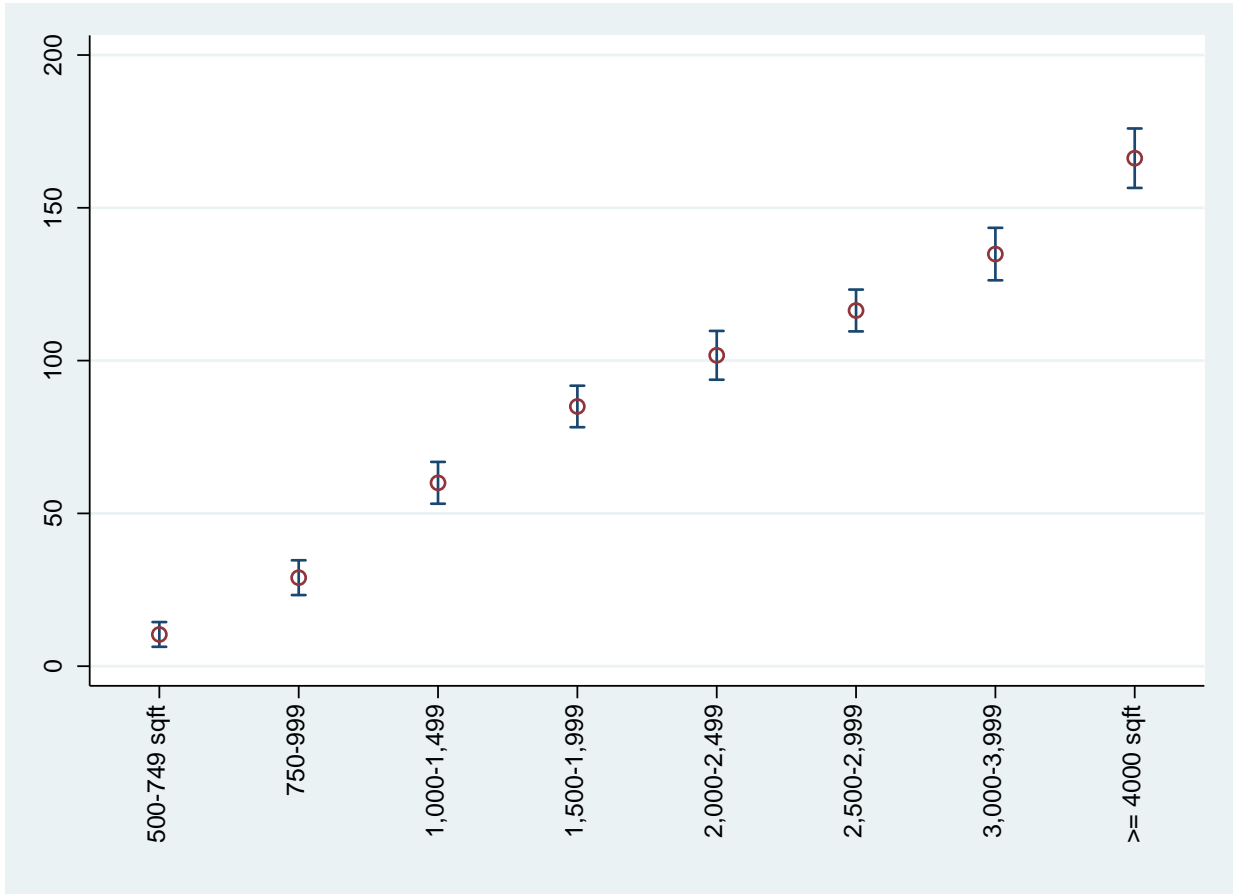
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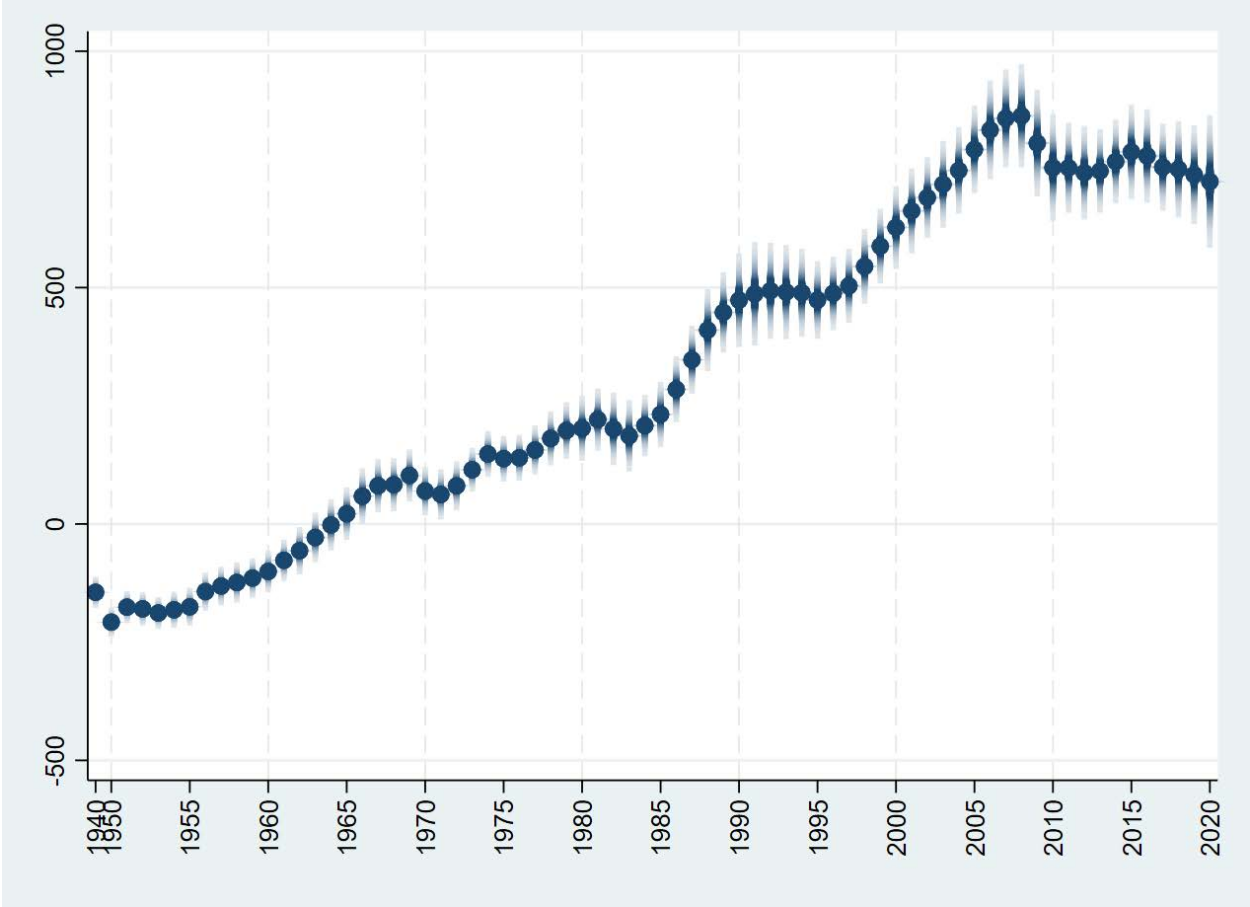
### Figure 1: Total monthly energy costs by house size

Figure shows total monthly energy costs in US dollars (including electricity, gas and fuel costs) for households living in single-family homes included in the American Housing Survey run by the Census. Sample includes 2015, 2017 and 2019 National and Metro surveys. We plot differences for houses in each square footage bin relative to the smallest bin (houses less than 500 square feet). Regressions control for household income and fixed effects for CBSA and decade built. Standard errors are clustered at the Census division-by-survey year level.



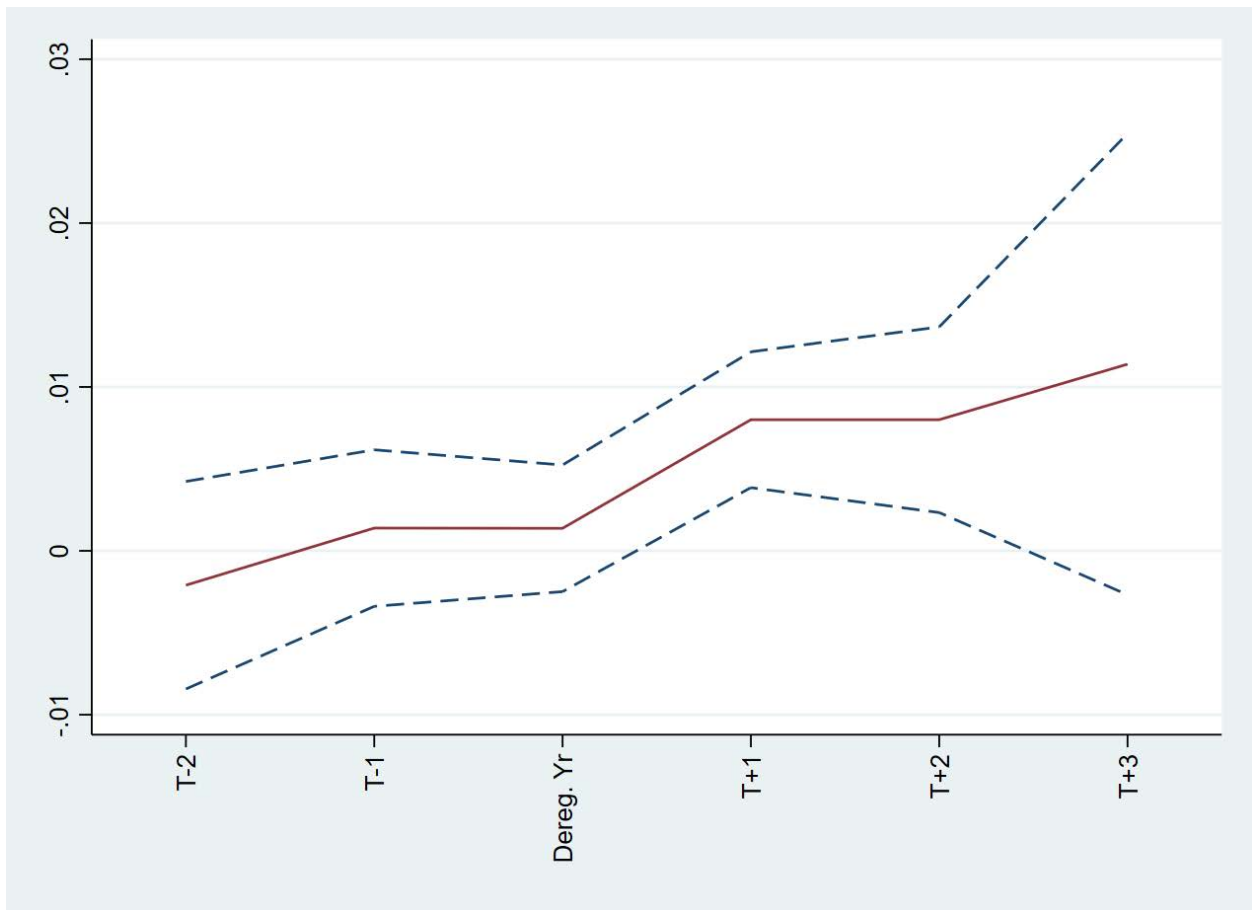
**Figure 2: Evolution of average size of new homes, 1930-2019**

Figure shows changes in average single-family house size by year of construction relative to the average size of homes completed during 1930-1939. Each point represents averages per year (except 1940, which includes 1940 through 1949), and standard errors are clustered at the county level. Data is from Zillow (ZTRAX Assessor files).



### Figure 3: Dynamic effects of interstate banking deregulation on average house size

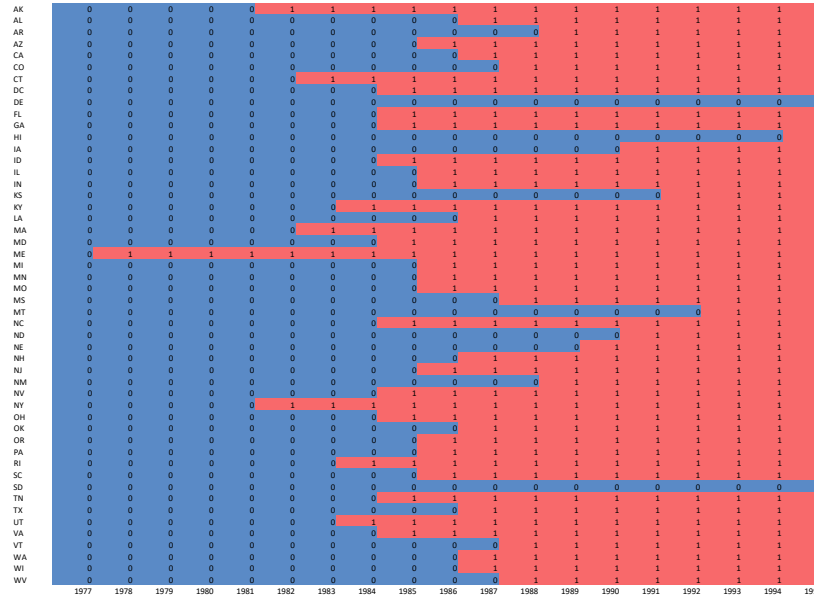
Figure shows coefficients from equation (1) where the “*Post*” coefficient is split into years before and after deregulation. All coefficients are shown relative to more than 3 years before interstate deregulation. Regressions control for Zip code and year built fixed effects and are weighted by Zip code population in 1998. Standard errors are clustered at the county and year level. Data is from Zillow (ZTRAX Assessor files).



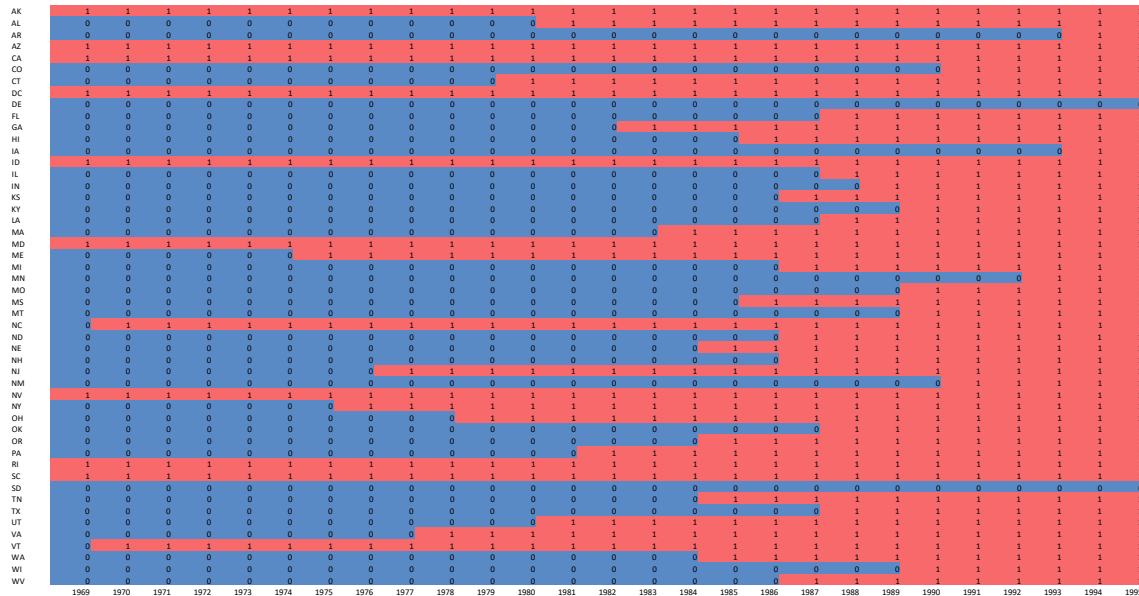
### Figure 4: Distribution of treatment timing: interstate and intrastate deregulation

Figure shows the years of deregulation for each state, as well as how many years each state spends before and after deregulation in the sample period in the regressions in Table 4. The figure is similar to Panel (i) of Figure 8 in Baker, Larcker and Wang (2022).

Panel A: Interstate deregulation



Panel B: Intrastate deregulation



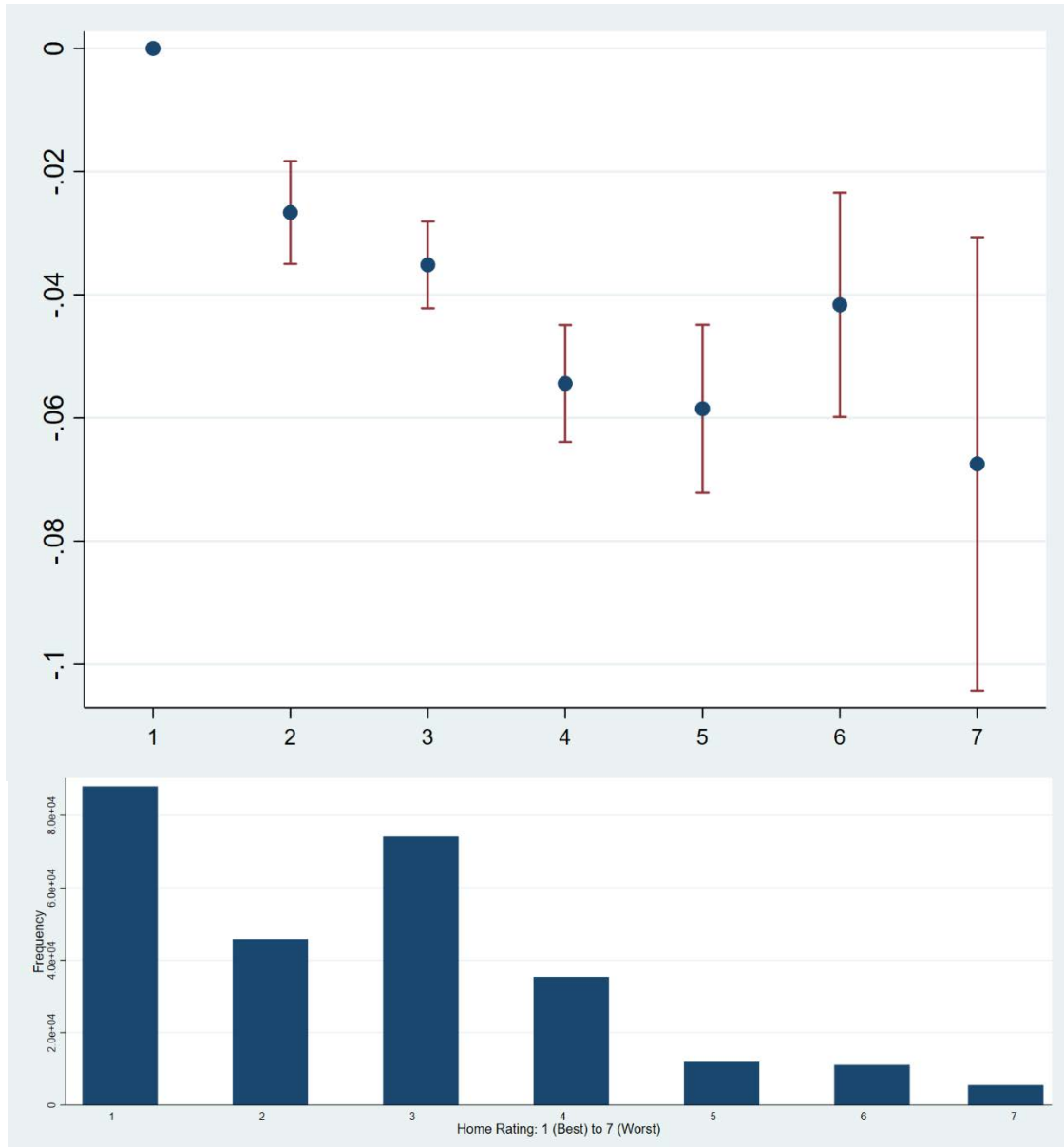
**Figure 5: Non-core liabilities and average house size over**

Figure shows coefficients from equation (2) and Table 5, but extending the sample to 1986 to 2011, split into 5 five-year periods interacted with the “*Non-core liabilities*” variable. The outcome is the 5-year change in the logarithm of average new house living area in a Zip code. “*Non-core liabilities*” are defined as the non-core liability ratio weighted by each institution’s mortgage origination market share in a Zip code (as in Mian and Sufi, 2022). Coefficients are relative to the 1986-1991 period. Regressions control for state-by-year fixed effects and are weighted by population in 1998. Standard errors are clustered at the county level. Data is from Zillow (ZTRAX Assessor files).



**Figure 6: Home quality rating and energy costs**

Figure shows coefficients from a regression of the logarithm of monthly energy costs on indicators for the “Rating of unit as a place to live” (variables *RATINGHS* post 2013, and *HOWH* until 2013) assigned by the homeowner. “1” is the best possible rating, “7” is the worst (combines ratings 7 through 10). Controls include the logarithm of home size and household income, as well as year built, metropolitan area, Census division-by-survey year, number of household members, income decile and home size decile fixed effects. Standard errors are clustered by division-by-survey year. Bottom panel plots the histogram of observations included in the regression by rating. Data is from American Housing Survey (AHS).



### Table 1: Summary statistics

Table shows summary statistics for the variables used in the analysis. Living area is measured in square feet, and both building quality index and condition are converted into a numerical scale as described in the text. Quality ratings are converted to a numeric scale and they range from a minimum of “D-” (replaced by a value of “1”) to a maximum of “A+” (coded as “12”). Building condition is coded in the assessor files from a minimum of “Poor”, which we replace with a numeric value of “1”, to a maximum of “Excellent”, replaced with a value of “5”. We show statistics weighted by 1998 Zip code population from the IRS. Data is from Zillow (ZTRAX Assessor files).

#### Panel A: Whole sample

	Mean	St. Dev.	Median	Min	Max	N. Obs
Living area (Sq. Feet)	1,976.0	790.5	1,784.8	102.0	10,000.0	1,108,902
Number of new houses	90.3	219.9	30.0	1.0	13,607.0	1,108,902
Year built	1982.9	21.5	1983.0	1930.0	2020.0	1,108,902
Building quality index	5.8	1.8	5.4	1.0	12.0	432,720
Building condition	4.1	0.6	4.0	1.0	6.0	646,156
New effective year built	0.12	0.27	0.00	0.00	1.00	1,108,641
Remodeled	0.04	0.14	0.00	0.00	1.00	1,108,859
Intrastate deregulation year	1979.8	9.3	1982.0	1965.0	1994.0	1,103,195
Interstate deregulation year	1986.0	2.0	1986.0	1978.0	1995.0	1,103,195
Non-core liabilities	0.74	0.06	0.74	0.53	0.95	280,216
Banking restriction index post-IBBEA	0.95	1.38	0.00	0.00	4.00	77,880
Supply elasticity (Saiz, 2010)	1.84	1.06	1.61	0.63	12.15	604,795

#### Panel B: Characteristics by decade

	Living area	Building quality	Building condition	Diff. effective year	Remodeled
1930-1939	1,653.0	4.7	3.9	0.20	0.08
1940-1949	1,506.5	4.8	3.9	0.18	0.07
1950-1959	1,486.2	4.9	4.0	0.17	0.06
1960-1969	1,654.7	5.3	4.0	0.16	0.05
1970-1979	1,781.8	5.5	4.1	0.15	0.05
1980-1989	1,921.7	5.7	4.1	0.12	0.04
1990-1999	2,161.0	6.1	4.2	0.10	0.03
2000-2009	2,428.1	6.4	4.3	0.07	0.02
2010-2019	2,441.3	6.6	4.4	0.04	0.01
Total	1,965.5	5.7	4.1	0.12	0.04

**Table 2: Banking deregulation and the characteristics of new homes**

The table shows the results from equation (1). The outcomes are year-by-Zip code averages of each variable and control for Zip code and year built fixed effects. Income per capita and population are at the state level and lagged by one year. “Different Effective Year Built” and “Remodeled” capture the average share of homes in a year that undergo new construction, major rehabilitation, or remodeling. Weights are Zip code population in 1998. Standard errors are clustered at the county and year level. Data is from Zillow (ZTRAX Assessor files).

**Panel A: Living area and number of new homes**

	Log(Living area in sq. ft)					Log(Number of new houses)				
Intrastate Deregulation	-0.012*	-0.012	-0.014*	-0.012*	-0.012*	-0.054*	-0.027	0.033	0.044	0.044
	0.006	0.009	0.007	0.007	0.007	0.031	0.050	0.044	0.044	0.045
Interstate Deregulation	0.010**	0.020***	0.020***	0.017***	0.017***	0.127***	0.120***	0.136***	0.143***	0.143***
	0.004	0.005	0.006	0.005	0.005	0.027	0.036	0.044	0.044	0.044
Log(Income per Capita)			-0.023	-0.025	-0.020			2.845***	2.852***	2.863***
			0.051	0.051	0.051			0.423	0.425	0.424
Log(State Population)			-0.031	-0.018	-0.032			0.865***	0.833***	0.860***
			0.025	0.029	0.025			0.206	0.218	0.204
Diff. Effective Year Built			0.048***	0.049***	0.049***			0.071	0.070	0.072
			0.009	0.010	0.009			0.078	0.079	0.078
Remodeled			0.071***	0.072***	0.071***			-0.268***	-0.271***	-0.266***
			0.021	0.021	0.021			0.091	0.091	0.091
Weighted by Zip Population		Y	Y	Y	Y		Y	Y	Y	Y
Year	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Zip Code	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
N	449,125	443,529	443,448	443,448	443,448	597,474	588,865	443,448	443,448	443,448
r2	0.61	0.70	0.70	0.70	0.70	0.86	0.85	0.68	0.68	0.68

**Panel B: Quality and condition**

	Building Quality Index					Building Condition (Latest)				
Intrastate Deregulation	-0.015	0.045	0.089***	0.092***	0.092***	0.009	-0.009	0.005	0.007	0.007
	0.022	0.033	0.029	0.029	0.029	0.012	0.014	0.014	0.014	0.014
Interstate Deregulation	-0.023	0.032	0.046*	0.057**	0.057**	0.029*	0.024*	0.021*	0.023*	0.023*
	0.029	0.027	0.027	0.029	0.029	0.015	0.012	0.011	0.012	0.012
Controls			Y	Y	Y			Y	Y	Y
Weighted by Zip Population		Y	Y	Y	Y		Y	Y	Y	Y
Year	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Zip Code	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
N	176,762	175,614	175,600	175,600	175,600	260,637	258,722	258,680	258,680	258,680
r2	0.74	0.78	0.78	0.78	0.78	0.63	0.74	0.75	0.75	0.75

**Table 3: Heterogeneous effects of banking deregulation across areas**

The table shows the results from equation (1), interacted with indicator variables for areas with low housing supply elasticity (as in Saiz (2010)), high building costs (as measured by RS Means (2003)), above-median degree days (from the Environmental Protection Agency), and high car travel times weighted by the proportion of commuting done by car (from the American Community Survey). The outcomes are year-by-Zip code averages of each variable and control for Zip code and year built fixed effects. Weights are Zip code population in 1998. Standard errors are clustered at the county and year level. Data is from Zillow (ZTRAX Assessor files).

	Log(Living area in sq. ft)				Log(Number of new houses)			
Interstate Deregulation	-0.003	0.002	0.006	0.001	0.208***	0.121*	-0.006	0.134***
	0.006	0.005	0.009	0.006	0.067	0.064	0.072	0.048
Interstate Deregulation x Low Elasticity	0.039***				-0.094			
	0.007				0.080			
Interstate Deregulation x High Building Costs		0.023***				0.055		
		0.008				0.073		
Interstate Deregulation x High Degree Days			0.021**				0.287***	
			0.010				0.061	
Interstate Deregulation x High Car Travel Intensity				0.032***				0.018
				0.009				0.052
Controls	Y	Y	Y	Y	Y	Y	Y	Y
Weighted by Population	Y	Y	Y	Y	Y	Y	Y	Y
Year	Y	Y	Y	Y	Y	Y	Y	Y
Zip Code	Y	Y	Y	Y	Y	Y	Y	Y
N	240,345	423,124	426,624	432,840	240,345	423,124	426,624	432,840
r <sup>2</sup>	0.74	0.73	0.70	0.70	0.64	0.67	0.67	0.67

### Table 4: Effect of banking deregulation in sub-periods

The table shows the effects of deregulation across sub-periods of the sample used in Table 2. In each column we replicate the regression in Table 2 for each of the outcome variables in that table, limiting the estimation period to the time-frame indicated in the column header. Specifically, panel A reports interstate deregulation estimates from column 4, while panel B reports intrastate deregulation estimates from column 5.

#### Panel A: Interstate deregulation

	Effect of interstate deregulation			
	1977-1995	1980-1993	1977-1986	1987-1995
Log(Living area in sq. ft)	0.016*** 0.005	0.017*** 0.006	0.015*** 0.004	0.019*** 0.006
Log(Number of new houses)	0.171*** 0.035	0.149*** 0.038	0.022 0.044	0.216*** 0.027
Building Quality Index	0.097*** 0.024	0.107*** 0.027	-0.026 0.069	0.041** 0.020
Building Condition (Latest)	0.003 0.008	0.001 0.008	-0.005 0.007	-0.028 0.024
Controls	Y	Y	Y	Y
Weighted by Zip Population	Y	Y	Y	Y
Year	Y	Y	Y	Y
Zip Code	Y	Y	Y	Y
N	269,599	195,074	143,300	124,960
r <sup>2</sup>	0.73	0.75	0.75	0.79

#### Panel B: Intrastate deregulation

	Effect of intrastate deregulation				
	1977-1995	1980-1993	1977-1986	1987-1995	1969-1977
Log(Living area in sq. ft)	-0.007 0.006	-0.010 0.007	0.004 0.005	-0.005 0.007	-0.001 0.008
Log(Number of new houses)	0.094* 0.050	0.069 0.060	0.016 0.041	0.270*** 0.052	-0.187** 0.082
Building Quality Index	0.123*** 0.042	0.078* 0.046	0.079** 0.036	-0.018 0.030	-0.025 0.028
Building Condition (Latest)	-0.001 0.011	0.006 0.009	0.000 0.007	0.005 0.013	0.002 0.009
Controls	Y	Y	Y	Y	Y
Weighted by Zip Population	Y	Y	Y	Y	Y
Year	Y	Y	Y	Y	Y
Zip Code	Y	Y	Y	Y	Y
N	269,599	195,074	143,300	124,960	130,381
r <sup>2</sup>	0.73	0.75	0.75	0.79	0.75

**Table 5: Non-core liabilities and the characteristics of new homes**

Table shows coefficients from equation (2) for the period 2001 through 2006. The outcomes in Panel A is the 5-year change in the logarithm of average new house living area in a Zip code or the number of new single-family homes in a Zip code. Panel B considers the 5-year change in building quality index and building condition, both from the ZTRAX assessor files. “*Non-core liabilities*” are defined as the non-core liability ratio weighted by each institution’s mortgage origination market share in a Zip code (as in Mian and Sufi, 2022). Regressions control for state fixed effects and are weighted by population in 1998. Standard errors are clustered at the county level. Data is from Zillow (ZTRAX Assessor files).

**Panel A: Living area and count of new single-family houses**

	$\Delta_5 \text{ Log(Living area in sq. ft)}$			$\Delta_5 \text{ Log(Number of new houses)}$		
Non-core liabilities	0.269*** 0.090	0.324*** 0.101	0.330*** 0.101	0.330*** 0.101	0.332 0.470	-0.362 0.615
Remodel Controls			Y			Y
Weighted by Population	Y	Y	Y	Y	Y	Y
State FE		Y	Y		Y	Y
N	3,797	3,795	3,795	3,795	3,797	3,795
r2	0.00	0.04	0.04	0.04	0.00	0.05

**Panel B: Quality and condition**

	$\Delta_5 \text{ (Building quality)}$			$\Delta_5 \text{ (Building condition)}$		
Non-core liabilities	-1.724* 0.939	-0.952 0.963	-0.923 0.933	-0.923 0.933	-0.157 0.186	-0.217 0.244
Remodel Controls			Y			Y
Weighted by Population	Y	Y	Y	Y	Y	Y
State FE		Y	Y		Y	Y
N	1,241	1,238	1,238	1,238	1,991	1,987
r2	0.01	0.03	0.03	0.03	0.00	0.05

### Table 6: Post-1994 interstate banking restrictions and new construction

Table shows coefficients from equation (3) for the period 1994 through 2001. The outcomes in Panel A is the logarithm of average new house living area in a Zip code and in Panel B it is the logarithm of the number of new single-family homes in a Zip code. “*Low Restrictions Index*” is the interstate banking restriction index from Rice and Strahan (2010) and Favara and Imbs (2015). Regressions control for Zip code and year fixed effects and are weighted by population in 1998. Standard errors are clustered at the county and year level. Data is from Zillow (ZTRAX Assessor files).

#### Panel A: Living area of new single-family houses

	Log(Living area in sq. ft)					
Low Restrictions Index	0.002	0.003*	-0.002	0.000	-0.002	0.000
	0.002	0.002	0.002	0.002	0.002	0.002
Low Restrictions Index x Low Elasticity			0.009***	0.008***		
			0.003	0.002		
Low Restrictions Index x High Building Costs					0.006**	0.006**
					0.002	0.002
Controls		Y		Y		Y
Weighted by Population	Y	Y	Y	Y	Y	Y
Year	Y	Y	Y	Y	Y	Y
Zip Code	Y	Y	Y	Y	Y	Y
N	77,153	71,984	60,276	57,565	73,798	70,133
r2	0.80	0.82	0.81	0.82	0.81	0.82

#### Panel B: Count of new single-family houses

	Log(Number of new houses)					
Low Restrictions Index	-0.018*	-0.011	-0.019	-0.007	-0.026**	-0.016
	0.010	0.010	0.013	0.013	0.012	0.012
Low Restrictions Index x Low Elasticity			-0.008	-0.015		
			0.016	0.017		
Low Restrictions Index x High Building Costs					0.012	0.008
					0.015	0.015
Controls		Y		Y		Y
Weighted by Population	Y	Y	Y	Y	Y	Y
Year	Y	Y	Y	Y	Y	Y
Zip Code	Y	Y	Y	Y	Y	Y
N	77,153	71,984	60,276	57,565	73,798	70,133
r2	0.86	0.86	0.86	0.86	0.86	0.86

**Table 7: Energy costs and house size**

Table shows OLS regressions of the logarithm of total energy costs on the logarithm of square footage and household income from the American Housing Survey administered by the Census. Sample includes all National and Metro surveys between 2005 and 2013 for which there is precise square footage. Regressions control for MSA whenever available, Census division-by-survey year, decade built, and household size fixed effects. Costs and income are adjusted to 2019 constant dollars. Standard errors are clustered at the Census division-by-survey year level.

	Year Built					
	<= 1939	1940-1959	1960-1979	1980-1999	2000-2019	All Years
Log(Square Feet)	0.27*** 0.01	0.30*** 0.01	0.38*** 0.02	0.33*** 0.01	0.34*** 0.01	0.33*** 0.01
Log(Income)	0.05*** 0.01	0.04*** 0.01	0.05*** 0.01	0.05*** 0.01	0.05*** 0.01	0.05*** 0.00
MSA	Y	Y	Y	Y	Y	Y
Decade Built	Y	Y	Y	Y	Y	Y
Household Size	Y	Y	Y	Y	Y	Y
Division x Survey Yr	Y	Y	Y	Y	Y	Y
N	28,821	32,569	60,241	52,578	24,626	198,842
r <sup>2</sup>	0.31	0.32	0.36	0.39	0.40	0.35

**Table 8: Energy costs and home renovation**

Table shows OLS regressions of the change in monthly total energy expenditure on measures of home renovation taken from the American Housing Survey administered by the Census. Sample includes all National and Metro surveys between 2005 and 2013 for which there is precise square footage. Regressions control for MSA whenever available, Census division-by-survey year, decade built, and household size fixed effects. Costs and income are adjusted to 2019 constant dollars. Standard errors are clustered at the Census division-by-survey year level.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Home Improvement Flag	0.02*** (0.005)	0.02*** (0.005)	0.02*** (0.004)			0.02** (0.007)	0.02*** (0.006)	0.01* (0.006)
Energy Saving Improvement Flag				-0.00 (0.007)	-0.00 (0.007)	-0.02** (0.007)	-0.01** (0.007)	-0.03*** (0.010)
Change in Income			0.02*** (0.004)		0.03*** (0.004)		0.03*** (0.004)	0.01*** (0.002)
Change in Sq. Feet								0.02* (0.013)
Constant	0.00 (0.008)	0.00 (0.005)	-0.01 (0.005)	-0.01*** (0.005)	-0.03*** (0.004)	-0.02*** (0.006)	-0.03*** (0.005)	-0.02*** (0.006)
Year	Y							
MSA x Year		Y	Y	Y	Y	Y	Y	Y
Observations	186,115	186,113	173,658	166,151	153,903	166,151	153,903	74,945
R-squared	0.020	0.024	0.055	0.019	0.045	0.019	0.045	0.095

**Online Appendix for:**  
**The Environmental Cost of Easy Credit: The Housing Channel**

Manuel Adelino, Duke University, CEPR and NBER

David Robinson, Duke and NBER

**Table A1: Banking deregulation analysis including lagged dependent variable as a control**

Table shows coefficients from equation (2) for the period 2001 through 2006, with non-core liabilities split into (population-weighted) quartiles. The outcomes are the same as Table 5: 5-year change in the logarithm of average new house living area in a Zip code, the number of new single-family homes, building quality index and building condition. “*Non-core liabilities*” are defined as the non-core liability ratio weighted by each institution’s mortgage origination market share in a Zip code (as in Mian and Sufi, 2022). Regressions control for state fixed effects and are weighted by population in 1998. Standard errors are clustered at the Zip code level. Data is from Zillow (ZTRAX Assessor files).

	Log(Living area in sq. ft)	Log(Number of new houses)	Building Quality Index	Building Condition (Latest)
Intrastate Deregulation	-0.011** 0.006	0.057* 0.031	0.063*** 0.020	0.004 0.010
Interstate Deregulation	0.016*** 0.004	0.098** 0.038	0.031* 0.016	0.015* 0.009
Log(Income per Capita)	-0.014 0.039	0.954*** 0.294	0.723*** 0.255	0.215*** 0.062
Log(State Population)	-0.026 0.019	0.245** 0.113	0.219* 0.130	0.108 0.079
Diff. Effective Year Built	0.040*** 0.008	0.041 0.045	0.051 0.046	-0.024 0.049
Remodeled	0.070*** 0.019	-0.157*** 0.050	0.164** 0.080	0.319** 0.151
Lagged Dependent Variable	Y	Y	Y	Y
Weighted by Zip Population	Y	Y	Y	Y
Year	Y	Y	Y	Y
Zip Code	Y	Y	Y	Y
N	440,139	434,641	434,641	434,641
r2	0.62	0.71	0.71	0.71

**Table A2: Heterogeneous effects of banking deregulation across areas (intrastate deregulation)**

Table shows the results from equation (1), interacted with indicator variables for areas with low housing supply elasticity (as in Saiz (2010)), high building costs (as measured by RS Means (2003)), above-median degree days (from the Environmental Protection Agency), and high car travel times weighted by the proportion of commuting done by car (from the American Community Survey). The outcomes are year-by-Zip code averages of each variable and control for Zip code and year built fixed effects. Weights are Zip code population in 1998. Standard errors are clustered at the county and year level. Data is from Zillow (ZTRAX Assessor files).

	Log(Living area in sq. ft)				Log(Number of new houses)			
Intrastate Deregulation	-0.024***	-0.016**	-0.026***	-0.020**	0.095	0.019	-0.029	-0.002
	0.007	0.007	0.010	0.008	0.070	0.060	0.061	0.049
Intrastate Deregulation x Low Elasticity	0.036***				-0.116*			
	0.007				0.065			
Intrastate Deregulation x High Building Costs		0.015**			0.043			
		0.006			0.051			
Intrastate Deregulation x High Degree Days			0.025***				0.141**	
			0.009				0.057	
Intrastate Deregulation x High Car Travel				0.015*				0.090**
				0.008				0.042
Controls	Y	Y	Y	Y	Y	Y	Y	Y
Weighted by Population	Y	Y	Y	Y	Y	Y	Y	Y
Year	Y	Y	Y	Y	Y	Y	Y	Y
Zip Code	Y	Y	Y	Y	Y	Y	Y	Y
N	240,345	423,124	426,624	432,840	240,345	423,124	426,624	432,840
r2	0.74	0.73	0.70	0.70	0.64	0.67	0.67	0.67

**Table A3: Quartiles of non-core liabilities**

Table shows coefficients from equation (2) for the period 2001 through 2006, with non-core liabilities split into (population-weighted) quartiles. The outcomes are the same as Table 5: 5-year change in the logarithm of average new house living area in a Zip code, the number of new single-family homes, building quality index and building condition. “*Non-core liabilities*” are defined as the non-core liability ratio weighted by each institution’s mortgage origination market share in a Zip code (as in Mian and Sufi, 2022). Regressions control for state fixed effects and are weighted by population in 1998. Standard errors are clustered at the Zip code level. Data is from Zillow (ZTRAX Assessor files).

	$\Delta_5$ Log(Square feet)	$\Delta_5$ Log(Number of new houses)	$\Delta_5$ (Building quality)	$\Delta_5$ (Building condition)
Q2.Non-core liabilities	0.025* 0.015	-0.015 0.057	-0.130 0.120	-0.005 0.024
Q3.Non-core liabilities	0.029 0.018	0.077 0.087	-0.362** 0.146	-0.066* 0.037
Q4.Non-core liabilities	0.069*** 0.021	-0.013 0.126	-0.264* 0.147	-0.003 0.060
Remodel Controls	Y	Y	Y	Y
Weighted by Population	Y	Y	Y	Y
State FE	Y	Y	Y	Y
N	3,738	3,738	1,224	1,962
r2	0.04	0.06	0.04	0.06

**Table A4: Effect of NCL in cheap and expensive areas**

Table shows the results from equation (2), interacted with indicator variables for areas with low housing supply elasticity (as in Saiz (2010)) and high building costs (as measured by RS Means (2003)). The outcomes are the 5-year change in the logarithm of average new house living area in a Zip code, the number of new single-family homes in a Zip code, the building quality index and the building condition. “*Non-core liabilities*” are defined as the non-core liability ratio weighted by each institution’s mortgage origination market share in a Zip code (as in Mian and Sufi, 2022). Weights are Zip code population in 1998. Standard errors are clustered at the county level. Data is from Zillow (ZTRAX Assessor files).

	$\Delta_5$ Log(Square feet)	$\Delta_5$ Log(Number of new houses)	$\Delta_5$ (Building quality)	$\Delta_5$ (Building condition)				
Non-core liabilities	0.124 0.098	0.121 0.119	-1.094 0.699	-1.838*** 0.679	-1.793** 0.852	-0.747 1.117	-0.099 0.302	0.530 0.393
Low Elasticity	-0.245* 0.146		-0.748 0.679		-0.083 1.244		-0.168 0.328	
Non-core liabilities x Low Elasticity	0.330 0.202		0.954 0.970		0.076 1.724		0.171 0.471	
High building costs		-0.231* 0.134		-1.730** 0.702		-0.156 1.141		0.767** 0.311
Non-core liabilities x High building costs		0.327* 0.186		2.513** 1.030		0.038 1.599		-1.194*** 0.435
Remodel Controls	Y	Y	Y	Y	Y	Y	Y	Y
Weighted by Population	Y	Y	Y	Y	Y	Y	Y	Y
State FE	Y	Y	Y	Y	Y	Y	Y	Y
N	3,161	3,727	3,161	3,727	1,003	1,212	1,651	1,952
r <sup>2</sup>	0.04	0.04	0.06	0.05	0.04	0.03	0.07	0.06

**Table A6: Summary statistics for American Housing Survey data**

Table shows summary statistics for the variables used in the American Housing Survey analysis in Section 5. Statistics are weighted by the AHS survey weights.

	Mean	St. Dev.	Median	Min	Max	N. Obs
Total Monthly Energy Costs (2020 dollars)	188.9	111.0	167.6	1.1	1,403.7	281,404
Monthly Electricity Costs (2020 dollars)	134.4	81.3	118.4	0.0	652.1	281,404
Monthly Gas Costs (2020 dollars)	47.5	62.9	31.3	0.0	523.6	281,404
Monthly Oil Costs (2020 dollars)	7.1	40.7	0.0	0.0	901.8	281,404
Living area (Sq. Feet)	1,886.5	1,609.6	1,600.0	99.0	24,870.0	281,404
Year Built	1977.1	17.0	1980.0	1950.0	2010.0	281,404
Improvement Flag	0.40	0.49	0.00	0.00	1.00	281,404
Green Improvement Flag	0.08	0.27	0.00	0.00	1.00	246,312
Home Rating (1: best, 10: worst)	2.6	1.6	3.0	1.0	10.0	271,692
Household Income (2020 dollars)	99.66	108.87	72.19	0.00	6,868.19	281,404

## Figure A1: Example of high and medium quality grade structures

Figure is from the Uniform Schedules of Values, Standards, and Rules for Single Family Residences (Volume 3, January 2016) for Durham County produced by the Office of Tax Administration. Below are examples of a “Grade A” and “Grade C” residence, as well as descriptions of the typical characteristics of homes of these grades.

### A Quality Dwellings

These homes are architecturally designed and custom built by contractors who specialize in good quality construction. Extensive detail is given to ornamentation with the use of good grade materials and skilled craftsmanship. Homes of this type are located in areas that are specifically developed for this level of quality.

#### BASE SPECIFICATIONS

**FOUNDATION:** Brick or reinforced concrete foundation walls on concrete footings with interior piers.

**EXTERIOR WALLS:** Stone, brick veneer, stucco, log, or frame siding. All exterior walls will be of good quality and constructed with detail and workmanship. Ample insulation and adequate openings for windows and doors is typical.

**ROOF:** Slate, tile, cedar shake, or architecture asphalt shingles on quality sheathing with well braced rafters having various slopes and ridges.

**INTERIOR FINISH:** The interior of these homes is of good design and good construction with much attention given to detail and good quality craftsmanship.

**FLOORS:** Heavy construction utilizing wood or steel joists and sub floor with a good quality combination of hardwoods, ceramic tile, marble or granite tile, vinyl, or good quality carpeting.

**PLUMBING:** A combination of good quality fixtures, good quality materials, and skilled workmanship; considered typical and adequate for the type of construction, generally exceeds a total of twelve fixtures.

**CLIMATE CONTROL:** A heating system equal to forced air with ample capacity and insulated ductwork throughout. Air conditioning is included as a part of the specifications; however, this item is considered an add-on item and is excluded from base pricing.

**ELECTRICAL:** Good quality wiring, maximum electrical outlets and expensive light fixtures.



### C Quality Dwellings

These homes are designed and built by contractors who specialize in average quality construction. Adequate detail is given to ornamentation with the use of average grade materials and typical workmanship. Homes of this type are located in areas that are specifically developed for this level of quality. These homes represent the prevalent quality.

#### BASE SPECIFICATIONS

**FOUNDATION:** Brick or reinforced concrete foundation walls on concrete footings with interior piers.

**EXTERIOR WALLS:** Stone, brick veneer, stucco, log, or frame siding. All exterior walls will be average quality and constructed with detail and workmanship. Ample insulation and adequate openings for windows and doors is typical.

**ROOF:** Tile, cedar shake, or asphalt shingles on average quality sheathing with frame trusses and having typical slopes.

**INTERIOR FINISH:** The interior of these homes is of average design and average construction with attention given to detail and average quality workmanship.

**FLOORS:** Moderate construction utilizing wood or steel joists and sub floor with an average combination of hardwoods, ceramic tile, vinyl, or average quality carpeting.

**PLUMBING:** A combination of average quality fixtures, average quality materials, and workmanship; considered typical and adequate for the type of construction, generally does not exceed a total of ten fixtures.

**CLIMATE CONTROL:** A heating system equal to forced air with ample capacity and insulated ductwork throughout. Air conditioning is included as a part of the specifications; however, this item is considered an add-on item and is excluded from base pricing.

**ELECTRICAL:** Average quality wiring, adequate electrical outlets and average light fixtures from base pricing.

