Regulating housing quality: evidence from France*

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Abstract

Minimum *quality* standards in housing markets can affect the equilibrium *quantity* of dwellings supplied, depending on the demand response to their shadow monetary and non-monetary costs. To estimate the consequences of quality regulations, this paper studies a rule requiring new single-family constructions in France to use the services of an architect, whenever their square footage exceeds a threshold. Using exhaustive administrative data on the universe of building permits in France and quasi-experimental variation in the threshold, I evidence that the cost of new housing production jumps above the notch, which in turn leads to substantial distortions in the size distribution of homes. New units bunch below the regulatory notch to avoid additional costs, and additions to existing dwellings are downsized, or avoided, to circumvent the requirement. Regression discontinuity estimates reveal that homeowners' demographics, dwelling features, and spatial location decisions all change sharply at the threshold, evidencing a segmentation of households by their taste for housing quality. Overall, the attribute-based regulation leads to significant misallocation of housing consumption.

JEL codes: R52, R21, R38.

Keywords: housing demand, bunching, building codes, quality standards.

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1 Introduction

Households in advanced economies dedicate a steadily rising share of consumption expenditures to housing — close to 25%, in OECD countries. Claims that tight regulatory constraints on new housing developments fostered the decline in housing affordability have led to calls for relaxing housing supply restrictions. Nonetheless, ensuring that newly built dwellings are abundant, while remaining of high enough caliber, requires walking a fine line between loosening *quantity* regulations and maintaining *quality* standards. Demonstrating this tension, when releasing his Housing Supply Action Plan in 2022, President Joe Biden stated that "*the best thing we can do to ease the burden of housing costs is to boost the supply of* quality *housing*".[1]

Most existing analyses of housing regulation, however, focus on the effects of laws regulating the *quantity* of new housing (Hsieh and Moretti, 2019; Glaeser and Gyourko, 2018). Up to now, little evidence has documented the consequences of regulations regarding the *quality* of housing production, and the trade-offs they must take into account. A key reason is that assessing their quantitative relevance is complex. While terms such as "neighbourhood character", "historic preservation" or "aesthetic requirements" abound in local building codes, most often, they do not have a measurable counterpart to credibly estimate the sensitivity of demand to quality constraints raising the cost of building new homes.

In this paper, I take advantage of a setting in which *quality* regulations exhibit sharp *quantitative* variation, and show that they have large effects on production costs, the demand for living space, and sorting across space. In France, since 1977, builders of single-family units are required to hire a government-certified architect to erect or modify any dwelling. The stated aim of the rule is to ensure that only aesthetically pleasing, durable and high-quality new housing gets built. However, individual households can be exempted from the constraint, whenever the square footage does not exceed an "Architect Requirement Threshold" (*ART*).[2]
This quasi-experimental setup exposes construction projects varying only slightly in size to distinct quality regulations. Whether and how much households are willing to reduce housing consumption to circumvent the "notched" increase in monetary and hassle costs can be used to reveal the sensitivity of housing demand to regulation-related costs. Using static and dynamic bunching, I show that the rule distorts the initial choice of dwelling size, and the decision to expand existing constructions. Regression discontinuity methods allow me to estimate the additional charge associated with regulatory compliance, and to evidence patterns of consumer sorting along the quality-quantity trade-off. Combining the reduced-form evidence with a simple theoretical framework allowing for discrete quality and continuous quantity choice, I study the implications of the results for the elasticity of housing demand, and the incidence of quality regulations.

Choosing a level of livable space consumption slightly below the *ART* allows consumers to avoid spending

[1] White House briefing (President Biden Announces New Actions to Ease the Burden of Housing Costs), emphasis added.

[2] From 1979 to 2017, the threshold value – for both new construction and the post-improvement size in the case of extensions – was 170 square meters (c. 1830 square feet). It was lowered to 150 square meters (1615 sq.ft.) in 2017.

a discrete amount on fees,[3] at the cost of a small distortion in their housing quantity choice. Quantifying this effect, however, bears a conceptual difference to usual bunching estimates of e.g., labor supply responses to "notched" tax schedules. Because architect services might be valuable to the consumer, the requirement to use them above the size threshold is not a pure tax, but rather an *attribute-based* regulation, which can distort choices for both quality compliance and quantity. I first develop a simple framework extending the bunching approach to the case of heterogeneous private values for a secondary attribute (housing quality). Leveraging novel exhaustive administrative data covering all authorized private construction projects in France from 1973 to 2019, I then exploit the initial implementation and successive reforms of the *ART* to test the key predictions of the model, evidencing four main results.

First, the realized average cost of housing construction jumps discretely at the size threshold, suggesting that the minimum quality standard is binding, and that the architect mandate raises prices (and potentially perceived housing quality) for consumers. Regression discontinuity estimates, while not directly interpretable as a causal effect in the presence of sorting, imply that housing costs for structures are on average eight percentage points higher for houses with a size slightly above the architect requirement trigger, relative to those just below.

Second, there is economically significant — and visually stark — bunching in the distribution of new dwelling sizes immediately below the regulatory threshold. The excess mass at the *ART*, and the missing mass above it, only appear with the implementation of the threshold at 250 square meters in 1977, and especially with its tightening to 170 square meters in 1979, eliminating explanations based on the time-invariant salience of round numbers or technological constraints in housing construction. Additionally, households are highly responsive to variation in regulatory norms over time. When the effective stringency of the *ART* was reduced, due to a change in the square footage computation in May 2012, bunching declined in magnitude, as the new constraint was less likely to bind. Conversely, when the *ART* was lowered to 150 square meters in March 2017, bunching quickly moved strictly below the new exemption level, with its absolute magnitude rising substantially. The evolution of the level and computation of the *ART* over time allows me to use the new unit size distribution in alternative years to estimate a non-parametric counter-factual distribution. I find a bunching mass of close to thirteen times the counter-factual density immediately below the *ART*, a conclusion robust to the use of alternative estimation strategies.

Third, households respond both at the extensive and intensive margins of housing demand. I show that extension projects for existing houses, which face a complex set of interlocked regulatory notches, are commonly downsized precisely to avoid triggering the architect requirement condition. They are also frequently not undertaken altogether, for units with a floor area initially close to the limit. Moreover, some households distort their housing consumption choices by a more substantial amount, in order to entirely avoid filing for a building license, and thus not be subject to the architect mandate.

Fourth, quality regulation leads to sorting across housing sub-markets. While bunching is considerable, the large implied marginal cost premium associated with exceeding the threshold implies reasonable user cost

[3] Architect fees in France are commonly set at a level ranging from five to twelve percent of overall construction costs costs.

elasticities. The regulations, however, lead to housing market segmentation. I use regression discontinuity evidence to assess the differential perceived quality associated with architects' services across demographics. Younger agents, and those in lower income groups, are more likely to bunch below the threshold. On the other hand, houses that comply with the regulation and remain above the threshold are more complex, take longer to complete, and are less likely to be used as primary residences. They also locate in municipalities with higher incomes, better amenities, and higher inequality. The requirement leads to a misallocation of housing consumption across families and locations, and to a potentially regressive transfer of rents away from less sophisticated households, and towards higher-income professionals.

This paper relates to two distinct strands of research. First, it improves our understanding of housing demand. Several papers have attempted to estimate its price sensitivity, using structural demand systems (Chen, Clapp, and Tirtiroglu, 2011) or quasi-experimental variation arising from government subsidies (Geyer, 2017; Gruber, Jensen, and Kleven, 2021). Most existing studies, however, have focused on *extensive* margins: the tenure choice to own or rent, the household formation phenomenon, or the location decision across space. Instead, I provide some of the first evidence on the *intensive* margin, for homeowners who build new units. Closest to this paper are two studies by DeFusco and Paciorek (2017) and Hanson (2020), both adopting a bunching approach to quantify borrower choices driven by discontinuous variation in interest rates in the US mortgage market. DeFusco and Paciorek (2017) avail themselves of the "conforming loan limit" for government-sponsored loans in the US; Hanson (2020) evidences an excess mass of loans at a kink in the mortgage interest tax deduction schedule. While I also use a bunching strategy, my design focuses on the effect of regulations on the size of new units, rather than the dollar amount of borrowing; unique data on housing permits directly demonstrate a real quantity response for livable space, and allow me to explore additional mechanisms for the decision to build new dwellings and expand existing ones.

On the other hand, this paper contributes to a growing literature on the economic consequences of housing regulation — reviewed in depth by Gyourko and Molloy (2015). Rules ranging from minimum lot sizes or maximum floor-area ratios, to parking space requirements to formal registration and licensing, constrain the provision of housing. Their relative stringency over time and across metro areas is widely thought to affect how promptly new construction responds to increasing demand (Ihlanfeldt, 2007; Glaeser and Gottlieb, 2008). The aggregate welfare costs of these rules have been deemed substantial, due to direct reductions in consumption (Turner, Haughwout, and Van Der Klaauw, 2014) or spatial misallocation (Herkenhoff, Ohanian, and Prescott, 2018; Hsieh and Moretti, 2019).

Credible causal evidence on the impact of housing regulations, however, has been surprisingly hard to obtain. First, data on regulation stringency are scarce and rarely harmonized. A few exceptions include the study of local refusal rates for housing projects in England (Hilber and Vermeulen, 2016), and recent work updating regulatory information across US metros by Gyourko, Hartley, and Krimmel (2021). Second, building rules are not randomly assigned, but rather the byproduct of local or national political economy processes. Thus, they co-vary over time and across locations with other characteristics of housing demand and supply, blurring the estimation of their causal impact (Davidoff et al., 2016). My paper makes progress on this identification issue, by exploiting a sharp discontinuity in regulatory norms between units that are similar in almost every respect, but for the fact that their square footage places them on either boundary of a regulatory threshold.[4] In that respect, it also relates to research on size-dependent regulations. Distortions implied by firm-size varying legal rules have been documented in the labor (Gourio and Roys, 2014; Garicano, Lelarge, and Van Reenen, 2016), product (Bachas, Jaef, and Jensen, 2019), and input markets (Chen et al., 2021). In my setting, the threshold renders the architect mandate size-dependent, or ”attribute-based” – to borrow the language of Ito and Sallee (2018). Recent work evidenced responses to such size-dependent rules for government procurement (Carril, 2019) or financial regulations (Dharmapala, 2016). I extend this framework to the housing market, to quantify the misallocation of housing *quality* due to size-dependent building codes.

Section 2 details the legal setting and exhaustive administrative data used in the rest of the paper. Section 3 then introduces my conceptual framework, and justifies the research design and methodology employed to assess the incidence of quality regulations in the French housing market. Section 4 presents the main empirical results, exploiting both cross-sectional bunching evidence and long-term data on the response of housing provision to regulatory reforms. Section 5 uses the reduced-form estimates to discuss the distortions introduced by size-dependent regulations in the housing market, and concludes.

2 Institutional background and data

2.1 Institutional background

The architect requirement threshold In France, building licenses (henceforth, BL) for new residential or commercial construction are granted by a town's urban planning office. The construction of new units, as well as the expansion of existing ones, must comply with a wide array of restrictions, including constraints on the maximum square footage built per acre of land, minimum parking requirements, maximum height limits, or energy efficiency mandates.

Among these regulations, one of the most salient is a 1977 law[5] requiring households filing for a building license to resort to the services of a government-certified architect[6] for the construction or modification of any building, if its square footage exceeds a pre-specified architect requirement threshold (*ART*) h^*. The official motive for the architect mandate was to ensure minimal quality standards in the housing stock and maintain ”neighbourhood character”. Individuals retain the option to use an architect for a square footage below h^*, but

[4] Importantly, unlike recent quasi-experimental work on the price response to built-area-ratios or minimum lot sizes in the US (Brueckner and Singh, 2020; Song, 2021), Brazil (Anagol, Ferreira, and Rexer, 2021) and China (Tan, Wang, and Zhang, 2020), the discontinuity I study is *not* based on the spatial boundaries between jurisdictions, but on the intensive margin quantity choice.

[5] Article 3 of the January 3rd, 1977 law n. 77-2 on Architecture.

[6] Architects in France receive a degree from certified schools and universities, allowing them to use the title of ”Government-recognized degree-holding Architect” (*Architecte DPLG*) until 2007. Since 2007, they must be affiliated with the Order of Architects, a government-sanctioned professional guild.

they are not mandated to do so.[7]

The exemption level h^* was initially set at 250 square meters (c. 2,691 square feet) in January 1977. It was reduced to 170 square meters (c. 1,830 square feet) starting October 15$^{\text{th}}$, 1979, a threshold that remained in force until March 1, 2017. The square footage definition used for the *ART* changed several times since the initial 1977 law. From January 2007 to March 2012, the relevant area was labelled the *SHON*, an acronym standing for *Surface Hors Oeuvre Nette*, or "Net Area based on Outside Structure". It included the floor area of all covered and enclosed spaces, starting from outside external walls, with only the exceptions of indoor parking spaces, and top floors with a ceiling lower than 1.8 meter (5 feet and 11 inches). The *SHON* applies a 5 percent deduction to the square footage thus calculated. Due to this consistent computation, the 2007-2011 period constitutes the core sample for my cross-sectional analysis of bunching below the ART.

The 2012 reform In 2012, as part of its climate strategy, France implemented new regulations in the residential construction sector, a leading consumer of energy. To encourage better housing insulation, the government adjusted the computation of the square footage used in urban planning regulations. It defined a new measure, the "floor area", or *Surface de Plancher* (henceforth, *SDP*), due to replace the *SHON* after March 1, 2012. The main difference was that the *SDP* computed the floor area starting from the *inside* of external walls, unlike the *SHON*, which started from the *outside* of the structure.The objective was to avoid penalizing building materials with better insulation properties: houses using thicker walls to lower energy consumption would not need to reduce indoors livable space in order to meet urban planning guidelines. Figure 1 compares the two measures: due to the exclusion of external walls, the *SDP* was generally c. 10 percent smaller than the *SHON*.[8] While an additional "dual test" was introduced to take into account the overall footprint of a construction,[9] the switch to the *SDP* implicitly loosened the architect mandate, by raising the amount of effective livable space below which an architect was not required by law. Indeed, due to the exclusion of external walls, an *SDP* of 170 sq.m. corresponded to a *SHON* of c. 185 to 190 sq.m..

The 2017 reform In 2017, the threshold was adjusted again. The dual test was eliminated: only the floor area (*SDP*) would count towards the exemption level. The level of the threshold itself, on the other hand, was lowered to 150 square meters of *SDP*. The objective was to roughly match the pre-2012 stringency, since an *SDP* of 150 square meters corresponded on average (depending on the shape of the unit and thickness of the walls) to a *SHON* of 165 to 170 square meters. The 2017 change fostered incentives to distort housing consumption levels at previously unaffected levels of *SDP* below 150 square meters, relative to the situation after the 2012

[7] Only individuals who build a home for their own dwelling purposes or destined to be leased can be exempt from the architect mandate below the ART. Corporations and other juridical persons are required to use the services of an architect for the construction or modification of any building, independently of its square footage. Agricultural constructions benefit from a higher threshold, and both are excluded from my main analysis sample.

[8] In the simplest case of a square home, with external walls of thickness ε and an *SDP* of side L, the *SDP* would be: $SDP = L^2$ while the corresponding *SHON* would be: $SHON = 0.95 \times (L + 2\varepsilon)^2$. Thus the *SDP* was smaller than the *SHON* as long as: $0.05L^2 < 3.8(\varepsilon^2 + L\varepsilon)$. Since on average, walls in homes built after 2012 had a thickness ε of 0.45 meter (c. 18 inches), the *SDP* would be from 5 to 12 percent lower than the *SHON* for standard floor areas, in the 100 to 300 square meters interval. It could be substantially lower, up to 20 percent less, for a more elongated or less compact construction.

[9] Appendix A provides additional institutional details on the March 2012 reform and the various adjustments to the computation made from March to May 2012.

reform. I exploit these changes in a difference-in-differences and difference-in-bunching empirical strategy to assess both the intensive and extensive margin responses to quality regulations.

The special case of additions If the size-dependent rule only applied to initial constructions, a simple avoidance strategy would involve gradual additions to a project initially below the *ART*. To circumvent such project-splitting incentives, additions are also subject to the architect mandate. If the owner of a house of initial size h^E uses a building license to expand it by h^N, they must resort to an architect if the completed size is above the *ART*: $h^N + h^E \geq h^*$. Similar to new units, this creates incentives to downsize expansion projects, so that the *completed* unit footage remains strictly below the *ART*, by choosing h^N immediately below $h^* - h^E$.
In addition, builders do not need to request a building license – and therefore never need an architect, independent of the completed size – when the addition size h^N is below the "BL threshold", $\bar{h}$.[10] Before 2012, the BL threshold $\bar{h}$ was 20 sqm. It was raised to $\bar{h} = 40$ after January 2012 only in urban areas, while remaining at 20 in rural areas. This creates incentives to bunch the size of the extension project, h^N, strictly below $\bar{h}$ (20 or 40).[11] Figure 2 describes the complex interaction of incentives to bunch at either the *ART* or the *BL* threshold, depending on the existing size of the unit and the desired size of the addition. For units with an existing size close enough to the *ART* ($h^E \geq h^* - \bar{h}$), there are no incentives to bunch the completed size ($h^E + h^N$) below h^*, since in that case, $h^N < \bar{h}$, and the project requires neither a building license nor an architect. At all existing sizes h^E, there is a strong rationale to build extensions smaller than $\bar{h}$, in order not to file for a BL altogether. I exploit discontinuities in these incentives in my empirical strategy when assessing the effect of quality regulations on incentives to expand the existing housing stock.

2.2 Data

To evaluate the impact of the regulation on housing production, I use the *Sit@del2* database, an administrative, restricted-access repository containing detailed information on the universe of housing permits requested in France from 1973 to 2022. The data are collected by the French Housing Authority and include details about the exact date, location, and characteristics of units built, for each approved and rejected construction project in the country. I restrict the sample to single-family new units. On average, from 2009 to 2019, the *Sit@del2* database counts around 130,000 authorized new housing units every year, and 165,000 approved extension projects for existing dwellings units.[12] I focus on the 2007-2011 period for my main analysis of the 170 square meters of *SHON* threshold, on the 2013-2016 period for the effect of the 2012 switch from the *SHON* to the *SDP*, and on the 2018-2022 period for the consequences of the reduction of the *ART* to 150 square meters in 2017. In

[10] The architect mandate can solely apply to projects for which a *building license* (BL) is required. Only construction projects with a square footage larger than $\bar{h}$ square meters must obtain a BL. Construction projects below 5 square meters require no approval. Construction projects larger than 5 square meters, but below $\bar{h} = 20$ square meters, are allowed to use a tacit approval expedited processing method, the *Declaration prealable* or "Pre-registered Statement" (PS), instead of a BL.

[11] An architect was still mandatory in urban areas, in the $20 \leq h^N < 40$ interval, if (i) the initial square footage h^E was less than the *ART* h^* and (ii) the addition would push the complete footage $h^E + h^N$ above h^*.

[12] Other building licenses in the sample correspond to small modifications of the exterior aspect of houses, or to commercial, industrial, or agricultural building projects, which I exclude from my main analysis sample, given my focus on housing constraints, and the non-applicability of the exemption threshold to units built by corporations and juridical persons.

robustness checks, I also exploit earlier, 1973 to 1985 data, to study the implementation of the threshold in 1977 and its modification in 1979. The *Sit@del2* database provides detailed information on the timing and processing of construction projects, as well as some additional data on the exact location of the projects. However, a key limitation in the data is the absence of pricing information or detailed households demographics. I therefore complement the data with project level micro-data from two detailed annual surveys. First, I use the EPTB survey[13], which is exhaustive since 2010, and includes information on the decomposition between land and structure prices for all new single-family unit building projects, in order to assess the extent of the cost jump associated with building units with a size above the architect requirement threshold. Second, I use the PRLN survey,[14] in which a sample of individual building licenses drawn from the *Sit@del2* database are surveyed every year to obtain highly detailed information on the duration, nature, and pricing of housing projects they correspond to, as well as some additional household demographics.

3 Conceptual framework and research design

3.1 A simple model of the housing quality-quantity trade-off

In the setting I study, households must trade off quality and quantity when purchasing housing, subject to regulatory frictions. To clarify the implications of this decision for the equilibrium distribution of dwelling sizes, I develop a simple model of the housing consumption decision. Agents allocate a fixed income to housing and other tradable goods. The dwelling choice involves a continuous *quantity* decision (how much livable space to purchase), and a discrete *quality* choice (whether or not to use an architect).

Household choice without quality regulation An agent j consumes a *quantity* of housing h, at user cost p_H, and a composite of other tradable goods c (defined to be the numeraire, with price $p_c = 1$). Besides, the consumer also makes a binary *quality* decision: using the services of an architect ($\mathbb{1}_A = 1$) or not ($\mathbb{1}_A = 0$). If they do, they receive an idiosyncratic taste shock for housing in their utility function. This shock, parameterized by γ_j, proxies for the heterogeneous perceived quality of architect-built units. They also have to pay a premium s over the baseline user cost of housing.[15] Households are defined by income y_j, and potential taste for quality γ_j, jointly distributed according to the CDF $F(y, \gamma)$.

Parameterizing the decision function further, the overall household problem consists of maximizing the constant elasticity of substitution (CES) aggregate:

$$\max u(h, c, \mathbb{1}_A) = \max[(\alpha + \gamma\mathbb{1}_A)^{\frac{1}{\sigma}} h^{\frac{\sigma-1}{\sigma}} + (1 - \alpha - \gamma\mathbb{1}_A)^{\frac{1}{\sigma}} c^{\frac{\sigma-1}{\sigma}}]^{\frac{\sigma}{\sigma-1}}$$

[13] *Enquete sur le Prix des Terrains a Batir* or Survey on the Price of Buildable Land.

[14] *Enquete sur le Prix de Revient des Logements Neufs* or Survey on the Cost of New Construction. In particular, this survey is used to build nationwide indices of construction costs employed in a plurality of rental housing regulations in France.

[15] This premium is modelled as an increase in average costs, starting from the first euro of housing consumption. An alternative specification could model the cost of an architect as a fixed payment, but to relate closely to the empirical context of my study, in which architect fees are often set as a percentage of total construction costs, I choose the proportional representation.

where γ reflects the perceived quality added value of using architect services, subject to a budget constraint:

$$c + (p_H + s\mathbb{1}_A)h \leq y$$

Counterfactual choices in the absence of a regulation are denoted with superscript x^0. In the absence of a minimum quality standard, each household decides whether to resort to an architect by comparing the indirect utility when using one $v^{0,A}(y, p_H + s)$ to their maximized utility at optimal choices without one $v^{0,N}(y, p_H)$:

$$\mathbb{1}_A = \text{argmax}\left[v^{0,N}(y, p_H, \mathbb{1}_A = 0), v^{0,A}(y, p_H + s, \mathbb{1}_A = 1)\right]$$

The solution of this program determines the un-distorted optimal quantities of housing and architect services consumed, as a function of income and potential tastes: $\left(h^{0,k}, \mathbb{1}_A^0\right)$ for $k = N, A$. The underlying joint distribution F of incomes y and taste shocks γ then gives rise to a combined counter-factual density of housing *quantity* consumption choices that sums the marginal densities for architect users and non-users, as in the left panel of figure 3:

$$g^0(h) = g^{0,N}(h) + g^{0,A}(h)$$

Household choice with quality regulation I then study the introduction of a notched regulation, requiring a household consuming more than h^* units of housing to use an architect. The new problem can be stated as:

$$\max u(h, c, \mathbb{1}_A) = \max[(\alpha + \gamma\mathbb{1}_A)^{\frac{1}{\sigma}} h^{\frac{\sigma-1}{\sigma}} + (1 - \alpha - \gamma\mathbb{1}_A)^{\frac{1}{\sigma}} c^{\frac{\sigma-1}{\sigma}}]^{\frac{\sigma}{\sigma-1}}$$

subject to:

$$c + (p_H + s\mathbb{1}_A)h \leq y$$

and the minimum quality standard attribute-based constraint:

$$\mathbb{1}_A \geq \mathbb{1}[h \geq h^*] \tag{1}$$

Table 1 summarizes the incentives faced by various types of household, depending on their counterfactual quantity and quality choice in the absence of the regulation. High-γ_j households, with a high taste for quality, would choose to use an architect ($\mathbb{1}_A = 1$) even absent constraint (1), and are thus left unaffected by the regulation, whether or not the quantity of housing they consume is above or below h^*. Formally, if the counterfactual quality choice is $\mathbb{1}_A^0 = 1$, then $\mathbb{1}_A = 1$, whether or not $h^0 > h^*$ or $h^0 \leq h^*$.

Absent the quality constraint, low-γ_j, low-y_j households would choose to consume a quantity of housing strictly below the threshold ($h_H^{N,0} < h^*$) and would not resort to an architect ($\mathbb{1}_A^0 = 0$). Thus their choices are also undistorted by the policy, as the previous decision remains optimal ($\mathbb{1}_A = 0, h_H^N < h^*$).

The only group directly affected by the constraint[16] is the subset of households with counter-factual choices $\mathbb{1}_A^0 = 0, h_H^{0,N} \geq h^*$ absent the policy, in the upper-right corner of table 1. These households, when re-optimizing subject to constraint 1, can keep consuming an interior amount $h^I \geq h^*$ above the threshold but now have to pay for the services of an architect $\mathbb{1}_A = 1$. Alternatively, they could reduce their housing consumption below h^*, the regulatory notch, and be exempted from the mandate $\mathbb{1}_A = 0$. In the latter case, the higher the difference with their preferred housing *quantity* choice in the absence of the regulation, the more substantial the welfare loss associated with bunching below the threshold. Thus they would "*bunch*", i.e. consume a quantity immediately below the threshold to distort quantity choices as little as possible relative to the counterfactual.

		Quality choice absent regulation	
		Architect	No architect
Quantity choice absent regulation	Above h^*	*No effect*	Bunch at h^* (quantity distortion) / Use architect (quality distortion)
	Below h^*	*No effect*	*No effect*

Table 1: **Summary of incentives relative to counter-factual choices absent regulation**

We can therefore define a marginal buncher (with choices $h^* + \Delta h$, $\mathbb{1}_A^0 = 0$ absent the regulation) who is indifferent between bunching at the notch h^*, or using an architect at an interior choice h such that $h^* + \Delta h > h > h^*$. The *actual* density of housing *quantity* choices with the regulation, $g(h)$, is then given by the sum:

$$g(h) = g^N(h) + g^A(h)$$

In the absence of extensive margin responses (households exiting the market for new homes), choices strictly below the notch ($h < h^*$) are undistorted and equal to the counter-factual distribution, both with and without an architect:

$$g^N(h) = g^{0,N}(h), g^A(h) = g^{0,A}(h) \text{ for } h < h^*$$

Exactly at the notch ($h = h^*$), the density of non-architect users is equal to the sum of counter-factual non-users, and the number of bunchers:

$$g^N(h^*) = g^{0,N}(h^*) + \int_{h^*}^{h^*+\Delta h} g^{0,N}(h)dh$$

and the density of architect users equals the counter-factual density of users:

$$g^A(h^*) = g^{0,A}(h^*)$$

Above the notch ($h > h^*$), the new density of non-architect users is $g^N(h) = 0$ by construction, while the density of users is larger than the counter-factual density of users, since it now includes counter-factual non-

[16] I abstract from any potential general equilibrium effects – such as regulation-induced variation in the cost of architect services – on groups not directly affected by the requirement.

users who did not bunch:

$$g(h^*) = g^A(h^*) > g^{0,A}(h^*) \text{ for } h > h^*$$

Figure 3 graphically describes a stylized view of the distribution of dwelling sizes in both the unconstrained and constrained case, showing that the incentives to bunch are concentrated among the group that would choose an unconstrained dwelling size above h^* but would prefer not to use an architect in the absence of the regulation. It also implies that the effective price of housing services should increase discontinuously at the notch: while all households above the threshold pay unit price $p_h + s$, the average price immediately below the notch is $\bar{p_h}(h^*) = \frac{(p_h+s)\times g^{0,A}(h^*)+p_h\times(g^{0,N}(h^*)+\int_{h^*}^{h^*+\Delta h} g^{0,N}(h))}{g(h^*)}dh$.

3.1.1 Bunching estimation

The conceptual framework outlined above suggests that, in the presence of an attribute-based regulation, the behavior of the overall density at and around the quantity notch can be used to reveal both the reaction of bunchers (alongside the *quantity* distortion), and of non-bunchers, who are either undistorted, or who distort their quality decision but not their quantity choice.

The construction of new houses To estimate the bunching response at the regulatory notch, I compare the observed quantity choices (the counts of new homes with a square footage of h square meters, $N(h)$) to an estimate of the counterfactual distribution $\hat{N}(h)$ that would obtain in the absence of discontinuities in the budget set, using two different estimates of the corresponding counter-factual distribution.

In the first, cross-sectional, methodology, I restrict the data to all new housing projects with a square footage above 20 square meters, and below 350 square meters, from 2007 to 2011.[17] I regress counts of projects in each 1 square meter bin of *SHON*[18] on a K-order polynomial of the floor area, and fit the observed distribution, excluding the manipulation range (corresponding to units with a square footage between h_L and h_U), and including an indicator for bunching at round and salient numbers in the (potentially empty) set S_r outside the manipulation range[19]:

$$N(h) = \sum_{k=0}^{k=K} \beta_k h^k + \sum_{i=h_l}^{h_u} \delta_i \mathbb{1}(h=i) + \gamma\mathbb{1}(h \in S_r) + \epsilon_h \tag{2}$$

The predicted distribution from the polynomial regression, excluding the contribution of dummies for the bins in the manipulation range, provides a hypothetical counterfactual $\hat{N}^{\text{Poly}}(h) = \sum_k = 0^K \hat{\beta}_k h^k + \gamma\mathbb{1}(h \in S_r)$. Bunching is then defined as the excess mass below the regulatory notch

$$B(h^*) = \sum_{i=h_L}^{h^*} N(h) - \hat{N}^{\text{Poly}}(h)$$

[17] This corresponds to close to 435,000 distinct approved housing projects. The time frame restriction allows me to focus on a period for which a consistent computation of the square footage – the *SHON* – was used throughout. The exclusion of new projects smaller than 20 square meters allows me to focus only on homes which require a BL throughout the 2007-2011 period, since new units with a floor area below 20 square meters were not required to file for a BL.

[18] Due to rounding in the underlying data collection process, the area of a project is only available at 1 square meter bin frequency.

[19] The set of round and/or salient numbers S_r is empty in the baseline empirical application, and includes multiples of 10 square meters and 5 square meters in robustness checks.

As is customary in the bunching literature, and given the graphical starkness of bunching, I obtain h_L by visual inspection of the start of the bunching mass under the notch. I then use the convergence method of Kleven and Waseem (2013) to algorithmically define the upper bound of the bunching interval h_U in order to minimize the difference between the resulting missing mass of units above the notch and the bunching mass below it. Standard errors are obtained using the bootstrap procedure described in Chetty et al. (2011).

In the second approach, I study bunching at 150 sq.m after the 2017 lowering of the threshold. I exploit the 2012 switch to the *SDP* measure, and the 2017 reform, to model the counterfactual distribution of square footage consumption choices. In years in which the regulation was located at the 170 sq.m ART, the mass at 150 sq.m was undistorted. The smoothness of square footage choices around the post-2017 notch in these "placebo" years provides proof of the causal distortion created by regulation in housing consumption, and contributes to the construction of an alternative counterfactual distribution choices, $\hat{N}^{\text{Placebo}}(h)$. Specifically, in order to measure bunching in the post-2017 reform period at the 150 sq.m of *SDP* mark, I use the 2013-2016 period distribution of consumption choices around 150 square meters as a counterfactual. I re-scale the counterfactual counts so that the total number of units is similar in the pre- and post-2017 periods. Formally, I rescale counter-factual housing size bins relative frequencies from 2013-2016 to match the post-2017 total counts:

$$\hat{N}^{\text{Placebo}}(h) = \frac{N^{\text{Pre}}(h)}{\sum_{h'} N^{\text{Pre}}(h')} \times \sum_{h'} N^{\text{Post}}(h') \tag{3}$$

and estimate bunching $B(h^*) = \sum_{i=h_L}^{h^*} N^{\text{Post}}(h) - \hat{N}^{\text{Placebo}}(h)$ as the excess mass of units below the 150 square meters threshold in 2018-2019, relative to the predicted counts of units in this region obtained from the 2013-2016 relative frequencies.

I use estimates of the bunching mass $B(h^*)$ obtained with either the cross-section (equation 2) or placebo notch approach (equation 3). Then, under the standard assumption that the distribution $g^{0,N}(h)$ of counter-factual choices for non-architect using households would be smooth around the threshold absent the policy, bunching immediately below the notch provides evidence of responsiveness to the regulation, and allows me to quantify the magnitude of the marginal response. In particular, I can estimate $h^* + \Delta h$, the point in the counter-factual distribution of choices where the marginal buncher comes from, based on the extent of bunching at h^*:

$$B(h^*) = \int_{h^*}^{h^*+\Delta h} g^{0,N}(h)dh \simeq \Delta h \times g^{0,N}(h^*) \tag{4}$$

where the approximation assumes the density is constant in the interval immediately above the notch.[20] The estimate of $B(h^*)$ is computed from the difference between the counter-factual and actual counts of homes strictly below the notch. The remaining difficulty lies in quantifying $g^{0,N}(h^*)$ at the notch, since the only estimated object is the aggregate density $g^0(h^*) = g^{0,A}(h^*) + g^{0,N}(h^*)$. Similar to the "bunching hole" approach of Kleven and Waseem (2013), this requires "grossing up" the estimate of the marginal buncher, Δh, by $\frac{1}{1-a(h^*)}$ where $a(h^*) = \frac{g^{0,A}(h^*)}{g^{0,A}(h^*)+g^{0,N}(h^*)}$ is the fraction of "always-takers" (estimated immediately above the notch), who

[20]This assumption is relaxed in the empirical application, where I use the downwards-sloping estimated counter-factual distribution above the notch to infer Δh from the observed amount of bunching.

correspond to households with a high enough γ who would use an architect at h^* and above even absent the regulation.

Additions to existing houses I also examine the behavioral response of owners of single-family units who expand existing homes.[21] Owners who wish to avoid being subject to the ART can exert two alternative behavioral responses: choose an extension of size h^N such that $h^E + h^N$ is strictly below h^*; or an extension of size $h^N \leq \bar{h}$, where $\bar{h}$ is the threshold below which no BL is required and a Preliminary Statement is sufficient. Therefore, I examine two separate behavioral responses for the size of extensions: bunching of the total completed size $h^N + h^E$ below h^*; and an increased use of extensions immediately below the BL requirement $\bar{h}$ for owners whose units have an existing size within $\bar{h}$ of the h^* ART threshold.

First, I quantify strategies designed to avoid the total area of the unit, including the addition, exceeding h^*. I compute the footage of the completed project as the sum of the area of the existing unit, plus any additions, minus any demolitions. The data from 2009 to 2019 contain slightly less than 1.3 million approved extension projects of existing homes with exhaustive data on the square footage of the completed unit and the extension. Similar to the approach of equation 2 for new homes, I examine bunching (in years 2009-2011) at the regulatory threshold by regressing the number of extensions with a post-extension area of h, $E(h)$, on a K-order polynomial in h, as well as dummies for counts in the manipulation range from h_L to h_U:

$$E(h) = \sum_{k=0}^{k=K} \beta_k^E h^k + \sum_{i=h_L}^{h_U} \delta_i \mathbb{1}(h = i) + \gamma \mathbb{1}(h \in S_r) + \epsilon_h \tag{5}$$

As before, the predicted distribution from the polynomial regression (including the contribution of an indicator for bunching at round and salient numbers) constitutes the hypothetical counterfactual $\hat{E}^{\text{Poly}}(h) = \sum_k = 0^K \hat{\beta}_k^E h^k + \gamma \mathbb{1}(h \in S_r)$. Bunching then corresponds to the excess mass of extensions below the notch:

$$B^E(h^*) = \sum_{i=h_l}^{h^*} E(h) - \hat{E}^{\text{Poly}}(h)$$

Second, I use a regression discontinuity approach to demonstrate that owners choose to build extensions below the BL threshold, $\bar{h}$, as an alternative strategy to avoid being subject to the architect requirement. While bunching below the BL threshold might be justified in its own right to reduce hassle costs, incentives to do so increase discontinuously due to the ART whenever the existing size of the unit is located between $h^* - \bar{h}$ and h^*. Therefore, I estimate $r_{\bar{h}}(h^E) = \frac{f_{\bar{h}}(h^E)}{f_{\bar{h}+1}(h^E)}$, the fraction of extensions with a size immediately below $\bar{h}$ relative to extensions with an area of $\bar{h}+1$, along the distribution of initial sizes h^E.

[21] Additions only start to be reported exhaustively and consistently in the data after 2008, so I focus on the 2009-2019 time period when examining bunching behavior.

4 Empirical results

4.1 Monetary and non-monetary costs of quality regulations

The first stage of the analysis demonstrates that the construction cost of new units indeed jumps at the architect requirement threshold, therefore implying that the quality regulation binds on the right-hand side of the threshold. Using data on new home building permits that were surveyed in order to obtain detailed information on project costs, I first offer evidence that homes with a square footage immediately above the threshold indeed present discontinuously higher construction costs than those immediately below. Pooling together all c. 760,000 building licenses for new housing units approved from 2007 to 2011, figure 4, panel (a), displays the average structure price per bin of 1 square meter of *SHON*, with a linear fit on both sides of the threshold, for the 2012-2016 period, when the ART was located at 170 square meters of square footage. The data are adjusted for year fixed effects which account for nationwide inflation in construction costs across years. Panel (b) plots the discontinuity of structure prices at 150 square meters for the post-2018 period. Appendix figure B.1 shows that houses on the right-hand side of the threshold appear to sell for about 8 log points more than those on the left-hand side of the threshold, a discontinuity representing about 10% of the baseline price, or 125 EUR out of an average price per square meter of 1250 EUR on the left-hand side of the threshold. The discontinuous increase in overall construction costs implies very high marginal costs for the square footage built immediately above the threshold, suggesting that the regulation can indeed (as per the framework of section 3) be formalized as a notch, rather than simply a kink.

While construction costs can be expected to respond directly to the architect requirement on the right-hand side of the *ART*, the jump in prices is actually visible for both the price of structures, and the cost of land. Appendix figure B.2 documents that the cost of land is about 15 to 20% higher for houses built with a square footage above the threshold (both in the 2012-2016 period above 170 square meters of *SDP*, and in the post-2018 period above 150), an increase of about 20 EUR/square meter of land over the baseline cost of 120 EUR. This increase in the cost of land suggests that the regulation is likely to not only lead to higher construction costs (as reflected in the higher cost of structures located above the *ART*) as a results of architect fees and other differential quality choices, but also to a segmentation of the housing market by quality level across locations with varying underlying land prices, a fact explored further in subsection 4.4.

Finally, additional non-monetary hassle costs can also discourage households from choosing a higher quality level. In particular, I compute the delay between the date of approval of the building license, and the actual starting date of construction works, when available. I show that construction starts systematically longer after the initial approval date for projects that are required to resort to the services of an architect - i.e. those above the *ART*. Figure 5 documents (for both the 2013-2016 and the post-2018 periods) that delays are systematically longer on the right-hand side of the threshold, consistent with the possible explanation that the mandate to resort to an architect also entails additional non-monetary compliance costs for households. Regression discontinuity estimates, while not directly interpretable as causally linked to the quality choice in the presence of sorting, help quantify this difference: I find an average delay of 22 days (std. err: 6.21) relative to the baseline on the right-hand side of the threshold.

4.2 Quantity effects of quality regulation

4.2.1 The bunching response of the size of new units

Having documented a discontinuous jump in (monetary and hassle) costs associated with dwelling sizes located on the right-hand side of the architect requirement threshold, I then turn to providing direct evidence that the binding *quality* regulation entails substantial *quantity* distortions (and resulting deadweight losses) for the size of newly built units. In particular, I show that households respond to these higher costs by adjusting the square footage of both new units and additions to existing units below the *ART*, in order to circumvent the architect mandate, leading to economically meaningful reductions in the real quantity of livable space they consume.

Polynomial approach I first document sharp bunching strictly below the 170 square meters of *SHON* threshold that was in force from 2007 to 2011. Pooling together all c. 760,000 building licenses for new housing units approved from 2007 to 2011, figure 6 displays counts of homes in bins of 1 square meter of *SHON*, as well as a polynomial fit of order 10 shown to fit the distribution of housing consumption fairly closely across non-manipulation region choices. The visual depiction of the house size distribution evidences two main results. First, the distribution exhibits a clearly visible and substantial spike in the immediate lower vicinity of the threshold (among projects with a square footage from 166 to 169 square meters). Most of the bunching response is concentrated in the 168 and 169 square meters bins, which together include around 27,000 new units throughout the period, or more than thirteen times the proportion in the two bins immediately above the notch (at 171 and 172 sq.m). Second, there is a sharp drop or "missing mass" immediately above the h^* threshold, relative to the smoothed polynomial counter-factual distribution plotted on the same figure, reaching up to 200 square meters, and robust to the use of alternative polynomial approximations to the counter-factual density. Bunching increases over time: figure 7 provides separate measures of bunching for selected years in the main analysis sample, from 1973 to 2019.[22] The year-by-year panel of histograms demonstrates that bunching started to appear at the 250 square meters mark after the regulatory notch was first implemented, in 1977 (so that the first full year of bunching at 250 square meters occurred for building licenses requests filed in 1978). The excess mass and bunching behavior then moved to the 170 square meters level immediately after the notch was lowered in October 1979 (the first full year of bunching at 170 square meters is 1980). It also shows that while the excess bunching mass remains at a similar magnitude after 1980, the missing mass immediately above the threshold increases substantially over the following twenty years, suggesting the presence of learning by households subject to the regulation, and a potential long-term unraveling of the market for homes with a size immediately above the threshold. A possible explanation relies on the presence of dynamic selection and learning by producers: as the most price-elastic households gradually exit the market for architect services by

[22] The corresponding square footage is expressed in units of the measure applicable at the time; therefore, it corresponds, for example, to the *SHON* from 2007 to March 2012, and to the *SDP* after March 2012.

bunching below the threshold, the remaining households above the notch are known to be less elastic and architects offer higher-markup services, further enhancing incentives to sort below the threshold. In the presence of learning, such a dynamic process, reminiscent of Atal et al. (2022), will lead to a gradually larger missing mass above the threshold.

As a placebo analysis, I also compare, in appendix figure 8, the distribution of the floor area of new constructions built by corporations and other juridical persons over the period 2013-2016 to the distribution for natural persons. As mentioned in section 2, the exemption below the *ART* only applies to natural persons, not to corporations or other juridical persons. The "juridical persons" distribution (which corresponds to a substantially smaller number of new constructions) does not exhibit any evidence of substantial bunching in relative frequencies at the h^* threshold, confirming the hypothesis that the excess mass visible for units built by natural persons is indeed driven by the architect requirement threshold, rather than by alternative legal constraints, round number bunching, salience of the 170 square meters threshold, or other institutional and technological reasons.

Placebo notch approach after 2017 As an alternative and complementary bunching strategy, I exploit variations in the level of the threshold over time to provide an estimate of the marginal bunching response that is non-parametric and therefore robust to mis-specifications of the counter-factual density. In particular, I exploit the "placebo notch" approach described in section 3. Once the threshold was reduced after March 2017, the choice of housing consumption by households building new units started to exhibit substantial bunching at the new threshold of 150 square meters. Figure 9 demonstrates how bunching immediately moved towards the 150 square meters regulatory threshold after March 2017, concentrating on the 2018-2019 period of full implementation of the reform, relative to the earlier threshold. Bunching at the 170 square meters mark entirely disappears after the modification in the level of the threshold. Once again, a stark and concentrated excess mass of housing projects is visible in the bins immediately below the new *ART*, and a substantial missing mass appears immediately above the new discontinuity in the quality-adjusted budget set.

As formalized by equation 3, in this alternative approach to measuring the bunching mass, I rescale the 2013-2016 choices of *SDP* to construct a fit of the counter-factual distribution of housing choices that matches the total counts of units in the post-reform time period. Because housing consumption choices were undistorted around the post-reform 150 sq.m. ART in the 2013-2016 data, their re-scaled counts provide a relevant counterfactual to compute the excess mass immediately below 150 sq.m. of *SDP*. Figure 10 graphically describes the empirical implementation of this alternative identification strategy. This alternative identification method has the added benefit, relative to the polynomial approach of the previous subsection, that bunching at round or salient numbers is mechanically accounted for, if it is stable over time in relative frequencies. Indeed, way below the bunching region, over the (likely) undistorted 40 to 130 square meters of *SDP* range, the placebo distribution based on re-scaled 2013-2016 counts matches almost exactly the actual distribution of housing consumption choices in 2018-2019. Excess bunching is very sharp below the post-reform new *ART* at 150 sq.m., and corresponds to more than 10.000 units (over two years) in the two bins immediately below the notch, or six times the counter-factual density to the left of the threshold. The missing mass above the regulatory threshold, however, cannot directly be estimated using this method, since the placebo distribution above 150 square meters is affected by the pre-reform notch at the previous *ART*. Reassuringly, the placebo notch approach to estimating the excess bunching mass in the 2018-2019 distribution of unit size for new constructions also provides similar results to adopting the polynomial fit approach and applying to the post-2017 reform around the new ART of 150 square meters. This polynomial fit approach to the 2018-2019 data is displayed in appendix figure B.3.

4.2.2 Dynamic response of quantities to regulatory reforms

I now provide additional evidence on the dynamics of the bunching response to the two regulatory reforms described in section 2: the introduction of the *SDP* computation (replacing the *SHON*) in 2012, and the lowering of the *ART* to 150 sq.m. of *SDP* in 2017.

Response to a change in computation I examine the implications of the change in the computation of the threshold that occurred after May 2012, and was in force until March 2017. While the nominal *level* of the *ART* stayed constant at 170 square meters, its effective stringency was reduced by the less inclusive *definition* of the square footage. Figure 11 examines bunching at the 170 square meters regulatory threshold during full years of implementation (2013-2016) for this interim period, relative to the distribution in the 2007-2011 period under the earlier computation. Since square footage is reported in square meters of *SDP* during 2013-2016 (while it was expressed in units of *SHON* before 2012), the overall distribution is shifted to the left relative to the pre-2012 period, as the *SDP* of a given house is likely to be about 10 percent lower than its *SHON*. More importantly, while bunching remains substantial and significant immediately below the 170 square meters exemption level, its quantitative magnitude falls substantially relative to the earlier period. This reduction in bunching is consistent with the regulatory notch hitting the distribution of counter-factual livable space choices at a "higher" effective level (since 170 square meters of *SDP* corresponds to roughly 185 to 190 square meters of *SHON*), where the density of consumption choices absent any regulation would be smaller.

Response to a change in the level of the notch Next, I turn to the dynamics of livable space consumption after the March 2017 reform. After March 2017, the *level* of the notch (using the new *SDP* computation) was adjusted downwards substantially, from 170 to 150 square meters. I assess the dynamic consequences of lowering the threshold in a difference-in-differences strategy. In particular, I take advantage of the fact that I can use as a control group the set of houses with a square footage strictly above (but not far from) 170 square meters, which are unaffected by the change in the level of the *ART*, as they were subject to the architect mandate both before, and after the reform. In practice, I use as a control group the set of houses in the $[171 - 180]$ sq.m. range of square footage. I plot in figure 12 the relative trends in construction of new units for various size categories. The figure shows that the *ART* reform leads to substantial real effects in the housing market, and a drastic decline in livable space built, as bunching moves towards the lower exemption level. In particular, the number of units built in the $(151, 170)$ range (formerly subject to bunching, but now falling under the purview of the architect mandate) falls dramatically, by around 50 percent, while the number of units in the new bunching range $(140 - 150)$ increases substantially by around ten percent, both relative to the unaffected control group. While the *relative* magnitude of the decrease for former bunchers $(151, 170)$ is larger than the relative increase for new bunchers $(140 - 150)$, the absolute *number* of new units (seen in panel (b) of figure 12) affected in both categories is comparable, at around 500 per month in each subgroup. This suggests a limited magnitude of extensive margin responses of newly built construction to the change in the level of the *ART* after March 2017. Overall, about 6000 homes per year move from the 150-170 range to the 140-150 range, leading to substantial deadweight losses, and a reduction of livable space consumption of around ten percent for close to two percent of all new homes in each year. By allowing for a granular assessment of the evolution of trends in subgroups of the $(151 - 170)$ region, the difference-in-differences strategy also allows for a decomposition of the "new" bunching response at 150 square meters by the sub-region of livable space consumption that they would have consumed under the previous level of the notch, as detailed in appendix figure B.4. This methodology demonstrates that about half the new bunching response can be assessed as likely to have come from households who would have otherwise bunched at the 170 threshold, while the other half comes from "likely non-bunchers" in the new missing mass region (151-164).

4.3 Quality regulation and the expansion of existing housing

A common concern in the presence of non-linear incentives, such as stepwise price schedules or size-dependent regulations, is the potential for "splitting", i.e. the arbitrage opportunity stemming from splitting a project that would be above a threshold into two or more sub-projects that all fall below the level at which the higher, non-linear price or regulation applies. If all bunching were due to project splitting, its real consequences for housing consumption would be limited, and its consequences should mostly be interpreted as a form of regulatory avoidance transferring revenue away from licensed architects. Such project-splitting incentives have been mentioned as a concern for the interpretation of bunching results in the case of contract-splitting under non-linear procurement regulatory guidelines Carril (2019), or firm-splitting for the case of value-added tax notches in Liu et al. (2019).

Because housing construction is a relatively lumpy process, and because the rules that govern expansions of existing housing in France (described in section 2.1) are precisely designed to limit the potential for project-splitting, this phenomenon is less likely to be a concern in my setting. Nonetheless, I document that the choice of additions to the existing housing stock is also likely distorted by the presence of the architect mandate.

4.3.1 Bunching of completed unit size below the *ART*

While new constructions represent between 110 000 and 160 000 building licenses every year in the pre-2012 sample, extensions of existing units are more numerous, at c. 165 000 building permits per year on average (not counting the simplified procedure of "preliminary statements"). As detailed in section 2, these projects are also affected by the *ART*, since any addition that is subject to a building license and pushes the completed floor area of the construction beyond h^* triggers the mandatory use of the services of an architect. In Figure 13, I plot the total (post-extension) square footage of completed units that underwent an extension project from 2009 to 2011, among houses with an initial *SHON* (h^E) of more than 20 square meters and less than 170 square meters.

The figure provides striking evidence of two facts. First, there is a substantial amount of bunching at amounts of new construction such that the *total* square footage ($h^E + h^N$) of the unit, lies strictly below the 170 square meters level that triggers the architect mandate. While for new constructions, a single and salient threshold may serve as a focal point for the size of new units, in the case of extensions, the threshold is "unit-specific": each household must compute the optimal maximum size of the extension $\hat{h^N}(h^E) = h^* - h^E$ in order to remain below the threshold. Second, there is clear evidence of a missing mass of extensions pushing the total size of the new construction to the right of the threshold. This suggests that for extensions of new construction, extensive margin responses may be substantial, with a large proportion of additions not taking place altogether, because they would bring the total square footage of the unit above the exemption level. In robustness checks, using the same approach for the post-2017 period, extensions of existing constructions also display significant excess mass at square footages limiting the overall floor area of the unit exactly below the threshold of 150 square meters in 2018 and 2019, as shown in appendix figure B.5.

4.3.2 Bunching of extensions below the BL requirement

When they decide to extend an existing building with an initial area lower than the threshold, homeowners can avoid the architect requirement in two distinct ways. They can either limit the total size of the expanded unit to strictly below the regulatory notch, as seen above; or they can build the extension itself under the minimum size above which a BL is required (since in the absence of a BL, the architect requirement threshold is moot). While there might exist other rationales to avoid filing for a building license and file a simplified "Preliminary Statement" instead, these incentives are particularly important for units with an initial size h^E in the $[h^* - \bar{h}, h^*]$ interval, for which the alternative bunching strategy is not relevant. Figure 14 provides evidence of this alternative avoidance strategy. In particular, it documents substantial bunching in the size of extensions below the 20 square meters *BL* threshold prior to 2011, and the gradual appearance of a bunching mass at the newly introduced *BL* threshold in urban areas at 40 square meters after 2013. The size of extensions themselves is therefore reduced at the level below which a building license is not necessary.

Moreover, households understand and act in response to the complex interlocked incentives of the *BL* and *architect requirement* thresholds. Indeed, figure 15 demonstrates that the excess mass at the new BL threshold of 40 square meters for extension sizes h^N only appears for units with an initial size h^E below 130 square meters, where an extension between 20 and 40 square meters would not trigger the architect requirement threshold, implying that the bunching at the BL threshold is at least partly driven specifically by the avoidance of the architect mandate, rather than other hassle costs associated with filing for a building license.

4.4 Quality regulations and market segmentation

In this section, I document that housing quality regulations have effects beyond the distortion in housing quantity consumption documented above. Specifically, they have the unintended consequence of segregating household types across sub-markets of housing consumption. In particular, instead of encouraging the production of high-quality units for all, the architect mandate effectively concentrates the quantity adjustment among the least well-off homeowners. Effectively, quality regulations act as a tool to foster spatial sorting, and reinforce local housing segregation.

4.4.1 Sorting of households across the threshold

I first provide evidence that households sort across the architect requirement threshold alongside characteristics that correlate with their quality type (high- or low-γ), and therefore with their propensity to favor a quantity distortion over the cost of complying with the prescribed level of construction quality. In particular, households on both sides of the threshold differ substantially by age and income levels. Households who remain above the threshold (and therefore comply with the attribute-based regulation) tend to be older, and are more likely to belong to higher socio-economic status professional categories, as shown in figures 16 and 17. Households who bunch below the threshold are more likely to benefit from government-sponsored and means-tested zero-interest loans (figure B.6), and more likely to be individuals building by themselves rather than resorting to contractors or other external suppliers (figure B.7). In addition, households on the right-hand side of the threshold are more likely to live in a different province than the location in which the housing construction project is occurring, suggesting that they may face larger supervision and monitoring costs, which may in turn partly explain their willingness to use the services of an architect (figure 18). Even conditional on living in the same province, the households filing for building licenses for homes below the threshold are less likely to be living in a different postcode than the municipality where the unit is to be built.

Housing units built with a dwelling size below the threshold are characterized by distinct characteristics from their counterparts above the threshold. As shown in figure 19, they are much more likely to be used as primary homes, rather than second homes, by their owners. Houses immediately below the threshold, which are more likely to correspond to strategic ”bunchers”, are also more likely to include additional elements, such as garden sheds or garages, that may correspond to ways for their owners to circumvent the strict measurement of square footage. As documented earlier, I find that houses above the threshold take longer to start construction after receiving an authorization, consistent with the presence of an architect and higher-quality constraints delaying the start of a project, but (for the subsample where data on completion date are available) do not take longer to complete overall. They are also likely to be more complex construction projects, notably by being more likely to involve the demolition of existing elements. On the other hand, average lot area evolves continuously around the threshold (appendix figure B.8).[23]

[23] Appendix figure B.9 documents bunching in the distribution of the ratio of square footage to lot area, suggesting that built-area ratios regulations may also bind in a substantial number of cases. However, there is no differential likelihood of bunching at any of the common built-area ratio thresholds (0.2, 0.25, 0.4, 0.5) on both sides of the *ART*.

4.4.2 Spatial sorting by quality

Finally, I document that housing units built immediately below the *ART* in order to avoid meeting the minimum quality standards involved with a larger size locate in towns and neighborhoods that differ substantially from those in which units above the threshold are situated. I merge all individual housing permits for the post-2017 period (when the threshold's value is constant at 150 square meters) to cross-sectional 2017 Census and Treasury data on the characteristics of French municipalities.[24] I then compare the characteristics of the municipalities in which units immediately around the threshold are located.

The towns corresponding to homes on the right-hand side of the threshold are, on average, characterized by higher rents and housing prices (figure 20). They also exhibit higher inequality (third to first quartile ratio and Gini coefficient), and higher incomes at the median and third quartiles of the income distribution (see figure 21), but not at the bottom quartile. Towns in which the higher quality units locate also generally exhibit substantially higher population and population density. I also find that the towns in which the bunchers are more likely to be located (those immediately below the 150 square meters threshold) exhibit a substantially higher share of household incomes deriving from a variety of public transfers (including unemployment insurance and means-tested benefits), as seen in figure 22. The pattern of benefit receipt likelihood, which shows a spike specifically among towns in which units at the 149 sq.m. are located, tends to suggests that bunching households, who are by construction over-represented in these bins of square footage, are substantially poorer than the rest of the population. These discontinuities in municipality characteristics are observed both for a 170 square meters *ART*, and after the *ART* moves below 150 square meters, suggesting that they are not driven by the relative availability, for example, of land suitable for different construction sizes in different types of towns, but rather by the effective spatial housing segregation introduced by the quality regulation itself.

5 Discussion and conclusion

I estimate the sensitivity of housing demand to its user cost, exploiting a notched regulation in the provision of new buildings in France. Until March 2012, France required an individual homebuilder of any unit with a floor area exceeding 170 square meters (c. 1830 square feet) to use the services of a government-licensed architect in order to obtain a building permit. This peculiar setting allows me to answer two specific questions: first, what is the price elasticity of housing demand at the intensive margin? second, how do regulations imposing administrative burdens on new housing development affect the provision of housing, its characteristics, and its spatial allocation?

In essence, the regulation intends to improve the aesthetic quality of new single-family homes beyond what the *laisser-faire* equilibrium would yield. It treats housing quality as an external amenity value, that households would under-consume in the absence of the regulation. Forcing all construction to be of high-quality, in the absence of a compliance trading system, could potentially generate inefficiently heterogeneous compliance

[24] There are about 36,000 municipalities in France, with an average population of around 1,800. 97% of them have fewer than 10,000 inhabitants, making them somewhat comparable in size to US Census tracts. The municipality level income data are called *Filosofi* files, and the municipality-level rent data are from the *Observatoire des loyers*.

costs: some households with adjustment costs (i.e. cost net of private benefit) above the unique Pigouvian tax-equivalent of the constraint will have to pay a cost in excess of the social value of their compliance. If such compliance costs are indeed systematically higher for small-scale constructions (for example because of fixed costs of compliance), making the architect mandate only applicable to large-scale houses might be more efficient than applying it to everyone.

In practice, however, I find that the attribute-based regulation leads to increased monetary and non-monetary costs above the threshold, but also to a sharp segregation of housing markets as households sort based on their relative taste for quality. Lower-income, lower socio-economic status households are forced to under-consume more standardized housing by bunching below the threshold, with the share of adjustment operating through quantities being substantially larger than the quality compliance effect of the regulation. Regulating housing quality thus leads to substantial *quantity* distorsions for newly built units, with temporary changes in regulatory norms having permanent effects on relative housing consumption, spatial sorting, and inequality.

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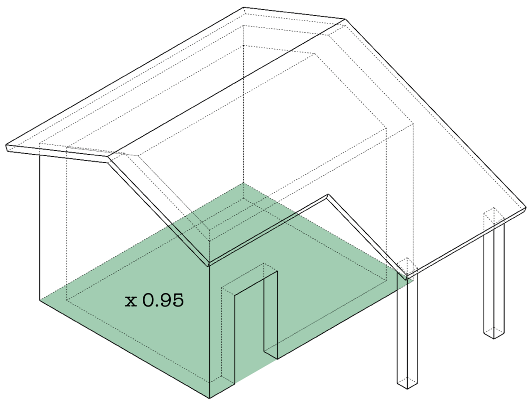
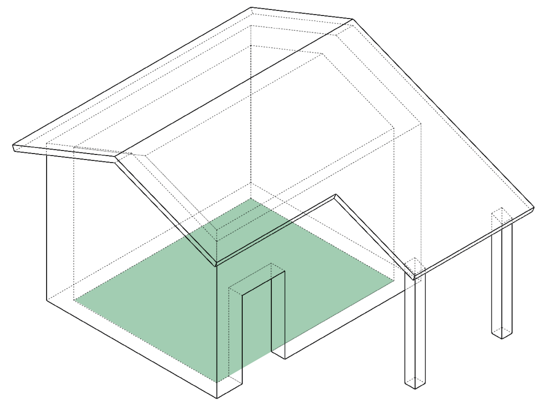
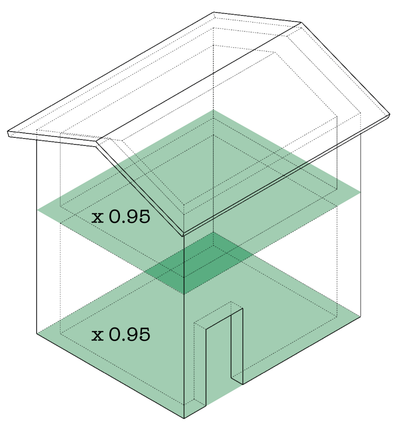
Main figures



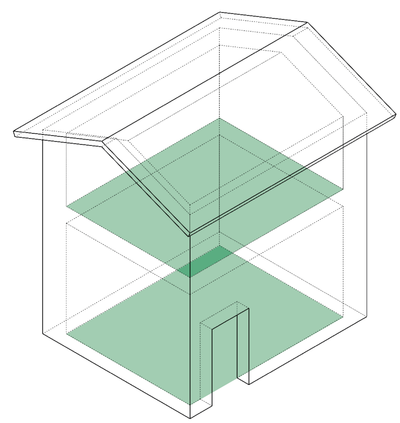
(a) *SHON*, single-story house



(b) *SDP*, single-story house

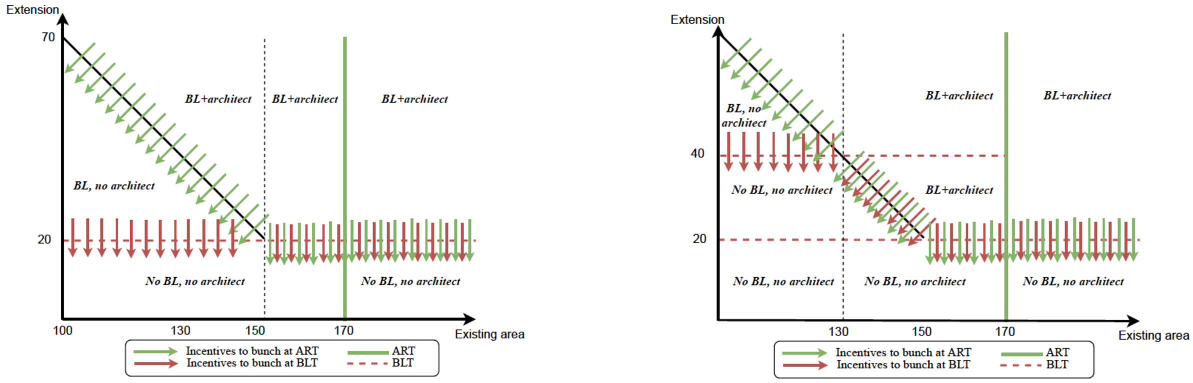


(c) *SHON*, multi-story house



(d) *SDP*, multi-story house

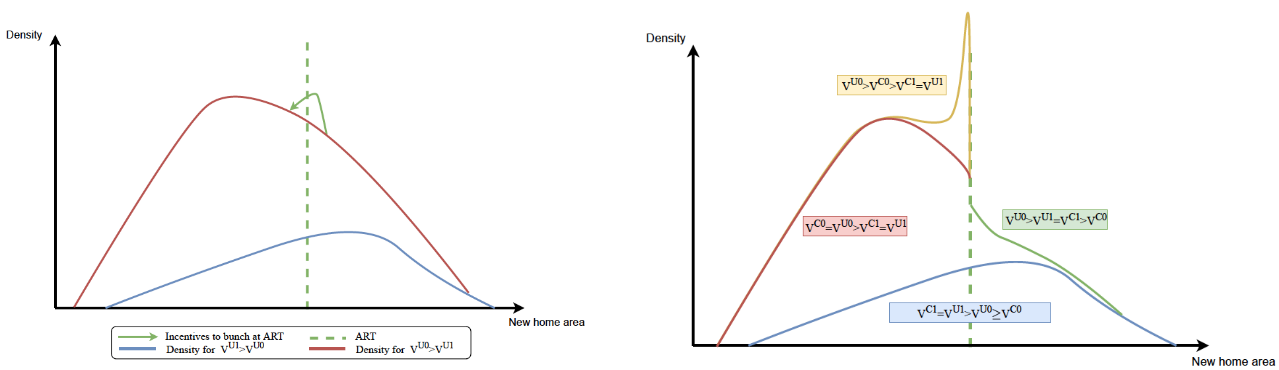
Figure 1: **Comparison of the *SHON* and *SDP*** The figure compares the pre-2012 definition of square footage (*SHON*) used in the computation of the architect requirement threshold to the post-March 2012 definition (*SDP*). Panels (a) and (b) compare the two computations for a single-story home, while panels (c) and (d) compares the computations for a multi-story unit. The *SHON* (panels (a) and (c)) includes a five percent flat deduction, but the non-inclusion of external walls in the *SDP* (panels (b) and (d)) makes the latter smaller for a given amount of livable space, especially in less compact or more elongated constructions. The *SDP* also excludes areas beneath indoor stairs. Sources: French Housing Ministry documentation.



(a) Non-urban areas

(b) Urban areas

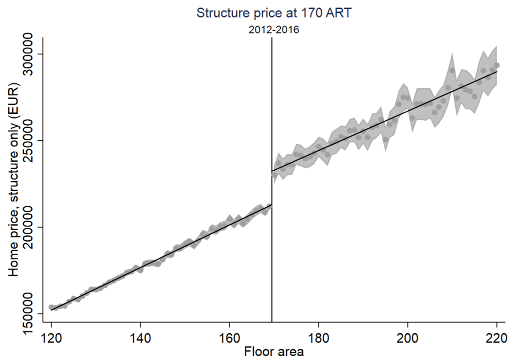
Figure 2: **Incentives for additions to existing units, 2012-2017** The figure describes graphically the incentives to bunch the size of the addition to an existing home either at the *building license* threshold $\bar{h}$, or at exactly the difference between the *ART* h^* and the existing size h^E, as described in section 2, for homes of various sizes. Panel (a) presents the case of non-urban areas, where the building license threshold is 20 square meters, while panel (b) presents the case of urban areas (after 2012), where the BL threshold is 40 square meters, except for extensions that would drive the completed size $h^E + h^N$ above the *ART*.



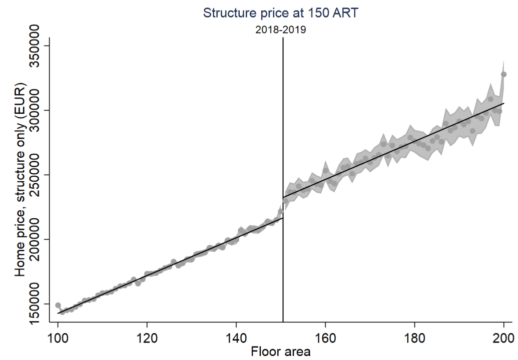
(a) Counter-factual case

(b) With the attribute-based regulation

Figure 3: **Stylized description of the quantity-quality trade-off model outcomes** The figure describes graphically the constrained choices (denoted by C) and incentives to bunch at the *ART* for both types of households (architect users, denoted by 1, and non-users, denoted by 0), depending on whether their unconstrained choices, denoted by U, would involve the use of an architect or not, as described in section 3.

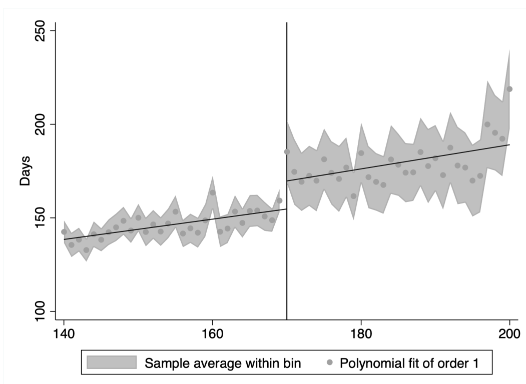


(a) 2012-2016, 170 sq.m. ART

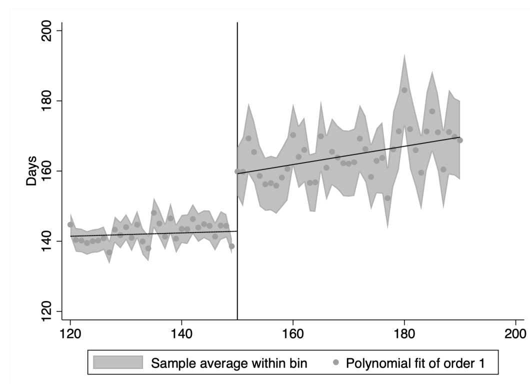


(b) Post-2018, 150 sq.m. ART

Figure 4: **Construction cost for new units** The figure plots a binned scatter plot of the construction cost (only including structure price) of new units against their square footage (*SDP*) for new units with approved building licenses in the EPTB data. Panel (a) plots the discontinuity at the 170 square meters mark in the 2012-2016 data, while panel (b) plots the discontinuity at 150 square meters after 2018.



(a) 2013-2016, 170 sq.m. ART



(b) Post-2018, 150 sq.m. ART

Figure 5: **Construction delays for new units** The figure plots a binned scatter plot of the construction delay (computed as the difference between the initial approval date of the building license and the stated start of construction works) of new units against their square footage (*SDP*) for new units with approved building licenses in the Sitadel data. Panel (a) plots the discontinuity in days at the 170 square meters mark in the 2012-2016 data, while panel (b) plots the discontinuity at 150 square meters after 2018.

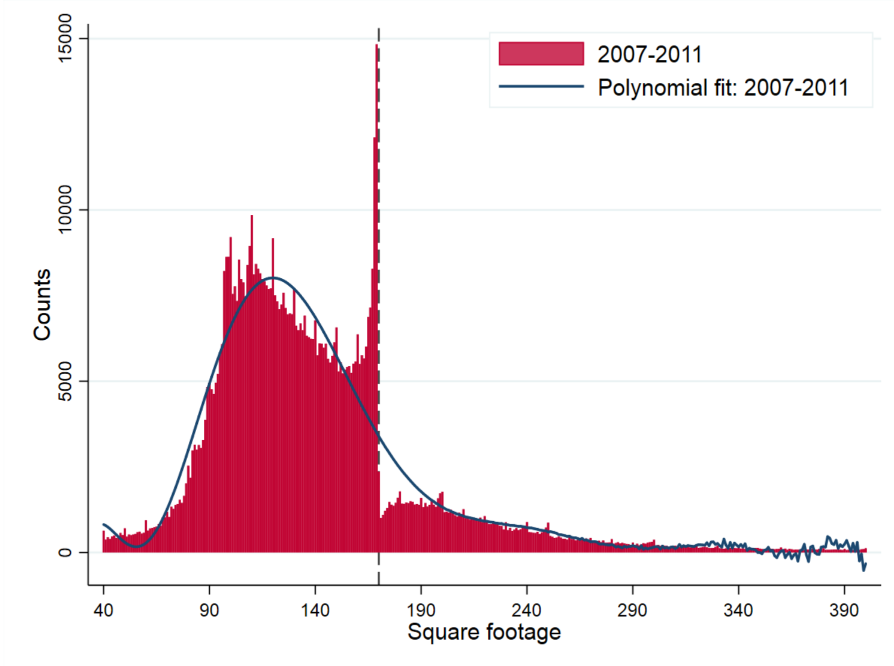
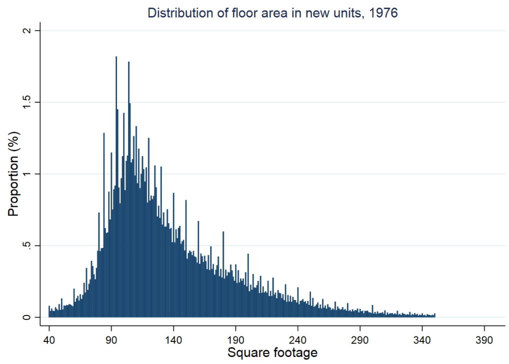
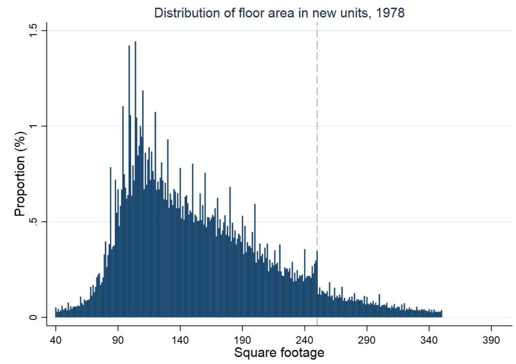


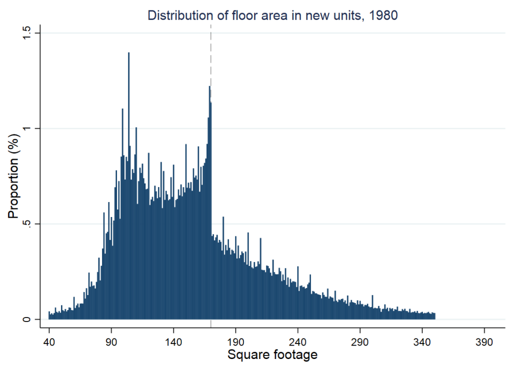
Figure 6: **Distribution of the size of newly built units, 2007-2011** The figure plots the distribution of the square footage (*SHON*) of new units with approved building licenses from 2007 to 2011 in the Sit@del data. The histogram corresponds to the counts of units in each square meter bin, while the solid line plots a polynomial fit of order 10 excluding the manipulation range, according to the methodology defined in section 3.



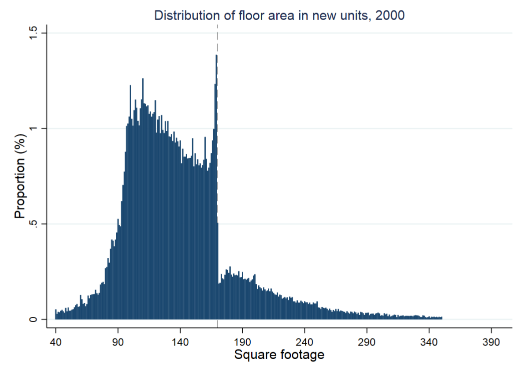
(a) 1976, no ART



(b) 1978, 250 sq.m. ART

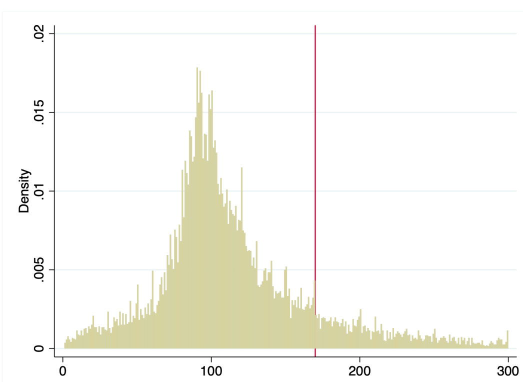


(c) 1980, 170 sq.m. ART

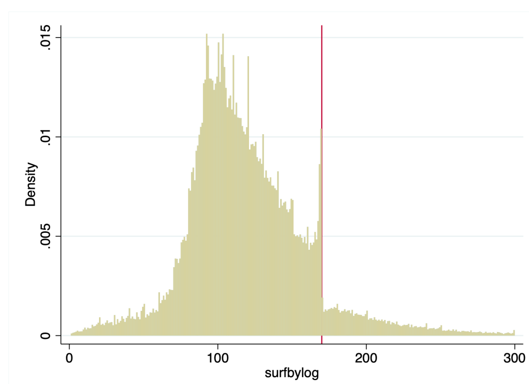


(d) 2000, 170 sq.m. ART

Figure 7: **Distribution of new unit size, selected years** The figure plots the distribution of square footage (*SHON*) for new units for selected years. In particular, panel (a) plots the distribution in 1976, before the implementation of the architect mandate. Panel (b) plots the distribution in 1978, the first full year of implementation of an ART at 250 square meters. Panel (c) plots the distribution in 1980, the first full year after the lowering of the threshold to 170 square meters. Panel (d) plots the distribution in 2000, showing the relative stability of bunching over a twenty year periods but also the substantially larger missing mass above the threshold.



(a) Juridical persons



(b) Natural persons

Figure 8: **Distribution of the size of newly built units, 2013-2016** The figure plots the distribution of the square footage (*SHON*) of new units built, respectively, by juridical persons (for whom no exemption exists) in panel (a), and by natural persons (for whom the ART applies) in panel (b), for approved building licenses from 2007 to 2011 in the Sit@del data. The histogram corresponds to the counts of units in each square meter bin.

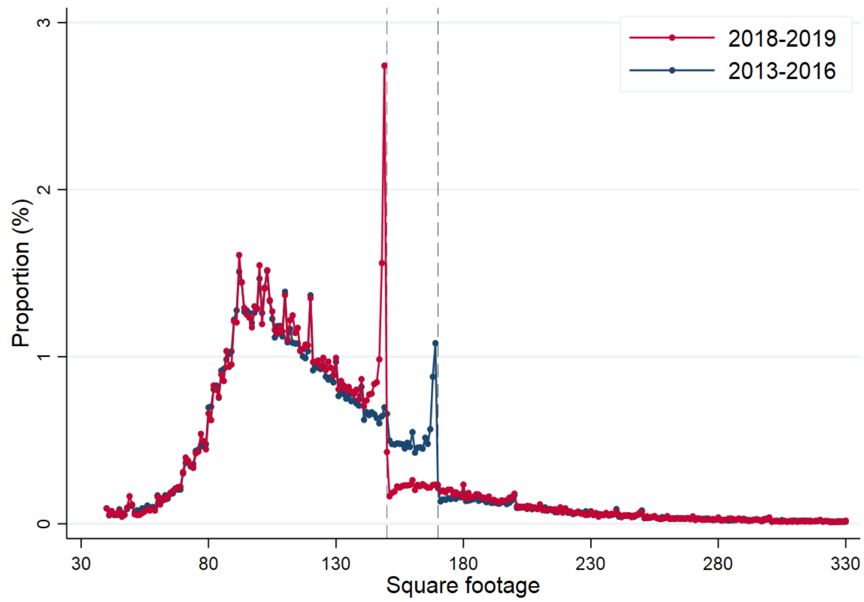


Figure 9: **Distribution of the size of newly built units, 2017 reform** The figure plots the distribution of the square footage (*SDP*) of new units with approved building licenses from 2018 to 2019 (red line), and from 2013 to 2016 (blue line) in the Sit@del data. The ART was lowered to 150 square meters in 2017, down from its earlier value of 170 square meters, as described in 2.1.

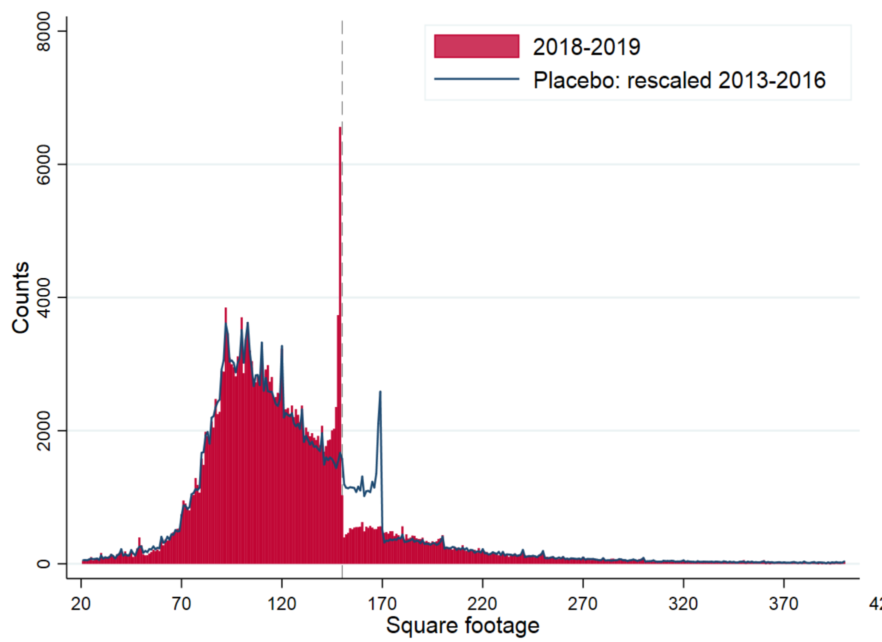


Figure 10: **Distribution of the size of newly built units, placebo notch approach** The figure plots the distribution of the square footage (*SDP*) of new units with approved building licenses from 2018 to 2019 in the Sit@del data. The ART was lowered to 150 square meters in 2017. The histogram corresponds to the counts of units in each square meter bin in the 2018-2019 period, while the solid line plots the distribution of 2013-2016 square footage choices (rescaled to match the total counts of units in 2018-2019), when the ART threshold stood at 170 square meters, as described in 3.

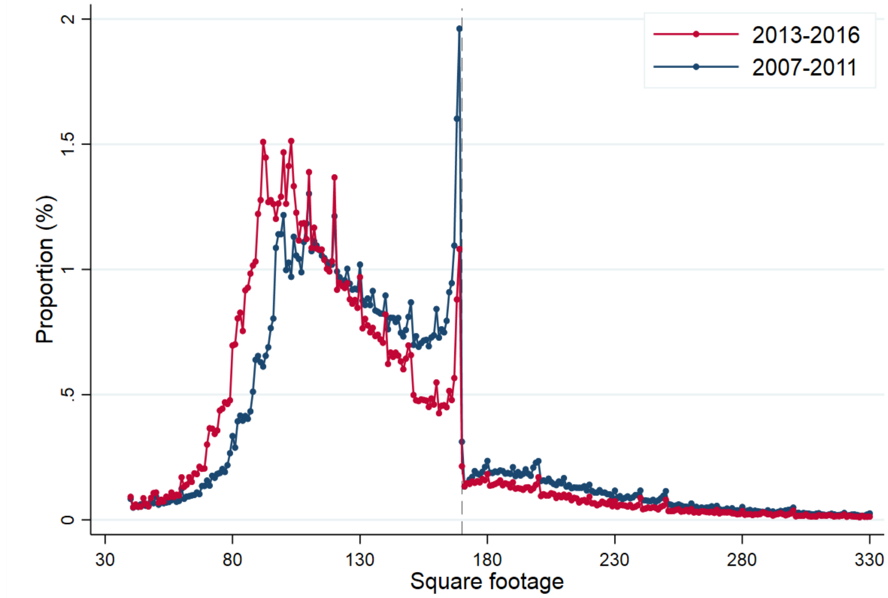
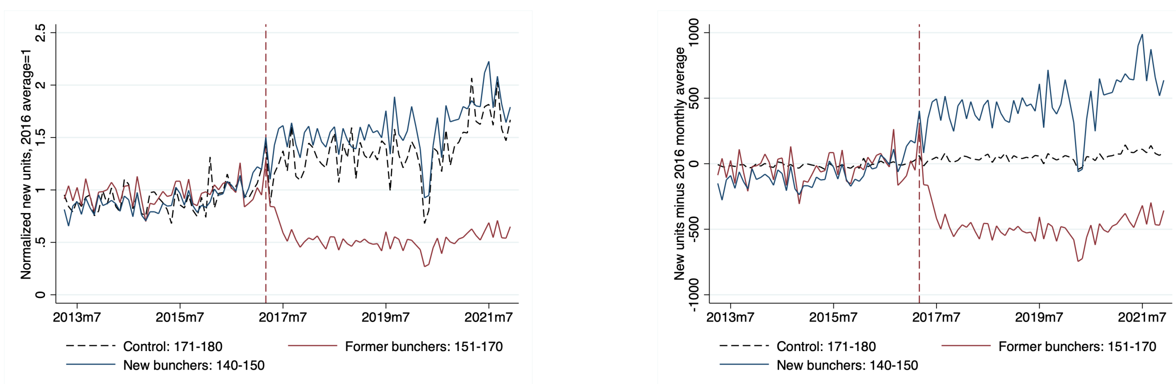


Figure 11: **Impact of the 2012 change in definition on the size distribution for new units** The figure plots the distribution of the square footage (*SHON*) of new units with approved building licenses from 2007 to 2011 (blue line), and the floor area (*SDP*) of new units built from 2013 to 2016 (red line) in the Sit@del data. The change in computation from the *SHON* to the *SDP*, as described in 2.1, shifted the distribution of unit sizes leftwards, and made the 170 square meters ART less likely to bind when expressed in terms of *SDP* than in terms of *SHON*.



(a) Relative changes

(b) Absolute changes

Figure 12: **Impact of the 2017 reform on the size distribution for new units** The figure plots the impact of the 2017 lowering of the *ART* from 170 square meters to 150 square meters for the relative (in panel (a)) and absolute (panel (b)) number of new units built in three size categories: former bunchers (150-170), new bunchers (140-150), and control (171-180), in the Sit@del data.

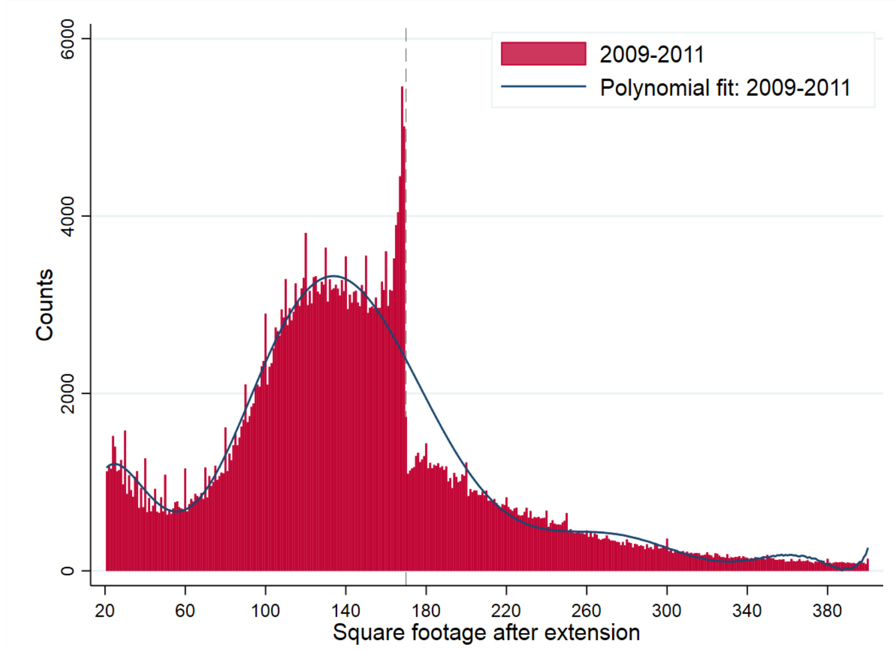


Figure 13: **Distribution of the size of completed units for extensions, 2009-2011** The figure plots the distribution of the square footage (*SHON*) of completed units after extension projects, from 2009 to 2011 in the Sit@del data. The histogram corresponds to the counts of units for which the size of the completed, post-extension dwelling falls in each square meter bin in the 2009-2011 period, while the solid line plots a polynomial fit of order 10 excluding the manipulation range, according to the methodology defined in section 3.

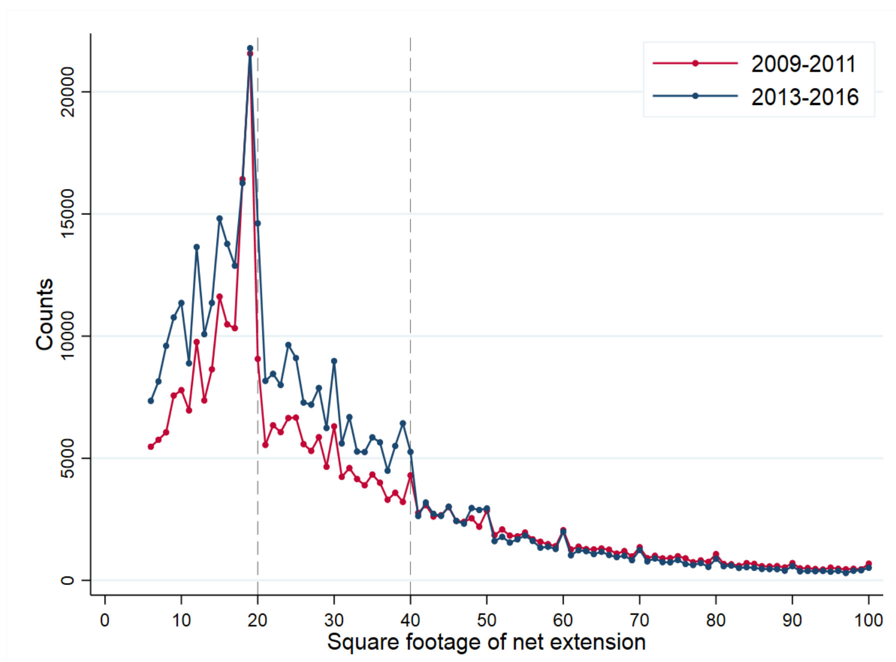
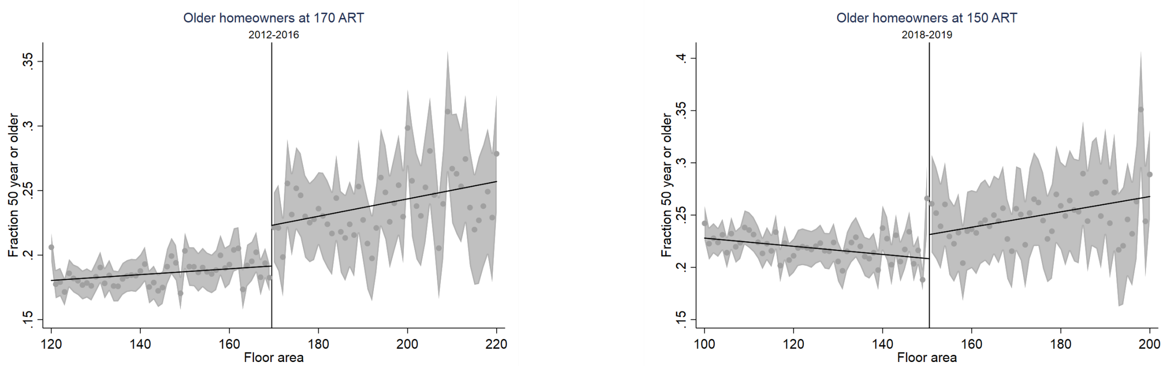


Figure 14: **Distribution of extension sizes: bunching at the building license thresholds** The figure plots the distribution of the square footage of extensions with approved building licenses from 2009 to 2011 (red line), and from 2013 to 2016 (blue line) in the Sit@del data. The sharp bunching at 20 square meters (and smaller bunching at 40 square meters after 2012) indicates the willingness of owners to avoid filing for a building license (BL), since only a preliminary statement (PS) is required for extensions below $\bar{h} = 20$ square meters (40 in urban areas after 2012). Filing a BL instead of a PS constitutes an alternative avoidance mechanism to avoid meeting the architect requirement conditions if the completed size of the unit exceeds the ART h^*.

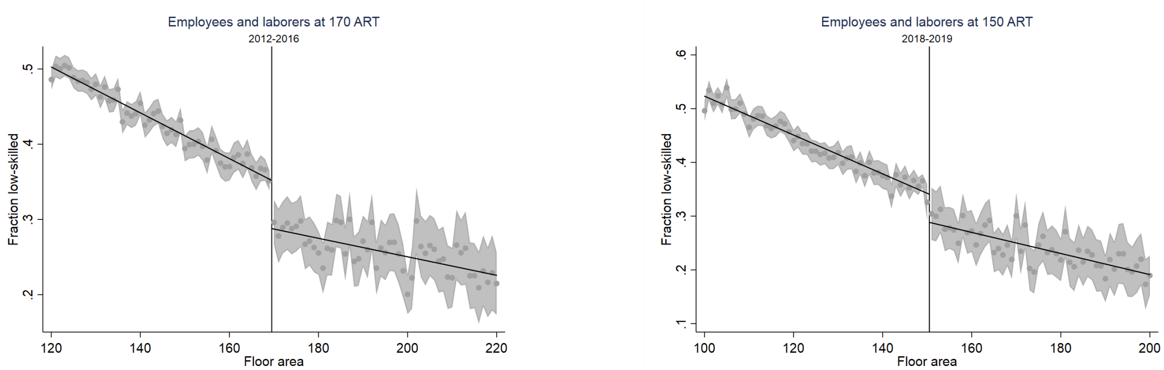
Figure 15: **Summary excess mass at 40 square meters** The figure plots the summary excess mass of additions at exactly 40 square meters in the Sit@del data, before and after the introduction of the new 40 square meters BL threshold in urban areas.



(a) 2012-2016, 170 sq.m. ART

(b) Post-2018, 150 sq.m. ART

Figure 16: **Share of older households** The figure plots the share of households with a head of household aged 50 or more against the square footage of new units, before and after the threshold was lowered to 150 square meters, in the EPTB data.



(a) 2012-2016, 170 sq.m. ART

(b) Post-2018, 150 sq.m. ART

Figure 17: **Share of low-skill households** The figure plots the share of lower-skill socio-economic status (employees and blue-collar workers) households against the square footage of new units, before and after the threshold was lowered to 150 square meters, in the EPTB data.

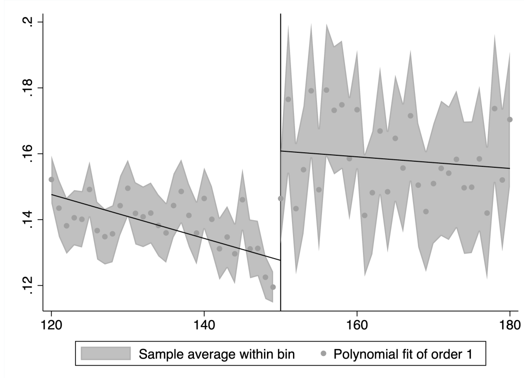


Figure 18: **Out-of-town households** The figure plots the share of filers who live in a different French province (*departement*), for each bin of square footage of new units, after the threshold was lowered to 150 square meters, in the EPTB data.

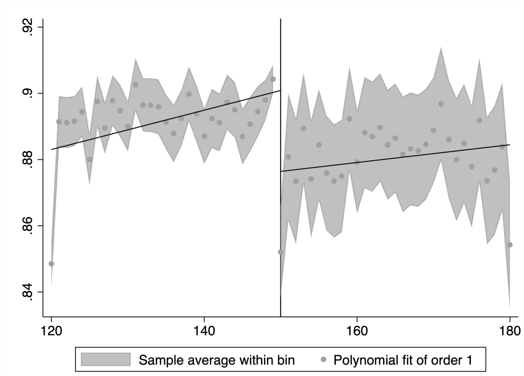


Figure 19: **Primary home designation** The figure plots the share of units designed to be used as the household's primary home, for each bin of square footage of new units, after the threshold was lowered to 150 square meters, in the EPTB data.

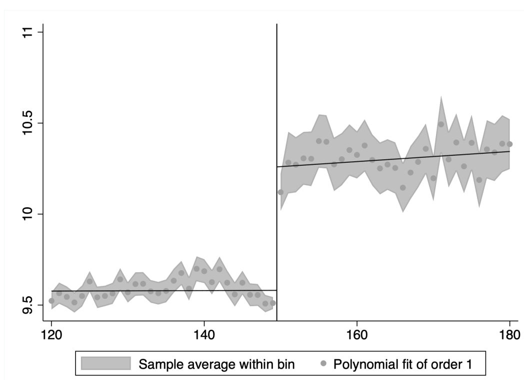
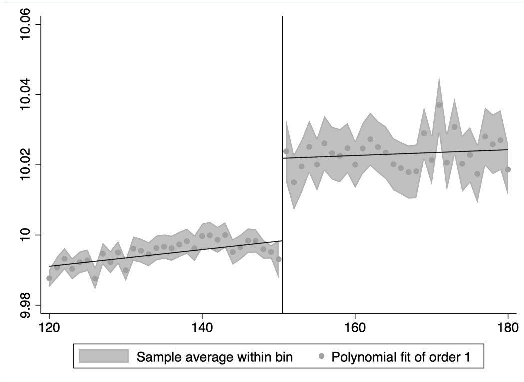
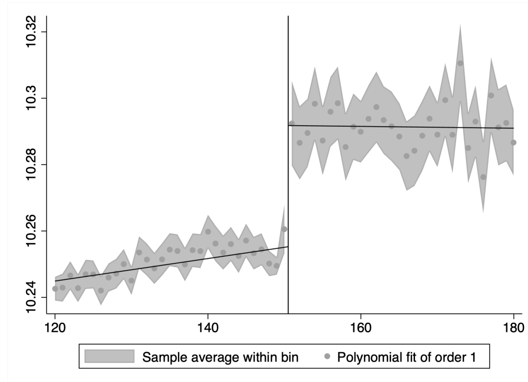


Figure 20: **Town average rents** The figure plots the average rents per square meters in the towns for each bin of square footage of new units, after the threshold was lowered to 150 square meters, in the Sitadel and *Observatoire des loyers* data.

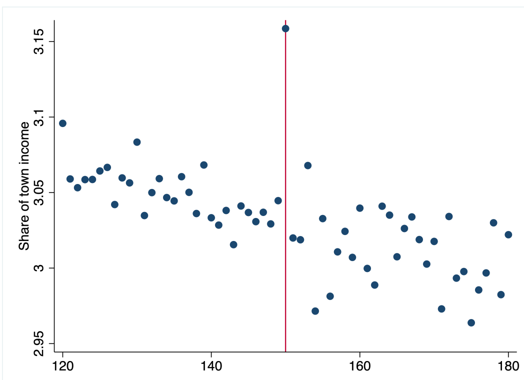


(a) Log Q2, income distribution

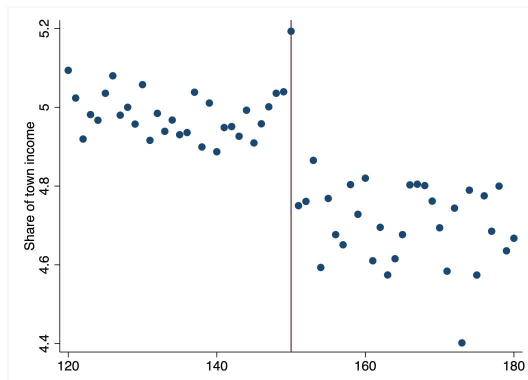


(b) Log Q3, income distribution

Figure 21: **Town incomes, median and third quartile** The figure plots the average median and third quartile of the income distribution of the towns for each bin of square footage of new units, after the threshold was lowered to 150 square meters, in the Sitadel and *Filosofi* 2017 data.



(a) Unemployment benefit share



(b) Other social benefits share

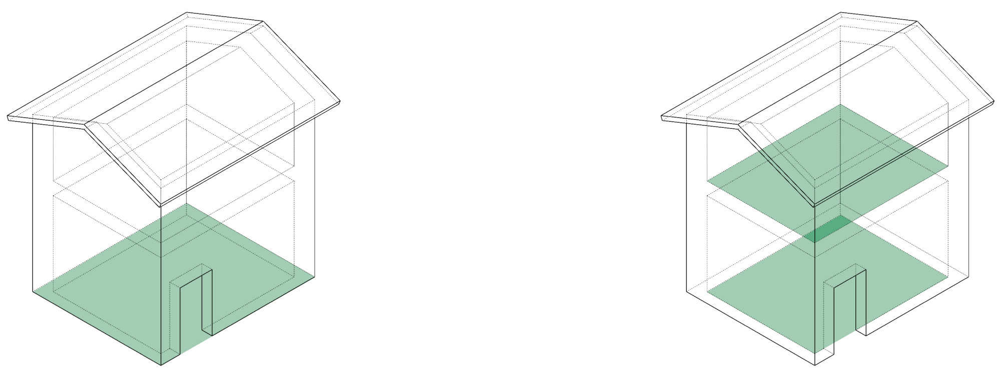
Figure 22: **Share of income in town derived from social transfers** The figure plots the average share of overall income in the town received, respectively from unemployment insurance (panel A) and from other social transfers (panel B), for each bin of square footage of new units, after the threshold was lowered to 150 square meters, in the Sitadel and *Filosofi* 2017 data.

Appendices

A Institutional background: addendum

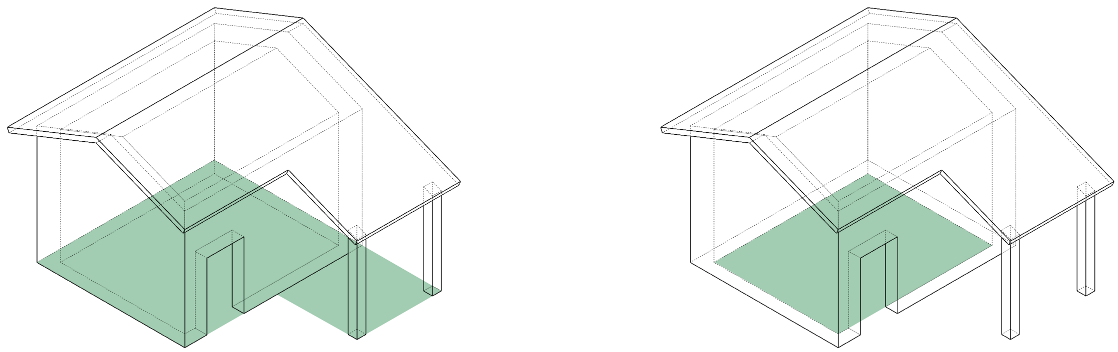
The March 2012 reform led to the replacement of the *SHON* (computed from the outside of external walls) by the *SDP*, computed from the inside of external walls. This led to a decrease of 5 to 12 percent of the measured square footage for the same new constrution, and therefore implied that the architect mandate effectively applied to only a more limited part of the home size distribution upper tail.

To compensate for the change and preserve the role of architects, the March 2012 reform initially added a dual test for the ART computation. It defined an additional measure, the *emprise au sol* (henceforth, *EAS*) or ”footprint” of a construction, which corresponded to the ground-level vertical projection of the structure. The *EAS* started from the *outside* of external walls, did not allow for a flat deduction, and included the projection of terraces, porch roofs, and indoor parking spaces, none of which were part of the computation of the *SHON* or the *SDP*. An architect was required for units in which *either* the *EAS* or the *SDP* exceeded the 170 sq.m. threshold.



(a) *EAS*, multi-story house (b) *SDP*, multi-story house

Figure A.1: **Comparison of the *EAS* and *SDP* for a multi-story house** The figure compares the March 2012 definition of square footage (*SDP*) to the March 2012 definition of footprint (*EAS*) used in the dual architect requirement threshold test. Panel (a) plots the *EAS* of a multi-story home, while panel (b) shows the *SDP* of the same unit. The *SDP* was generally larger than the *EAS* for multi-story homes, since the same amount of livable space deployed over several floors took up a smaller amount of land footprint. Sources: French Housing Ministry documentation.



(a) *EAS*, single-story house

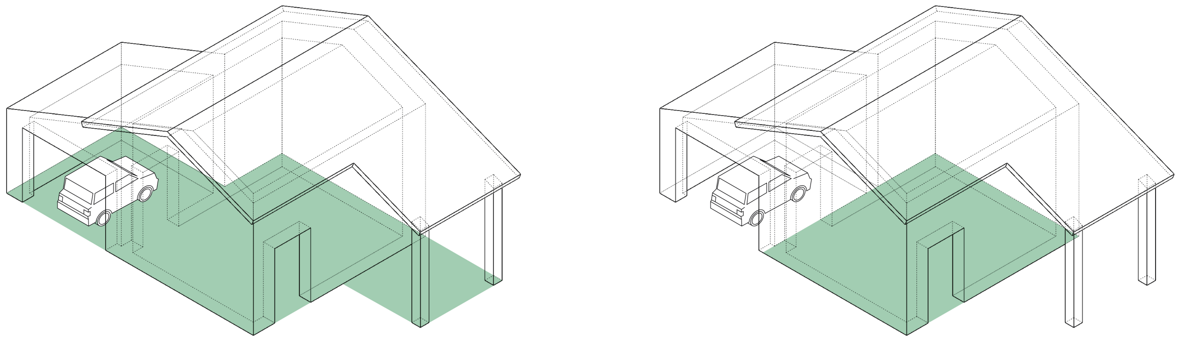
(b) *SDP*, single-story house

Figure A.2: **Comparison of the *EAS* and *SDP* for a single-story house** The figure compares the March 2012 definition of square footage (*SDP*) to the March 2012 definition of footprint (*EAS*) used in the dual architect requirement threshold test. Panel (a) plots the *EAS* of a single-story home, while panel (b) shows the *SDP* of the same unit. The *EAS* was generally larger than the *SDP* for single-story homes, due to its inclusion of the vertical projection of garages, balconies, awnings, and external walls, all excluded from the *SDP* computation. Sources: French Housing Ministry documentation.

Figure A.1 shows that for a multi-story unit, the *EAS* was much smaller than the *SDP*, and therefore was not a binding constraint. However, for single-story units with awnings or garages (see figure A.2), the *EAS* was higher than both the *SDP* and the pre-2012 *SHON*. For these units, the dual test actually lowered the *de facto* amount of livable space below the exemption. It quickly became apparent that many single-story homes with a *SHON* below 170 square meters now fell under the architect mandate's purview, due to the *EAS* condition. In May 2012, the law was rectified again. In the dual test, the *EAS* was replaced by the so-called *EAS-CSDP*[25]. The *EAS-CSDP* included only the "footprint" of the elements of a structure with a "floor area" (*SDP*), therefore excluding balconies or garages (see figure A.3). After the May 2012 modification, the reform had thus substituted a dual test (*EAS-CSDP* < 170 and *SDP* < 170) to the previous single-measure test (*SHON* < 170). Relative to the pre-2012 situation, the reform had effectively raised the ART by 10 to 12 percent for multi-story units, but lowered it for single-story units by c. 5 percent.[26]

[25]The acronym stands for *emprise au sol constitutive de surface de plancher* or "*SDP*-generative footprint".

[26]Since $SDP > EAS - CSDP$ in multi-story homes, the binding constraint for these was $SDP < 170$, and generally *SDP* was 10 to 12 percent below the *SHON*. On the other hand, since $SDP < EAS - CSDP$ in single-story homes, the binding constraint among these units was $EAS - CSDP < 170$, and *EAS-CSDP* was five percent higher than the *SHON* in the absence of the flat deduction.

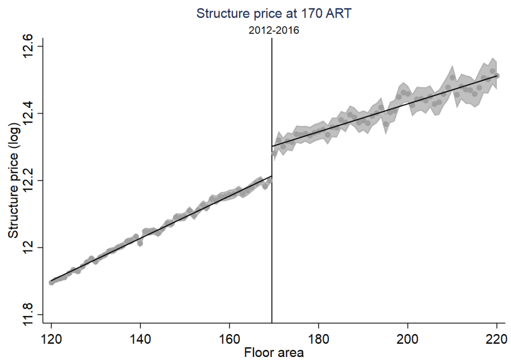


(a) *EAS*, single-story house

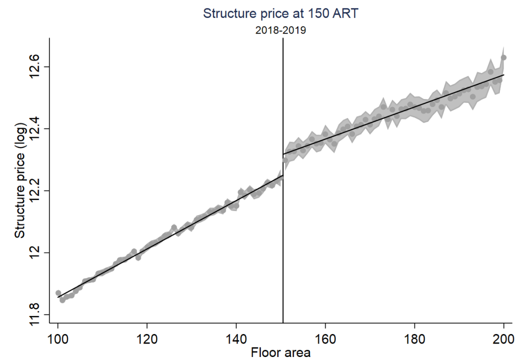
(b) *EAS-CSDP*, single-story house

Figure A.3: **Comparison of the *EAS* and the *EAS-CSDP* after the May 2012 rectification** The figure compares the March 2012 definition of footprint (*EAS*) to the May 2012 reformed definition of floor-area generative footprint (*EAS-CSDP*) used in the architect requirement threshold test. Panel (a) plots the *EAS* of a home, while panel (b) shows the *EAS-CSDP* of the same unit. The *EAS-CSDP* was generally smaller than the *EAS* since it no longer included the vertical projection of garages, balconies, and awnings. This had the implication of generally making the *EAS-CSDP* smaller than the *SDP*. It was therefore no longer relevant for the dual test in multi-story units, but still relevant and slightly larger than the pre-March 2012 *SHON* for single-story units. Sources: French Housing Ministry documentation.

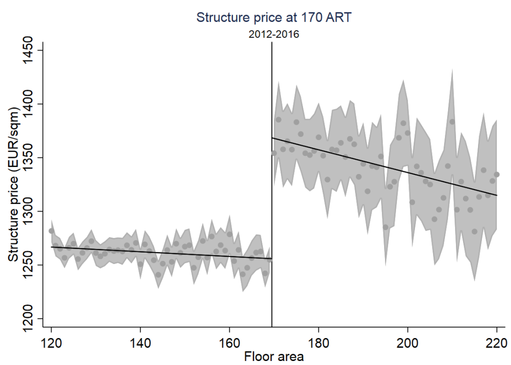
B Additional figures



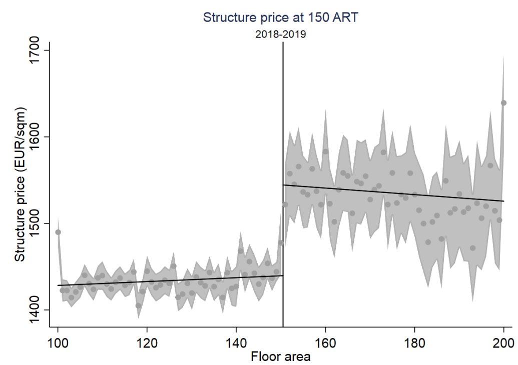
(a) 2012-2016, 170 sq.m. ART



(b) Post-2018, 150 sq.m. ART

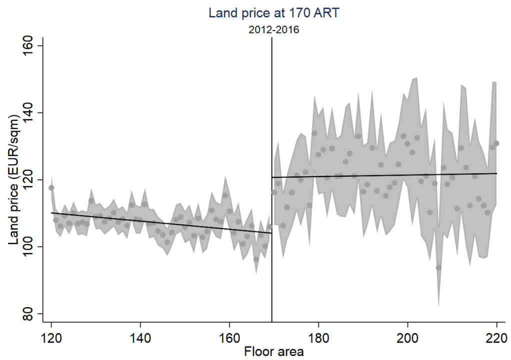


(c) 2012-2016, 170 sq.m. ART

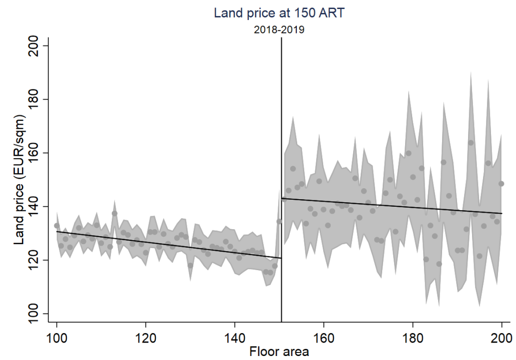


(d) Post-2018, 150 sq.m. ART

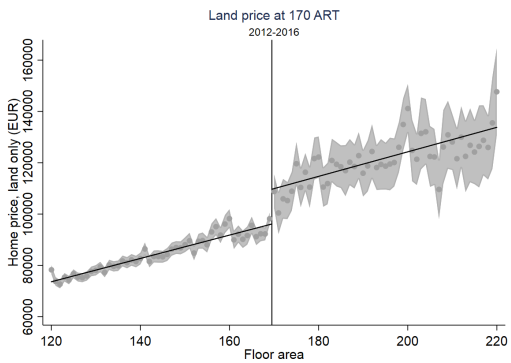
Figure B.1: **Construction cost for new units** The figure plots a binned scatter plot of the construction cost (only including structure price) of new units against their square footage (*SDP*) for new units with approved building licenses in the EPTB data. Panel (a) plots the discontinuity in log points at the 170 square meters mark in the 2012-2016 data, while panel (b) plots the discontinuity at 150 square meters after 2018. Panels (c) and (d) plot the discontinuity in EUR/sq.m. of *SDP* around the same thresholds for the same periods.



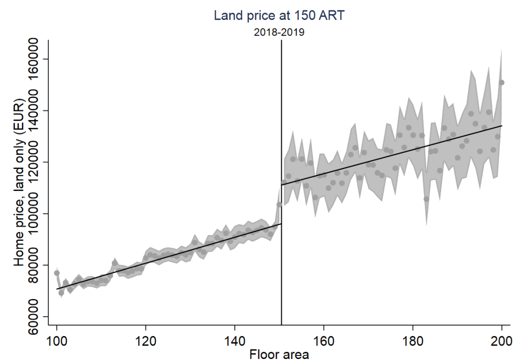
(a) 2012-2016, 170 sq.m. ART



(b) Post-2018, 150 sq.m. ART



(c) 2012-2016, 170 sq.m. ART



(d) Post-2018, 150 sq.m. ART

Figure B.2: **Land prices for new units** The figure plots a binned scatter plot of the cost of land for new units against their square footage (*SDP*) for new units with approved building licenses in the EPTB data. Panel (a) plots the discontinuity in EUR/sq.m. of land at the 170 square meters mark in the 2012-2016 data, while panel (b) plots the discontinuity at 150 square meters after 2018. Panels (c) and (d) plot the discontinuity in overall land costs around the same thresholds for the same periods.

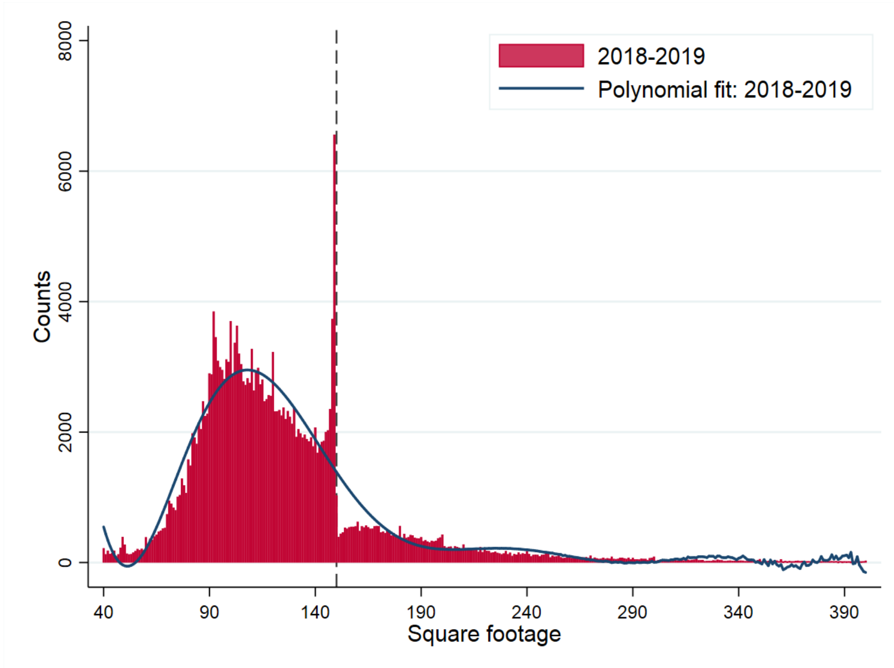


Figure B.3: **Distribution of the size of newly built units, after the 2017 reform** The figure plots the distribution of the square footage (*SDP*) of new units with approved building licenses from 2018 to 2019 in the Sit@del data. The histogram corresponds to the counts of units in each square meter bin, while the solid line plots a polynomial fit of order 10 excluding the manipulation range, according to the methodology defined in section 3.

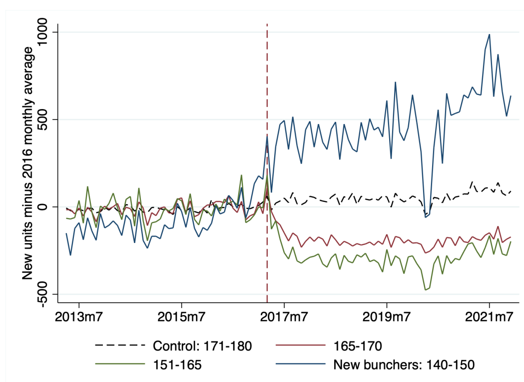


Figure B.4: **Impact of the 2017 reform on the size distribution for new units** The figure plots the impact of the 2017 lowering of the *ART* from 170 square meters to 150 square meters for the absolute number of new units built in four size categories: former likely non-bunchers in new bunching region (150-164), former likely bunchers (165-170), new bunchers (140-150), and control (171-180), in the Sit@del data.

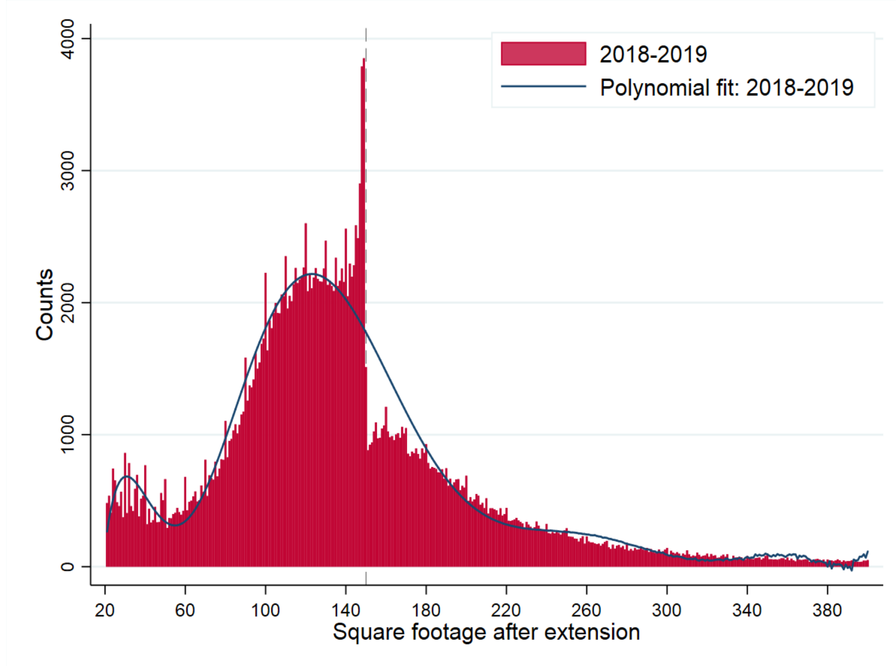


Figure B.5: **Distribution of the size of completed units for extensions, 2018-2019** The figure plots the distribution of the square footage (*SDP*) of completed units after extension projects, from 2018 to 2019 in the Sit@del data. The histogram corresponds to the counts of units for which the size of the completed, post-extension dwelling falls in each square meter bin in the 2018-2019 period, while the solid line plots a polynomial fit of order 10 excluding the manipulation range, according to the methodology defined in section 3.

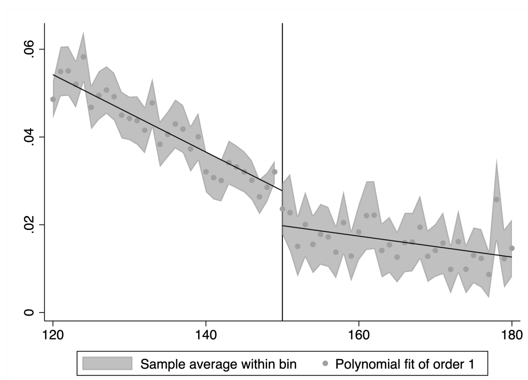
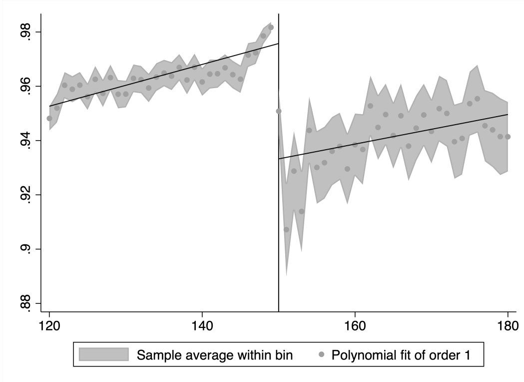
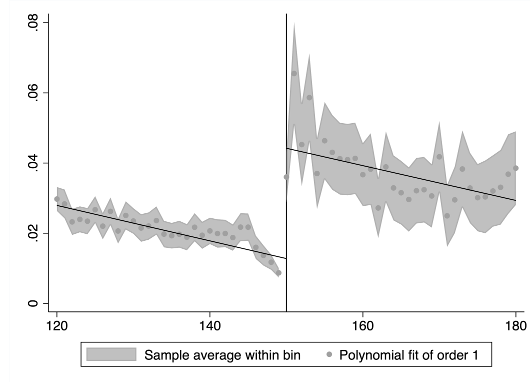


Figure B.6: **Share with means-tested zero-interest loans** The figure plots the share of households who received a means-tested zero interest loan for their construction project, for each bin of square footage of new units, after the threshold was lowered to 150 square meters, in the Sitadel data.



(a) Filer is an individual



(b) Filer is a developer

Figure B.7: **Household characteristics around the threshold, post-2018** The figure plots the share of households who file by themselves (left panel) and the share resorting to a developer, for each bin of square footage of new units, after the threshold was lowered to 150 square meters, in the Sitadel data.

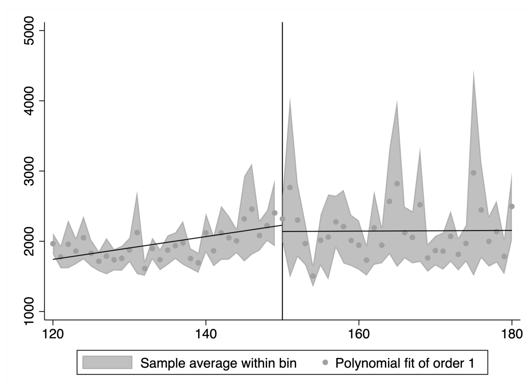


Figure B.8: **Average lot area** The figure plots the average land area of construction projects, for each bin of square footage of new units, after the threshold was lowered to 150 square meters, in the Sitadel data.

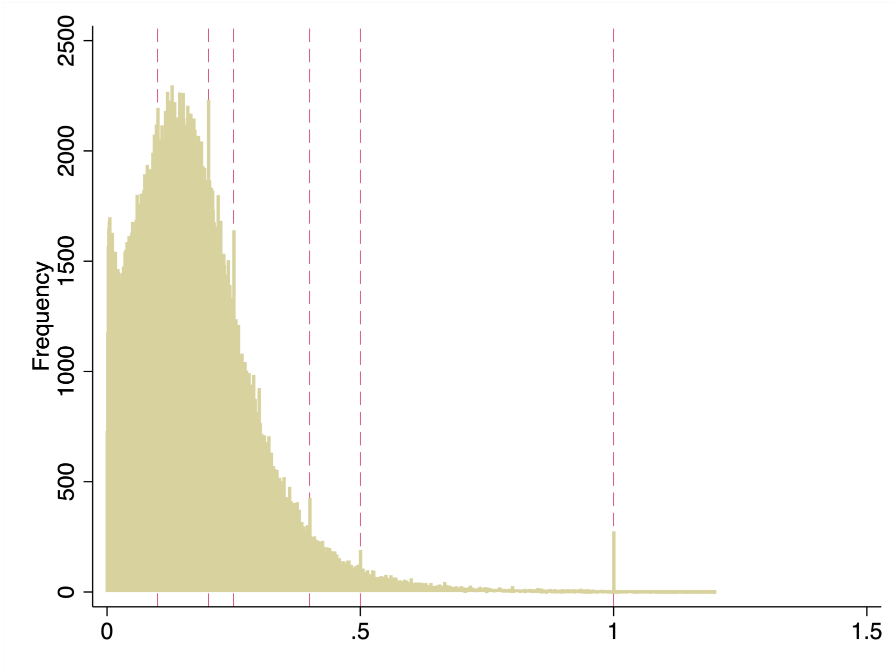


Figure B.9: **Distribution of the built-area ratio of new units, 2018-2019** The figure plots the distribution of the ratio of the square footage (*SDP*) to lot area for new units, from 2018 to 2019 in the Sit@del data. The histogram corresponds to the counts of units in each 0.001 width bin, while the vertical bars document common local binding built-area maximum ratios (0.1, 0.2, 0.25, 0.4, 0.5).